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## Automated Conversion of Text Instructions to Human Motion Animation

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# AUTOMATED CONVERSION OF TEXT INSTRUCTIONS TO HUMAN MOTION ANIMATION

A Thesis

Submitted to the Graduate Faculty of the  
Louisiana State University and  
Agricultural and Mechanical College  
in partial fulfillment of the  
requirements for the degree of  
Master of Science

in

The Interdepartmental Program in  
Engineering Science

by  
Ravikumar V. Chimmalgi  
B.S., Louisiana State University, 2011  
August 2015

To my parents Shobha and Vishwanath Chimmalgi

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## **Abstract**

Text to animation is the conversion of textual instructions to animations following and depicting those instructions. Text to animation is important to fields such as crime scene investigation, military special operations and storytelling where text is utilized. It is also useful for physical therapy where a doctor can factor in disability parameters in the 3D models and determine the safest therapy exercises for patients. It can be used in robotics, where robot assistants can be instructed to perform tasks through text instructions. In this research, a system was created to generate 3D animation of workouts from their textual instructions.

An algorithm was developed to generate animation sequences from test cases. The algorithm utilized an animation graph which was created from a training set of 100 workouts with the nodes as postures and the links as animation-clip names along with their action data. The algorithm is designed to find and generate the closest animations available. A testing set of 40 similar workouts was used to test the algorithm and obtain an output of sequence of animations which were later depicted by the Unity Game Engine.

In user evaluations, for 25 of the 40 test workouts, or 62.5% of the test workouts, the animation was determined by the users, to have the same or almost the same human motions as compared to a video of a human performing the workout. Analysis of the 15 workouts that were not similar to the human video (37.5%) showed that their issues can be fixed and the animation search can be improved by training the animation graph on more varieties of the workouts and on different text instructions of the same workouts from different sources.

For 64.5% of the 156 sentences of all the text workouts, the animations were determined to correctly depict the text instructions.

This research provides an initial animation graph and animation library which can be expanded to include more poses and animations from other domains such as yoga or dance. In the future system has the potential to provide users with no 3D modeling/animation expertise, a way to create 3D animations with just texts.

## **Chapter 1: Introduction**

Text-to-scene processing is an emerging field in semantic analysis which tries to infer meaning from text stories (narratives, instructions) to render 2-D or 3-D image and animation of the story. It relies on natural language processing (NLP) techniques to process text which, is then converted into semantic representations for image rendering.

Simple text-to-animation systems have been developed to depict car accident and crime scene reports, simple children's stories, and cooking recipes. In this research, we focus on animation from text describing human motion; specifically, we focus on the domain of physical fitness exercise instructions. In addition to direct potential applications in physical fitness, physical therapy, and work training, the techniques derived here have wider application to all areas of human animation.

### **1.1 Problem Statement**

Existing text-to-scene systems have only focused on coarse motion animation, for instance "walk", "run", or "sit". Finer grained animations of human poses, as well as complex motion sequences, have not previously been addressed.

This research focused on text-based exercise instructions and the depiction of these routines using 3D human models and animations. The scope was limited to body-only exercise routines without the use of exercise equipment.

### **1.2 Objectives**

The major objectives of this research are:

- Identify common position and motion terms in text, and the associated postures and motions for in a 3D human skeleton model. This was limited to the domain of exercise routines.
- Develop an algorithm to map semantics from textual descriptions of human positions and motions to 3D animation.

## Chapter 2: Literature Review

### 2.1 Related Systems

There are several systems at present that do some form of text-animation or text-scene conversion, but none of them are related to human character animation.

#### 2.1.1 WordsEye

WordsEye (Coyne & Sproat, 2001) is a text-scene conversion system which it provides a blank slate where a user can create a picture with words. The user text may consist not only of spatial relations but also actions performed by the objects in the scene. Currently, WordsEye only produces static scenes and does not implement animations. WordsEye has a collection of over 12000 objects that is uses to create a 3D scene from the text. WordsEye is available online at <http://www.semanticious.com/wordseye/>.

In WordsEye, text is initially tagged with a part-of-speech-tagger, and then a dependency representation is obtained from it. A dependency representation is a list of the words in the text showing the words that they are dependent on (heads) and the words that are dependent on them (dependents). The dependency representation is then converted to semantic representation where the entities to be depicted are described as well as the relationships between them. This semantic representation is used to map graphical objects to the entities and depict them accordingly.

The text – “the farmer is next to santa claus. santa claus is on the white mountain range.” – generates the following the scene:



Figure 1: WordsEye Example

#### 2.1.2 Web2Animation

Web2Animation (Shim, Kang, & Kwag, 2009) automatically generates 3D animation from the web text. It focuses on cooking recipes and generates a 3D animation of a character following the recipe. The system first converts the recipe into an XML representation and then automatically integrates it with 3D graphical objects and character animations by leveraging the

recipe ontology. The character animations include only a small fixed set of generic cooking actions such as pouring, stirring, cutting etc.



Figure 2: Web2Animation Example

### 2.1.3 Xtranormal

Xtranormal (<http://www.xtranormal.com/>) is a website which allows the users to create 3D animated scenes using a drag and drop interface. In Xtranormal, the user selects the characters, actions, audio and sets from a list of options and types in the dialogs for the characters. Xtranormal then takes all these information and generates the 3D animations.

### 2.1.4 CarSim

CarSim (Johansson, Williams, Berglund, & Nugues, 2005) is system that creates a 3D animation of car accidents by analyzing chronological event descriptions from accident reports. The system consists of two parts, a linguistic module and scene generator. The linguistic module extracts information for the accident reports and creates a template of information. The scene generator takes the information template as input, graphically renders the entities and animates them. CarSim also uses constraint solving techniques for calculating trajectories of the vehicles involved in the accident.

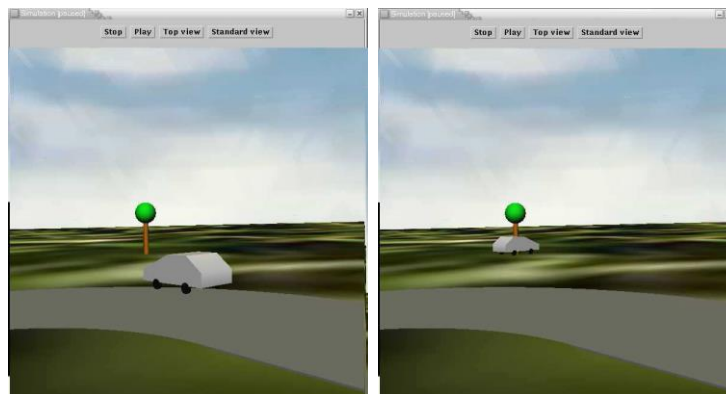


Figure 3: CarSim Example

### **2.1.5 Real-Time Automatic 3D Scene Generator**

Seversky & Yin (2006) developed a new system for automatically generating 3D scenes from voice and text description in real-time. The object placement is determined by spatial relationships which represent spatial terms that can be applied to two or more 3D objects (e.g. mouse *under* horse). The algorithm followed by the system consists of:

1. conversion of 3D polygon to voxelized representation
2. extraction of object's surfaces and partitioning into spatially coherent regions
3. object placement by validating a location from the regions that satisfies the spatial relationship for the objects
4. addition of the objects to the scene

### **2.1.6 Animated Storytelling System via Text**

Sumi & Nagata (2006) describe a system called Interactive e-Hon for helping children understand difficult content in Japanese text. The Interactive e-Hon divides text into parts by using POS taggers and transform natural language into animation by selecting and combining the animations parts from an archive according to the tags. It then generated dialogue from the content and presents it as a conversation between parent and child agents. If concept of a word is not known to the user, with the click of a button, the system using the parent agent explains the difficult concept while simultaneously playing the related animation. The animations generated are simple 2D animations and are intended to explain difficult definitions, concepts, phrases and metaphors to children.

### **2.1.7 Constraint-Based Conversion of Text to Time-based Graphical Representation**

Glass & Bangau (2007) present a method to convert text to a time-based animation using constraints describing entities in a scene. Entities are categorized as area, object (inanimate items), and avatar (characters). Textual timeline and animation timeline are maintained and then trajectories for the animation of entities are calculated. Constraints for each entity animation are formed and solved such that after all the entities are places in a 3D scene, their animations occur according to the timelines within the frame. The animations are simple translational animations and do not involve complex human motions.

### **2.1.8 Text Description to Animation Sequences**

Chua & Lim (1996) implemented a concept-based information retrieval engine to perform text-animation conversion of a printer user manual. Their system uses a frame-based graphical model which handles both information retrieval and graphic hierarchy for rendering and animation. The system uses a dependency-list for each of the printer part objects, where each dependency contains a task-list of all the related tasks along with the current state of the object. The 3D animations generated are of simple motions of printer modules, such as opening the door, removing the tray etc., and it does not involve human motions.

### 2.1.9 Text Generated TV

Hayashi, Bachelder, & Nakajima (2014) present a television system which transmits text-based script representing visual content instead of video data. The television system uses a technology called Text-To-Vision or T2V Player (Hayashi, et al., 2013) which converts text to video through computer graphic animation. In the T2V Player, users can create animations by typing in text in a specific format called Television Making Language (TVML). The main part of the TVML script is speech text and commands for character's movement, camera etc. are placed in a parenthesis. Then TV-like news or talk show is depicted by the T2V Player by using the TVML script and a speech synthesizer. The character animations are limited to the actions involved in character interactions and dialogue, for example actions normally seen on typical TV news program. Actions mostly include facial expressions and simple hands & head movements.



Figure 4: T2V Player

### 2.1.10 Prototype Natural Language Interface for Animation Systems

Inkpen & Kipp (2004) present a prototype implementation of a system which allows a user to issue commands in natural language to a virtual 2D avatar. The system consisted of a parser, a semantic interpreter, and a command interpreter. The parser converts the input text to a parse tree, the semantic interpreter converts the parse tree into a script-like command language and the command interpreter interprets and executes the command language to produce the 2D animation. The following is an example of input and output of the system:

Input: John, walk five steps to the right. Output: walk speed=5 direction=right repetition=5
---



The system uses a simplified avatar (stick figure) for the 2D animations. The 2D animations are translational and do not involve arm and leg movements with only the position of the avatar changing at every frame. The system was only able to process successfully the most predictable sentences. It was not successful in processing ambiguous and variable language used by the user.

## **2.2 Animation Techniques**

Animation techniques can be evaluated by the following criteria (Savenko, 2002):

- *Is it automatic?* It should generate motion automatically and require few specific high level parameters. Only automatic animations can be used for real-time application
- *Is it easy to control?* A method should not require the animator to have special skills
- Does it require additional equipment? Preferably it should not need additional equipment such as a video camera for motion capture.
- Is it general-purpose? It should be able to generate different variations of the same animation and generate the same animation in different settings.
- Does the animation look natural?

There are three animation techniques for generating 3D computer animation; key-frame, motion capture, and procedural (Savenko, 2002).

### **2.2.1 Key-Frame**

In key-frame animation, the starting and the ending frame are specified. An algorithm interpolates all intermediate frames to constitute a smooth animation. For character animation, the animator specifies initial and final joint angles of a skeleton and the in-between postures are interpolated. For more smoothness of the animation, more intermediary frames are keyed in.

One drawback of this technique is that it is very labor intensive as the animator will have to specify frames for all possible animations and keep tweaking them such that the animations seem natural.

### **2.2.2 Motion Capture**

In motion capture techniques, human movements of real actors are captured and then later mapped to a computer model. The motion of joints of the actor is recorded and then the 3D positions are reconstructed. The joints of the computer model are mapped to the corresponding joints of the model obtained from motion capture

With motion capture it is possible to obtain human like motions of the computer models without the use of any bio-mechanics. Drawbacks include expensive equipment, non-real-time, and extensive post-processing

### **2.2.3 Procedural**

Procedural animation is created by an algorithm or a procedure as compared to manually (key-frames) or using measured data (motion capture). But the algorithms can contain key-frames and motion capture methods.

Procedural technique consists of kinematics (time, distance, speed, acceleration) based procedures and dynamics (momentum, force) based procedures to describe motion.

In procedural animation, motions are defined either using goals or parameters. In goal-directed methods usually inverse kinematics or inverse dynamics methods are used to calculate the animations to obtain the goal state. In parametric methods, parameters are used to control aspects of the animation like speed and length.

For real time applications, procedural animation using parametric methods are considered more suitable compared to goal-directed methods. Parametric methods are faster and more reliable and the animator has more control of the animation.

## Chapter 3: Methodology

The methodology for the text-to-animation system consisted of three major phases. In the first phase (Section 3.1 ), using semantic analysis, human motion and position related keywords collectively called as ‘ActionInfos’ were mined and collected from a sample of workout instructions obtained from the internet. In the second phase (Section 3.2 Animation Graph), an adjacency graph called ‘animation graph’ was created, where nodes were human poses and links were the animation-clip IDs. In the third phase (Section 3.3 Animation Collection), animations for all the animation-clip IDs were created. The fourth phase (Section 3.4 Text-to-Animation Conversion System) involved the creation the text-to-animation system itself. The algorithm of the system included the semantic analysis of the input text, determining the sequence of the animation-clips of the motions, and finally rendering the complete animation.

### 3.1 Data Collection & Preprocessing

The website [www.bodybuilding.com](http://www.bodybuilding.com) is a very well-known fitness website which has hundreds of different workouts each with written textual instructions, images of intermediary poses and videos of real humans doing the workout. Body-only workout routines represent a wide range of human motions and also include stretching routines. Body-only workout routines were reviewed and routines with ambiguous instructions or insufficient details were discarded, until 100 body-only workout routines were collected. This collection of workouts was termed as the training set as the animation graph and the animations were created based on these 100 workouts. The text instructions of all the collected workout routines were then imported to a database table after checking for spelling and grammar mistakes.

The Stanford Parser (Klein & Manning, 2003) was then used to semantically analyze the text of the routines to obtain parts-of-speech tags and dependencies. In Natural Language Processing, a dependency is an asymmetric one-to-one relation between a head and its dependents and usually a tensed verb is taken to be the head.

The dependencies of the following workout instruction (Figure 5) are shown in Figure 7:

*“Start off on your hands and knees, then lift your leg off the floor and hold the foot with your hand.”*

Figure 5: Example Workout Instruction

The dependency list consists of the type of relation between the governor and the dependent which is followed by the governor text and dependent text in parenthesis along with position in the input sentence.

```

root(ROOT-0, Start-1)
prt(Start-1, off-2)
poss(hands-5, your-4)
prep_on(Start-1, hands-5)
prep_on(Start-1, knees-7)
conj_and(hands-5, knees-7)
advmod(lift-10, then-9)
conj_and(Start-1, lift-10)
poss(leg-12, your-11)
dobj(lift-10, leg-12)
det(floor-15, the-14)
prep_off(lift-10, floor-15)
conj_and(Start-1, hold-17)
det(foot-19, the-18)
dobj(hold-17, foot-19)
poss(hand-22, your-21)
prep_with(hold-17, hand-22)

```

Figure 6: Dependencies

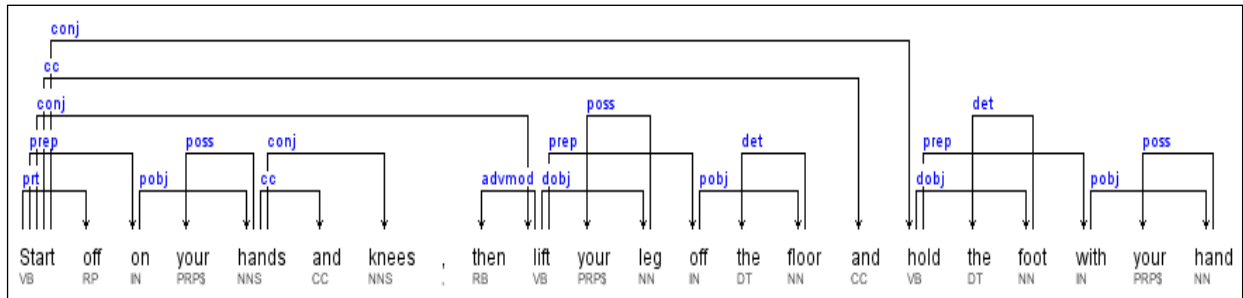


Figure 7: Dependency Graph

The Stanford Parser outputs an XML document for each workout routine which were parsed and saved to a database. The Entity Relationship Diagram (ERD) of the database is displayed in Figure 8. The ‘sentence’ table contained all the sentences. For each sentence, all the dependencies were stored, where ‘dep’ table contained the type of dependency and the ‘governor’ and ‘dependent’ tables contained the governor and dependent texts respectively. Also for each sentence, all the words were tokenized, tagged with parts-of-speech tags and stored in the ‘token’ table along with the word lemma and location in the sentence.

The dependencies were extracted from XML and merged with parts-of-speech (POS) information for the words into a single table for further processing. An example of the merged table, sorted by the dependent text, is shown in Table 1.

C# code was written which parsed through each row of the merged table and for every sentence in a work-out routine, ActionInfos were mined by checking the dependencies and parts-of-speech tags of each word and using if-else rules to handle all the dependency types (Figure 10: ActionInfo Mining Rules). If the sentence had two actions conjugated by an ‘and’, they were treated as two different ActionInfos.

Each ActionInfo consisted of 4 categories:

- ActionVerb (sentence root, verbs)
- ActionNoun (nouns)
- ActionVerbDetail (adverbs, verb modifiers)
- ActionNounDetail (noun related prepositions, adjectives)

While mining ActionInfos, stop words and duplicates were excluded in each category before saving to the database. The ActionInfo class is shown in Figure 9. By using Table 1, ActionInfos mined from the workout instruction in Figure 5 is shown in Table 2.

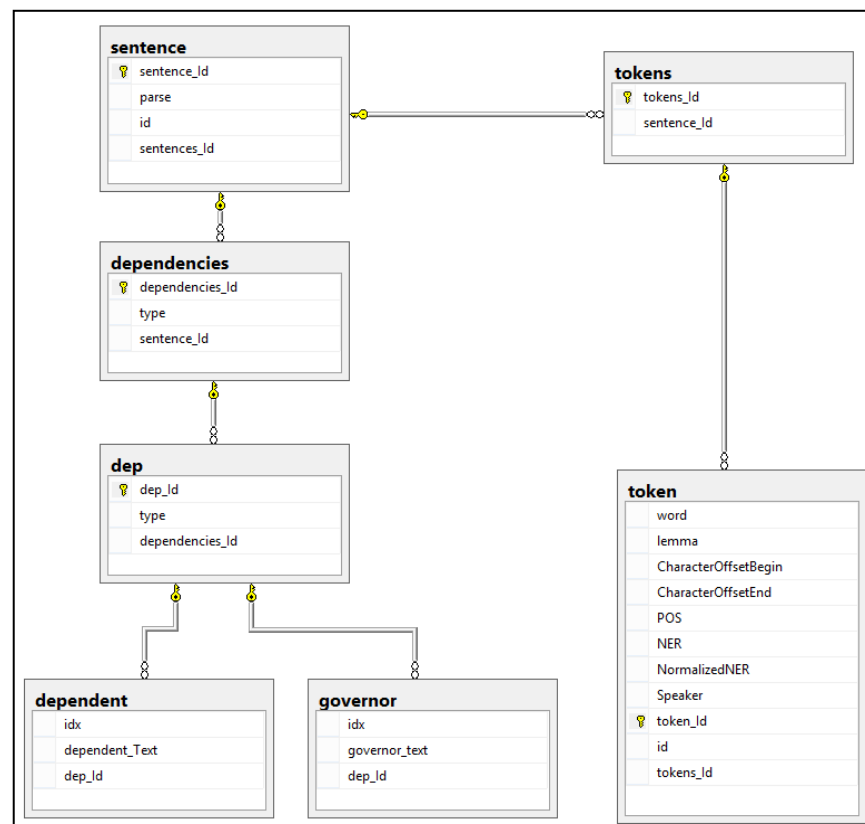


Figure 8: Stanford Parser Output ERD

Table 1: Collapsed Dependencies Example

DepType	Gov_text	Dep_text	Gov_POS	Gov_lemma	Dep_POS	Dep_lemma
root	ROOT	Start			VB	start
prt	Start	off	VB	start	RP	off
poss	hands	your	NNS	hand	PRP\$	you
prep_on	Start	hands	VB	start	NNS	hand
conj_and	hands	knees	NNS	hand	NNS	knee
advmod	lift	then	VB	lift	RB	then
conj_and	Start	lift	VB	start	VB	lift
poss	leg	your	NN	leg	PRP\$	you
dobj	lift	leg	VB	lift	NN	leg
det	floor	the	NN	floor	DT	the
prep_off	lift	floor	VB	lift	NN	floor
conj_and	Start	hold	VB	start	VB	hold
det	foot	the	NN	foot	DT	the
dobj	hold	foot	VB	hold	NN	foot
poss	hand	your	NN	hand	PRP\$	you
prep_with	hold	hand	VB	hold	NN	hand

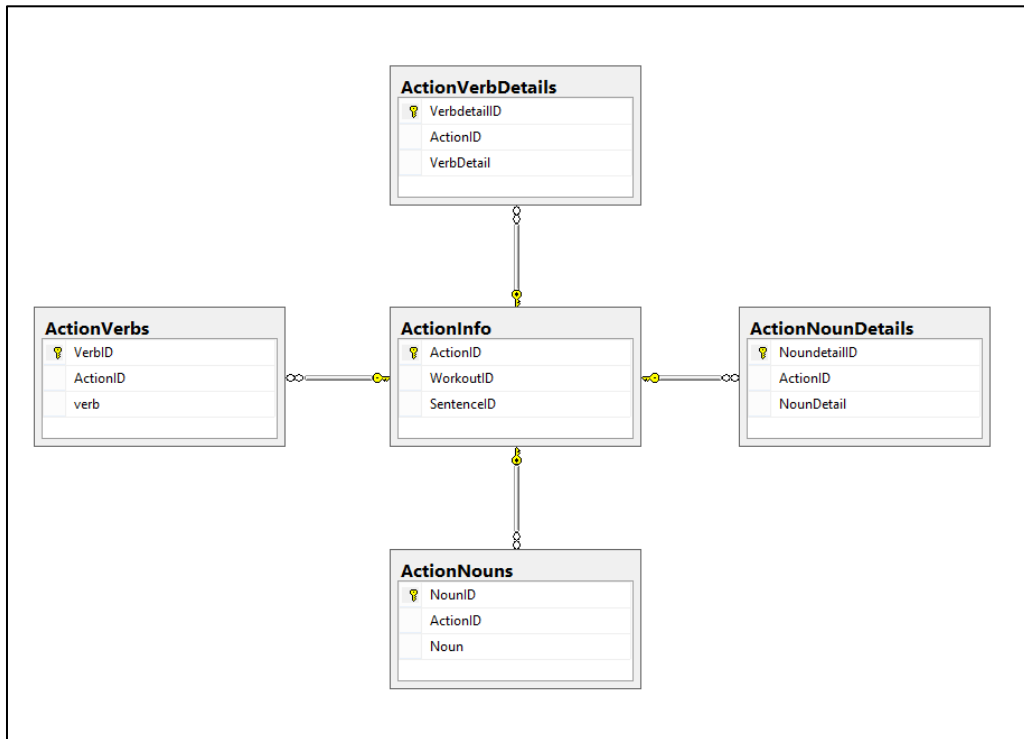


Figure 9: ActionInfo Class

```

FOR each dependency in a sentence{
  IF (dependency is root) THEN add dependent to ActionVerb
  IF (dependency is Prepositional Compliment, Open Clausal Compliment, Clausal Compliment, Clausal Subject, OR
  Dependent)
  {
    IF (dependent is Verb) THEN add dependent to ActionVerb
    IF (dependent is Particle) THEN add dependent to ActionVerbDetail
    IF (dependent is Noun) THEN add dependent to ActionNoun
    IF (dependent is Adjective) THEN add dependent to ActionNounDetail
  }
  IF (dependency is Direct Object, Preposition Object, Nominal Subject, Noun, OR Passive Nominal Subject)
  {
    IF (dependent is Noun) THEN add dependent to ActionNoun
  }
  IF (dependency is Adverbial Clause Modifier, Verb Particle, Adverb Modifier, Verb Modifier, Negation, OR Adjectival
  Complement)
  {
    IF (dependency type is Verb Modifier AND dependent is Verb) THEN add dependent to ActionVerb
    ELSE add dependent to ActionVerbDetail
  }
  IF (dependency is Preposition)
  {
    IF (governor is Verb) THEN add dependent to ActionVerbDetail
    IF (governor is Noun) THEN add dependent to ActionNounDetail
  }
  IF (dependency is Preposition_xyz OR Preposition Clausal Modifier_xyz)
  {
    IF (governor is Verb) THEN add xyz to ActionVerbDetail
    IF (governor is Noun) THEN add xyz to ActionNounDetail
    IF (dependent is Verb) THEN add dependent to ActionVerb
    IF (dependent is Noun) THEN add dependent to ActionNoun
    IF (dependent is Cardinal Number) THEN add dependent to ActionNounDetail
  }
  IF (dependency is Quantifier Phrase Modifier AND governor is Cardinal Number) THEN add governor to
  ActionNounDetail
  IF (dependency is Determiner, Adjectival Modifier, OR Relative Clause Modifier) THEN add dependent to
  ActionNounDetail
  IF (dependency is Numerical Modifier) THEN add governor to ActionNoun AND add dependent to ActionNounDetail
  IF (dependency is Agent AND dependent is Noun) THEN add dependent to ActionNoun
  IF (dependency is Conject_or AND dependent is Verb) THEN add dependent to ActionVerb
  IF (dependency type is Conject_and)
  {
    IF ((dependent AND governor are Noun) OR dependent is Adverb)
    {
      IF (dependent is Adverb) THEN add dependent to ActionVerbDetail
      ELSE add dependent to ActionNoun
    }
    ELSE IF (governor is Adverb AND dependent is Noun) THEN add dependent to ActionNoun
    ELSE IF (governor is Adverb AND dependent is Preposition) THEN add dependent to ActionVerbDetail
    ELSE IF (dependent is Adjective) THEN add dependent to ActionNounDetail
    ELSE (new ActionInfo as two verb phrases are conjugated with an 'and')
  }
}

```

Figure 10: ActionInfo Mining Rules

Table 2: ActionInfos from Table 1

SentenceID	ActionID		
1	1	Verb:	start
		VerbDetail:	off on
		Noun:	hands knees
		NounDetail:	
1	2	Verb:	lift
		VerbDetail:	off
		Noun:	leg floor
		NounDetail:	
1	3	Verb:	hold
		VerbDetail:	
		Noun:	foot hand
		NounDetail:	

### 3.2 Animation Graph

While manually parsing through the 100 training workout routines and the ActionInfos, an adjacency graph (‘animation graph’) was created. In the animation graph, the nodes are poses, and links are the animation-clips IDs that cause the pose transitions. The graph is composed of 213 nodes and 354 animation-clips (Appendix D: Animation Graph Nodes & Animation-Clips). The animations and poses of the workouts were determined by watching the videos associated with the training workouts and pausing after every action, as well as personally enacting the motions specified. Different ActionInfos of the same motions across different workout routines were added to a list and mapped to a single animation-clip id. Therefore every link contains a list of ActionInfos. An example of the animation graph is shown in Figure 11. ActionInfos of sentences regarding breathing, negations like ‘do not do this’, and non-action statements such as ‘your leg should be straight’ were ignored while creating the graph as they are not motion related. In the example, ‘GetOnHandsKnee’ is the ID of an animation-clip which causes the 3D model to get into the prone position on the knees (ProneOnKnees). From ‘ProneOnKnees’ the 3D model can get to any of the next poses with the corresponding animation-clips. The full animation graph is shown in the appendix. (Appendix C: Animation Graph)



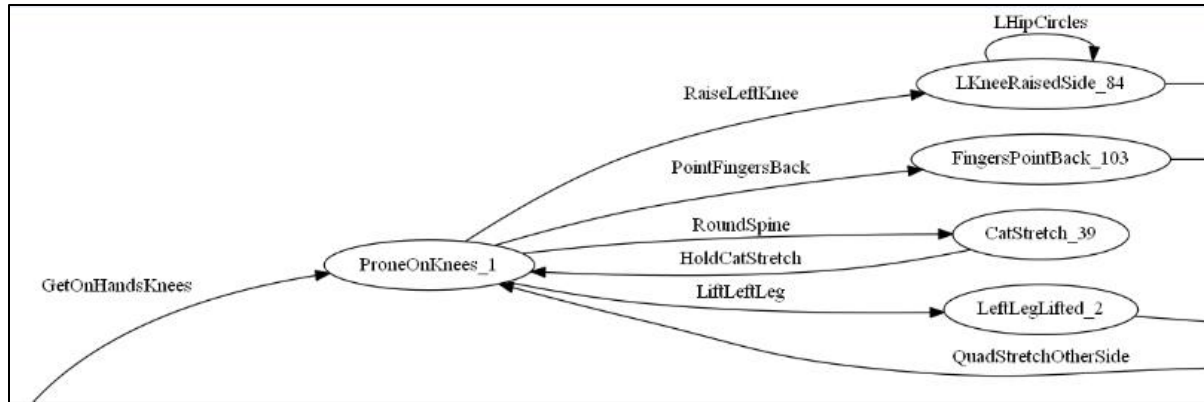


Figure 11: Animation Graph

### 3.3 Animation Collection

Animations for each animation-clip ID in the animation graph were created by using the key-frame technique with the software called Autodesk Maya.

