Motion Capture Technologies

Jessica Hodgins

Motion Capture

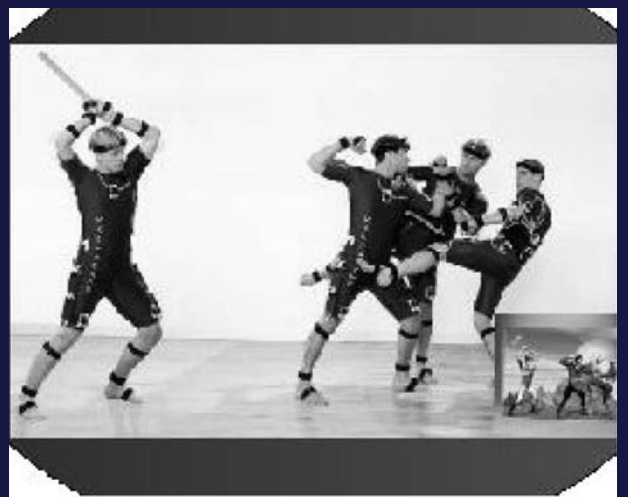
- Animation
- Video Games
- Robot Control

What games use motion capture?

- NBA live
- PGA tour
- NHL hockey
- Legends of Wrestling 2
- Lords of Everquest
- Lord of the Rings
- Tony Hawk Pro Skater
- Batman: Dark Tomorrow
- Grand Theft Auto
- Soul Caliber

Motion Capture

- Track motion of reference points
- Convert to joint angles
- Use angles to drive an articulated model
- Motion paths can then be combined to give greater control

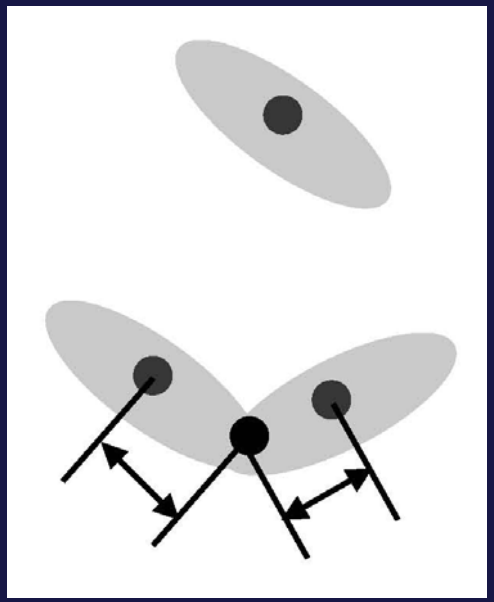


What is Captured?

- What do we need to know?
  - X,Y,Z
  - Roll, pitch, yaw

Errors cause

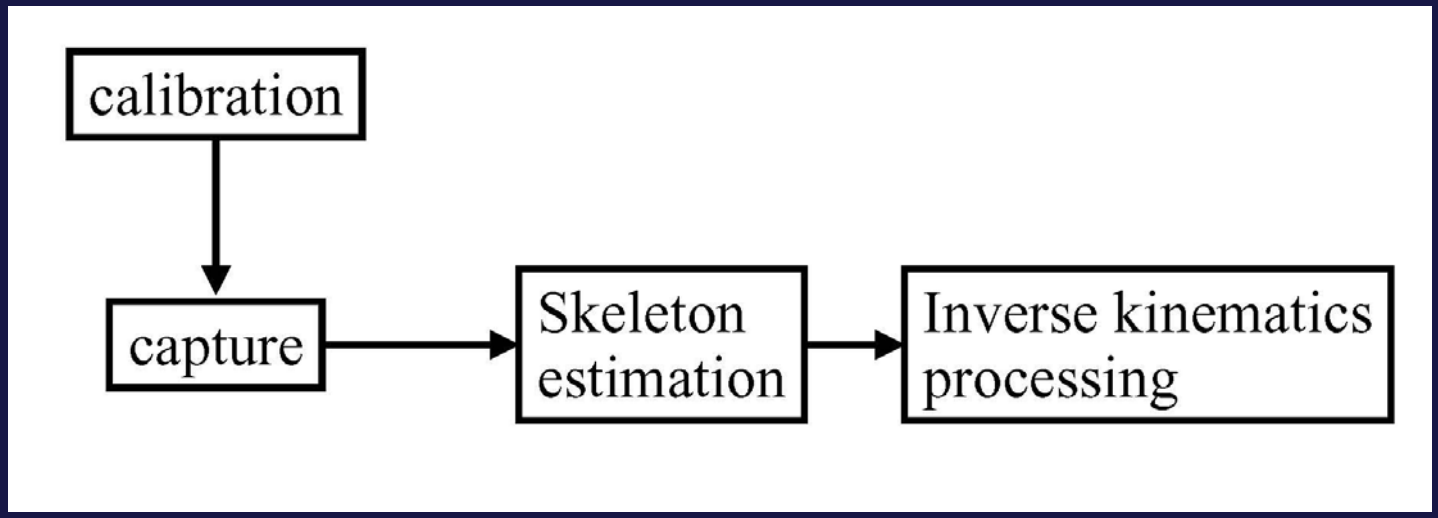
  - Joints to come apart
  - Links to grow/shrink
  - Bad contact points



How to use the data

- Off-line
  - Processing by filter, inverse kinematics
  - Produce libraries of motion
    - Choose among them
    - Blend between them
    - Modify on the fly
- On-line (performance animation)
  - Driving character directly based on what user does in real-time. Konami games (for a few dof)

