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The line of action: an intuitive interface for expressive character posing

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Topics: Character animation

The Line of Action: an Intuitive Interface for Expressive Character Posing

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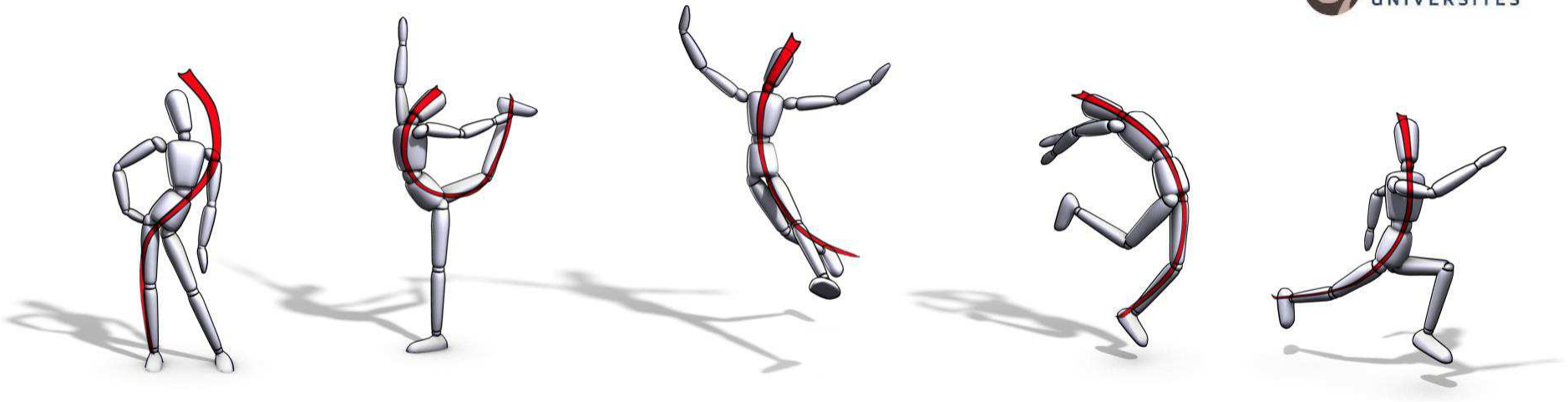
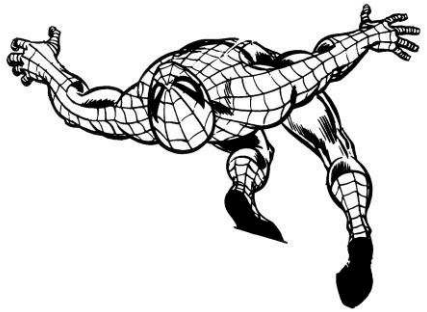
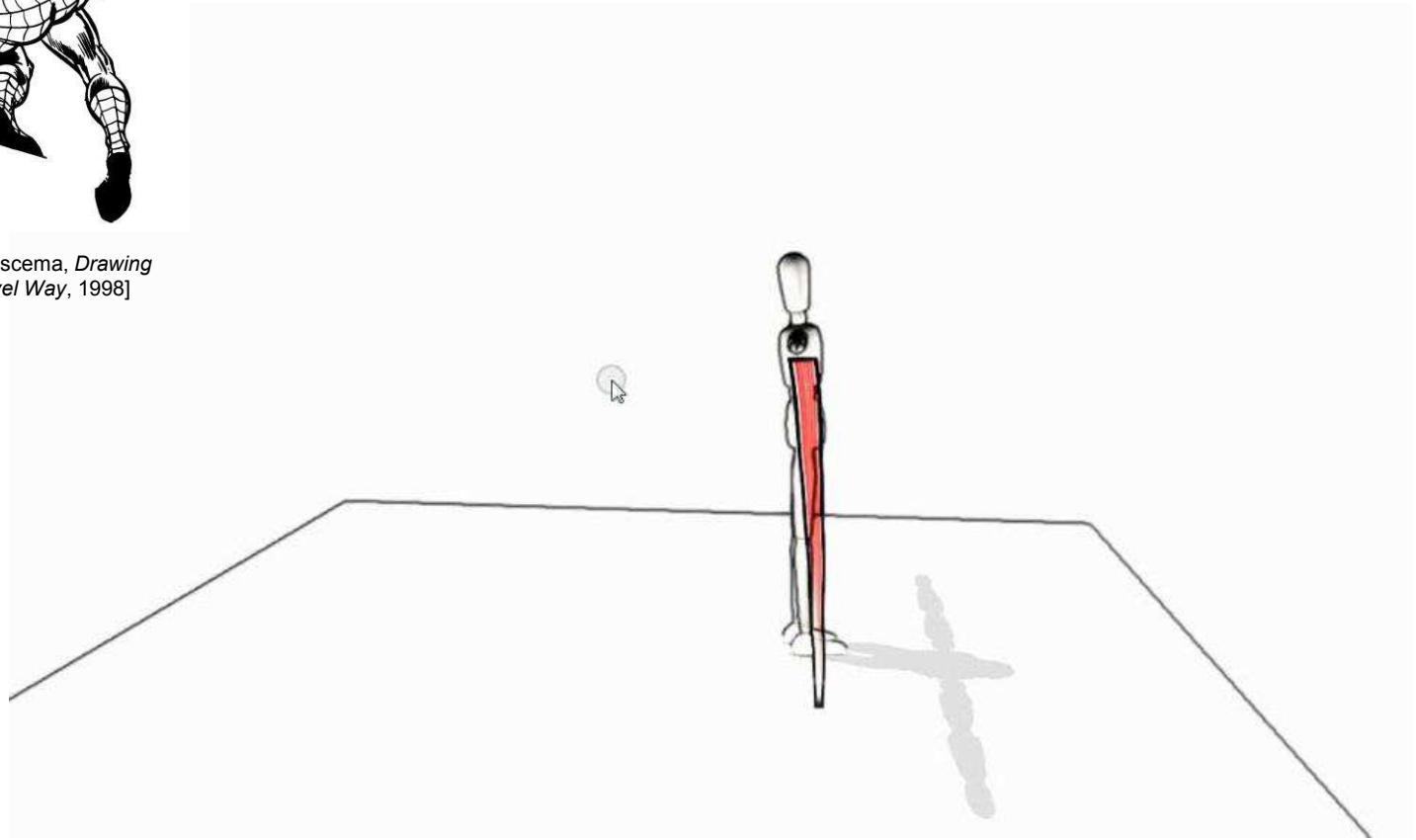
LJK, INRIA, Université de Grenoble





[S.Lee and J. Buscema, *Drawing Comics the Marvel Way*, 1998]



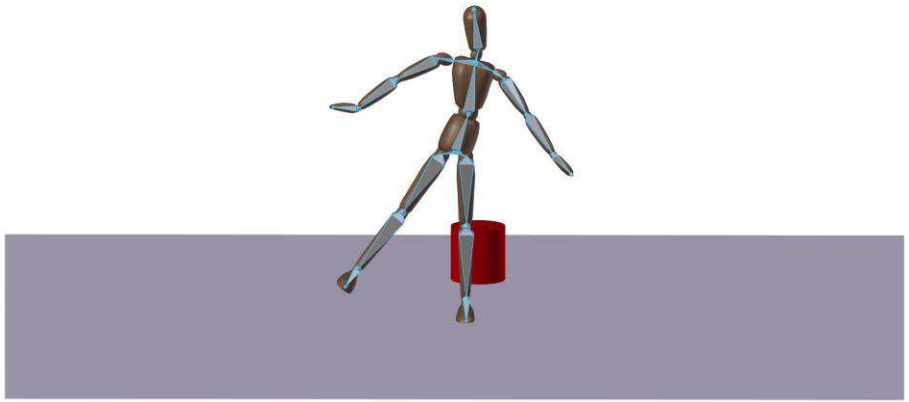
Introduction

3D Character Posing

- Placing a 3D character in a 3D world.

3D Character Posing

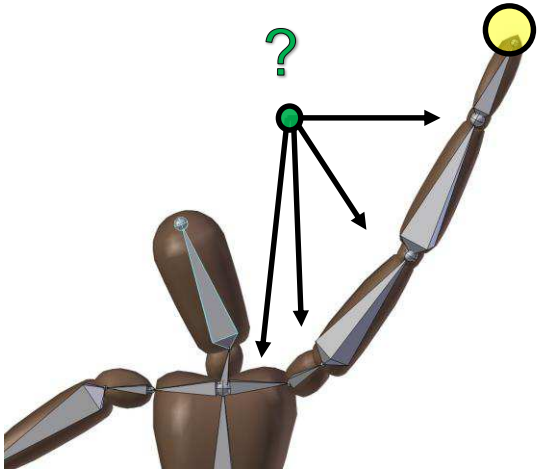
- Intuitive: Skeleton parametrization



[Burtnyk, N., at al, Interactive skeleton techniques for enhancing motion dynamics in key frame animation, 1976.]

3D Character Posing

- More Intuitive: Inverse Kinematics (IK)



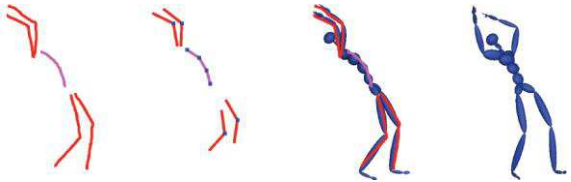
[Girard, M., et al., *Computational modeling for the computer animation of legged figures*, 1985.]

[Zhao, J., et al., *Inverse kinematics positioning using nonlinear programming for highly articulated figures*, 1994]

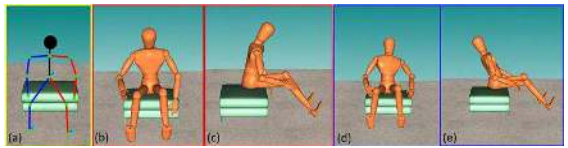
3D Character Posing

- More Intuitive: 2D Stickfigures

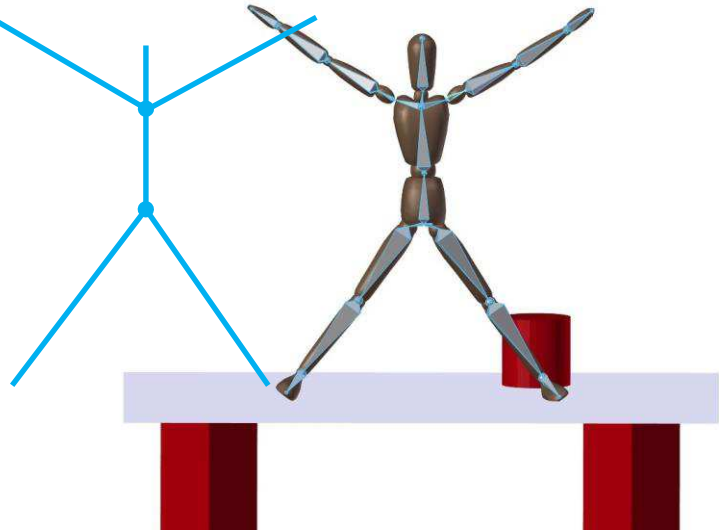
- [Davis. J. et al., A sketching interface for articulated figure animation, 2003.]



