CS 775: Advanced Computer Graphics

Lecture 21 : Motion Graphs

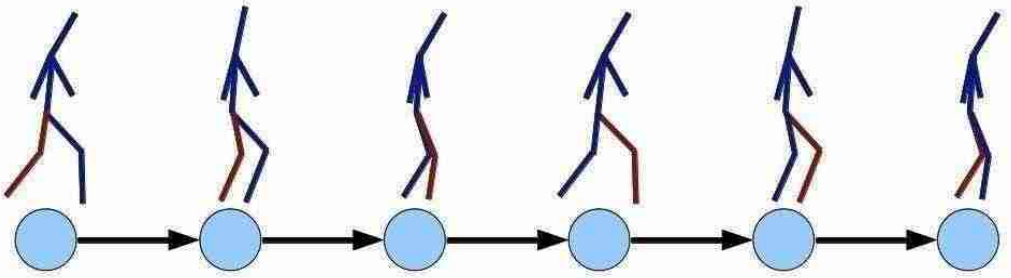
Motion Graphs

- Given
  - Database of Motion Clips
  - Constraints or a Query
- Problem
  - No single motion in the database will satisfy all the constraints or the query
- Solution
  - Join motions together, to synthesize a new motion and try to satisfy the constraints

Motion Graphs - Idea

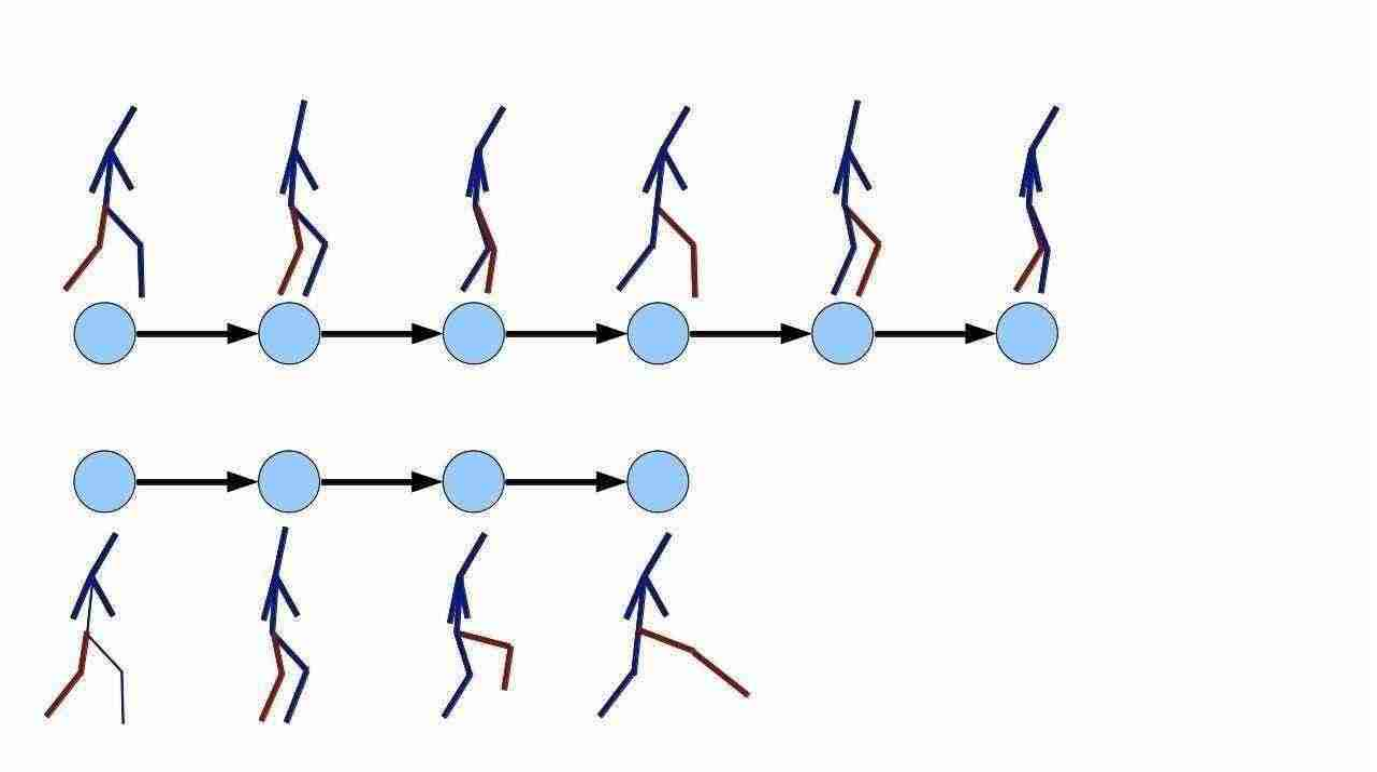
Every motion clip is a graph.

Vertex ~ pose, Edge ~ transition frames.



Motion Graphs - Idea

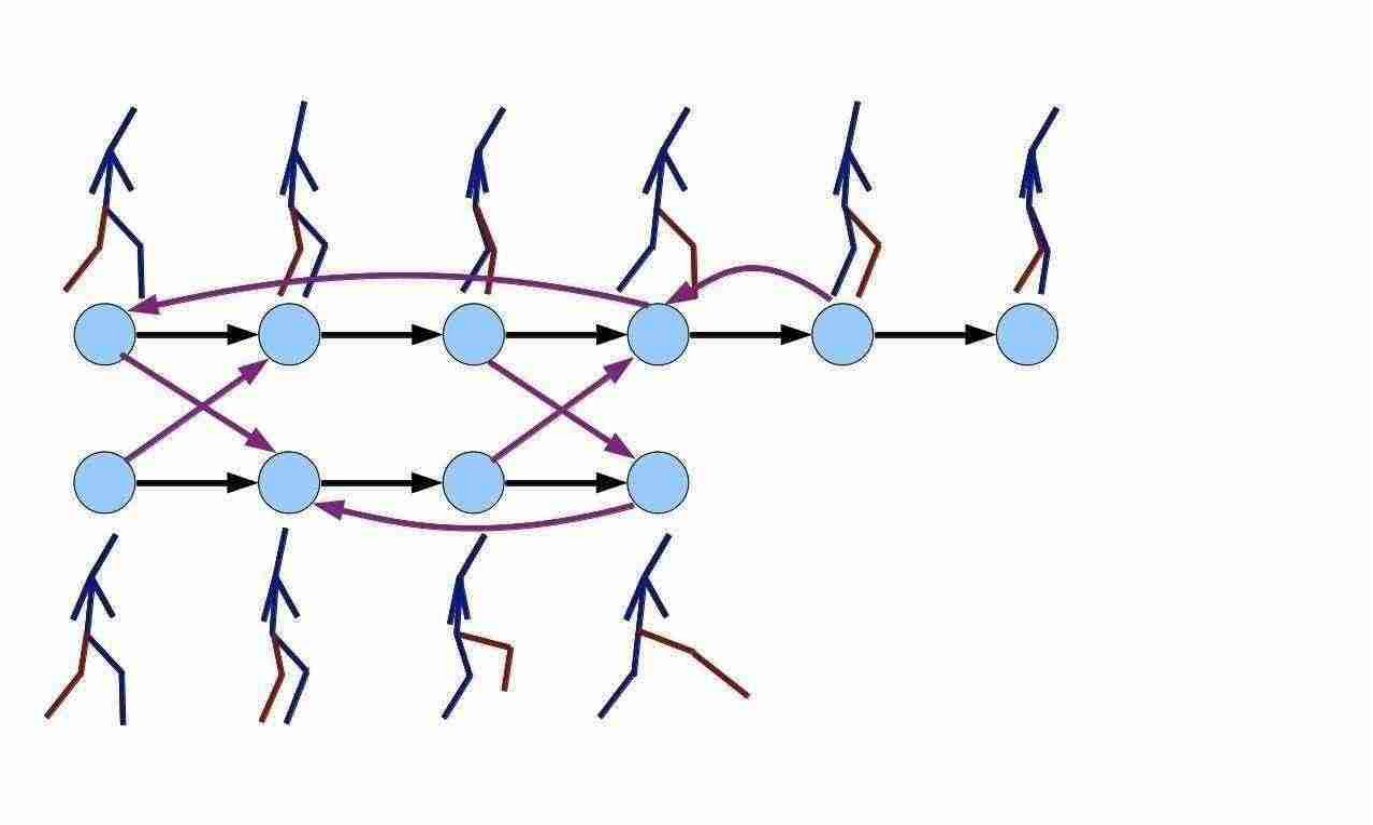
There are many such clips in a motion database.



