Motion Cues for Illustration of Skeletal Motion Capture Data

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LIGUM, Dept. I.R.O
Université de Montréal

Symposium on Non-Photorealistic Animation and Rendering, 2007

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Outline

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Limitations Of The 2D Image

- Conversion of 4D $\{x, y, z, t\}$ information to 2D $\{x, y\}$ data
- Artists use visual cues to compensate inherent limitations of the visualization medium.
- Motion cues are visual cues emphasizing temporal information in a static 2D representation.

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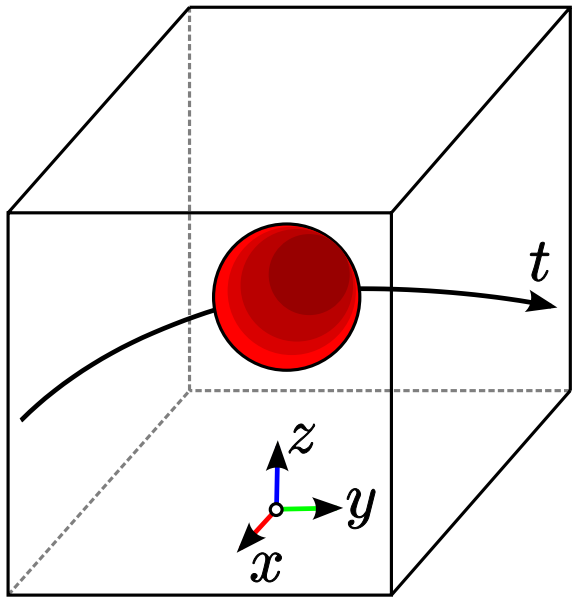

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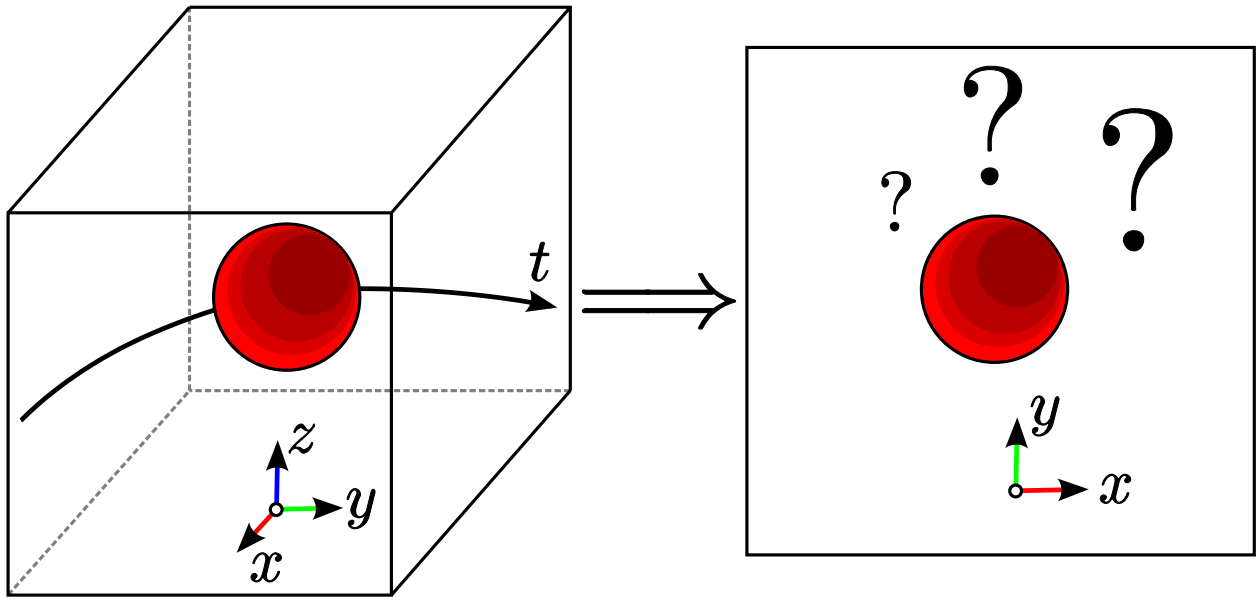

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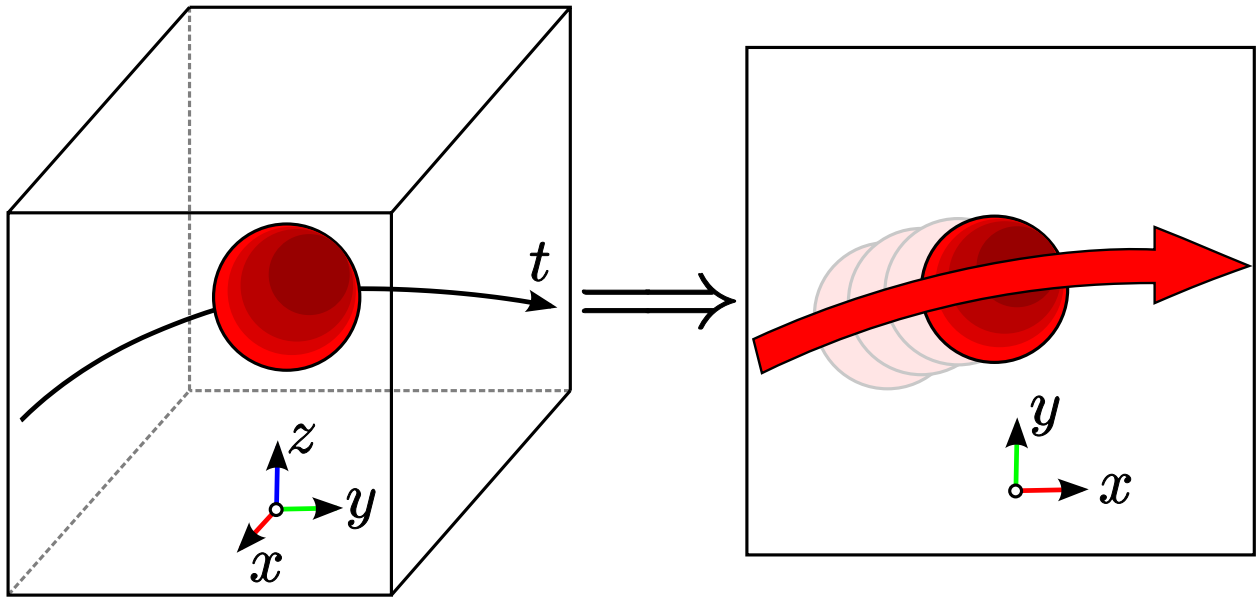

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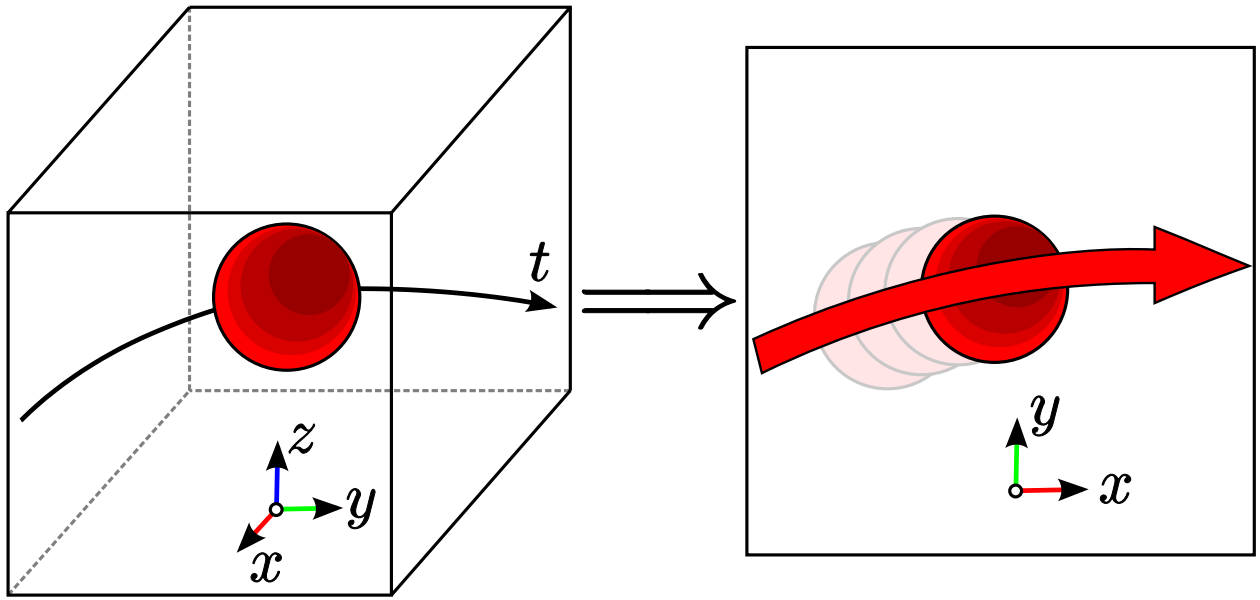

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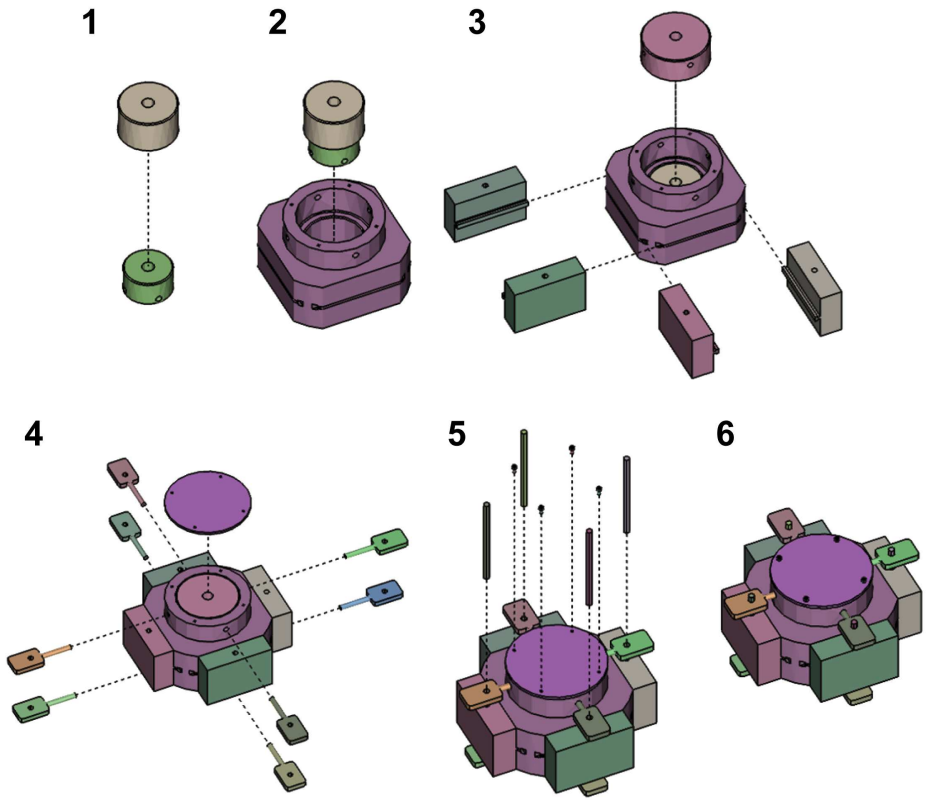
Visual Cues

1. Technical design
2. Cartoon illustration
3. Storyboard illustration



[Agrawala *et al.* 2003]

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[Collomosse *et al.* 2005]

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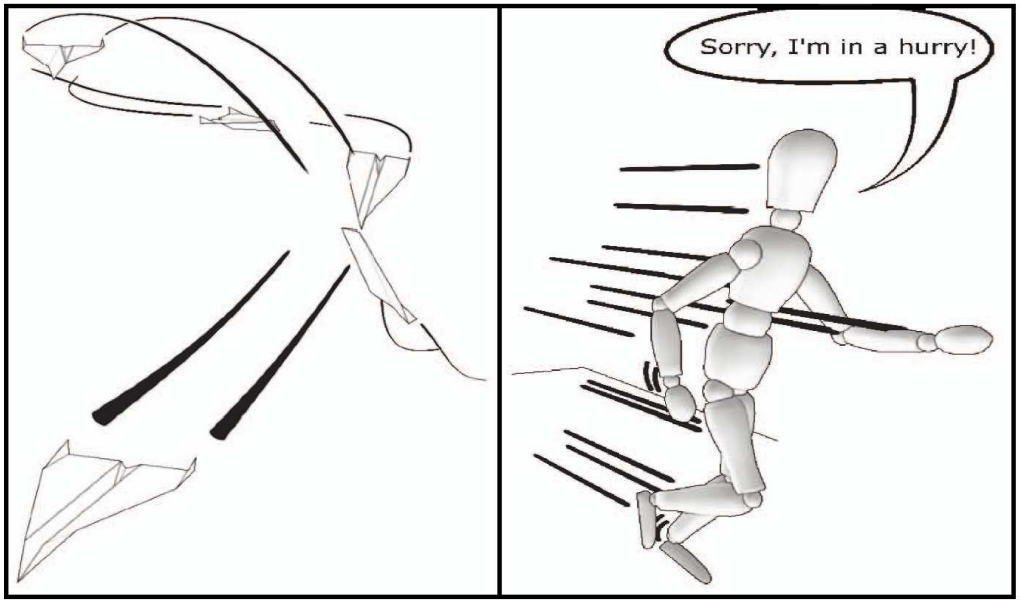

[Nienhaus *et al.* 2005]

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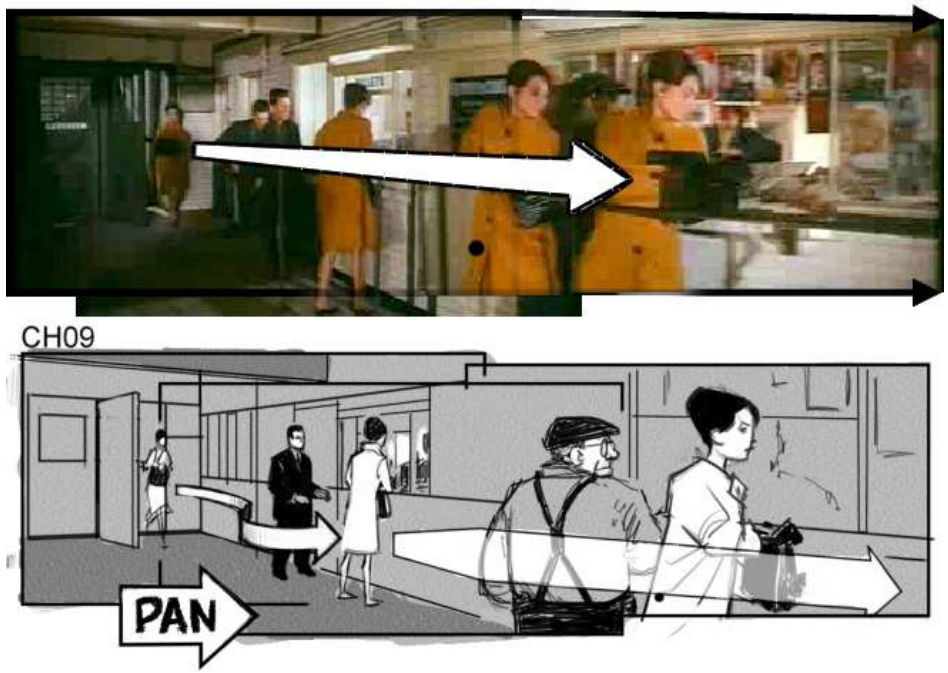

[Goldman *et al.* 2006]

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Criteria For The Motion Cue

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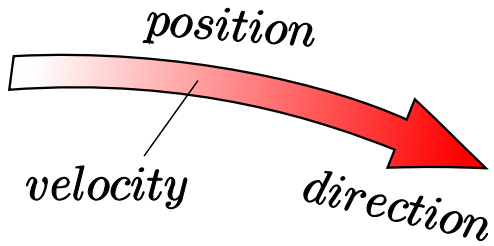

Evocative

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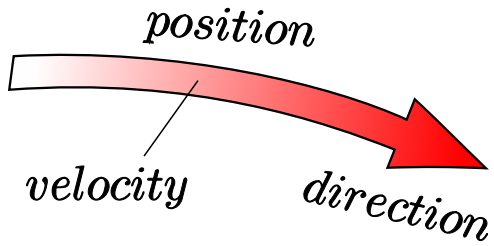

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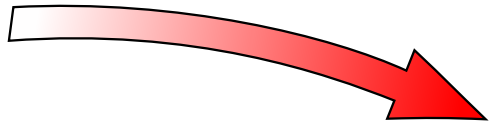

Clear

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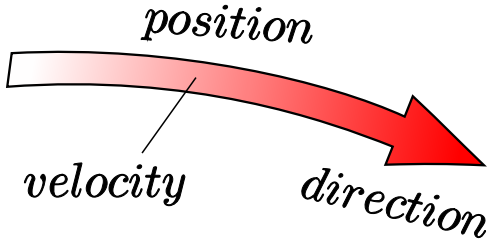

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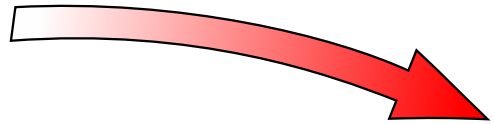

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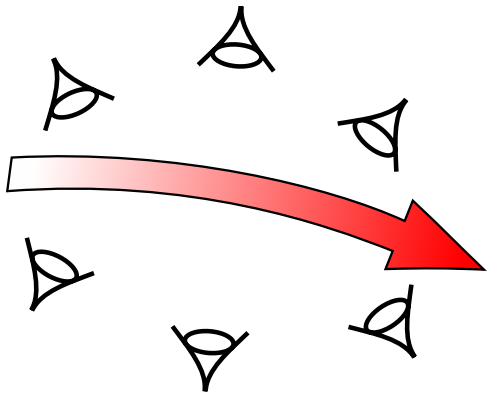

Robust

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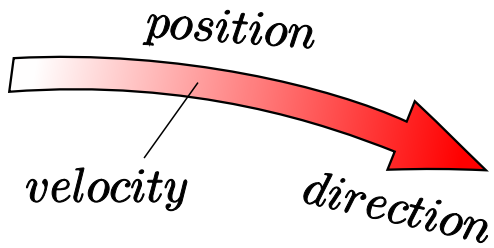

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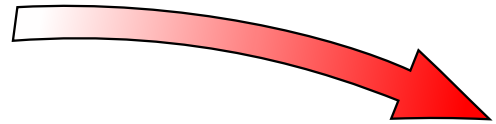

