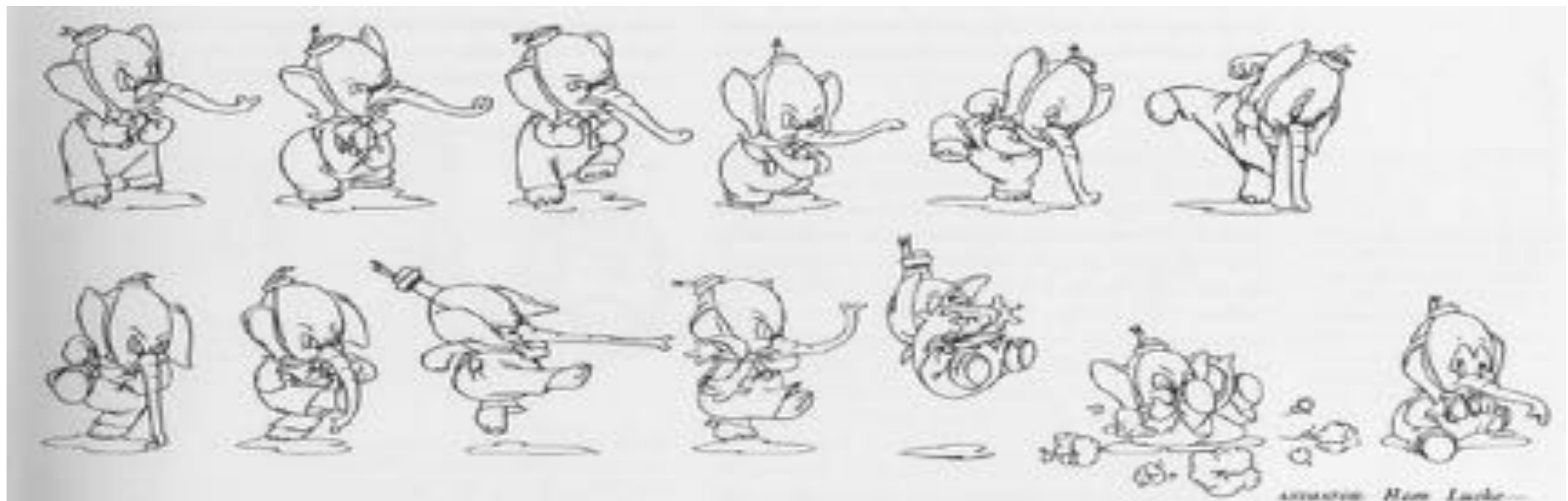# Computer Animation

Lesson 6 - Motion planning

Remi Ronfard, Nov 2019

Principle 6 Follow-through & Overlap

Just as the anticipation is the preparation of an action, *follow through* is the termination of an action. Actions very rarely come to a sudden and complete stop, but are generally carried past their termination point. For example, a hand, after releasing a thrown ball, continues past the actual point of release.
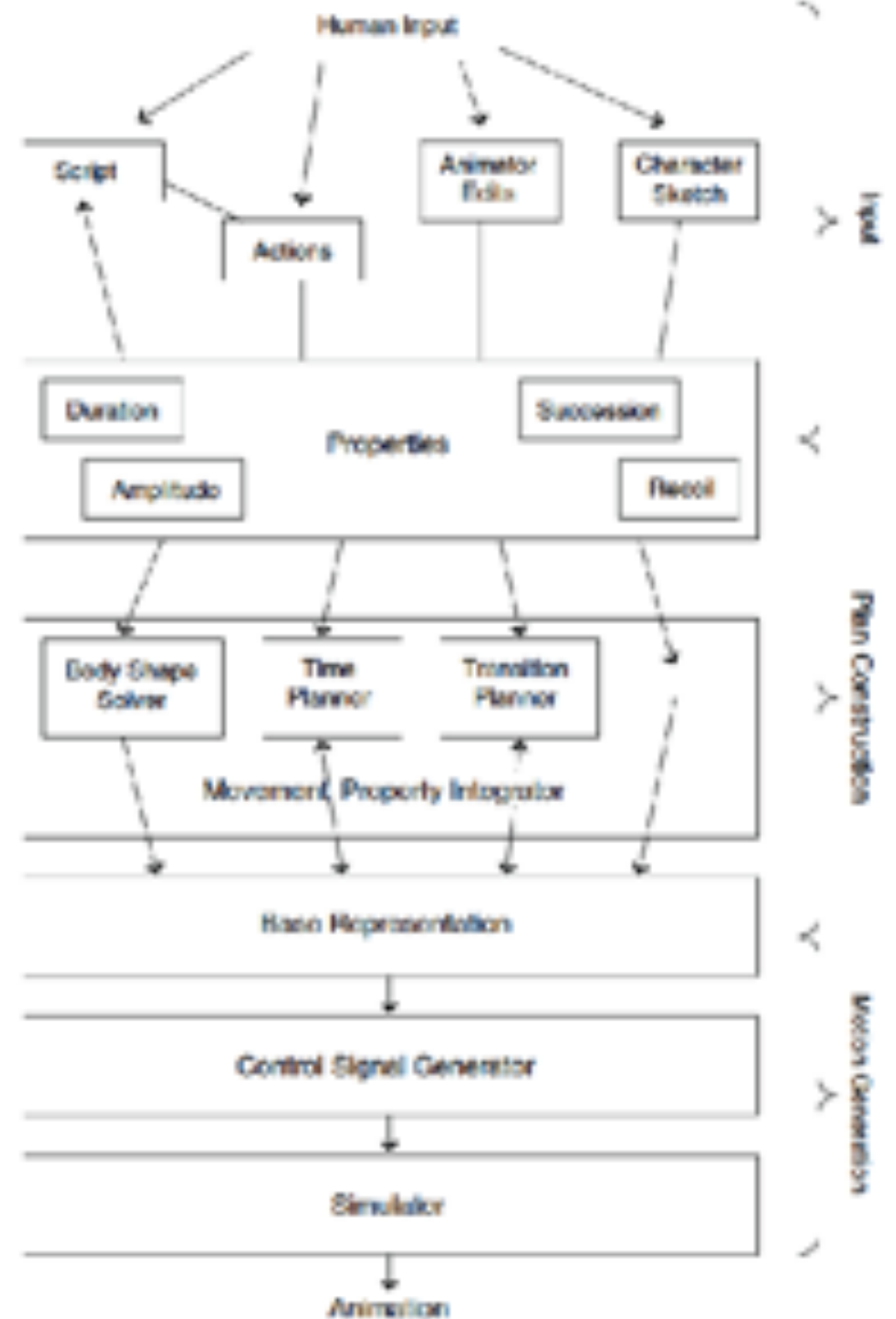
5. Follow Through & Overlapping Action