Motion Graphs - Idea

Find similar poses between clips.

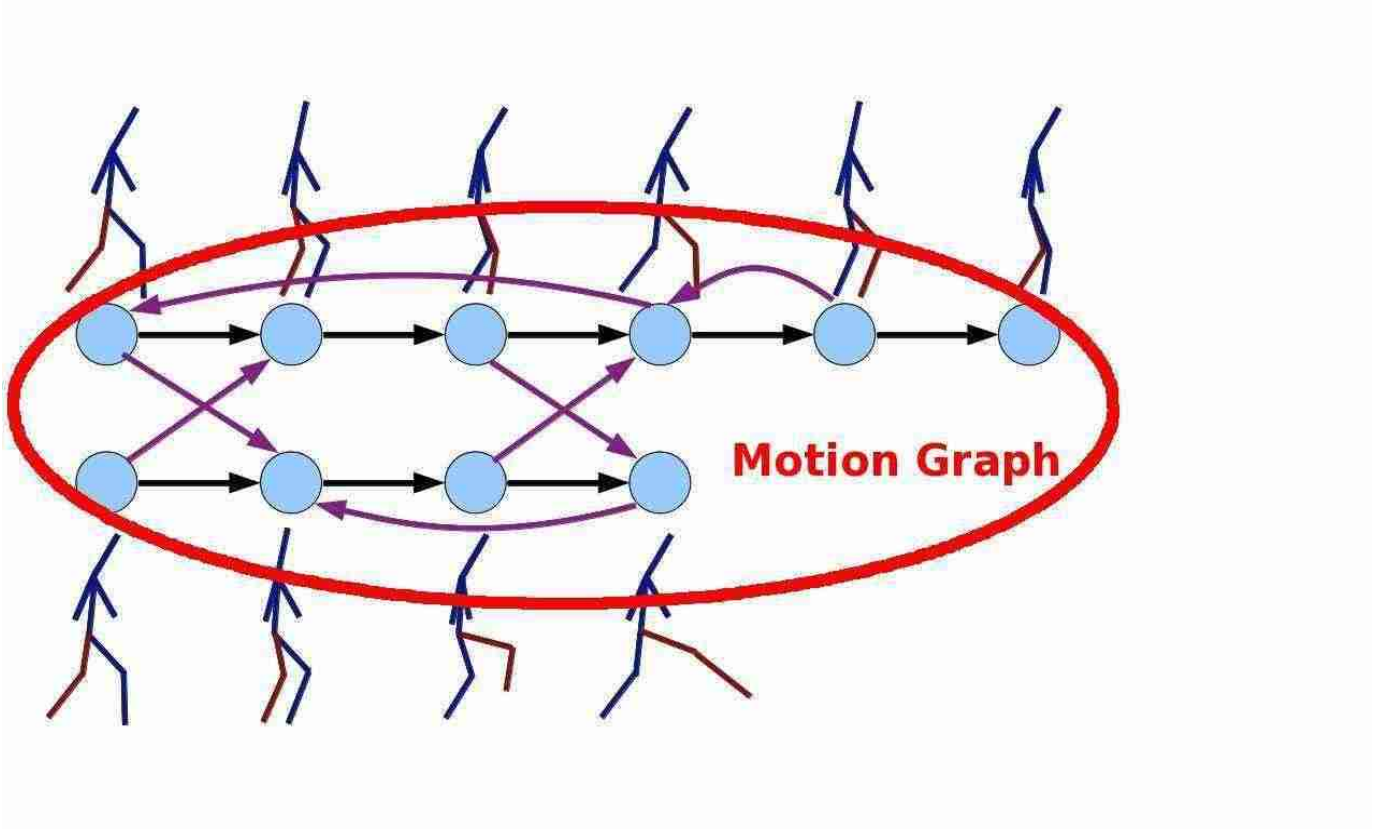
Add transitions between them.



