

Procedural Skeletons: Kinematic Extensions to CGA-Shape Grammars

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- Procedural modeling
- Grammars
- Articulated objects



- ↑ Abstraction
- ↓ Design costs
- ↓ Artistic skills
- ↑ Reusability
- ↑ Domain knowledge
- ↓ Local control
- ↑ Formal theory
- ↓ Reconstruction



- Elements
- Survival
- Jagged
- Long evolution
- Regular
- Short term
- Planarity
- Batch changes



Rome Rebuild, Pascal Müller



- Sets of shapes instead of symbols
- Large amount of rules and attributes
- Attribute propagation
- Rule selection
- Image based reconstruction
 - ◆ Symmetries
 - ◆ Visual editing
- [Wonka et al. 2003]

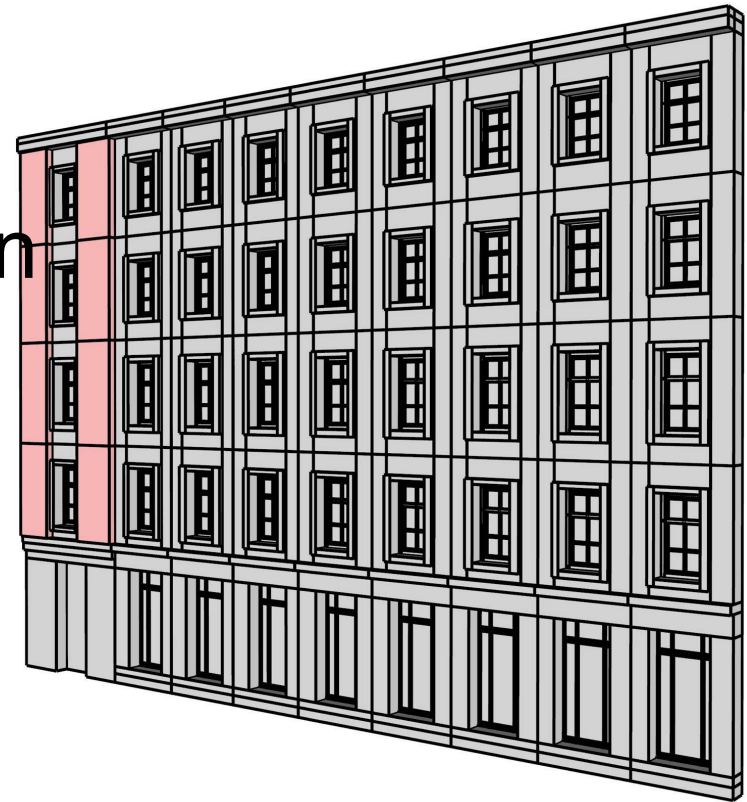


image by Peter Wonka



- Scope to oriented bounding boxes
 - ◆ transformation rules
 - ◆ splits and repetition
 - ◆ absolute and relative scaling
 - ◆ component splits
- Sequential
- Occlusion
- Snapping
- [Müller et al. 2006]
- [Lipp et al. 2008]

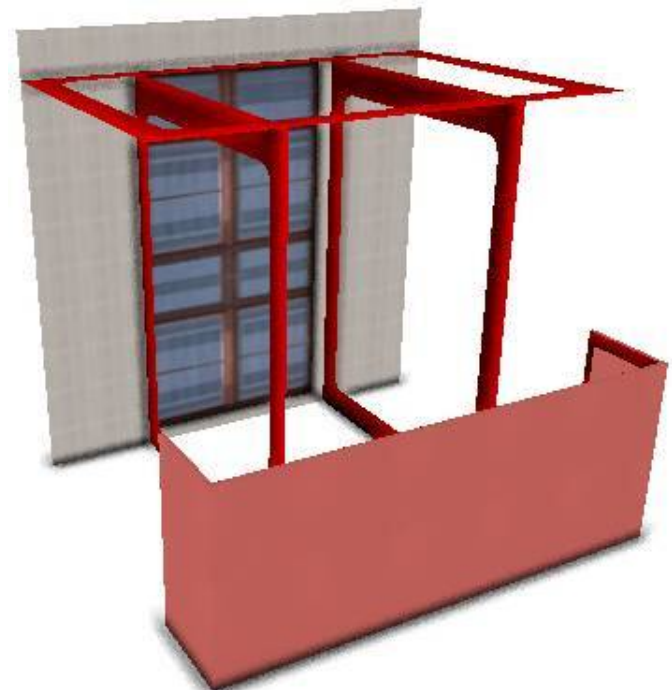


image by Markus Lipp



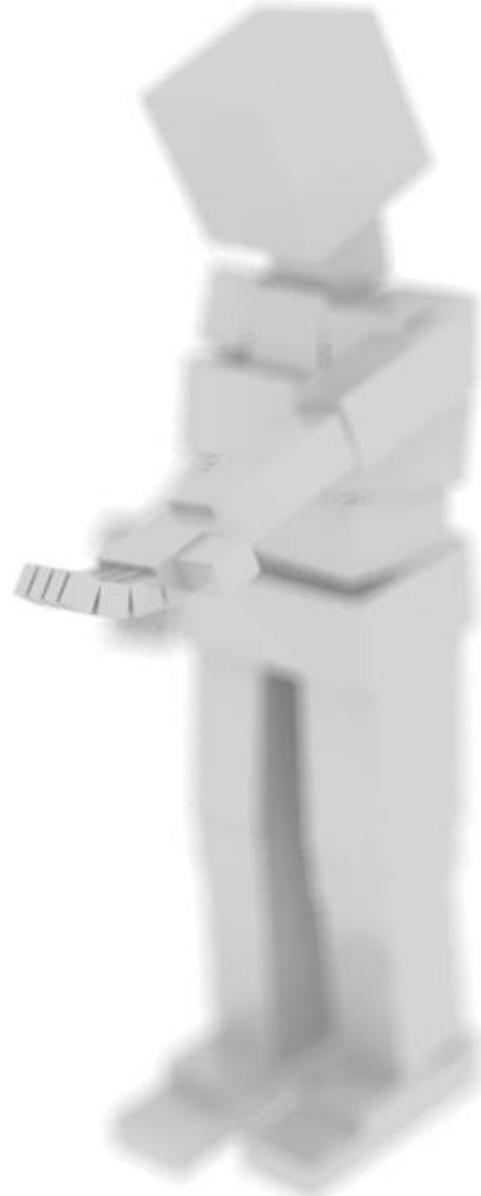
Procedural modeling of cities



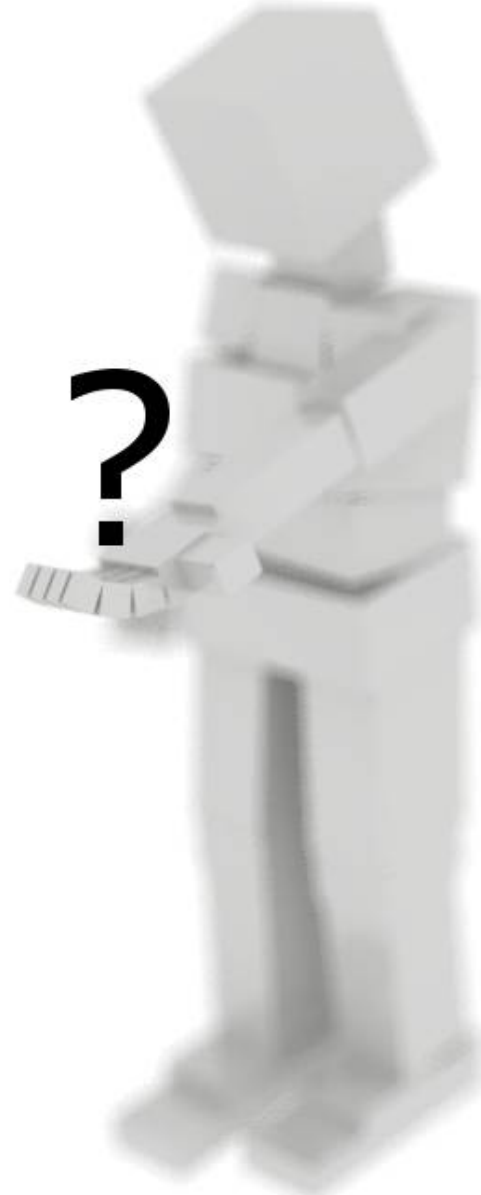
- **Pose**
- Expression
- Semantics
- Relations
- Functionality



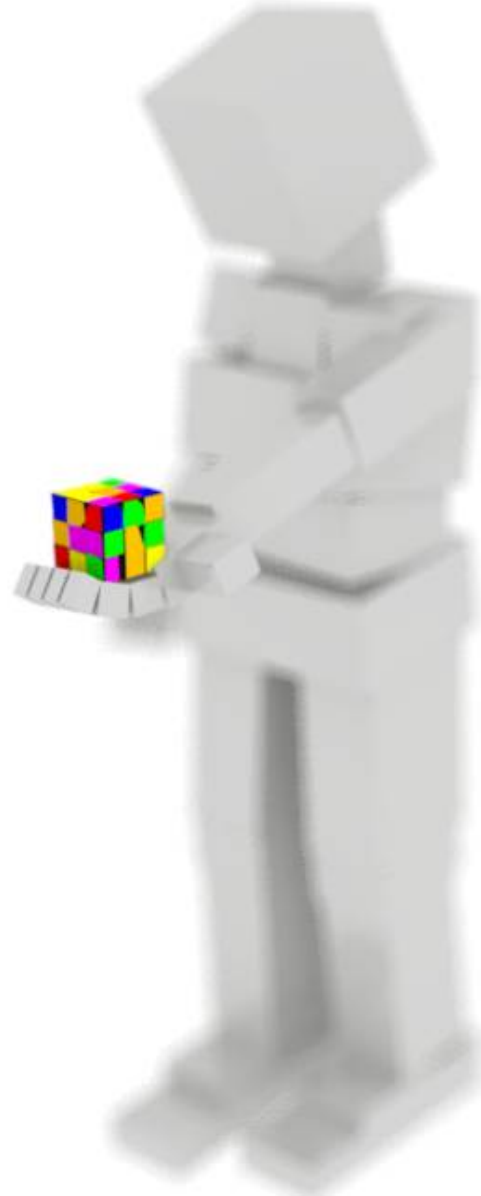
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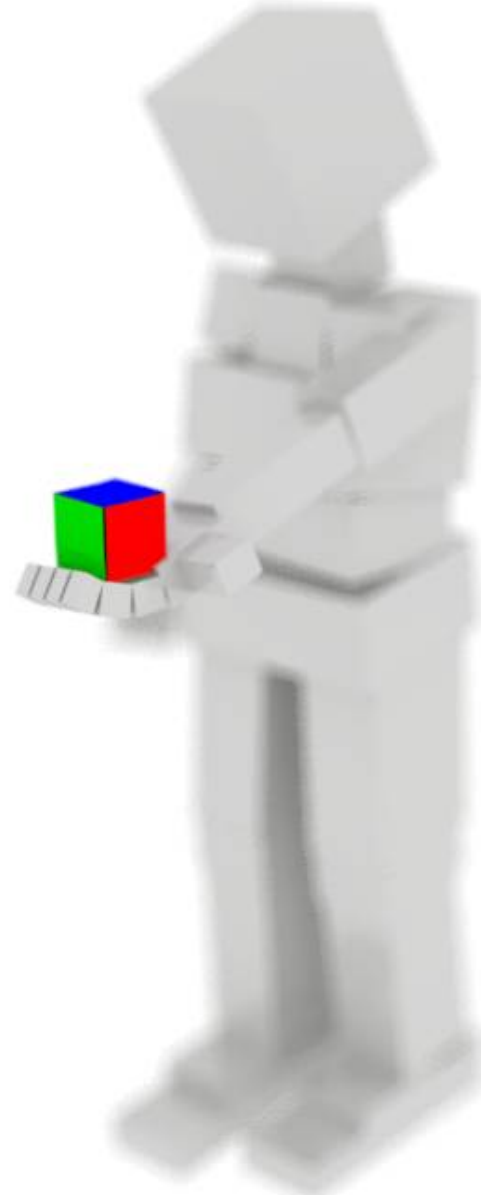
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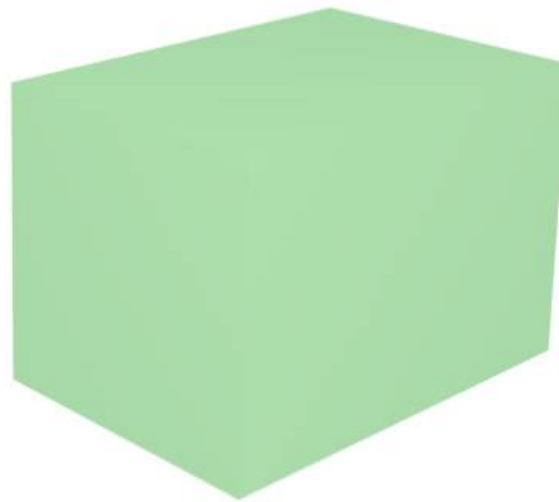