High-level control

- Walking style
- Physics
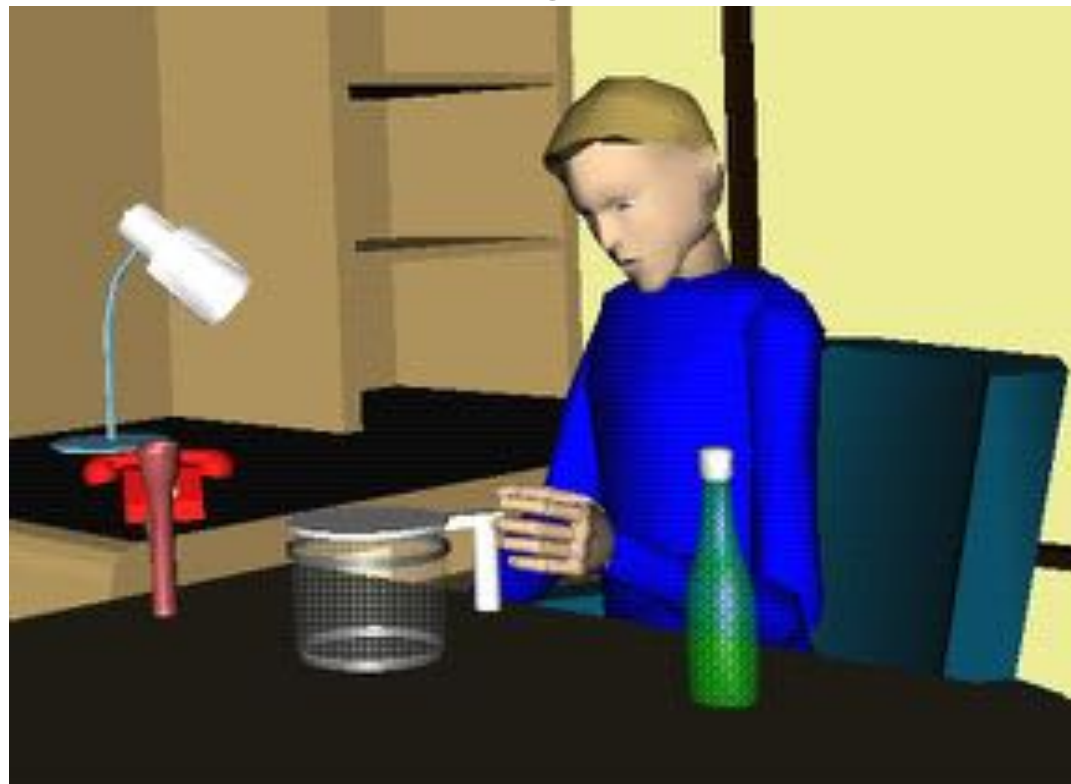- Aesthetics
- Expressivity
- Goal-driven