Production Pipeline



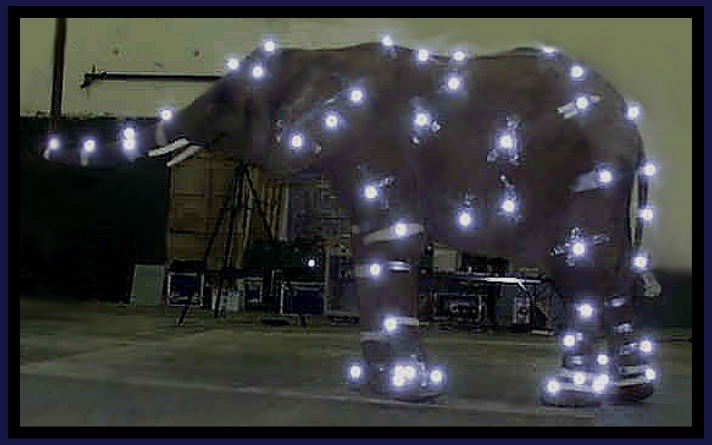
What is captured?

- Dynamic motions?

House of Moves

What is captured?

- Scale?



Motion Analysis

What is captured?

- Non-rigid objects?

House of Moves

What is captured?

- Props often cause problems
  - Ball in pingpong
  - Fly fishing
  - Sword
- Passive behaviors are hard
  - Complicated motion of clothing
  - Explosions

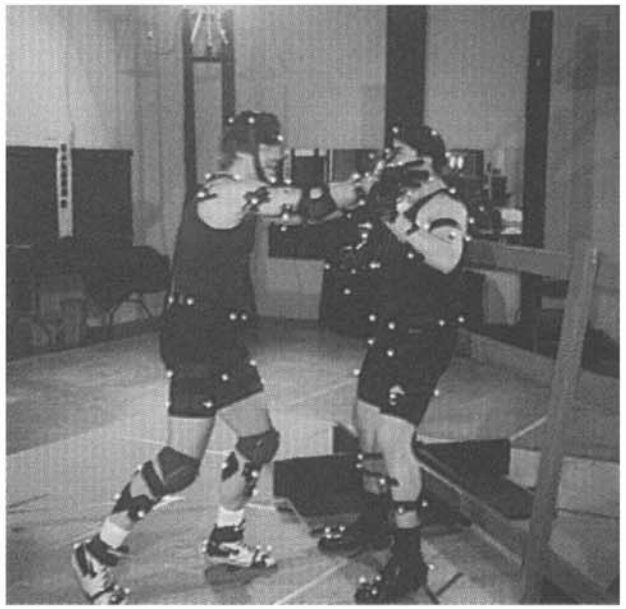
History of the Technology

- Recording motion for biomechanics
  - High accuracy
  - Fewer recorded points
  - Hand digitizing film
  - Supplement with force plate, muscle activity
- Computer animation
  - Rotoscoping
- Robot measurements
  - Selspot LED system
- VR tracking technology
  - Less accuracy required
  - Fewer sensors

Technologies: Optical Passive

Vicon, Motion Analysis

Position of markers only



Technologies: Optical Passive

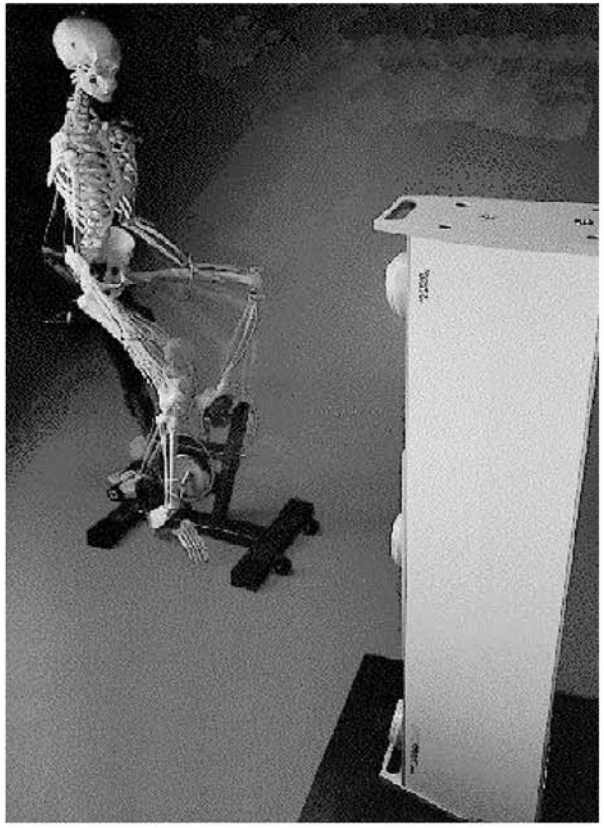
- $180K
- high resolution cameras
  - cameras at 120-240HZ, 1000x1000 pixels
  - IR or visible light strobe
  - 6 characters with 30 markers/each
- not outdoors (no sunlight)
- just recently real time