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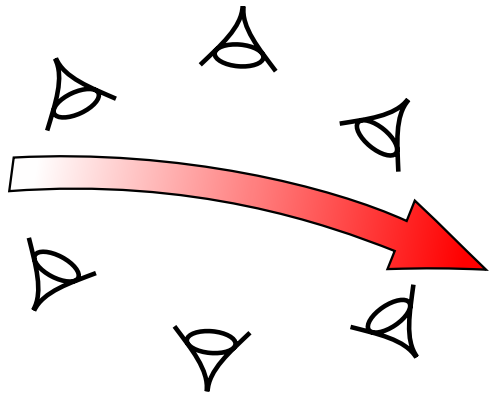

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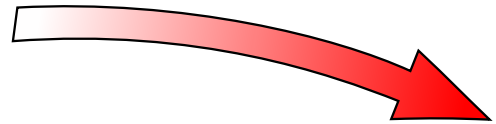

Interactive

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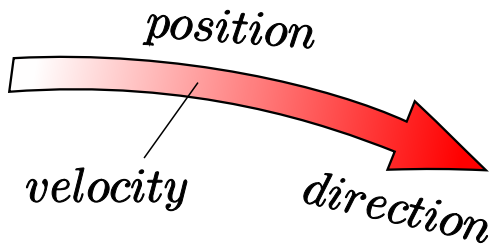

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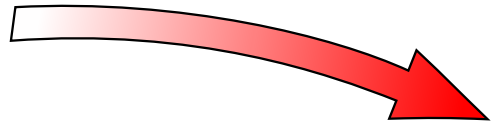

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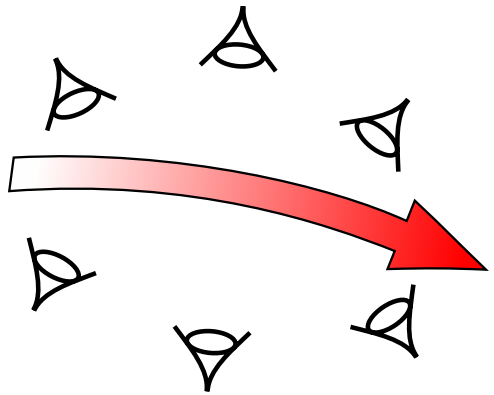

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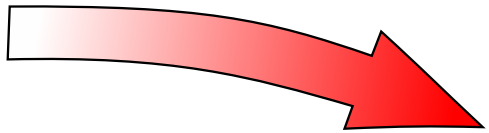

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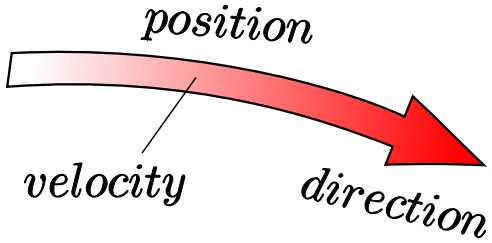

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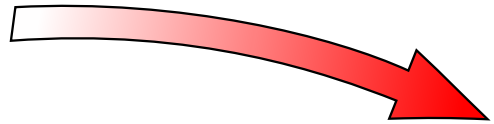

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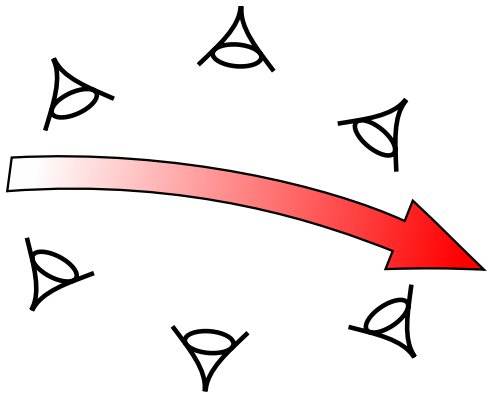

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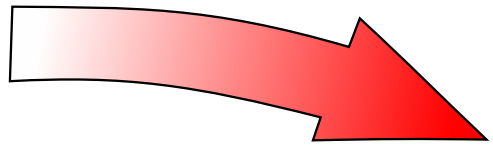

Interactive

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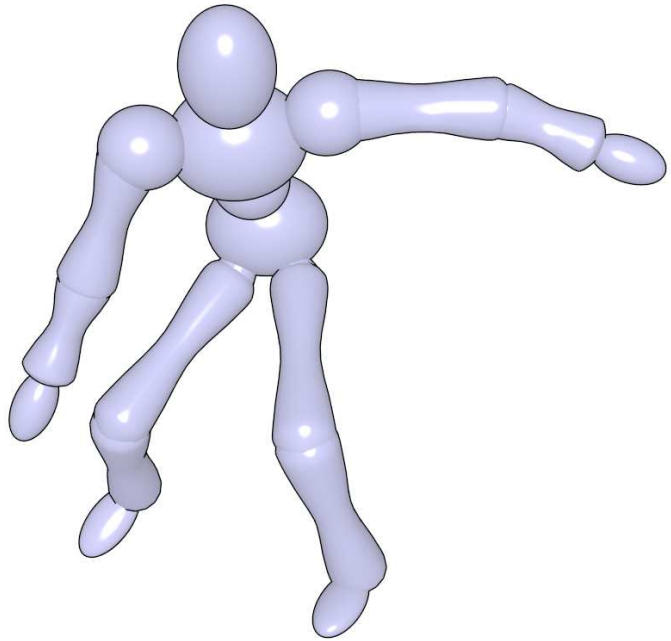
A Quick Example

- Is this character in motion ?
  If so, what is he doing ?
- Motion cues can help reconstitute past and future motions.
- Other cues will emphasize subtle, otherwise imperceptible, movements.



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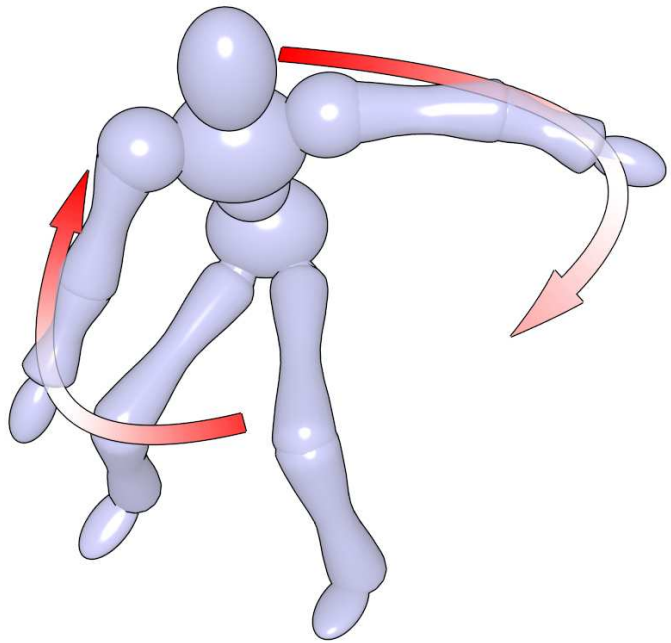

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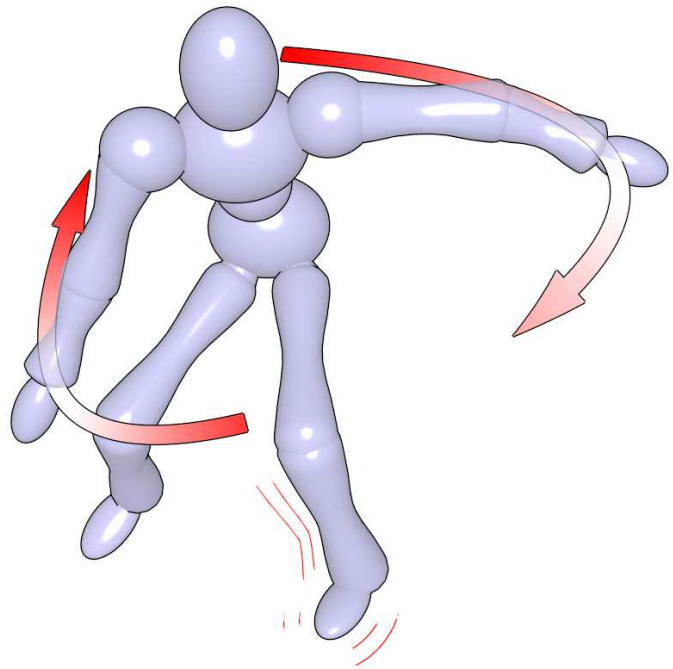

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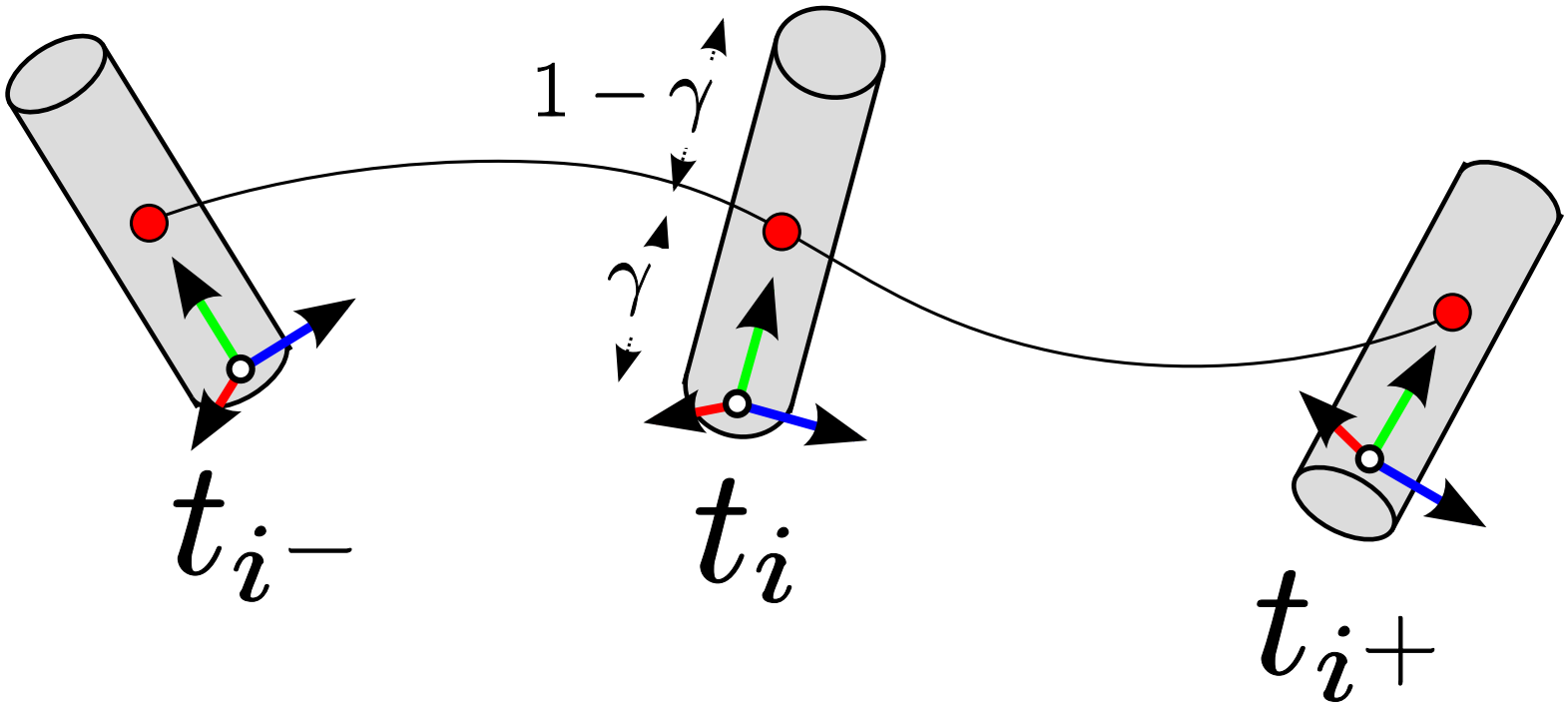
Capturing Motion On A Single Bone

- We extract a sequence of points at γ on the bone from pose t_{i-} to pose t_{i+} to create a motion curve.



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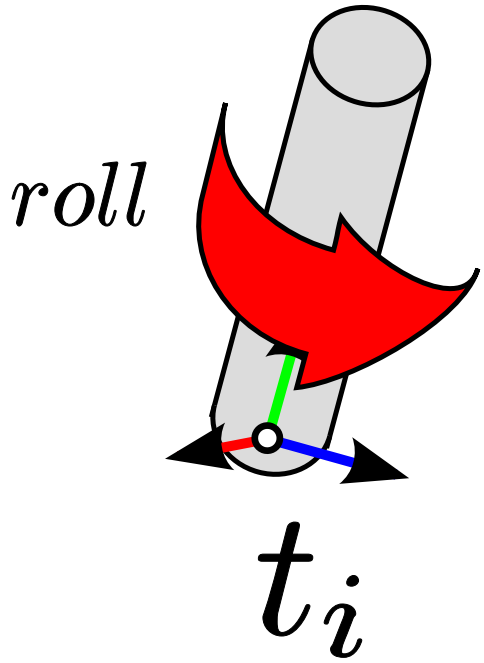
Capturing Motion On A Single Bone

- The motion curve gives satisfactory results for translations and most rotations.
- The motion curve cannot evaluate the rolling value in a rotation.



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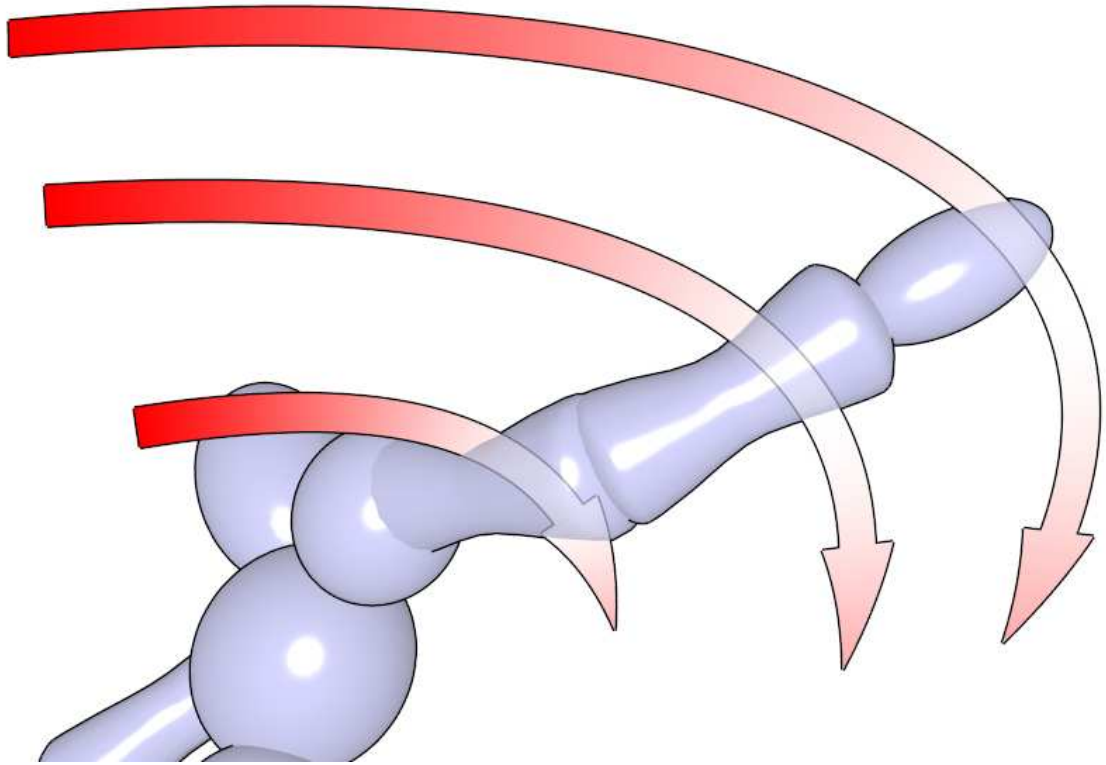
Possible Result Using Such Technique



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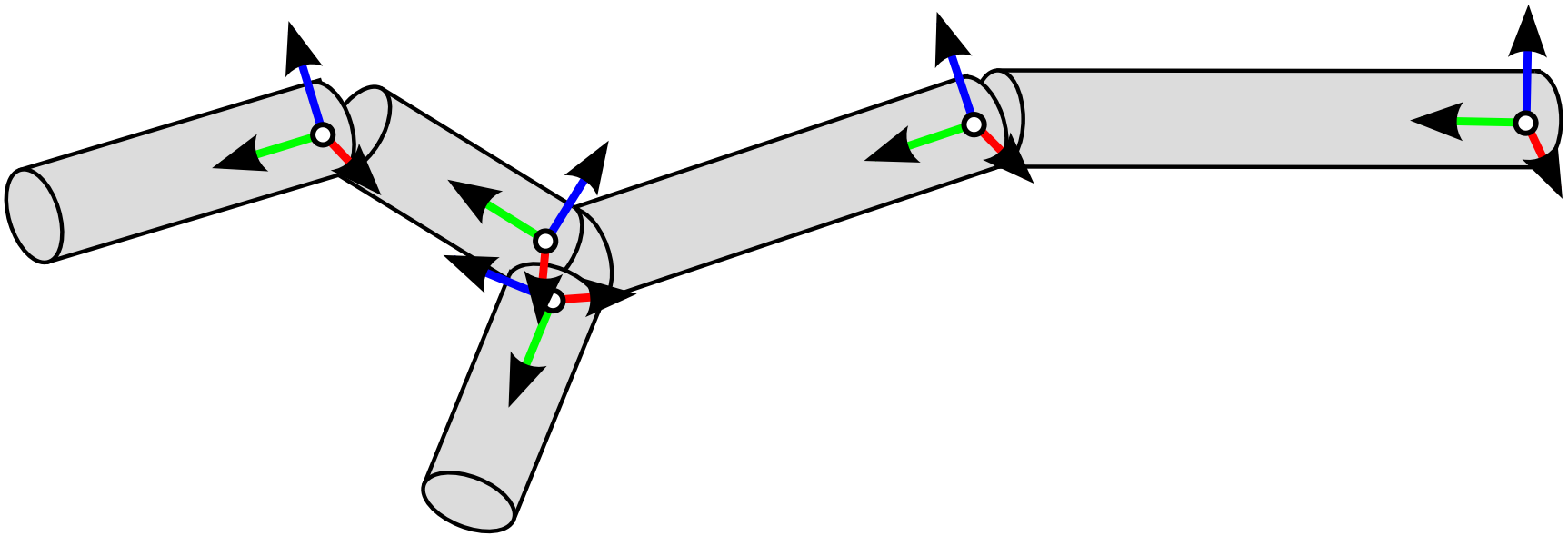
Subdivide The Skeleton In Joint Groupings