- [Wei, X.K., et al., Intuitive interactive human character posing with millions of example poses, 2011]

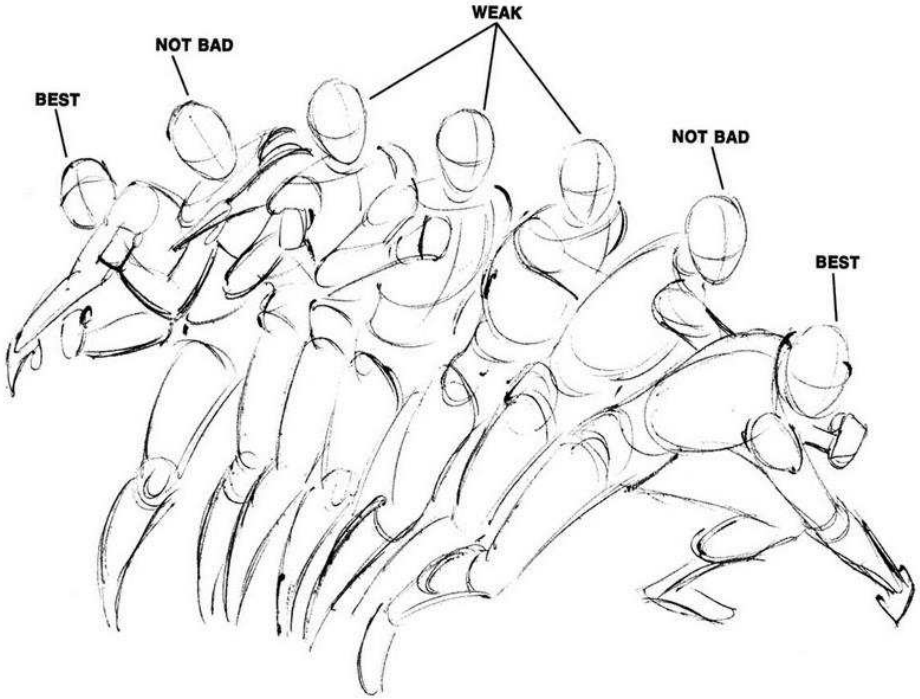


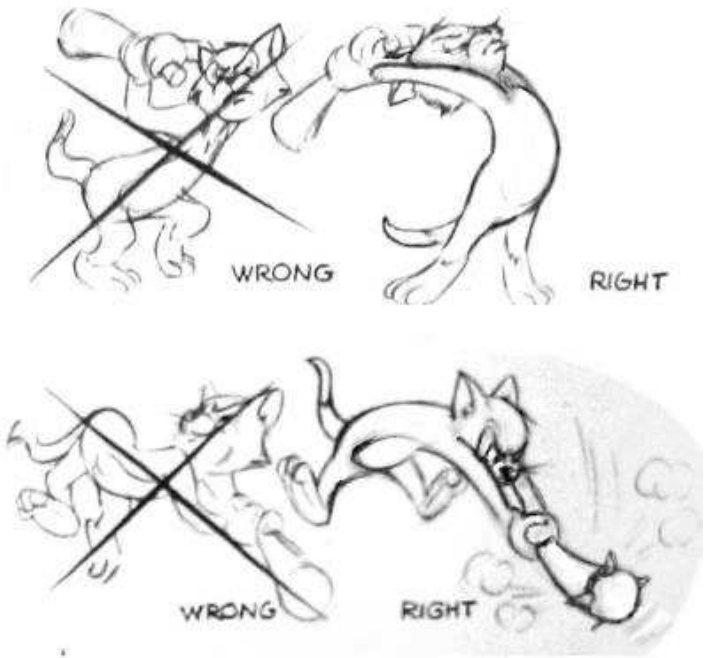
- [Lin, J., et al., A sketching interface for sitting-pose design. 2010



Expressive Poses

- Emotion expressed, body language is as *clear*---and *readable*---as possible.

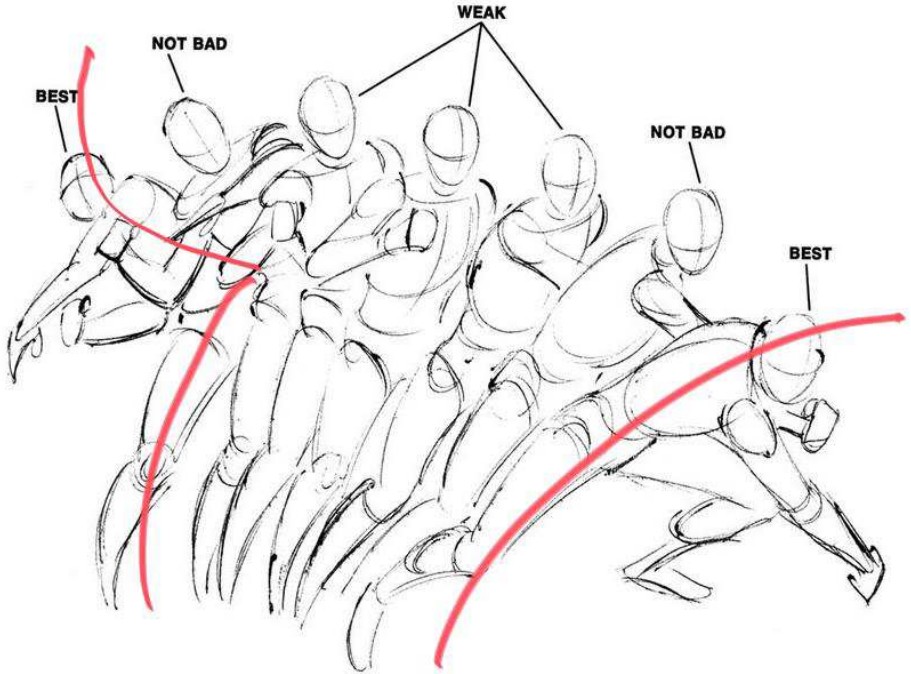




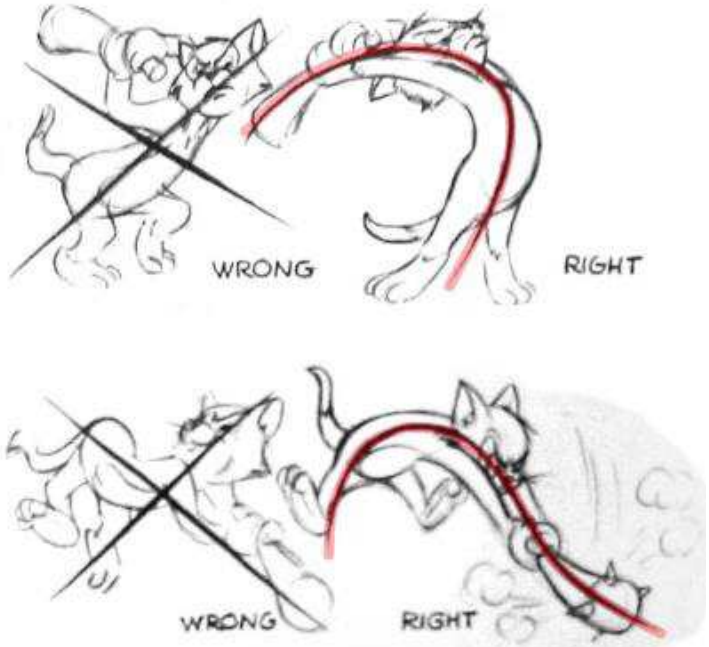
- [S.Lee and J. Buscema, *Drawing Comics the Marvel Way*, 1998]
- [Blair, P., *Cartoon Animation*, 1994]

Expressive Poses

- Lines of Action



- [S.Lee and J. Buscema, *Drawing Comings the Marvel Way*, 1998]

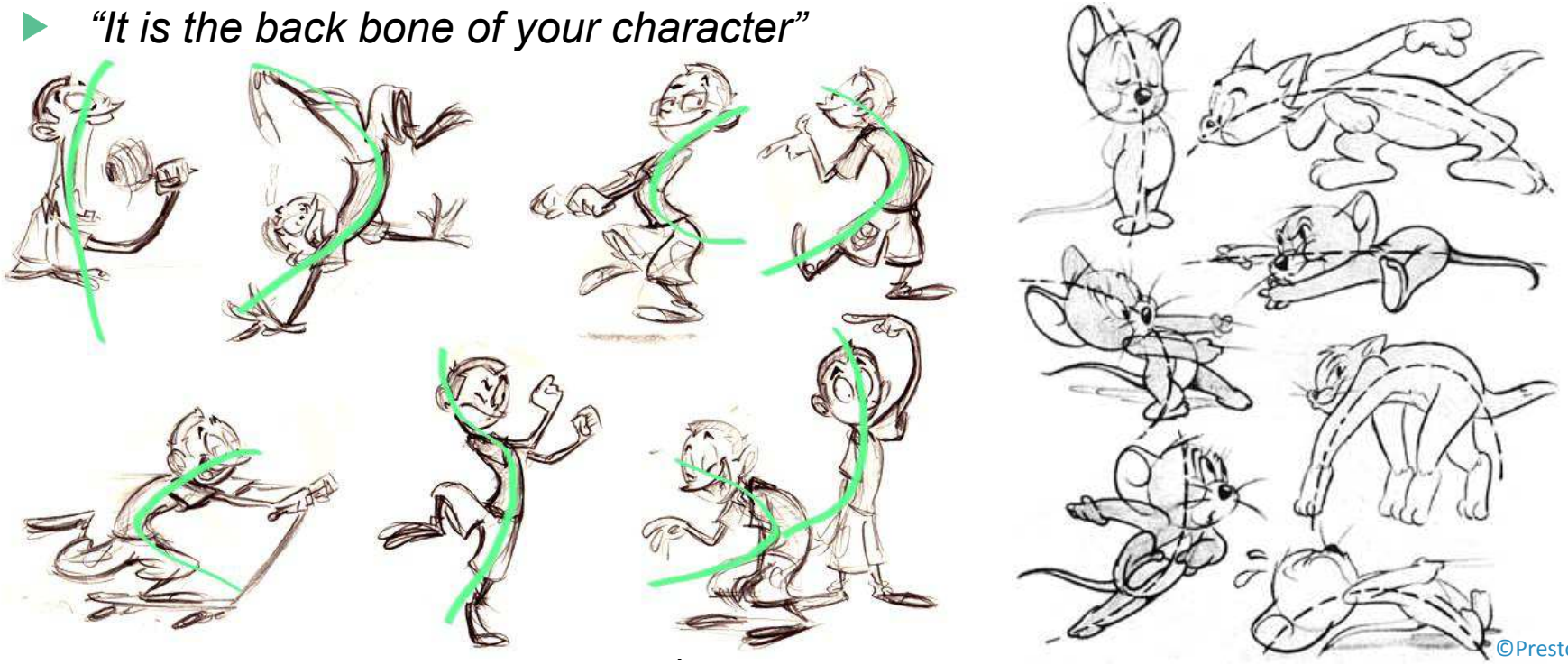


- [Blair, P., *Cartoon Animation*, 1994]