#### 3.3.1 3D Models

To create the animations, two human models were used; a male and a female. The models were created with Adobe Mixamo, a 3D character creation software, and were obtained from the online Unity Asset Store ([www.assetstore.unity3d.com](http://www.assetstore.unity3d.com)). Both models have 90 joints each and all the major human joints and bones are in a hierarchy. The hierarchy of the female model in Figure 12 is shown in Figure 14.



Figure 12: Female 3D Model



Figure 13: Male 3D Model



Figure 14: Bone Hierarchy

### 3.3.2 Animations & Animation Clips

While exploring procedural animation using parameters, it was found that it was rather difficult to control, manipulate and adjust the animations, especially the complex ones, so that the motions are realistic and human-like. Therefore key-frame animation technique (2.2.1 Key-Frame) was used to generate the animations.

The animations for all animation-clip IDs were created in Autodesk Maya. For each animation-clip ID, the motions and poses were determined by analyzing the animation graph as well as the referring to the videos associated with the training workouts. The animations were manually edited and tuned so that they were similar to the human videos of the workouts and the motions were as human-like as possible. Appendix D: Animation Graph Nodes & Animation-Clips shows all the node poses of the animation graph and the animation-clips between them.

While creating the animations, multiple animations were saved in the same Maya files and the start & end frames of the animation-clips were noted. The Maya files were then imported to the game development software called Unity3D. In Unity3D the animations were split into the animation-clips according to the frame numbers. The names of the animation-clips in Unity were consistent with the animation graph.

### **3.4 Text-to-Animation Conversion System**

The Text-to-Animation Conversion System follows the process flow as shown in Figure 15. When the input text is provided, it runs semantic analysis and for each action and obtains ActionInfos. For each ActionInfo, by calculating and selecting the highest MatchScore of all the animations originating from the current node, the animation graph is traversed and a sequence of animation-clips names is obtained. This sequence of animation-clips is then played in Unity.

#### **3.4.1 Semantic Analysis**

Using the same procedure as for the initial 100 training workout routine texts (documented in Section 3.1 Data Collection & Preprocessing), input texts are first processed by the Stanford Parser and then ActionInfos are mined from the dependencies.

#### **3.4.2 MatchScore**

After obtaining the ActionInfos of the input texts, for each input ActionInfo, a MatchScore was calculated with each link available from the current node position. The link which provided the highest MatchScore was selected as the correct animation-clip. To calculate the MatchScore, a form of bag-of-words approach was used. First the number of common words in each category of the two ActionInfos (the input ActionInfo and the graph-ActionInfo) were counted and then added together. The final match count is then divided by the average number of words in both ActionInfos. The match count is divided by the average so that the sizes of the ActionInfos do not influence the MatchScore.

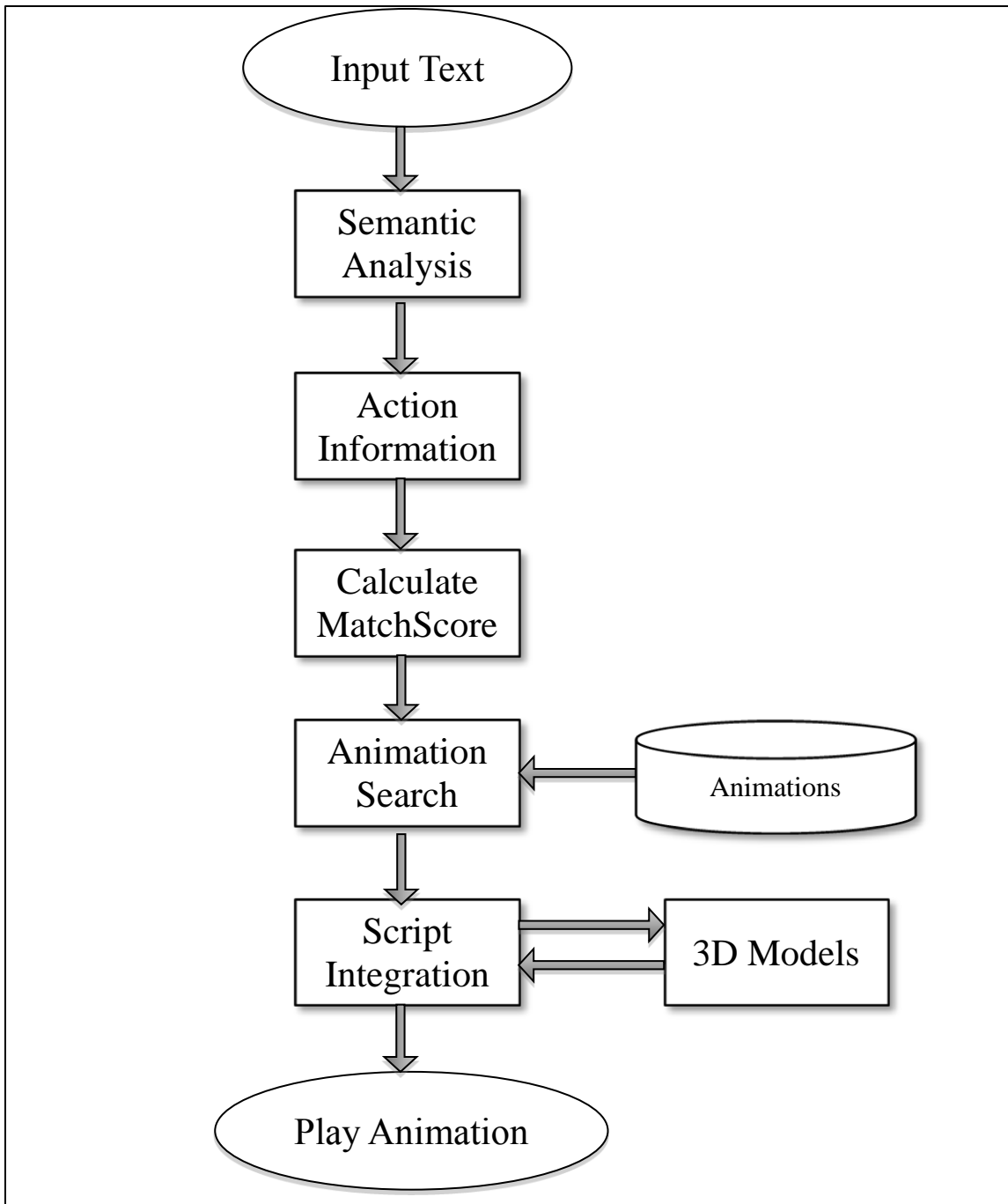


Figure 15: System Process Flow Chart

```

Matchscore = 0
if (there is at-least 1 common noun){
for each available link from current node position,
    {
        for each actioninfo associated with the link
            {
                count = total number of words in graph-actioninfo
                input count = total number of words in input-actioninfo
                if (input-actioninfo contains at-least one verb and one noun)
                    {
                        match count = number of common verbs + nouns + noundetails + verbdetails
                        tempscore = match count/((count + inputcount)/2)
                    }
                if tempscore > matchscore
                    = tempscore
            }
        return matchscore
    }
}

```

Figure 16: Calculating MatchScore

### 3.4.3 Animation Graph Search

The starting node for the animation graph is always the idle standing position. From the starting position, for each ActionInfo of an input workout, the MatchScore was calculated for all the available links. A threshold value was set and all the links with MatchScore less than the threshold were ignored so that the wrong animation is not selected because of few common words. A threshold value of 0.1 was found to give the best results while testing with the test workout routines. The link with the highest score was selected and the position was updated to its destination. After processing all the input ActionInfos, the names and order of the animation-clips is obtained from the link sequence. This list of names of the animation-clips is then used by the Unity3D program to fetch the corresponding animations and blend them together into a single continuous animation using the 3D models.

During initial testing, it was observed that in some cases, the link with the highest MatchScore lead to a dead-end situation, in which case the MatchScores for all the next possible links were zero, but the link with the second highest score found the right sequence of animations. Therefore a feature was added to the search algorithm that in case of a dead-end, it traversed one node back and selected the second best animation and continued searching for subsequent animations from there on.

This situation is depicted in Figure 17, where the right sequence is 1-2-3, but since link A has the highest score, link A is selected which leads to node 4. At node 4, the search will stop as there is

no link between 4 and 2. This is resolved if traversed back to node 1 and link C (second highest score) is selected.

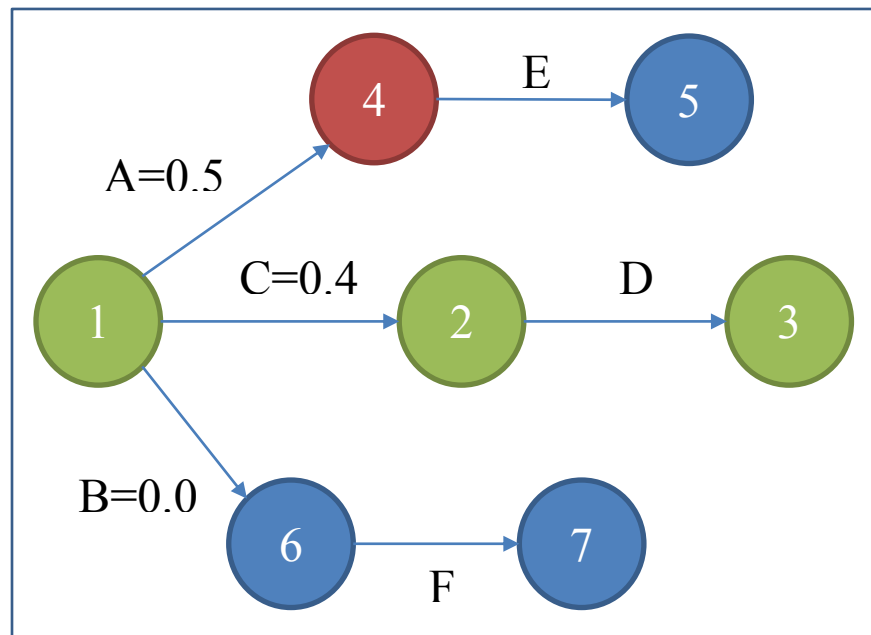


Figure 17: Dead End Example 1

In some other cases, the traversal came to a dead-end due to an extra step present in the animation graph which was not present in the input text. So in order to continue, it was necessary to skip the intermediary node to check if indeed there was an extra step in the graph. For such cases, a look ahead functionality was added to the search algorithm to look a step ahead if it is at a dead-end and when the animation was found, the intermediary nodes were interpolated. In such cases the closest animation is obtained if not the exact.

For example in Figure 18, if input text was 'Raise both hands. Lower both hands' the search will get stuck at node 2 as it is looking for 'Lower both hands' but only 'Touch your head' is available. This is resolved by looking ahead and seeing that 'Lower both hands' is available at node 3. Therefore 'Touch your head' is interpolated and accepted in the search results.

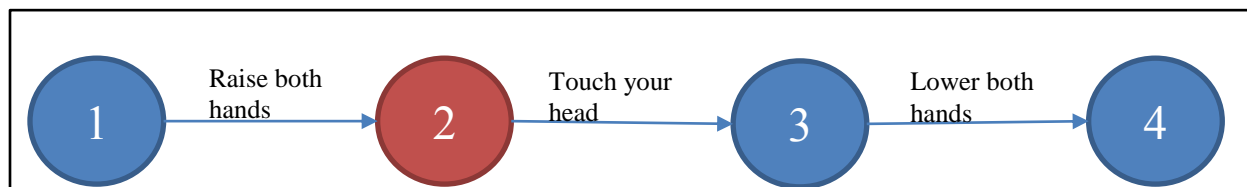


Figure 18: Dead End Example 2

### 3.4.4 Synonyms

During initial testing of the system, it was observed that in some of the cases the animation-graph search was not able to find the right animations-clips for some of the texts due to the usage of synonyms. Since the search algorithm uses a form of bag of words approach, adding blanket synonyms to all the ActionInfos will increase the number of words and influence the MatchScore. Therefore only the most common, obvious and human motion related synonyms were added to all the animation-graph and testing ActionInfos.

### 3.4.5 Unity3D Animation

Unity3D through its Mechanim Animation Model allows the implementation of animation state machines. In the state machines, the states are the animation-clips and the links are the transition between one animation-clip to another. In Figure 20, the more the state 0 and state 1 overlap, the transition between their animations will be more blended and smooth. The Animator component of Mechanim allows smooth transition between animations by overlapping and blending the animation-clips. An example of the Animation State Machine is shown in Figure 19.

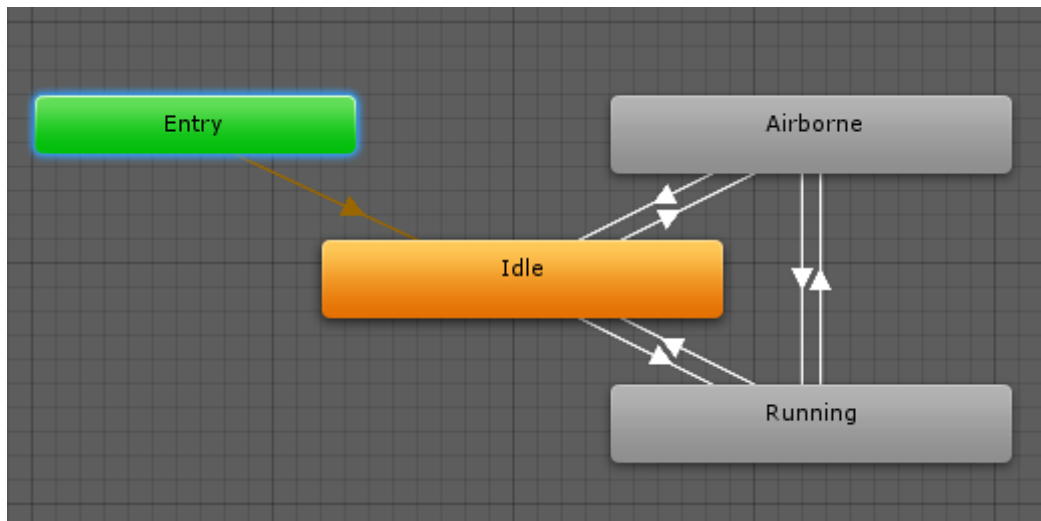


Figure 19: Unity Animation State Machine Example

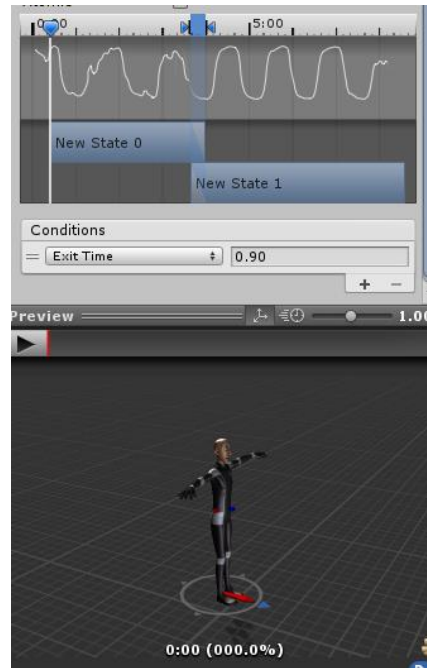


Figure 20: Animation Transition

An Animation State Machine was created using the animation-clips created in section 3.3.2 Animations & Animation Clips. Boolean triggers for the clips were set according to the unique animation-clip names used in the animation graph. After obtaining the sequence of animation-clip names from the animation graph search, the Boolean triggers are fired in that sequence and the animation-clips are played.

The Mechanim model also provides a feature of Avatars, which allows the reuse of the animations on any similar 3D model. While the 3D models are being animated, the user can move around the models and view them from different angles.



## Chapter 4: Results and Analysis

The performance of the text to animation system was analyzed testing it with 40 test workout routines (Appendix B: Testing Workout Routines). The workout routines were manually collected from the internet with the constraint that the motions of the workouts were available in the animation graph. The text instructions of the test workout routines were manually processed for spelling & grammar mistakes and non-motion statements were deleted. After processing, the test ActionInfos were mined and the animation graph traversed to find the animation sequence. The animation sequence was then rendered in Unity3D.

An ideal text-to-animation system would be one which generates animations mimicking realistic human motions described in the text. To evaluate the text-to-animation system, a web application (Figure 21) was created to ask users to observe the output animation and provide feedback by answering a Likert scale based questionnaire. The Likert survey was of a six-level format: Strongly disagree, Disagree, Somewhat Disagree, Somewhat Agree, Agree, and Strongly Agree.

On the web application, each user was first asked to register by providing some information on a form. The user was asked for his/her age group, gender, profession / area of expertise, if they exercised regularly and what type of exercise they did the most. The web application randomly showed workout animations to the users such that every test workout was surveyed at least 5 times. The users were able to observe the workout animations, and compare the animation with the video of a human performing the workout. The users were also asked to observe the animations for each sentence and compare with the corresponding text. Instructions provided on the web application are shown in Figure 22.

For each test workout, after observing the 3D animation and video of real human video, the user rated the following statements:

- The animation depicts realistic human motions
- The animation is similar to the video
- The animation is easy to comprehend and follow

For each sentence of a workout, after observing the text and corresponding animation clip, the users rated the statement:

- The animation depicts the text instruction.

The users were not asked for any open-ended comments.

### 4.1 User Profiles

There were a total of 30 users who participated in the online survey. The users were from various backgrounds and age groups. Out of the 30 users, 11 were female, 19 were male and 20 of the 30 users said they exercised regularly (Table 3 & Table 4). The users were of a diverse range of age groups but majority of them (63.33%) were aged between 25 and 34 years. The age group

statistics is shown in Table 5. The users were of diverse areas of expertise, Table 6 shows user area of expertise statistics. Table 7 shows the exercise preferences of the users, and majority of them chose running followed by stretching/body only exercises as their most preferred.

Table 3: User Gender Ratio

<b>Gender</b>	<b>#</b>	<b>%</b>
Male	19	63.3
Female	11	36.7

Table 4: User Exercise Habit

<b>Regular Exercise?</b>	<b>#</b>	<b>%</b>
Yes	20	66.7
No	10	33.3

Table 5: User Age Groups

<b>Age</b>	<b>#</b>	<b>%</b>
18-24	5	16.7 %
25-34	19	63.3 %
35-44	3	10 %
45-55	1	3.3 %
55+	2	6.7 %

Table 6: User Area of Expertise

<b>Expertise</b>	<b>#</b>	<b>%</b>
Art	3	10 %
Business	5	16.7 %
Biochemistry	1	3.3 %
Biomedical	1	3.3 %
Engineering	5	16.7 %
English	1	3.3 %
IT	8	26.7 %
Kinesiology	1	3.3 %
Management	2	6.7 %
Math	2	6.7 %
Psychology	1	3.3 %

Table 7: User Exercise Preference

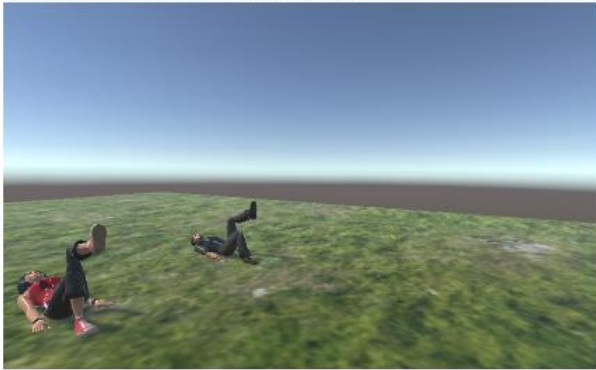
Exercise Type	#	%
Aerobics	3	10 %
Boxing/Martial Arts	2	6.7 %
Cycling	1	3.3 %
Running	8	26.7 %
Sports	3	10 %
Stretching/Body only	6	20 %
Weight Lifting	2	6.7 %
Yoga	1	3.3 %
Zumba/Dancing	1	3.3 %
None	3	10 %

[Text to Animation](#)
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[Consent Form](#)
[Contact](#)
[Begin Evaluation](#)
[Register](#)
[Log in](#)


Instructions: Observe the exercise animation on the left by using the arrow keys on your keyboard to move around and using your mouse to look around. Compare the Exercise Animation on the left to the Exercise Video on the right and rate the following statements.

Unity Web Player | TextTo Animation

Exercise Simulation




Exercise Video



	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
The animation depicts realistic human motions.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The animation is similar to the video on the right.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The animation is easy to comprehend and follow.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Instruction: Compare the Exercise video on the left to the text instruction on the right and rate the following statement.

workout4



Lie on your back with your knees bent and your feet flat on the floor

Figure 21: Web Application

Instructions: Observe the exercise animation on the left by using the arrow keys on your keyboard to move around and using your mouse to look around. Compare the exercise animation on the left to the exercise video on the right and rate the following statements.

Instruction: Compare the exercise video on the left to the text instruction on the right and rate the following statement.

Figure 22: Web Application Instructions

## 4.2 Test Results

During result analysis, it was observed that 4 of the users were biased and had an always positive answering method. This bias could be due to either their impatience or their concern for the researcher's graduation. The results of those 4 users were considered as outliers and removed from further analysis. They were excluded from the user statistics (4.1 User Profiles) and more users were recruited in their stead. For each of the survey statement results, the responses were given numerical values (Strongly Disagree – 1, Strongly Agree – 6) and scored. Raw survey results can be found in Appendix F: Survey Data.

### 4.2.1 Statement 1: The animation depicts realistic human motions.

For statement 1, there were 336 responses. Table 8 shows the frequency distribution of the responses. The mode of all the responses for Statement 1 was 'agree'.

Table 8: Statement 1 Frequency Distribution

Category	Frequency	%
strongly agree	120	35.7 %
agree	129	38.4 %
somewhat agree	53	15.8 %
somewhat disagree	21	6.3 %
disagree	9	2.7 %
strongly disagree	4	1.2 %

Table 24 (Appendix G: Survey Statement Scores) shows composite and average scores of the responses for statement 1 for each test workout. For all 40 test workouts, the average minimum score was 3.6, the average maximum score was 5.7 and the average score was 4.9 (Table 9). The averages were computed across all responses for each workout id. On average, the respondents 'agreed' to the statement that the animations depicted realistic human motions.