- Form anatomically meaningful groups of bones



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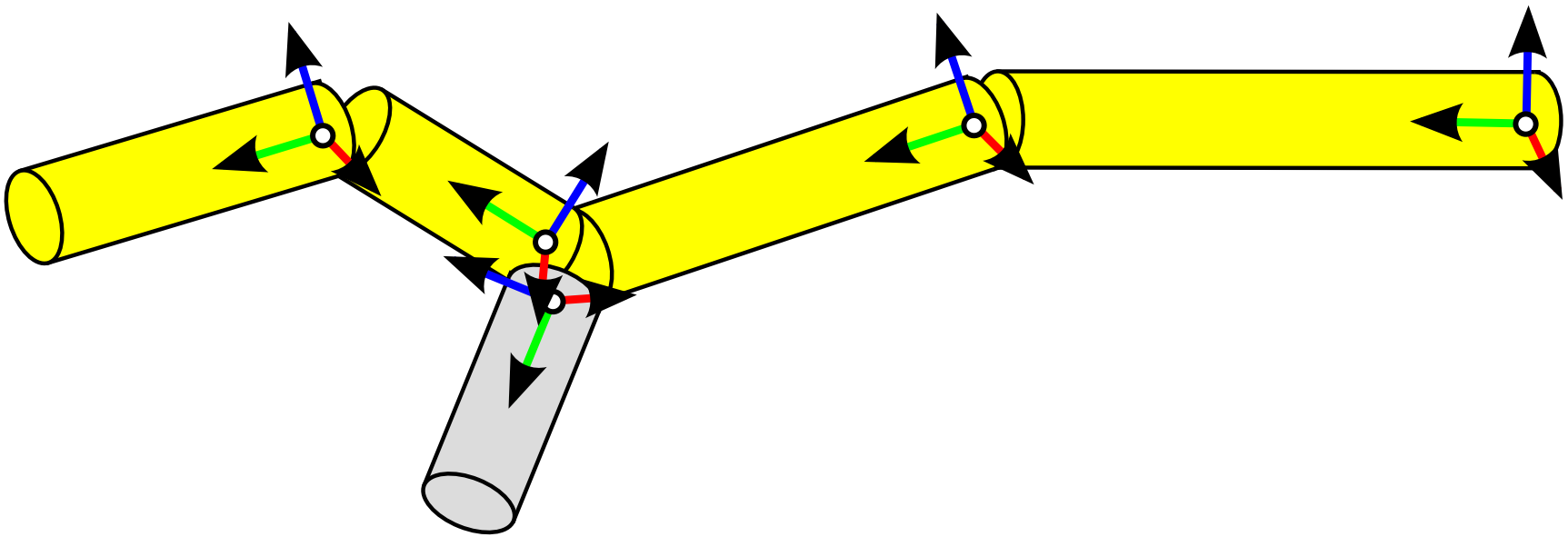
Subdivide The Skeleton In Joint Groupings

- Isolate articulated path



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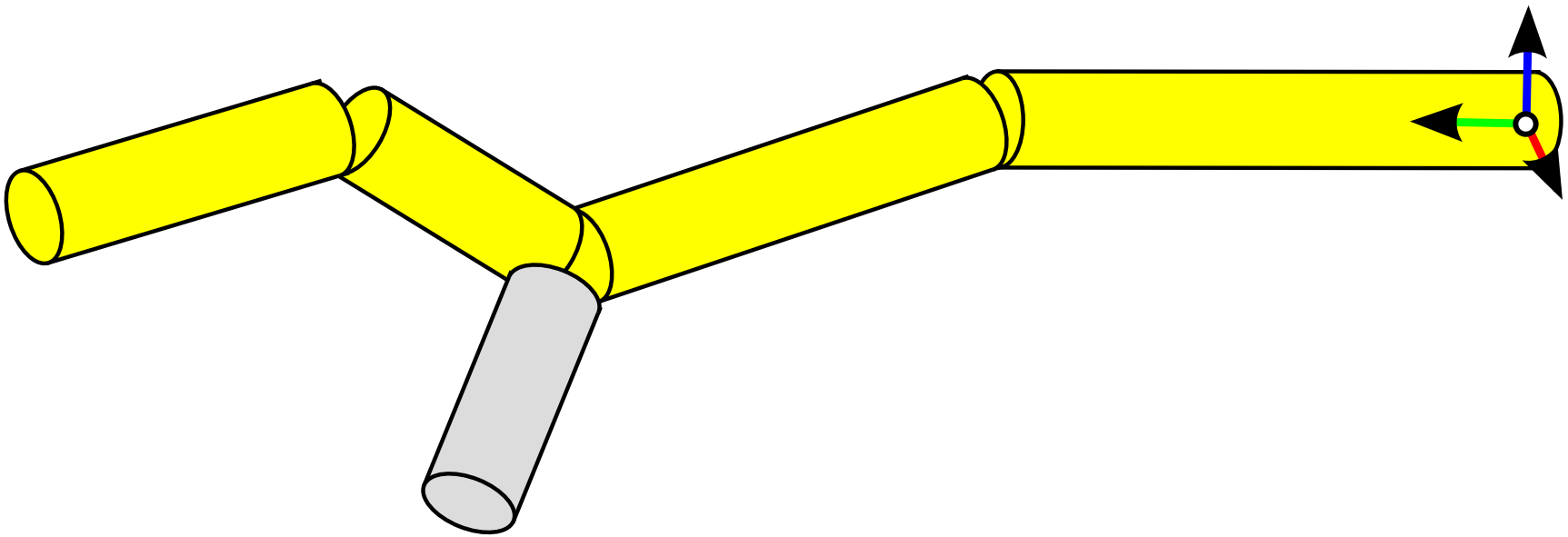
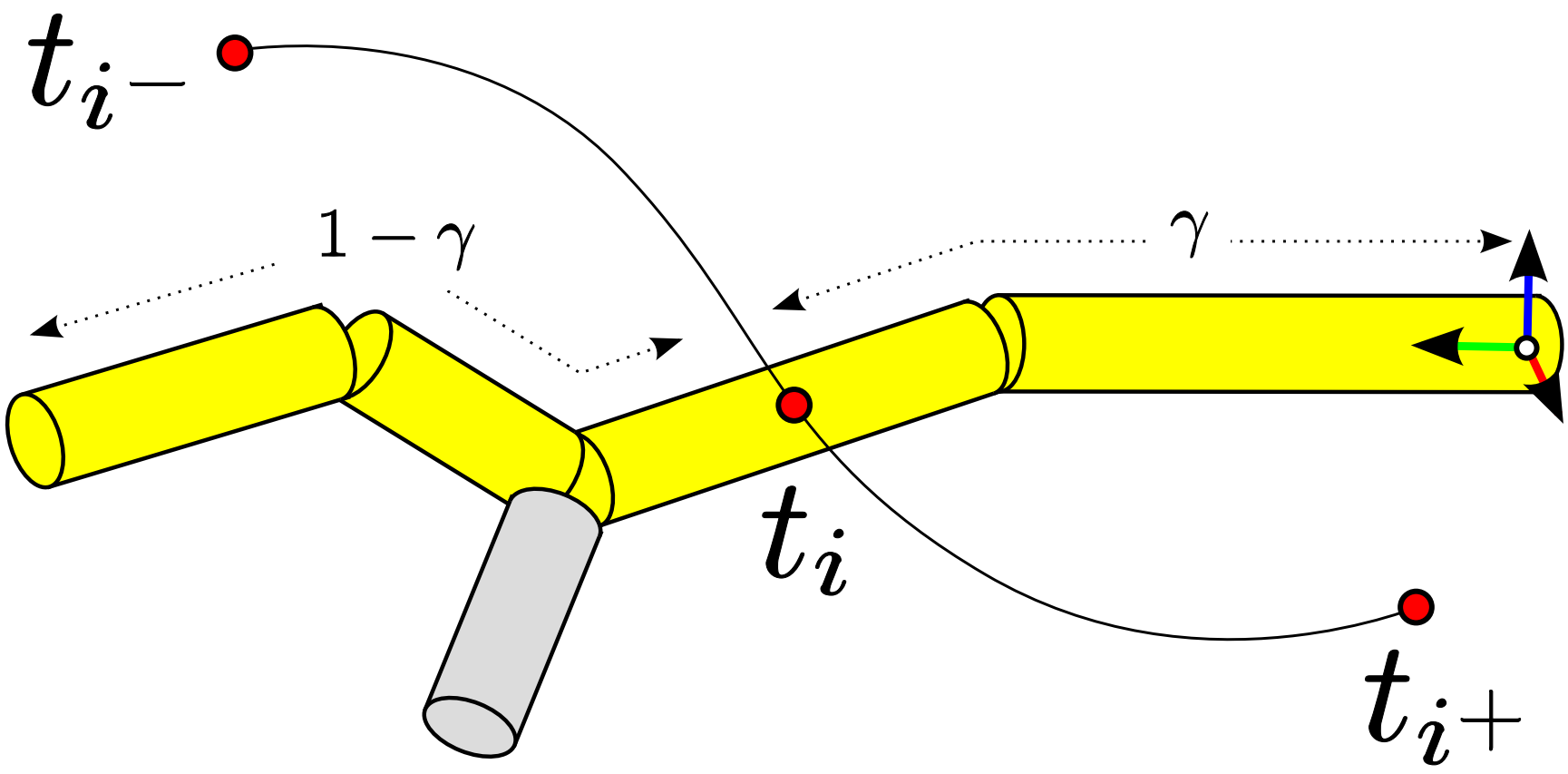
Subdivide The Skeleton In Joint Groupings

- Identify local root quaternion



Subdivide The Skeleton In Joint Groupings

- Define a point at distance γ on the articulated path



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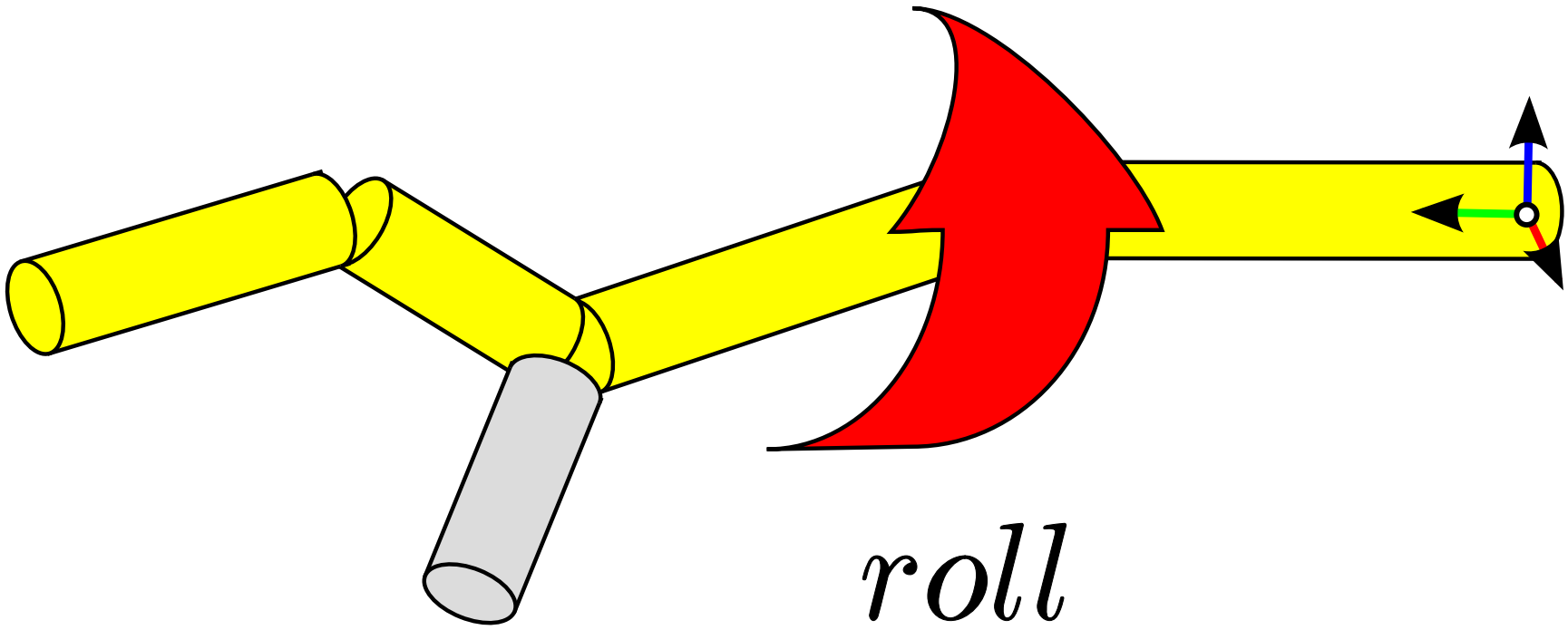
Subdivide The Skeleton In Joint Groupings

- Extract the “roll” value from the local root quaternion



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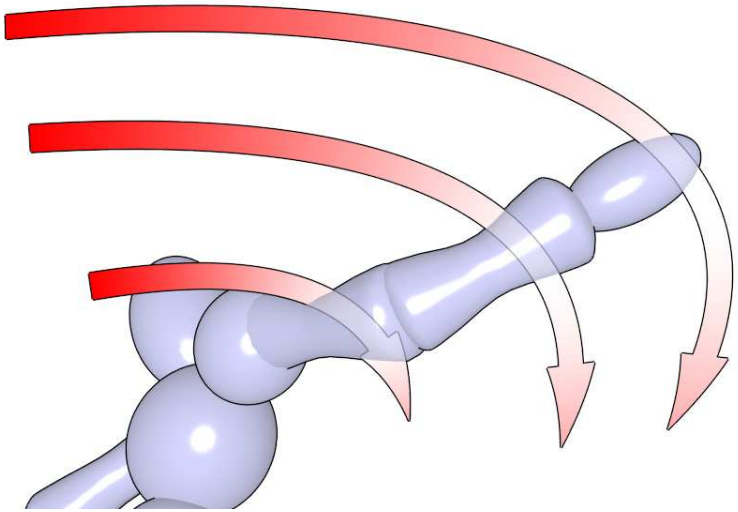
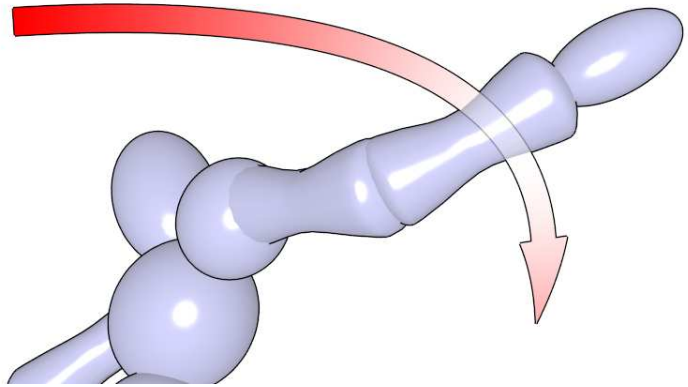
Modified Result With Improved Technique



Before



After

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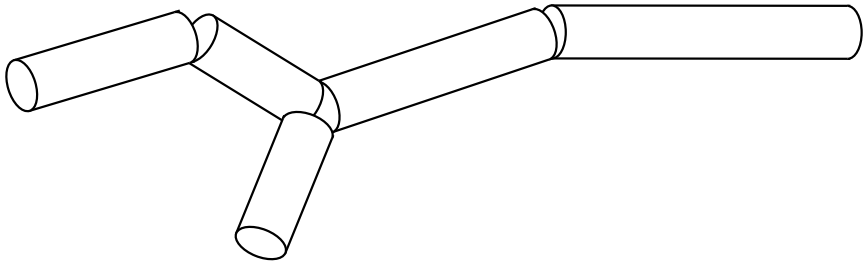
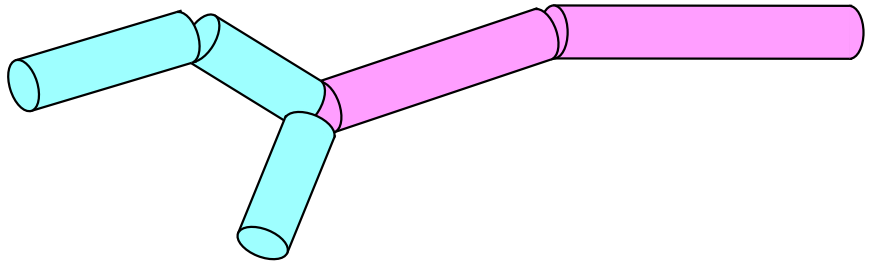
Generalizing The Groupings Into A Motion Hierarchy

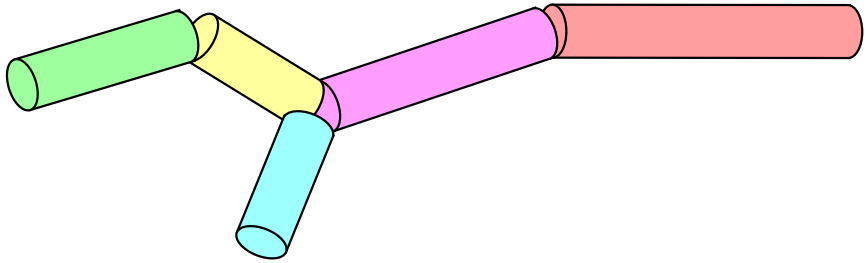
- Recursively refine the groupings



No subdivision



1 subdivision, 2 groups



2 subdivisions, 5 groups

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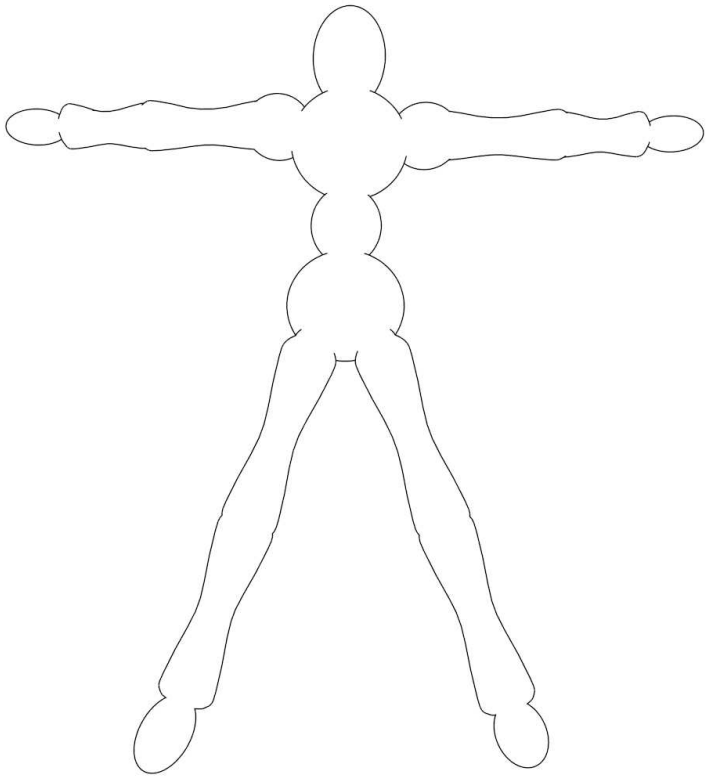
Human Skeleton Hierarchy: Level 0