Posing with lines of action

Posing with lines of action

- *"It is the imaginary line that passes through the main action of the character"*
- *"It is the imaginary line that dictates how the body will move"*
- *"It is the back bone of your character"*



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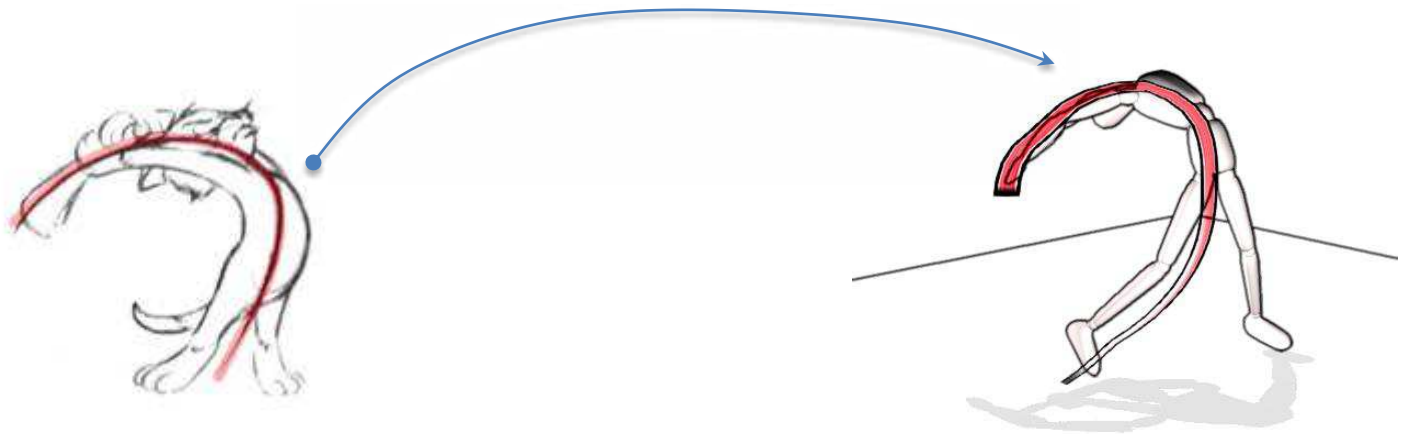
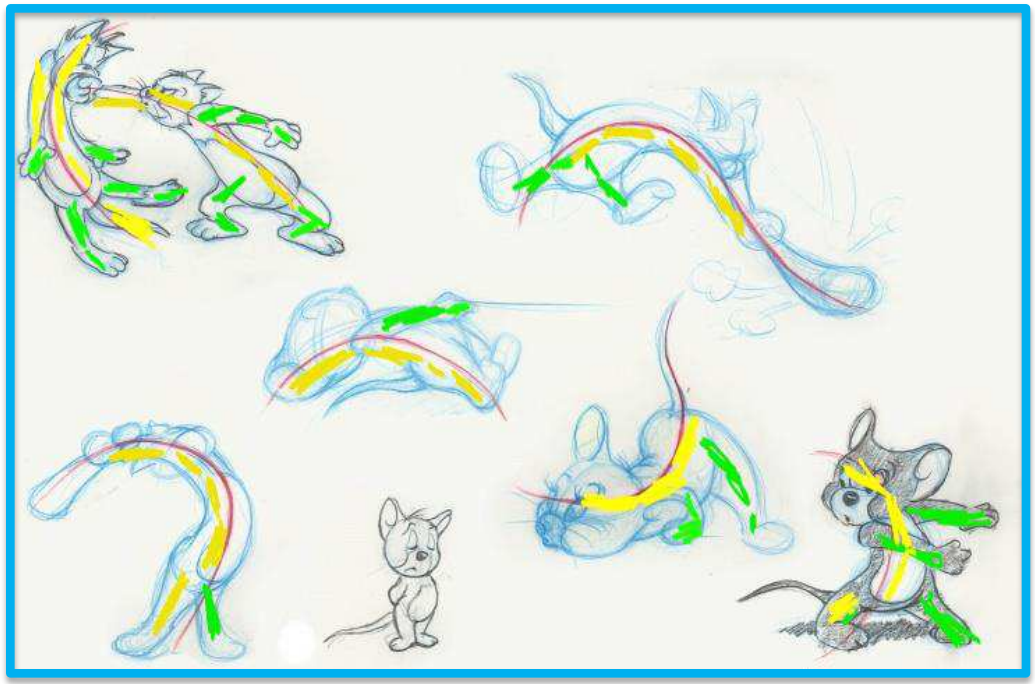
Posing with lines of action: Overview

- A formal definition of the line of action.
- Posing as an optimization problem.



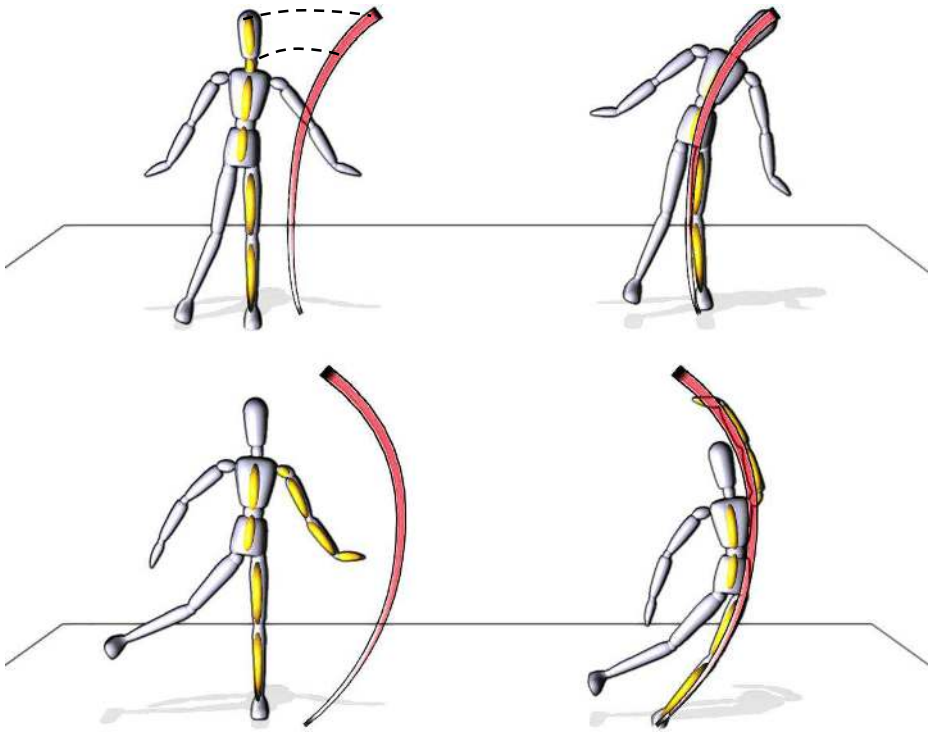
Line of Action: Definition

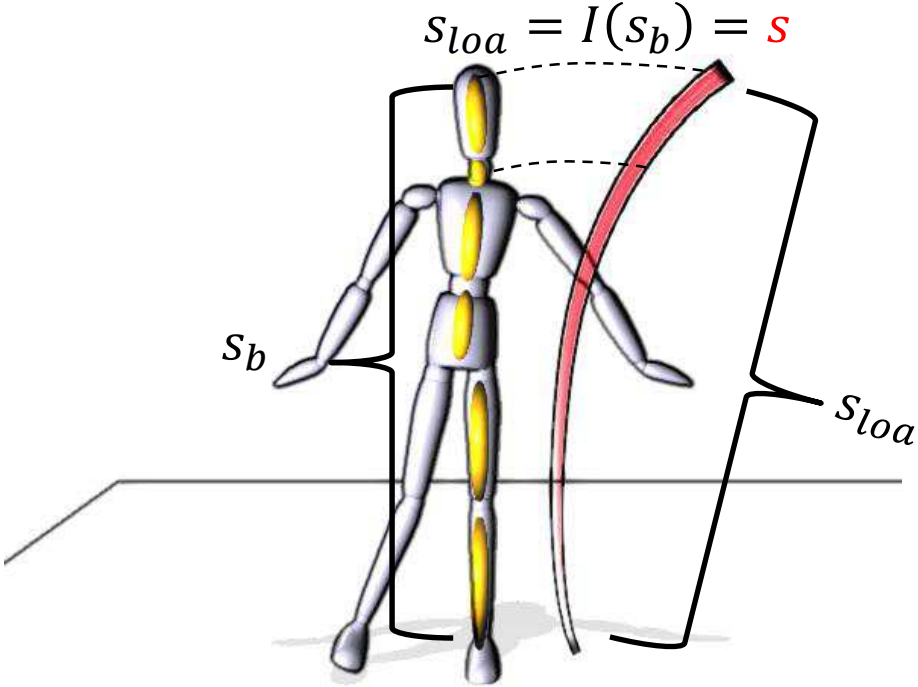
- Definition: A line of action dictates the *shape,* in image space, of a linear *sub-chain* in the kinematic tree.