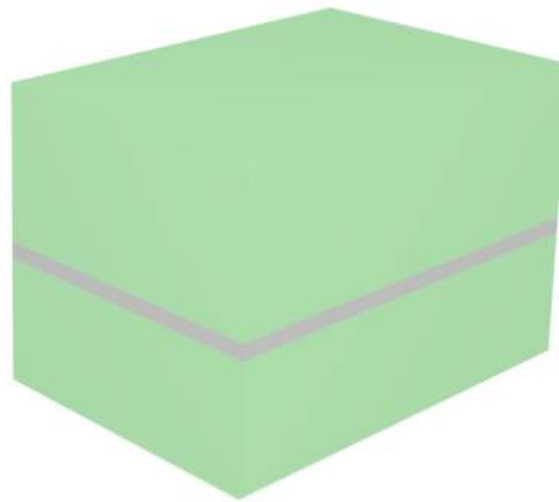
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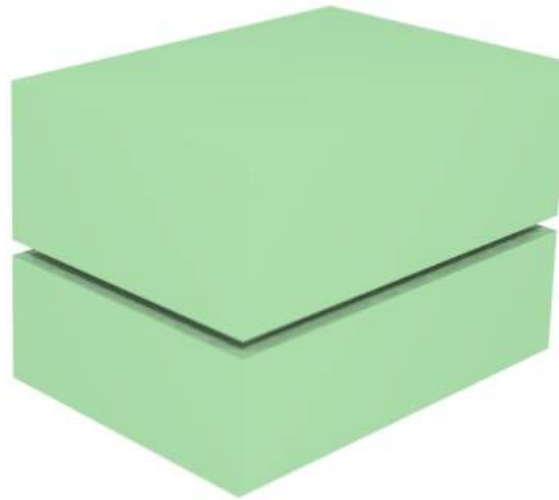


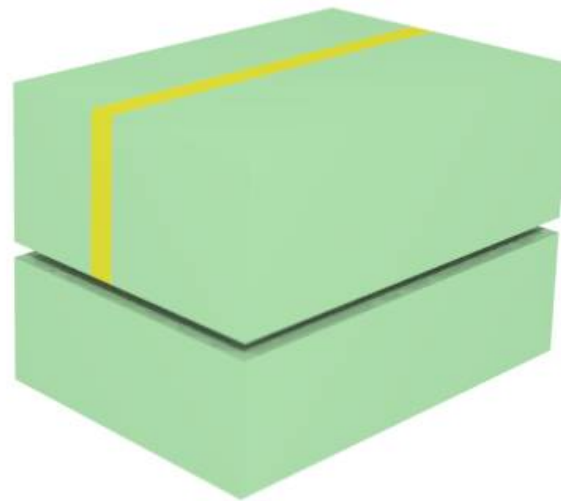
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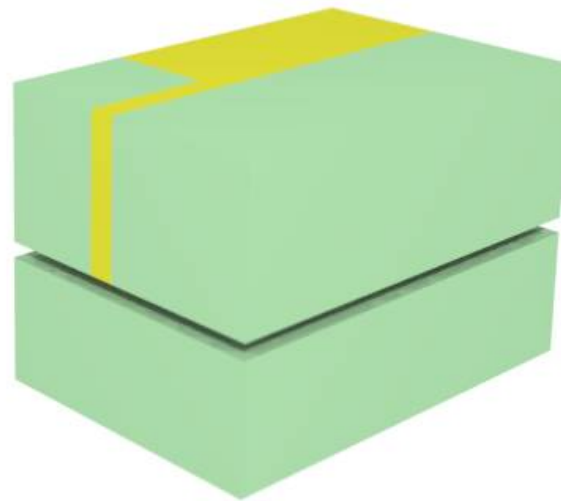