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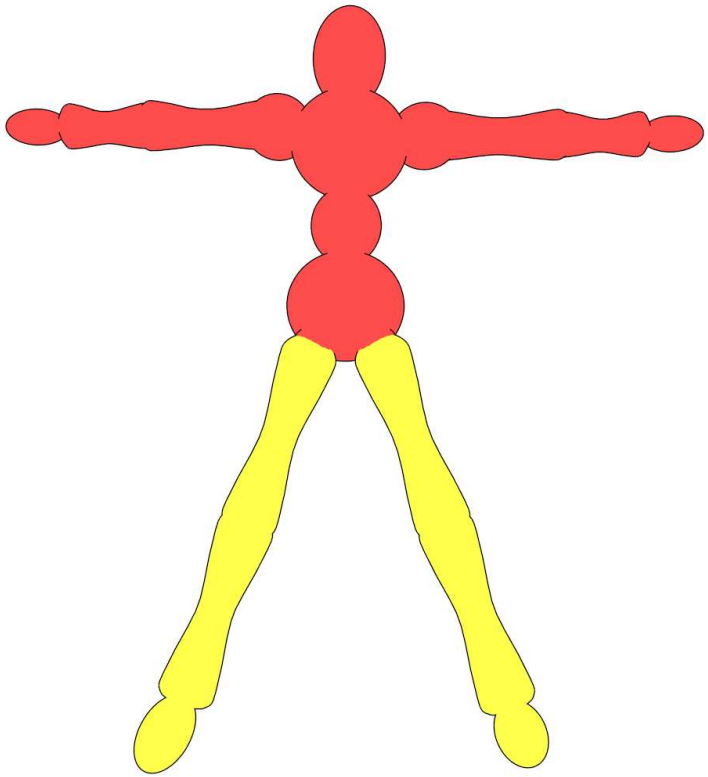
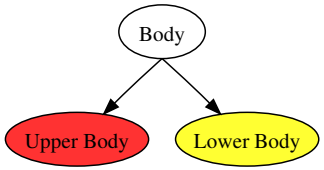
Human Skeleton Hierarchy: Level 1





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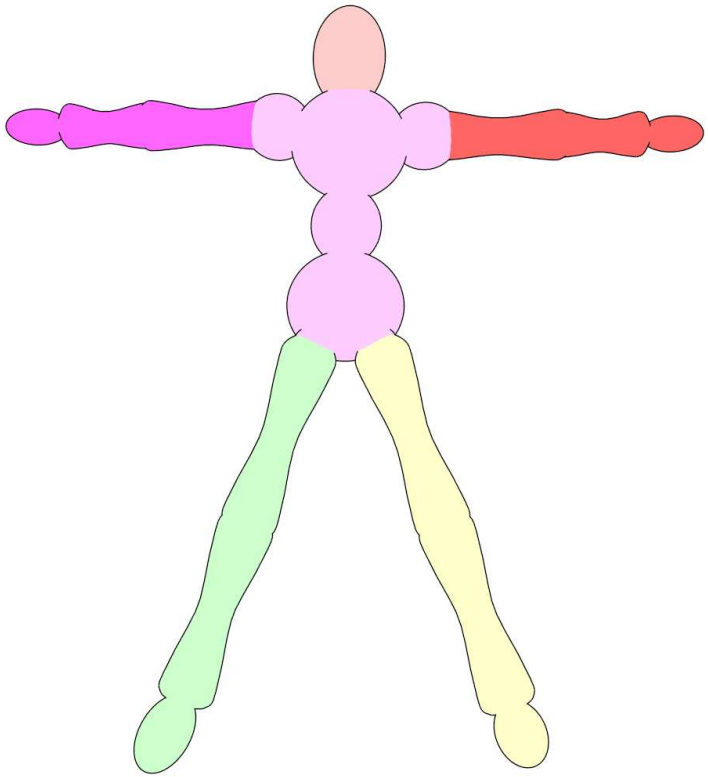
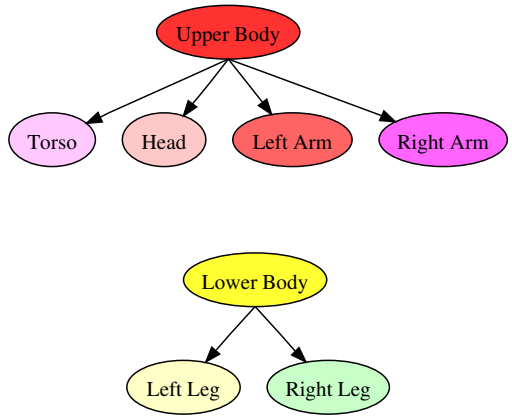
Human Skeleton Hierarchy: Level 2





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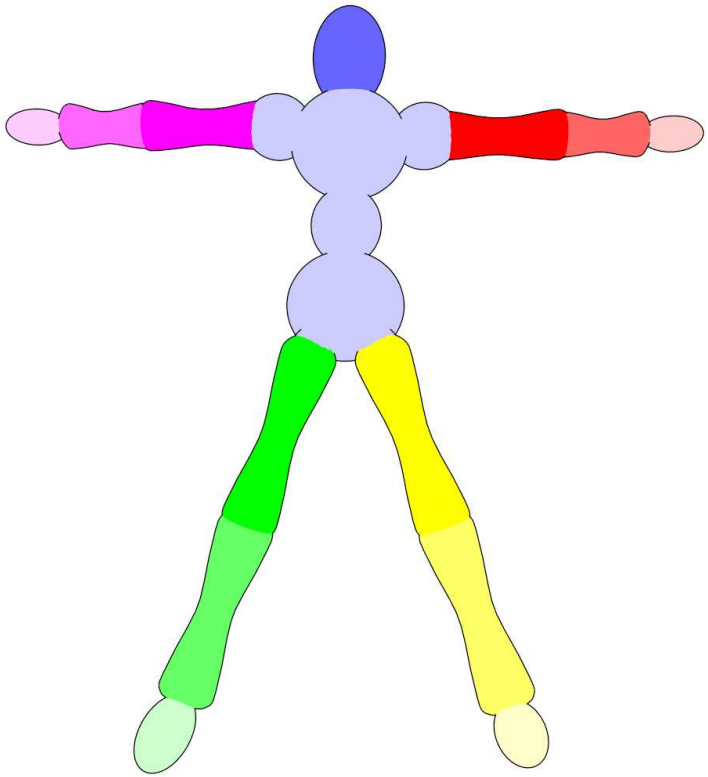
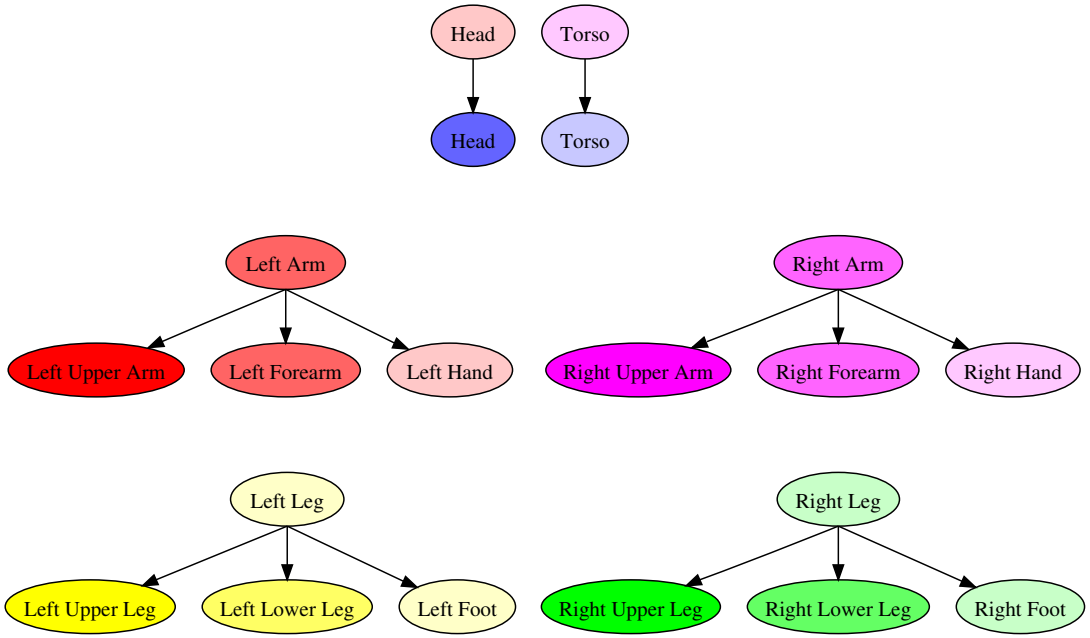
Human Skeleton Hierarchy: Level 3





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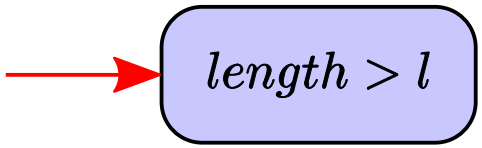
Motion Arrow: Analysis Of Motion Data



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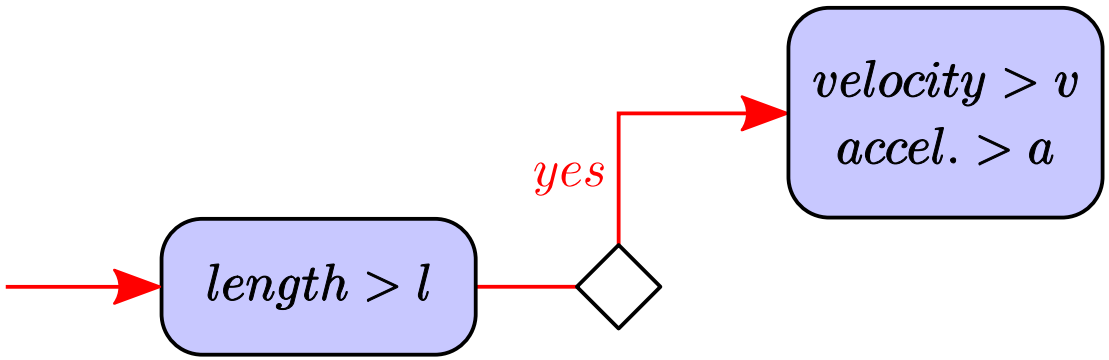

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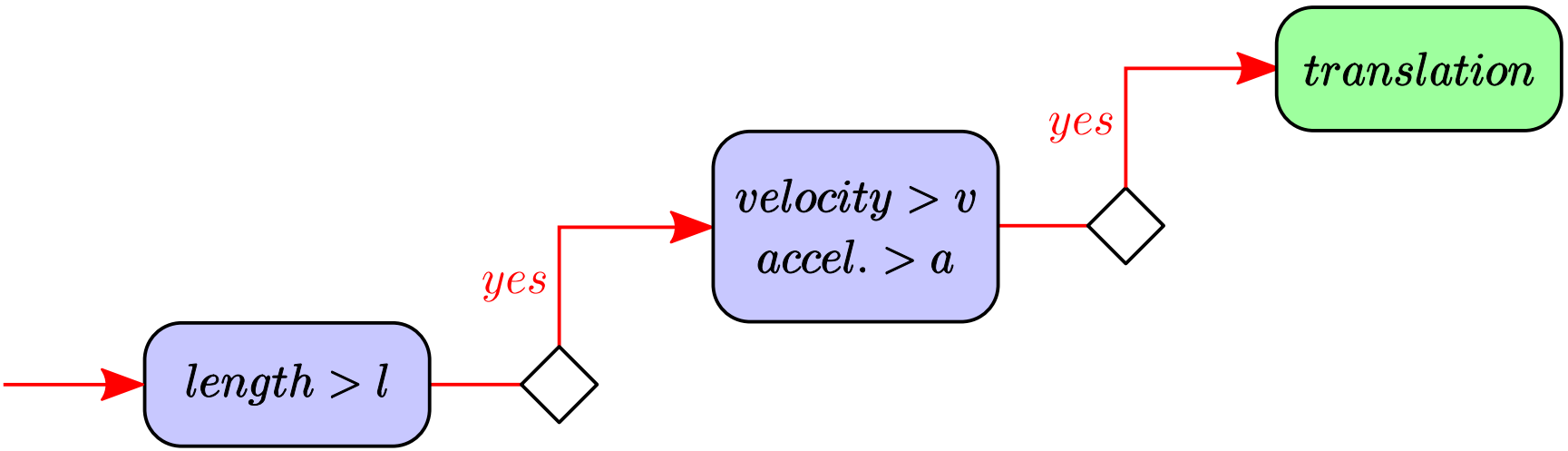

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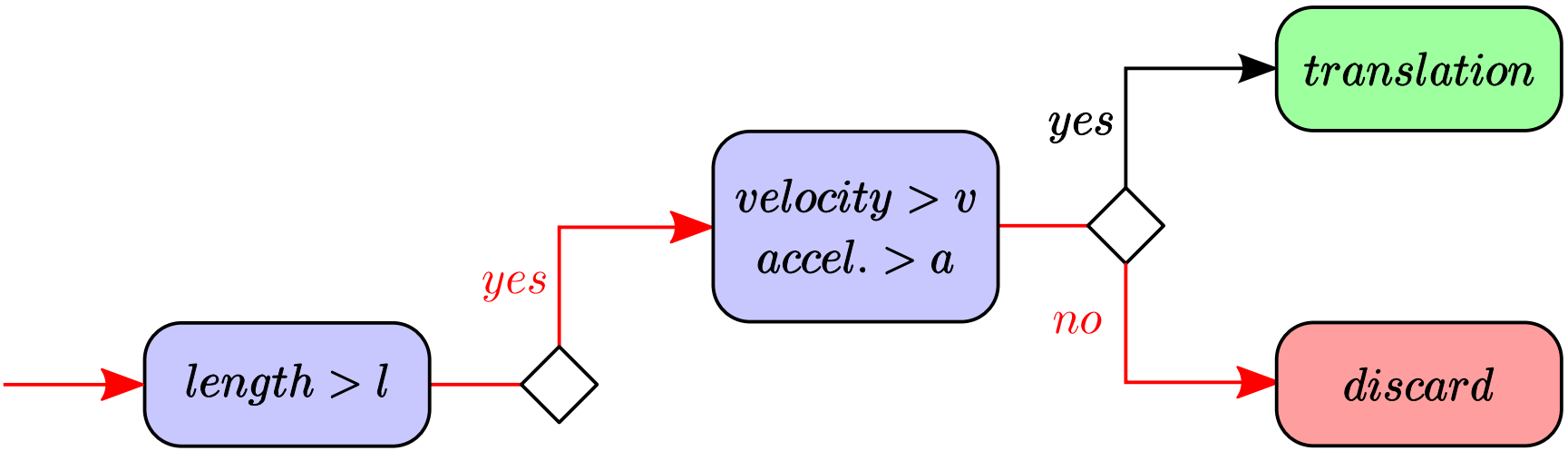

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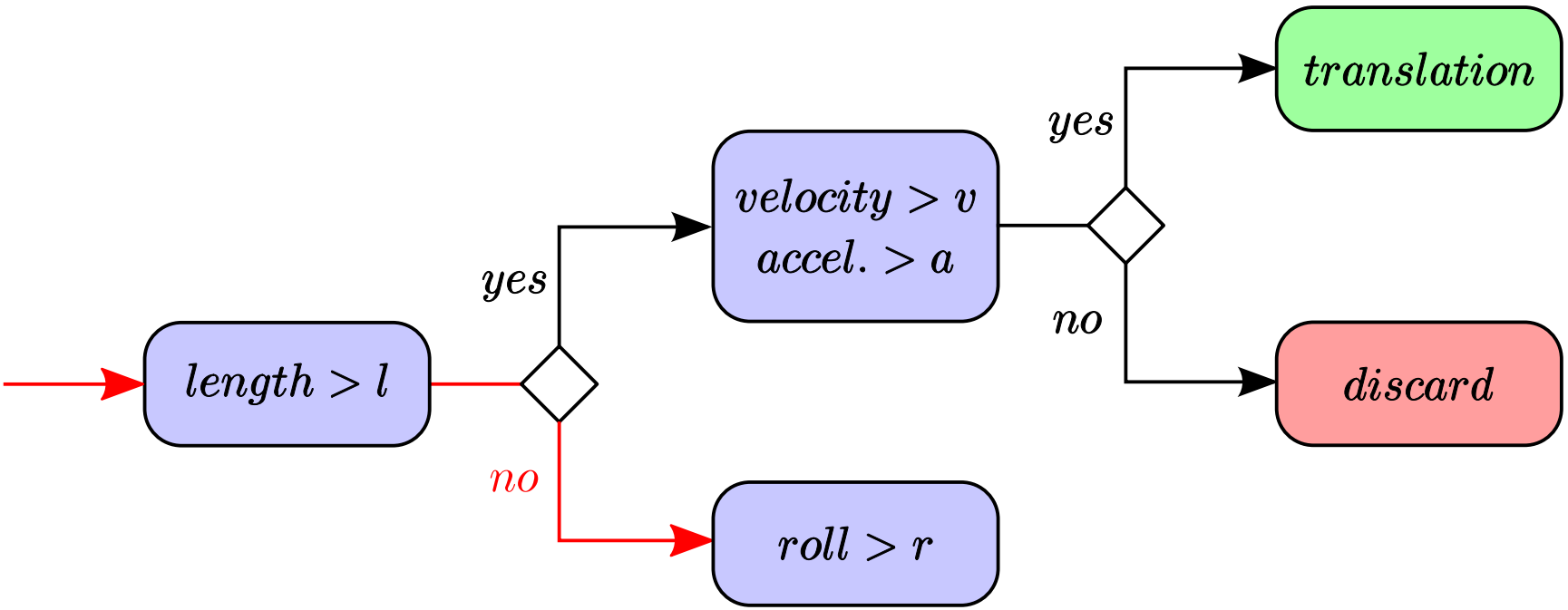