Line of Action: Definition

- Dictates shape of a *body line*:





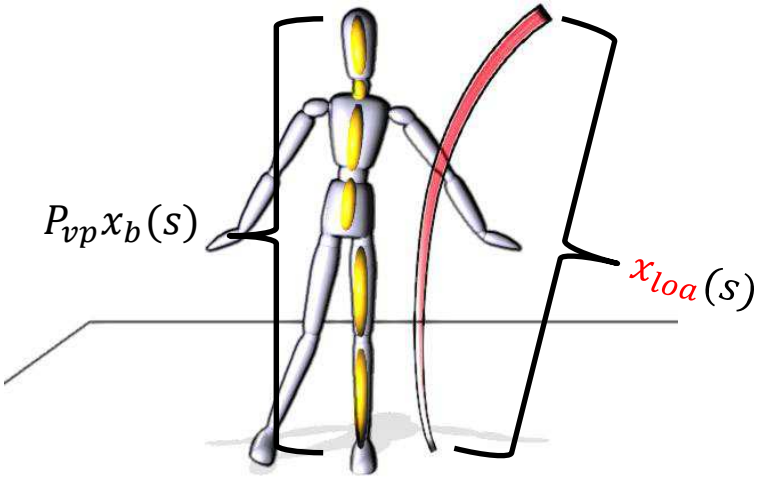
I: *Identity*

Line of Action: Problem

$$\min_{\boldsymbol{x}_b(s)} \int_s E_{\boldsymbol{x}}(s) + E_{\partial \boldsymbol{x}}(s)\, ds$$

$$E_{\boldsymbol{x}}(s) = \mu_{\boldsymbol{x}}(s) \left\| \boldsymbol{P}_{vp} \boldsymbol{x}_b(s) - \boldsymbol{x}_{loa}(s) \right\|^2$$

$$E_{\partial \boldsymbol{x}}(s) = \mu_{\partial \boldsymbol{x}}(s) \left\| \frac{\partial \boldsymbol{P}_{vp} \boldsymbol{x}_b}{\partial s}(s) - \frac{\partial \boldsymbol{x}_{loa}}{\partial s}(s) \right\|^2$$



$\boldsymbol{x}_b(s)$: Bone Position (world space)
$\boldsymbol{x}_{loa}(s)$: Line of Action Position (screen space)
$\boldsymbol{P}_{vp}$: View Projection Transformation

Line of Action: Problem

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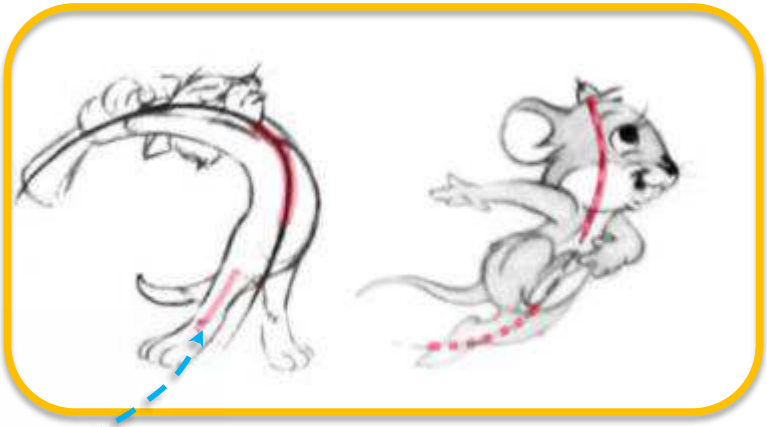

$\boldsymbol{x}_b(s)$: Bone Position (world space)
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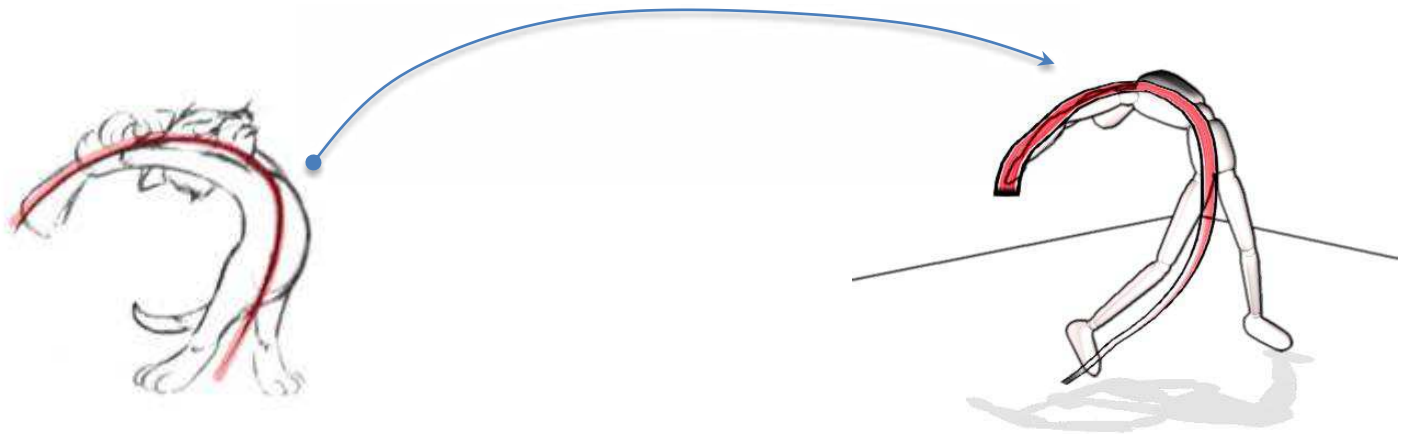
$\boldsymbol{P}_{vp}$: View Projection Transformation

Posing with lines of action: Overview

- A formal definition of the line of action.
- Posing as an optimization problem.
  - Select the body line
  - Resolve Depth Ambiguities
  - Determine Correspondence (spatial warping)



Line Selection

Body Line Selection

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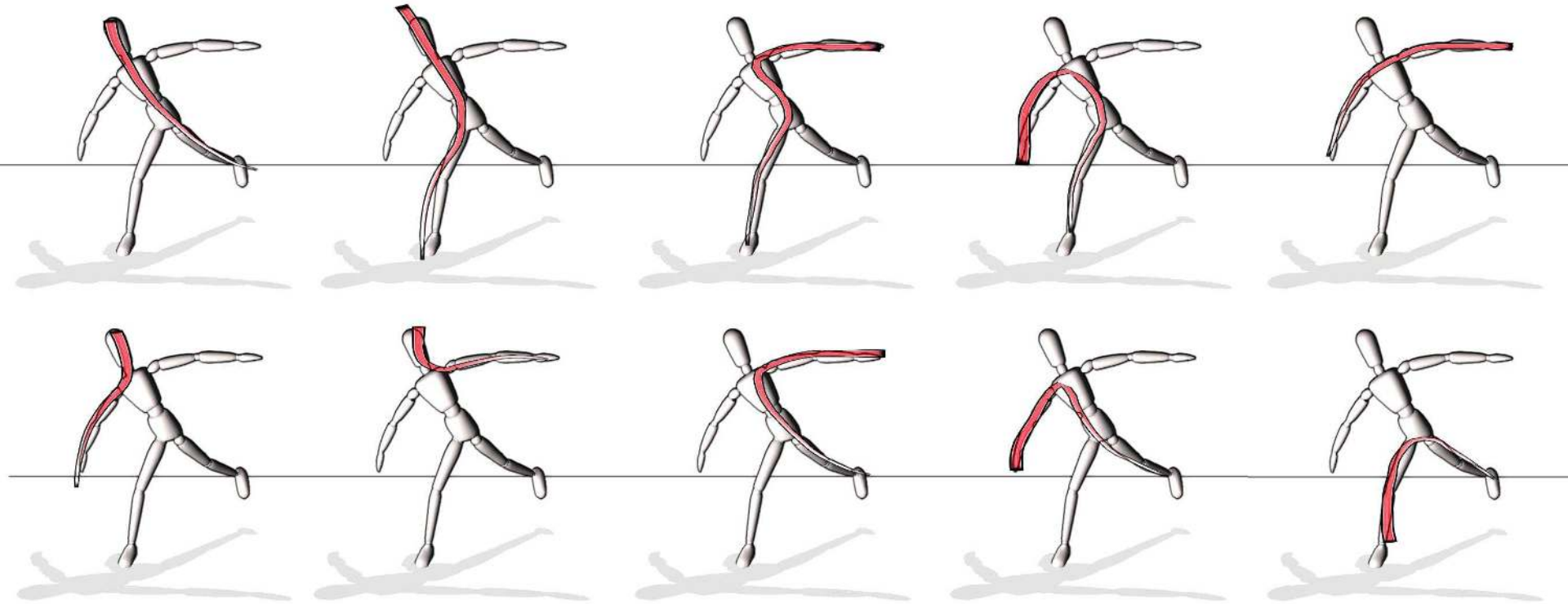
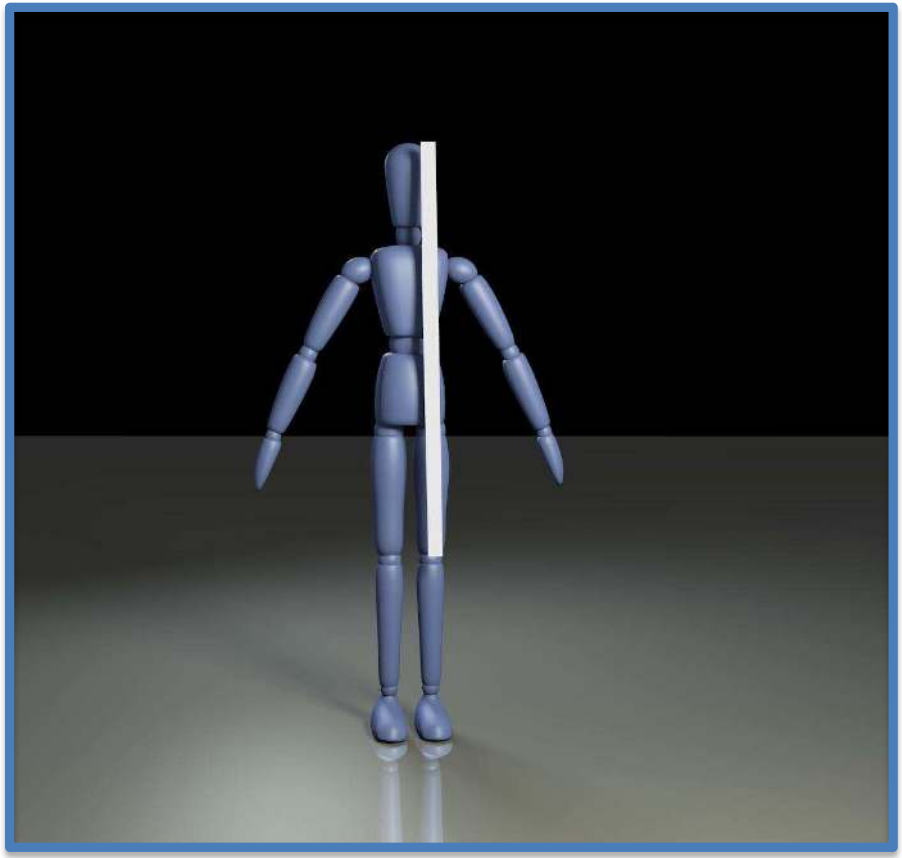
- 10 Maximal chains for a humanoid:



Depth Ambiguities

Resolving Depth Ambiguities

- 2D to 3D reconstruction is under-constrained
- Many solutions (poses) for the same initial conditions