Motion Graphs - Idea

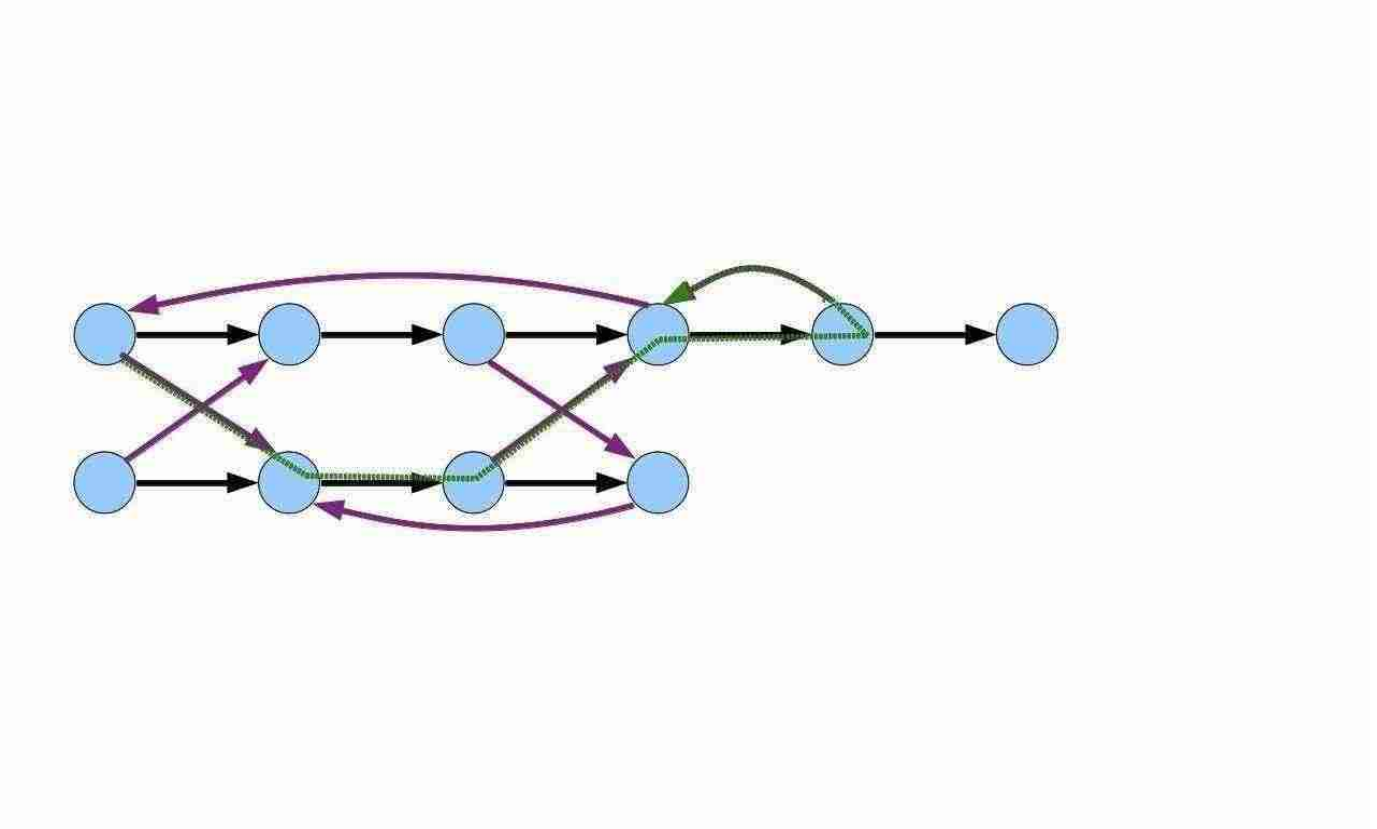
Find similar poses between clips.

Add transitions between them.



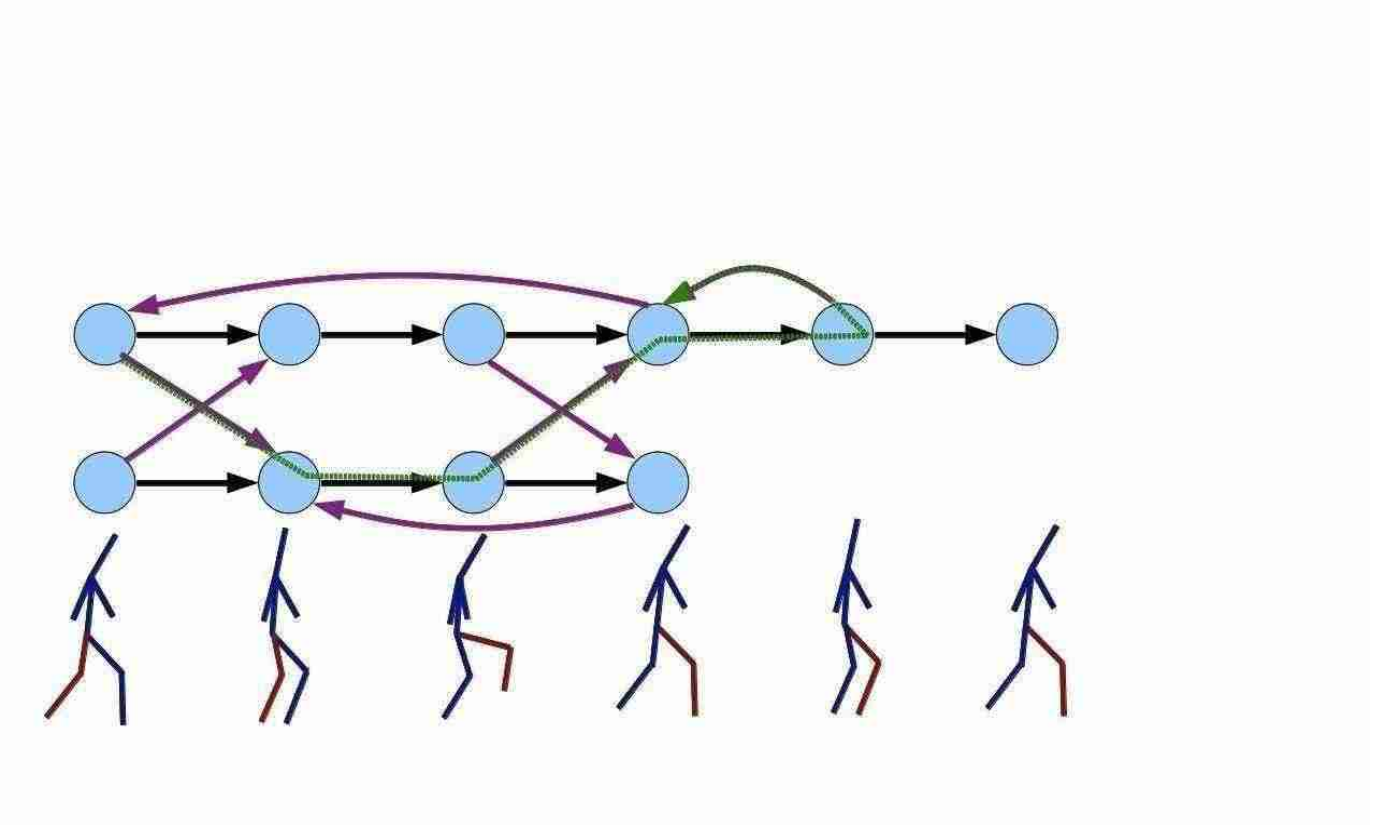
Motion Graphs - Idea

Now any walk on this graph...



Motion Graphs - Idea

...generates a new motion.

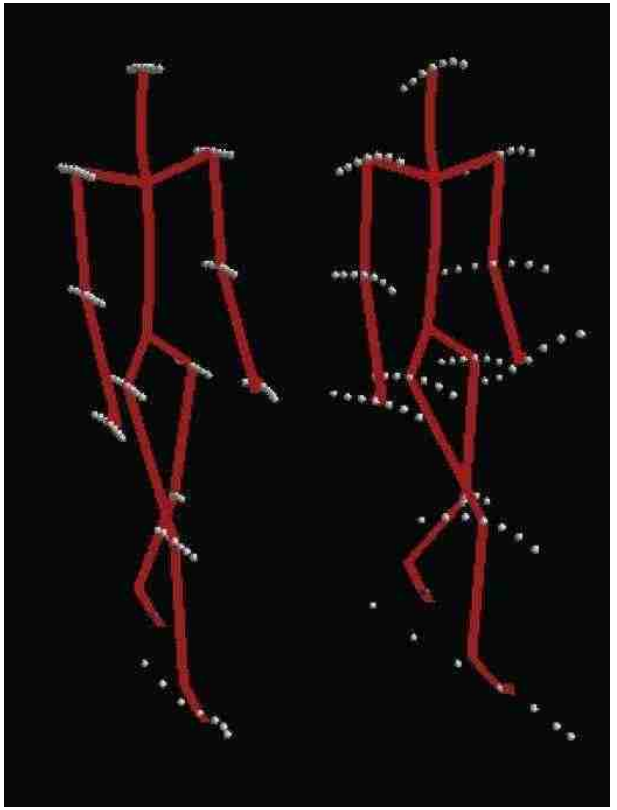


Motion Graphs - Construction

- Similarity between poses across clips
  - Identify compatible coordinate systems.
  - Account for changes in body pose.
  - Account for changes in joint-velocity and acceleration.
  - Relative importance of joints.