Table 9: Statement 1 Scores Summary

Average Min Score	3.6
Average Max Score	5.7
Average Score	4.9

#### 4.2.2 Statement 2: The animation is similar to the video.

For statement 2, the frequency distribution of the 336 responses is shown in Table 10. The mode of all the responses for Statement 1 was ‘somewhat agree’.

Table 10: Statement 2 Frequency Distribution

Category	Frequency	%
strongly agree	55	16.4 %
agree	79	23.5 %
somewhat agree	83	24.7 %
somewhat disagree	49	14.6 %
disagree	46	13.7 %
strongly disagree	24	7.1 %

Table 25 (Appendix G: Survey Statement Scores) shows composite and average scores of the responses for statement 2 for each test workout. For all 40 test workouts, the average minimum score was 1.9, the average maximum score was 5.6 and the average score was 3.9 (Table 11). The averages were computed across all responses for each workout id. On average, the respondents ‘somewhat agreed’ to the statement that the animations were similar to the human videos.

Table 11: Statement 2 Scores Summary

Average Min Score	1.9
Average Max Score	5.6
Average Score	3.9

#### 4.2.3 Statement 3: The animation is easy to comprehend and follow.

For statement 2, the frequency distribution of the 336 responses is shown in Table 12. The mode of all the responses for Statement 1 was ‘agree’.

Table 12: Statement 3 Frequency Distribution

Category	Frequency	%
strongly agree	114	33.9 %
agree	163	48.5 %
somewhat agree	40	11.9 %
somewhat disagree	5	1.5 %
disagree	10	3 %
strongly disagree	4	1.2 %

Table 26 (Appendix G: Survey Statement Scores) shows composite and average scores of the responses for statement 3 for each test workout. For all 40 test workouts, the average minimum score was 3.9, the average maximum score was 5.6 and the average score was 5.1 (Table 13). The averages were computed across all responses for each workout id. On average, the respondents ‘agreed’ to the statement that the animations were easy to comprehend and follow.

Table 13: Statement 3 Scores Summary

Average Min Score	3.9
Average Max Score	5.6
Average Score	5.1

#### 4.2.4 Statement 4: The animation depicts the text instruction.

For Statement 4, there were 1312 responses in total for the 156 sentences of the 40 test workouts. The frequency distribution of the responses is shown in Table 14. The mode for the responses for statement 4 was ‘agree’.

Table 14: Statement 4 Frequency Distribution

Category	Frequency	%
strongly agree	282	21.5 %
agree	323	24.6 %
somewhat agree	242	18.4 %
somewhat disagree	124	9.5 %
disagree	116	8.8 %
strongly disagree	225	17.1 %

Scores for statement 4 can be found in Table 27 (Appendix G: Survey Statement Scores). For all 156 sentences, the average minimum score was 1, the average maximum score was 5.8 and the average score was 3.9 (Table 15). The averages were computed across all responses for each sentence id. The sentences with a 100% strongly disagree responses were due to the cases when the algorithm was not able to find an animation and so no animation was played. On average, the respondents ‘somewhat agreed’ to the statement that the animations depicted the text instructions.

Table 15: Statement 4 Scores Summary

Average Min Score	1
Average Max Score	5.8
Average Score	3.9

### 4.3 Discussion

Even if the algorithm didn’t the correct animation sequence for all the test workouts, the users rated almost all the test workout animations to be human-like and easy to follow and understand. This indicates that the system has succeeded in the goal of generating human-like motion animations with smooth transitions.

15 test workout animations had either a significant ‘strongly disagree’ responses or had an average score of 3 or less for the statement that the animation is similar to the human workout video. Further analysis on these 15 test workouts is as follows-

- Test Workout 3: The test workout starts off with standing and hands behind the head. The similar workout in training set starts off with hands by the side. Since the workout animation sequence is not available with hands behind the head, the algorithm selects the best animation-clips according to MatchScore and ends up selecting the wrong clips.

Possible solution is to either create and add animations of the same workout but with the hands behind head to the graph, or add a node for the hands behind head pose to the existing graph but with no extra animations, so that at the least it will find and play the similar workout.

- Test Workout 6: The first sentence in the workout is “Lie flat on the floor with the knees bent.” In the training set, most of the similar sentences explicitly instructed to bend the knees. This sentence has never been seen by the system before, so the highest MatchScore is obtained and LieDown is selected and not LieDownBendKnees. Because of this, the subsequent animation-clips selected are incorrect.

The solution is to train the system on more text instructions, so that the right animation-clip has the highest MatchScore.

- Test Workouts 11, 13, 19, 28, 31: Just as in workout 6, for these test workouts, the algorithm couldn't find all the animation-clips for the first sentence due to system never having seen such a sentence before. Due to this the graph doesn't have the ActionInfo to be able to find the right animation-clips.
- Test Workouts 22, 33, 34: The workouts involves, bending of the knees after bringing arms by the head, whereas in the animation graph, following the path of a similar workout, bending of knees comes before bringing the arms by the head. Due to this the algorithm lost track of the right sequence and ended up playing parts of different workout routines.

A possible solution would be to create the necessary links so the right sequence is attainable and depend on Unity to blend the disjoint animation-clips and make the transition as smooth as possible.

- Test Workout 24: In this case, the animation graph had the required animations, but it did not have the required links. Therefore, the order of the animation-clips could not be attained with the current graph. Training the animation graph on a wide variety of workouts can solve this issue.
- Test Workout 26: In this case, the animation graph had the required animations and well as the right sequence, but the sentences used to describe the workout are much different from the training set sentences. Training the animation graph on different text instructions of the same workouts can solve this issue.
- Test Workout 29: In this case, half of the animation-clips were not in the animation graph. The algorithm found the right sequence of the available animation-clips and found the closest animation-clip at the end before hitting a dead-end.
- Test Workout 30: In sentence 2 of this workout, the algorithm tries to find an animation for the part "finishing the movement by squeezing your butt." This instruction is not an explicit motion instruction and the animation-clip corresponding to the first part of the sentence follows this instruction. Because of the wrong selection of animation-clip, the subsequent animation-clips are wrong. This can be fixed by deleting texts of the non-explicit motion instructions.



- Test Workout 35: This workout is a variation of the dead-bug workout from the training set. But, the starting position and movement of the hands are different in both the workouts. Therefore this case is similar to workout 3.

The results indicate that it is possible to improve the accuracy of the system, as the problems encountered in the failed test workout animations appear to be solvable.

## **Chapter 5: Conclusion and Future Research**

The text-to-animation system was successful in many test cases. The system was not able to search the right animations for all the test cases for a same workout obtained from multiple sources. The search algorithm will further improve if the system is trained on multiple versions of each of the 100 training workout obtained from different sources. The more text instructions the system is trained on and the graph populated with, the better it will be in searching for the right animation. More exhaustive human-motions related synonyms will be needed for new test cases.

Some of the animations were not perfectly human-like, as a great level of skill and amount of time is required to make the complex motions human-like. For future animation generation, Motion Capture technique of animation generation is recommended as it is faster and more efficient. It would allow for the scaling up of the system to other human physical motion domains such as dancing, yoga, martial arts etc. much quickly.

In the future, after training the system on more workout routines, the animation graph is imagined to be crowded with ActionInfos and pose nodes. A possible way to more accurately search for animations, would be that at every node all possible further paths can be recursively processed and MatchScore added up into a Path Score. So at every node, a Path Score table is generated, and the animation-clip that allows the greatest Path Score can be selected as the next animation-clip.

Another way to search for animations would be by using a Bayesian Probabilistic approach.

After scaling up the system to other domains and when a reasonable accuracy is achieved, the system can be integrated into a standalone Unity3D application and published on the internet for the public where users can enter texts instructions and animations are generated spontaneously.

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## Appendix A: Training Workout Routines ([www.bodybuilding.com](http://www.bodybuilding.com))

Table 16: Training Workout Routines

#	Name	Text
0	All Fours Quad Stretch	Start off on your hands and knees, then lift your leg off the floor and hold the foot with your hand. Use your hand to hold the foot or ankle, keeping the knee fully flexed, stretching the quadriceps and hip flexors. Focus on extending your hips, thrusting them towards the floor. Hold for 10-20 seconds and then switch sides.
1	Three Fourth Sit-Up	Lie down on the floor and secure your feet. Your legs should be bent at the knees. Place your hands behind or to the side of your head. You will begin with your back on the ground. This will be your starting position. Flex your hips and spine to raise your torso toward your knees. At the top of the contraction your torso should be perpendicular to the ground. Reverse the motion, going only 3/4 of the way down. Repeat for the recommended amount of repetitions.
2	90-90 Hamstring	Lie on your back, with one leg extended straight out. With the other leg, bend the hip and knee to 90 degrees. You may brace your leg with your hands if necessary. This will be your starting position. Extend your leg straight into the air, pausing briefly at the top. Return the leg to the starting position. Repeat for 10-20 repetitions, and then switch to the other leg.
3	Alternate Heel Touchers	Lie on the floor with the knees bent and the feet on the floor around 18-24 inches apart. Your arms should be extended by your side. This will be your starting position. Crunch over your torso forward and up about 3-4 inches to the right side and touch your right heel as you hold the contraction for a second. Exhale while performing this movement. Now go back slowly to the starting position as you inhale. Now crunch over your torso forward and up around 3-4 inches to the left side and touch your left heel as you hold the contraction for a second. Exhale while performing this movement and then go back to the starting position as you inhale. Now that both heels have been touched, that is considered 1 repetition. Continue alternating sides in this manner until all prescribed repetitions are done.
4	Ankle Circles	Use a sturdy object like a squat rack to hold yourself. Lift the right leg in the air (just around 2 inches from the floor) and perform a circular motion with the big toe. Pretend that you are drawing a big circle with it. Breathe normally as you perform the movement. When you are done with the right foot, then repeat with the left leg.
5	Ankle On The Knees	From a lying position, bend your knees and keep your feet on the floor. Place your ankle of one foot on your opposite knee. Grasp the thigh or knee of the bottom leg and pull both of your legs into the chest. Relax your neck and shoulders. Hold for 10-20 seconds and then switch sides.

6	Arm Circles	Stand up and extend your arms straight out by the sides. The arms should be parallel to the floor and perpendicular to your torso. This will be your starting position. Slowly start to make circles of about 1 foot in diameter with each outstretched arm. Breathe normally as you perform the movement. Continue the circular motion of the outstretched arms for about ten seconds. Then reverse the movement, going the opposite direction.
7	Bent-Knee Hip Raise	Lay flat on the floor with your arms next to your sides. Now bend your knees at around a 75 degree angle and lift your feet off the floor by around 2 inches. Using your lower abs, bring your knees in towards you as you maintain the 75 degree angle bend in your legs. Continue this movement until you raise your hips off of the floor by rolling your pelvis backward. Breathe out as you perform this portion of the movement. Squeeze your abs at the top of the movement for a second and then return to the starting position slowly as you breathe in. Repeat for the recommended amount of repetitions.
8	Body-Up	Assume a plank position on the ground. You should be supporting your bodyweight on your toes and forearms, keeping your torso straight. Your forearms should be shoulder-width apart. This will be your starting position. Pressing your palms firmly into the ground, extend through the elbows to raise your body from the ground. Keep your torso rigid as you perform the movement. Slowly lower your forearms back to the ground by allowing the elbows to flex. Repeat.
9	Bodyweight Squat	Stand with your feet shoulder width apart. You can place your hands behind your head. This will be your starting position. Begin the movement by flexing your knees and hips, sitting back with your hips. Continue down to full depth if you are able, and quickly reverse the motion until you return to the starting position. As you squat, keep your head and chest up and push your knees out.
10	Bodyweight Walking Lunge	Begin standing with your feet shoulder width apart and your hands on your hips. Step forward with one leg, flexing the knees to drop your hips. Descend until your rear knee nearly touches the ground. Your posture should remain upright, and your front knee should stay above the front foot. Drive through the heel of your lead foot and extend both knees to raise yourself back up. Step forward with your rear foot, repeating the lunge on the opposite leg.
11	Bottoms Up	Begin by lying on your back on the ground. Your legs should be straight and your arms at your side. This will be your starting position. To perform the movement, tuck the knees toward your chest by flexing the hips and knees. Following this, extend your legs directly above you so that they are perpendicular to the ground. Rotate and elevate your pelvis to raise your glutes from the floor. After a brief pause, return to the starting position.
12	Butt Lift	Lie flat on the floor on your back with the hands by your side and your knees bent. Your feet should be placed around shoulder width. This will be your starting position. Pushing mainly with your heels, lift your hips

		off the floor while keeping your back straight. Breathe out as you perform this part of the motion and hold at the top for a second. Slowly go back to the starting position as you breathe in.
13	Butt-Ups	Begin a pushup position but with your elbows on the ground and resting on your forearms. Your arms should be bent at a 90 degree angle. Arch your back slightly out rather than keeping your back completely straight. Raise your glutes toward the ceiling, squeezing your abs tightly to close the distance between your ribcage and hips. The end result will be that you will end up in a high bridge position. Exhale as you perform this portion of the movement. Lower back down slowly to your starting position as you breathe in. Repeat for the recommended amount of repetitions.
14	Cat Stretch	Position yourself on the floor on your hands and knees. Pull your belly in and round your spine, lower back, shoulders, and neck, letting your head drop. Hold for 15 seconds.
15	Child's Pose	Get on your hands and knees, walk your hands in front of you. Lower your buttocks down to sit on your heels. Let your arms drag along the floor as you sit back to stretch your entire spine. Once you settle onto your heels, bring your hands next to your feet and relax. "breathe" into your back. Rest your forehead on the floor.
16	Chin To Chest Stretch	Get into a seated position on the floor. Place both hands at the rear of your head, fingers interlocked, thumbs pointing down and elbows pointing straight ahead. Slowly pull your head down to your chest. Hold for 20-30 seconds.
17	Clock Push-Up	Move into a prone position on the floor, supporting your weight on your hands and toes. Your arms should be fully extended with the hands around shoulder width. Keep your body straight throughout the movement. This will be your starting position. Descend by flexing at the elbow, lowering your chest toward the ground. At the bottom, reverse the motion by pushing yourself up through elbow extension as quickly as possible until you are airborne. Aim to jump • 12-18 inches to one side. As you accelerate up, move your outside foot away from your direction of travel. Leaving the ground, shift your body about 30 degrees for the next repetition. Return to the starting position and repeat the exercise, working all the way around until you are back where you started.
18	Cocoons	Begin by lying on your back on the ground. Your legs should be straight and your arms extended behind your head. This will be your starting position. To perform the movement, tuck the knees toward your chest, rotating your pelvis to lift your glutes from the floor. As you do so, flex the spine, bringing your arms back over your head to perform a simultaneous crunch motion. After a brief pause, return to the starting position.
19	Crossover Reverse Lunge	Stand with your feet shoulder width apart. This will be your starting position. Perform a rear lunge by stepping back with one foot and flexing the hips and front knee. As you do so, rotate your torso across the front

		leg. After a brief pause, return to the starting position and repeat on the other side, continuing in an alternating fashion.
20	Crunch - Hands Overhead	Lie on the floor with your back flat and knees bent with around a 60-degree angle between the hamstrings and the calves. Keep your feet flat on the floor and stretch your arms overhead with your palms crossed. This will be your starting position. Curl your upper body forward and bring your shoulder blades just off the floor. At all times, keep your arms aligned with your head, neck and shoulder. Don't move them forward from that position. Exhale as you perform this portion of the movement and hold the contraction for a second. Slowly lower down to the starting position as you inhale. Repeat for the recommended amount of repetitions.
21	Crunches	Lie flat on your back with your feet flat on the ground, or resting on a bench with your knees bent at a 90 degree angle. If you are resting your feet on a bench, place them three to four inches apart and point your toes inward so they touch. Now place your hands lightly on either side of your head keeping your elbows in. While pushing the small of your back down in the floor to better isolate your abdominal muscles, begin to roll your shoulders off the floor. Continue to push down as hard as you can with your lower back as you contract your abdominals and exhale. Your shoulders should come up off the floor only about four inches, and your lower back should remain on the floor. At the top of the movement, contract your abdominals hard and keep the contraction for a second. After the one second contraction, begin to come down slowly again to the starting position as you inhale. Repeat for the recommended amount of repetitions.
22	Dancer's Stretch	Sit up on the floor. Cross your right leg over your left, keeping the knee bent. Your left leg is straight and down on the floor. Place your left arm on your right leg and your right hand on the floor. Rotate your upper body to the right, and hold for 10-20 seconds. Switch sides.
23	Dead Bug	Begin lying on your back with your hands extended above you toward the ceiling. Bring your feet, knees, and hips up to 90 degrees. Exhale hard to bring your ribcage down and flatten your back onto the floor, rotating your pelvis up and squeezing your glutes. Hold this position throughout the movement. This will be your starting position. Initiate the exercise by extending one leg, straightening the knee and hip to bring the leg just above the ground. Maintain the position of your lumbar and pelvis as you perform the movement, as your back is going to want to arch. Stay tight and return the working leg to the starting position. Repeat on the opposite side, alternating until the set is complete.
24	Double Leg Butt Kick	Begin standing with your knees slightly bent. Quickly squat a short distance, flexing the hips and knees, and immediately extend to jump for maximum vertical height. As you go up, tuck your heels by flexing the knees, attempting to touch the buttocks. Finish the motion by landing with the knees only partially bent, using your legs to absorb the impact.



25	Elbow Circles	Sit or stand with your feet slightly apart. Place your hands on your shoulders with your elbows at shoulder level and pointing out. Slowly make a circle with your elbows. Breathe out as you start the circle and breathe in as you complete the circle.
26	Elbow to Knee	Lie on the floor, crossing your right leg across your bent left knee. Clasp your hands behind your head, beginning with your shoulder blades on the ground. This will be your starting position. Perform the motion by flexing the spine and rotating your torso to bring the left elbow to the right knee. Return to the starting position and repeat the movement for the desired number of repetitions before switching sides.
27	Elbows Back	Stand up straight. Place both hands on your lower back, fingers pointing downward and elbows out. Then gently pull your elbows back aiming to touch them together.
28	Freehand Jump Squat	Cross your arms over your chest. With your head up and your back straight, position your feet at shoulder width. Keeping your back straight and chest up, squat down as you inhale until your upper thighs are parallel, or lower, to the floor. Now pressing mainly with the ball of your feet, jump straight up in the air as high as possible, using the thighs like springs. Exhale during this portion of the movement. When you touch the floor again, immediately squat down and jump again. Repeat for the recommended amount of repetitions.
29	Frog Hops	Stand with your hands behind your head, and squat down keeping your torso upright and your head up. This will be your starting position. Jump forward several feet, avoiding jumping unnecessarily high. As your feet contact the ground, absorb the impact through your legs, and jump again. Repeat this action 5-10 times.
30	Frog Sit-Ups	Lie with your back flat on the floor (or exercise mat) and your legs extended in front of you. Now bend at the knees and place your outer thighs by the floor as you make the soles of your feet touch each other. Now try pushing both soles and bringing them up as near you as possible while you keep the outer thighs on the floor. Now, cross your arms in front of you by touching the opposite shoulders. This will be your starting position. As you exhale flatten your lower back to the floor while curling the torso upwards. Hold at the top position for a second. As you inhale, slowly lower back to the starting position. Repeat for the recommended amount of repetitions.
31	Glute Kickback	Kneel on the floor or an exercise mat and bend at the waist with your arms extended in front of you (perpendicular to the torso) in order to get into a kneeling push-up position but with the arms spaced at shoulder width. Your head should be looking forward and the bend of the knees should create a 90-degree angle between the hamstrings and the calves. This will be your starting position. As you exhale, lift up your right leg until the hamstrings are in line with the back while maintaining the 90-degree angle bend. Contract the glutes throughout this movement and hold the contraction at the top for a second. Go back to the initial position as you inhale and now repeat with the left leg. Continue to

		alternate legs until all of the recommended repetitions have been performed.
32	Groin and Back Stretch	Sit on the floor with your knees bent and feet together. Interlock your fingers behind your head. This will be your starting position. Curl downwards, bringing your elbows to the inside of your thighs. After a brief pause, return to the starting position with your head up and your back straight. Repeat for 10-20 repetitions.
33	Groiners	Begin in a pushup position on the floor. This will be your starting position. Using both legs, jump forward landing with your feet next to your hands. Keep your head up as you do so. Return to the starting position and immediately repeat the movement, continuing for 10-20 repetitions.
34	Hip Circles (prone)	Position yourself on your hands and knees on the ground. Maintaining good posture, raise one bent knee off of the ground. This will be your starting position. Keeping the knee in a bent position, rotate the femur in an arc, attempting to make a big circle with your knee. Perform this slowly for a number of repetitions, and repeat on the other side.
35	Hug Knees To Chest	Lie down on your back and pull both knees up to your chest. Hold your arms under the knees, not over (that would put too much pressure on your knee joints). Slowly pull the knees toward your shoulders. This also stretches your buttocks muscles.
36	Inchworm	Stand with your feet close together. Keeping your legs straight, stretch down and put your hands on the floor directly in front of you. This will be your starting position. Begin by walking your hands forward slowly, alternating your left and your right. As you do so, bend only at the hip, keeping your legs straight. Keep going until your body is parallel to the ground in a pushup position. Now, keep your hands in place and slowly take short steps with your feet, moving only a few inches at a time. Continue walking until your feet are by your hands, keeping your legs straight as you do so.
37	Iron Crosses (stretch)	Lie face down on the floor, with your arms extended out to your side, palms pressed to the floor. This will be your starting position. To begin, flex one knee and bring that leg across the back of your body, attempting to touch it to the ground near the opposite hand. Promptly return the leg to the starting position, and quickly repeat with the other leg. Continue alternating for 10-20 repetitions.
38	Isometric Wipers	Assume a push-up position, supporting your weight on your hands and toes while keeping your body straight. Your hands should be just outside of shoulder width. This will be your starting position. Begin by shifting your body weight as far to one side as possible, allowing the elbow on that side to flex as you lower your body. Reverse the motion by extending the flexed arm, pushing yourself up and then dropping to the other side. Repeat for the desired number of repetitions.

39	Jackknife Sit-Up	Lie flat on the floor (or exercise mat) on your back with your arms extended straight back behind your head and your legs extended also. This will be your starting position. As you exhale, bend at the waist while simultaneously raising your legs and arms to meet in a jackknife position. While inhaling, lower your arms and legs back to the starting position. Repeat for the recommended amount of repetitions.
40	Knee Across The Body	Lie down on the floor with your right leg straight. Bend your left leg and lower it across your body, holding the knee down toward the floor with your right hand. Place your left arm comfortably beside you and turn your head to the left. Imagine you have a weight tied to your tailbone. Let your tailbone fall back toward the floor as your chest reaches in the opposite direction to stretch your lower back. Switch sides.
41	Knee Circles	Stand with your legs together and hands by your waist. Now move your knees in a circular motion as you breathe normally. Repeat for the recommended amount of repetitions.
42	Knee Tuck Jump	Begin in a comfortable standing position with your knees slightly bent. Hold your hands in front of you, palms down with your fingertips together at chest height. This will be your starting position. Rapidly dip down into a quarter squat and immediately explode upward. Drive the knees towards the chest, attempting to touch them to the palms of the hands. Jump as high as you can, raising your knees up, and then ensure a good land by re-extending your legs, absorbing impact through the knees to rebend.
43	Kneeling Forearm Stretch	Start by kneeling on a mat with your palms flat and your fingers pointing back toward your knees. Slowly lean back keeping your palms flat on the floor until you feel a stretch in your wrists and forearms. Hold for 20-30 seconds.
44	Kneeling Hip Flexor	Kneel on a mat and bring your right knee up so the bottom of your foot is on the floor and extend your left leg out behind you so the top of your foot is on the floor. Shift your weight forward until you feel a stretch in your hip. Hold for 15 seconds, then repeat for your other side.
45	Leg Pull-In	Lie on an exercise mat with your legs extended and your hands either palms facing down next to you or under your glutes. This will be your starting position. Bend your knees and pull your upper thighs into your midsection as you breathe out. Continue the motion until your knees are around chest level. Contract your abs as you execute this movement and hold for a second at the top. Return to the starting position as you inhale. Repeat for the recommended amount of repetitions.
46	Leg-Up Hamstring Stretch	Lie flat on your back, bend one knee, and put that foot flat on the floor to stabilize your spine. Extend the other leg in the air. If you're tight, you won't be able to straighten it. That's okay. Extend the knee so that the sole of the lifted foot faces the ceiling. Slowly straighten the legs as much as possible and then pull the leg toward your nose. Switch sides.
47	Looking At Ceiling	Kneel on the floor, holding your heels with both hands. Lift your buttocks up and forward while bringing your head back to look up at the ceiling, to give an arch in your back.