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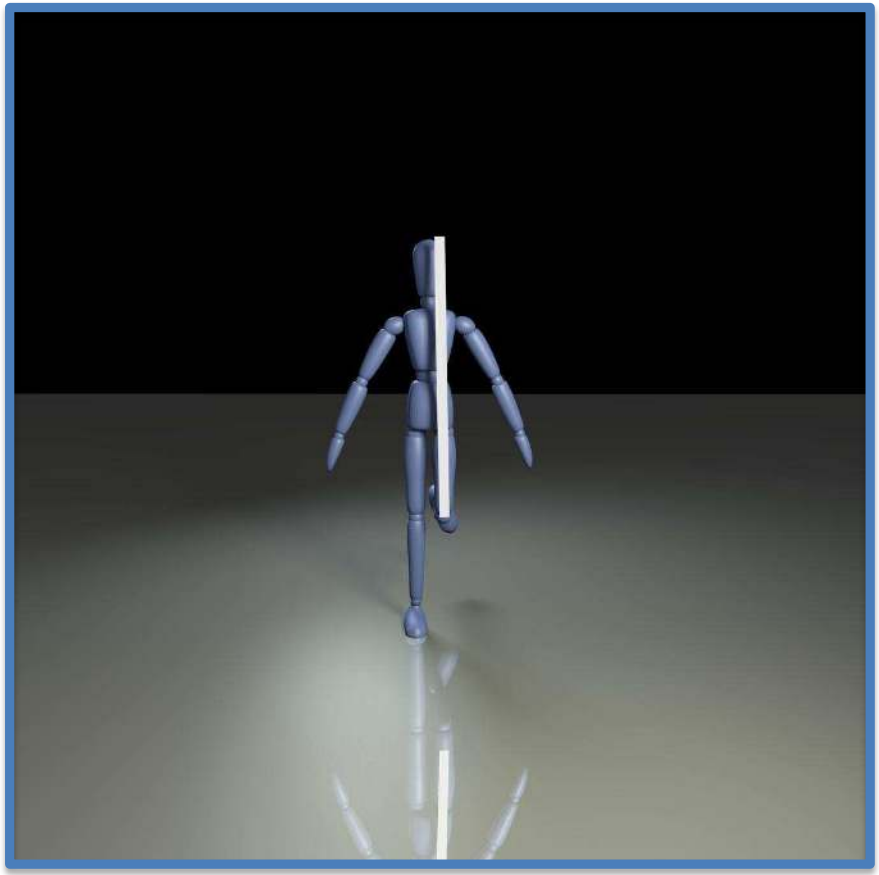

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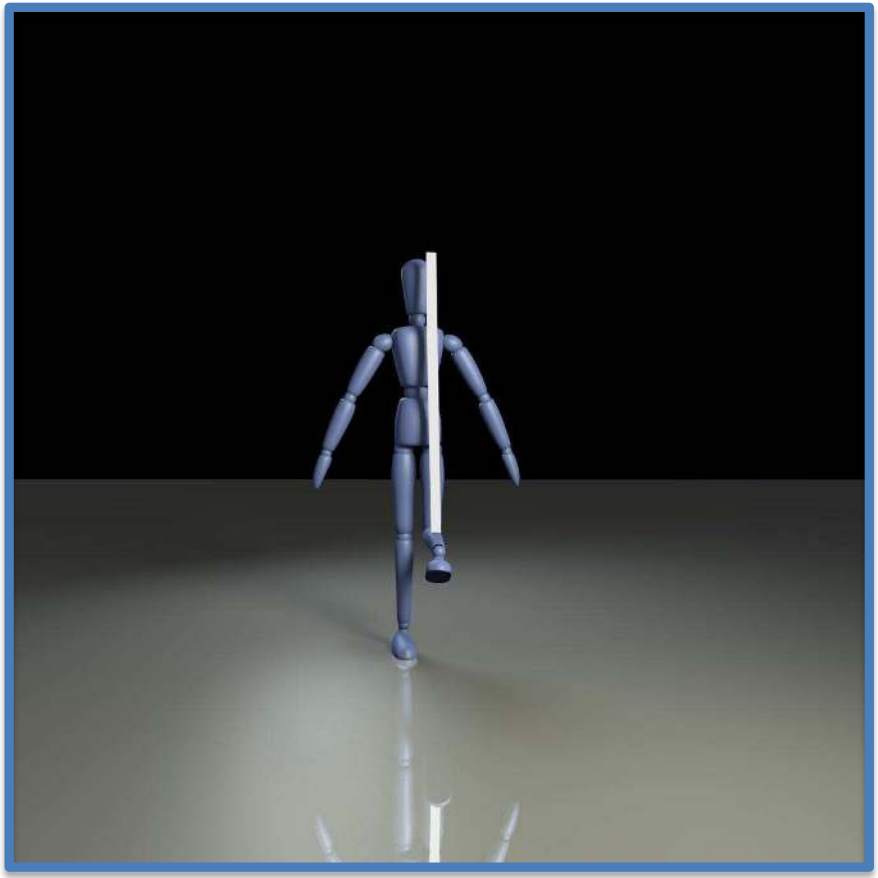
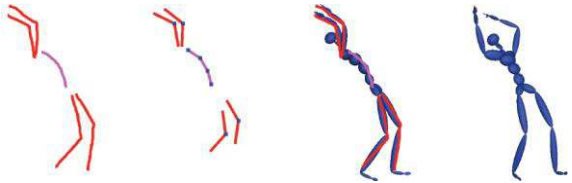


Resolving Depth Ambiguities

- Previous Work: Stick figures

- [Davis. J. et al., A sketching interface for articulated figure animation, 2003.]



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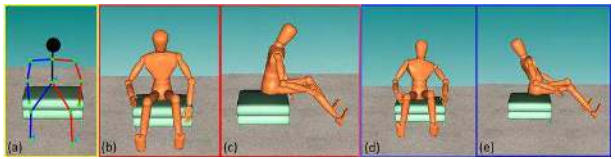
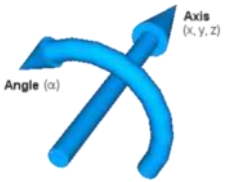
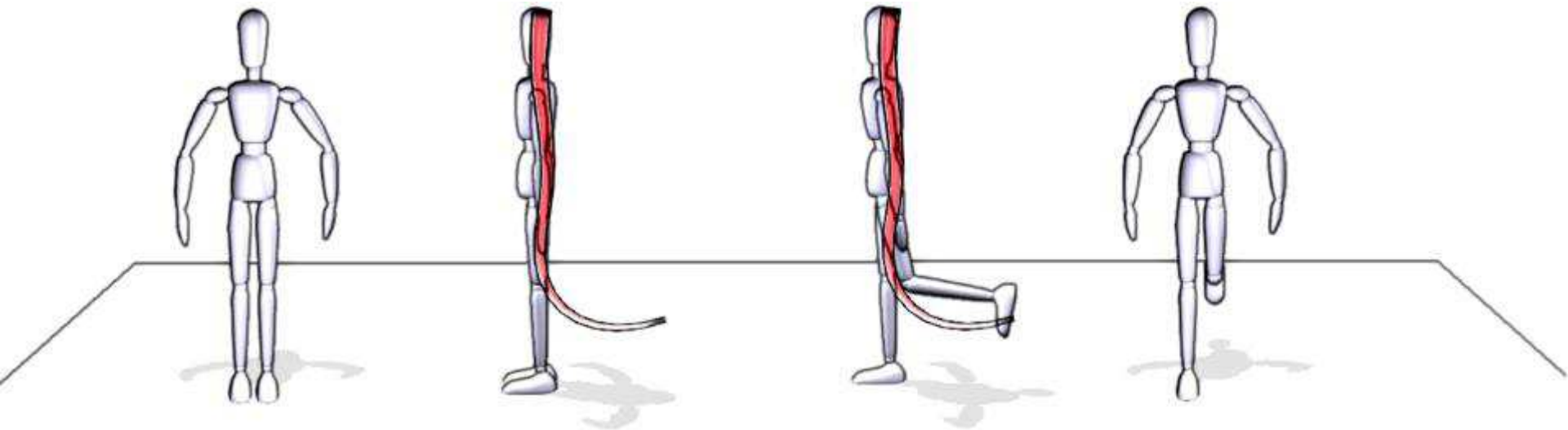


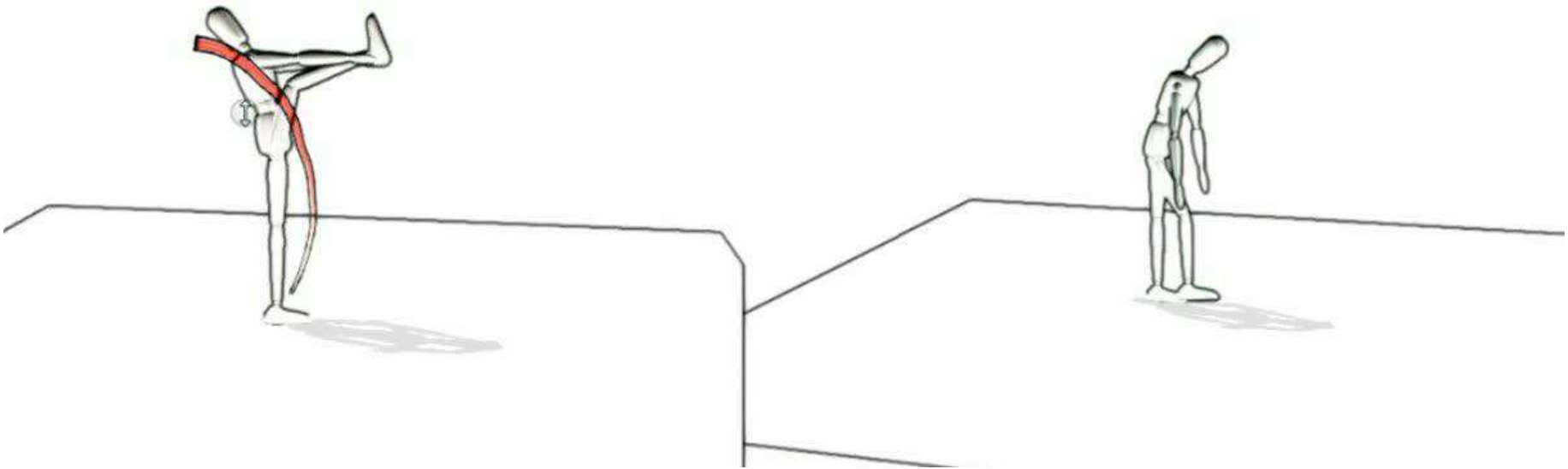
- [Lin, J., et al., A sketching interface for sitting-pose design. 2010