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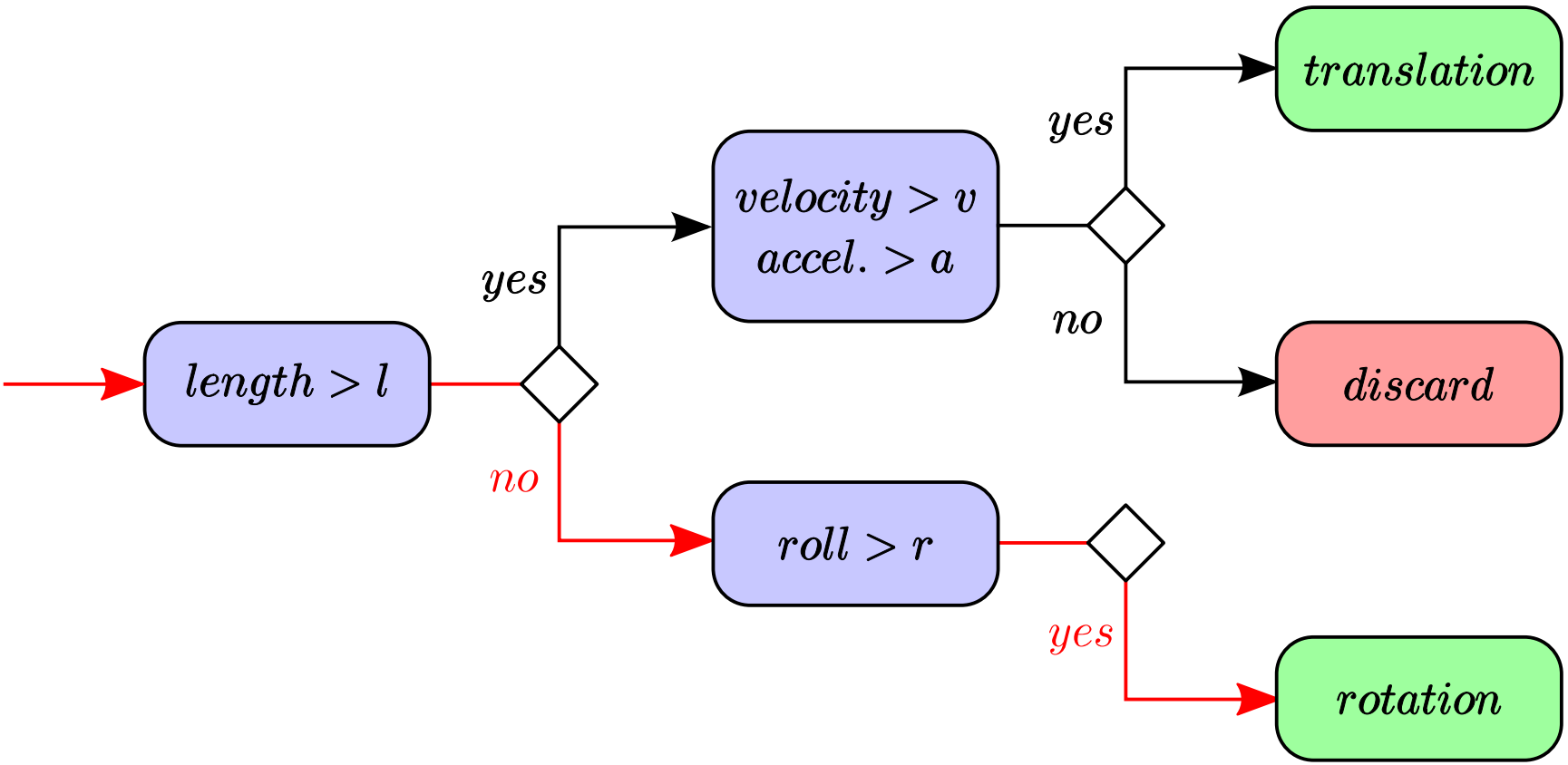
Motion Arrow: Analysis Of Motion Data



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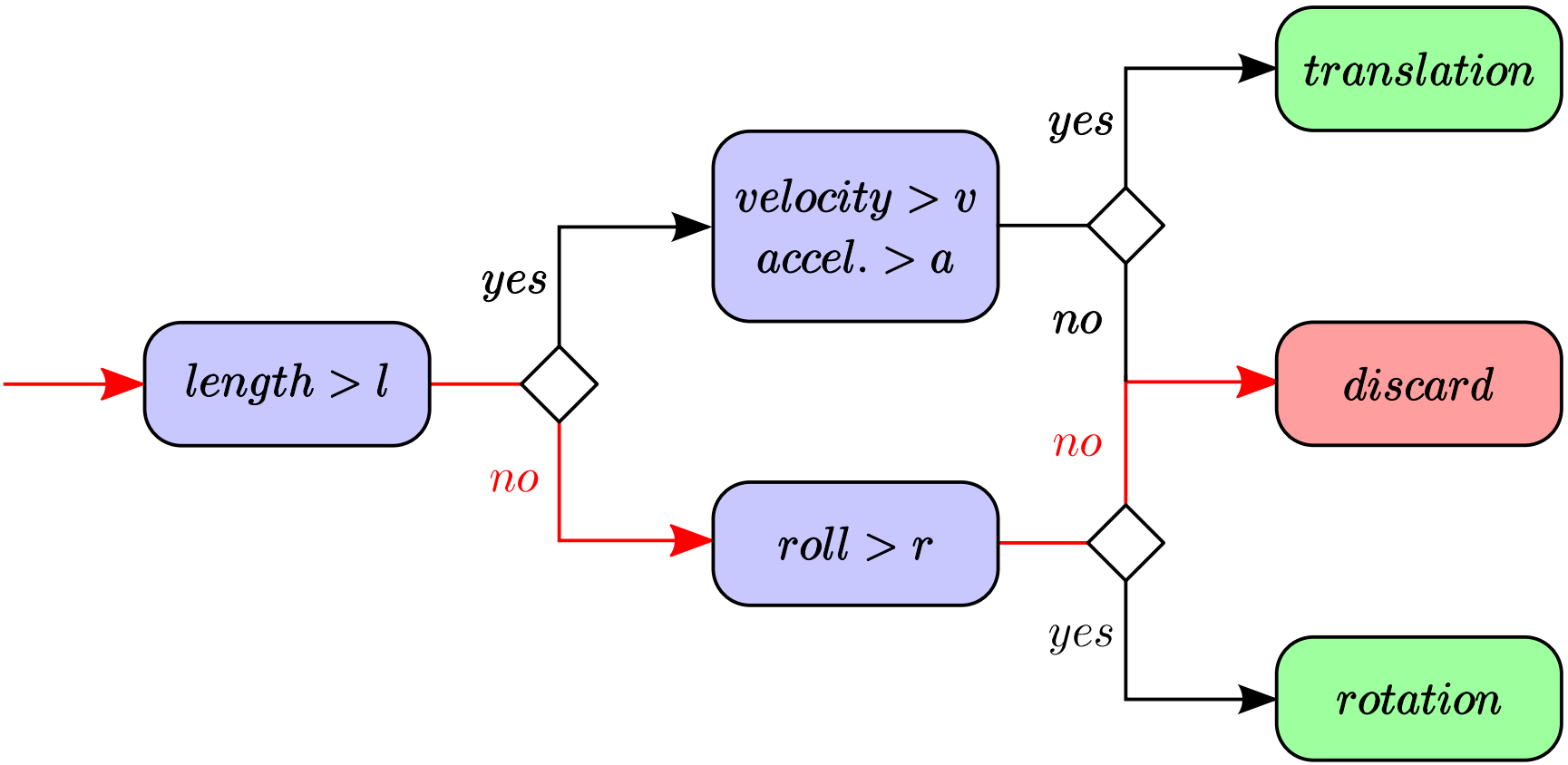
Motion Arrow: Analysis Of Motion Data



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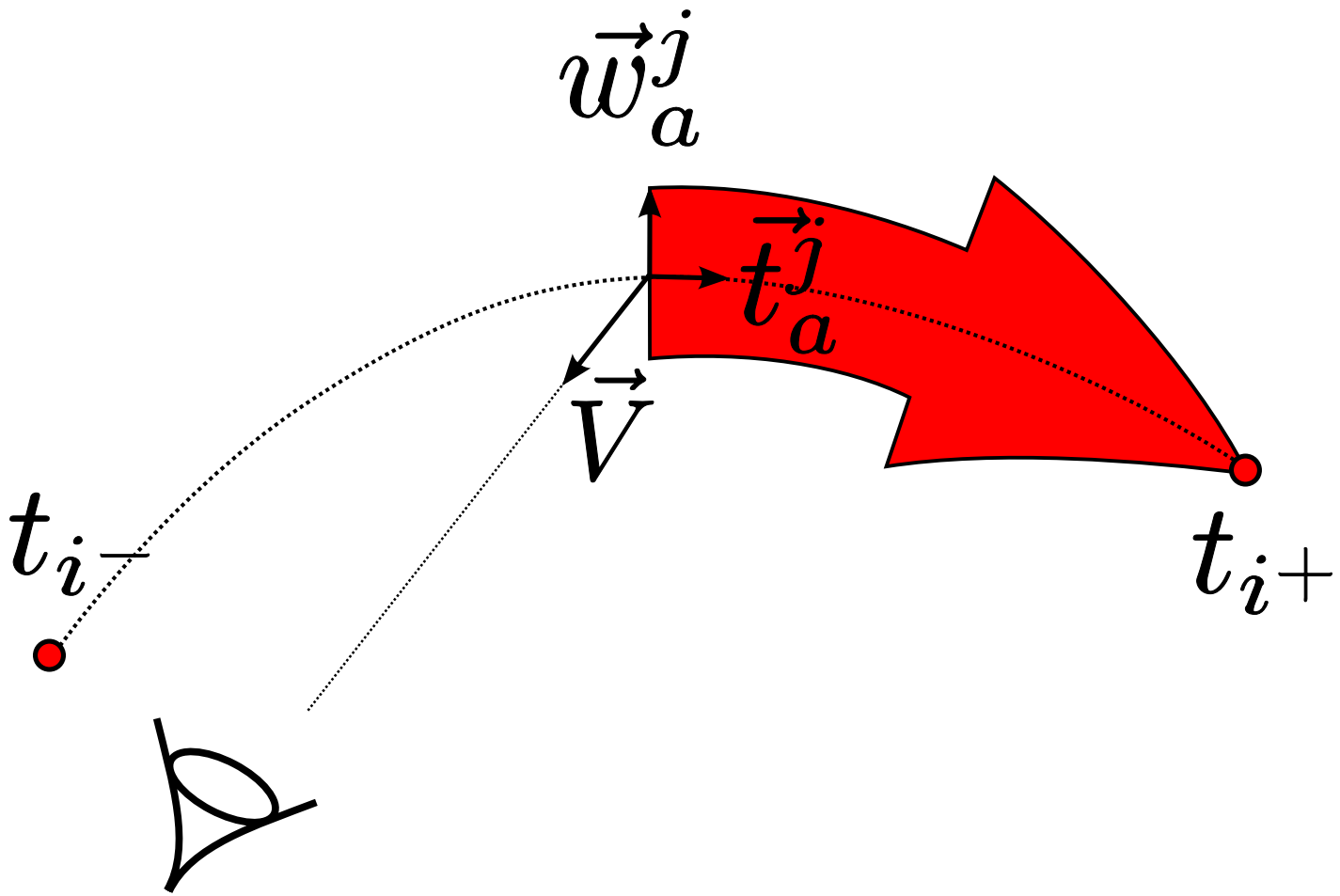
Motion Arrow: Construction



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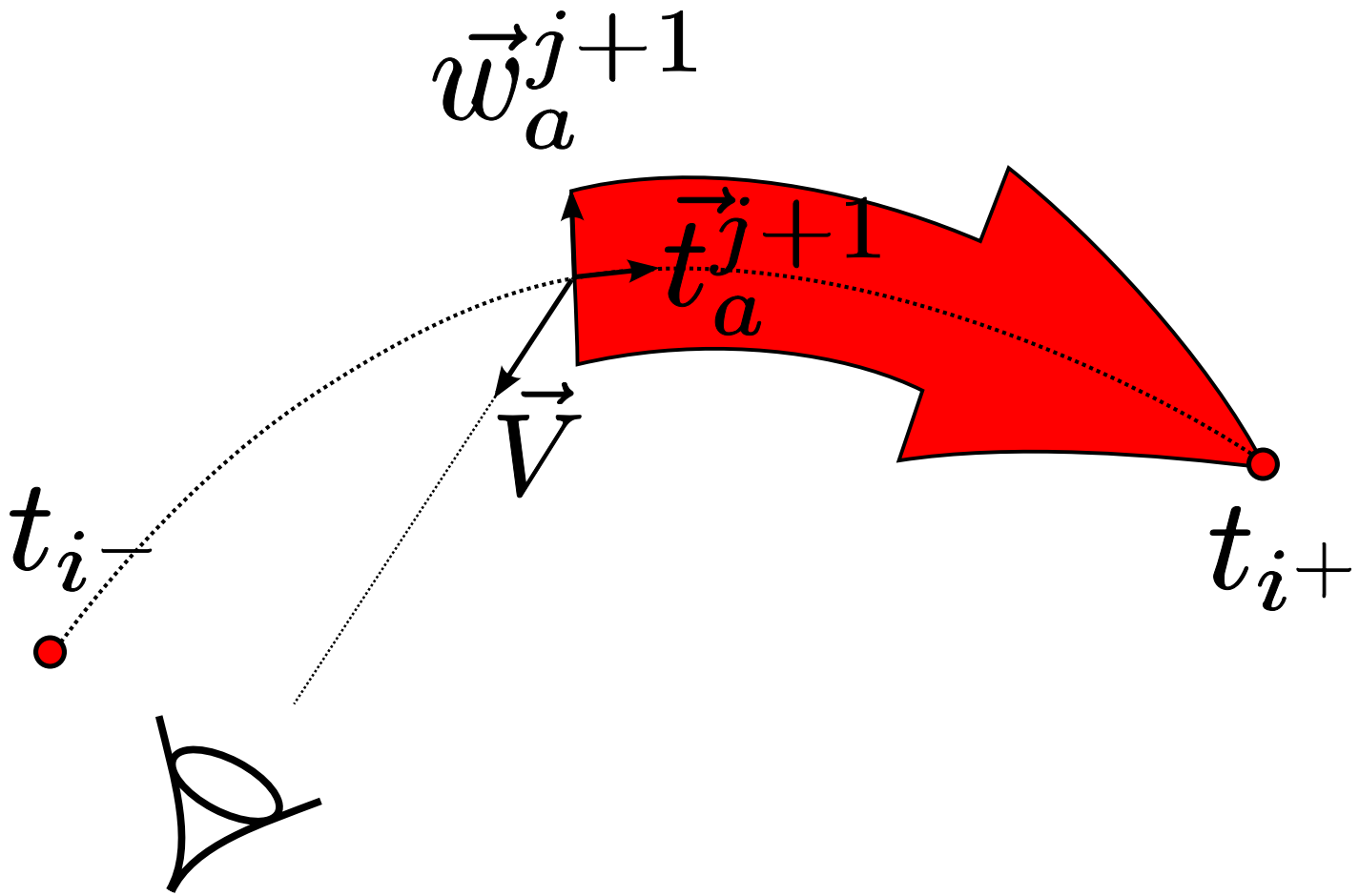
Motion Arrow: Construction



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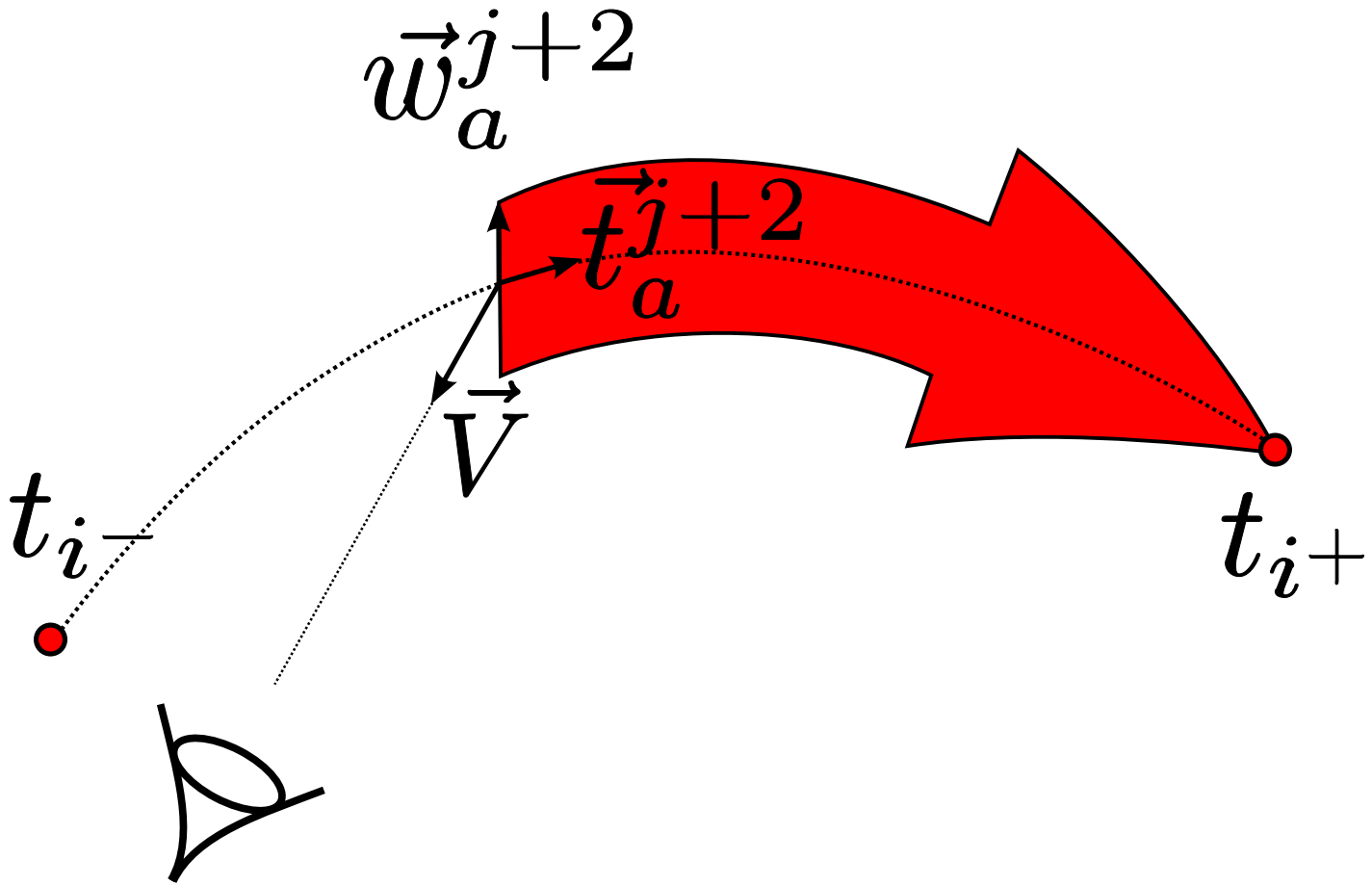
Motion Arrow: Construction