48	Lower Back Curl	Lie on your stomach with your arms out to your sides. This will be your starting position. Using your lower back muscles, extend your spine lifting your chest off of the ground. Do not use your arms to push yourself up. Keep your head up during the movement. Repeat for 10-20 repetitions.
49	Middle Back Stretch	Stand so your feet are shoulder width apart and your hands are on your hips. Twist at your waist until you feel a stretch. Hold for 10 to 15 seconds, then twist to the other side.
50	Mountain Climbers	Begin in a pushup position, with your weight supported by your hands and toes. Flexing the knee and hip, bring one leg until the knee is approximately under the hip. This will be your starting position. Explosively reverse the positions of your legs, extending the bent leg until the leg is straight and supported by the toe, and bringing the other foot up with the hip and knee flexed. Repeat in an alternating fashion for 20-30 seconds.
51	Oblique Crunches - On The Floor	Start out by lying on your right side with your legs lying on top of each other. Make sure your knees are bent a little bit. Place your left hand behind your head. Once you are in this set position, begin by moving your left elbow up as you would perform a normal crunch except this time the main emphasis is on your obliques. Crunch as high as you can, hold the contraction for a second and then slowly drop back down into the starting position. Remember to breathe in during the eccentric (lowering) part of the exercise and to breathe out during the concentric (elevation) part of the exercise.
52	On Your Side Quad Stretch	Start off by lying on your right side, with your right knee bent at a 90-degree angle resting on the floor in front of you. Bend your left knee behind you and hold your left foot with your left hand. To stretch your hip flexor, press your left hip forward as you push your left foot back into your hand. Switch sides.
53	One Half Locust	Lie facedown on the floor. Put your left hand under your left hipbone to pad your hip and pubic bone. Bend your right knee so you can hold the foot in your right hand. Lift the foot in the air and simultaneously lift your shoulders off the floor. This also stretches the right hip flexor and the chest and shoulders. Switch sides. If it doesn't bother your back, you can try it with both arms and legs at the same time.
54	One Knee To Chest	Start off by lying on the floor. Extend one leg straight and pull the other knee to your chest. Hold under the knee joint to protect the kneecap. Gently tug that knee toward your nose. Switch sides. This stretches the buttocks and lower back of the bent leg and the hip flexor of the straight leg.
55	Overhead Stretch	Standing straight up, lace your fingers together and open your palms to the ceiling. Keep your shoulders down as you extend your arms up. To create a full torso stretch, pull your tailbone down and stabilize your torso as you do this. Stretch the muscles on both the front and the back of the torso.

56	Pelvic Tilt Into Bridge	Lie down with your feet on the floor, heels directly under your knees. Lift only your tailbone to the ceiling to stretch your lower back. Pull in your stomach. To go into a bridge, lift the entire spine except the neck.
57	Push Up to Side Plank	Get into pushup position on the toes with your hands just outside of shoulder width. Perform a pushup by allowing the elbows to flex. As you descend, keep your body straight. Do one pushup and as you come up, shift your weight on the left side of the body, twist to the side while bringing the right arm up towards the ceiling in a side plank. Lower the arm back to the floor for another pushup and then twist to the other side. Repeat the series, alternating each side, for 10 or more reps.
58	Push-Up Wide	With your hands wide apart, support your body on your toes and hands in a plank position. Your elbows should be extended and your body straight. Do not allow your hips to sag. This will be your starting position. To begin, allow the elbows to flex, lowering your chest to the floor as you inhale. Using your pectoral muscles, press your upper body back up to the starting position by extending the elbows. Exhale as you perform this step. After pausing at the contracted position, repeat the movement for the prescribed amount of repetitions.
59	Push-Ups - Close Triceps Position	Lie on the floor face down and place your hands closer than shoulder width for a close hand position. Make sure that you are holding your torso up at arms' length. Lower yourself until your chest almost touches the floor as you inhale. Using your triceps and some of your pectoral muscles, press your upper body back up to the starting position and squeeze your chest. Breathe out as you perform this step. After a second pause at the contracted position, repeat the movement for the prescribed amount of repetitions.
60	Pushups	Lie on the floor face down and place your hands about 36 inches apart while holding your torso up at arms length. Next, lower yourself downward until your chest almost touches the floor as you inhale. Now breathe out and press your upper body back up to the starting position while squeezing your chest. After a brief pause at the top contracted position, you can begin to lower yourself downward again for as many repetitions as needed.
61	Rear Leg Raises	Place yourself on your hands knees on an exercise mat. Your head should be looking forward and the bend of the knees should create a 90-degree angle between the hamstrings and the calves. This will be your starting position. Extend one leg up and behind you. The knee and hip should both extend. Repeat for 5-10 repetitions, and then switch sides.
62	Reverse Crunch	Lie down on the floor with your legs fully extended and arms to the side of your torso with the palms on the floor. Your arms should be stationary for the entire exercise. Move your legs up so that your thighs are perpendicular to the floor and feet are together and parallel to the floor. This is the starting position. While inhaling, move your legs towards the torso as you roll your pelvis backwards and you raise your hips off the floor. At the end of this movement your knees will be touching your chest. Hold the contraction for a second and move your legs back to the

		starting position while exhaling. Repeat for the recommended amount of repetitions.
63	Rocket Jump	Begin in a relaxed stance with your feet shoulder width apart and hold your arms close to the body. To initiate the move, squat down halfway and explode back up as high as possible. Fully extend your entire body, reaching overhead as far as possible. As you land, absorb your impact through the legs.
64	Russian Twist	Lie down on the floor placing your feet either under something that will not move or by having a partner hold them. Your legs should be bent at the knees. Elevate your upper body so that it creates an imaginary V-shape with your thighs. Your arms should be fully extended in front of you perpendicular to your torso and with the hands clasped. This is the starting position. Twist your torso to the right side until your arms are parallel with the floor while breathing out. Hold the contraction for a second and move back to the starting position while breathing out. Now move to the opposite side performing the same techniques you applied to the right side. Repeat for the recommended amount of repetitions.
65	Scissor Kick	To begin, lie down with your back pressed against the floor. Your arms should be fully extended to the sides with your palms facing down. With a slight bend at the knees, lift your legs up so that your heels are about 6 inches off the ground. This is the starting position. Now lift your left leg up to about a 45 degree angle while your right leg is lowered until the heel is about 2-3 inches from the ground. Switch movements by raising your right leg up and lowering your left leg. Remember to breathe while performing this exercise. Repeat for the recommended amount of repetitions.
66	Seated Calf Stretch	Sit up straight on an exercise mat. Bend one knee and put that foot on the floor to stabilize the torso. Straighten your other leg and flex your ankle. Using a band, towel, or your hand if you can reach, pull the toes toward you. Hold for 10 to 20 seconds, then switch sides.
67	Seated Floor Hamstring Stretch	Sit on a mat with your right leg extended in front of you and your left leg bent with your foot against your right inner thigh. Lean forward from your hips and reach for your ankle until you feel a stretch in your hamstring. Hold for 15 seconds, then repeat for your other side.
68	Seated Overhead Stretch	Sit up straight on an exercise mat. Touch the soles of your feet together with your feet six to eight inches in front of your hips. Place one hand on the floor beside you and your other hand behind your head. Lift your elbow to the ceiling as you incline your torso to the other side. Hold for 10 to 20 seconds, then switch sides.
69	Shoulder Circles	With shoulders relaxed and arms resting loosely at your sides, gently roll your shoulders forward, up, back, and down. Reverse direction. You can do this exercise alternating shoulders or both at the same time.

70	Shoulder Raise	Relax your arms to your sides and raise your shoulders up toward your ears, then back down.
71	Shoulder Stretch	Reach your left arm across your body and hold it straight. With your right hand, grasp your left elbow and pull it across your body towards your chest.
72	Side Jackknife	Lying on your right side and keeping your left leg over your right one, place your right hand in a comfortable spot and clasp your left hand behind your head. Bring your torso and left leg toward each other as you pull with your obliques. Squeeze for a moment and return to the starting position.
73	Side Bridge	Lie on your side and support your body between your forearm and knee to your feet. Hold position for two to four seconds. Repeat on the other side.
74	Side Lying Groin Stretch	Start off by lying on your right side and bend your right knee in front of you to stabilize the torso. Rest your head on your right hand or shoulder. Lift your left leg upward and hold it by the back of the knee (easier) or the foot (harder). Pull your left knee in toward your left shoulder and simultaneously press your foot or knee down to the floor. To intensify this stretch, straighten your left leg. Switch sides.
75	Side Neck Stretch	Start with your shoulders relaxed, gently tilt your head towards your shoulder. Assist stretch with a gentle pull on the side of the head.
76	Side-Lying Floor Stretch	First lie on your left side, bending your left knee in front of you to stabilize your torso. Straighten your right leg and rest the right foot on the floor behind your left. Straighten your right arm over your head and gently pull on your right wrist to stretch the entire right side of the body. Switch sides.
77	Single Leg Glute Bridge	Lay on the floor with your feet flat and knees bent. Raise one leg off of the ground, pulling the knee to your chest. This will be your starting position. Execute the movement by driving through the heel, extending your hip upward and raising your glutes off of the ground. Extend as far as possible, pause and then return to the starting position.
78	Single-Arm Push-Up	Begin laying prone on the ground. Move yourself into a position supporting your weight on your toes and one arm. Your working arm should be placed directly under the shoulder, fully extended. Your legs should be extended, and for this movement you may need a wider base, placing your feet further apart than in a normal push-up. Maintain good posture, and place your free hand behind your back. This will be your starting position. Lower yourself by allowing the elbow to flex until you touch the ground. Descend slowly, and reverse direction by extending the arm to return to the starting position.
79	Sit Squats	Stand with your feet shoulder width apart. This will be your starting position. Begin the movement by flexing your knees and hips, sitting back with your hips. Continue until you have squatted a portion of the way down, but are above parallel, and quickly reverse the motion until you return to the starting position. Repeat for 5-10 repetitions.

80	Sit-Up	Lie down on the floor placing your feet either under something that will not move or by having a partner hold them. Your legs should be bent at the knees. Place your hands behind your head and lock them together by clasping your fingers. This is the starting position. Elevate your upper body so that it creates an imaginary V-shape with your thighs. Breathe out when performing this part of the exercise. Once you feel the contraction for a second, lower your upper body back down to the starting position while inhaling. Repeat for the recommended amount of repetitions.
81	Spider Crawl	Begin in a prone position on the floor. Support your weight on your hands and toes, with your feet together and your body straight. Your arms should be bent to 90 degrees. This will be your starting position. Initiate the movement by raising one foot off of the ground. Externally rotate the leg and bring the knee toward your elbow, as far forward as possible. Return this leg to the starting position and repeat on the opposite side.
82	Split Squats	Being in a standing position. Jump into a split leg position, with one leg forward and one leg back, flexing the knees and lowering your hips slightly as you do so. As you descend, immediately reverse direction, standing back up and jumping, reversing the position of your legs. Repeat 5-10 times on each leg.
83	Standing Hip Circles	Begin standing on one leg, holding to a vertical support. Raise the unsupported knee to 90 degrees. This will be your starting position. Open the hip as far as possible, attempting to make a big circle with your knee. Perform this movement slowly for a number of repetitions, and repeat on the other side.
84	Standing Lateral Stretch	Take a slightly wider than hip distance stance with your knees slightly bent. Place your right hand on your right hip to support the spine. Raise your left arm in a vertical line and place your left hand behind your head. Keep it there as you incline your torso to the right. Keep your weight evenly distributed between both legs. Switch sides.
85	Standing Hip Flexors	Stand up straight with the spine vertical, the left foot slightly in front of the right. Bend both knees and lift the back heel off the floor as you press the right hip forward. You can't get a thorough, deep stretch in this position, however, because it's hard to relax the hip flexor and stand on it at the same time. Switch sides.
86	Standing Soleus And Achilles Stretch	Stand with your feet hip-distance apart, one foot slightly in front of the other. Bend both knees, keeping your back heel on the floor. Switch sides.
87	Standing Pelvic Tilt	Start off with your feet hip-distance apart. Bend your knees slightly to keep them soft and springy. You may want to move your pelvis forward and backward and back few times before holding the tailbone forward in this stretch.
88	Standing Toe Touches	Stand with some space in front and behind you. Bend at the waist, keeping your legs straight, until you can relax and let your upper body



		hang down in front of you. Let your arms and hands hang down naturally. Hold for 10 to 20 seconds.
89	Superman	To begin, lie straight and face down on the floor or exercise mat. Your arms should be fully extended in front of you. This is the starting position. Simultaneously raise your arms, legs, and chest off of the floor and hold this contraction for 2 seconds. Slowly begin to lower your arms, legs and chest back down to the starting position while inhaling. Repeat for the recommended amount of repetitions prescribed in your program.
90	The Straddle	Begin in a seated, upright position. Start by extending your legs in front of you in a V. With your hands on the floor, lean forward as far as possible. Hold for 10 to 20 seconds.
91	Toe Touchers	To begin, lie down on the floor or an exercise mat with your back pressed against the floor. Your arms should be lying across your sides with the palms facing down. Your legs should be touching each other. Slowly elevate your legs up in the air until they are almost perpendicular to the floor with a slight bend at the knees. Your feet should be parallel to the floor. Move your arms so that they are fully extended at a 45 degree angle from the floor. This is the starting position. While keeping your lower back pressed against the floor, slowly lift your torso and use your hands to try and touch your toes. Remember to exhale while perform this part of the exercise. Slowly begin to lower your torso and arms back down to the starting position while inhaling. Remember to keep your arms straight out pointing towards your toes. Repeat for the recommended amount of repetitions.
92	Tricep Side Stretch	Bring right arm across your body and over your left shoulder, holding your elbow with your left hand, until you feel a stretch in your tricep. Then repeat for your other arm.
93	Triceps Stretch	Reach your hand behind your head, grasp your elbow and gently pull. Hold for 10 to 20 seconds, then switch sides.
94	Tuck Crunch	To begin, lie down on the floor or an exercise mat with your back pressed against the floor. Your arms should be lying across your sides with the palms facing down. Your legs should be crossed by wrapping one ankle around the other. Slowly elevate your legs up in the air until your thighs are perpendicular to the floor with a slight bend at the knees. Note: Your knees and toes should be parallel to the floor as opposed to the thighs. Move your arms from the floor and cross them so they are resting on your chest. This is the starting position. While keeping your lower back pressed against the floor, slowly lift your torso. Remember to exhale while perform this part of the exercise. Slowly begin to lower your torso back down to the starting position while inhaling. Repeat for the recommended amount of repetitions.
95	Upper Back Stretch	Clasp fingers together with your thumbs pointing down, round your shoulders as you reach your hands forward.
96	Upper Back-Leg Grab	While seated, bend forward to hug your thighs from underneath with both arms. Keep your knees together and your legs extended out as you bring your chest down to your knees. You can also stretch your middle

		back by pulling your back away from your knees as your hugging them.
97	Upward Stretch	Extend both hands straight above your head, palms touching. Slowly push your hands up and back, keeping your back straight.
98	Windmills	Lie on your back with your arms extended out to the sides and your legs straight. This will be your starting position. Lift one leg and quickly cross it over your body, attempting to touch the ground near the opposite hand. Return to the starting position, and repeat with the opposite leg. Continue to alternate for 10-20 repetitions.
99	World's Greatest Stretch	This is a three-part stretch. Begin by lunging forward, with your front foot flat on the ground and on the toes of your back foot. With your knees bent, squat down until your knee is almost touching the ground. Keep your torso erect, and hold this position for 10-20 seconds. Now, place the arm on the same side as your front leg on the ground, with the elbow next to the foot. Your other hand should be placed on the ground, parallel to your lead leg, to help support you during this portion of the stretch. After 10-20 seconds, place your hands on either side of your front foot. Raise the toes of the front foot off of the ground, and straighten your leg. You may need to reposition your rear leg to do so. Hold for 10-20 seconds, and then repeat the entire sequence for the other side.
100	Wrist Circles	Start by standing straight with your feet being shoulder width apart from each other. Elevate your arms to the side of you until they are fully extended and parallel to the floor at a height that is evenly aligned with your shoulders. Keeping your entire body stationary except for the wrists, begin to rotate both wrists forward in a circular motion. Repeat for the recommended amount of repetitions.

## Appendix B: Testing Workout Routines

Table 17: Testing Workout Routines

#	Name	Text
0	Pike Walk-Pushup Combo	Stand with your feet together, arms at your sides. Bend over and place your hands or fingertips on the floor in front of you. Walk your hands forward into plank position and do one pushup. Keeping your hands in place, walk your feet up until they're as close to your hands as possible.
1	Inchworm1	Stand tall with your legs straight and bend over and touch the floor. Keeping your legs straight, walk your hands forward. Then take tiny steps to walk your feet back to your hands. Walk your hands out as far as you can without allowing your hips to sag.
2	Prisoner Squat	Stand as tall as you can with your feet spread shoulder width apart. Place your fingers on the back of your head. Lower your body as far as you can by pushing your hips back and bending your knees. Pause, then slowly push yourself back to the starting position.
3	Body-Weight Lunge	Stand with your feet shoulder width apart and hands behind your head. Step forward with your right leg and slowly lower your body until your front knee is bent at least 90 degrees. Pause, then push yourself to the starting position as quickly as you can. Complete the prescribed number of repetitions with your right leg, then do the same number with your left leg.
4	Lying Gluteal Bridge	Lie on your back with your knees bent and your feet flat on the floor. Squeeze your glutes and slowly raise your butt off the floor until your body forms a straight line from your knees to your shoulders. Hold this position for 3 to 5 seconds, then slowly lower yourself to the floor.
5	Body-Weight Jump Squat	Place your fingers on the back of your head and pull your elbows back so that they're in line with your body. Dip your knees in preparation to leap. Explosively jump as high as you can. When you land, immediately squat down and jump again.
6	Glute Bridge with Leg Raise	Lie flat on your back with your knees bent. Raise your hips so your lower back is off the floor. Straighten your right leg and move it up as far as possible. Slowly bring the leg back down, lower your foot to its starting position, and slowly lower your hips to the floor. Repeat with your left leg.
7	Mountain Climber1	Assume a pushup position with your arms completely straight. Lift your right foot off the floor and slowly raise your knee as close to your chest as you can. Touch the floor with your right foot. Return to the starting position. Repeat with your left leg. Alternate back and forth for 30 seconds.
8	V-Up1	Lie down on the floor with your legs and arms straight. Hold your arms straight above the top of your head. In one movement, simultaneously lift your torso and legs as if you're trying to touch your toes. Lower your body back to the starting position.
9	T-Stabilization	Assume a pushup position. Keeping your arms straight and your body rigid, shift your weight onto your left arm and rotate your torso up and to the right until you're facing sideways. Pause for 3 seconds, then lower back down to the starting position. Rotate to your left. Continue to rotate back and forth.

1 0	Extended Bridges	Lying on your back with your arms by your sides, bend your knees up and bring your heels as close to your butt as possible. Fluidly raise your hips high to the sky while lifting your arms up and back overhead. Clench your glutes at the top and really press up. Slowly disengage and lower your hips while bringing your arms back to the start position. Go for 10 repetitions.
1 1	Hip Raise1	Lie down on the floor with your knees bent. Squeeze your glutes and press into your heels to raise your hips until your body forms a straight line from your shoulders to your knees. Pause, then slowly lower back to the starting position. That's one repetition.
1 2	Tricep Pushup	Get in plank position with your hands shoulder width apart. Lower your chest toward the floor while keeping your upper arms parallel to your sides and your elbows pointing straight back. Push back up to starting position.
1 3	One Knee To Chest	Start off laying down with your back flat on the floor and knees bent as in a standard sit-up position. Push your right leg straight out and pull your left knee tightly to your chest bringing the knee as close as you can to your head. Repeat this exercise for as many repetitions as needed.
1 4	All Fours Quad Stretch	Start off on your hands and knees, then lift your leg off the floor and hold the foot with your hand. Use your hand to hold the foot or ankle, keeping the knee fully flexed, stretching the quadriceps and hip flexors. Hold for 10-20 seconds and then switch sides.
1 5	Push Ups	Begin on all fours placing your hands on the floor slightly wider than shoulder width apart. Lower your body until your chest nearly touches the floor. Pause, then push yourself back to the starting position.
1 6	Shoulder Circles	Stand tall with your arms hanging at both sides. Lift and roll your shoulders back in a large circular motion.
1 7	Groiners	Assume a pushup position, your core braced and glutes tights. Lift one foot off of the floor and bring it as close to your opposite hand as possible. Return to the pushup position.
1 8	Inchworm2	Stand tall with your legs straight. Bend forward and touch the floor with both hands. Walk your hands forward while keeping your legs straight so that you almost end up in a pushup position. Walk your feet forward in small steps keeping your hands on the ground so that you end up back in the starting position.
1 9	Hip Raise2	Lie down on the floor with your knees bent. Raise your hips so your body forms a straight line from your shoulders to your knees. Pause in the up position, then lower your body back to the starting position.
2 0	V-Up2	Lie on the ground with your legs straight and feet together. Bring both arms over your head and rest them beside your ears. Simultaneously, lift your legs and torso off the ground. Bring your arms forward and reach for your ankles as you balance on your hips. Reverse the movement and return to the starting position.
2 1	T PushUp	Get in the standard pushup position with your hands slightly wider than shoulder width apart and elbows completely locked out. Slowly lower yourself towards the ground. Once your chest touches the ground, pause, and then press back up to the starting position. From here, pick one hand off the ground and reach towards the ceiling, rotating your upper body in the same

		direction until your body forms a T-shape. Return to starting position.
2 2	Crunch	Lie flat on your back and place your hands behind your head. Bend your knees and firmly plant your feet on the floor. Lift your shoulders and upper back off of the floor. Hold at the top for a second and then retract back down to starting position.
2 3	Spiderman Pushup	Begin on all fours placing your hands on the floor slightly wider than shoulder width apart. As you lower into the pushup, pull one knee up and towards the elbow of the same side. Pause, then push your body back up and return the lifted leg back to the starting position. Alternate sides.
2 4	Marching Hip Raises	Lie on your back with your knees bent and feet flat on the floor. Lift your hips off the ground. Lift one leg off the ground. Return the leg to the floor and repeat on the opposite leg.
2 5	Three Way Plank	Get into a plank position resting on your forearms with feet close to one another. Slowly turn your toes, knees, and hips to one side as you reach one arm up to the ceiling and stack one foot on top of another in a side plank on your elbow. Slowly lower back to your starting plank and then repeat to the other side.
2 6	One Arm Pushup	Get in the standard pushup position with feet wider than shoulder width apart. Place one hand on the ground directly beneath your chest and the other behind your lower back. Straighten your legs behind you, spread them wide, and point your toes into the ground. "Screw" the palm of your planted hand into the floor, twisting it slightly, and slowly lower your chest towards the ground. Pause and return to the starting position.
2 7	Wide Hands Pushup	Get in the standard pushup position with hands and feet wider than shoulder width apart. Slowly lower chest to the ground, pausing for two seconds just above the ground. Engage your pecs and triceps to push back up to the starting position.
2 8	Ankle Circles	Stand on one foot. Raise the opposite foot a few inches off of the floor. Rotate your ankle in a large circle in one direction.
2 9	Plank with Leg Lift	Begin in the top of a pushup position with your hands directly beneath your shoulders. Lift one leg off the ground until it's at hip height. Pause for a moment and return to the starting position.
3 0	Bridge with leg extension	Lie on your back with your knees bent and heels flat against the floor. Press your heels into the floor, driving your hips upwards and finishing the movement by squeezing your butt. Take one foot off the ground and extend that leg fully in front of you. Return your leg to the ground and repeat with the opposite leg.
3 1	Reverse Crunch	Lie on your back with your knees together and your legs bent to 90 degrees, feet planted on the floor. Lift your hips off the floor as you crunch your knees inward to your chest. Pause at the top for a moment, then lower back down.
3 2	Situp	Lie on your back with your knees bent and feet flat on the floor. Place your fingertips behind your ears with your elbows pointed out. Curl your upper body upward toward your thighs. Lower your upper body under control back to the ground.
3 3	Elbow to knee	Lie flat on your back and place your hands behind your head. Bend your knees and bring them up so that your thighs and hips form a 90 degree angle,

	crunch	calves parallel to the floor. With elbows flared lift your shoulder blades off the floor and hold the position. Twist your upper body in one direction bringing the elbow to the opposite knee while fully extending your other leg. Hold and then return back to the starting position. Repeat in the opposite direction.
3 4	Crossed Arms Crunch	Lie flat on your back and cross your arms across your chest. Bend your knees and firmly plant your feet on the floor. Lift your shoulders and upper back off of the floor. Hold at the top for a second and then retract back down to starting position.
3 5	Deadbug	Lie flat on your back with arms fully extended along your sides. Bend your knees and bring them up so that your thighs and hips form a 90 degree angle, calves parallel to the floor. Reach one arm up and behind your head while straightening out the opposite leg. Don't let the leg touch the floor. Return to the starting position to repeat on the other side.
3 6	Quadruped Leg Raise	Get on all fours, your knees bent at 90 degrees. Raise one leg with knee bent until your thigh is in line with your body. Hold and then return to starting position.
3 7	Plank Pike Jump	Get into a plank position with your hands directly beneath your shoulders. Jump your feet under your hips. Jump back to starting position.
3 8	Bodyweight Jump Squat	Cross your arms over your chest and standing with your feet at shoulder width apart. With a slight bend in you knees, straighten your back and push your chest out. Squat down at least until your thighs are parallel to the floor or as far as comfortably possible. The moment you reach the depth of your squat, explode upward driving the balls of your feet into the floor. Jump as high as possible and land as softly as possible using your toes to brace for the impact. Upon landing immediately begin your next squat, repeating for the desired amount of repetitions.
3 9	Single Leg Hip Raise	Lie on your back with your knees bent and heels flat against the floor. Take one leg off the ground and straighten it completely. Press your remaining heel into the floor, driving your hips upwards and finishing the movement by squeezing your glutes. Return to the starting position and repeat.