Technologies: Optical Active

Optitrak

~56 markers at 100 fps

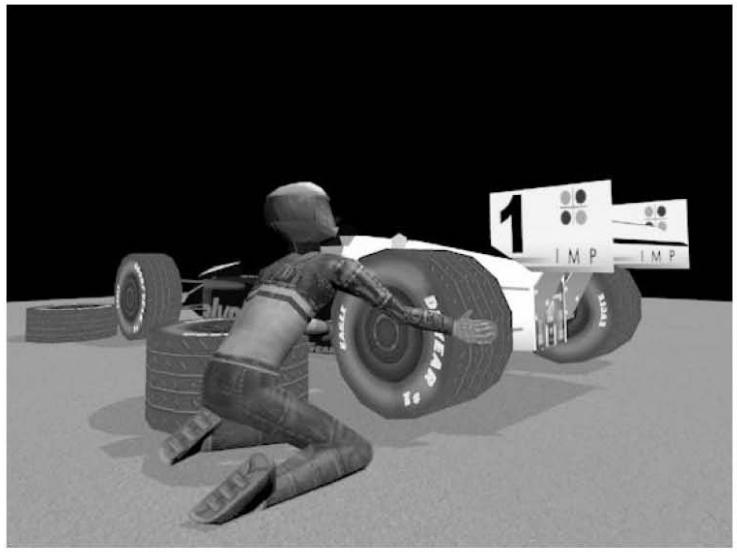
No correspondence problem



Technologies: Magnetic

Ascension, Polhemus

Position and orientation



Technologies: Magnetic

heavier sensors (more flop)

wires on body (wireless back to base station)

both position and orientation information

real time

$70K ($2K/additional marker)

limited accuracy (~10x less accuracy than optical)

smaller workspace

spikes in data -> filtering

~80 hz max

sensors are the cost and so it doesn't scale

sensitive to EMI/ metal, particularly in floor—hard to debug

Technologies: Exoskeleton

Analogous, Sarcos

some restriction of movement

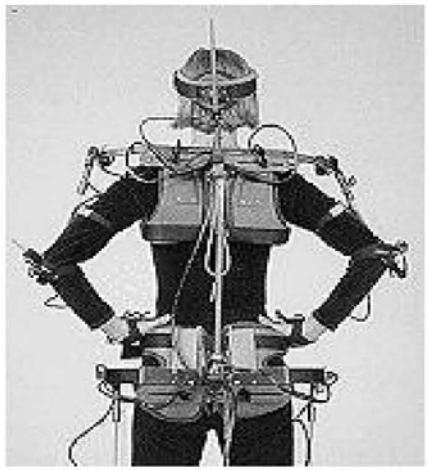
assumptions of transformation to rigid body motion made at time of design of system

another technology needed for the root node

not range limited

high frequency (500 Hz)

truly real-time



Technologies: Monkey

Puppeteering of animated characters

Not exactly motion capture but exoskeleton without the person?

Technology Issues

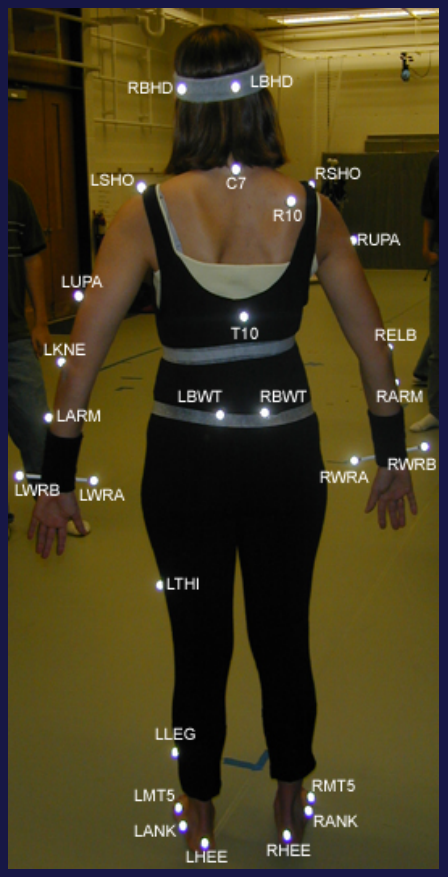
- Resolution/range of motion
- Calibration
- Accuracy
  - Marker movement
  - Capture rate
- Occlusion/correspondence

Marker Placement

- Location should move rigidly with limb
- Stay away from bulging muscles
- Shoulders: skeletal motion not closely tied to skin
- Shoulders: not a rigid body chain

Marker Set

- 3D points -> joint angles
- It matters!
- So do assumptions about human kinematics



Calibration

- Calibration of cameras
  - Fairly automatic with L-bracket and wand
- Calibration of subject
  - Also fairly automatic but not so accurate
  - What are limb lengths
  - What are joint limits?
  - Where are markers wrt to joints?

Eric Darnell, co-director of Antz

The main problem with motion capture associated with characters has to do with mass distribution, weight, and exaggeration. He says that it is impossible for a performer to produce the kind of motion exaggeration that a cartoon character needs, and the mass and weight of the performer almost never looks good when applied to a character of different proportions.

Richard Chuang, VP at PDI

The mapping of human motion to a character with non-human proportions doesn’t work, because the most important things you get out motion capture are the weight shifts and the subtleties and that balancing act of the human body. If the proportions change, you throw all that out the door, so you might as well animate it.