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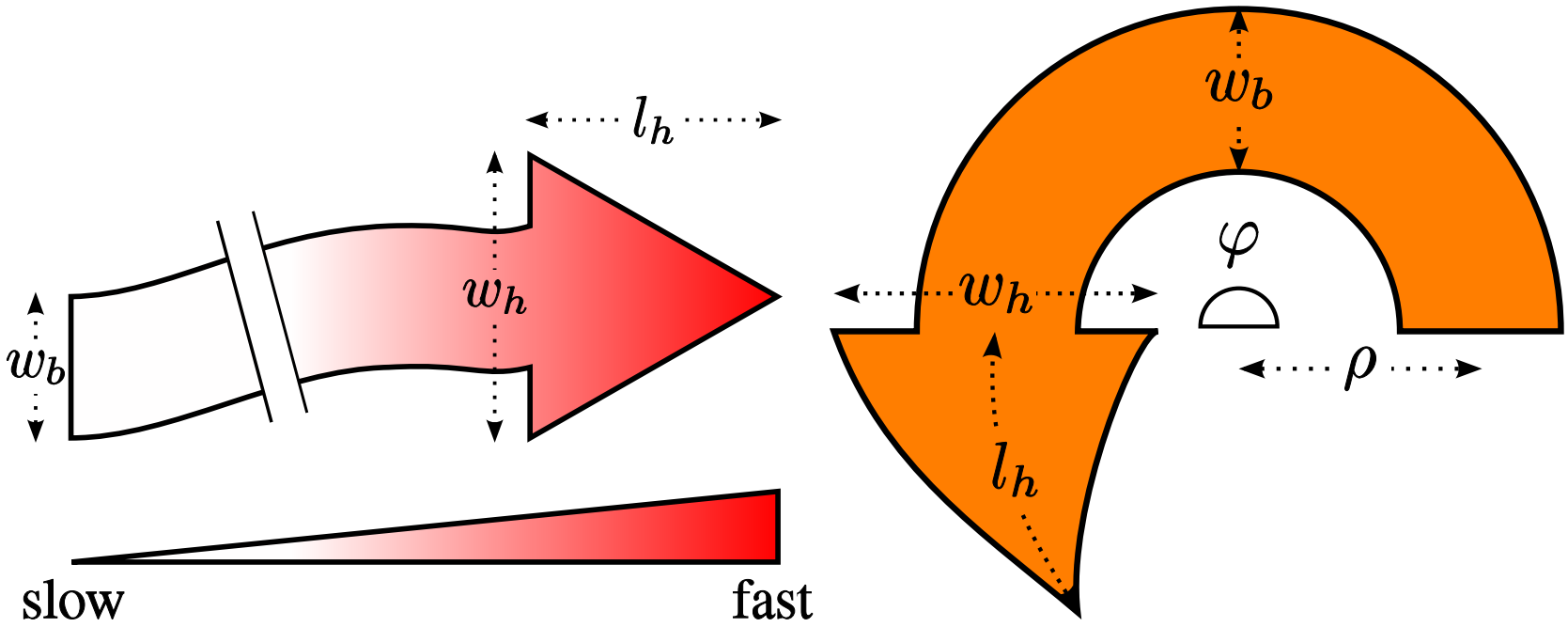
Motion Arrow: Parameters



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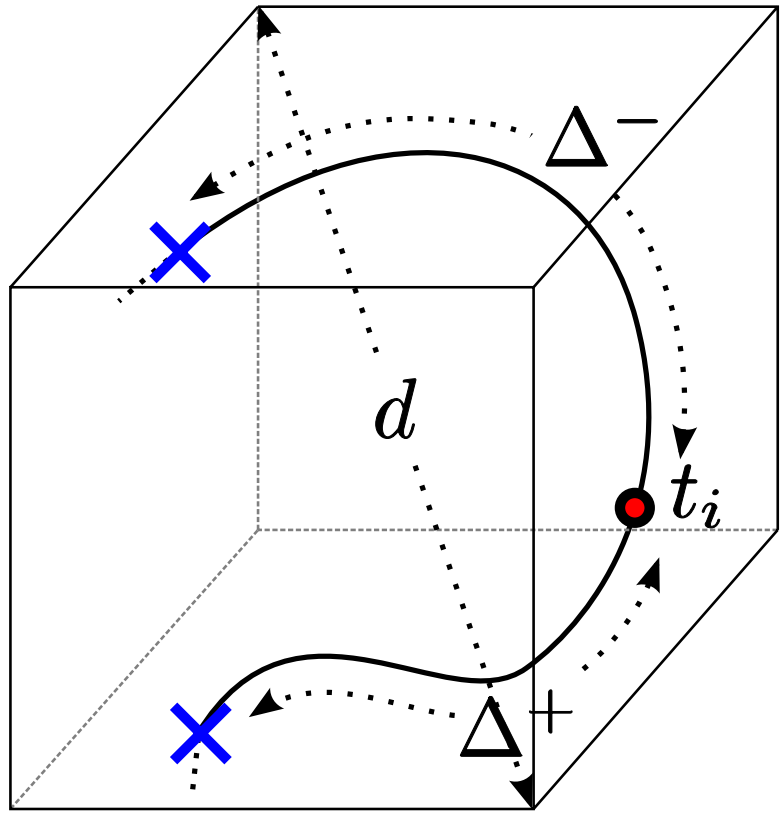
Noise Waves: Analysis Of Motion Data

- We calculate motion amplitude using bounding box of motion curve.



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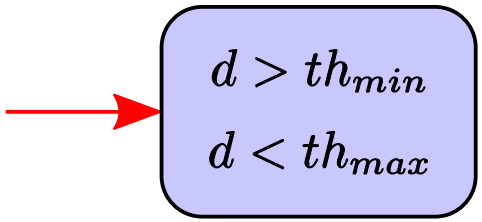
Noise Waves: Analysis Of Motion Data



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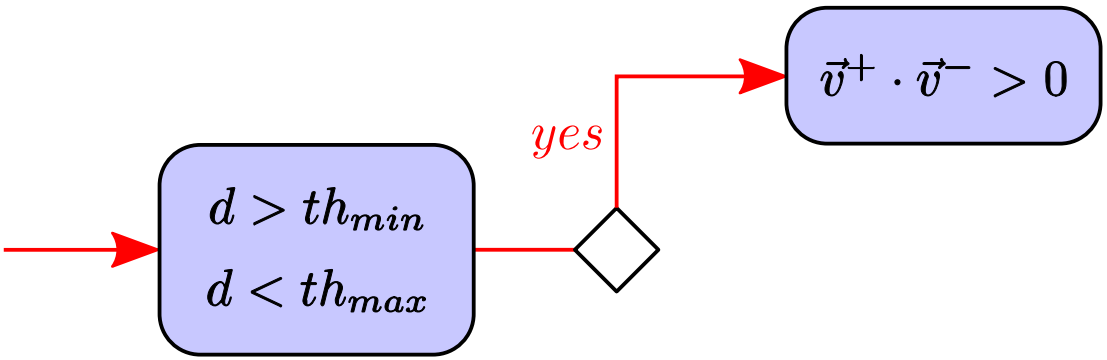
Noise Waves: Analysis Of Motion Data



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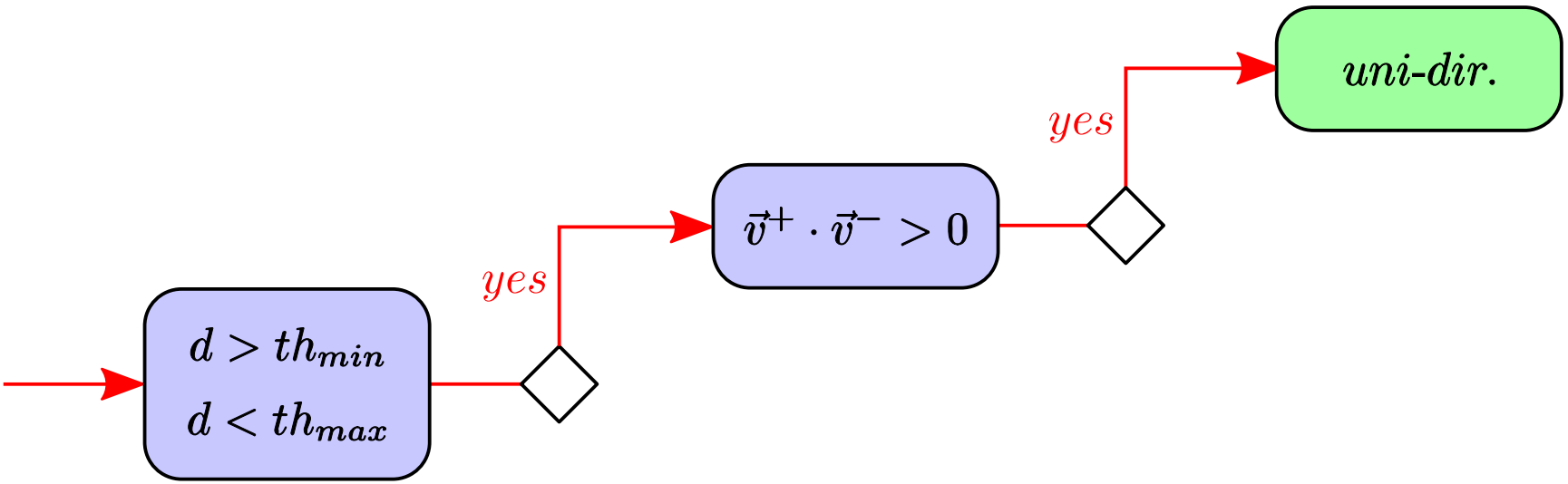
Noise Waves: Analysis Of Motion Data



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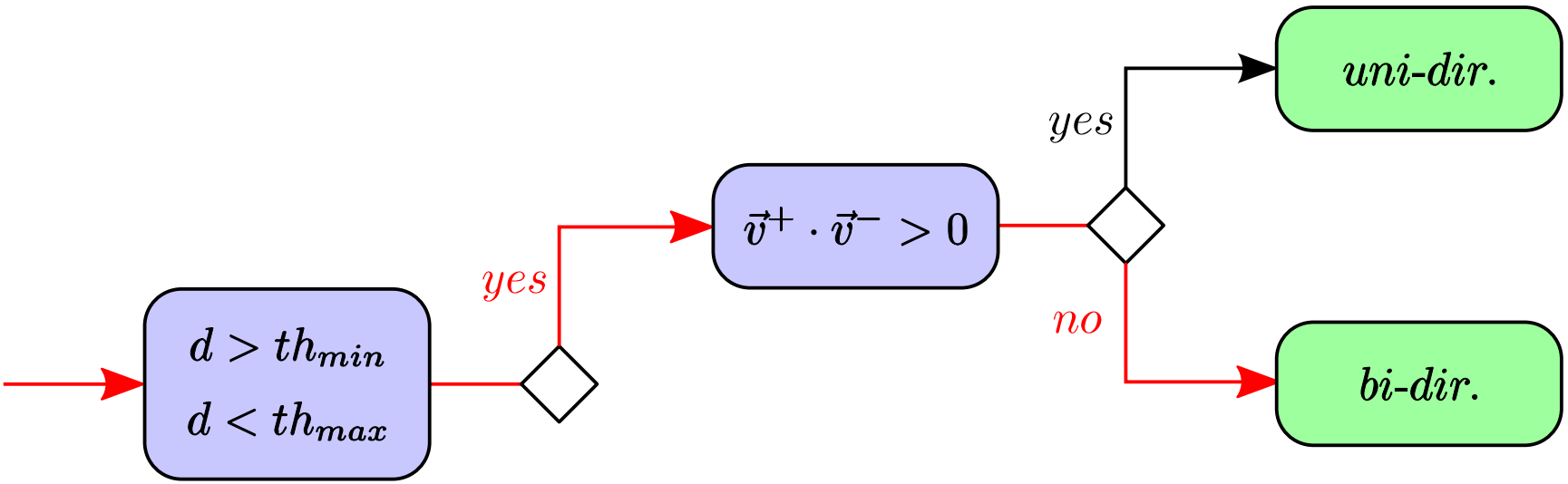
Noise Waves: Analysis Of Motion Data



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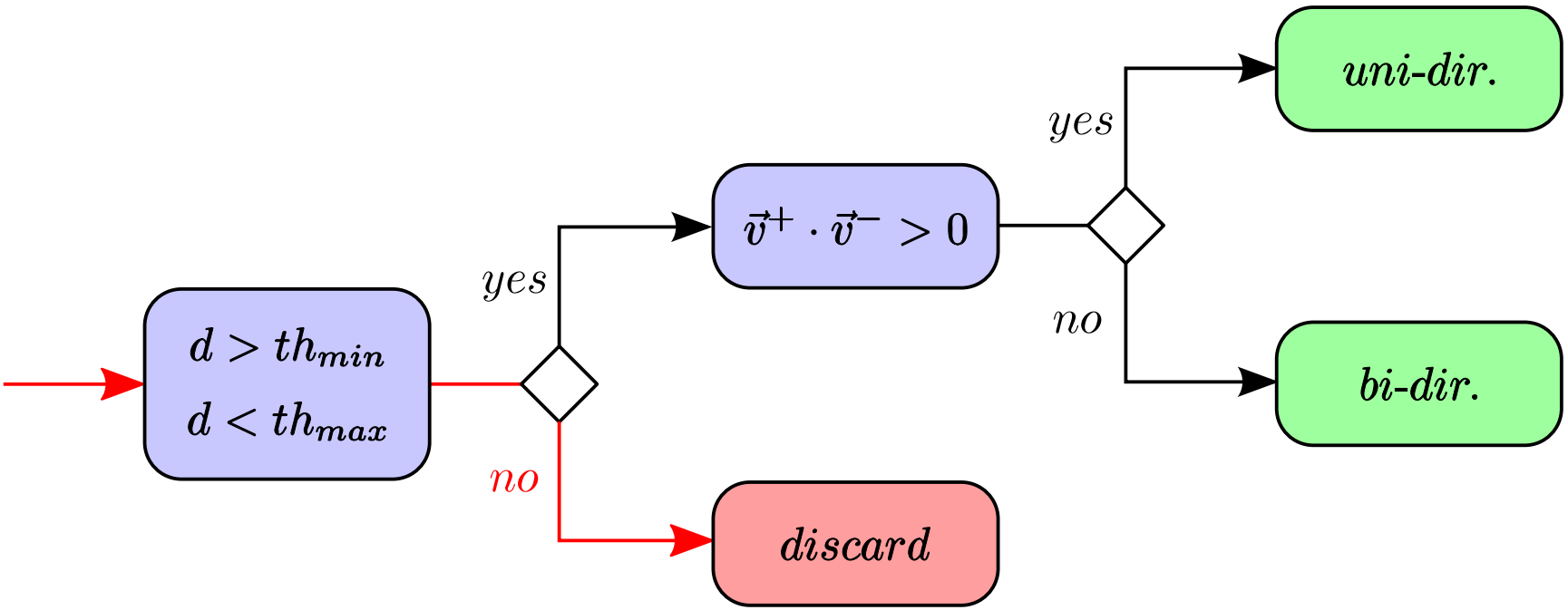
Noise Waves: Analysis Of Motion Data



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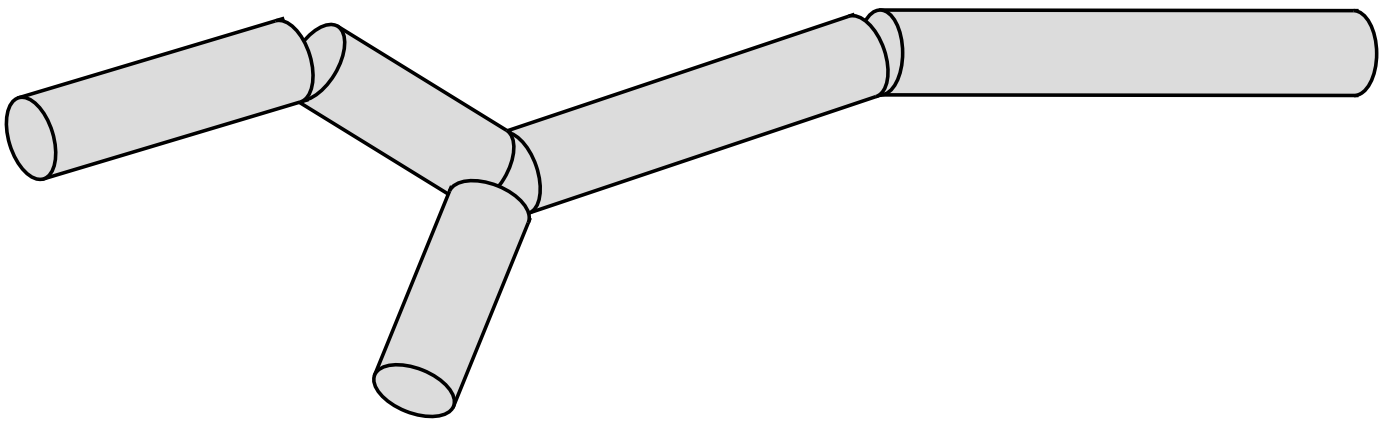
Noise Waves: Construction



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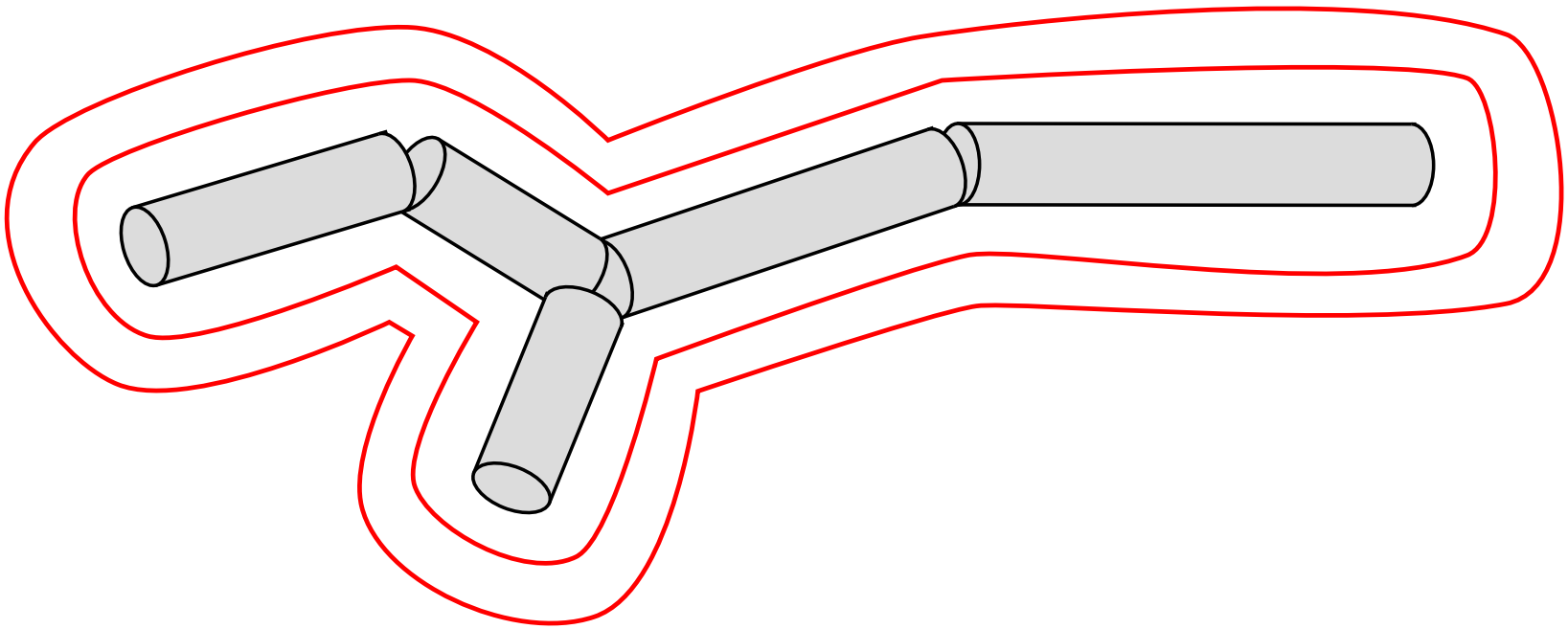
Noise Waves: Construction