Source: Aesthetic Exploration and Refinement: A Computational Framework for Expressive Character Animation, Michael Neff, 2005.
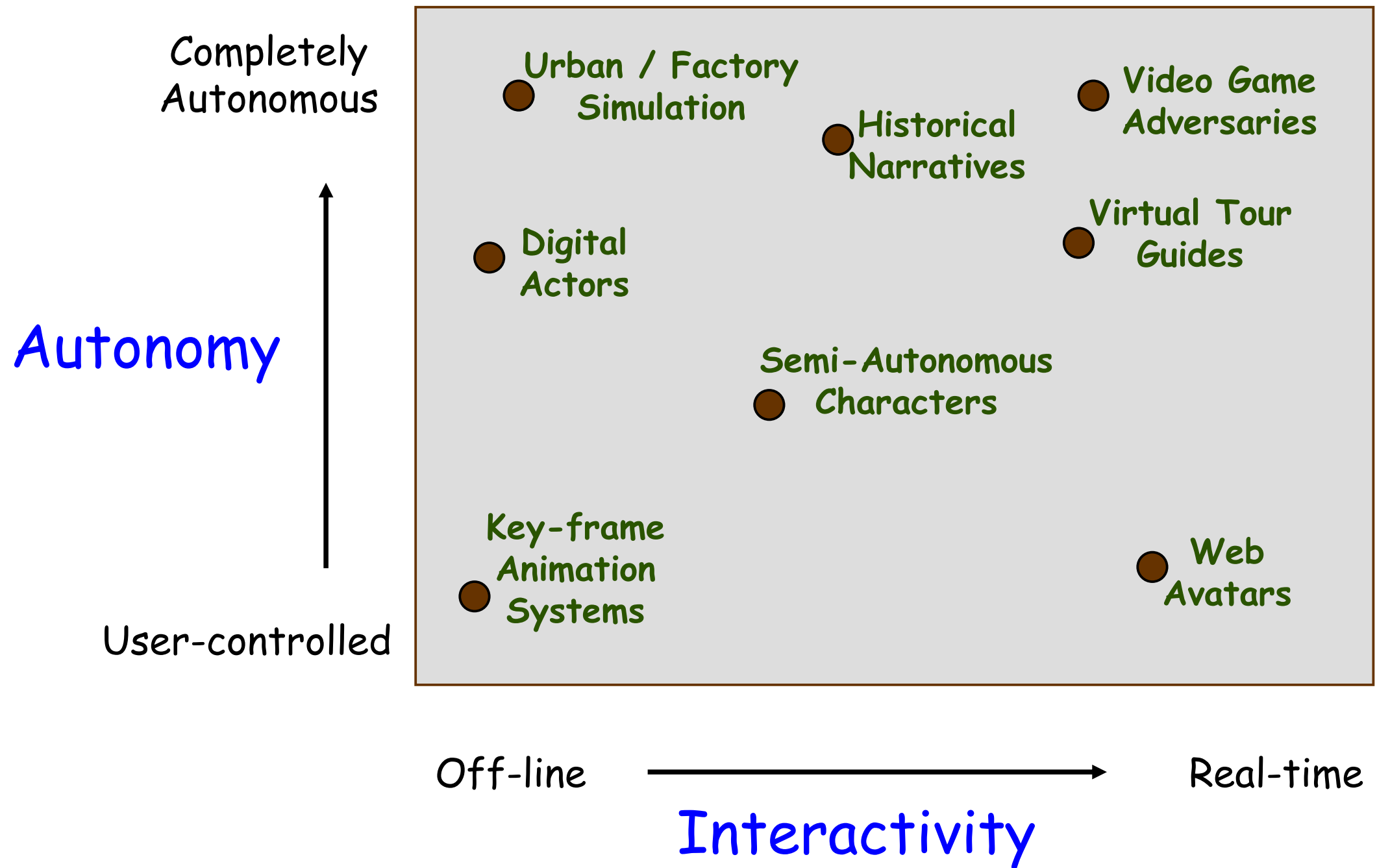
Digital Actor/Character

?

	Parts	DOF
L	19	68
H	51	118

Some Applications

Completely Autonomous

Autonomy

User-controlled

Urban / Factory Simulation

Historical Narratives

Video Game Adversaries

Virtual Tour Guides

Digital Actors

Semi-Autonomous Characters

Key-frame Animation Systems

Web Avatars

Off-line → Real-time

Interactivity

[Kuffner, 99]