## Appendix C: Animation Graph

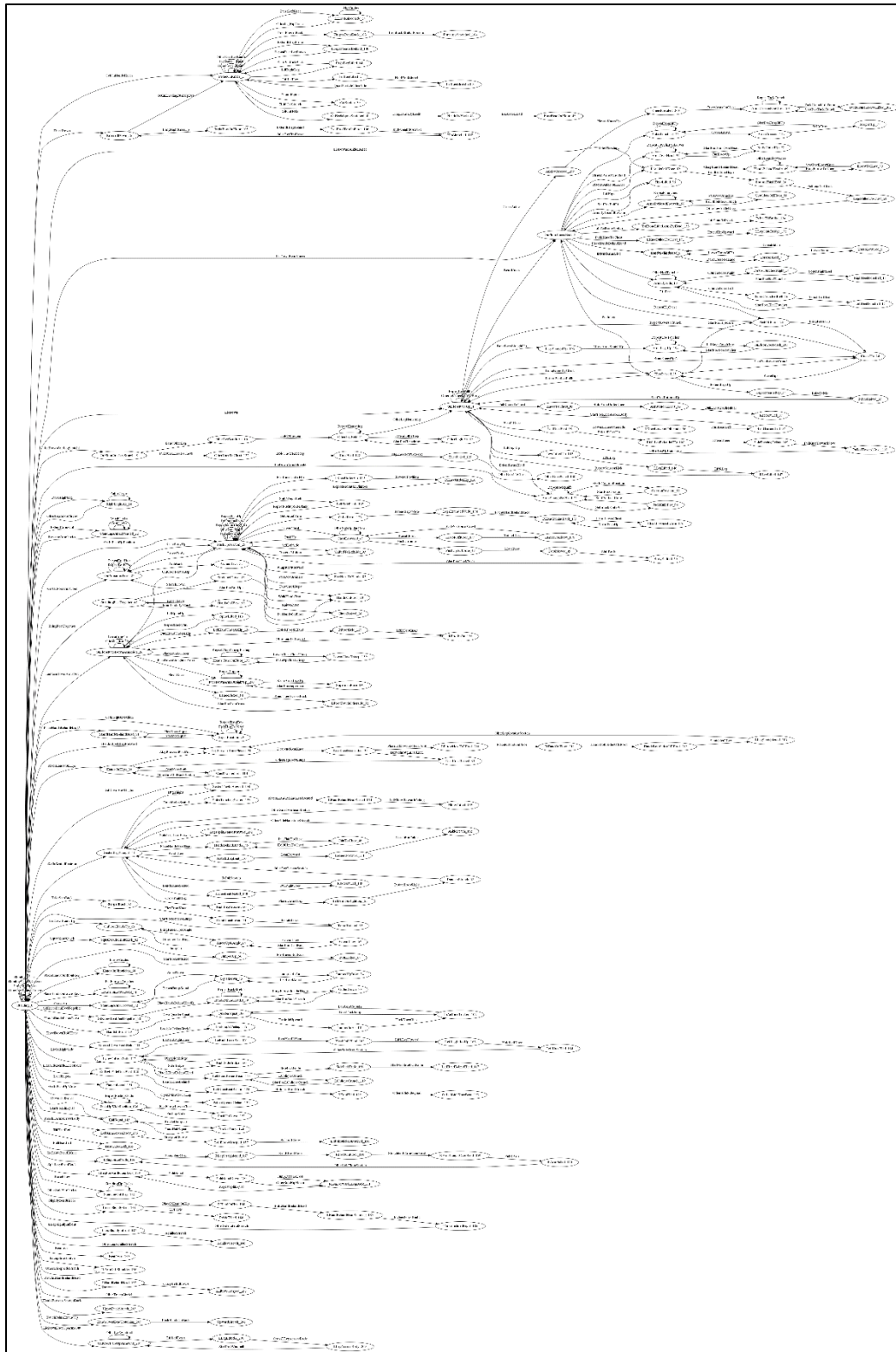


Figure 23: Animation Graph

## Appendix D: Animation Graph Nodes & Animation-Clips

Table 18: Animation Graph Nodes & Animation Clips

ActionInfo	Origin Node	Origin Node Name	Destination Node	Destination Node Name	Animation-Clip ID
1	0	Standing	1	ProneOnKnees	GetOnHandsKnees
2	1	ProneOnKnees	2	LeftLegLifted	LiftLeftLeg
3	2	LeftLegLifted	3	LeftLegStretched	HoldFootStretch
4	2	LeftLegLifted	3	LeftLegStretched	HoldFootStretch
7	3	LeftLegStretched	1	ProneOnKnees	QuadStretchOtherSide
8	0	Standing	4	OnFloorFaceUp	LieDown
9	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
10	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
11	5	OnFloorKneesBent	6	HandsBehindHead	PlaceHandsBehindHead
12	0	Standing	4	OnFloorFaceUp	LieDown
14	6	HandsBehindHead	7	TorsoRaised	RaiseTorsoToKnee
16	7	TorsoRaised	8	TorsoLowered	LowerTorso
17	8	TorsoLowered	6	HandsBehindHead	RepeatSitUp
18	0	Standing	9	OnFloorOneLegStraight	LieDownOneLegStraight
19	9	OnFloorOneLegStraight	10	OtherLegBentInAir	BendOtherLeg
20	10	OtherLegBentInAir	11	OtherLegHeld	HoldOtherLeg
22	11	OtherLegHeld	12	OtherLegInAir	ExtendOtherLeg
23	12	OtherLegInAir	11	OtherLegHeld	StartPosHamstring
24	11	OtherLegHeld	11	OtherLegHeld	RepeatHamstring
25	11	OtherLegHeld	4	OnFloorFaceUp	OtherLegHamstring
26	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
27	5	OnFloorKneesBent	13	ArmsBySide	ExtendArmsSide
29	13	ArmsBySide	14	TorsoCrunchedRight	CrunchTorsoRight
30	14	TorsoCrunchedRight	15	RightHeelTouched	TouchRightHeel
32	15	RightHeelTouched	13	ArmsBySide	StartPosHeelToucher
33	13	ArmsBySide	16	TorsoCrunchedLeft	CrunchTorsoLeft
34	16	TorsoCrunchedLeft	17	LeftHeelTouched	TouchLeftHeel
36	17	LeftHeelTouched	13	ArmsBySide	StartPos1HeelToucher
38	13	ArmsBySide	13	ArmsBySide	OtherHeelToucher
40	0	Standing	18	RightLegInAir	RaiseRightLeg
41	18	RightLegInAir	18	RightLegInAir	AnkleCircles
42	18	RightLegInAir	18	RightLegInAir	AnkleCircles
44	18	RightLegInAir	0	Standing	OtherLegAnkleCircles
45	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
46	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
47	5	OnFloorKneesBent	19	RAnkleOnLKnee	PlaceRAnkleOnLKnee



48	19	RAnkleOnLKnee	20	BottomThighHeld	HoldBottomThigh
49	20	BottomThighHeld	21	LegsPulledToChest	PullLegsToChest
52	21	LegsPulledToChest	5	OnFloorKneesBent	OtherLegAnkleKnee
53	0	Standing	0	Standing	Standing
54	0	Standing	22	StandingArmsExtended	ExtendArmsOut
55	0	Standing	22	StandingArmsExtended	ExtendArmsOut
57	22	StandingArmsExtended	22	StandingArmsExtended	ArmCircles
60	22	StandingArmsExtended	0	Standing	ReverseArmCircles
61	0	Standing	4	OnFloorFaceUp	LieDown
62	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
63	5	OnFloorKneesBent	23	FeetOffFloor	LiftFeet
64	23	FeetOffFloor	24	KneesUp	BringKneesUp
65	24	KneesUp	25	HipsRaised	RaiseHips
67	24	KneesUp	25	HipsRaised	RaiseHips
68	25	HipsRaised	23	FeetOffFloor	StartPosHipRaise
69	23	FeetOffFloor	5	OnFloorKneesBent	RepeatHipRaise
70	0	Standing	27	OnForearmsToes	GetOnForearmsToes
71	0	Standing	27	OnForearmsToes	GetOnForearmsToes
74	27	OnForearmsToes	28	PushUpPosition	RaiseBodyUp
76	28	PushUpPosition	27	OnForearmsToes	LowerBody
77	27	OnForearmsToes	27	OnForearmsToes	RepeatBodyUp
78	0	Standing	0	Standing	Standing
79	0	Standing	81	StandHandsBehindHead	PlaceHandsBehindHeadA
81	81	StandHandsBehindHead	29	SquatPosition	FlexKneesSquat
82	81	StandHandsBehindHead	29	SquatPosition	FlexKneesSquat
83	29	SquatPosition	81	StandHandsBehindHead	StartPosSquat
85	29	SquatPosition	81	StandHandsBehindHead	StartPosSquat
86	0	Standing	0	Standing	Standing
87	0	Standing	30	HandsOnHips	PlaceHandsOnHips
88	30	HandsOnHips	31	LegForwardKneeFlexed	StepForwardFlexKnee
89	31	LegForwardKneeFlexed	32	RearKneeDescended	DescendRearKnee
92	32	RearKneeDescended	33	RearKneeRaised	DriveThroughLeadHeel
93	32	RearKneeDescended	33	RearKneeRaised	DriveThroughLeadHeel
94	33	RearKneeRaised	30	HandsOnHips	OtherLegBodyLunge
95	0	Standing	4	OnFloorFaceUp	LieDown
96	0	Standing	0	Standing	Standing
98	4	OnFloorFaceUp	25	HipsRaised	BringKneesByChest
99	25	HipsRaised	34	LegsExtendedUp	ExtendLegsUp
101	34	LegsExtendedUp	35	PelvisRaised	RaisePelvis
102	35	PelvisRaised	4	OnFloorFaceUp	StartPosBottomsUp
103	0	Standing	5	OnFloorKneesBent	LieDownBendKnees

104	0	Standing	0	Standing	Standing
106	5	OnFloorKneesBent	36	HipsLifted	LiftHips
109	36	HipsLifted	5	OnFloorKneesBent	StartPosButtLift
110	0	Standing	27	OnForearmsToes	GetOnForearmsToes
112	27	OnForearmsToes	37	ArchedBack	ArchBack
113	37	ArchedBack	38	GlutesRaised	RaiseGlutes
114	37	ArchedBack	38	GlutesRaised	RaiseGlutes
116	38	GlutesRaised	27	OnForearmsToes	StartPosButtUps
117	27	OnForearmsToes	27	OnForearmsToes	RepeatButtUps
118	0	Standing	1	ProneOnKnees	GetOnHandsKnees
120	1	ProneOnKnees	39	CatStretch	RoundSpine
121	39	CatStretch	1	ProneOnKnees	HoldCatStretch
122	0	Standing	1	ProneOnKnees	GetOnHandsKnees
123	1	ProneOnKnees	41	OnHeelsSpineStretched	SitOnHeels
124	1	ProneOnKnees	41	OnHeelsSpineStretched	SitOnHeels
125	41	OnHeelsSpineStretched	42	HandsByHeels	DragHandsByHeels
128	42	HandsByHeels	43	ForeHeadOnFloor	RestForeHead
129	0	Standing	44	SeatedLegStraight	GetInSeatedPosition
130	44	SeatedLegStraight	45	HandsBehindHeadA	PlaceHandsRearHead
131	44	SeatedLegStraight	45	HandsBehindHeadA	PlaceHandsRearHead
132	45	HandsBehindHeadA	46	ChinToChest	PullChinToChest
133	46	ChinToChest	45	HandsBehindHeadA	HoldChinToChest
134	0	Standing	28	PushUpPosition	GetInPushUpPosition
138	28	PushUpPosition	47	ChestLowered	LowerChest
139	47	ChestLowered	48	PushUpAirborne	PushUpJump
140	47	ChestLowered	48	PushUpAirborne	PushUpJump
141	48	PushUpAirborne	49	FootMoved	MoveFoot
142	49	FootMoved	50	BodyShifted	ShiftBody
143	50	BodyShifted	28	PushUpPosition	StartPosClockPush
145	0	Standing	4	OnFloorFaceUp	LieDown
146	0	Standing	0	Standing	Standing
147	4	OnFloorFaceUp	51	ArmsStraightByHead	ExtendArmsHead
149	51	ArmsStraightByHead	52	CocoonPosition	GetInCocoonPosition
150	51	ArmsStraightByHead	52	CocoonPosition	GetInCocoonPosition
151	52	CocoonPosition	51	ArmsStraightByHead	StartPosCocoon
152	0	Standing	0	Standing	Standing
154	0	Standing	53	SteppedBack	TakeStepBack
155	53	SteppedBack	54	FrontKneeFlexed	FlexFrontKnee
156	54	FrontKneeFlexed	55	TorsoRotated	RotateTorso
157	55	TorsoRotated	0	Standing	StartPosReverseLunge
158	0	Standing	0	Standing	OtherLegReverseLunge

159	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
160	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
161	5	OnFloorKneesBent	56	ArmsOverHead	StretchArmsOverHead
163	56	ArmsOverHead	57	BodyCurledUp	CurlBodyUp
164	56	ArmsOverHead	57	BodyCurledUp	CurlBodyUp
169	57	BodyCurledUp	56	ArmsOverHead	StartPosArmsOverHead
170	56	ArmsOverHead	56	ArmsOverHead	RepeatCrunchHandsOver
171	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
174	5	OnFloorKneesBent	58	ArmsByHeadElbowsIn	ArmsByHeadElbowsIn
175	58	ArmsByHeadElbowsIn	59	ShouldersOffFloor	RollShouldersCrunch
178	58	ArmsByHeadElbowsIn	59	ShouldersOffFloor	RollShouldersCrunch
180	58	ArmsByHeadElbowsIn	59	ShouldersOffFloor	RollShouldersCrunch
182	59	ShouldersOffFloor	58	ArmsByHeadElbowsIn	StartPosCrunches
183	58	ArmsByHeadElbowsIn	58	ArmsByHeadElbowsIn	RepeatCrunches
184	0	Standing	44	SeatedLegStraight	GetInSeatedPosition
185	44	SeatedLegStraight	60	RightLegCrossed	CrossRightLeg
187	60	RightLegCrossed	61	LeftArmOnRightLeg	PlaceLArmRLeg
188	61	LeftArmOnRightLeg	62	DancersStretch	RotateBodyRight
190	62	DancersStretch	44	SeatedLegStraight	OtherLegDancerStretch
191	0	Standing	63	OnFloorHandsUp	LieDownHandsUp
192	63	OnFloorHandsUp	64	KneesUpRAngle	BringKneesUpRAngle
193	63	OnFloorHandsUp	64	KneesUpRAngle	BringKneesUpRAngle
195	63	OnFloorHandsUp	64	KneesUpRAngle	BringKneesUpRAngle
199	64	KneesUpRAngle	65	ExtendLLeg	ExtendLLeg
200	64	KneesUpRAngle	65	ExtendLLeg	ExtendLLeg
201	64	KneesUpRAngle	65	ExtendLLeg	ExtendLLeg
204	65	ExtendLLeg	64	KneesUpRAngle	StartPosDeadBug
205	64	KneesUpRAngle	63	OnFloorHandsUp	OtherLegDeadBug
206	0	Standing	0	Standing	Standing
207	0	Standing	82	SquatPositionButtKick	SquatShortQuick
208	82	SquatPositionButtKick	66	JumpedUp	JumpUp
209	66	JumpedUp	67	ButtKicked	FlexKneesButtKick
210	67	ButtKicked	0	Standing	StartPosButtKick
211	0	Standing	0	Standing	Standing
212	0	Standing	68	HandsOnShoulders	PlaceHandsOnShoulders
214	68	HandsOnShoulders	68	HandsOnShoulders	ElbowCircles
215	68	HandsOnShoulders	68	HandsOnShoulders	ElbowCircles
216	68	HandsOnShoulders	68	HandsOnShoulders	ElbowCircles
217	0	Standing	19	RAnkleOnLKnee	LieDownRAnkleLKnee
218	19	RAnkleOnLKnee	69	HandsBehindHeadA	ClaspHandsBehindHead
220	69	HandsBehindHeadA	70	ElbowToKnee	BringElbowToKnee

221	69	HandsBehindHeadA	70	ElbowToKnee	BringElbowToKnee
222	70	ElbowToKnee	69	HandsBehindHeadA	StartPosElbowKnee
223	69	HandsBehindHeadA	69	HandsBehindHeadA	OtherLegElbowKnee
224	0	Standing	0	Standing	Standing
225	0	Standing	71	HandsOnLowerBack	PlaceHandsOnLowerBack
227	71	HandsOnLowerBack	71	HandsOnLowerBack	PullElbowsTogether
228	0	Standing	72	StandingArmsCrossed	CrossArms
229	0	Standing	0	Standing	Standing
230	72	StandingArmsCrossed	73	SquatDown	SquatDown
231	72	StandingArmsCrossed	73	SquatDown	SquatDown
232	73	SquatDown	74	JumpedUpInAir	JumpUpInAir
234	74	JumpedUpInAir	73	SquatDown	LandAndSquat
235	73	SquatDown	72	StandingArmsCrossed	RepeatJumpSquat
236	73	SquatDown	72	StandingArmsCrossed	RepeatJumpSquat
237	0	Standing	29	SquatPosition	GetInSquatPosition
240	29	SquatPosition	29	SquatPosition	FrogHopForward
242	29	SquatPosition	29	SquatPosition	RepeatFrogHop
243	29	SquatPosition	29	SquatPosition	RepeatFrogHop
244	0	Standing	4	OnFloorFaceUp	LieDown
246	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
247	5	OnFloorKneesBent	75	SolesTouching	SolesTouching
248	5	OnFloorKneesBent	75	SolesTouching	SolesTouching
249	5	OnFloorKneesBent	75	SolesTouching	SolesTouching
250	75	SolesTouching	142	ArmsCrossed	CrossArmsA
252	142	ArmsCrossed	77	FrogSitUp	SitUpFrog
254	77	FrogSitUp	75	SolesTouching	StartPosFrogSitUp
255	75	SolesTouching	75	SolesTouching	RepeatFrogSitUp
256	0	Standing	76	KneeledDown	KneelDown
257	76	KneeledDown	1	ProneOnKnees	GetInKneelingPushUpPos
259	76	KneeledDown	1	ProneOnKnees	GetInKneelingPushUpPos
261	1	ProneOnKnees	141	RightLegLifted	LiftRightLeg
262	1	ProneOnKnees	141	RightLegLifted	LiftRightLeg
264	141	RightLegLifted	1	ProneOnKnees	StartPosKickBack
265	1	ProneOnKnees	1	ProneOnKnees	OtherLegKickBack
266	1	ProneOnKnees	1	ProneOnKnees	RepeatKickBack
267	0	Standing	78	SitKneesBentFeetTogether	SitKneesBentFeetTogether
268	78	SitKneesBentFeetTogether	79	HandsBehindHeadB	PlaceHandsBehindHeadB
270	79	HandsBehindHeadB	80	CurledDown	BringElbowsInsideThighs
271	80	CurledDown	79	HandsBehindHeadB	StartPosBackStretch
272	79	HandsBehindHeadB	79	HandsBehindHeadB	RepeatBackStretch
273	0	Standing	28	PushUpPosition	GetInPushUpPosition

275	28	PushUpPosition	83	FeetNextToHands	JumpFeetForward
277	83	FeetNextToHands	28	PushUpPosition	StartPosGroiners
278	28	PushUpPosition	28	PushUpPosition	RepeatGroiners
279	0	Standing	1	ProneOnKnees	GetOnHandsKnees
280	1	ProneOnKnees	84	LKneeRaisedSide	RaiseLeftKnee
282	84	LKneeRaisedSide	84	LKneeRaisedSide	LHipCircles
284	84	LKneeRaisedSide	1	ProneOnKnees	OtherLegHipCircles
285	0	Standing	4	OnFloorFaceUp	LieDown
286	4	OnFloorFaceUp	85	KneesToChest	PullKneesToChest
287	85	KneesToChest	86	ArmsUnderKnees	HoldArmsUnderKnee
288	86	ArmsUnderKnees	87	KneesPulled	PullKneesToShoulder
289	86	ArmsUnderKnees	87	KneesPulled	PullKneesToShoulder
290	0	Standing	88	StandingFeetTogether	BringFeetTogether
291	88	StandingFeetTogether	89	StretchedDown	StretchDown
292	89	StretchedDown	90	HandsOnFloor	PutHandsOnFloor
294	90	HandsOnFloor	28	PushUpPosition	WalkHandsFront
295	88	StandingFeetTogether	89	StretchedDown	StretchDown
296	90	HandsOnFloor	28	PushUpPosition	WalkHandsFront
298	28	PushUpPosition	90	HandsOnFloor	TakeShortSteps
299	28	PushUpPosition	90	HandsOnFloor	TakeShortSteps
300	0	Standing	26	OnFloorFaceDownArmsSide	LieFaceDownArmsOut
302	26	OnFloorFaceDownArmsSide	91	LKneeFlexed	FlexLKnee
303	91	LKneeFlexed	92	LFootTouchOtherside	BringLLegAcrossBack
304	92	LFootTouchOtherside	26	OnFloorFaceDownArmsSide	StartPosIronCross
305	26	OnFloorFaceDownArmsSide	26	OnFloorFaceDownArmsSide	OtherLegIronCross
306	26	OnFloorFaceDownArmsSide	26	OnFloorFaceDownArmsSide	RepeatIronCross
307	0	Standing	28	PushUpPosition	GetInPushUpPosition
310	28	PushUpPosition	93	ShiftedToLeftSide	SiftLeftSide
311	93	ShiftedToLeftSide	28	PushUpPosition	ReverseMotion
312	93	ShiftedToLeftSide	28	PushUpPosition	ReverseMotion
313	28	PushUpPosition	28	PushUpPosition	OtherSideWiper
314	28	PushUpPosition	28	PushUpPosition	RepeatIsometricWiper
315	0	Standing	51	ArmsStraightByHead	LieDownArmsStraight
318	51	ArmsStraightByHead	94	JackKnifePos	GetInJackKnifePos
319	94	JackKnifePos	51	ArmsStraightByHead	StartPosJackKnife
320	51	ArmsStraightByHead	51	ArmsStraightByHead	RepeatJackKnife
321	0	Standing	4	OnFloorFaceUp	LieDown
322	4	OnFloorFaceUp	95	LeftKneeBent	BendLKnee
323	95	LeftKneeBent	96	LKneeLoweredOtherside	LowerLKneeOtherside

325	96	LKneeLoweredOtherside	97	HeadTurnedLeft	TurnHeadLeft
327	97	HeadTurnedLeft	4	OnFloorFaceUp	StartPosKneeAcrossBody
328	4	OnFloorFaceUp	4	OnFloorFaceUp	OtherLegKneeAcrossBody
329	0	Standing	88	StandingFeetTogether	BringFeetTogether
330	88	StandingFeetTogether	98	HandsOnWaist	BringHandsByWaist
331	98	HandsOnWaist	88	StandingFeetTogether	KneeCircles
333	0	Standing	0	Standing	Standing
334	0	Standing	99	HandsInFront	TouchHandsPalmsDown
336	99	HandsInFront	100	QuarterSquat	DownQuarterSquat
337	100	QuarterSquat	101	JumpedInAir	ExplodeUpward
338	101	JumpedInAir	102	InAirKneeTucked	TuckKneeChest
339	100	QuarterSquat	102	InAirKneeTucked	KneeTuckJump
340	102	InAirKneeTucked	100	QuarterSquat	LandAndSquatA
341	0	Standing	1	ProneOnKnees	GetOnHandsKnees
342	1	ProneOnKnees	103	FingersPointBack	PointFingersBack
343	103	FingersPointBack	104	ForearmsStretched	LeanBackStretchForearm
345	0	Standing	76	KneeledDown	KneelDown
346	76	KneeledDown	105	RightFootOnFloor	BringRightKneeUp
347	105	RightFootOnFloor	106	LeftFootTopOnFloor	ExtendLLegBehind
348	106	LeftFootTopOnFloor	107	HipStretched	ShiftWeightForward
349	107	HipStretched	76	KneeledDown	OtherLegHipFlexor
350	0	Standing	4	OnFloorFaceUp	LieDown
353	4	OnFloorFaceUp	5	OnFloorKneesBent	BendKnees
354	5	OnFloorKneesBent	25	HipsRaised	PullInLeg
355	5	OnFloorKneesBent	25	HipsRaised	PullInLeg
356	5	OnFloorKneesBent	25	HipsRaised	PullInLeg
358	25	HipsRaised	4	OnFloorFaceUp	ReturnPosLegPullIn
359	4	OnFloorFaceUp	4	OnFloorFaceUp	RepeatLegPullIn
360	0	Standing	4	OnFloorFaceUp	LieDown
361	4	OnFloorFaceUp	95	LeftKneeBent	BendLKnee
362	4	OnFloorFaceUp	95	LeftKneeBent	BendLKnee
363	95	LeftKneeBent	108	RightLegExtendedUp	ExtendRLegUp
366	108	RightLegExtendedUp	109	SoleFacingCeiling	ExtendKnee
367	108	RightLegExtendedUp	109	SoleFacingCeiling	ExtendKnee
368	109	SoleFacingCeiling	110	PulledTowardNose	PullKneeTowardNose
369	110	PulledTowardNose	4	OnFloorFaceUp	OtherLegUpHamstring
370	0	Standing	111	KneeledDownHeelsHeld	KneelDownHoldHeels
371	111	KneeledDownHeelsHeld	112	LookingAtCeiling	LookAtCeilingStretch
372	0	Standing	26	OnFloorFaceDownArmsSide	LieFaceDownArmsOut
374	26	OnFloorFaceDownArmsSide	113	SpineLifted	LiftSpineUp