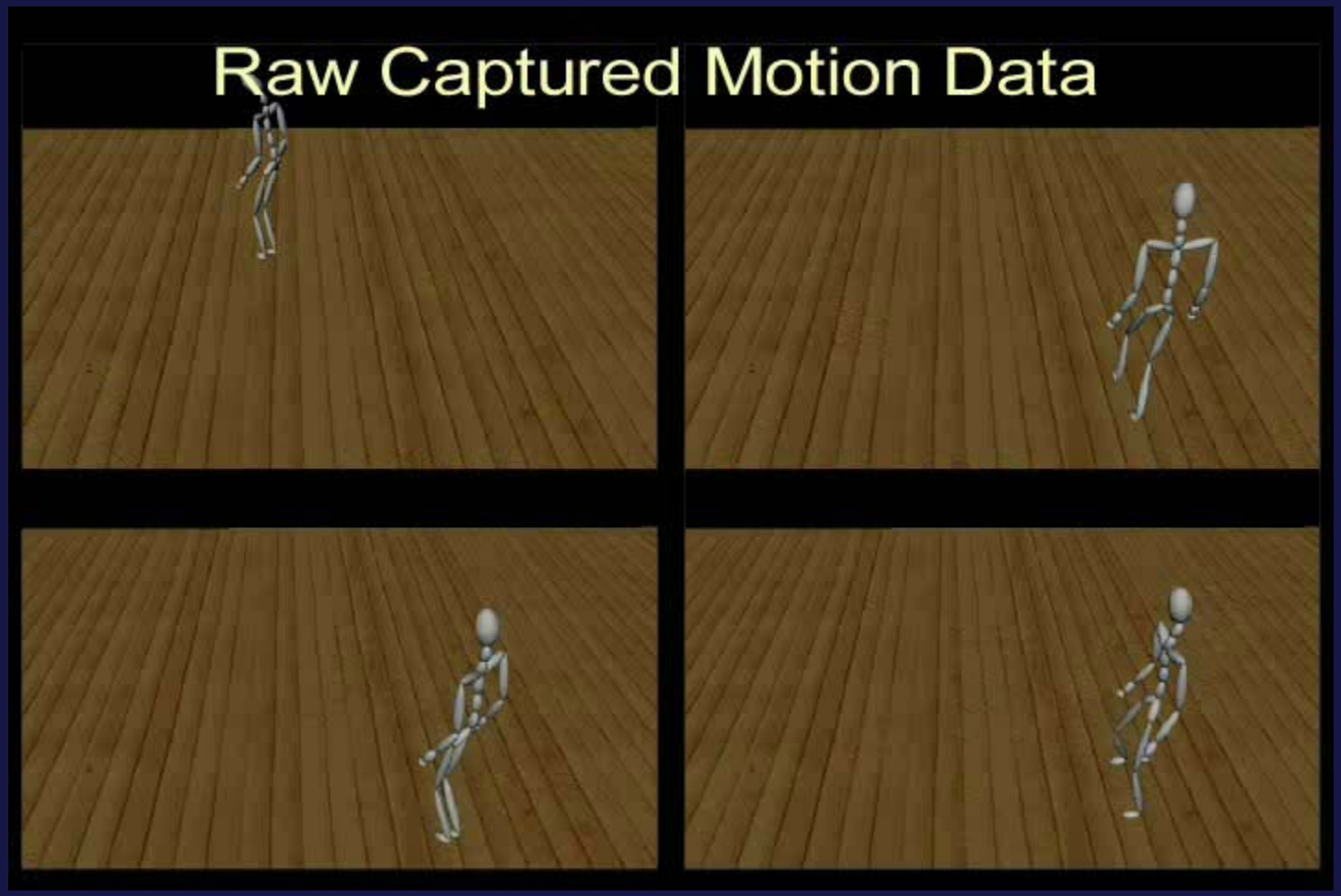
Godzilla: Karen Goulekas

The reason that we pulled the plug on using the motion capture was, very simply, because the motion we captured from the human actor could not give us the lizard-like motion we were seeking. The mocap could also not reflect the huge mass of Godzilla either. During our keyframe tests, we found that the Godzilla motion we wanted was one that maintained the sense of huge mass and weight while still moving in a graceful and agile manner. No human actor could give us this result.

Research Topics

- Marker placement/extraction of skeleton
- Capture of deforming skin rather than pretending it is a rigid chain?
- Retargeting
- Constraint satisfaction
- Generalization of data
  - Interpolation
- Interfaces for controlling human motion