http://robotics.stanford.edu/~latombe/cs326/2002

Manipulation

Reach

Transfer

Return
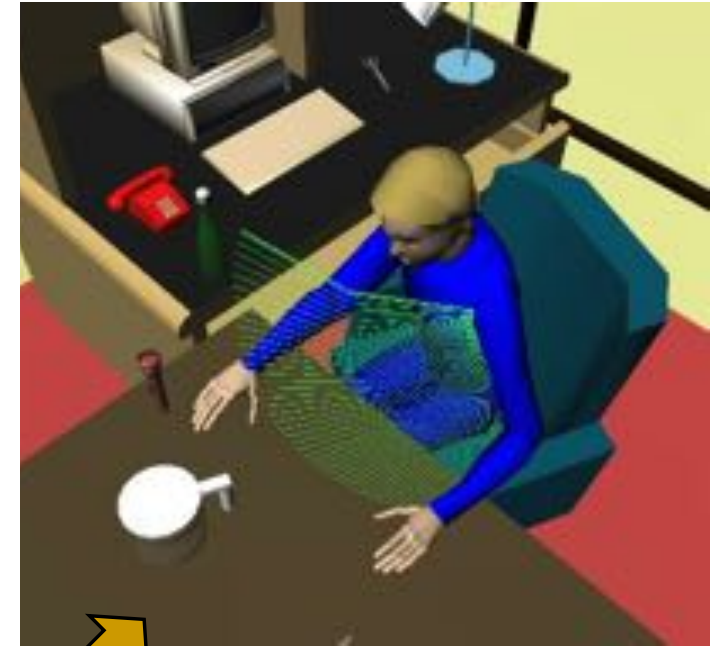
Grab

Release

Treadmill Method:
Motion Planning + Motion Capture

Hip

World

Base