Motion Graphs - Construction

$$D(P_i, P_j) = \min_{\theta, x_o, z_o} \sum_{k=1}^{n} \omega_k \| p_i^k - T_{\theta, x_o, z_o} p_j^k \|^2$$

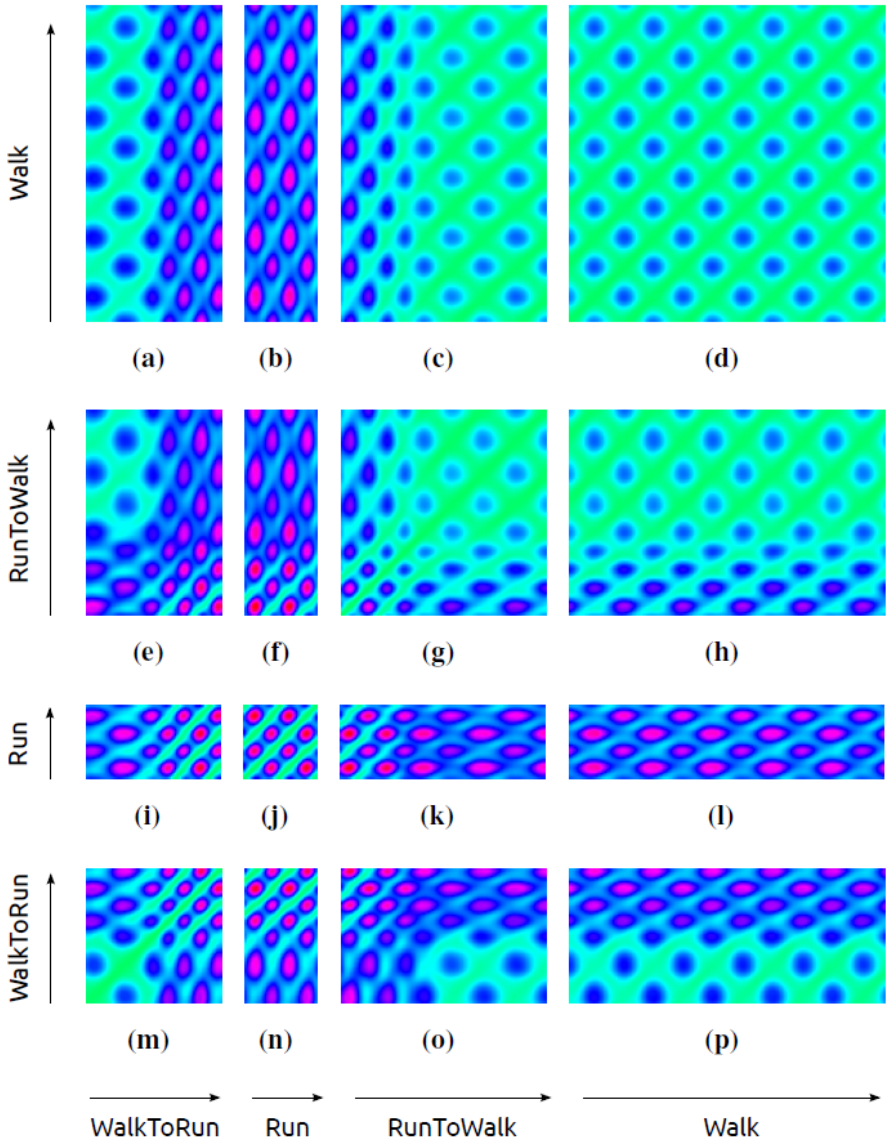


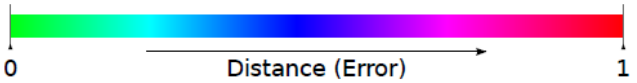
Compute distance over a window of $2L+1$ frames centered at P_i and P_j

Constructing Good Quality Motion Graphs for Realistic Human Animation, Limin Zhaog, PhD Thesis, University of Pennsylvania, 2009.

Motion Graphs, Lucas Kovar, Michael Gleicher and Frederic Pighin, SIGGRAPH 2002.

Motion Graphs - Construction





(q)

Fig.	Y-axis clip *	X-axis clip*
(a)	Walk	WalkToRun
(b)	Walk	Run
(c)	Walk	RunToWalk
(d)	Walk	Walk
(e)	RunToWalk	WalkToRun
(f)	RunToWalk	Run
(g)	RunToWalk	RunToWalk
(h)	RunToWalk	Walk
(i)	Run	WalkToRun
(j)	Run	Run
(k)	Run	RunToWalk
(l)	Run	Walk
(m)	WalkToRun	WalkToRun
(n)	WalkToRun	Run
(o)	WalkToRun	RunToWalk
(p)	WalkToRun	Walk

*Note: The lower left corner represents beginning of both clips in each figure.

Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2011

Motion Graphs - Construction

- Create transitions between similar frames.
- Retain the largest strongly connected component.
- Linear interpolation of translations, SLERP for rotations.

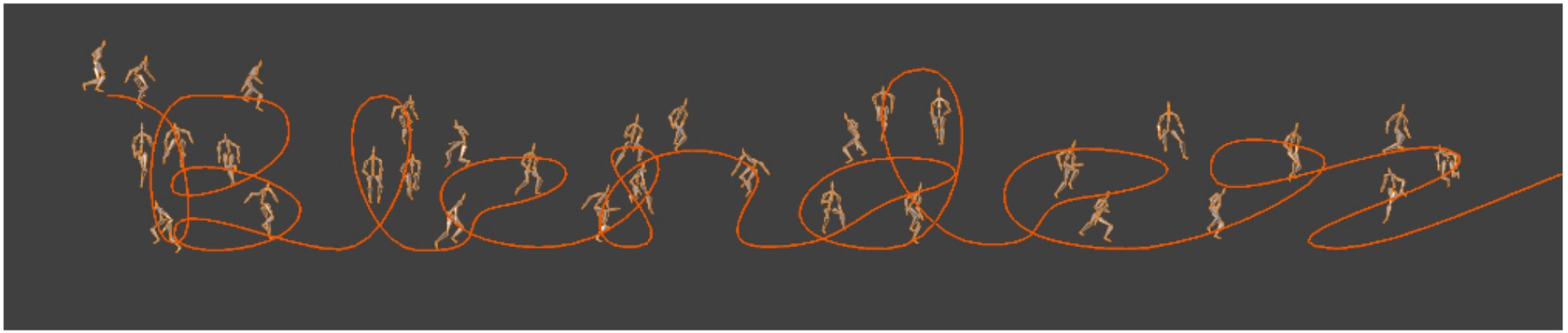
Motion Graphs, Lucas Kovar, Michael Gleicher and Frederic Pighin, SIGGRAPH 2002.