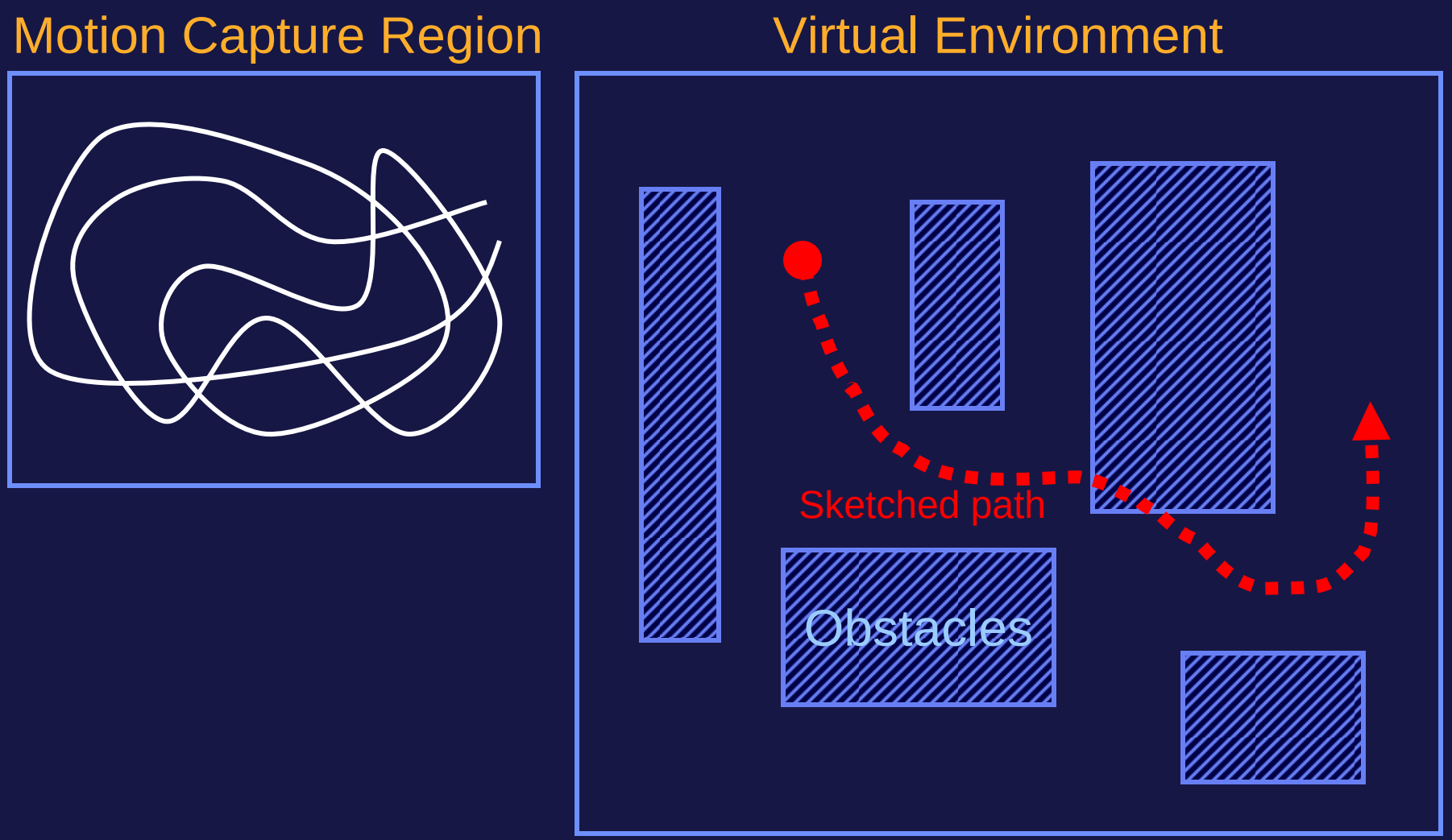
Motion Database



User Specified Path

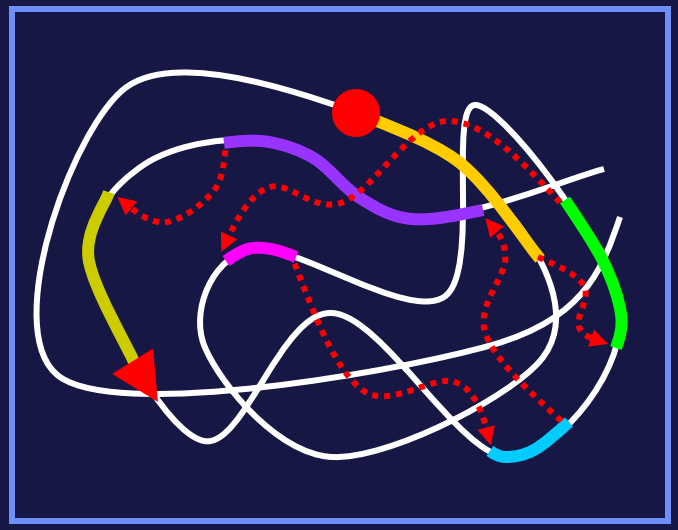
Jehee Lee, Jinxiang Chai, Paul Reitsma, Jessica Hodgins, Nancy Pollard SIGGRAPH 2002