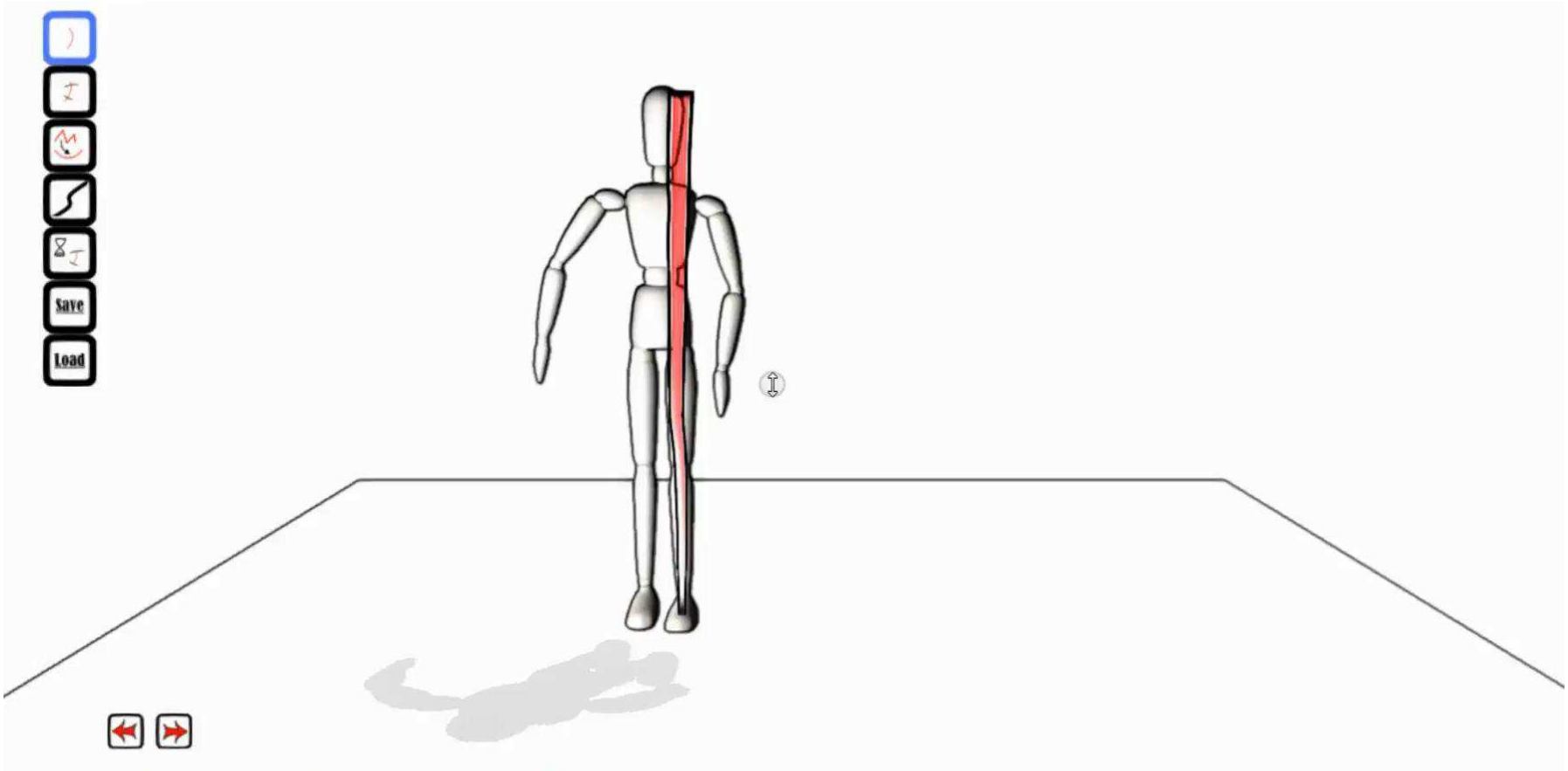
Resolving Depth Ambiguities

- Solution: constrain transformations to viewing plane
  - Single axis-angle parametrization of bone rotations
  - Along the view direction.





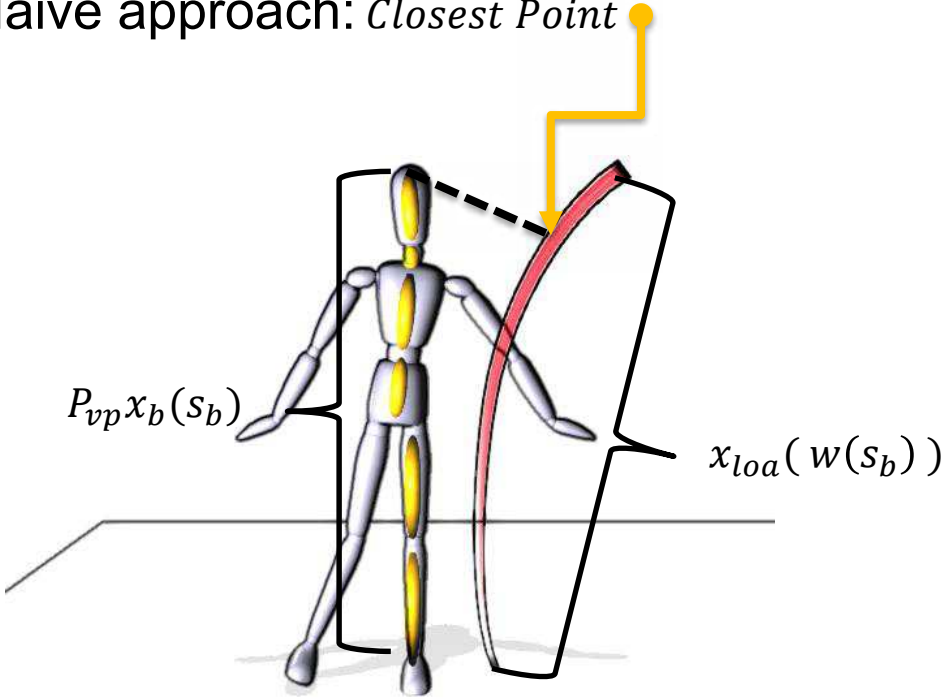


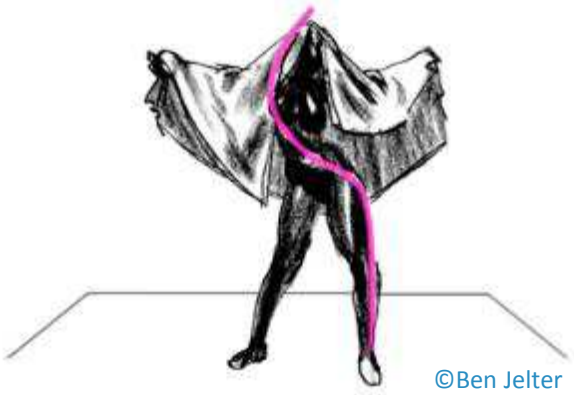

Save
Load

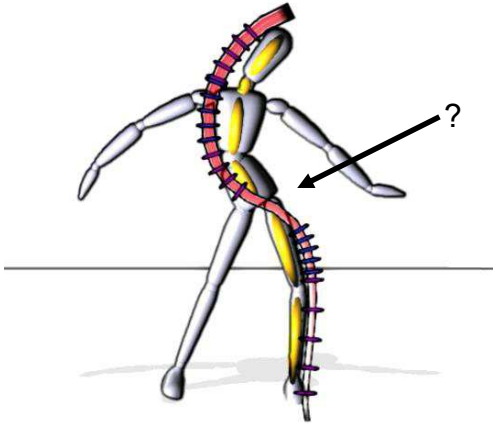
Mapping Both Lines

Mapping Both Lines

- Spatial Warping $w : s_b \rightarrow s_{loa}$
- Naive approach: $Closest\ Point$







Mapping Both Lines

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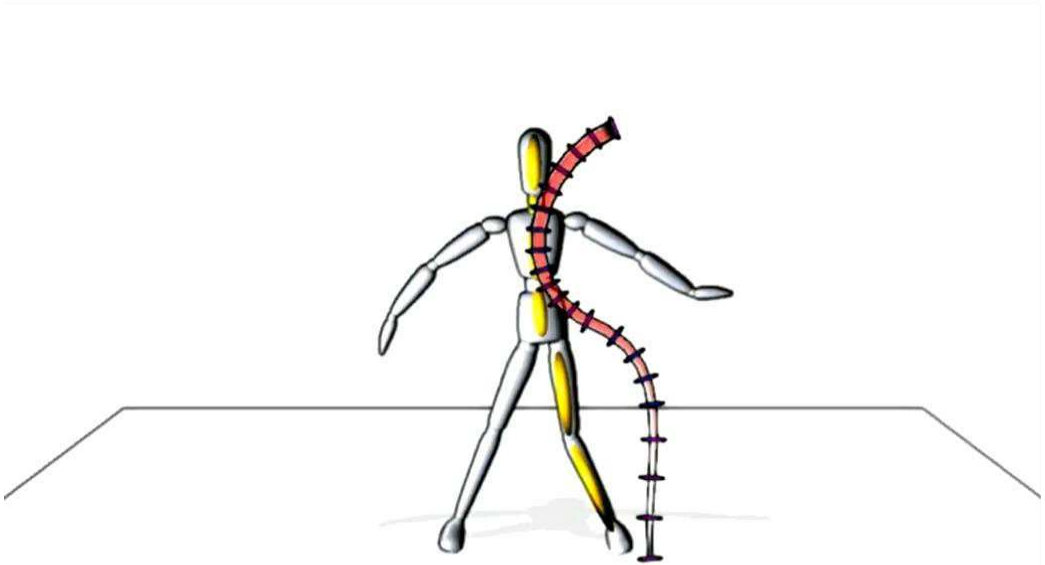
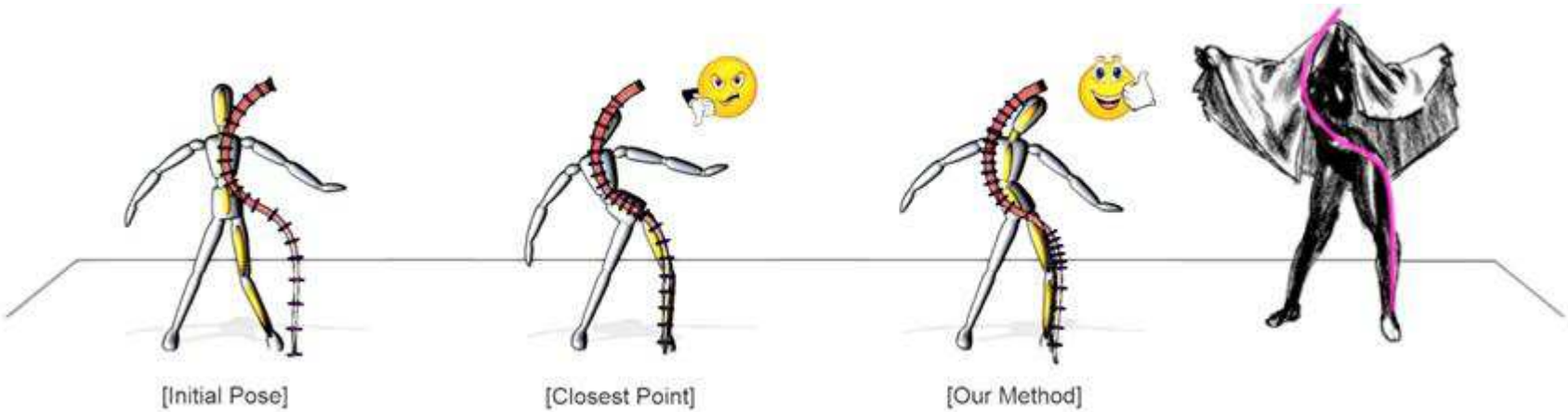
- Solution: High curvature ⟶ joint.