$\boldsymbol{\omega}$

W

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http://robotics.stanford.edu/~latombe/cs326/2002
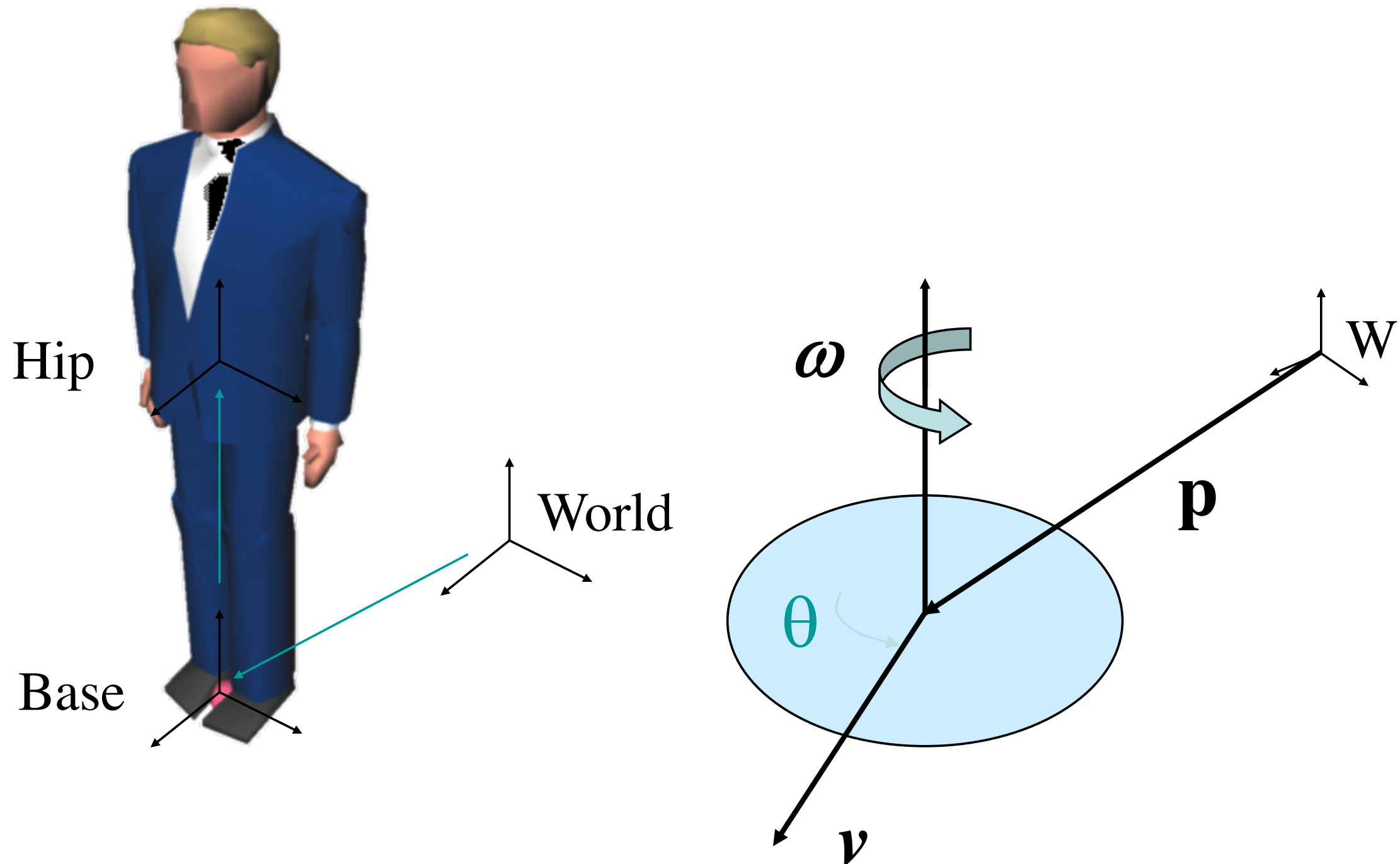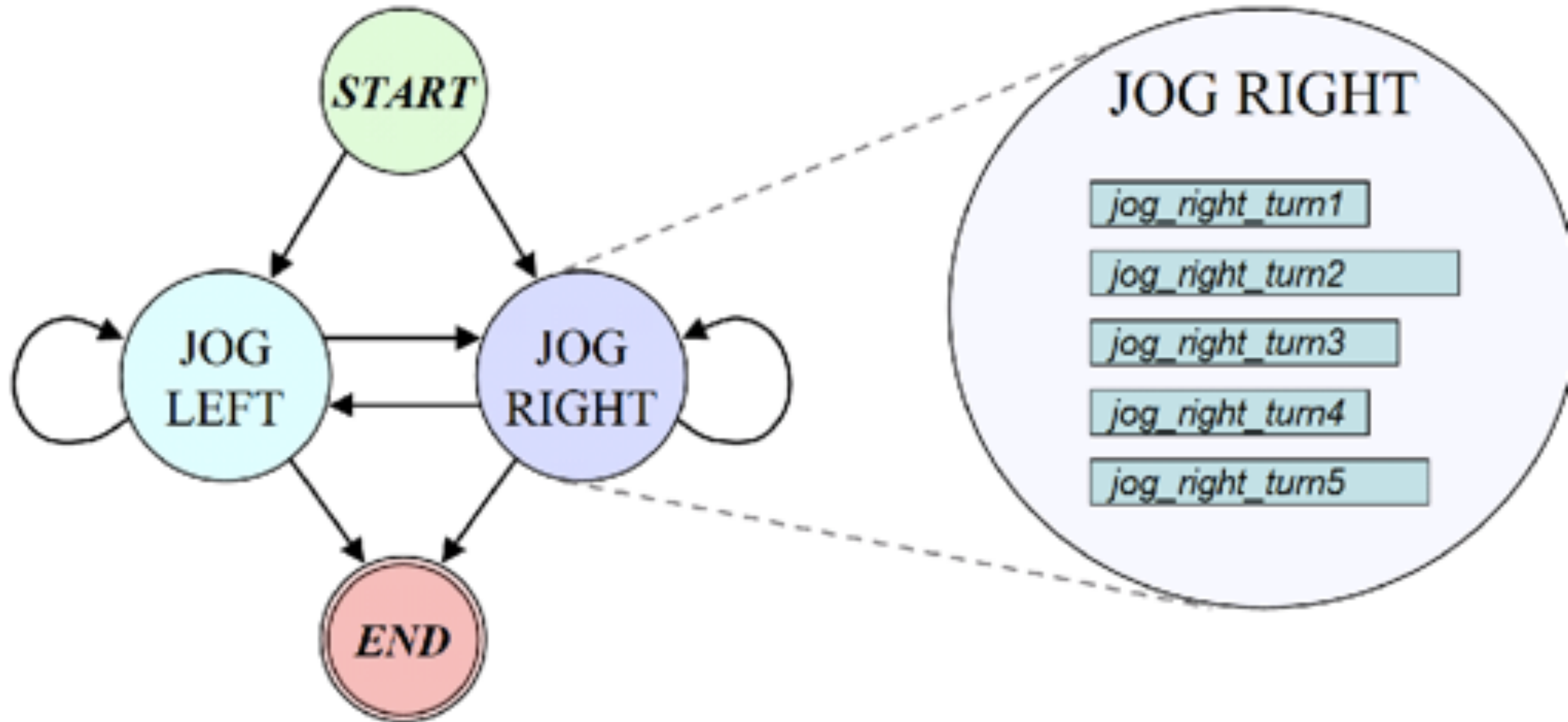
Behaviour planning