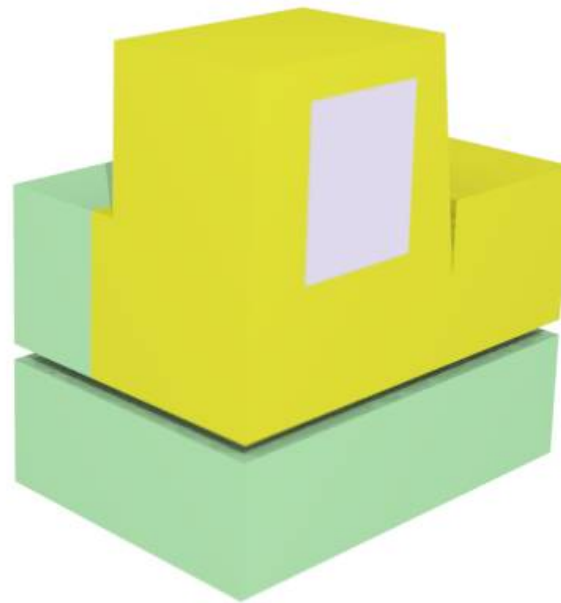


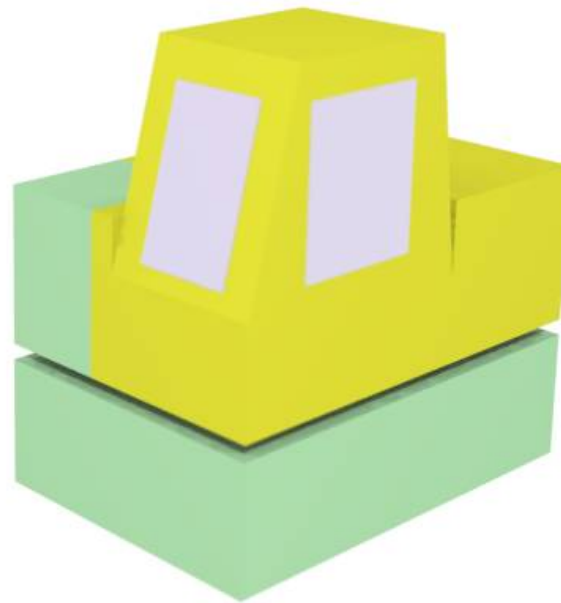


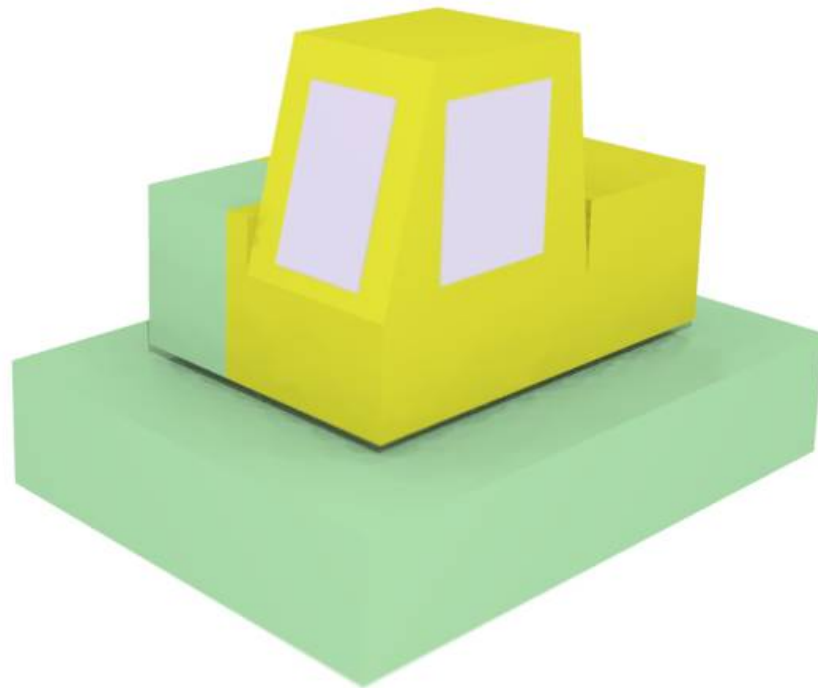


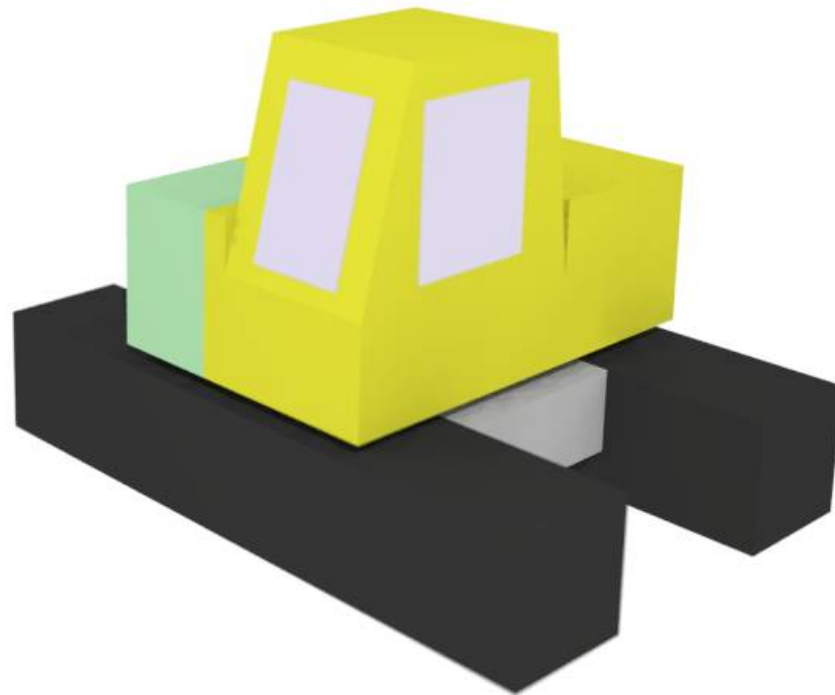


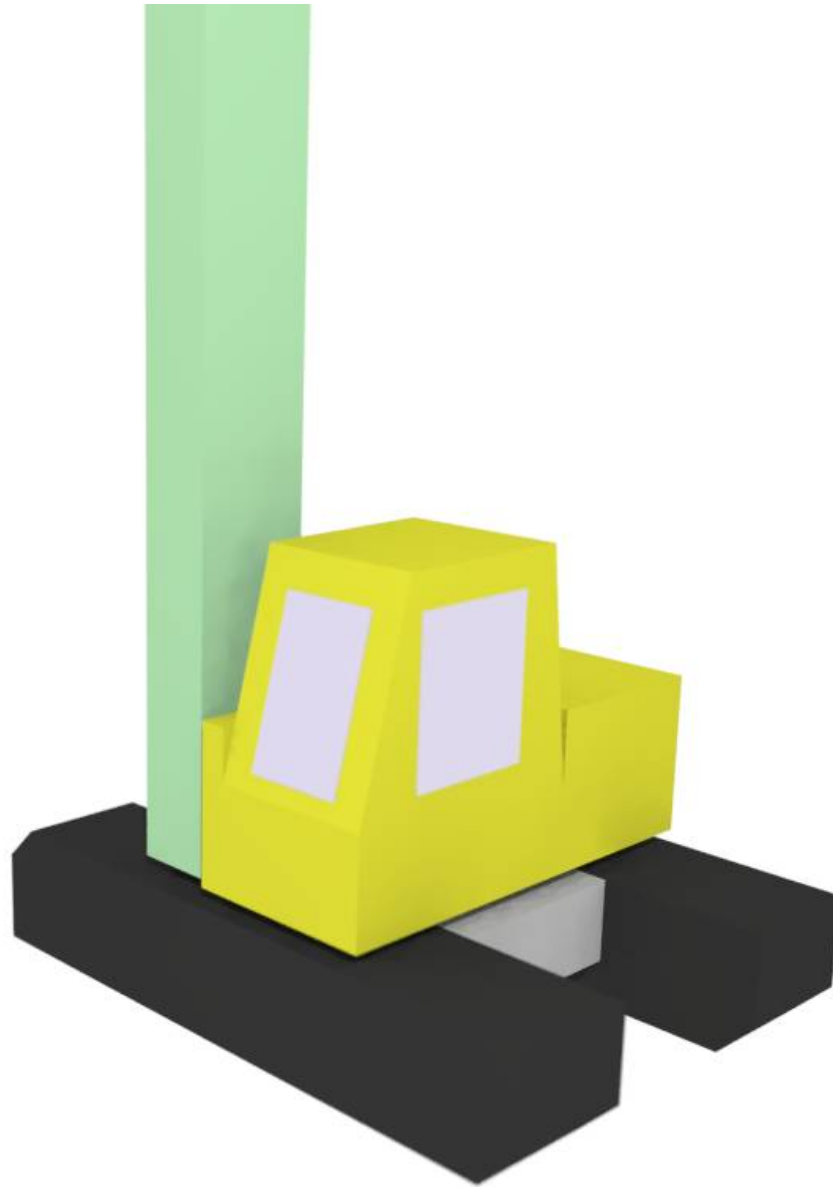


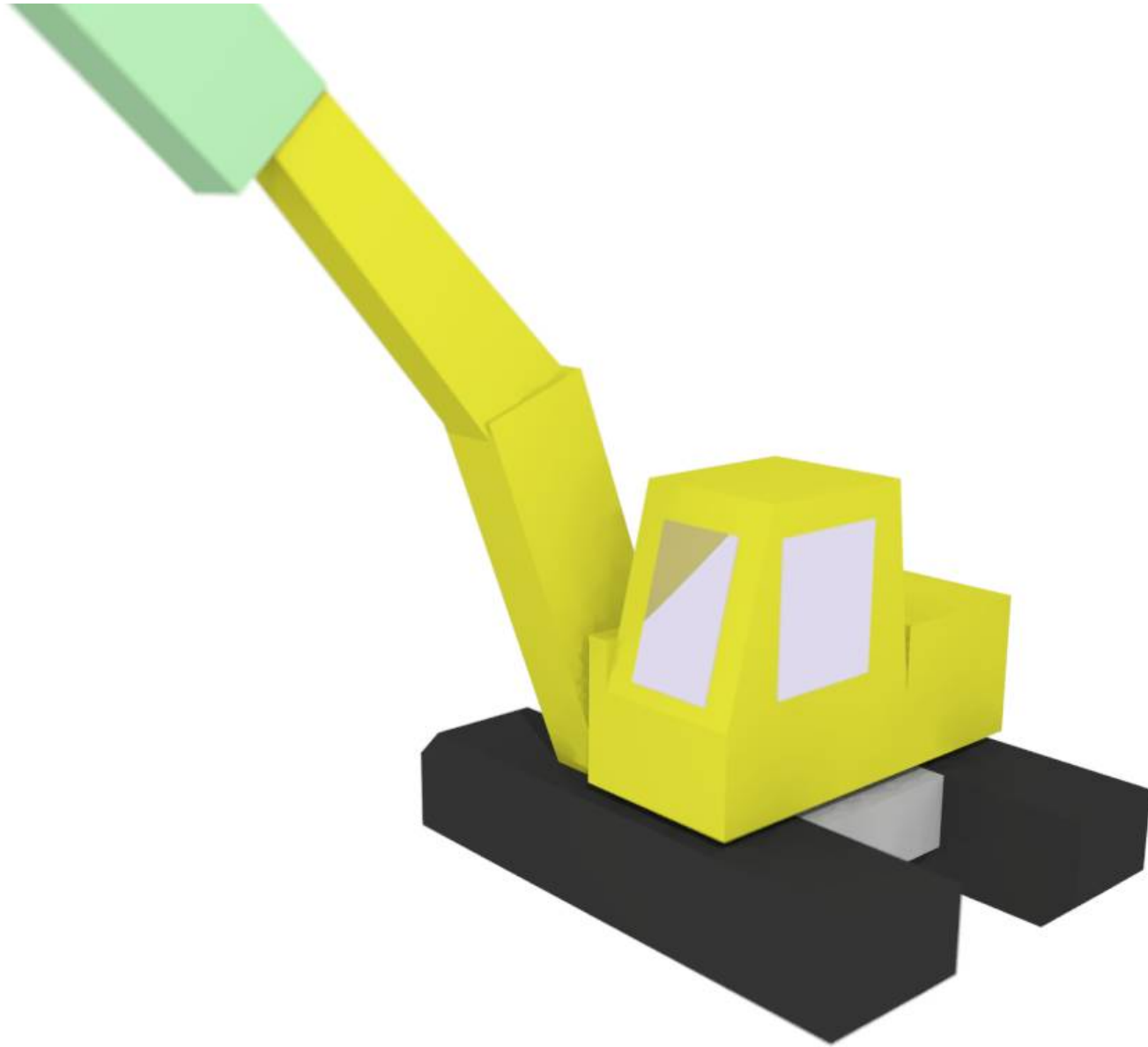


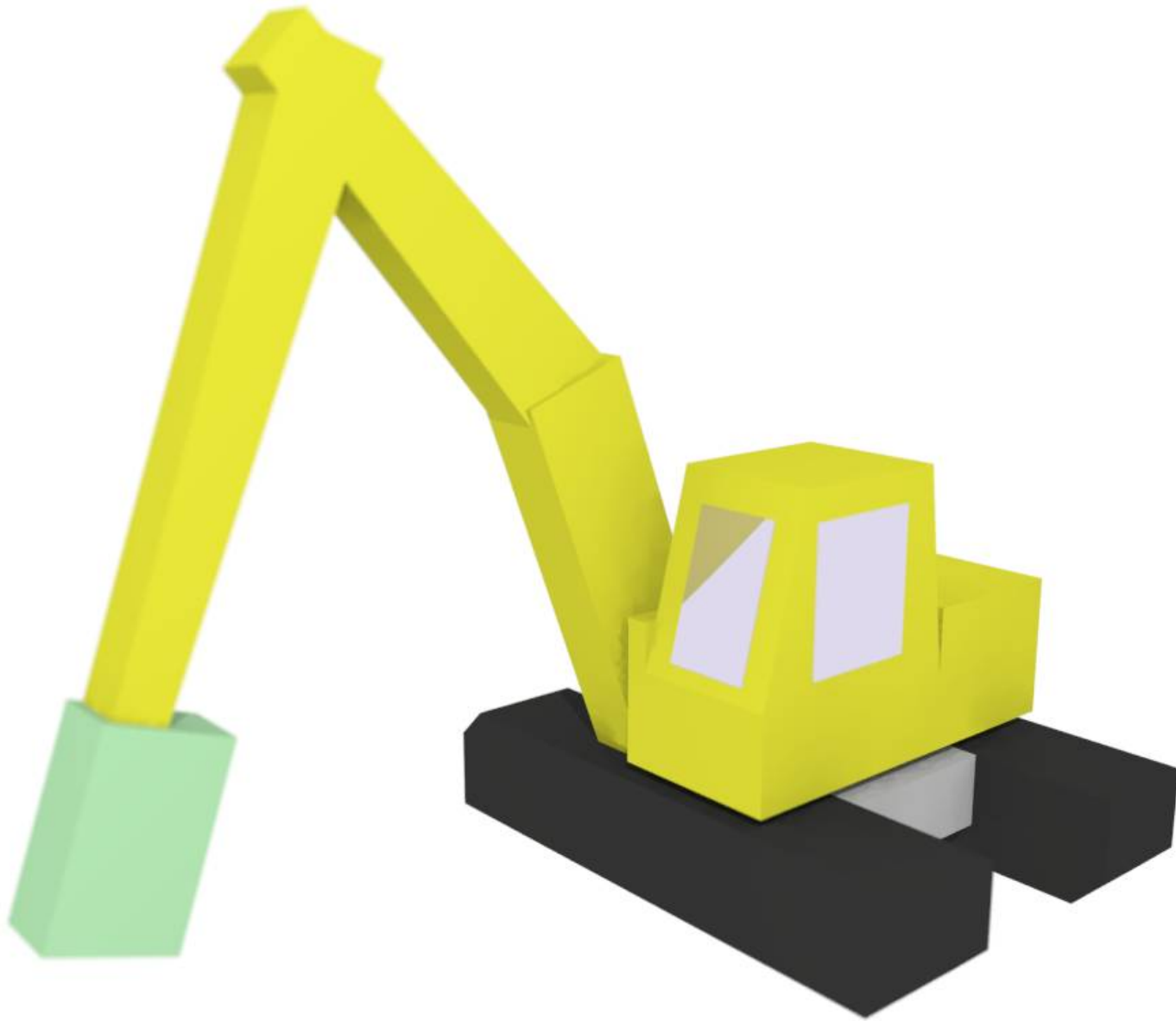