Find Transitions and Re-sequence

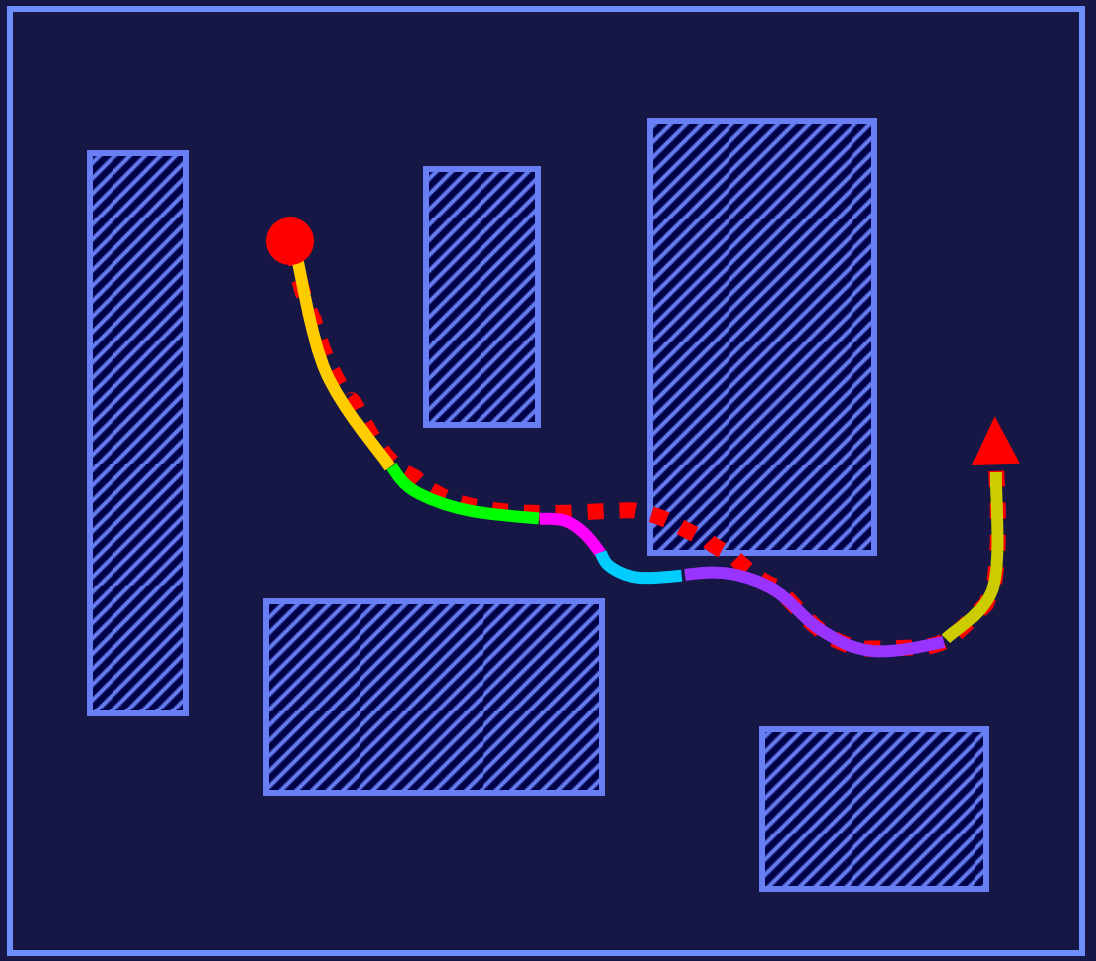


Find Transitions and Re-sequence

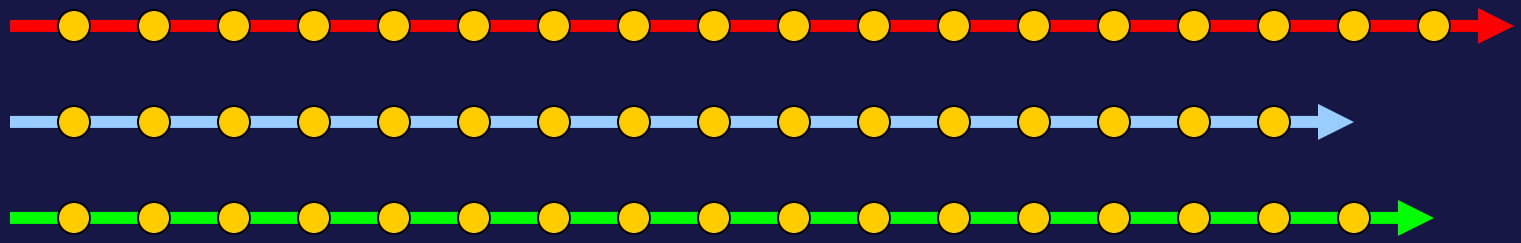
Motion Capture Region



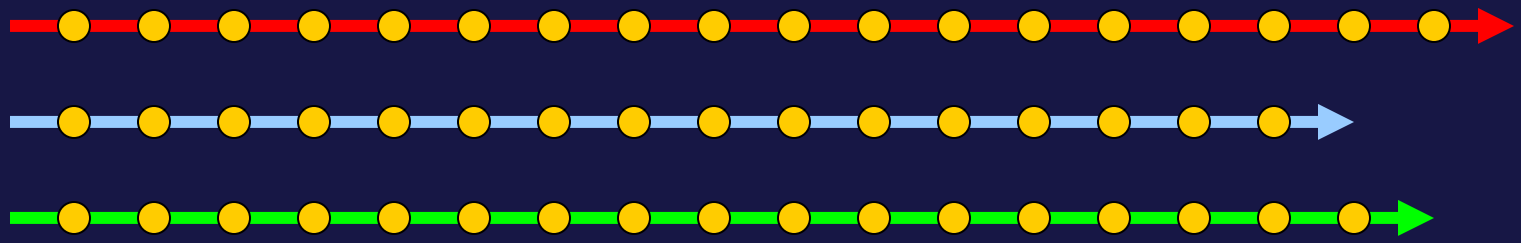
Virtual Environment

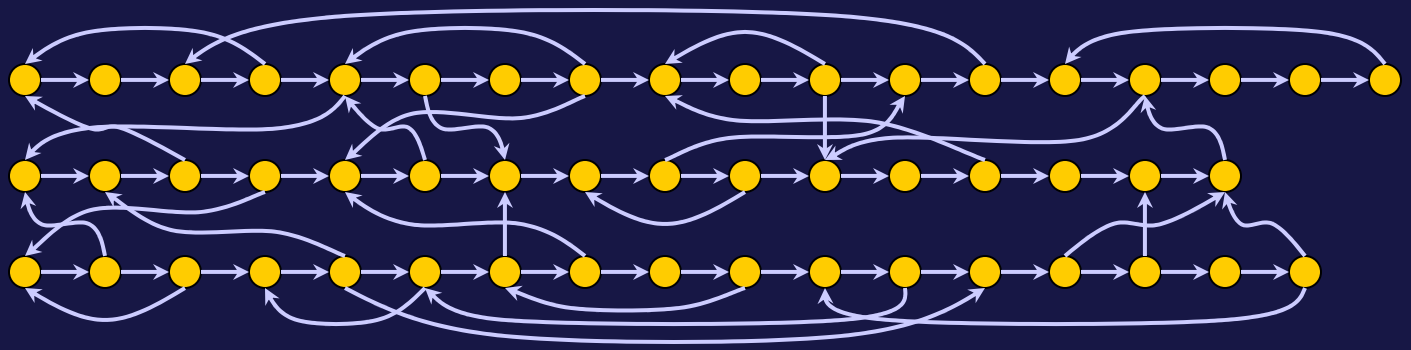