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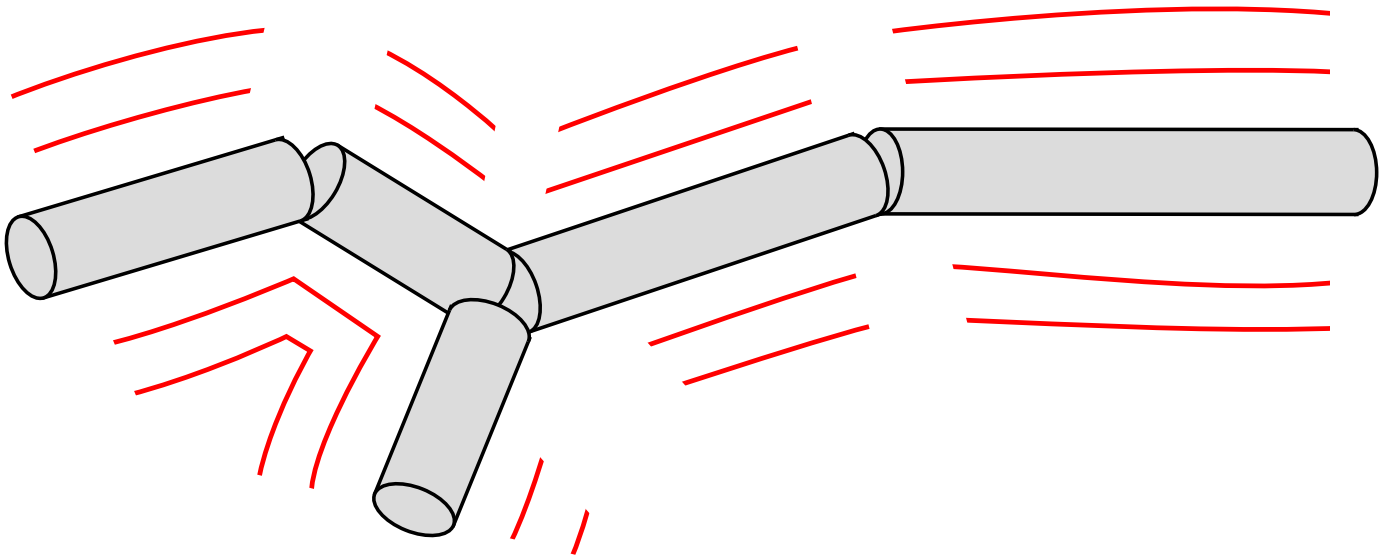
Noise Waves: Construction



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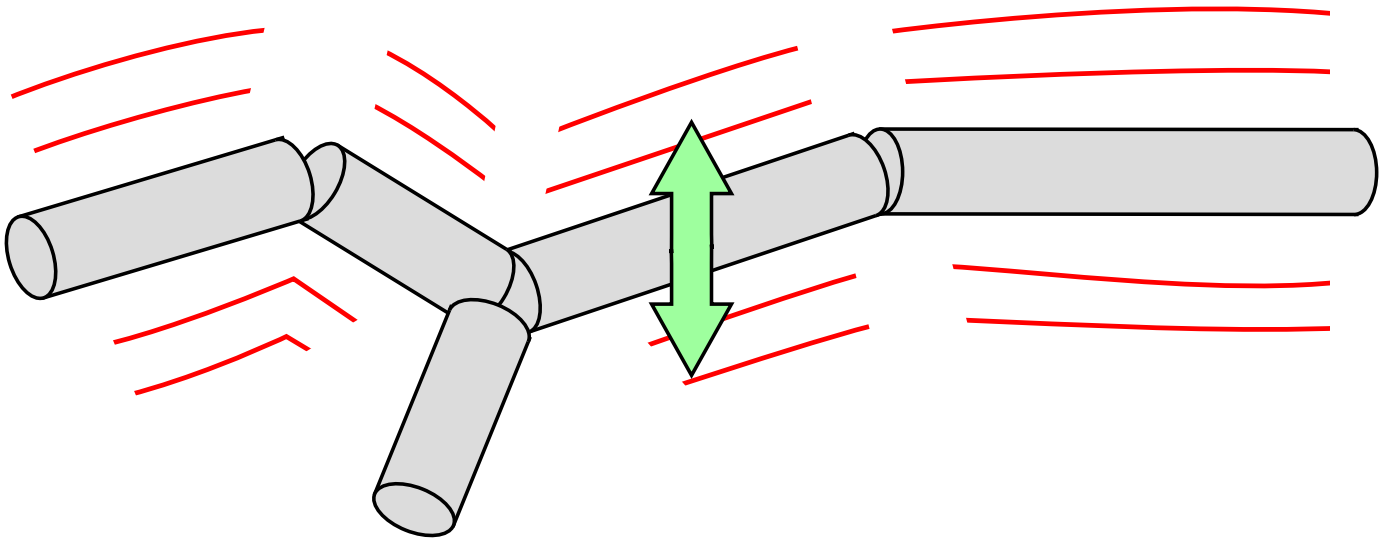
Noise Waves: Construction



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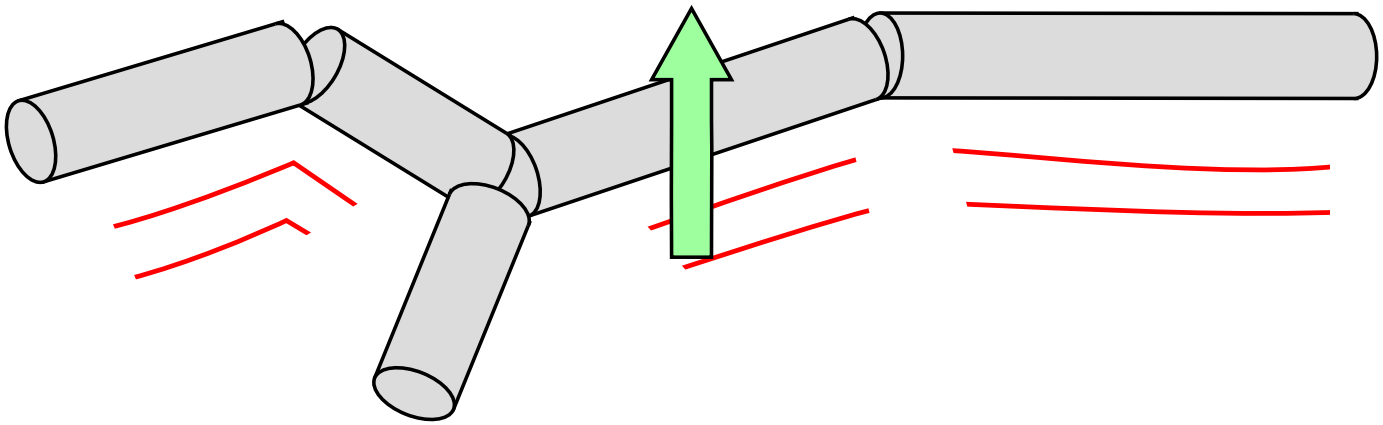
Noise Waves: Construction



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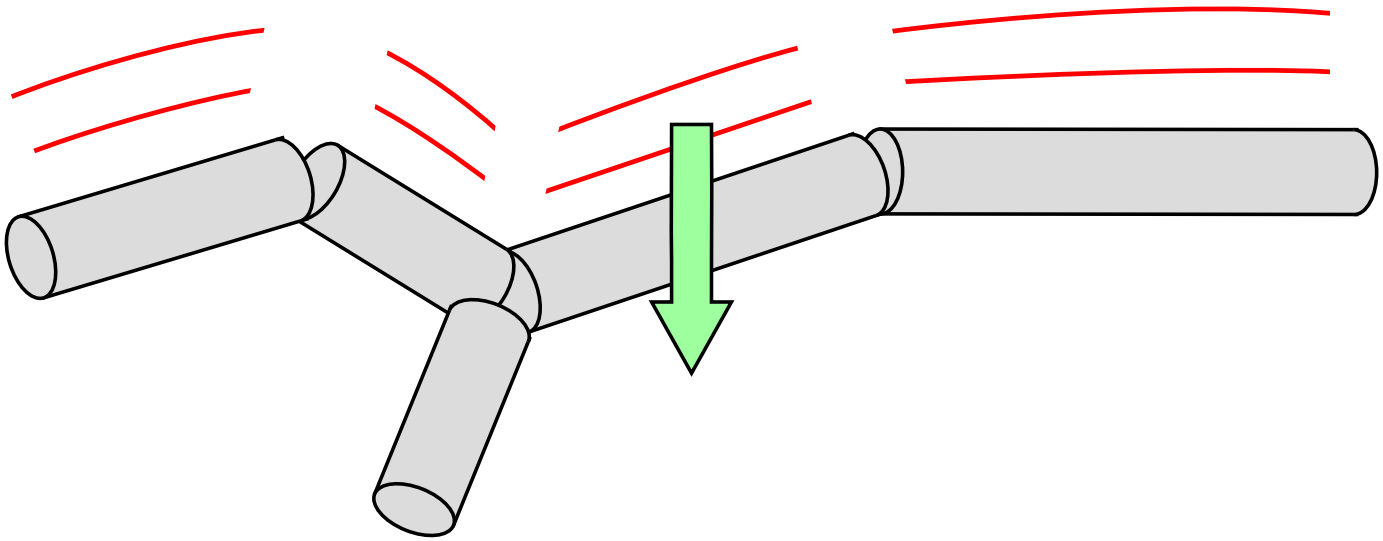
Noise Waves: Construction



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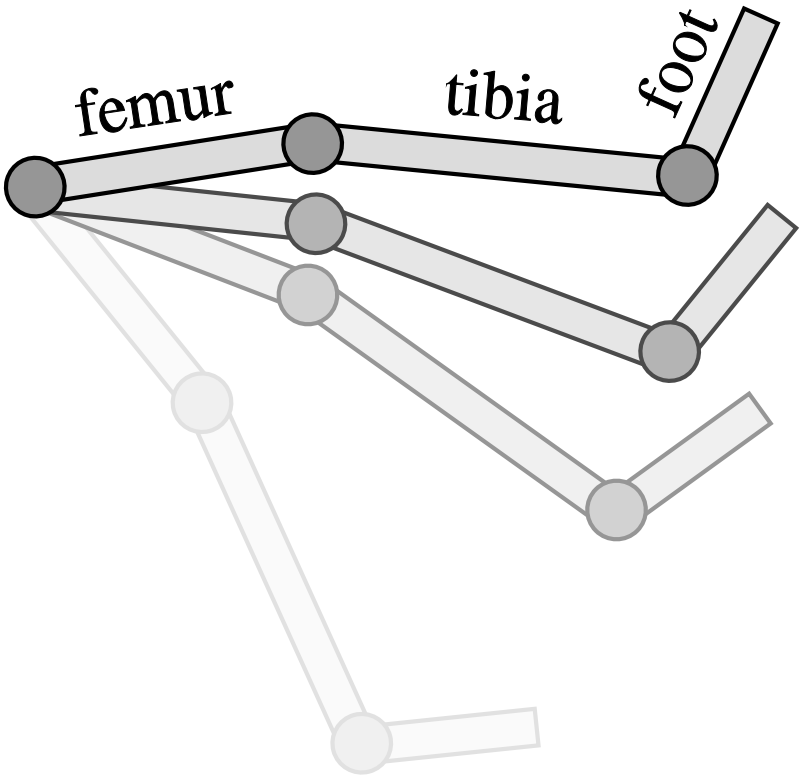
Stroboscopic Motion



$$
\begin{aligned}
t_i \quad & \alpha \leftarrow (\alpha_0)^0 \\
t_{i-1} \quad & \alpha \leftarrow (\alpha_0)^1 \\
t_{i-2} \quad & \alpha \leftarrow (\alpha_0)^2 \\
\vdots \quad & \vdots \\
t_{i-n} \quad & \alpha \leftarrow (\alpha_0)^n
\end{aligned}
$$

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Outline

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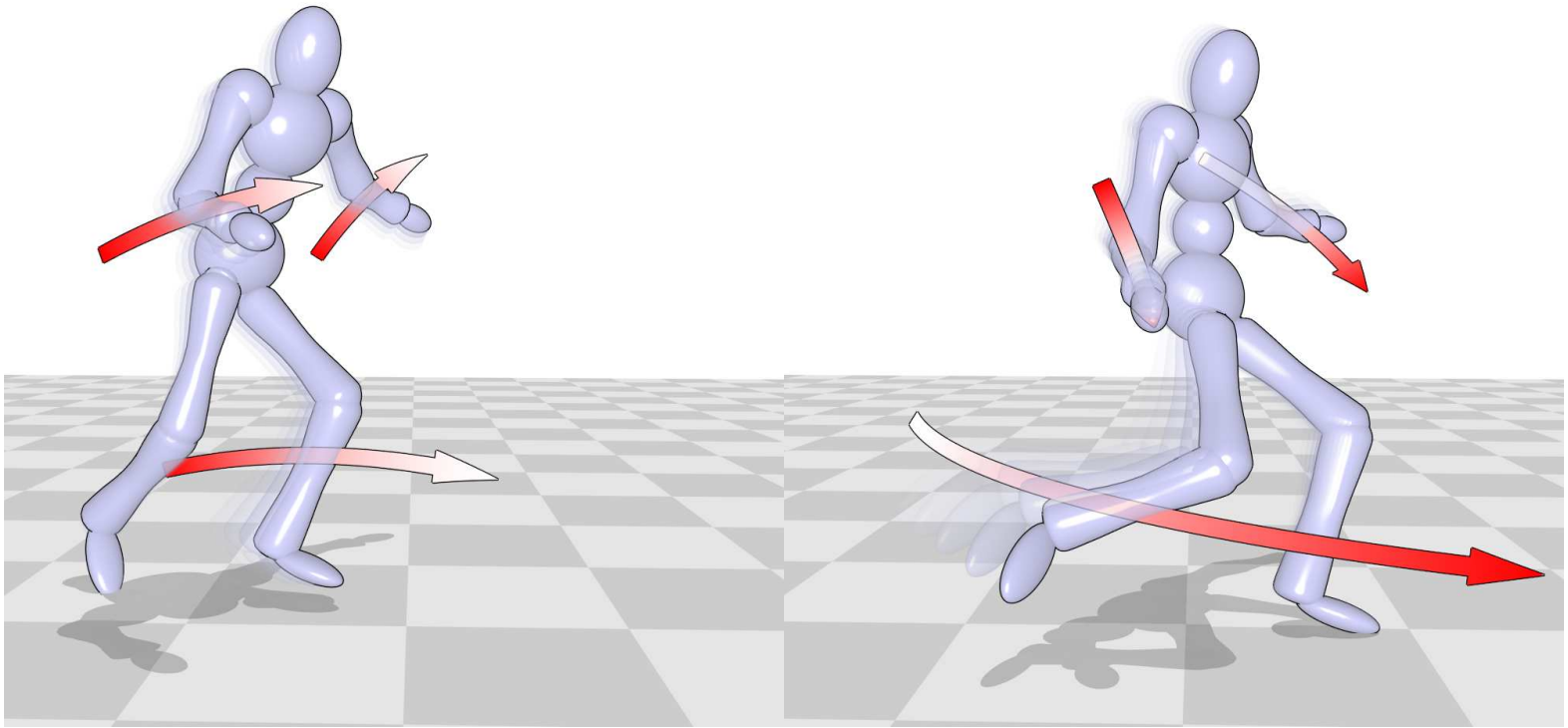
A Soccer Player



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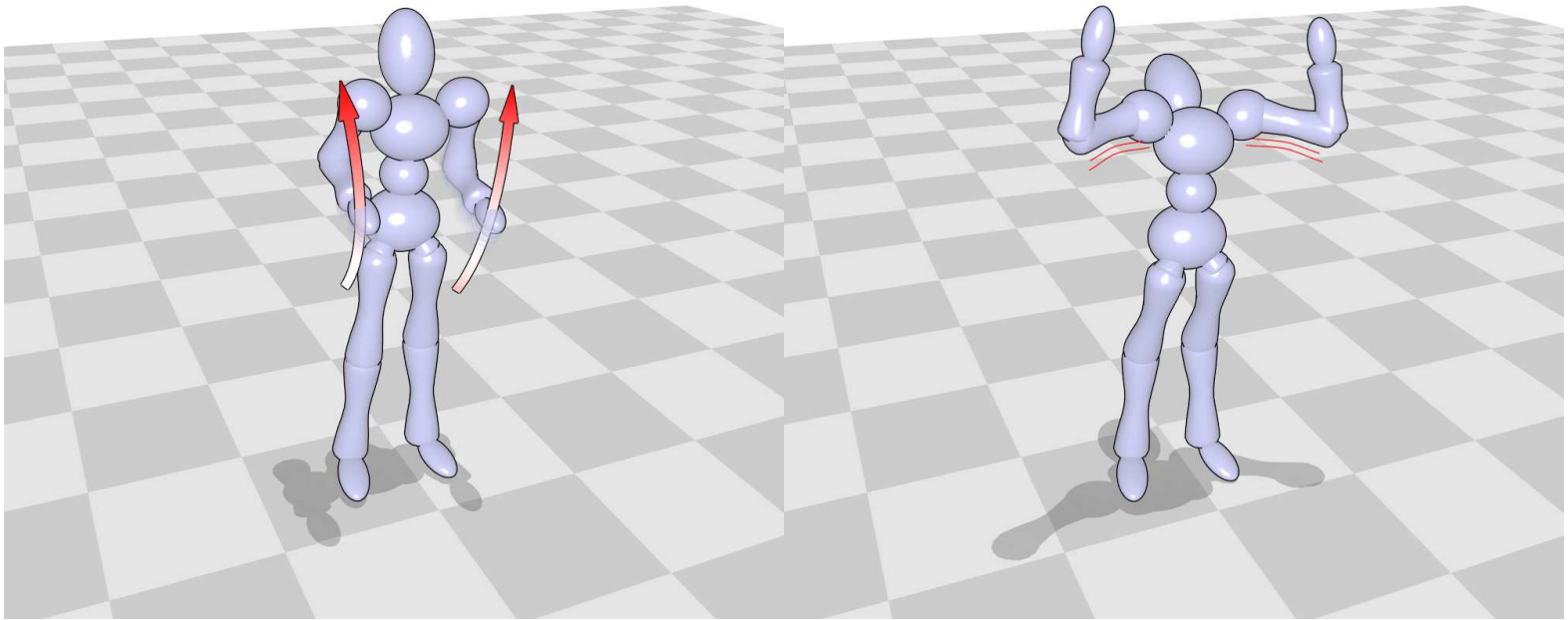
A Weight-Lifter