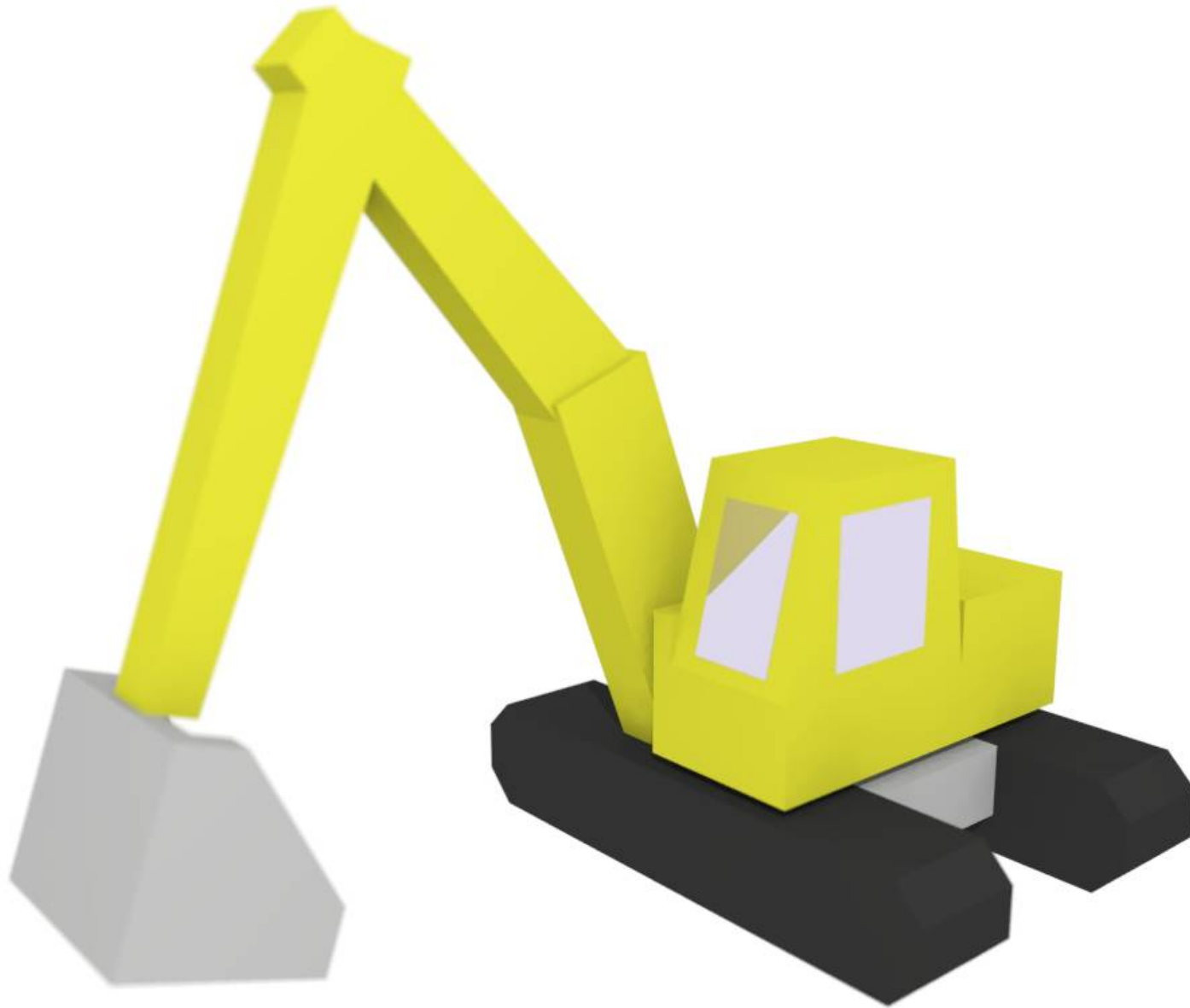


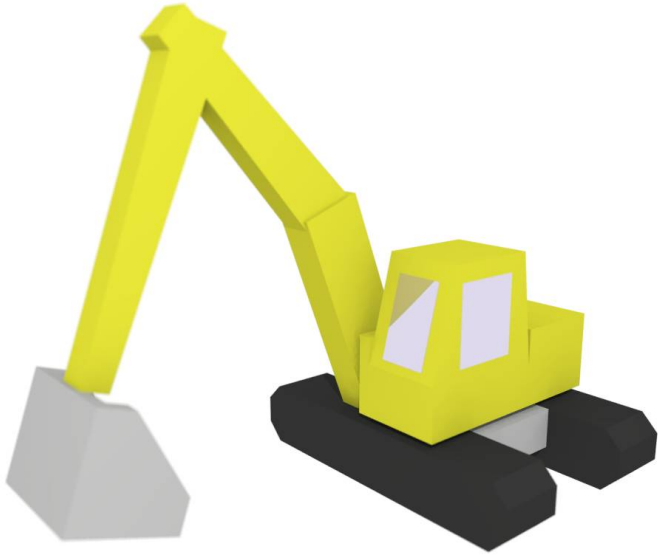


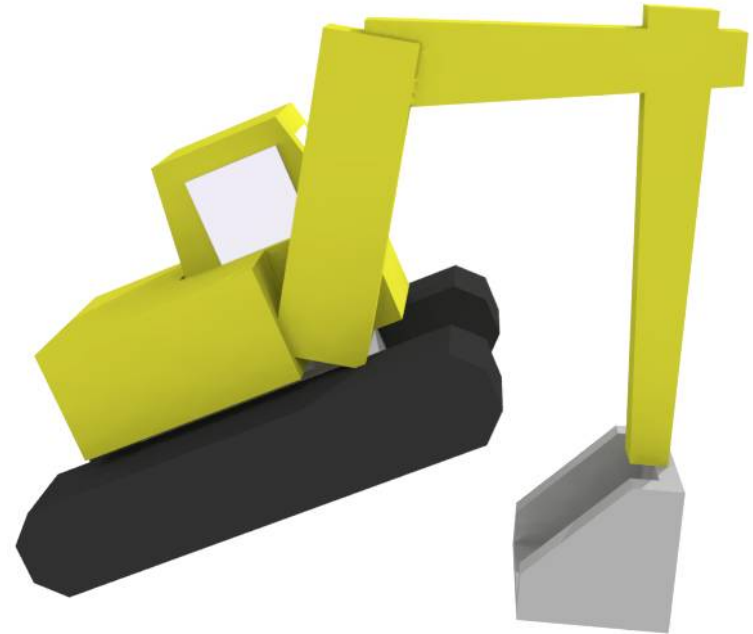
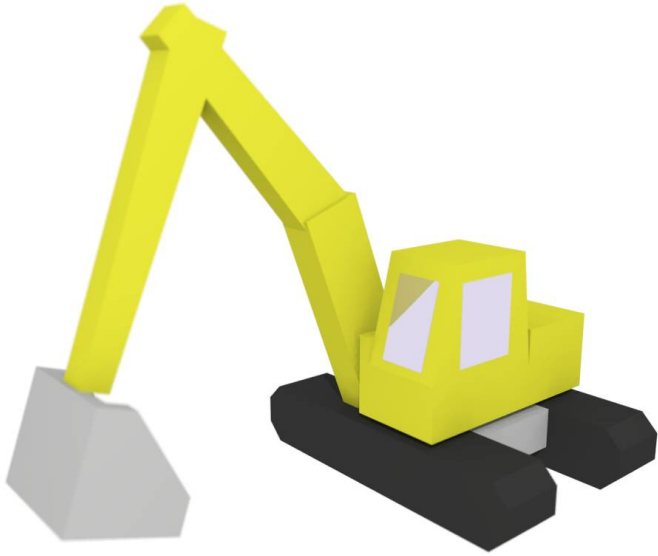


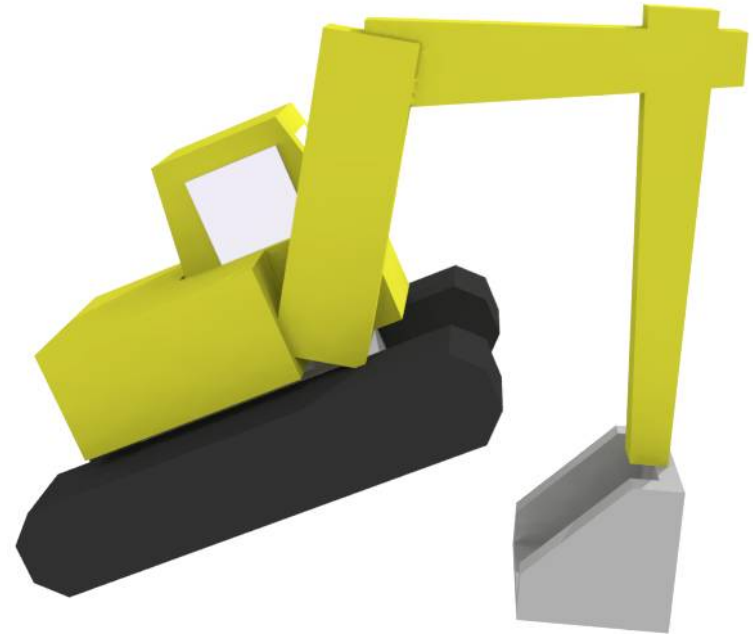
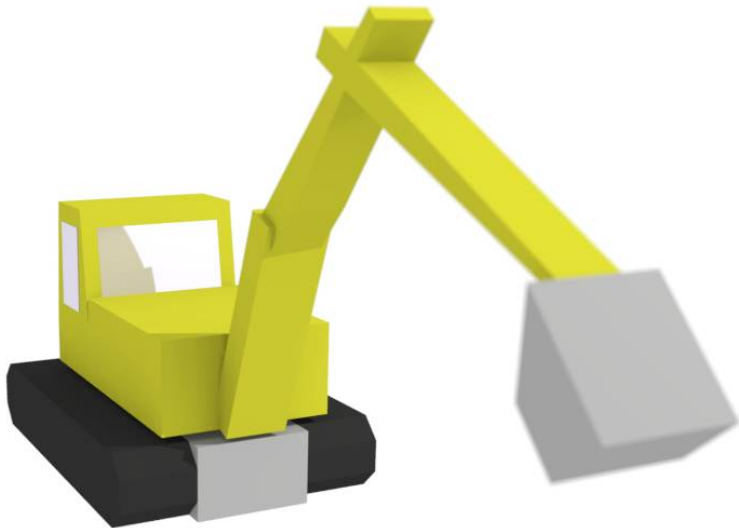
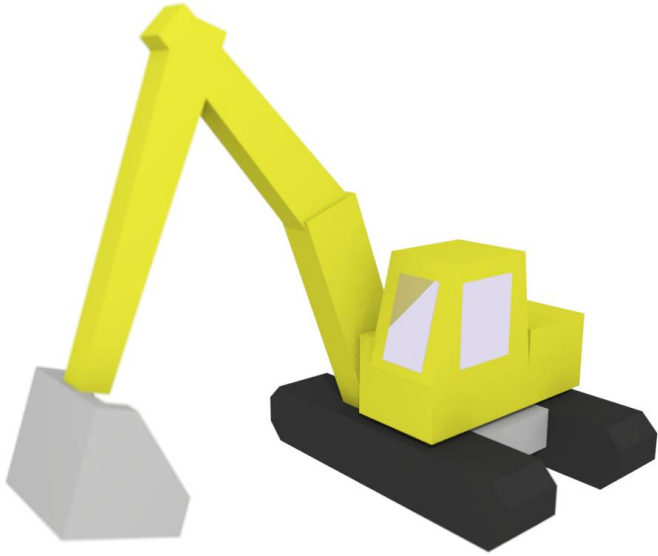