Behavior Planning
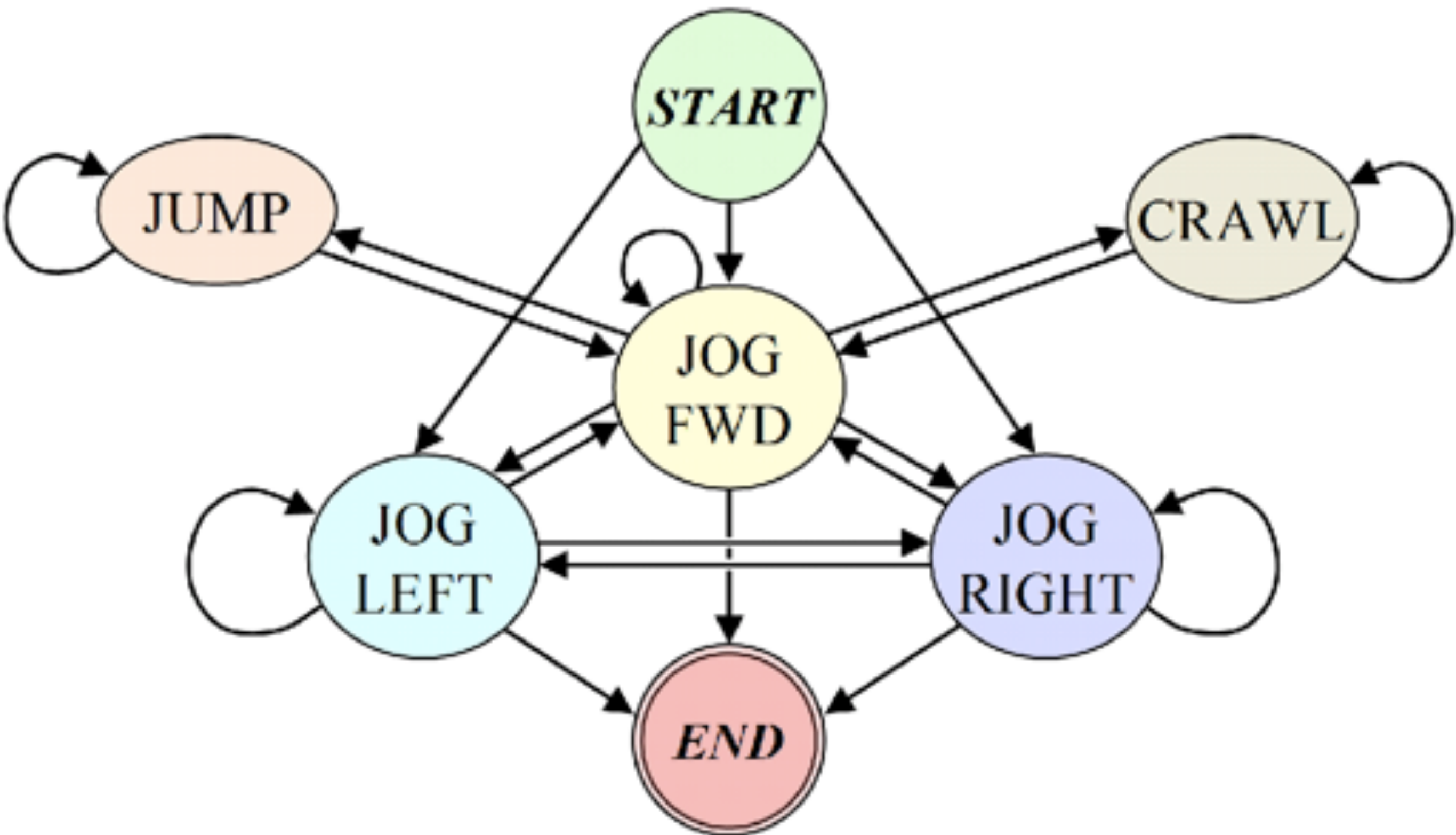for Character Animation
[with audio]