Unstructured Input Data



Connecting Transitions



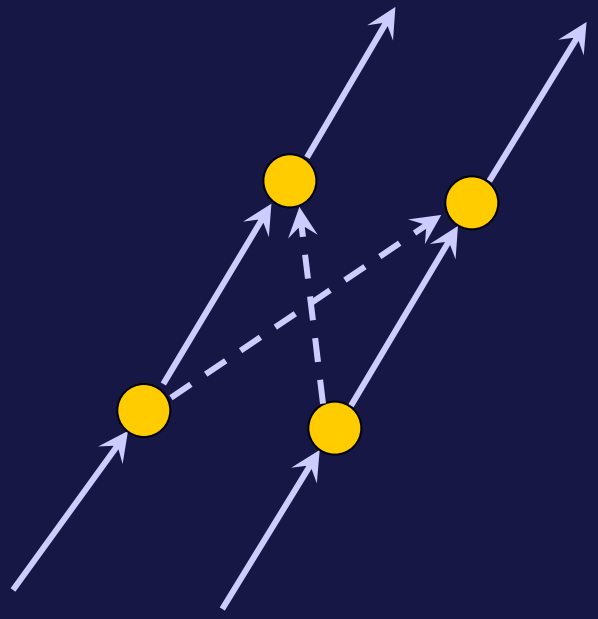


Synthetic Transitions

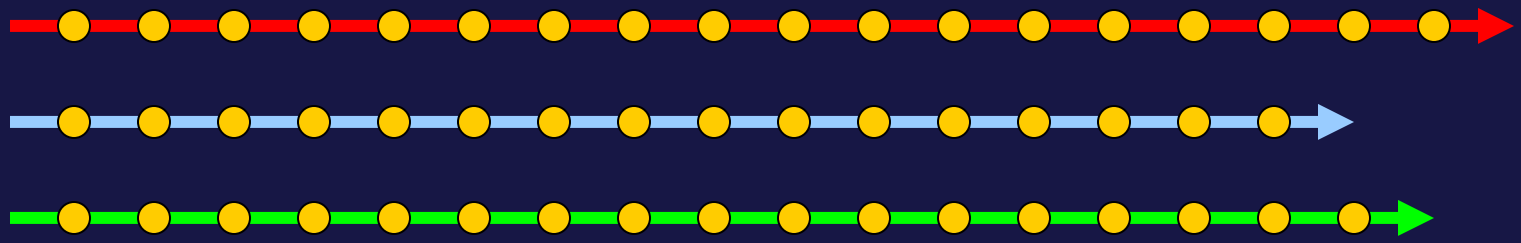
Good transitions taken with high probability

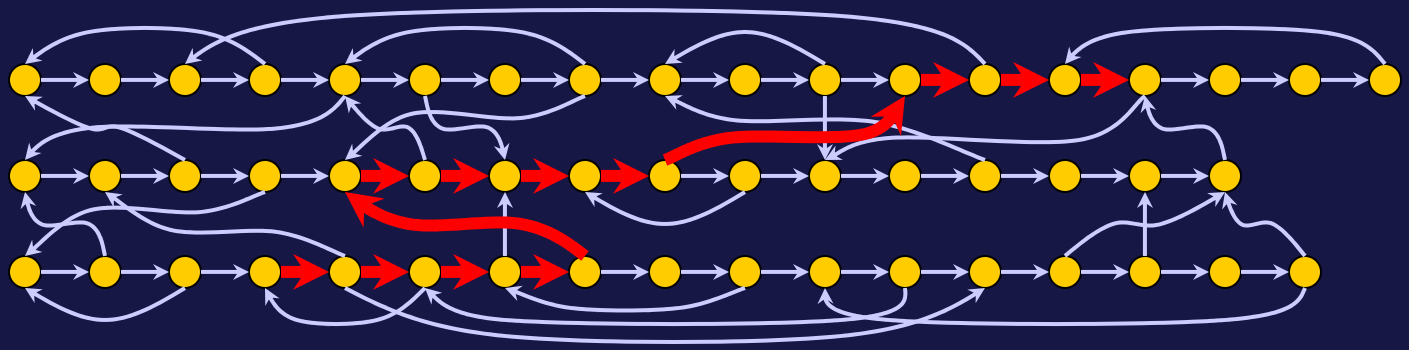
"Video Texture" [Schoedl et al. SIGGRAPH 2000]