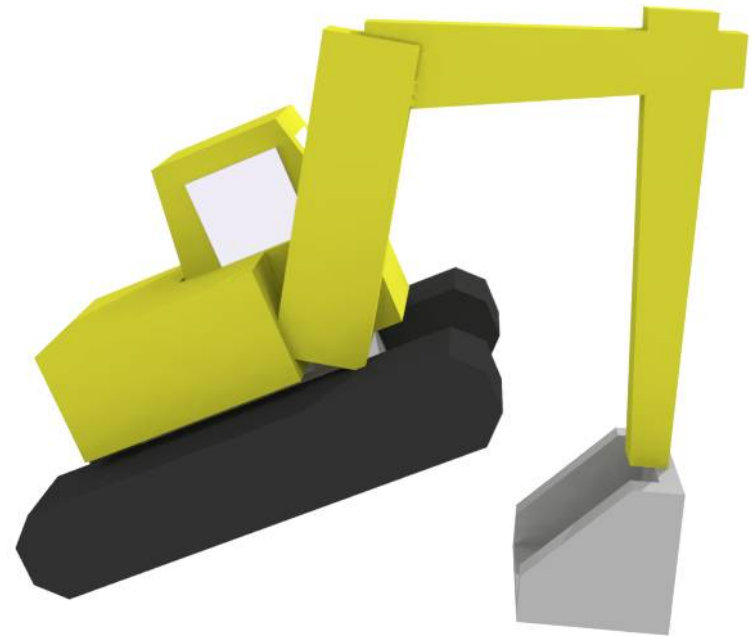
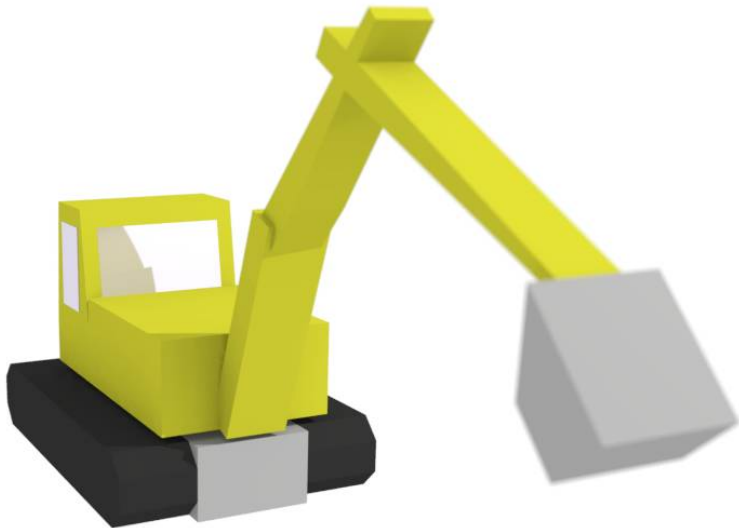
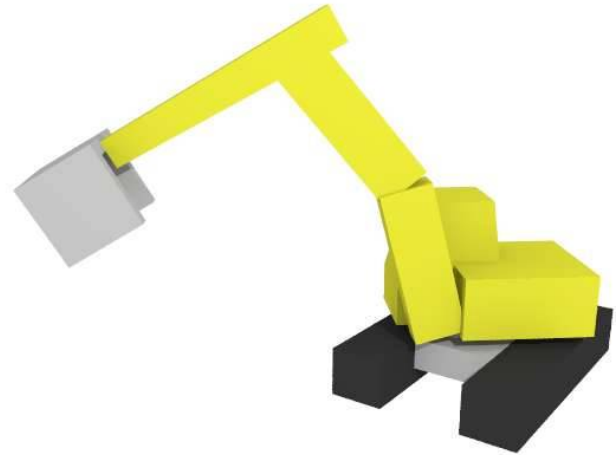
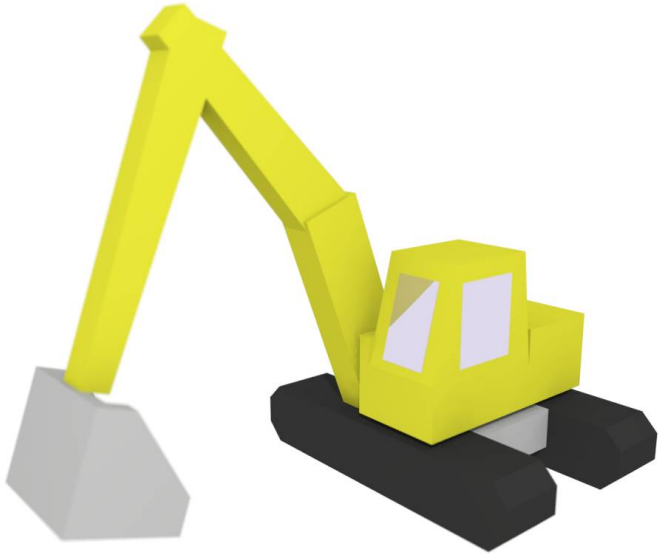