Parag Chaudhuri

Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2011

Motion Graphs – Generating Motion

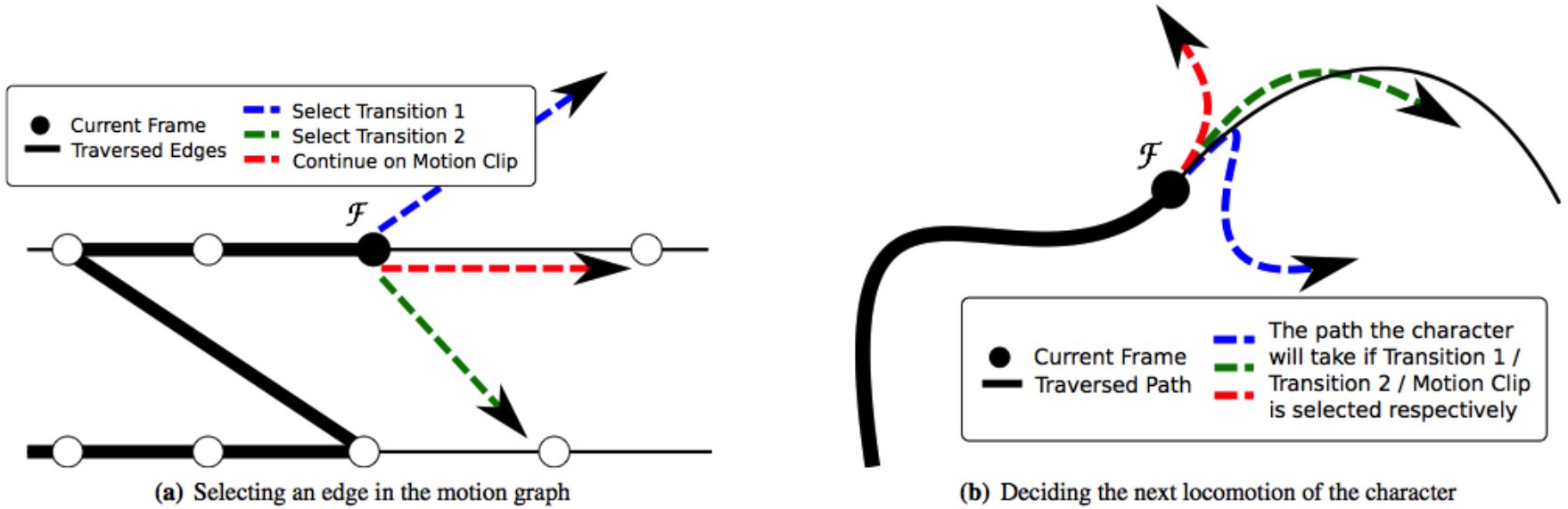
- Follow a path – minimize a "path follow" function during the graph walk.



Path Synthesis for Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2012

Motion Graphs – Generating Motion

- Follow a path – minimize a "path follow" function during the graph walk.



(a) Selecting an edge in the motion graph

(b) Deciding the next locomotion of the character

Figure 1: *Selecting an edge in the motion graph is equivalent to deciding next locomotion of the character*

Path Synthesis for Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2012

Motion Graphs – Generating Motion

- Follow a path – minimize a "path follow" function during the graph walk.

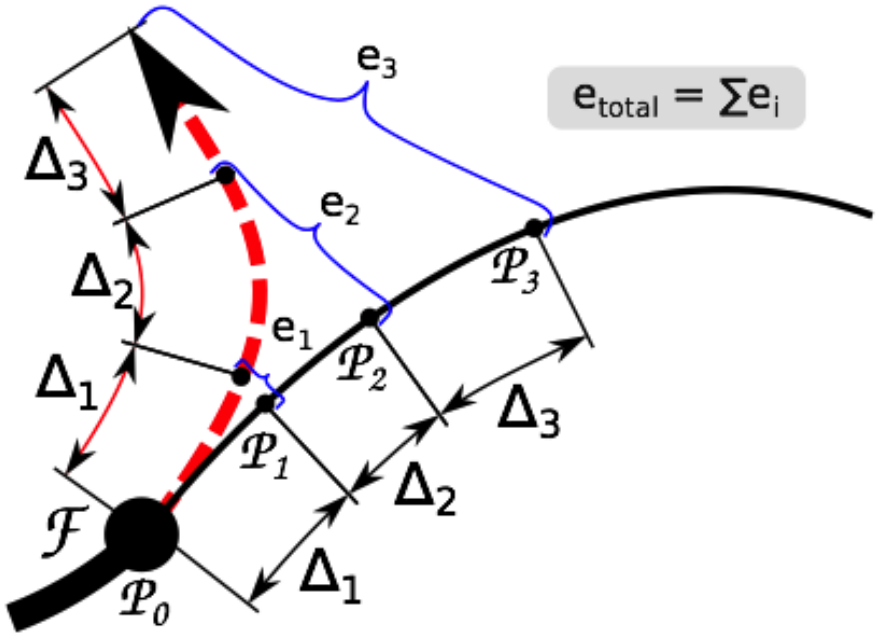
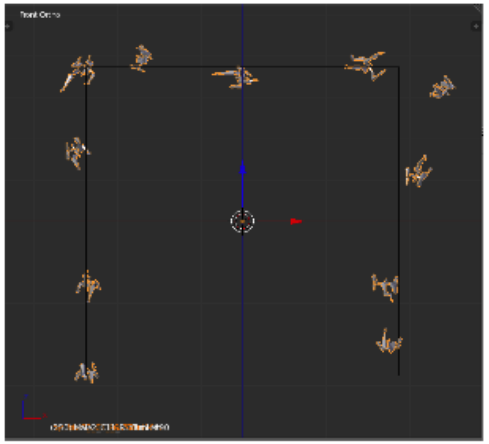


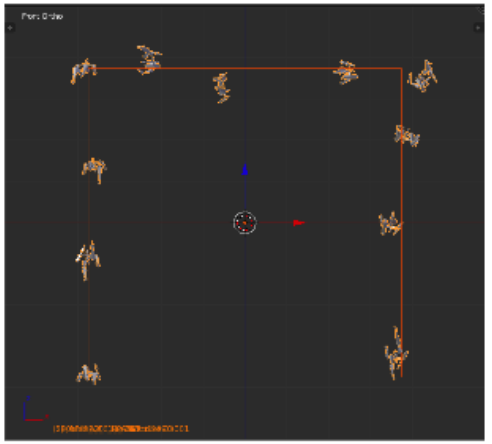
Figure 5: *Finding the deviation of motion from path segment*