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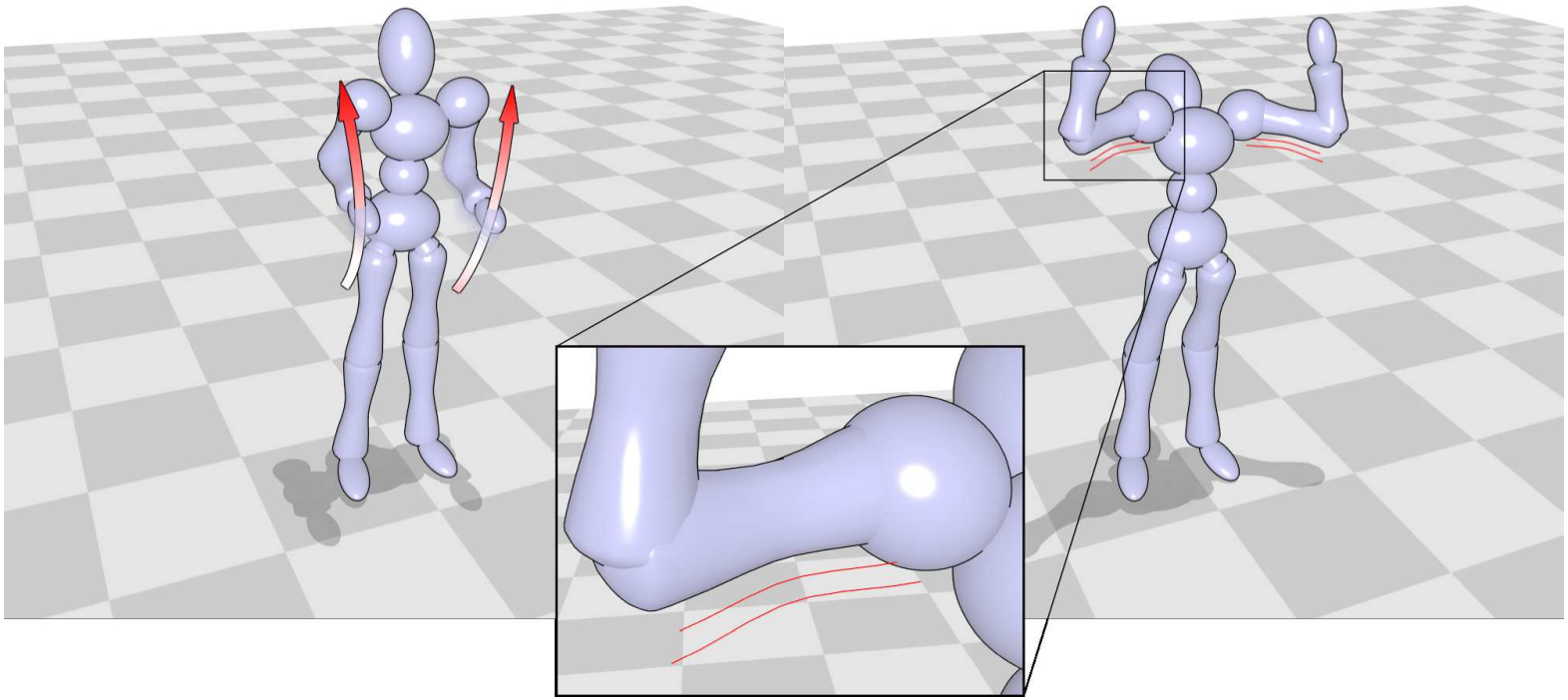
A Weight-Lifter



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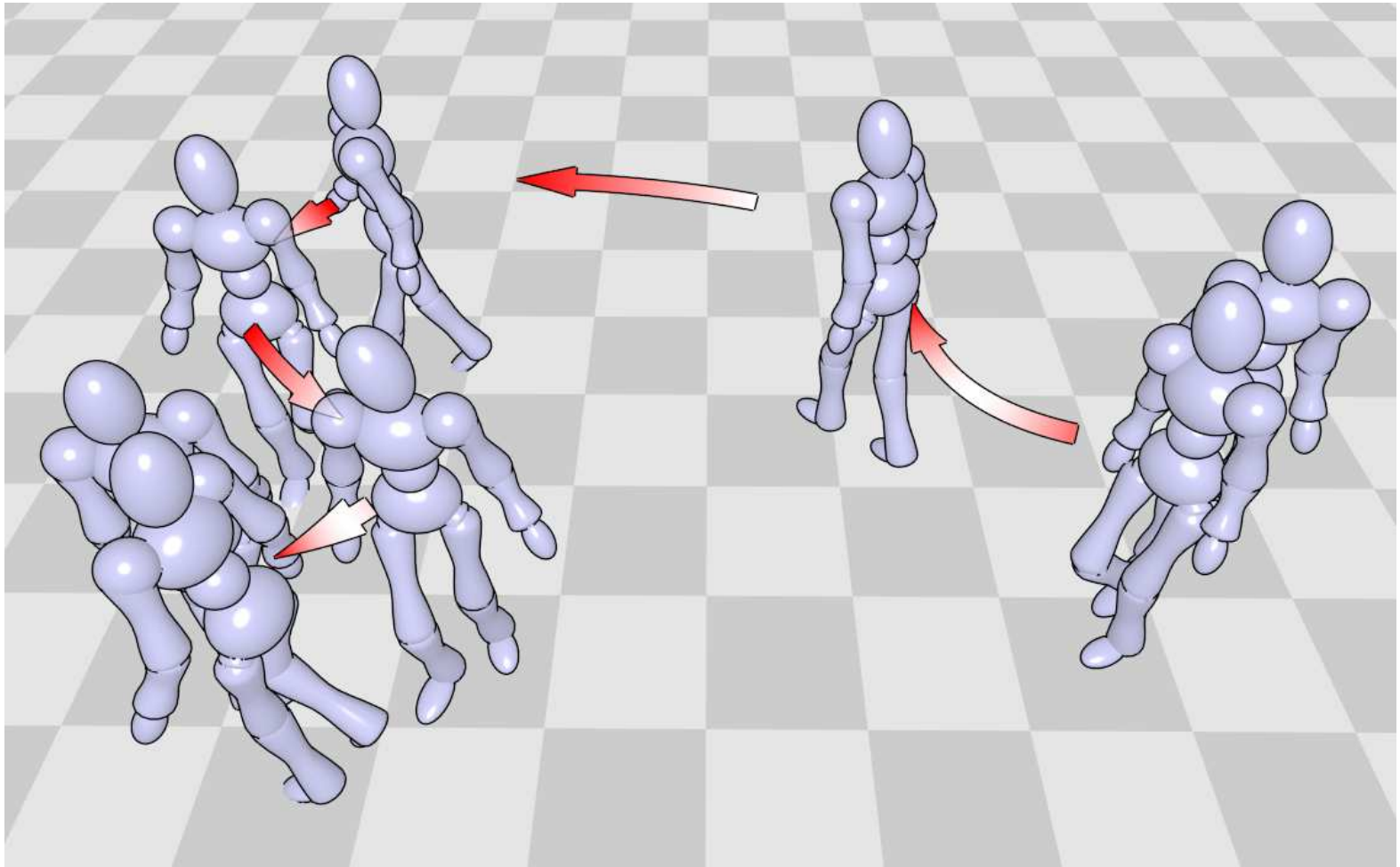
Multiple Key Poses



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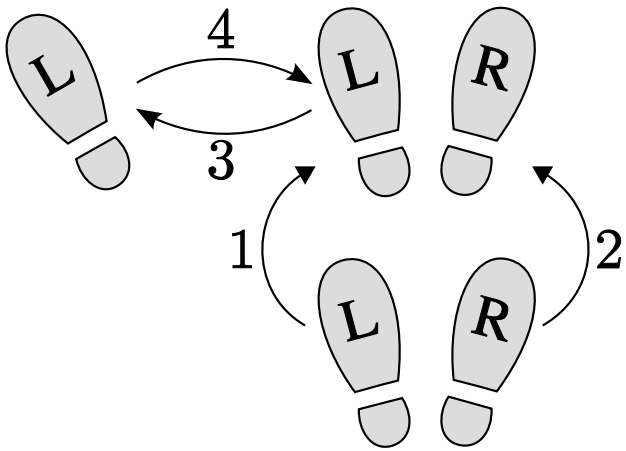
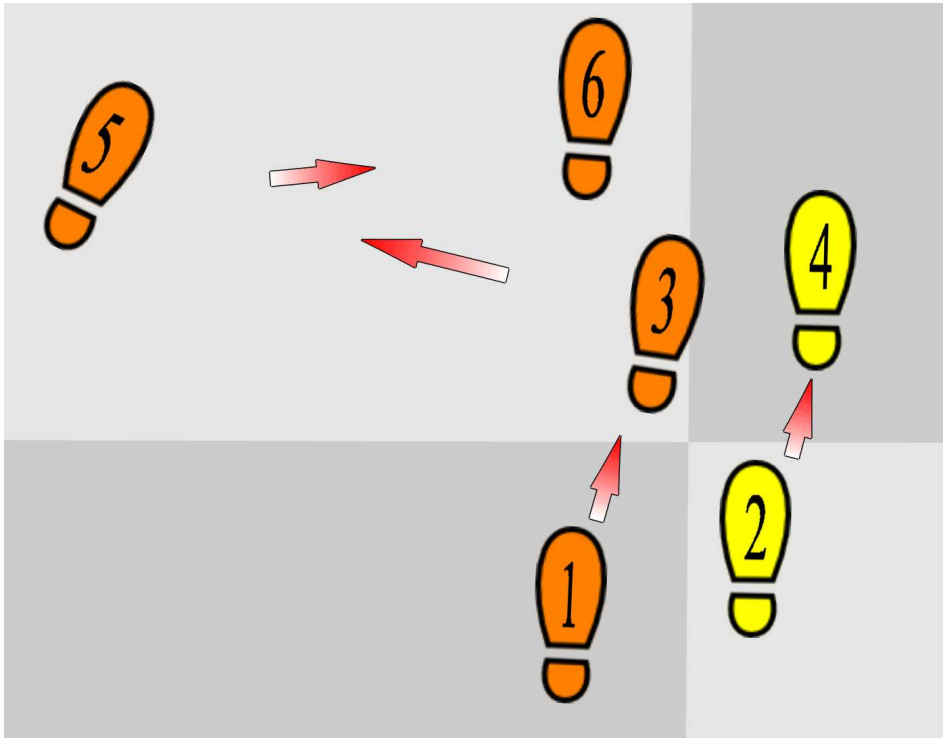
Foot Steps



Technical illustration



Our result

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Outline

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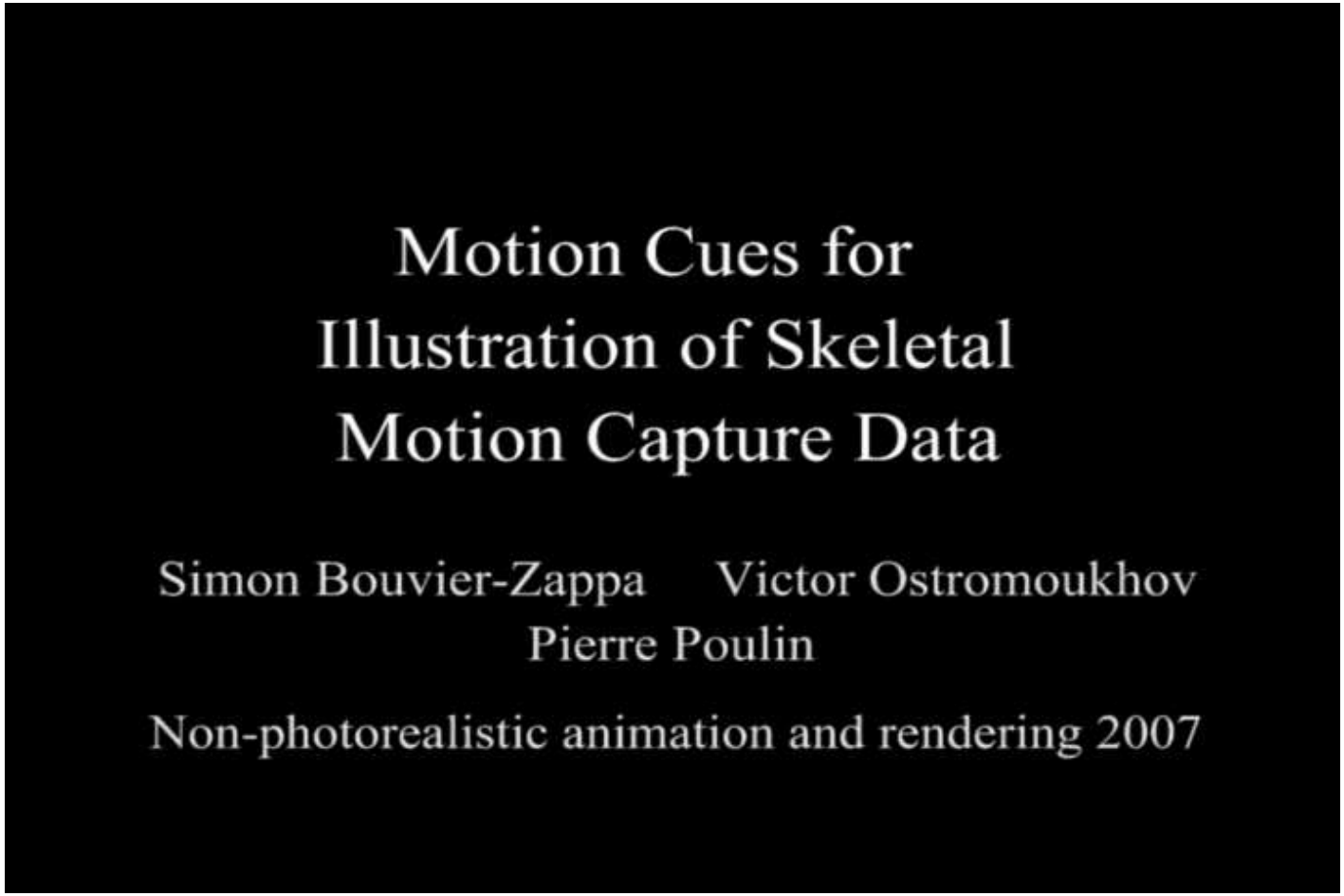
Video



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Outline

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Summary

- Combined use of motion arrows, noise waves and stroboscopic motion to illustrate skeletal motion capture data.
- Robust implementation of motion cues that adapt to the point of view and the character's geometry.
- Interactive system to perform intuitive manipulations on motion cues.

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Future Work

- Short term
  - Integrate other motion cues to the system
    - Speed lines
    - Motion blur
  - Refine motion analysis tool for better pattern recognition
  - Perform user evaluation of our system
- Long term
  - Automatically recognize specific movements from a database and apply adapted motion cues

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Thank You !

- Acknowledgements
  - Ubisoft
  - Philippe Beaudoin and Luc Leblanc for support and precious insights !
  - Yann Rousseau for vector support !
  - All the people at the LIGUM !

- Credits
  - Motion capture data: Carnegie Mellon University

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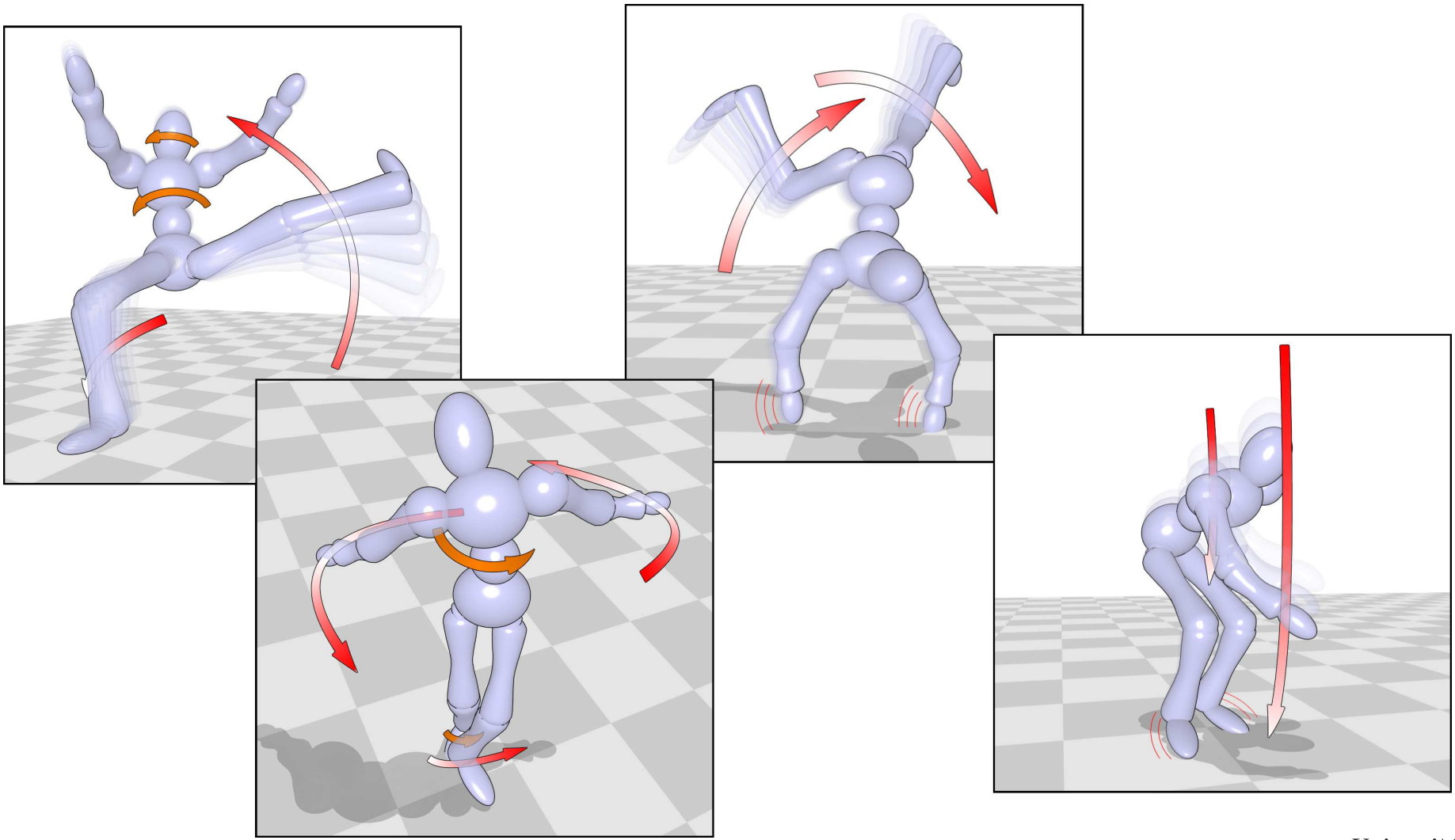
Thank You !



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