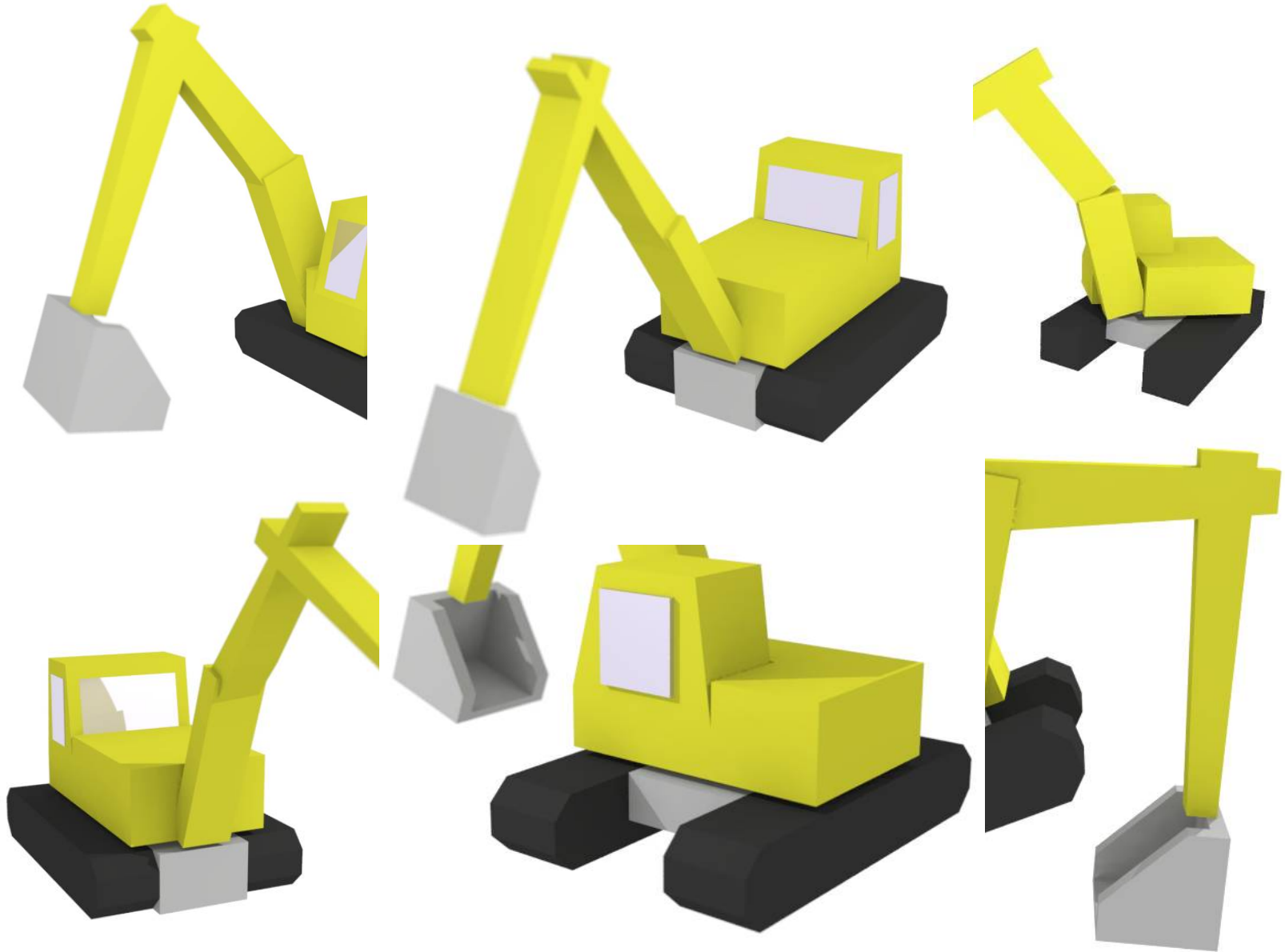




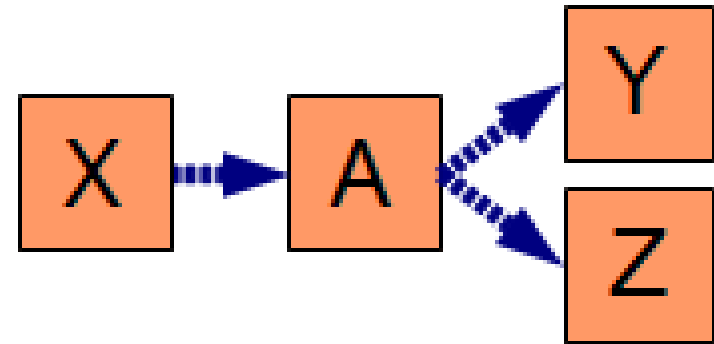




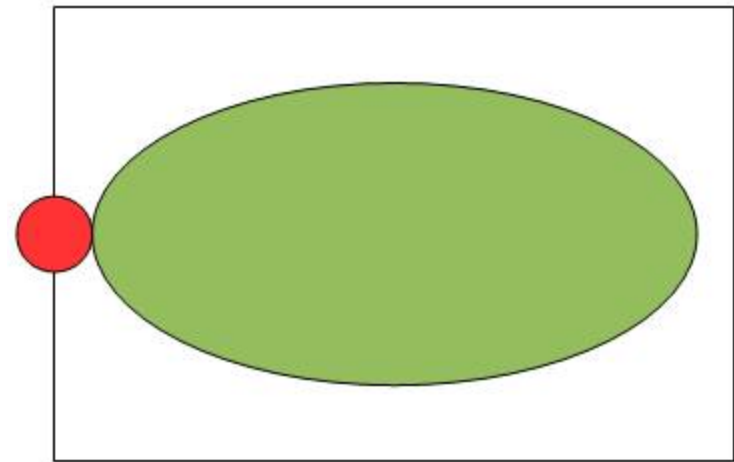




- Kinematic Shapes
- Rigid bodies
- Bones
 - ◆ Parent link
 - ◆ Children links



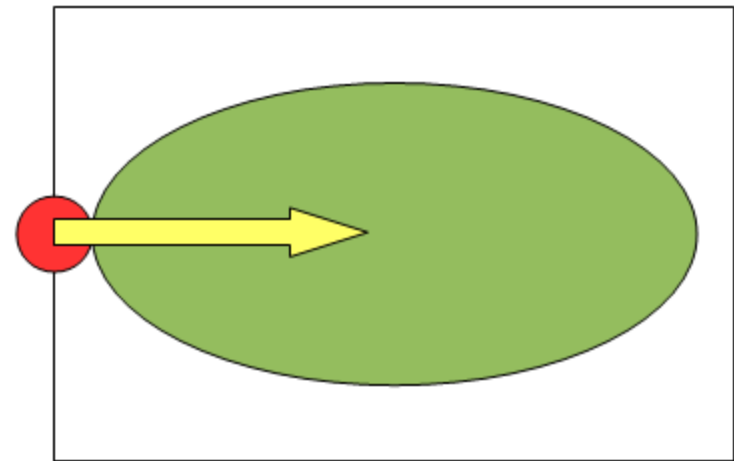
- Kinematic Shapes
 - Rigid bodies
 - Bones
 - ◆ Parent link
 - ◆ Children links
- Joint



- Shape
- Scope
- Pivot placement



- Kinematic Shapes
 - Rigid bodies
 - Bones
 - ◆ Parent link
 - ◆ Children links
- Joint
 - ◆ Default pose

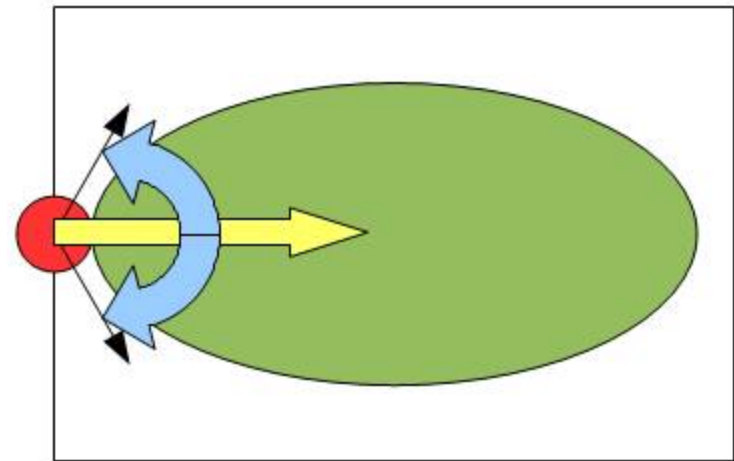


- Shape
- Scope
- Pivot placement

→ Rest rotation



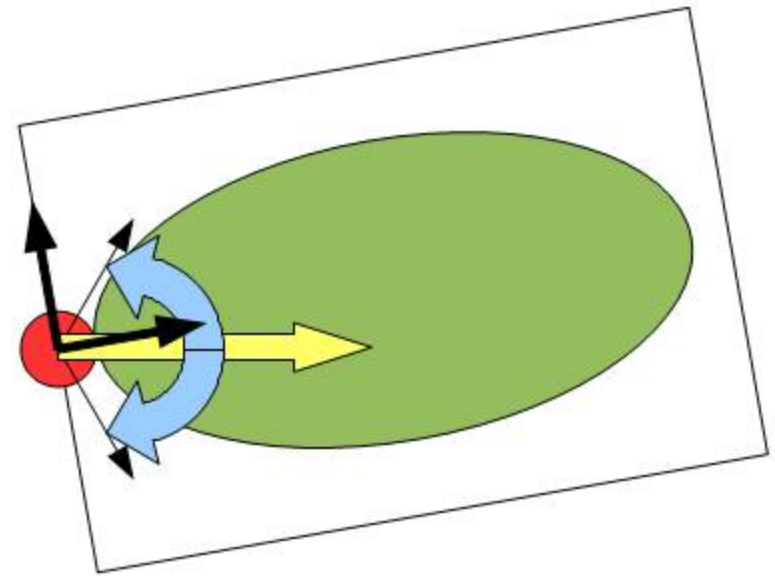
- Kinematic Shapes
- Rigid bodies
- Bones
 - ◆ Parent link
 - ◆ Children links
- Joint
 - ◆ Default pose
 - ◆ Limited transformations



- Shape
- Scope
- Pivot placement
- ↻ Rotation limits
- Rest rotation



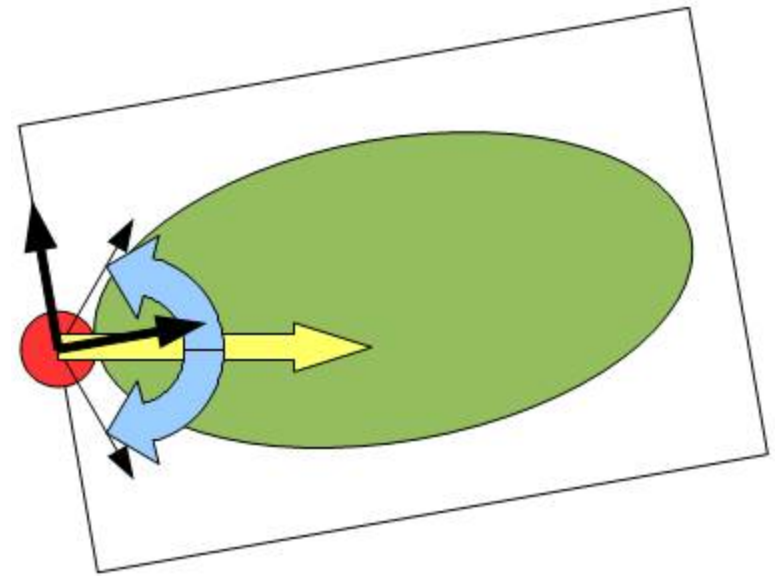
- Kinematic Shapes
- Rigid bodies
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 - ◆ Parent link
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- Shape
- Scope
- Pivot placement
- Current rotation
- ↻ Rotation limits
- Rest rotation



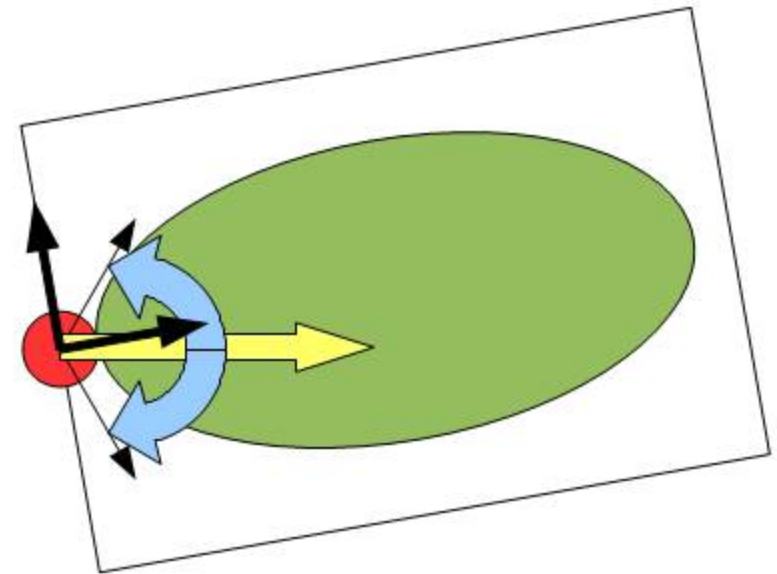
- Kinematic Shapes
- Rigid bodies
- Bones – **Automatic**
 - ◆ Parent link
 - ◆ Children links
- Joint
 - ◆ Default pose
 - ◆ Limited transformations
 - ◆ Current transformation



- Shape
- Scope
- Pivot placement
- Current rotation
- ↷ Rotation limits
- Rest rotation