Path Synthesis for Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2012

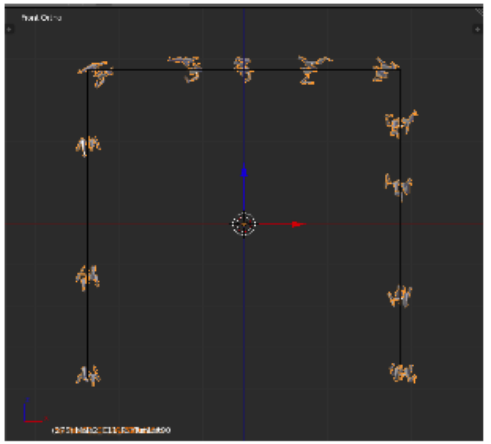
Motion Graphs – Generating Motion



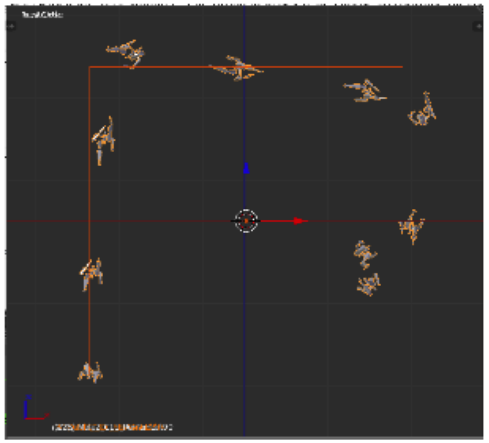
(a) Threshold = 50%, Prediction = 0 frames, No Grouping



(b) Threshold = 50%, Prediction = 5 frames, No Grouping

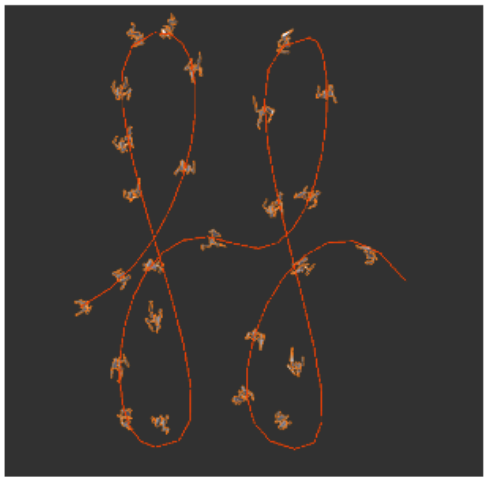


(c) Threshold = 50%, Prediction = 15 frames, No Grouping



(d) Threshold = 50%, Prediction = 15 frames, Inbound and Outbound Grouping

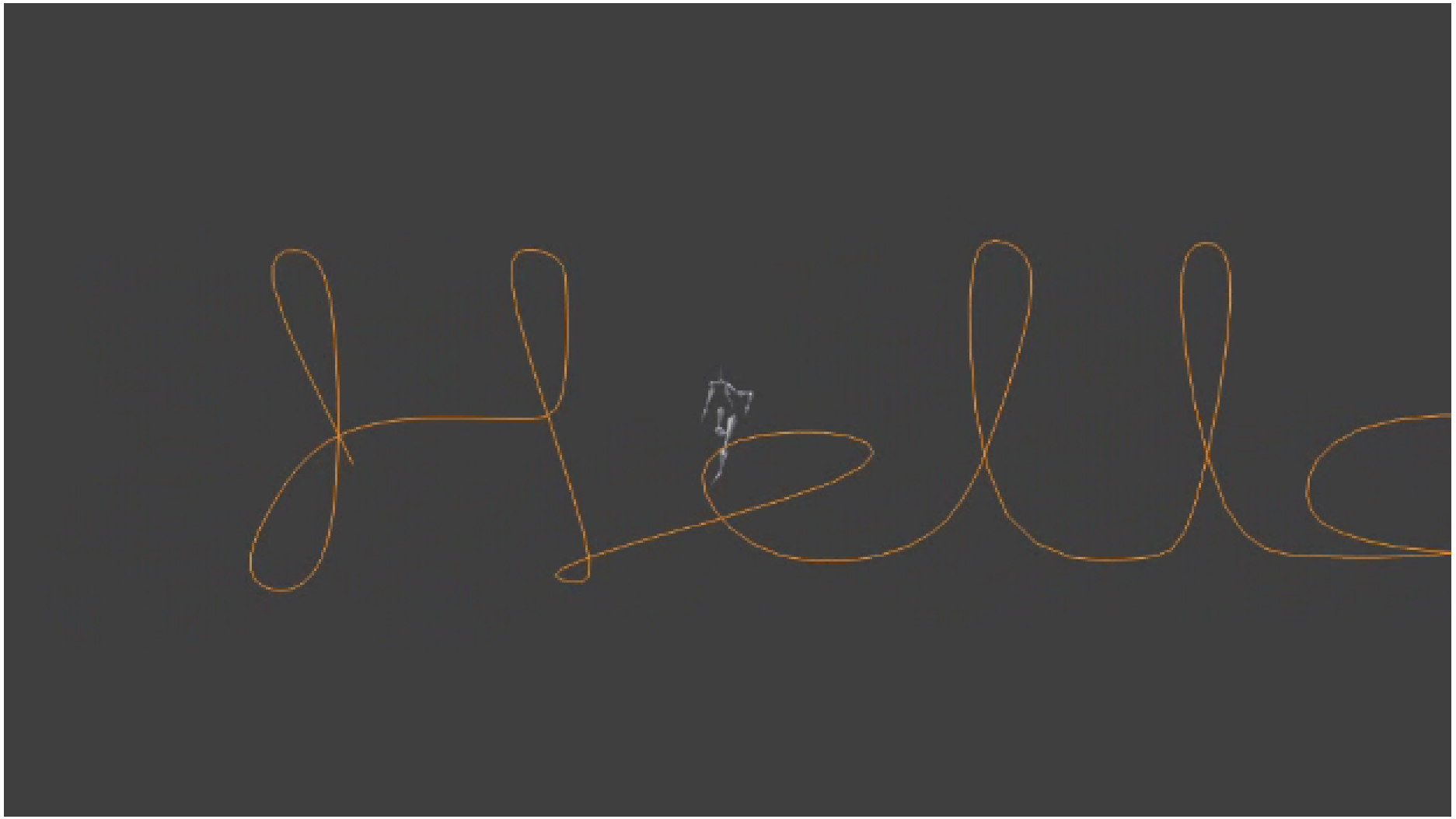
(e) Threshold = 50%, Prediction = 0 frames, Inbound and Outbound Grouping