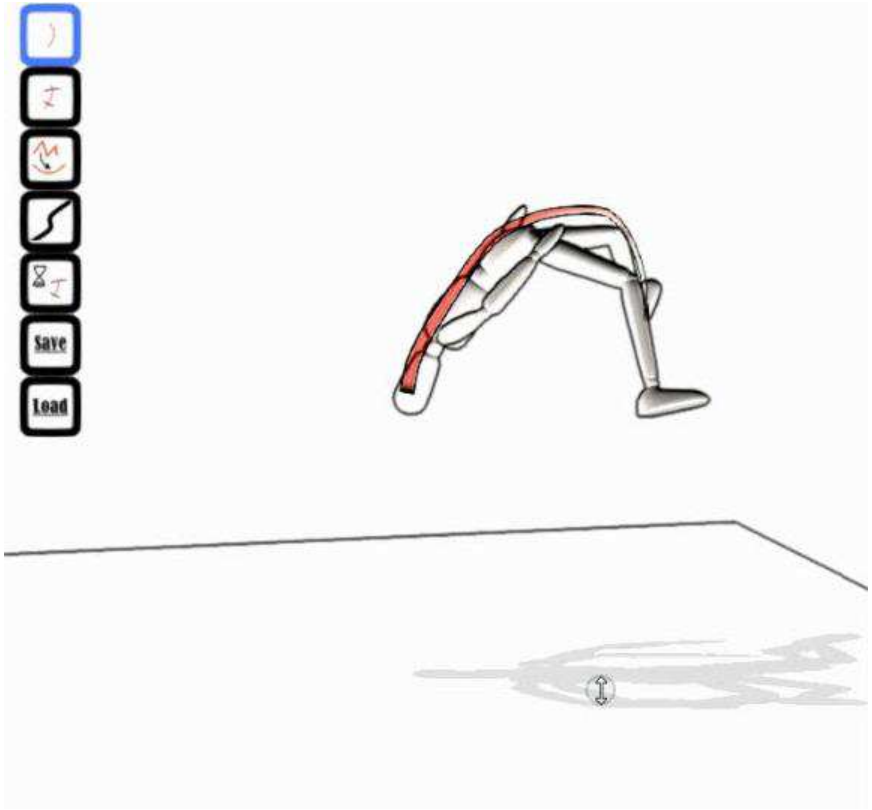


Mapping Both Lines

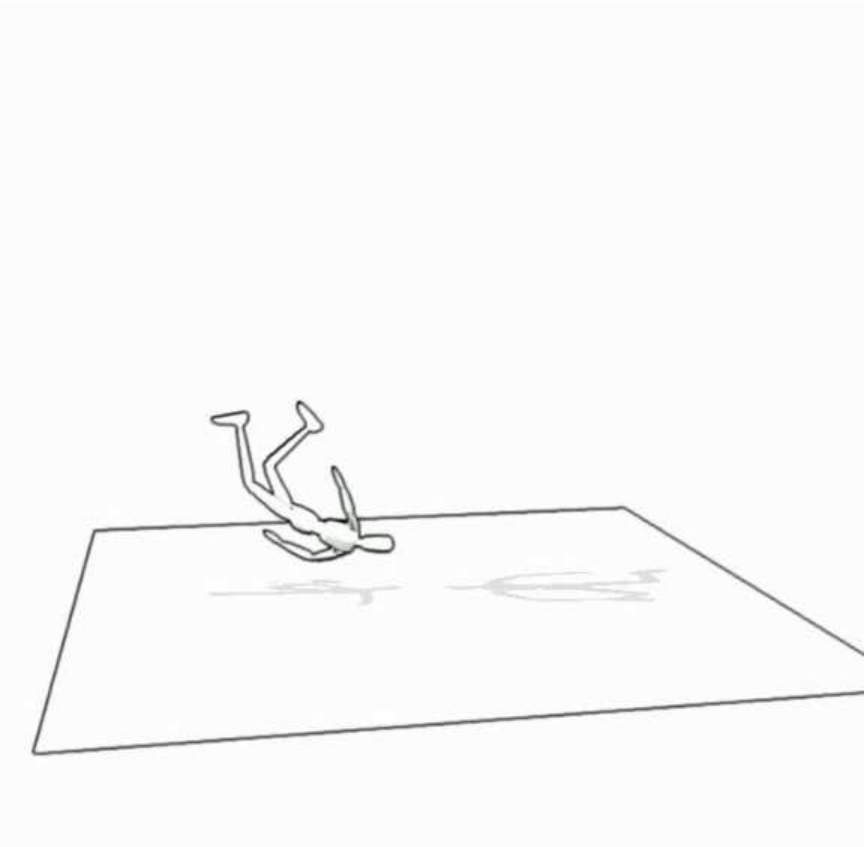


Results

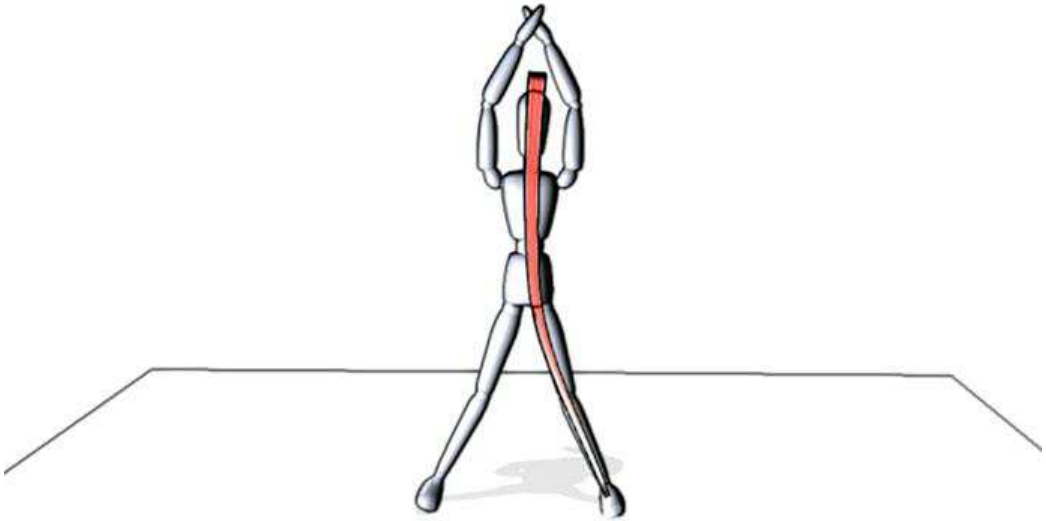
Results

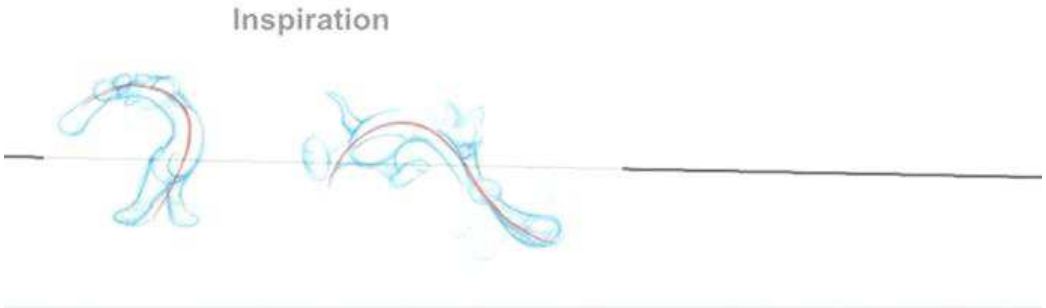


Results



Results





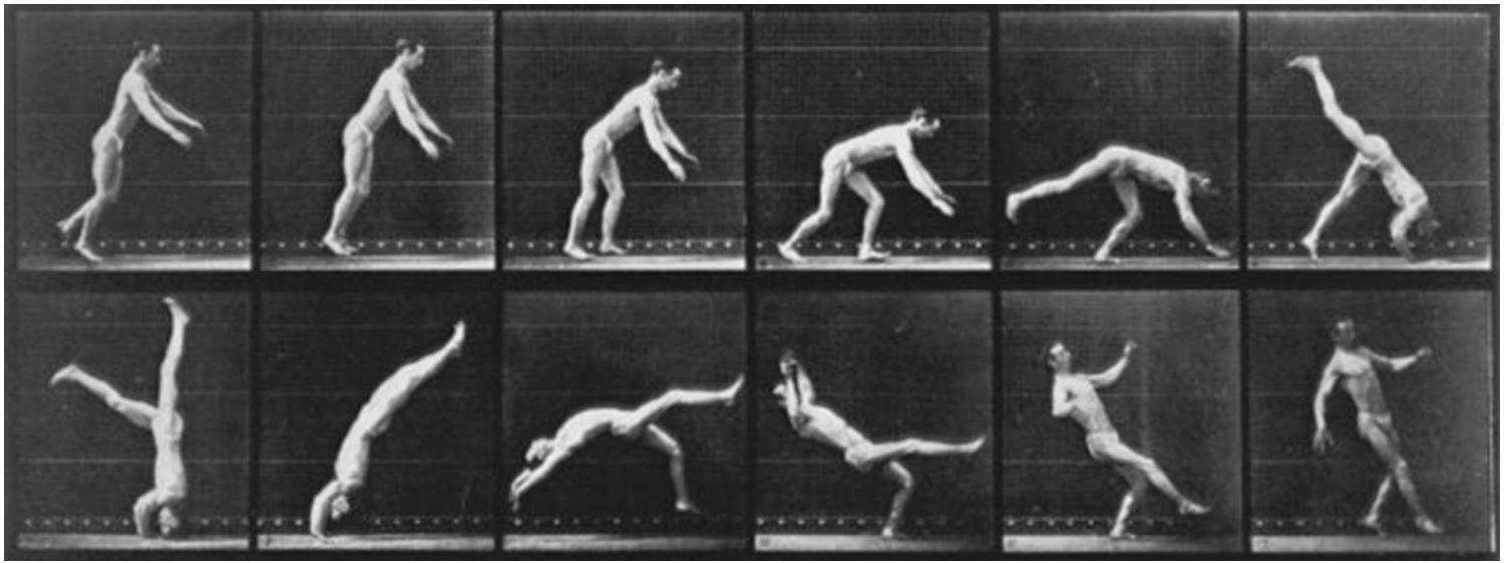
Result

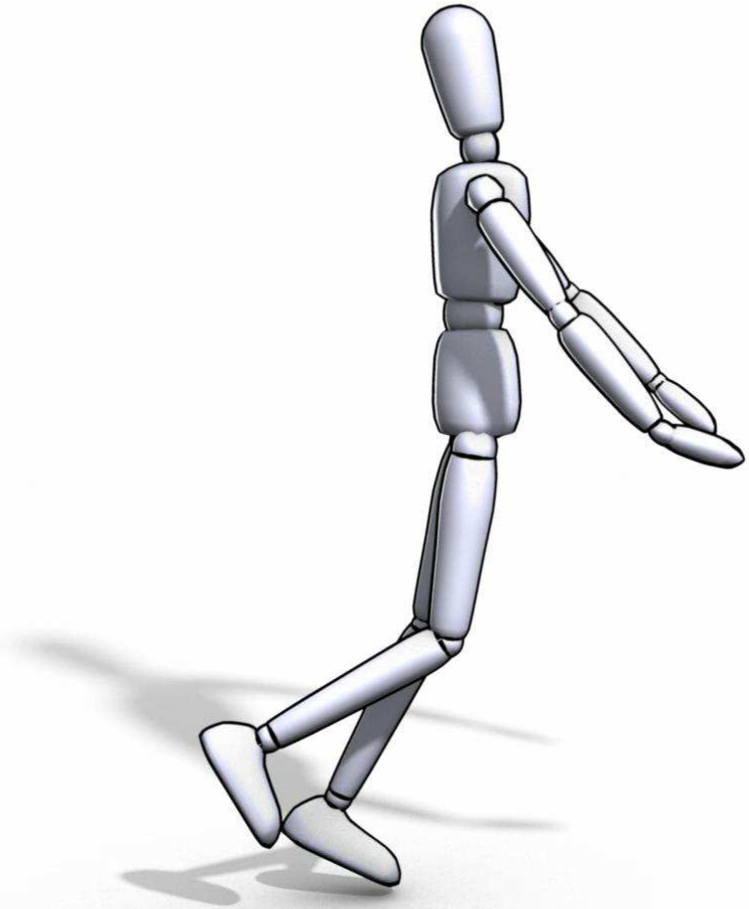
Results

Dance

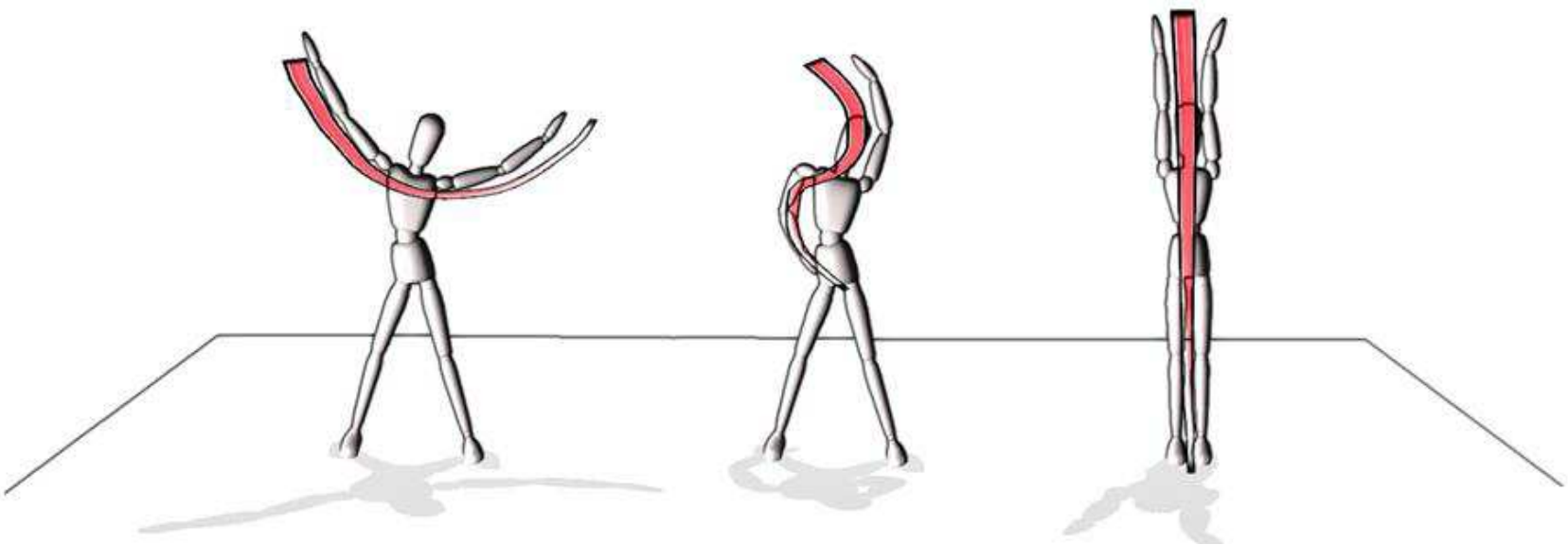
Result

Muybridge





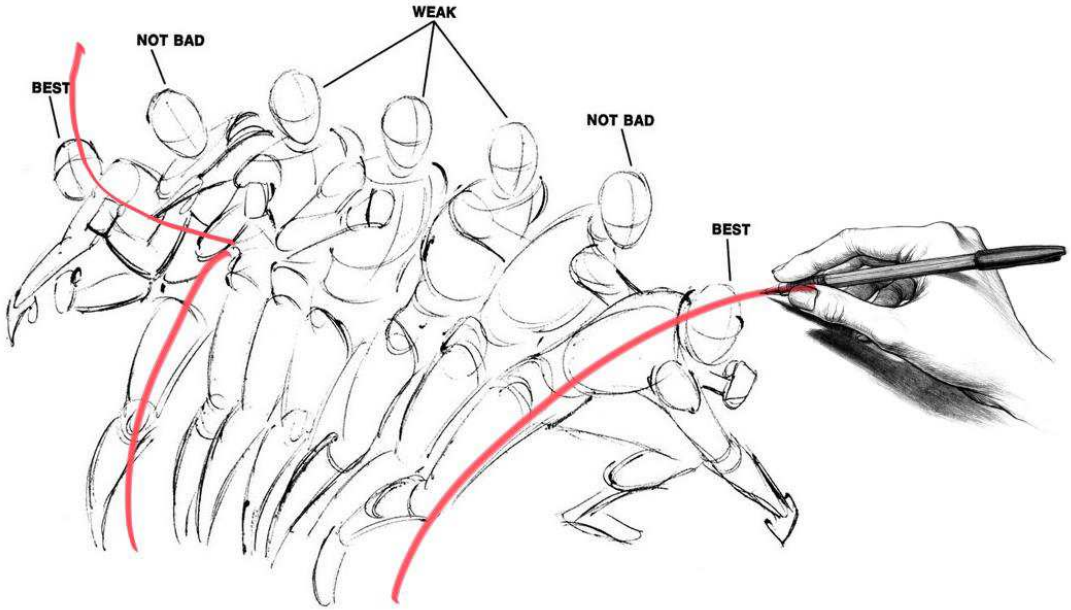
Expressive: CSI-shaped curves



- Simple curves make the pose as *readable* as possible.
- Freeform curves allow more poses, and nuances.