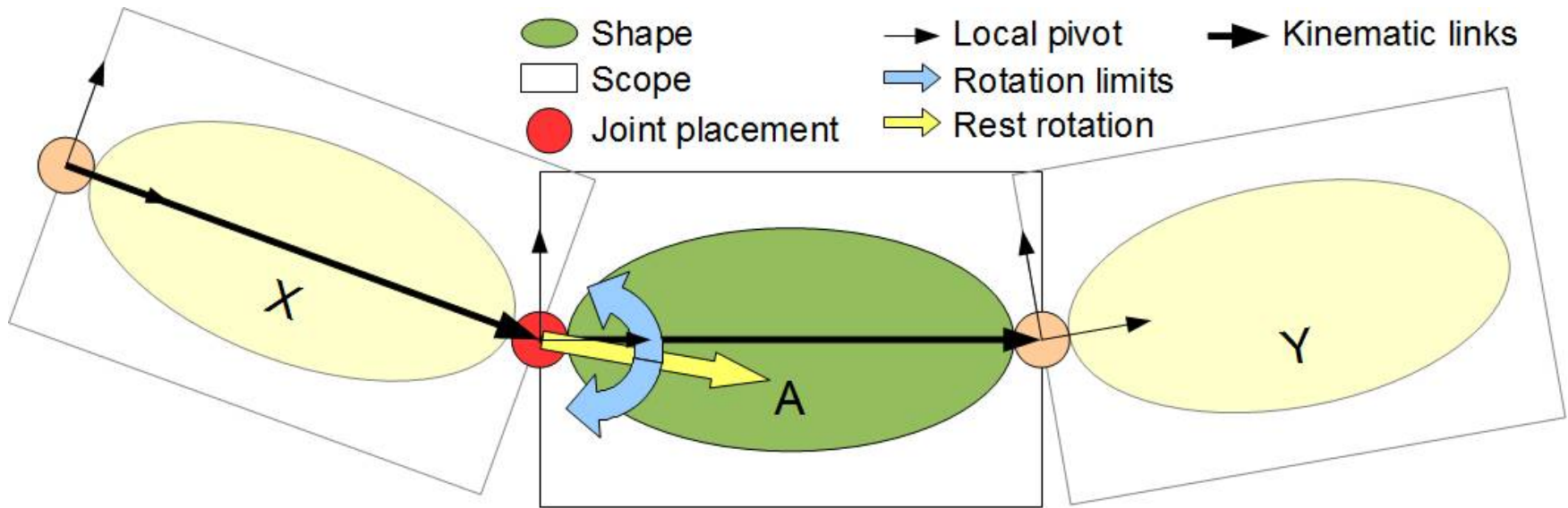


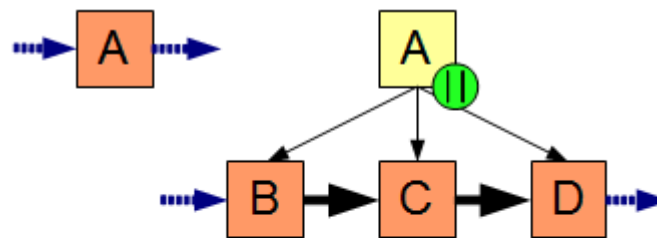
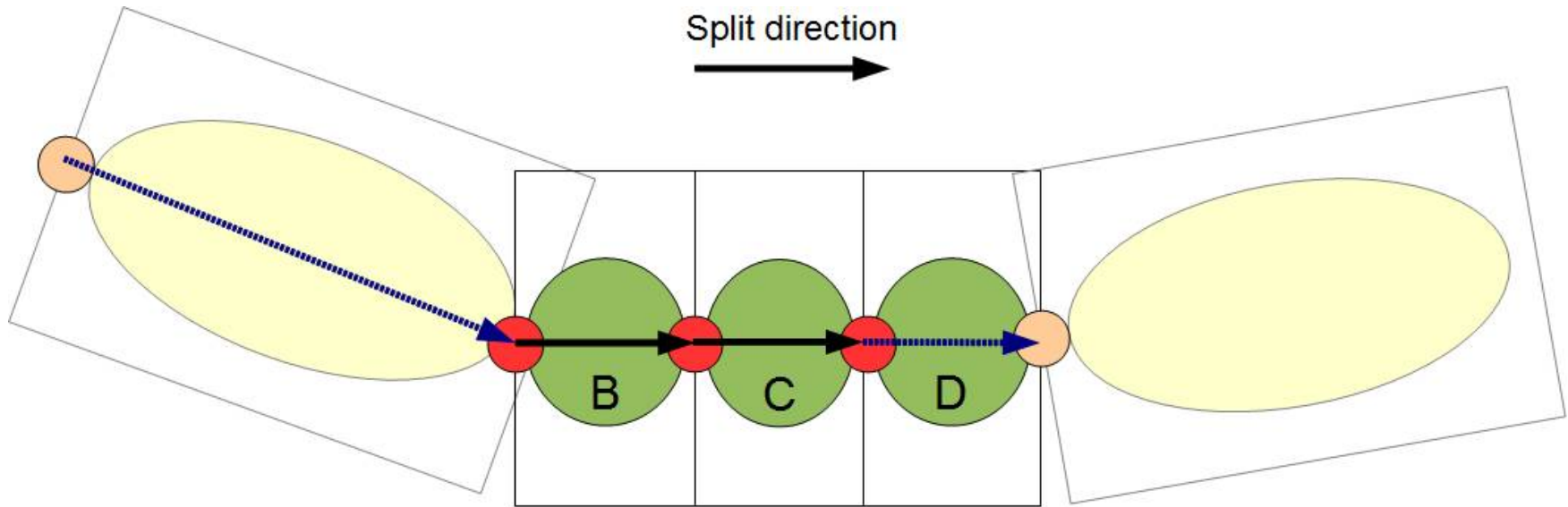
- Kinematic Shapes
- Rigid bodies
- Bones – **Automatic**
 - ◆ Parent link
 - ◆ Children links
- Joint – **Kinematic Rules**
 - ◆ Default pose
 - ◆ Limited transformations
 - ◆ Current transformation



- Shape
- Scope
- Pivot placement
- Current rotation
- ↷ Rotation limits
- Rest rotation