377	113	SpineLifted	26	OnFloorFaceDownArmsSide	RepeatBackCurl
378	0	Standing	0	Standing	Standing
379	0	Standing	30	HandsOnHips	PlaceHandsOnHips
380	30	HandsOnHips	114	WaistTwistedLeft	TwistWaistLeft
381	114	WaistTwistedLeft	30	HandsOnHips	OtherSideMidBackStretch
382	0	Standing	28	PushUpPosition	GetInPushUpPosition
383	28	PushUpPosition	115	LKneeUnderHip	FlexKneeUnderHip
384	28	PushUpPosition	115	LKneeUnderHip	FlexKneeUnderHip
386	115	LKneeUnderHip	116	RKneeUnderHip	ReversePosition
388	115	LKneeUnderHip	116	RKneeUnderHip	ReversePosition
389	116	RKneeUnderHip	28	PushUpPosition	RepeatMountainClimber
390	0	Standing	117	LyingOnRightSide	LieOnRightSide
392	117	LyingOnRightSide	118	LeftHandBehindHead	PlaceLHandBehindHead
393	118	LeftHandBehindHead	119	LObliqueCrunch	LObliqueCrunch
394	118	LeftHandBehindHead	119	LObliqueCrunch	LObliqueCrunch
396	119	LObliqueCrunch	118	LeftHandBehindHead	StartPosLObliqueCrunch
399	0	Standing	120	OnRightSideKneeBent	LieRSideBendRKneeFront
400	120	OnRightSideKneeBent	121	LeftKneeBentBehind	BendLKneeBehind
401	121	LeftKneeBentBehind	122	LFootHeld	HoldLeftFootStretch
402	121	LeftKneeBentBehind	122	LFootHeld	HoldLeftFootStretch
403	122	LFootHeld	123	OnLeftSideKneeBent	OtherSideSideQuad
404	0	Standing	26	OnFloorFaceDownArmsSide	LieFaceDownArmsOut
405	26	OnFloorFaceDownArmsSide	124	LeftHandUnderLHip	PutLHandUnderLHip
406	124	LeftHandUnderLHip	125	RFootHeld	HoldRFootRHand
407	125	RFootHeld	126	RFootInAir	LiftRFootInAir
408	125	RFootHeld	126	RFootInAir	LiftRFootInAir
409	125	RFootHeld	126	RFootInAir	LiftRFootInAir
410	126	RFootInAir	26	OnFloorFaceDownArmsSide	OtherLegHalfLocust
412	0	Standing	9	OnFloorOneLegStraight	LieDownOneLegStraight
414	9	OnFloorOneLegStraight	127	OtherKneeToChest	PullOtherKneeToChest
415	127	OtherKneeToChest	128	KneeHeld	HoldUnderKneecap
416	128	KneeHeld	129	KneePulled	TugKneeTowardNose
417	129	KneePulled	130	OtherKneePulled	OtherKneeToChest
418	128	KneeHeld	129	KneePulled	TugKneeTowardNose
419	128	KneeHeld	129	KneePulled	TugKneeTowardNose
420	0	Standing	0	Standing	Standing
421	0	Standing	131	FingersLaced	LaceFingers
422	131	FingersLaced	132	PalmsOpenedCeiling	OpenPalmsToCeiling
423	131	FingersLaced	132	PalmsOpenedCeiling	OpenPalmsToCeiling
424	131	FingersLaced	132	PalmsOpenedCeiling	OpenPalmsToCeiling

428	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
429	5	OnFloorKneesBent	133	TailBoneLiftedArmsByHead	LiftTailBoneStretch
431	133	TailBoneLiftedArmsByHead	134	PelvicTiltBridge	LiftSpineTillNeck
432	0	Standing	28	PushUpPosition	GetInPushUpPosition
433	28	PushUpPosition	28	PushUpPosition	DoOnePushUp
435	28	PushUpPosition	28	PushUpPosition	DoOnePushUp
436	28	PushUpPosition	135	LeftSidePlank	ShiftWeightLeft
437	135	LeftSidePlank	28	PushUpPosition	RepeatPushupSidePlank
438	135	LeftSidePlank	28	PushUpPosition	RepeatPushupSidePlank
439	0	Standing	136	PushUpWidePosition	GetInPushUpWide
443	136	PushUpWidePosition	137	PushUpDown	FlexElbowLowerChest
444	137	PushUpDown	136	PushUpWidePosition	PushupWide
446	136	PushUpWidePosition	136	PushUpWidePosition	RepeatPushupWide
447	0	Standing	26	OnFloorFaceDownArmsSide	LieFaceDownArmsOut
448	26	OnFloorFaceDownArmsSide	138	HandsCloseOnFloor	PlaceHandsCloser
450	138	HandsCloseOnFloor	139	LowerCloseTricep	LowerChestCloseTricep
451	139	LowerCloseTricep	138	HandsCloseOnFloor	PushUpCloseTricep
452	139	LowerCloseTricep	138	HandsCloseOnFloor	PushUpCloseTricep
454	138	HandsCloseOnFloor	138	HandsCloseOnFloor	RepeatCloseTricepPushup
455	0	Standing	26	OnFloorFaceDownArmsSide	LieFaceDownArmsOut
456	26	OnFloorFaceDownArmsSide	28	PushUpPosition	OnFloorToPushUp
457	28	PushUpPosition	47	ChestLowered	LowerChest
459	47	ChestLowered	28	PushUpPosition	PushUp
460	28	PushUpPosition	28	PushUpPosition	RepeatPushUp
461	0	Standing	1	ProneOnKnees	GetOnHandsKnees
465	1	ProneOnKnees	140	LLegExtendedBehind	ExtendLLegProne
467	140	LLegExtendedBehind	1	ProneOnKnees	RepeatRearLegRaises
468	1	ProneOnKnees	1	ProneOnKnees	OtherRearLegRaises
469	0	Standing	4	OnFloorFaceUp	LieDown
472	4	OnFloorFaceUp	24	KneesUp	BringKneesUpA
475	24	KneesUp	25	HipsRaised	RaiseHips
476	24	KneesUp	25	HipsRaised	RaiseHips
477	24	KneesUp	25	HipsRaised	RaiseHips
479	25	HipsRaised	24	KneesUp	StartPosReverseCrunch
480	24	KneesUp	4	OnFloorFaceUp	RepeatReverseCrunch
481	0	Standing	0	Standing	Standing
482	0	Standing	0	Standing	Standing
484	0	Standing	143	HalfSquat	DownHalfSquat
485	143	HalfSquat	144	RocketJump	RocketJumpUp
486	143	HalfSquat	144	RocketJump	RocketJumpUp



487	144	RocketJump	143	HalfSquat	LandHalfSquat
499	0	Standing	4	OnFloorFaceUp	LieDown
501	4	OnFloorFaceUp	145	LegsLiftedUp	LiftLegsUp
503	145	LegsLiftedUp	146	LLegLifted	LiftLLeg
504	146	LLegLifted	147	RLegLifted	LiftRLeg
505	146	LLegLifted	147	RLegLifted	LiftRLeg
507	147	RLegLifted	4	OnFloorFaceUp	RepeatScissorKick
508	0	Standing	44	SeatedLegStraight	GetInSeatedPosition
509	44	SeatedLegStraight	148	LKneeBentSeated	BendLKneeSeated
513	148	LKneeBentSeated	149	RToesPulled	PullRightToes
514	149	RToesPulled	44	SeatedLegStraight	RCalfStretch
515	0	Standing	44	SeatedLegStraight	GetInSeatedPosition
516	44	SeatedLegStraight	150	SeatedLLegBent	BendLLeg
517	150	SeatedLLegBent	151	LeanedForward	LeanForward
518	151	LeanedForward	152	AnkleReach	ReachForAnkle
519	152	AnkleReach	44	SeatedLegStraight	OtherSideHamstringStretch
520	0	Standing	44	SeatedLegStraight	GetInSeatedPosition
521	44	SeatedLegStraight	153	SolesTouchingSeated	TouchSolesSeated
522	153	SolesTouchingSeated	154	LHandBehindHeadSeated	PlaceLHandBehindHeadSeated
523	154	LHandBehindHeadSeated	155	ElbowLifted	LiftElbowTowardCeiling
524	155	ElbowLifted	44	SeatedLegStraight	OtherSideOverheadStretch
525	0	Standing	0	Standing	ShoulderCircles
526	0	Standing	0	Standing	ShoulderCircles
527	0	Standing	0	Standing	ShoulderCirclesReverse
529	0	Standing	0	Standing	Standing
530	0	Standing	0	Standing	ShoulderRaises
531	0	Standing	156	LeftArmAcrossBody	ReachLArmAcrossBody
533	156	LeftArmAcrossBody	157	LeftElbowGrasped	GraspLeftElbow
534	157	LeftElbowGrasped	158	LeftShoulderStretched	PullLeftElbow
535	0	Standing	117	LyingOnRightSide	LieOnRightSide
536	117	LyingOnRightSide	118	LeftHandBehindHead	PlaceLHandBehindHead
537	118	LeftHandBehindHead	159	SideJackKnife	SideJackKnife
539	159	SideJackKnife	117	LeftHandBehindHead	StartPosSideJackKnife
540	0	Standing	117	LyingOnRightSide	LieOnRightSide
541	117	LyingOnRightSide	160	RightSideBridge	SideBridge
543	160	RightSideBridge	117	LyingOnRightSide	OtherSideBridge
544	0	Standing	117	LyingOnRightSide	LieOnRightSide
545	117	LyingOnRightSide	161	LieRightKneeBent	LieBendRightKnee
546	161	LieRightKneeBent	162	HeadOnRHand	RestHeadRHand
547	162	HeadOnRHand	163	LeftLegLiftedUp	LiftLLegUpward
548	163	LeftLegLiftedUp	164	LeftKneeHeld	HoldLeftKnee

549	163	LeftLegLiftedUp	164	LeftKneeHeld	HoldLeftKnee
552	164	LeftKneeHeld	117	LyingOnRightSide	OtherSideGroinStretch
553	0	Standing	165	HeadTiltedLeft	TiltHeadLeft
554	165	HeadTiltedLeft	0	Standing	PullHeadLeft
555	0	Standing	166	LyingOnLeftSide	LieLSideBendLKnee
556	166	LyingOnLeftSide	167	RLegStraightened	StraightenRLeg
557	167	RLegStraightened	168	RFootOnFloor	RestRFootFloor
558	168	RFootOnFloor	169	RArmStraightOverHead	StraightenRArmOverHead
559	169	RArmStraightOverHead	170	RArmPulled	PullRArm
560	170	RArmPulled	166	LyingOnLeftSide	OtherSideFloorStretch
561	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
562	5	OnFloorKneesBent	171	LKneePulledToChest	PullLKneeToChest
565	171	LKneePulledToChest	172	LLegGluteBridge	ExtendHipUpward
566	171	LKneePulledToChest	172	LLegGluteBridge	ExtendHipUpward
567	171	LKneePulledToChest	172	LLegGluteBridge	ExtendHipUpward
568	0	Standing	28	PushUpPosition	GetInPushUpPosition
569	28	PushUpPosition	173	OnLeftArm	GetOnLeftArm
570	28	PushUpPosition	173	OnLeftArm	GetOnLeftArm
571	173	OnLeftArm	174	LegsExtendedWide	ExtendLegsWide
572	173	OnLeftArm	174	LegsExtendedWide	ExtendLegsWide
574	174	LegsExtendedWide	175	RHandBehindBack	PlaceRHandBehindBack
576	175	RHandBehindBack	176	ChestLoweredLArm	LArmLowerChest
577	175	RHandBehindBack	176	ChestLoweredLArm	LArmLowerChest
578	176	ChestLoweredLArm	175	RHandBehindBack	LArmPushUp
579	0	Standing	0	Standing	Standing
581	0	Standing	143	HalfSquat	DownHalfSquat
582	0	Standing	143	HalfSquat	DownHalfSquat
583	143	HalfSquat	0	Standing	StartPosSitSquat
585	0	Standing	5	OnFloorKneesBent	LieDownBendKnees
587	5	OnFloorKneesBent	6	HandsBehindHead	PlaceHandsBehindHead
590	6	HandsBehindHead	7	TorsoRaised	RaiseTorsoToKnee
592	7	TorsoRaised	6	HandsBehindHead	LowerTorsoSitUp
594	0	Standing	28	PushUpPosition	GetInPushUpPosition
595	0	Standing	28	PushUpPosition	GetInPushUpPosition
596	28	PushUpPosition	47	ChestLowered	LowerChest
598	47	ChestLowered	177	LFootOffFloor	RaiseLFoot
599	177	LFootOffFloor	178	LKneeToElbow	RotateLLeg
600	177	LFootOffFloor	178	LKneeToElbow	RotateLLeg
601	178	LKneeToElbow	47	ChestLowered	StartPosSpiderCrawl
602	47	ChestLowered	47	ChestLowered	OtherSideSpiderCrawl
603	0	Standing	0	Standing	Standing

604	0	Standing	179	LLegForwardRLegBack	SplitLegsFrontBack
605	179	LLegForwardRLegBack	180	SplitSquatDown	SplitSquat
606	179	LLegForwardRLegBack	180	SplitSquatDown	SplitSquat
607	180	SplitSquatDown	181	RLegForwardLLegBack	JumpReverseFeet
608	180	SplitSquatDown	181	RLegForwardLLegBack	JumpReverseFeet
609	181	RLegForwardLLegBack	179	LLegForwardRLegBack	RepeatSplitSquat
610	0	Standing	182	StandingOnLLeg	RaiseRLeg
611	0	Standing	182	StandingOnLLeg	RaiseRLeg
613	182	StandingOnLLeg	182	StandingOnLLeg	StandingHipCircles
615	182	StandingOnLLeg	0	Standing	OtherSideHipCircles
616	0	Standing	183	KneesSlightlyBent	SlightlyBendKnees
617	183	KneesSlightlyBent	184	RHandOnHip	PlaceRHandOnHip
618	184	RHandOnHip	185	LHandBehindHeadStanding	PutLHandBehindHead
619	184	RHandOnHip	185	LHandBehindHeadStanding	PutLHandBehindHead
620	185	LHandBehindHeadStanding	186	TorsoInclinedRight	InclineTorsoRight
622	186	TorsoInclinedRight	0	Standing	OtherSideLateralStretch
623	0	Standing	179	LLegForwardRLegBack	SplitLegsFrontBack
624	179	LLegForwardRLegBack	180	SplitSquatDown	SplitSquat
625	179	LLegForwardRLegBack	180	SplitSquatDown	SplitSquat
628	180	SplitSquatDown	181	RLegForwardLLegBack	OtherSideHipFlexor
629	0	Standing	187	LLegSlightlyInfront	LLegSlightlyInfront
630	187	LLegSlightlyInfront	188	AchillesStretch	AchillesStretch
631	188	AchillesStretch	0	Standing	OtherLegAchillesStretch
632	0	Standing	0	Standing	Standing
633	0	Standing	183	KneesSlightlyBent	SlightlyBendKnees
634	183	KneesSlightlyBent	184	PelvicTilted	TiltPelvic
637	0	Standing	0	Standing	Standing
638	0	Standing	189	BentOver	Bendover
639	0	Standing	189	BentOver	Bendover
644	0	Standing	26	OnFloorFaceDownArmsSide	LieFaceDownArmsOut
645	26	OnFloorFaceDownArmsSide	190	FaceDownArmsStraightUp	FaceDownStraightenArms
647	190	FaceDownArmsStraightUp	191	SupermanPose	RaiseArmsLegsUp
649	191	SupermanPose	190	FaceDownArmsStraightUp	StartPosSuperman
650	190	FaceDownArmsStraightUp	190	FaceDownArmsStraightUp	RepeatSuperman
651	0	Standing	44	SeatedLegStraight	GetInSeatedPosition
652	44	SeatedLegStraight	192	LegsSplitLeanedForward	SplitLegsLeanForward
654	0	Standing	4	OnFloorFaceUp	LieDown
655	0	Standing	4	OnFloorFaceUp	LieDown
656	4	OnFloorFaceUp	193	LegsStraightUp	BringLegsStraightUp
657	4	OnFloorFaceUp	193	LegsStraightUp	BringLegsStraightUp

659	193	LegsStraightUp	194	ArmsLegsUp	MoveArmsStraighUp
661	194	ArmsLegsUp	195	OnFloorToeTouch	LiftBackTouchToes
663	194	ArmsLegsUp	195	OnFloorToeTouch	LiftBackTouchToes
665	195	OnFloorToeTouch	194	ArmsLegsUp	StartPosToeToucher
667	194	ArmsLegsUp	194	ArmsLegsUp	RepeatToeToucher
669	0	Standing	196	RArmOnLShoulder	TricepSideStretch
670	196	RArmOnLShoulder	0	Standing	OtherTricepSideStretch
671	0	Standing	197	LHandBehindHead	ReachLHandBehindHead
672	197	LHandBehindHead	198	LElbowGrasped	GraspLeftElbowA
674	198	LElbowGrasped	0	Standing	OtherTricepStretch
675	0	Standing	4	OnFloorFaceUp	LieDown
676	0	Standing	4	OnFloorFaceUp	LieDown
677	4	OnFloorFaceUp	199	AnklesCrossed	CrossAnkles
678	199	AnklesCrossed	200	KneesElevated	ElevateKneesUp
681	200	KneesElevated	201	ArmsCrossedOnChest	CrossArmsOnChest
683	201	ArmsCrossedOnChest	202	TuckCrunchTorsoLifted	TuckCrunchLiftTorso
685	202	TuckCrunchTorsoLifted	201	ArmsCrossedOnChest	StartPosTuckCrunch
686	201	ArmsCrossedOnChest	201	ArmsCrossedOnChest	RepeatTuckCrunch
687	0	Standing	203	UpperBackStretch	HandsForwardStretchBack
688	0	Standing	204	SeatedThighsHugged	SitDownHugThighs
690	44	SeatedLegStraight	204	SeatedThighsHugged	HugThighs
692	0	Standing	205	HandsOverHeadTouching	TouchPalmsExtendUp
693	205	HandsOverHeadTouching	206	UpwardStretch	PushHandsUpBack
694	0	Standing	207	OnFloorFaceUpArmsOut	LieDownFaceUpArmsOut
696	207	OnFloorFaceUpArmsOut	208	LLegLiftedA	LiftLeftLegA
697	208	LLegLiftedA	209	LLegAcrossBody	CrossLLegAcrossBody
698	209	LLegAcrossBody	207	OnFloorFaceUpArmsOut	StartPosWindmill
699	207	OnFloorFaceUpArmsOut	207	OnFloorFaceUpArmsOut	OtherLegWindmill
702	0	Standing	31	LegForwardKneeFlexed	HandsHipsLLegForward
703	31	LegForwardKneeFlexed	32	RearKneeDescended	DescendRearKnee
706	32	RearKneeDescended	210	LElbowNextToLFoot	PlaceLElbowNextToLFoot
707	210	LElbowNextToLFoot	211	RHandOnFloor	PlaceRHandOnFloor
708	211	RHandOnFloor	212	HandsBothSidesOfLFoot	HandsBothSidesOfLFoot
709	212	HandsBothSidesOfLFoot	213	LLegStraightened	StraightenLLeg
710	212	HandsBothSidesOfLFoot	213	LLegStraightened	StraightenLLeg
713	213	LLegStraightened	31	LegForwardKneeFlexed	OtherLegGreatestStretch
714	0	Standing	0	Standing	Standing
715	0	Standing	22	StandingArmsExtended	ExtendArmsOut
717	22	StandingArmsExtended	22	StandingArmsExtended	WristCircles

## Appendix E: Algorithm Output

Table 19: Algorithm Output

WorkoutID, SentenceNumber, ActionInfo ID, Animation-Clip ID, Current Node after Animation			
start: 0			
0	1	actionid: 1	BringFeetTogether current: 88
0	2	actionid: 2	StretchDown current: 89
0	2	actionid: 3	PutHandsOnFloor current: 90
0	3	actionid: 4	WalkHandsFront current: 28
0	3	actionid: 5	DoOnePushUp current: 28
0	4	actionid: 6	TakeShortSteps current: 90
start: 0			
1	1	actionid: 7	BringFeetTogether current: 88
1	1	actionid: 8	StretchDown current: 89
1	1	actionid: 9	PutHandsOnFloor current: 90
1	2	actionid: 10	WalkHandsFront current: 28
1	3	actionid: 11	JumpFeetForward current: 83
DeadEnd, select new previous			
1	3	actionid: 11	TakeShortSteps current: 90
1	4	actionid: 12	WalkHandsFront current: 28
start: 0			
2	1	actionid: 13	Standing current: 0
2	2	actionid: 14	PlaceHandsBehindHeadA current: 81
2	3	actionid: 15	FlexKneesSquat current: 29
2	3	actionid: 16	StartPosSquat current: 81
MidAnim: FlexKneesSquat			
2	4	actionid: 17	StartPosSquat current: 81
start: 0			
3	1	actionid: 18	Standing current: 0
3	1	actionid: 19	ReachLHandBehindHead current: 197
DeadEnd, select new previous			
3	1	actionid: 19	GetInSeatedPosition current: 44
3	2	actionid: 20	BendLLeg current: 150
MidAnim: null			
3	2	actionid: 21	NotAvailable current: 150
MidAnim: null			
3	3	actionid: 22	NotAvailable current: 150
MidAnim: null			
3	4	actionid: 23	NotAvailable current: 150
start: 0			
4	1	actionid: 24	LieDownBendKnees current: 5

MidAnim: PullLKneeToChest			
4	2	actionid: 25	ExtendHipUpward current: 172
MidAnim: null			
4	2	actionid: 26	NotAvailable current: 172
MidAnim: null			
4	3	actionid: 27	NotAvailable current: 172
start: 0			
5	1	actionid: 28	PlaceHandsBehindHeadA current: 81
MidAnim: null			
5	1	actionid: 29	NotAvailable current: 81
5	2	actionid: 30	FlexKneesSquat current: 29
5	3	actionid: 31	FrogHopForward current: 29
MidAnim: null			
5	4	actionid: 32	NotAvailable current: 29
5	4	actionid: 33	RepeatFrogHop current: 29
start: 0			
6	1	actionid: 34	LieDown current: 4
6	2	actionid: 35	LiftLegsUp current: 145
6	3	actionid: 36	LiftLLeg current: 146
MidAnim: null			
6	3	actionid: 37	NotAvailable current: 146
6	4	actionid: 38	LiftRLeg current: 147
MidAnim: RepeatScissorKick			
6	4	actionid: 39	BendLKnee current: 95
6	4	actionid: 40	LowerLKneeOtherside current: 96
MidAnim: null			
6	5	actionid: 41	NotAvailable current: 96
start: 0			
7	1	actionid: 42	GetInPushUpPosition current: 28
7	2	actionid: 43	LowerChest current: 47
MidAnim: PushUp			
7	2	actionid: 44	FlexKneeUnderHip current: 115
7	3	actionid: 45	ReversePosition current: 116
MidAnim: RepeatMountainClimber			
7	4	actionid: 46	GetOnLeftArm current: 173
MidAnim: null			
7	5	actionid: 47	NotAvailable current: 173
MidAnim: null			
7	6	actionid: 48	NotAvailable current: 173
start: 0			
8	1	actionid: 49	LieDown current: 4

8 2	actionid: 50	ExtendArmsHead	current: 51
8 3	actionid: 51	GetInCocoonPosition	current: 52
8 4	actionid: 52	StartPosCocoon	current: 51
start: 0			
9 1	actionid: 53	GetInPushUpPosition	current: 28
9 2	actionid: 54	LowerChest	current: 47
9 2	actionid: 55	PushUp	current: 28
9 2	actionid: 56	ShiftWeightLeft	current: 135
MidAnim: RepeatPushupSidePlank			
9 2	actionid: 57	ShiftWeightLeft	current: 135
MidAnim: null			
9 2	actionid: 58	NotAvailable	current: 135
MidAnim: RepeatPushupSidePlank			
9 3	actionid: 59	RepeatPushUp	current: 28
MidAnim: TakeShortSteps			
9 4	actionid: 60	WalkHandsFront	current: 28
9 5	actionid: 61	DoOnePushUp	current: 28
start: 0			
10 1	actionid: 62	LieDown	current: 4
10 1	actionid: 63	BendKnees	current: 5
10 1	actionid: 64	LiftHips	current: 36
MidAnim: StartPosButtLift			
10 2	actionid: 65	LiftTailBoneStretch	current: 133
MidAnim: null			
10 3	actionid: 66	NotAvailable	current: 133
MidAnim: null			
10 3	actionid: 67	NotAvailable	current: 133
MidAnim: null			
10 4	actionid: 68	NotAvailable	current: 133
MidAnim: null			
10 4	actionid: 69	NotAvailable	current: 133
MidAnim: null			
10 5	actionid: 70	NotAvailable	current: 133
start: 0			
11 1	actionid: 71	LieDown	current: 4
MidAnim: ExtendArmsHead			
11 2	actionid: 72	GetInCocoonPosition	current: 52
MidAnim: StartPosCocoon			
11 2	actionid: 73	GetInCocoonPosition	current: 52
11 3	actionid: 74	StartPosCocoon	current: 51
MidAnim: null			

11	4	actionid: 75	NotAvailable	current: 51
start: 0				
12	1	actionid: 76	GetInPushUpPosition	current: 28
12	2	actionid: 77	LowerChest	current: 47
DeadEnd, select new previous				
12	1	actionid: 77	DoOnePushUp	current: 28
12	2	actionid: 78	LowerBody	current: 27
MidAnim: ArchBack				
12	3	actionid: 79	RaiseGlutes	current: 38
start: 0				
13	1	actionid: 80	GetOnForearmsToes	current: 27
DeadEnd, select new previous				
13	1	actionid: 80	LieDownOneLegStraight	current: 9
13	2	actionid: 81	BendOtherLeg	current: 10
MidAnim: null				
13	2	actionid: 82	NotAvailable	current: 10
MidAnim: null				
13	3	actionid: 83	NotAvailable	current: 10
start: 0				
14	1	actionid: 84	GetOnHandsKnees	current: 1
14	1	actionid: 85	LiftLeftLeg	current: 2
14	1	actionid: 86	HoldFootStretch	current: 3
MidAnim: QuadStretchOtherSide				
14	2	actionid: 87	PointFingersBack	current: 103
MidAnim: null				
14	3	actionid: 88	NotAvailable	current: 103
MidAnim: null				
14	3	actionid: 89	NotAvailable	current: 103
start: 0				
15	1	actionid: 90	GetOnHandsKnees	current: 1
15	2	actionid: 91	LiftLeftLeg	current: 2
MidAnim: null				
15	3	actionid: 92	NotAvailable	current: 2
start: 0				
16	1	actionid: 93	Standing	current: 0
16	2	actionid: 94	RaiseRLeg	current: 182
DeadEnd, select new previous				
16	1	actionid: 94	ShoulderRaises	current: 0
16	2	actionid: 95	ShoulderCircles	current: 0
start: 0				
17	1	actionid: 96	GetInPushUpPosition	current: 28