(f) Threshold = 50%, Prediction = 15 frames, Inbound and Outbound Grouping

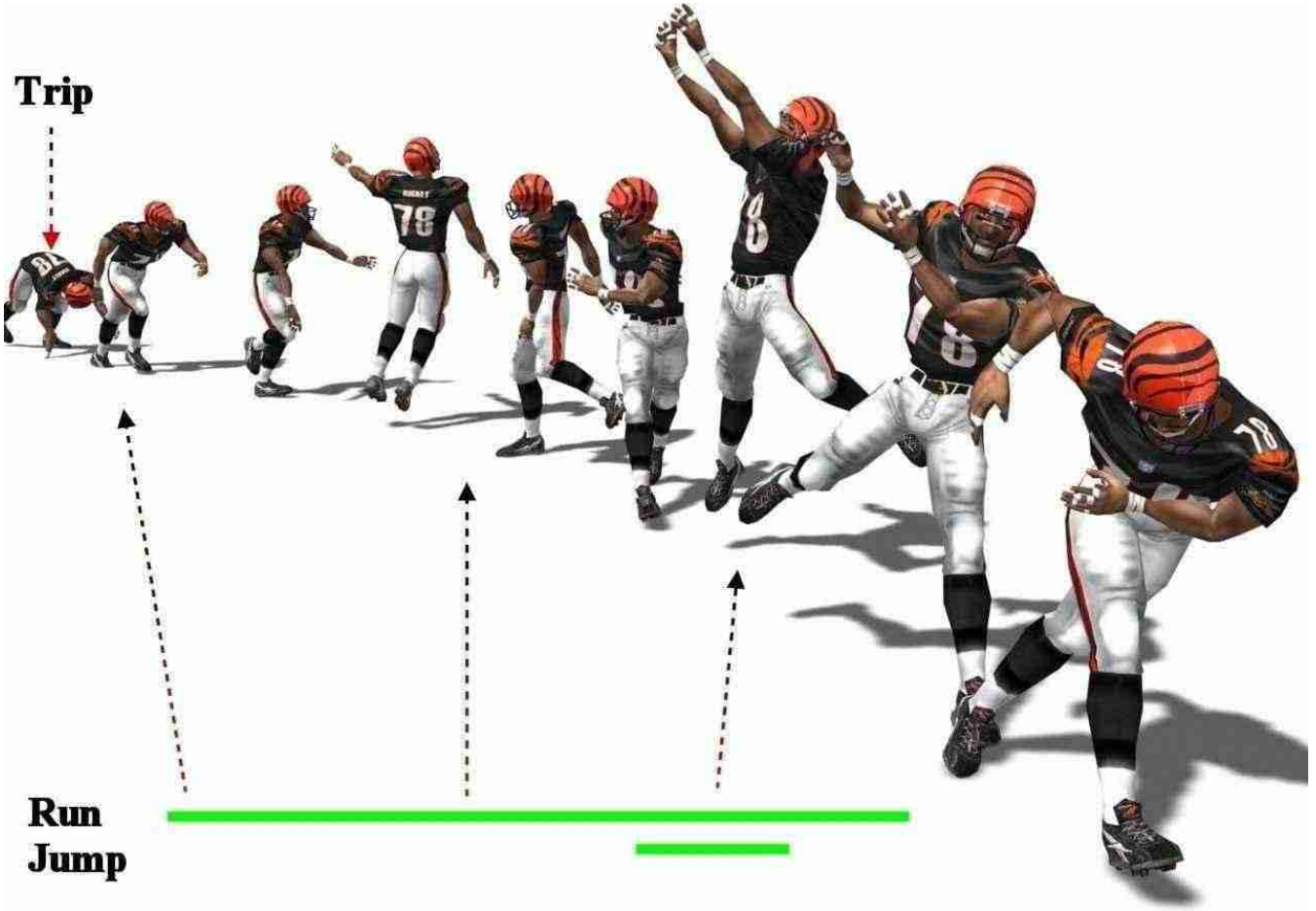
Path Synthesis for Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2012

Motion Graphs – Generating Motion



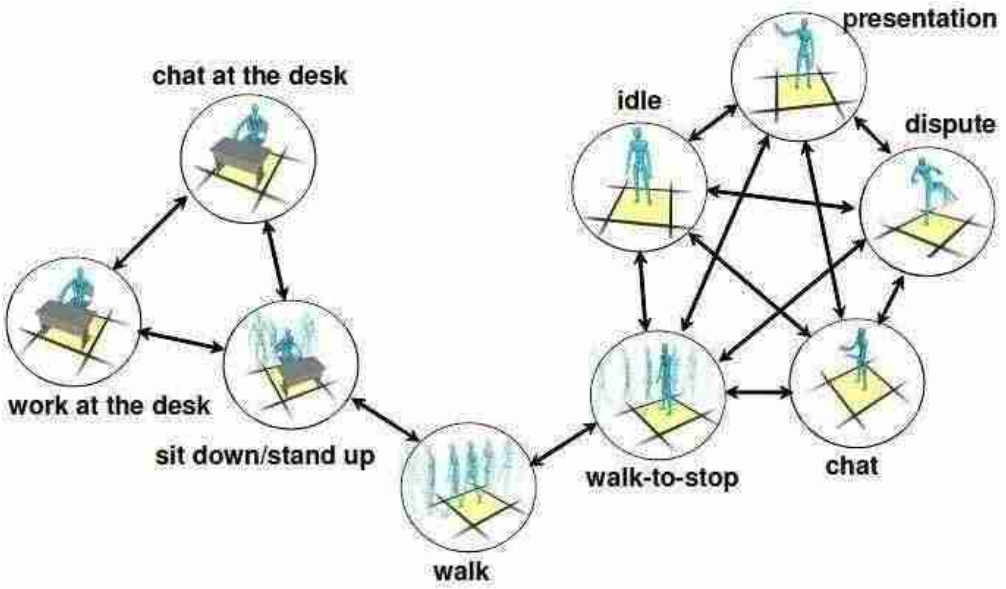
Path Synthesis for Motion Graphs in Blender, Mihir Gokani and Parag Chaudhuri, Blender Conference, 2012

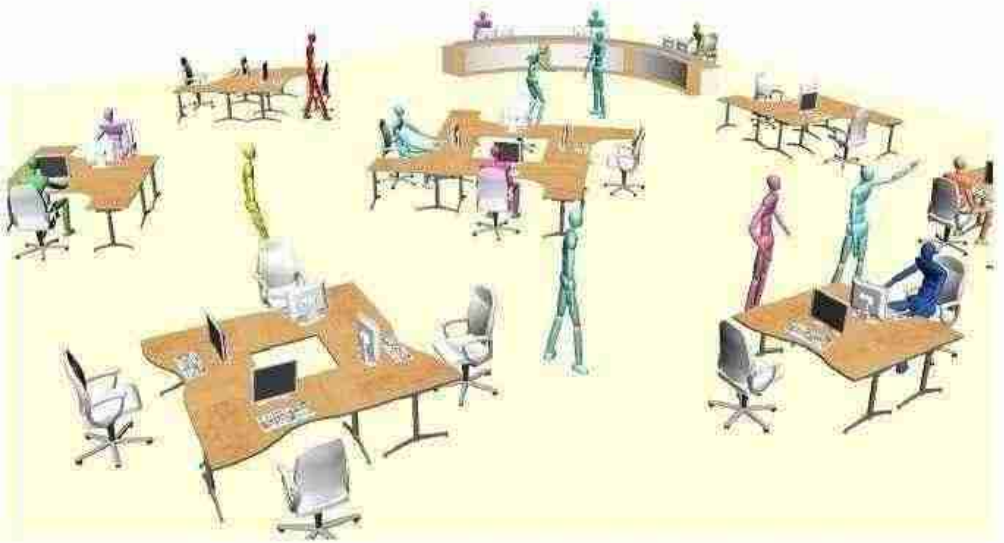
More Motion Graphs



Motion Synthesis from Annotations, Okan Arikan, David Forsyth, James O'Brien, SIGGRAPH 2003