- Poses
- Velocities
- Contact state



Search to Find Path





Motion Data for Rough Terrain

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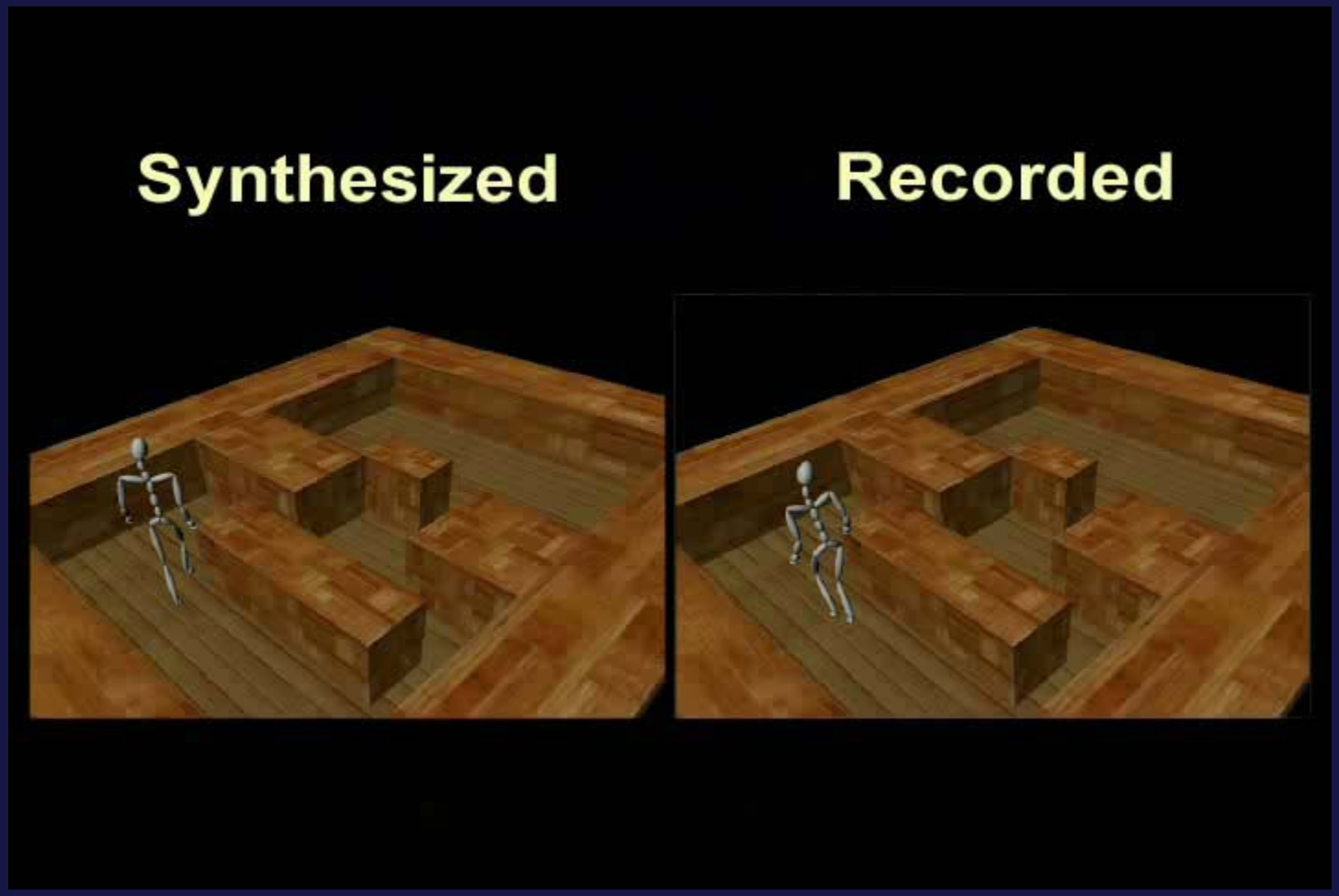
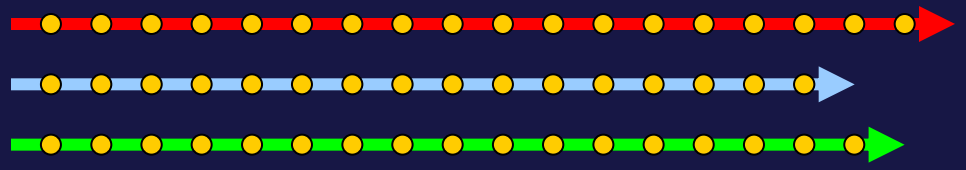
Comparison to Real Motion

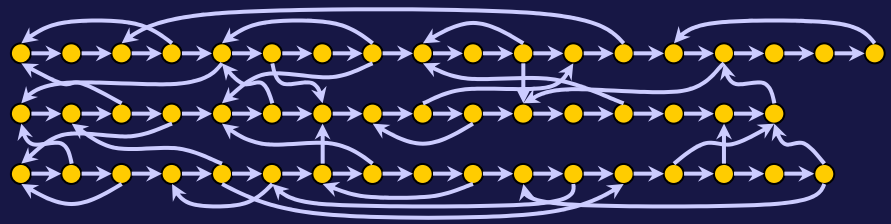
Comparison to Real Motion



What are the tricks?

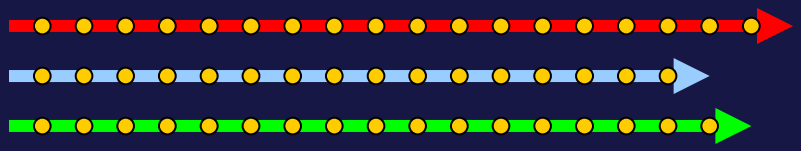
- Enough data?
  - Wash out yaw
  - Only locomotion
- Wash out yaw?

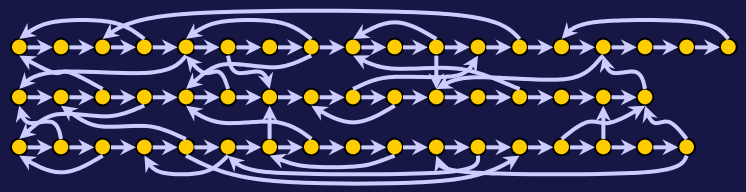


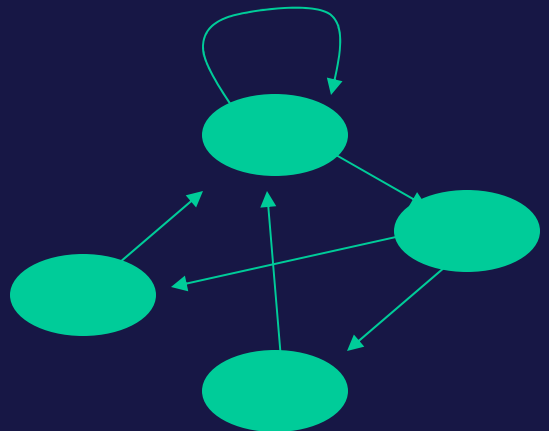


Why isn’t this used in industry?

- No control over transitions?
- More dynamic behaviors so automatic transitions would be few?
- Have to plan for shoot anyway so might as well plan for transitions?
- Not enough data?







Next lecture

- Details on transition metrics
- Details on washing out yaw
- Representations for orientation
  - Euler angles
  - Quaternions
  - Axis/angle
- A bit about editing, generalizing