17	2	actionid: 97	LowerChest	current: 47
MidAnim: PushUp				
17	2	actionid: 98	JumpFeetForward	current: 83
17	3	actionid: 99	StartPosGroiners	current: 28
start: 0				
18	1	actionid: 100	BringFeetTogether	current: 88
18	2	actionid: 101	StretchDown	current: 89
18	2	actionid: 102	PutHandsOnFloor	current: 90
18	3	actionid: 103	WalkHandsFront	current: 28
18	4	actionid: 104	GetOnLeftArm	current: 173
start: 0				
19	1	actionid: 105	LieDown	current: 4
19	2	actionid: 106	LiftLegsUp	current: 145
MidAnim: null				
19	3	actionid: 107	NotAvailable	current: 145
start: 0				
20	1	actionid: 108	LieDown	current: 4
MidAnim: null				
20	1	actionid: 109	NotAvailable	current: 4
20	2	actionid: 110	ExtendArmsHead	current: 51
20	2	actionid: 111	GetInCocoonPosition	current: 52
MidAnim: StartPosCocoon				
20	3	actionid: 112	GetInCocoonPosition	current: 52
MidAnim: StartPosCocoon				
20	4	actionid: 113	GetInJackKnifePos	current: 94
MidAnim: null				
20	4	actionid: 114	NotAvailable	current: 94
20	5	actionid: 115	StartPosJackKnife	current: 51
start: 0				
21	1	actionid: 116	GetInPushUpPosition	current: 28
MidAnim: null				
21	1	actionid: 117	NotAvailable	current: 28
21	2	actionid: 118	LowerBody	current: 27
21	3	actionid: 119	RaiseBodyUp	current: 28
21	3	actionid: 120	GetOnLeftArm	current: 173
DeadEnd, select new previous				
21	3	actionid: 120	LowerBody	current: 27
21	4	actionid: 121	RaiseBodyUp	current: 28
21	4	actionid: 122	ShiftWeightLeft	current: 135
MidAnim: RepeatPushupSidePlank				
21	5	actionid: 123	RepeatPushUp	current: 28

start: 0			
22	1	actionid: 124	LieDown current: 4
22	1	actionid: 125	ExtendArmsHead current: 51
MidAnim: RepeatJackKnife			
22	2	actionid: 126	GetInCocoonPosition current: 52
MidAnim: StartPosCocoon			
22	2	actionid: 127	GetInCocoonPosition current: 52
MidAnim: StartPosCocoon			
22	3	actionid: 128	GetInCocoonPosition current: 52
MidAnim: null			
22	4	actionid: 129	NotAvailable current: 52
22	4	actionid: 130	StartPosCocoon current: 51
start: 0			
23	1	actionid: 131	GetOnHandsKnees current: 1
23	2	actionid: 132	RaiseLeftKnee current: 84
MidAnim: null			
23	3	actionid: 133	NotAvailable current: 84
23	3	actionid: 134	LHipCircles current: 84
MidAnim: OtherLegHipCircles			
23	4	actionid: 135	OtherRearLegRaises current: 1
start: 0			
24	1	actionid: 136	LieDownBendKnees current: 5
24	2	actionid: 137	LiftFeet current: 23
DeadEnd, select new previous			
24	2	actionid: 137	PullLKneeToChest current: 171
24	3	actionid: 138	ExtendHipUpward current: 172
MidAnim: null			
24	4	actionid: 139	NotAvailable current: 172
MidAnim: null			
24	4	actionid: 140	NotAvailable current: 172
start: 0			
25	1	actionid: 141	GetOnForearmsToes current: 27
MidAnim: RaiseBodyUp			
25	2	actionid: 142	ShiftWeightLeft current: 135
25	2	actionid: 143	RepeatPushupSidePlank current: 28
MidAnim: RepeatGoiners			
25	3	actionid: 144	ShiftWeightLeft current: 135
25	3	actionid: 145	RepeatPushupSidePlank current: 28
start: 0			
26	1	actionid: 146	GetInPushUpPosition current: 28
26	2	actionid: 147	TakeShortSteps current: 90

MidAnim: WalkHandsFront
26 3 actionid: 148      JumpFeetForward      current: 83
MidAnim: null
26 3 actionid: 149      NotAvailable      current: 83
MidAnim: StartPosGroiners
26 3 actionid: 150      LowerChest      current: 47
26 4 actionid: 151      RaiseLFoot      current: 177
DeadEnd, select new previous
26 3 actionid: 151      PushUp      current: 28
26 4 actionid: 152      LowerChest      current: 47
MidAnim: null
26 5 actionid: 153      NotAvailable      current: 47
26 5 actionid: 154      PushUp      current: 28
start: 0
27 1 actionid: 155      GetInPushUpPosition      current: 28
27 2 actionid: 156      LowerChest      current: 47
27 3 actionid: 157      PushUp      current: 28
start: 0
28 1 actionid: 158      LLegSlightlyInfront      current: 187
28 2 actionid: 159      AchillesStretch      current: 188
MidAnim: OtherLegAchillesStretch
28 3 actionid: 160      ShoulderCirclesReverse      current: 0
start: 0
29 1 actionid: 161      GetInPushUpPosition      current: 28
29 2 actionid: 162      FlexKneeUnderHlp      current: 115
MidAnim: null
29 3 actionid: 163      NotAvailable      current: 115
MidAnim: null
29 3 actionid: 164      NotAvailable      current: 115
start: 0
30 1 actionid: 165      LieDownBendKnees      current: 5
30 2 actionid: 166      LiftHips      current: 36
MidAnim: StartPosButtLift
30 2 actionid: 167      PullInLeg      current: 25
30 3 actionid: 168      ExtendLegsUp      current: 34
DeadEnd, select new previous
30 2 actionid: 168      ReturnPosLegPullIn      current: 4
30 3 actionid: 169      BendLKnee      current: 95
30 4 actionid: 170      LowerLKneeOtherside      current: 96
MidAnim: null
30 4 actionid: 171      NotAvailable      current: 96

start: 0			
31	1	actionid: 172	SlightlyBendKnees current: 183
MidAnim: null			
31	1	actionid: 173	NotAvailable current: 183
MidAnim: null			
31	2	actionid: 174	NotAvailable current: 183
MidAnim: null			
31	3	actionid: 175	NotAvailable current: 183
start: 0			
32	1	actionid: 176	LieDownBendKnees current: 5
32	2	actionid: 177	PlaceHandsBehindHead current: 6
32	3	actionid: 178	RaiseTorsoToKnee current: 7
32	4	actionid: 179	LowerTorsoSitUp current: 6
start: 0			
33	1	actionid: 180	LieDown current: 4
33	1	actionid: 181	ExtendArmsHead current: 51
MidAnim: RepeatJackKnife			
33	2	actionid: 182	GetInCocoonPosition current: 52
MidAnim: StartPosCocoon			
33	2	actionid: 183	GetInCocoonPosition current: 52
MidAnim: StartPosCocoon			
33	3	actionid: 184	GetInCocoonPosition current: 52
33	3	actionid: 185	StartPosCocoon current: 51
MidAnim: null			
33	4	actionid: 186	NotAvailable current: 51
MidAnim: null			
33	5	actionid: 187	NotAvailable current: 51
33	5	actionid: 188	GetInJackKnifePos current: 94
MidAnim: null			
33	6	actionid: 189	NotAvailable current: 94
start: 0			
34	1	actionid: 190	LieDown current: 4
34	1	actionid: 191	ExtendArmsHead current: 51
MidAnim: RepeatJackKnife			
34	2	actionid: 192	GetInCocoonPosition current: 52
MidAnim: StartPosCocoon			
34	2	actionid: 193	GetInCocoonPosition current: 52
MidAnim: StartPosCocoon			
34	3	actionid: 194	GetInCocoonPosition current: 52
MidAnim: null			
34	4	actionid: 195	NotAvailable current: 52

34	4	actionid: 196	StartPosCocoon	current: 51
start: 0				
35	1	actionid: 197	LieDownFaceUpArmsOut	current: 207
DeadEnd, select new previous				
35	1	actionid: 197	LieDownBendKnees	current: 5
35	2	actionid: 198	PullInLeg	current: 25
35	2	actionid: 199	ExtendLegsUp	current: 34
MidAnim: null				
35	3	actionid: 200	NotAvailable	current: 34
35	4	actionid: 201	RaisePelvis	current: 35
35	5	actionid: 202	StartPosBottomsUp	current: 4
start: 0				
36	1	actionid: 203	GetOnHandsKnees	current: 1
36	2	actionid: 204	RaiseLeftKnee	current: 84
MidAnim: null				
36	3	actionid: 205	NotAvailable	current: 84
36	3	actionid: 206	LHipCircles	current: 84
start: 0				
37	1	actionid: 207	GetInPushUpPosition	current: 28
37	2	actionid: 208	JumpFeetForward	current: 83
37	3	actionid: 209	StartPosGroiners	current: 28
start: 0				
38	1	actionid: 210	CrossArms	current: 72
MidAnim: SquatDown				
38	1	actionid: 211	JumpUpInAir	current: 74
MidAnim: null				
38	2	actionid: 212	NotAvailable	current: 74
MidAnim: null				
38	2	actionid: 213	NotAvailable	current: 74
38	3	actionid: 214	LandAndSquat	current: 73
38	4	actionid: 215	JumpUpInAir	current: 74
MidAnim: LandAndSquat				
38	5	actionid: 216	RepeatJumpSquat	current: 72
MidAnim: null				
38	5	actionid: 217	NotAvailable	current: 72
MidAnim: SquatDown				
38	6	actionid: 218	RepeatJumpSquat	current: 72
start: 0				
39	1	actionid: 219	LieDownBendKnees	current: 5
39	2	actionid: 220	LiftFeet	current: 23
MidAnim: null				

39	2	actionid: 221	NotAvailable	current: 23
MidAnim: RepeatHipRaise				
39	3	actionid: 222	LiftHips	current: 36
MidAnim: StartPosButtLift				
39	3	actionid: 223	PullInLeg	current: 25
39	4	actionid: 224	StartPosHipRaise	current: 23

## Appendix F: Survey Data

Statement 1: The animation depicts realistic human motions.

Table 20: Survey Statement 1 Results

WorkoutID	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	Number of Surveys Done
0	0	0	0	1	4	7	12
1	0	0	0	0	7	3	10
2	0	0	0	0	3	6	9
3	0	1	1	1	5	2	10
4	0	0	0	1	4	3	8
5	0	0	0	1	3	4	8
6	0	0	0	3	5	4	12
7	0	0	0	1	2	4	7
8	0	0	0	1	1	5	7
9	0	0	0	1	1	6	8
10	0	0	0	3	4	4	11
11	0	0	0	2	1	2	5
12	0	0	0	2	7	3	12
13	0	0	0	1	5	4	10
14	0	0	0	2	3	3	8
15	0	0	1	0	5	3	9
16	0	0	1	1	3	3	8
17	0	0	0	1	3	2	6
18	0	1	1	2	5	1	10
19	1	0	1	1	4	4	11
20	0	0	1	2	3	2	8
21	0	0	1	1	2	3	7
22	0	0	1	1	1	2	5
23	0	0	1	0	1	3	5
24	0	0	1	0	4	4	9
25	0	1	0	0	3	3	7
26	0	2	1	0	3	1	7
27	0	0	1	4	2	1	8
28	0	0	1	1	5	1	8
29	0	0	2	2	4	2	10
30	0	1	2	2	3	3	11
31	2	1	0	1	1	2	7

32	0	0	0	3	3	2	8
33	1	0	1	2	4	3	11
34	0	2	0	2	4	3	11
35	0	0	0	1	2	3	6
36	0	0	1	0	2	2	5
37	0	0	1	1	4	3	9
38	0	0	1	3	1	1	6
39	0	0	0	2	2	3	7



Statement 2: The animation is similar to the video.

Table 21: Survey Statement 2 Results

WorkoutID	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	Number of Surveys Done
0	0	0	1	0	4	7	12
1	0	0	0	0	6	4	10
2	0	0	0	0	4	5	9
3	4	3	0	2	0	1	10
4	0	1	1	4	2	0	8
5	0	0	0	2	3	3	8
6	0	5	2	2	2	1	12
7	0	0	1	1	2	3	7
8	0	1	0	0	4	2	7
9	0	0	2	3	2	1	8
10	0	0	2	7	1	1	11
11	0	2	1	1	1	0	5
12	0	0	2	5	3	2	12
13	0	2	4	2	1	1	10
14	0	0	0	2	4	2	8
15	2	1	1	3	2	0	9
16	0	0	1	0	2	5	8
17	0	0	1	1	4	0	6
18	0	2	3	4	1	0	10
19	2	4	0	3	2	0	11
20	0	0	0	5	3	0	8
21	0	0	1	2	2	2	7
22	0	3	0	2	0	0	5
23	1	0	1	1	2	0	5
24	1	0	4	3	0	1	9
25	0	0	2	4	0	1	7
26	2	4	1	0	0	0	7
27	0	0	0	3	4	1	8
28	3	2	1	2	0	0	8
29	2	2	4	1	0	1	10
30	1	2	6	1	1	0	11
31	3	1	0	1	1	1	7
32	0	0	0	1	4	3	8
33	3	4	1	1	1	1	11
34	0	5	2	3	0	1	11
35	0	1	2	2	0	1	6

36	0	0	1	2	1	1	5
37	0	0	0	2	4	3	9
38	0	0	0	1	5	0	6
39	0	1	1	4	1	0	7

Statement 3: The animation is easy to comprehend and follow.

Table 22: Survey Statement 3 Results

WorkoutID	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	Number of Surveys Done
0	0	0	0	0	5	7	12
1	0	0	0	0	5	5	10
2	0	0	0	1	3	5	9
3	0	1	0	2	4	3	10
4	0	0	0	1	5	2	8
5	0	0	0	0	4	4	8
6	0	0	0	0	9	3	12
7	0	0	0	0	3	4	7
8	0	0	0	0	3	4	7
9	0	0	0	0	3	5	8
10	0	0	0	3	5	3	11
11	0	0	0	1	2	2	5
12	0	0	0	1	9	2	12
13	0	0	0	1	5	4	10
14	0	0	0	0	4	4	8
15	0	0	0	1	6	2	9
16	0	0	0	0	3	5	8
17	0	0	1	0	3	2	6
18	0	2	1	1	4	2	10
19	1	0	0	1	4	5	11
20	0	0	1	0	7	0	8
21	0	0	0	1	3	3	7
22	0	1	0	0	1	3	5
23	0	0	0	0	4	1	5
24	0	0	0	2	3	4	9
25	0	0	0	2	3	2	7
26	0	0	1	0	5	1	7
27	0	0	0	3	4	1	8
28	0	1	0	1	5	1	8
29	0	0	0	3	5	2	10
30	1	1	1	2	4	2	11
31	2	0	0	2	1	2	7
32	0	0	0	0	5	3	8
33	0	3	0	0	6	2	11
34	0	1	0	3	3	4	11

35	0	0	0	2	2	2	6
36	0	0	0	1	2	2	5
37	0	0	0	2	4	3	9
38	0	0	0	1	4	1	6
39	0	0	0	2	3	2	7

Statement 4: The animation depicts the text instruction.

Table 23: Survey Statement 4 Results

WorkoutID	SentenceID	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree	Number of Surveys Done
0	0	0	0	0	0	4	8	12
0	1	0	0	0	0	4	8	12
0	2	0	0	0	0	4	8	12
0	3	0	0	0	0	4	8	12
1	4	0	0	0	1	1	8	10
1	5	0	0	0	1	4	5	10
1	6	0	0	0	2	3	5	10
1	7	0	0	0	1	3	6	10
2	8	0	0	0	0	2	7	9
2	9	0	0	0	2	0	7	9
2	10	0	0	0	0	2	7	9
2	11	0	0	0	2	1	6	9
3	12	3	2	3	0	1	1	10
3	13	4	3	1	0	1	1	10
3	14	10	0	0	0	0	0	10
3	15	10	0	0	0	0	0	10
4	16	0	0	0	5	2	1	8
4	17	0	1	1	3	3	0	8
4	18	8	0	0	0	0	0	8
5	19	0	0	0	3	2	3	8
5	20	0	0	0	1	4	3	8
5	21	0	0	0	4	1	3	8
5	22	0	0	0	1	4	3	8
6	23	0	1	1	6	2	2	12
6	24	1	3	2	4	1	1	12
6	25	0	4	1	7	0	0	12
6	26	0	4	3	1	3	1	12
6	27	12	0	0	0	0	0	12
7	28	0	0	0	1	2	4	7
7	29	0	0	1	0	3	3	7
7	30	0	0	2	1	2	2	7
7	31	0	0	0	0	6	1	7
7	32	7	0	0	0	0	0	7
7	33	7	0	0	0	0	0	7
8	34	0	0	1	2	1	3	7

8	35	0	0	0	1	2	4	7
8	36	0	1	0	2	3	1	7
8	37	0	0	1	2	0	4	7
9	38	0	0	0	1	5	2	8
9	39	0	0	0	0	5	3	8
9	40	0	0	1	3	2	2	8
9	41	0	4	0	1	2	1	8
9	42	0	3	1	1	2	1	8
10	43	0	0	1	3	6	1	11
10	44	0	1	3	4	2	1	11
10	45	11	0	0	0	0	0	11
10	46	11	0	0	0	0	0	11
10	47	11	0	0	0	0	0	11
11	48	0	0	2	2	0	1	5
11	49	0	2	0	1	1	1	5
11	50	0	1	1	2	0	1	5
12	51	0	0	0	5	5	2	12
12	52	0	0	2	4	4	2	12
12	53	0	2	2	5	2	1	12
13	54	0	0	3	4	2	1	10
13	55	0	1	2	5	1	1	10
13	56	10	0	0	0	0	0	10
14	57	0	0	0	1	3	4	8
14	58	0	0	0	1	4	3	8
14	59	8	0	0	0	0	0	8
15	60	0	1	1	2	5	0	9
15	61	1	3	3	0	2	0	9
15	62	9	0	0	0	0	0	9
16	63	0	0	0	0	4	4	8
16	64	0	0	0	1	3	4	8
17	65	0	0	0	1	3	2	6
17	66	0	0	2	1	2	1	6
17	67	0	0	2	0	2	2	6
18	68	0	1	0	2	2	5	10
18	69	0	0	1	0	4	5	10
18	70	0	0	0	1	5	4	10
18	71	2	4	0	1	2	1	10
19	72	1	2	2	3	3	0	11
19	73	2	4	0	3	2	0	11
19	74	11	0	0	0	0	0	11
20	75	0	0	1	2	5	0	8

20	76	0	0	1	1	6	0	8
20	77	0	0	0	3	4	1	8
20	78	0	0	1	2	4	1	8
20	79	0	0	1	3	4	0	8
21	80	0	0	2	0	0	5	7
21	81	0	1	0	1	2	3	7
21	82	0	0	1	2	2	2	7
21	83	0	0	0	1	3	3	7
21	84	0	0	1	2	2	2	7
22	85	0	1	0	3	0	1	5
22	86	0	1	3	1	0	0	5
22	87	0	0	1	2	2	0	5
22	88	0	0	2	0	3	0	5
23	89	0	1	0	1	1	2	5
23	90	0	2	0	1	1	1	5
23	91	0	1	2	1	1	0	5
23	92	0	0	0	2	2	1	5
24	93	0	1	0	2	4	2	9
24	94	0	1	3	1	3	1	9
24	95	0	0	1	4	3	1	9
24	96	9	0	0	0	0	0	9
25	97	0	0	0	2	3	2	7
25	98	0	1	0	2	3	1	7
25	99	0	1	3	2	0	1	7
26	100	0	1	2	1	3	0	7
26	101	2	4	0	1	0	0	7
26	102	2	2	1	2	0	0	7
26	103	1	5	0	1	0	0	7
26	104	0	2	1	3	1	0	7
27	105	0	0	1	2	3	2	8
27	106	0	0	0	3	1	4	8
27	107	0	0	2	1	2	3	8
28	108	1	4	1	1	0	1	8
28	109	1	5	0	2	0	0	8
28	110	2	4	1	1	0	0	8
29	111	0	0	0	2	7	1	10
29	112	1	3	3	2	1	0	10
29	113	10	0	0	0	0	0	10
30	114	0	0	1	0	5	5	11
30	115	1	1	0	5	2	2	11
30	116	1	3	4	1	1	1	11

30	117	2	5	2	1	1	0	11
31	118	3	1	1	1	0	1	7
31	119	7	0	0	0	0	0	7
31	120	7	0	0	0	0	0	7
32	121	0	0	0	0	3	5	8
32	122	0	0	1	0	6	1	8
32	123	0	0	0	1	4	3	8
32	124	0	0	0	2	3	3	8
33	125	0	0	1	5	3	2	11
33	126	0	1	1	6	2	1	11
33	127	0	1	5	2	2	1	11
33	128	11	0	0	0	0	0	11
33	129	0	0	2	5	4	0	11
33	130	11	0	0	0	0	0	11
34	131	0	3	4	3	0	1	11
34	132	1	4	3	2	0	1	11
34	133	0	2	1	5	2	1	11
34	134	0	2	0	3	4	2	11
35	135	0	0	1	2	1	2	6
35	136	0	0	1	3	1	1	6
35	137	6	0	0	0	0	0	6
35	138	0	0	2	1	2	1	6
35	139	0	0	3	1	1	1	6
36	140	0	0	1	0	2	2	5
36	141	0	1	1	1	1	1	5
36	142	0	1	1	1	2	0	5
37	143	0	0	0	2	4	3	9
37	144	0	0	1	0	5	3	9
37	145	0	0	0	1	5	3	9
38	146	0	0	0	2	2	2	6
38	147	6	0	0	0	0	0	6
38	148	0	0	1	1	3	1	6
38	149	0	0	0	1	3	2	6
38	150	0	0	1	0	2	3	6
38	151	0	0	0	1	2	3	6
39	152	0	0	0	2	3	2	7
39	153	1	1	1	2	2	0	7
39	154	0	1	2	2	2	0	7
39	155	0	0	1	3	2	1	7



## Appendix G: Survey Statement Scores

Table 24: Statement 1 Scores

WorkoutID	Number of Surveys Done	Composite Score	Average Score	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
0	12	66	5.5	0.0%	0.0%	0.0%	8.3%	33.3%	58.3%
1	10	53	5.3	0.0%	0.0%	0.0%	0.0%	70.0%	30.0%
2	9	51	5.7	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
3	10	46	4.6	0.0%	10.0%	10.0%	10.0%	50.0%	20.0%
4	8	42	5.3	0.0%	0.0%	0.0%	12.5%	50.0%	37.5%
5	8	43	5.4	0.0%	0.0%	0.0%	12.5%	37.5%	50.0%
6	12	61	5.1	0.0%	0.0%	0.0%	25.0%	41.7%	33.3%
7	7	38	5.4	0.0%	0.0%	0.0%	14.3%	28.6%	57.1%
8	7	39	5.6	0.0%	0.0%	0.0%	14.3%	14.3%	71.4%
9	8	45	5.6	0.0%	0.0%	0.0%	12.5%	12.5%	75.0%
10	11	56	5.1	0.0%	0.0%	0.0%	27.3%	36.4%	36.4%
11	5	25	5.0	0.0%	0.0%	0.0%	40.0%	20.0%	40.0%
12	12	61	5.1	0.0%	0.0%	0.0%	16.7%	58.3%	25.0%
13	10	53	5.3	0.0%	0.0%	0.0%	10.0%	50.0%	40.0%
14	8	41	5.1	0.0%	0.0%	0.0%	25.0%	37.5%	37.5%
15	9	46	5.1	0.0%	0.0%	11.1%	0.0%	55.6%	33.3%
16	8	40	5.0	0.0%	0.0%	12.5%	12.5%	37.5%	37.5%
17	6	31	5.2	0.0%	0.0%	0.0%	16.7%	50.0%	33.3%
18	10	44	4.4	0.0%	10.0%	10.0%	20.0%	50.0%	10.0%
19	11	52	4.7	9.1%	0.0%	9.1%	9.1%	36.4%	36.4%
20	8	38	4.8	0.0%	0.0%	12.5%	25.0%	37.5%	25.0%
21	7	35	5.0	0.0%	0.0%	14.3%	14.3%	28.6%	42.9%
22	5	24	4.8	0.0%	0.0%	20.0%	20.0%	20.0%	40.0%
23	5	26	5.2	0.0%	0.0%	20.0%	0.0%	20.0%	60.0%
24	9	47	5.2	0.0%	0.0%	11.1%	0.0%	44.4%	44.4%
25	7	35	5.0	0.0%	14.3%	0.0%	0.0%	42.9%	42.9%
26	7	28	4.0	0.0%	28.6%	14.3%	0.0%	42.9%	14.3%
27	8	35	4.4	0.0%	0.0%	12.5%	50.0%	25.0%	12.5%
28	8	38	4.8	0.0%	0.0%	12.5%	12.5%	62.5%	12.5%
29	10	46	4.6	0.0%	0.0%	20.0%	20.0%	40.0%	20.0%
30	11	49	4.5	0.0%	9.1%	18.2%	18.2%	27.3%	27.3%
31	7	25	3.6	28.6%	14.3%	0.0%	14.3%	14.3%	28.6%

32	8	39	4.9	0.0%	0.0%	0.0%	37.5%	37.5%	25.0%
33	11	50	4.5	9.1%	0.0%	9.1%	18.2%	36.4%	27.3%
34	11	50	4.5	0.0%	18.2%	0.0%	18.2%	36.4%	27.3%
35	6	32	5.3	0.0%	0.0%	0.0%	16.7%	33.3%	50.0%
36	5	25	5.0	0.0%	0.0%	20.0%	0.0%	40.0%	40.0%
37	9	45	5.0	0.0%	0.0%	11.1%	11.1%	44.4%	33.3%
38	6	26	4.3	0.0%	0.0%	16.7%	50.0%	16.7%	16.7%
39	7	36	5.1	0.0%	0.0%	0.0%	28.6%	28.6%	42.9%