SCA 2005

Manfred Lau and James J. Kuffner
Carnegie Mellon University

Behaviour planning

Behaviour planning

Behaviour planning

Algorithm 1: BEHAVIOR PLANNER

Tree.Initialize(s_{init});
Queue.Insert(s_{init},DistToGoal(s_{init},s_{goal}));
while !Queue.Empty() **do**
    $s_{best} \leftarrow$ Queue.RemoveMin();
    if GoalReached(s_{best},s_{goal}) **then**
        | **return** s_{best};
    end
    $e \leftarrow E(s_{best}, Time)$;
    $A \leftarrow F(s_{best}, e)$;
    foreach $a \in A$ **do**
        $s_{next} \leftarrow T(s_{best}, a)$;
        if $G(s_{next}, s_{best}, e)$ **then**
            Tree.Expand(s_{next},s_{best});
            Queue.Insert(s_{next},DistToGoal(s_{next},s_{goal}));
        end
    end
end
return no possible path found;

Behaviour planning

- Behaviour is a sequence of actions

- Action has pre-conditions and post-conditions

- Action has preparation, execution and follow-through

- Behaviour planning finds a minimal sequence of actions achieving the required goals

Paper 6 - From footprints to animation

Figure 1: Specification of a Walking Motion (a) plan view of footprints (b) timing diagram.
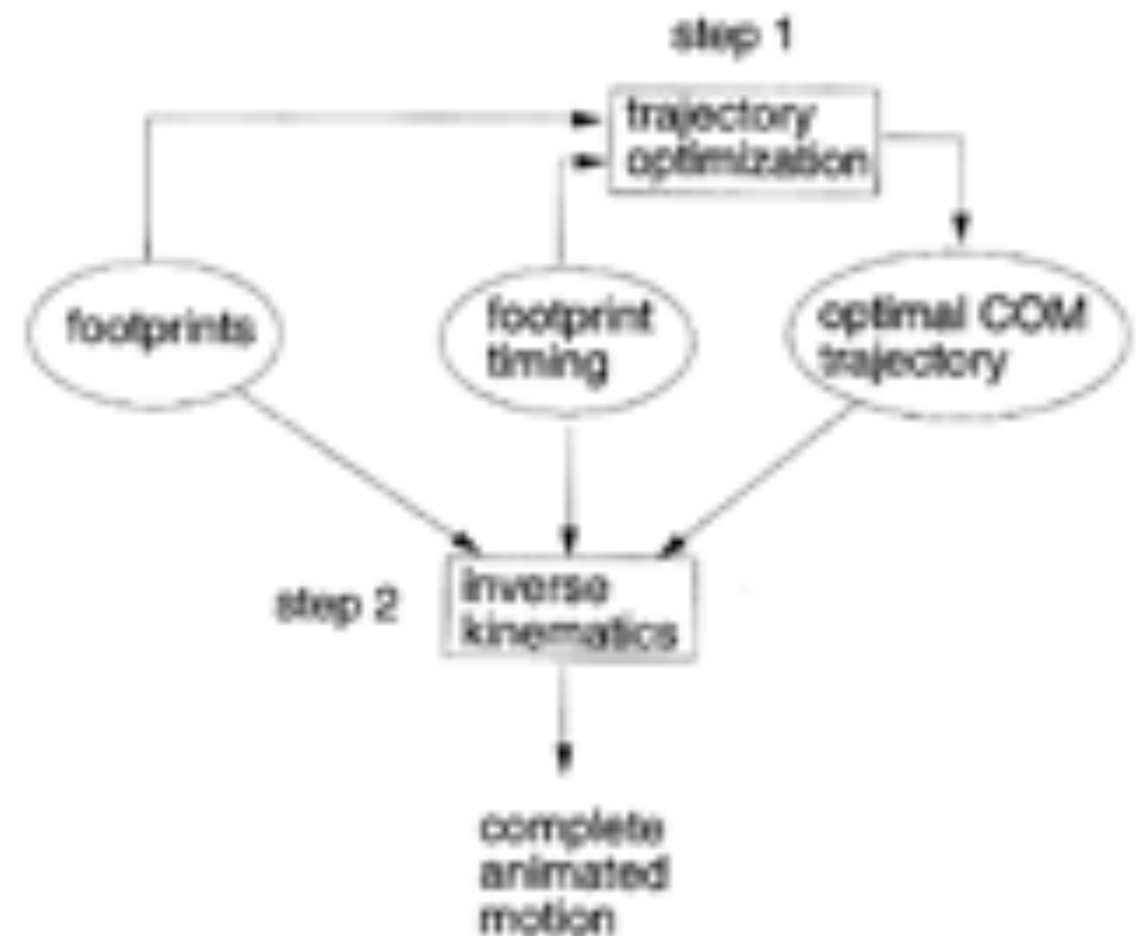
Figure 2: Block diagram for motion synthesis from footprints.