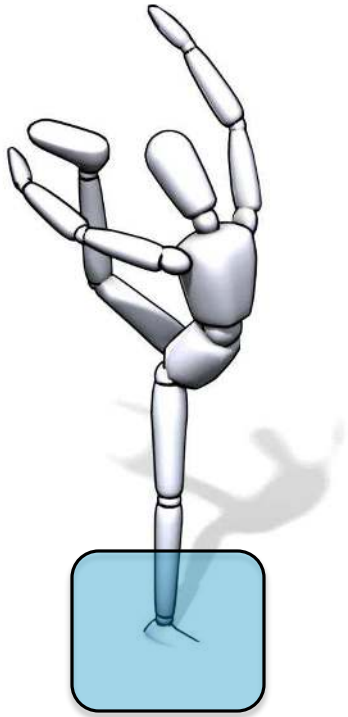
Expressive

- Single stroke, in a single hand gesture---with direct *visual* feedback.
  - (Gesture comes from the heart)



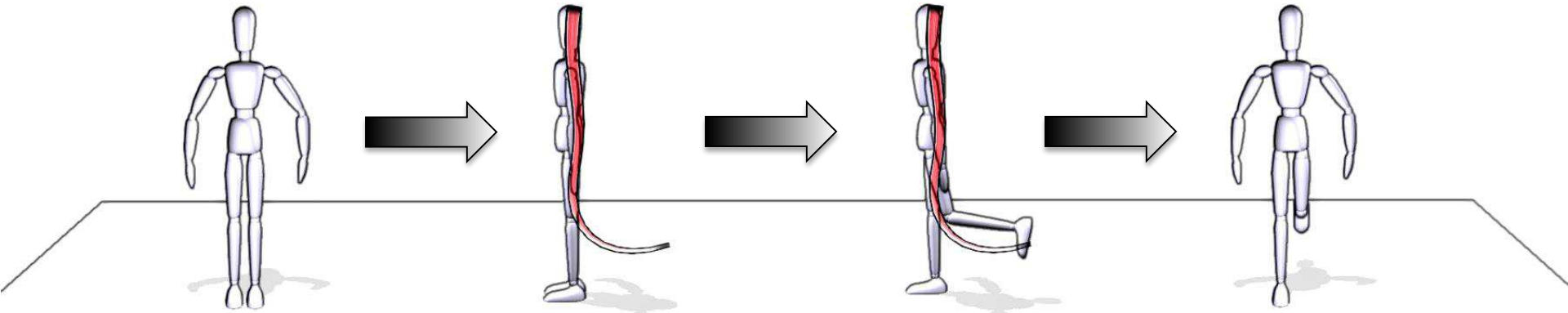
Limitations

- Foot contacts



Limitations

- Sketch-Rotate-Sketch



Limitations

- Assumed rigid transformations
  - No stretch,
  - But bending is possible!

Thank You !

- Also, thank:
- Laura Paiardini for support with Maya,
- Anonymous reviewers for useful comments and suggestions,
- ERC *Expressive* grant for funding.