Table 25: Statement 2 Scores

WorkoutID	Number of Surveys Done	Composite Score	Average Score	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
0	12	65	5.4	0.0%	0.0%	8.3%	0.0%	33.3%	58.3%
1	10	54	5.4	0.0%	0.0%	0.0%	0.0%	60.0%	40.0%
2	9	50	5.6	0.0%	0.0%	0.0%	0.0%	44.4%	55.6%
3	10	24	2.4	40.0%	30.0%	0.0%	20.0%	0.0%	10.0%
4	8	31	3.9	0.0%	12.5%	12.5%	50.0%	25.0%	0.0%
5	8	41	5.1	0.0%	0.0%	0.0%	25.0%	37.5%	37.5%
6	12	40	3.3	0.0%	41.7%	16.7%	16.7%	16.7%	8.3%
7	7	35	5.0	0.0%	0.0%	14.3%	14.3%	28.6%	42.9%
8	7	34	4.9	0.0%	14.3%	0.0%	0.0%	57.1%	28.6%
9	8	34	4.3	0.0%	0.0%	25.0%	37.5%	25.0%	12.5%
10	11	45	4.1	0.0%	0.0%	18.2%	63.6%	9.1%	9.1%
11	5	16	3.2	0.0%	40.0%	20.0%	20.0%	20.0%	0.0%
12	12	53	4.4	0.0%	0.0%	16.7%	41.7%	25.0%	16.7%
13	10	35	3.5	0.0%	20.0%	40.0%	20.0%	10.0%	10.0%
14	8	40	5.0	0.0%	0.0%	0.0%	25.0%	50.0%	25.0%
15	9	29	3.2	22.2%	11.1%	11.1%	33.3%	22.2%	0.0%
16	8	43	5.4	0.0%	0.0%	12.5%	0.0%	25.0%	62.5%
17	6	27	4.5	0.0%	0.0%	16.7%	16.7%	66.7%	0.0%
18	10	34	3.4	0.0%	20.0%	30.0%	40.0%	10.0%	0.0%
19	11	32	2.9	18.2%	36.4%	0.0%	27.3%	18.2%	0.0%
20	8	35	4.4	0.0%	0.0%	0.0%	62.5%	37.5%	0.0%
21	7	33	4.7	0.0%	0.0%	14.3%	28.6%	28.6%	28.6%
22	5	14	2.8	0.0%	60.0%	0.0%	40.0%	0.0%	0.0%
23	5	18	3.6	20.0%	0.0%	20.0%	20.0%	40.0%	0.0%
24	9	31	3.4	11.1%	0.0%	44.4%	33.3%	0.0%	11.1%
25	7	28	4.0	0.0%	0.0%	28.6%	57.1%	0.0%	14.3%
26	7	13	1.9	28.6%	57.1%	14.3%	0.0%	0.0%	0.0%
27	8	38	4.8	0.0%	0.0%	0.0%	37.5%	50.0%	12.5%
28	8	18	2.3	37.5%	25.0%	12.5%	25.0%	0.0%	0.0%
29	10	28	2.8	20.0%	20.0%	40.0%	10.0%	0.0%	10.0%
30	11	32	2.9	9.1%	18.2%	54.5%	9.1%	9.1%	0.0%
31	7	20	2.9	42.9%	14.3%	0.0%	14.3%	14.3%	14.3%
32	8	42	5.3	0.0%	0.0%	0.0%	12.5%	50.0%	37.5%
33	11	29	2.6	27.3%	36.4%	9.1%	9.1%	9.1%	9.1%
34	11	34	3.1	0.0%	45.5%	18.2%	27.3%	0.0%	9.1%

35	6	22	3.7	0.0%	16.7%	33.3%	33.3%	0.0%	16.7%
36	5	22	4.4	0.0%	0.0%	20.0%	40.0%	20.0%	20.0%
37	9	46	5.1	0.0%	0.0%	0.0%	22.2%	44.4%	33.3%
38	6	29	4.8	0.0%	0.0%	0.0%	16.7%	83.3%	0.0%
39	7	26	3.7	0.0%	14.3%	14.3%	57.1%	14.3%	0.0%

Table 26: Statement 3 Scores

WorkoutID	Number of Surveys Done	Composite Score	Average Score	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
0	12	67	5.6	0.0%	0.0%	0.0%	0.0%	41.7%	58.3%
1	10	55	5.5	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%
2	9	49	5.4	0.0%	0.0%	0.0%	11.1%	33.3%	55.6%
3	10	48	4.8	0.0%	10.0%	0.0%	20.0%	40.0%	30.0%
4	8	41	5.1	0.0%	0.0%	0.0%	12.5%	62.5%	25.0%
5	8	44	5.5	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%
6	12	63	5.3	0.0%	0.0%	0.0%	0.0%	75.0%	25.0%
7	7	39	5.6	0.0%	0.0%	0.0%	0.0%	42.9%	57.1%
8	7	39	5.6	0.0%	0.0%	0.0%	0.0%	42.9%	57.1%
9	8	45	5.6	0.0%	0.0%	0.0%	0.0%	37.5%	62.5%
10	11	55	5.0	0.0%	0.0%	0.0%	27.3%	45.5%	27.3%
11	5	26	5.2	0.0%	0.0%	0.0%	20.0%	40.0%	40.0%
12	12	61	5.1	0.0%	0.0%	0.0%	8.3%	75.0%	16.7%
13	10	53	5.3	0.0%	0.0%	0.0%	10.0%	50.0%	40.0%
14	8	44	5.5	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%
15	9	46	5.1	0.0%	0.0%	0.0%	11.1%	66.7%	22.2%
16	8	45	5.6	0.0%	0.0%	0.0%	0.0%	37.5%	62.5%
17	6	30	5.0	0.0%	0.0%	16.7%	0.0%	50.0%	33.3%
18	10	43	4.3	0.0%	20.0%	10.0%	10.0%	40.0%	20.0%
19	11	55	5.0	9.1%	0.0%	0.0%	9.1%	36.4%	45.5%
20	8	38	4.8	0.0%	0.0%	12.5%	0.0%	87.5%	0.0%
21	7	37	5.3	0.0%	0.0%	0.0%	14.3%	42.9%	42.9%
22	5	25	5.0	0.0%	20.0%	0.0%	0.0%	20.0%	60.0%
23	5	26	5.2	0.0%	0.0%	0.0%	0.0%	80.0%	20.0%
24	9	47	5.2	0.0%	0.0%	0.0%	22.2%	33.3%	44.4%
25	7	35	5.0	0.0%	0.0%	0.0%	28.6%	42.9%	28.6%
26	7	34	4.9	0.0%	0.0%	14.3%	0.0%	71.4%	14.3%
27	8	38	4.8	0.0%	0.0%	0.0%	37.5%	50.0%	12.5%
28	8	37	4.6	0.0%	12.5%	0.0%	12.5%	62.5%	12.5%
29	10	49	4.9	0.0%	0.0%	0.0%	30.0%	50.0%	20.0%
30	11	46	4.2	9.1%	9.1%	9.1%	18.2%	36.4%	18.2%
31	7	27	3.9	28.6%	0.0%	0.0%	28.6%	14.3%	28.6%
32	8	43	5.4	0.0%	0.0%	0.0%	0.0%	62.5%	37.5%
33	11	48	4.4	0.0%	27.3%	0.0%	0.0%	54.5%	18.2%
34	11	53	4.8	0.0%	9.1%	0.0%	27.3%	27.3%	36.4%

35	6	30	5.0	0.0%	0.0%	0.0%	33.3%	33.3%	33.3%
36	5	26	5.2	0.0%	0.0%	0.0%	20.0%	40.0%	40.0%
37	9	46	5.1	0.0%	0.0%	0.0%	22.2%	44.4%	33.3%
38	6	30	5.0	0.0%	0.0%	0.0%	16.7%	66.7%	16.7%
39	7	35	5.0	0.0%	0.0%	0.0%	28.6%	42.9%	28.6%

Table 27: Statement 4 Scores

SentenceID	Number of Surveys Done	Composite Score	Average Score	Strongly Disagree	Disagree	Somewhat Disagree	Somewhat Agree	Agree	Strongly Agree
0	12	68	5.7	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
1	12	68	5.7	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
2	12	68	5.7	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
3	12	68	5.7	0.0%	0.0%	0.0%	0.0%	33.3%	66.7%
4	10	57	5.7	0.0%	0.0%	0.0%	10.0%	10.0%	80.0%
5	10	54	5.4	0.0%	0.0%	0.0%	10.0%	40.0%	50.0%
6	10	53	5.3	0.0%	0.0%	0.0%	20.0%	30.0%	50.0%
7	10	55	5.5	0.0%	0.0%	0.0%	10.0%	30.0%	60.0%
8	9	52	5.8	0.0%	0.0%	0.0%	0.0%	22.2%	77.8%
9	9	50	5.6	0.0%	0.0%	0.0%	22.2%	0.0%	77.8%
10	9	52	5.8	0.0%	0.0%	0.0%	0.0%	22.2%	77.8%
11	9	49	5.4	0.0%	0.0%	0.0%	22.2%	11.1%	66.7%
12	10	27	2.7	30.0%	20.0%	30.0%	0.0%	10.0%	10.0%
13	10	24	2.4	40.0%	30.0%	10.0%	0.0%	10.0%	10.0%
14	10	10	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
15	10	10	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
16	8	36	4.5	0.0%	0.0%	0.0%	62.5%	25.0%	12.5%
17	8	32	4.0	0.0%	12.5%	12.5%	37.5%	37.5%	0.0%
18	8	8	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
19	8	40	5.0	0.0%	0.0%	0.0%	37.5%	25.0%	37.5%
20	8	42	5.3	0.0%	0.0%	0.0%	12.5%	50.0%	37.5%
21	8	39	4.9	0.0%	0.0%	0.0%	50.0%	12.5%	37.5%
22	8	42	5.3	0.0%	0.0%	0.0%	12.5%	50.0%	37.5%
23	12	51	4.3	0.0%	8.3%	8.3%	50.0%	16.7%	16.7%

24	12	40	3.3	8.3%	25.0%	16.7%	33.3%	8.3%	8.3%
25	12	39	3.3	0.0%	33.3%	8.3%	58.3%	0.0%	0.0%
26	12	42	3.5	0.0%	33.3%	25.0%	8.3%	25.0%	8.3%
27	12	12	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
28	7	38	5.4	0.0%	0.0%	0.0%	14.3%	28.6%	57.1%
29	7	36	5.1	0.0%	0.0%	14.3%	0.0%	42.9%	42.9%
30	7	32	4.6	0.0%	0.0%	28.6%	14.3%	28.6%	28.6%
31	7	36	5.1	0.0%	0.0%	0.0%	0.0%	85.7%	14.3%
32	7	7	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
33	7	7	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
34	7	34	4.9	0.0%	0.0%	14.3%	28.6%	14.3%	42.9%
35	7	38	5.4	0.0%	0.0%	0.0%	14.3%	28.6%	57.1%
36	7	31	4.4	0.0%	14.3%	0.0%	28.6%	42.9%	14.3%
37	7	35	5.0	0.0%	0.0%	14.3%	28.6%	0.0%	57.1%
38	8	41	5.1	0.0%	0.0%	0.0%	12.5%	62.5%	25.0%
39	8	43	5.4	0.0%	0.0%	0.0%	0.0%	62.5%	37.5%
40	8	37	4.6	0.0%	0.0%	12.5%	37.5%	25.0%	25.0%
41	8	28	3.5	0.0%	50.0%	0.0%	12.5%	25.0%	12.5%
42	8	29	3.6	0.0%	37.5%	12.5%	12.5%	25.0%	12.5%
43	11	51	4.6	0.0%	0.0%	9.1%	27.3%	54.5%	9.1%
44	11	43	3.9	0.0%	9.1%	27.3%	36.4%	18.2%	9.1%
45	11	11	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
46	11	11	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
47	11	11	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
48	5	20	4.0	0.0%	0.0%	40.0%	40.0%	0.0%	20.0%
49	5	19	3.8	0.0%	40.0%	0.0%	20.0%	20.0%	20.0%
50	5	19	3.8	0.0%	20.0%	20.0%	40.0%	0.0%	20.0%
51	12	57	4.8	0.0%	0.0%	0.0%	41.7%	41.7%	16.7%
52	12	54	4.5	0.0%	0.0%	16.7%	33.3%	33.3%	16.7%



53	12	46	3.8	0.0%	16.7%	16.7%	41.7%	16.7%	8.3%
54	10	41	4.1	0.0%	0.0%	30.0%	40.0%	20.0%	10.0%
55	10	39	3.9	0.0%	10.0%	20.0%	50.0%	10.0%	10.0%
56	10	10	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
57	8	43	5.4	0.0%	0.0%	0.0%	12.5%	37.5%	50.0%
58	8	42	5.3	0.0%	0.0%	0.0%	12.5%	50.0%	37.5%
59	8	8	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
60	9	38	4.2	0.0%	11.1%	11.1%	22.2%	55.6%	0.0%
61	9	26	2.9	11.1%	33.3%	33.3%	0.0%	22.2%	0.0%
62	9	9	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
63	8	44	5.5	0.0%	0.0%	0.0%	0.0%	50.0%	50.0%
64	8	43	5.4	0.0%	0.0%	0.0%	12.5%	37.5%	50.0%
65	6	31	5.2	0.0%	0.0%	0.0%	16.7%	50.0%	33.3%
66	6	26	4.3	0.0%	0.0%	33.3%	16.7%	33.3%	16.7%
67	6	28	4.7	0.0%	0.0%	33.3%	0.0%	33.3%	33.3%
68	10	50	5.0	0.0%	10.0%	0.0%	20.0%	20.0%	50.0%
69	10	53	5.3	0.0%	0.0%	10.0%	0.0%	40.0%	50.0%
70	10	53	5.3	0.0%	0.0%	0.0%	10.0%	50.0%	40.0%
71	10	30	3.0	20.0%	40.0%	0.0%	10.0%	20.0%	10.0%
72	11	38	3.5	9.1%	18.2%	18.2%	27.3%	27.3%	0.0%
73	11	32	2.9	18.2%	36.4%	0.0%	27.3%	18.2%	0.0%
74	11	11	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
75	8	36	4.5	0.0%	0.0%	12.5%	25.0%	62.5%	0.0%
76	8	37	4.6	0.0%	0.0%	12.5%	12.5%	75.0%	0.0%
77	8	38	4.8	0.0%	0.0%	0.0%	37.5%	50.0%	12.5%
78	8	37	4.6	0.0%	0.0%	12.5%	25.0%	50.0%	12.5%
79	8	35	4.4	0.0%	0.0%	12.5%	37.5%	50.0%	0.0%
80	7	36	5.1	0.0%	0.0%	28.6%	0.0%	0.0%	71.4%
81	7	34	4.9	0.0%	14.3%	0.0%	14.3%	28.6%	42.9%
82	7	33	4.7	0.0%	0.0%	14.3%	28.6%	28.6%	28.6%

83	7	37	5.3	0.0%	0.0%	0.0%	14.3%	42.9%	42.9%
84	7	33	4.7	0.0%	0.0%	14.3%	28.6%	28.6%	28.6%
85	5	20	4.0	0.0%	20.0%	0.0%	60.0%	0.0%	20.0%
86	5	15	3.0	0.0%	20.0%	60.0%	20.0%	0.0%	0.0%
87	5	21	4.2	0.0%	0.0%	20.0%	40.0%	40.0%	0.0%
88	5	21	4.2	0.0%	0.0%	40.0%	0.0%	60.0%	0.0%
89	5	23	4.6	0.0%	20.0%	0.0%	20.0%	20.0%	40.0%
90	5	19	3.8	0.0%	40.0%	0.0%	20.0%	20.0%	20.0%
91	5	17	3.4	0.0%	20.0%	40.0%	20.0%	20.0%	0.0%
92	5	24	4.8	0.0%	0.0%	0.0%	40.0%	40.0%	20.0%
93	9	42	4.7	0.0%	11.1%	0.0%	22.2%	44.4%	22.2%
94	9	36	4.0	0.0%	11.1%	33.3%	11.1%	33.3%	11.1%
95	9	40	4.4	0.0%	0.0%	11.1%	44.4%	33.3%	11.1%
96	9	9	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
97	7	35	5.0	0.0%	0.0%	0.0%	28.6%	42.9%	28.6%
98	7	31	4.4	0.0%	14.3%	0.0%	28.6%	42.9%	14.3%
99	7	25	3.6	0.0%	14.3%	42.9%	28.6%	0.0%	14.3%
100	7	27	3.9	0.0%	14.3%	28.6%	14.3%	42.9%	0.0%
101	7	14	2.0	28.6%	57.1%	0.0%	14.3%	0.0%	0.0%
102	7	17	2.4	28.6%	28.6%	14.3%	28.6%	0.0%	0.0%
103	7	15	2.1	14.3%	71.4%	0.0%	14.3%	0.0%	0.0%
104	7	24	3.4	0.0%	28.6%	14.3%	42.9%	14.3%	0.0%
105	8	38	4.8	0.0%	0.0%	12.5%	25.0%	37.5%	25.0%
106	8	41	5.1	0.0%	0.0%	0.0%	37.5%	12.5%	50.0%
107	8	38	4.8	0.0%	0.0%	25.0%	12.5%	25.0%	37.5%
108	8	22	2.8	12.5%	50.0%	12.5%	12.5%	0.0%	12.5%
109	8	19	2.4	12.5%	62.5%	0.0%	25.0%	0.0%	0.0%
110	8	17	2.1	25.0%	50.0%	12.5%	12.5%	0.0%	0.0%
111	10	49	4.9	0.0%	0.0%	0.0%	20.0%	70.0%	10.0%
112	10	29	2.9	10.0%	30.0%	30.0%	20.0%	10.0%	0.0%
113	10	10	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%

114	11	58	5.3	0.0%	0.0%	9.1%	0.0%	45.5%	45.5%
115	11	45	4.1	9.1%	9.1%	0.0%	45.5%	18.2%	18.2%
116	11	34	3.1	9.1%	27.3%	36.4%	9.1%	9.1%	9.1%
117	11	27	2.5	18.2%	45.5%	18.2%	9.1%	9.1%	0.0%
118	7	18	2.6	42.9%	14.3%	14.3%	14.3%	0.0%	14.3%
119	7	7	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
120	7	7	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
121	8	45	5.6	0.0%	0.0%	0.0%	0.0%	37.5%	62.5%
122	8	39	4.9	0.0%	0.0%	12.5%	0.0%	75.0%	12.5%
123	8	42	5.3	0.0%	0.0%	0.0%	12.5%	50.0%	37.5%
124	8	41	5.1	0.0%	0.0%	0.0%	25.0%	37.5%	37.5%
125	11	50	4.5	0.0%	0.0%	9.1%	45.5%	27.3%	18.2%
126	11	45	4.1	0.0%	9.1%	9.1%	54.5%	18.2%	9.1%
127	11	41	3.7	0.0%	9.1%	45.5%	18.2%	18.2%	9.1%
128	11	11	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
129	11	46	4.2	0.0%	0.0%	18.2%	45.5%	36.4%	0.0%
130	11	11	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
131	11	36	3.3	0.0%	27.3%	36.4%	27.3%	0.0%	9.1%
132	11	32	2.9	9.1%	36.4%	27.3%	18.2%	0.0%	9.1%
133	11	43	3.9	0.0%	18.2%	9.1%	45.5%	18.2%	9.1%
134	11	48	4.4	0.0%	18.2%	0.0%	27.3%	36.4%	18.2%
135	6	28	4.7	0.0%	0.0%	16.7%	33.3%	16.7%	33.3%
136	6	26	4.3	0.0%	0.0%	16.7%	50.0%	16.7%	16.7%
137	6	6	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
138	6	26	4.3	0.0%	0.0%	33.3%	16.7%	33.3%	16.7%
139	6	24	4.0	0.0%	0.0%	50.0%	16.7%	16.7%	16.7%
140	5	25	5.0	0.0%	0.0%	20.0%	0.0%	40.0%	40.0%
141	5	20	4.0	0.0%	20.0%	20.0%	20.0%	20.0%	20.0%
142	5	19	3.8	0.0%	20.0%	20.0%	20.0%	40.0%	0.0%

143	9	46	5.1	0.0%	0.0%	0.0%	22.2%	44.4%	33.3%
144	9	46	5.1	0.0%	0.0%	11.1%	0.0%	55.6%	33.3%
145	9	47	5.2	0.0%	0.0%	0.0%	11.1%	55.6%	33.3%
146	6	30	5.0	0.0%	0.0%	0.0%	33.3%	33.3%	33.3%
147	6	6	1.0	100.0%	0.0%	0.0%	0.0%	0.0%	0.0%
148	6	28	4.7	0.0%	0.0%	16.7%	16.7%	50.0%	16.7%
149	6	31	5.2	0.0%	0.0%	0.0%	16.7%	50.0%	33.3%
150	6	31	5.2	0.0%	0.0%	16.7%	0.0%	33.3%	50.0%
151	6	32	5.3	0.0%	0.0%	0.0%	16.7%	33.3%	50.0%
152	7	35	5.0	0.0%	0.0%	0.0%	28.6%	42.9%	28.6%
153	7	24	3.4	14.3%	14.3%	14.3%	28.6%	28.6%	0.0%
154	7	26	3.7	0.0%	14.3%	28.6%	28.6%	28.6%	0.0%
155	7	31	4.4	0.0%	0.0%	14.3%	42.9%	28.6%	14.3%

## Appendix H: IRB Approval


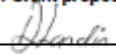
ACTION ON EXEMPTION APPROVAL REQUEST		 Institutional Review Board Dr. Dennis Landin, Chair 130 David Boyd Hall Baton Rouge, LA 70803 P: 225.578.8692 F: 225.578.5983 <a href="mailto:irb@lsu.edu">irb@lsu.edu</a>   <a href="http://lsu.edu/irb">lsu.edu/irb</a>
TO:	Ravikumar Chimmalgil Mechanical & Industrial Engineering	
FROM:	Dennis Landin Chair, Institutional Review Board	
DATE:	October 20, 2014	
RE:	IRB# E8986	
TITLE:	Automated Conversion of Text Instructions to Human Motion Animation	
New Protocol/Modification/Continuation: <u>New Protocol</u>		
Review Date: <u>10/17/2014</u>		
Approved <u>X</u> Disapproved _____		
Approval Date: <u>10/17/2014</u> Approval Expiration Date: <u>10/16/2017</u>		
Exemption Category/Paragraph: <u>2b</u>		
Signed Consent Waived?: <u>Yes if the consent form is distributed online; No if consent form is presented in person.</u>		
Re-review frequency: <u>(three years unless otherwise stated)</u>		
LSU Proposal Number (if applicable): _____		
Protocol Matches Scope of Work in Grant proposal: (if applicable) _____		
By: Dennis Landin, Chairman 		
<b>PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –</b>		
Continuing approval is <b>CONDITIONAL</b> on:		
<ol style="list-style-type: none"><li>1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects</li><li>2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.</li><li>3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.</li><li>4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.</li><li>5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants, including notification of new information that might affect consent.</li><li>6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.</li><li>7. Notification of the IRB of a serious compliance failure.</li><li>8. <b>SPECIAL NOTE:</b> *All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at <a href="http://www.lsu.edu/irb">http://www.lsu.edu/irb</a></li></ol>		

Figure 24: IRB Approval

### Consent Form

1. **Study Title:** Automated Conversion of Text Instruction to Human Motion Animation
2. **Performance Site:** Louisiana State University and Agricultural and Mechanical College
3. **Investigators:** The following investigators are available for questions about this study,  
M-F, 9:00 a.m. - 4:30p.m.  
Ravikumar Chimmaji 225-614-8427
4. **Purpose of the Study:** The purpose of this study is to evaluate the system developed by the principle investigator to determine its accuracy of the text to animation conversion and get user feedback on future improvements.
5. **Subject Inclusion:** Individuals between the ages of 18 and 65 who do not report psychological or neurological conditions.
6. **Number of subjects:** 30
7. **Study Procedures:** In this study, subjects will create a user account on a computer/web application to evaluate the text to animation conversion system. In each test case, the application shows an animation generated from text instructions as well as a video of a real human following the same instructions. After observing both the depictions, subjects will spend approximately 5-10 minutes completing a questionnaire, comparing and contrasting the system generated animation with the human video. After clicking the submit button, they will be shown a new test case with a different set of text instruction as well as corresponding animation and video depictions and also a fresh questionnaire. Subjects will be asked to evaluate at least 5 test cases, but they are welcome to do more if they choose.
8. **Benefits:** The study will determine the accuracy of the system in text to animation conversion. If successful, the system can be extended for use in the domains of physical therapy and rehabilitation, special operations, storytelling, crime scene investigation etc.
9. **Risks:** The only study risk is the inadvertent release of subjects' account information. No confidential information except for the subject's name and age will be asked while creating the account. However, every effort will be made to maintain the confidentiality of your study records. Data will be kept on a secure server to which only the investigator has access.
10. **Right to Refuse:** Subjects may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.
11. **Privacy:** Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law.
12. **Signatures:** The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Dennis Landin, Institutional Review Board, (225) 578-8692, irb@lsu.edu, www.lsu.edu/irb. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

Subject Signature: \_\_\_\_\_ Date: \_\_\_\_\_

Figure 25: Consent Form

## **Vita**

Ravikumar V. Chimmalgi was born in Gokak, India in 1989. After completing high school in Panvel, India, in 2007, he obtained his bachelor's degree in Computer Science from Louisiana State University, Baton Rouge, Louisiana, in 2011. He began working towards the degree of Master of Science in Engineering Science with concentration in Information Technology and Engineering at Louisiana State University in 2011. During his time as a graduate student, he worked as a graduate assistant for Louisiana State Youth Opportunities Unlimited (LSYOU). His degree will be conferred at the Summer Commencement, August 2015.