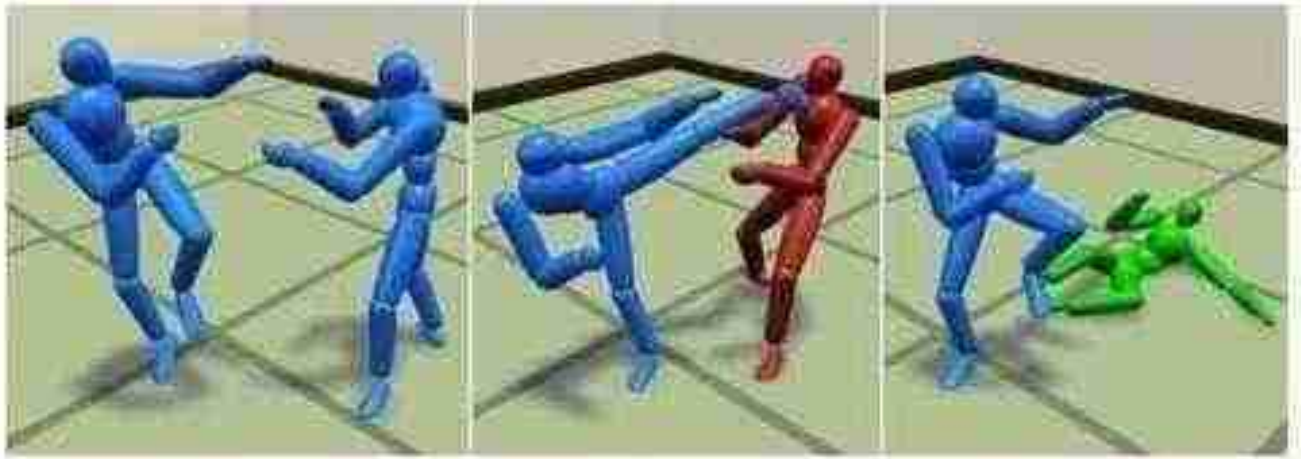
More Motion Graphs





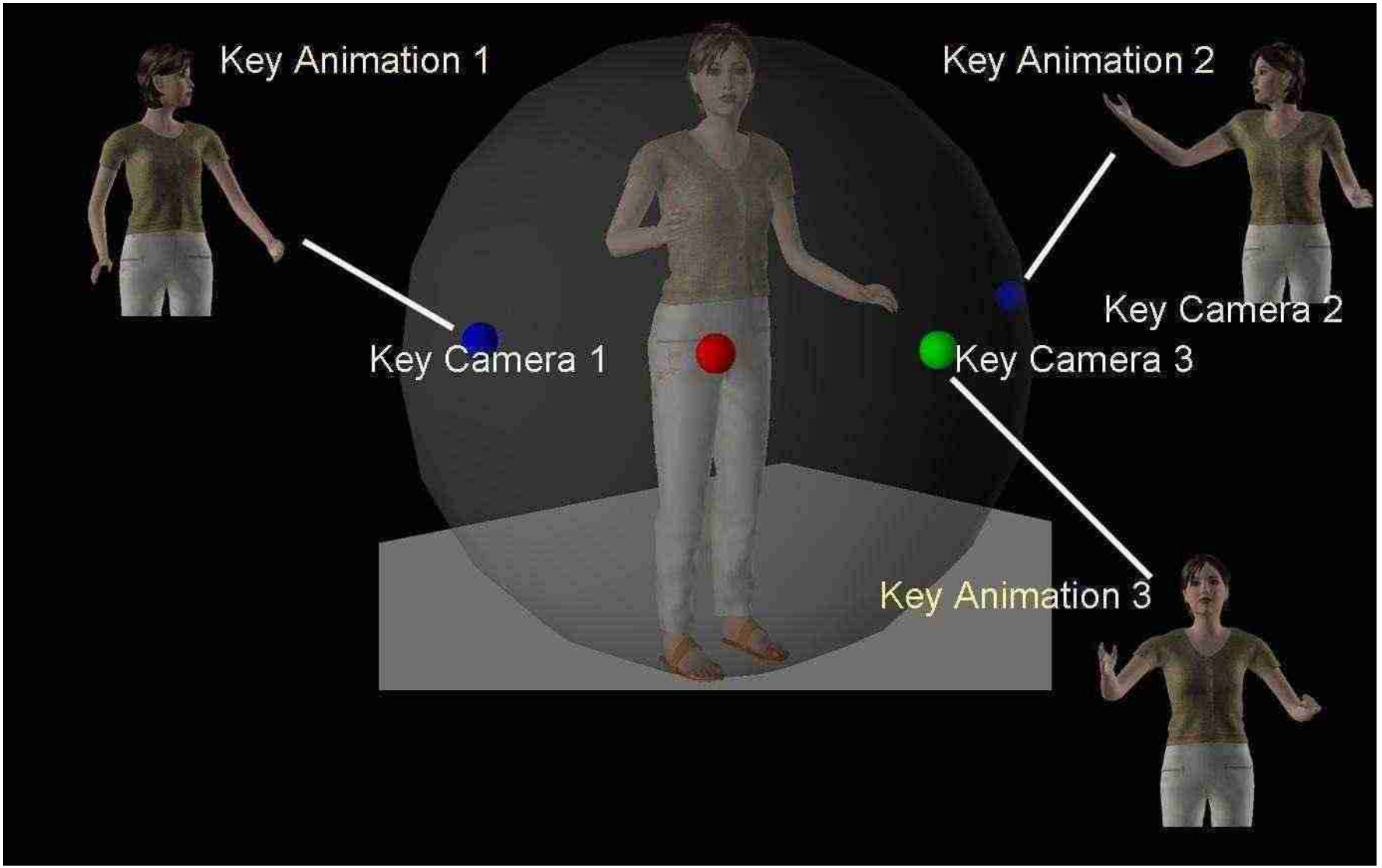
Motion Patches: Building Blocks for Virtual Environments Annotated with Motion Data, Kang Hoon Lee, Myung Geol Choi and Jehee Lee, SIGGRAPH 2006

More Motion Graphs



Dynamic Response for Motion Capture Animation, Victor Zordan, Anna Majkowska, Bill Chiu and Matthew Fast, SIGGRAPH 2005

More Motion Graphs



Self Adaptive Animation based on User Perspective, Parag Chaudhuri, George Papagiannakis, Nadia Magnenat-Thalmann, CGI 2008