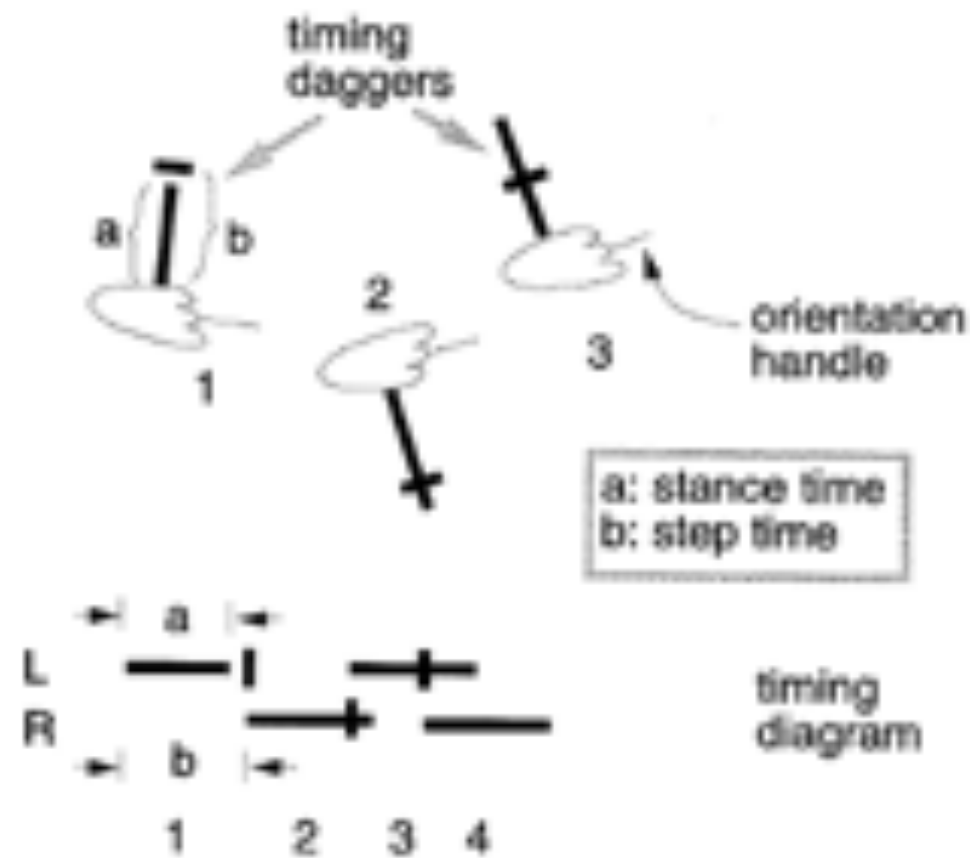# Paper 6 - From footprints to animation

Figure 3: Footprints with timing information and manipulation handles.
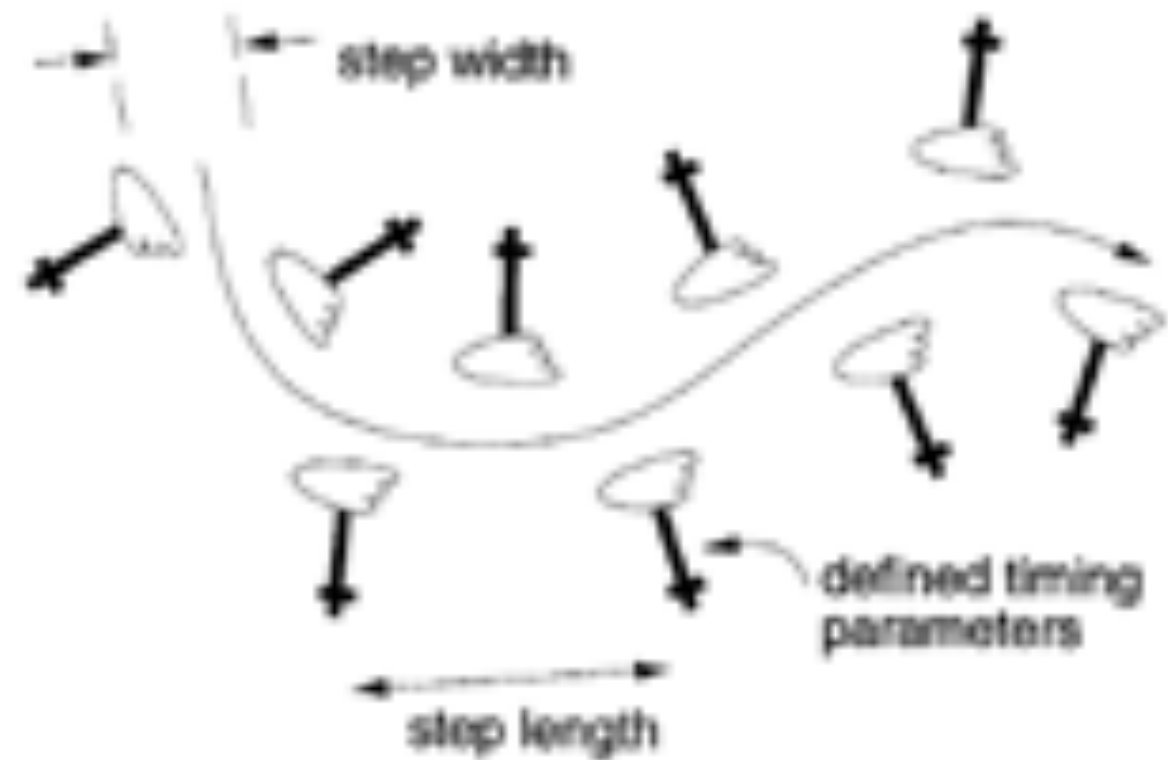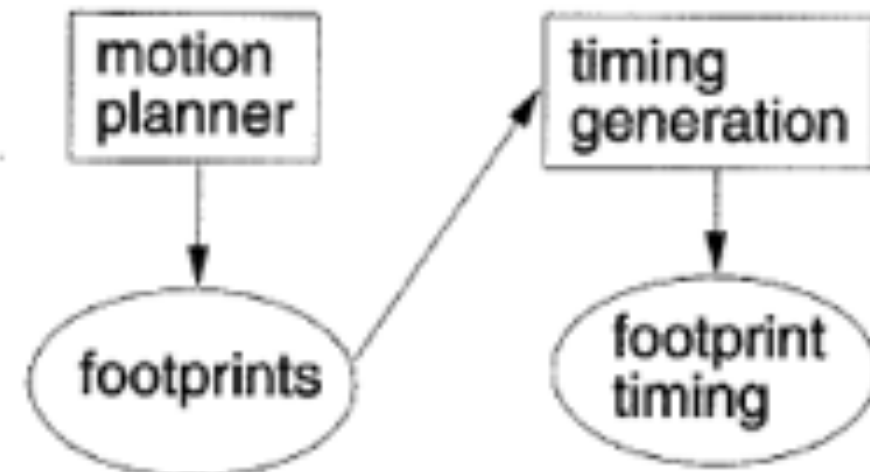
Figure 4: Automatic footprint generation from a path.

Paper 6 - From footprints to animation

Figure 5: *The generic biped model.*

$$E = \int_{0}^{T} \left(\mathcal{E}_{physics} + \mathcal{E}_{comfort} \right) dt$$

$$\mathcal{E}_{physics} = \left\| F + mg - ma \right\|$$

$$\mathcal{E}_{comfort} = k \left(\ell - \ell_{nom} \right)^2$$