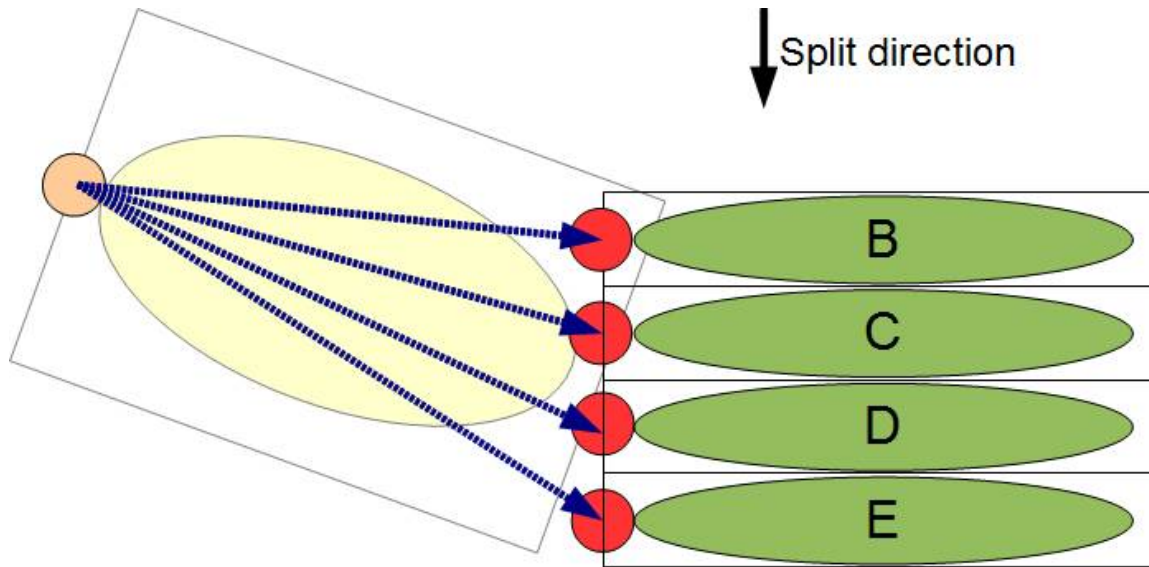




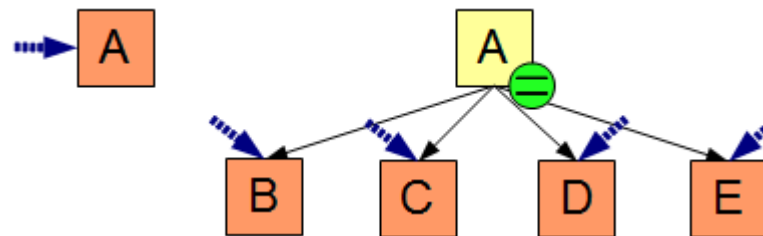


- Sequential split
- Existing skeleton
- New skeleton



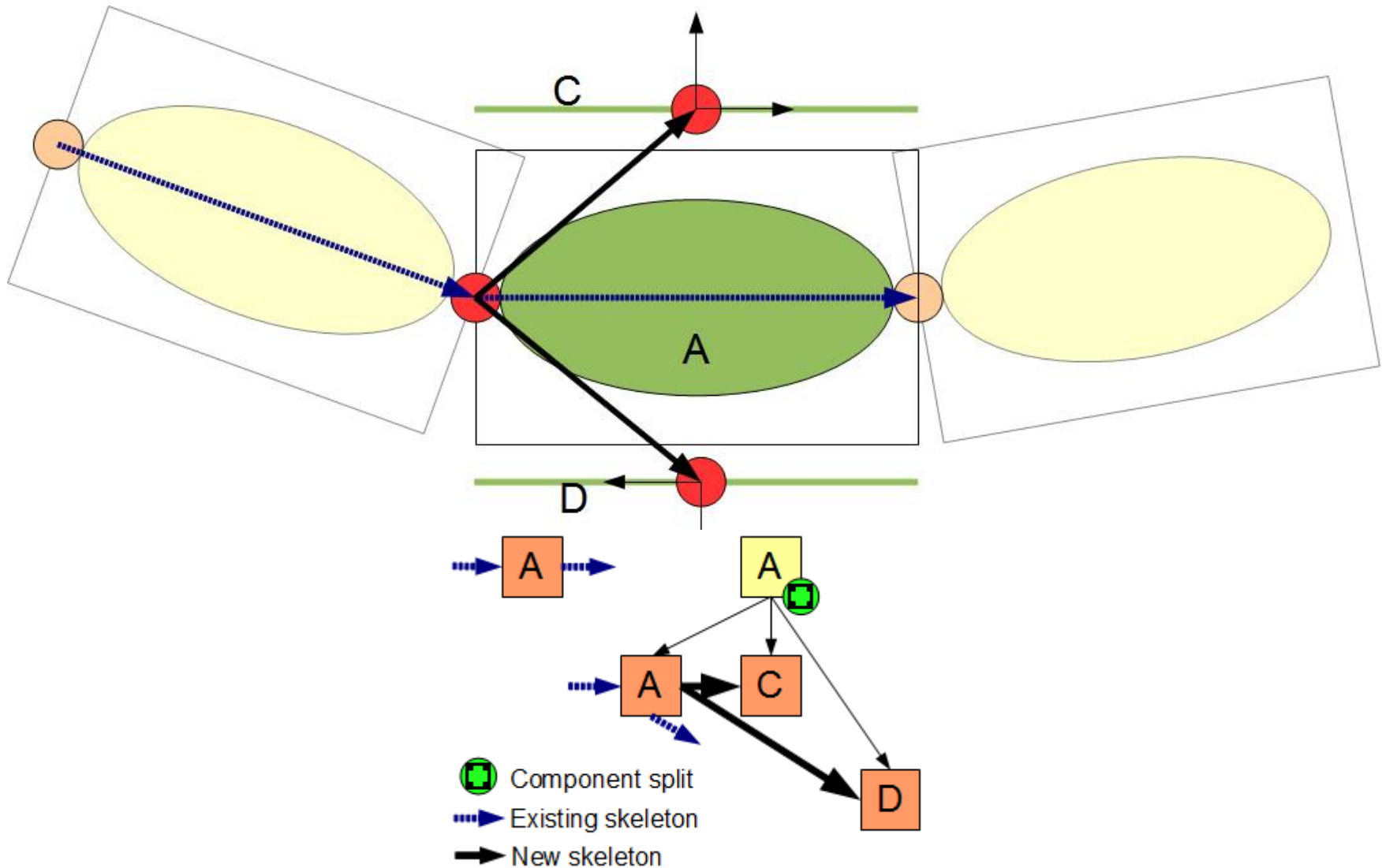


NO CHILDREN
ALLOWED DURING A
PARALLEL SPLIT

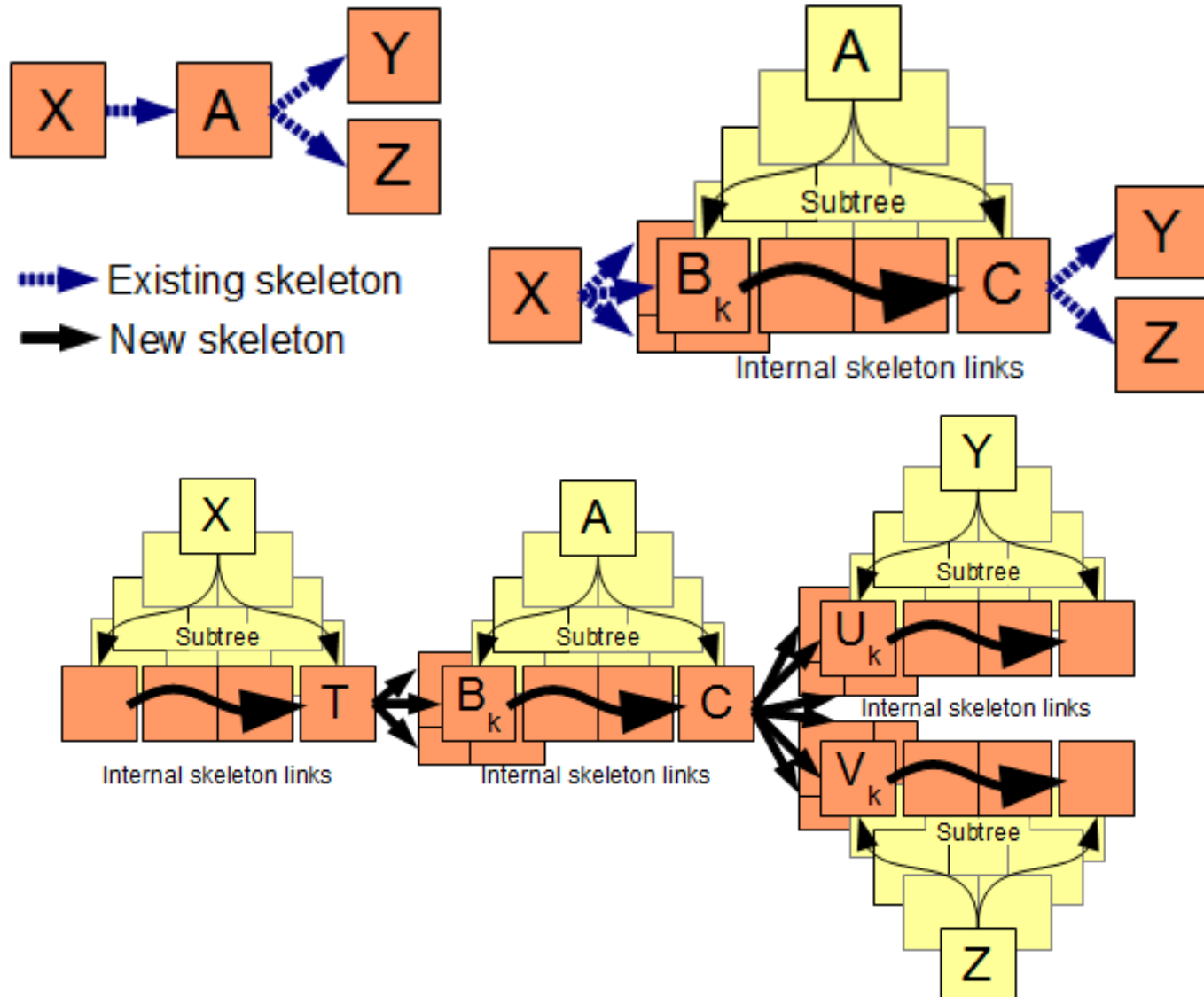


- Parallel split
- Existing skeleton
- New skeleton





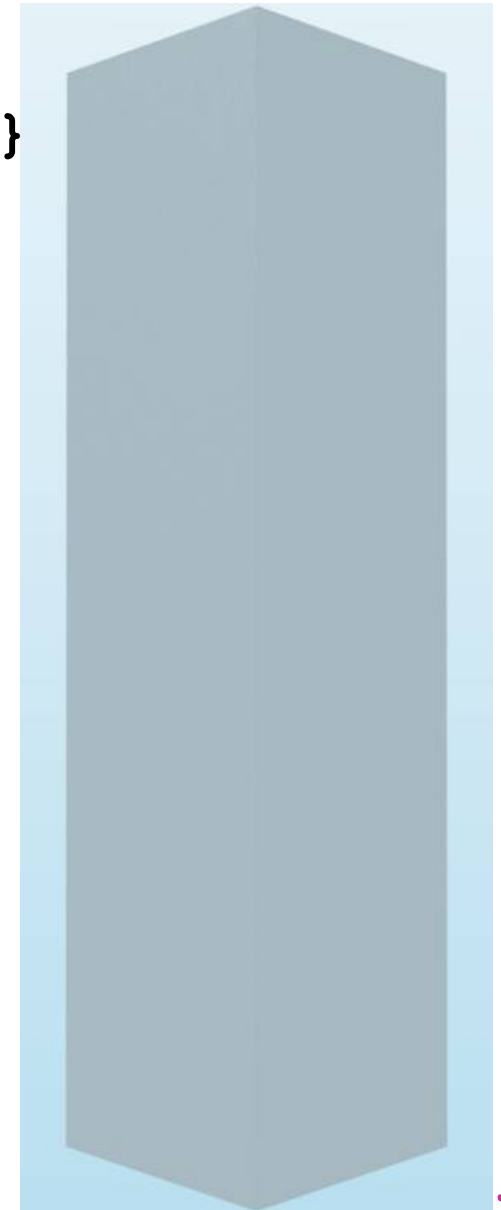
Kinematic independence



BuildingRoot →

Subdiv("Y", 3.5) {**Basement**|**Floor**}

Floors → **Repeat**("Y", 3a) {**Floor**}



BuildingRoot →

`Subdiv("Y", 3.5) {Basement|Floor}`

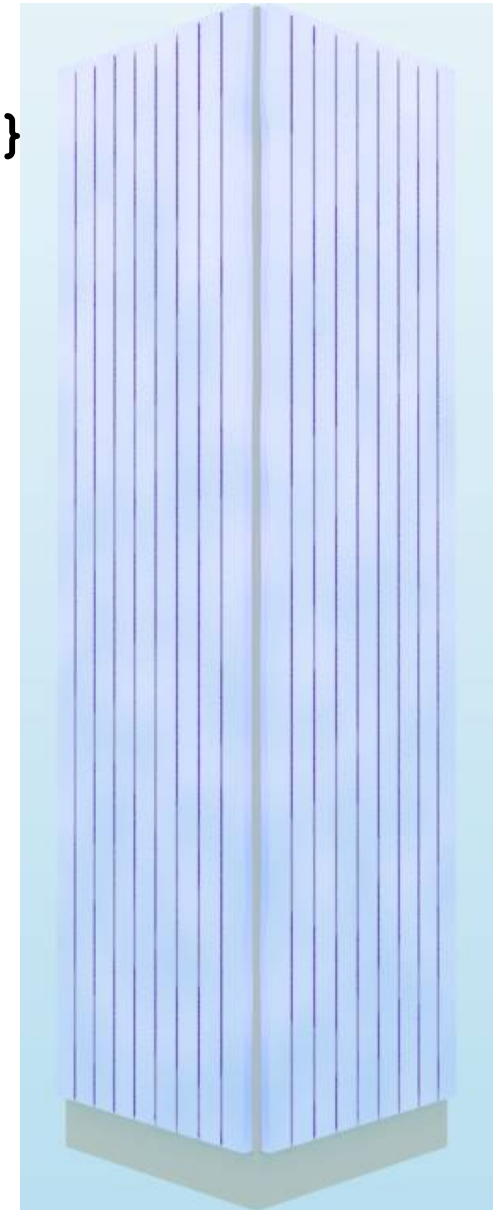
Floors → `Repeat("Y", 3a) {Floor}`

Floor →

`Comp("sidefaces") {FloorFacade}`

FloorFacade →

`Repeat("Y", 1.5a) {WindowPane}`



BuildingRoot →

Subdiv("Y", 3.5) {**Basement**|**Floor**}

Floors → **Repeat**("Y", 3a) {**Floor**}

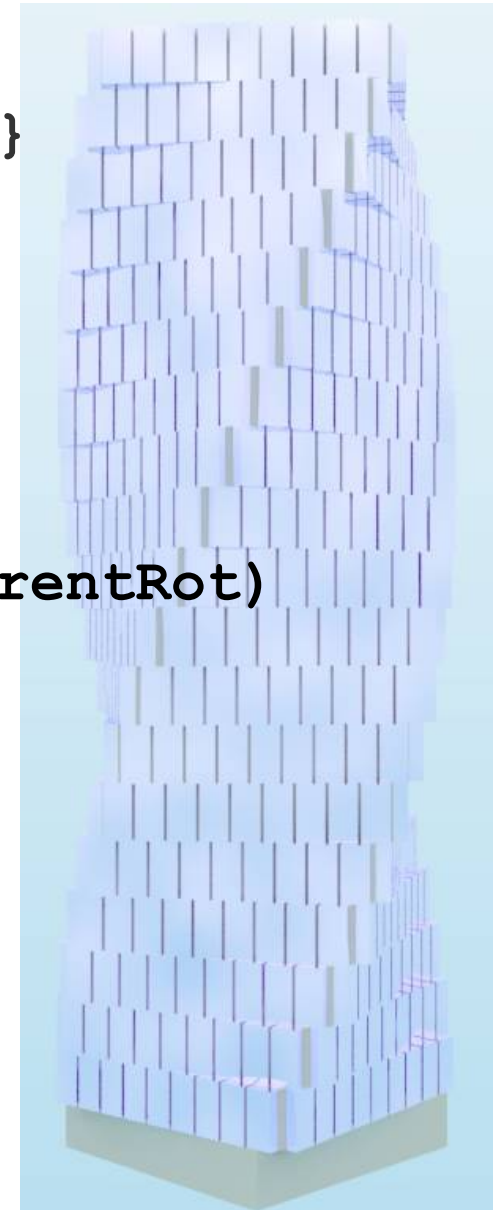
Floor →

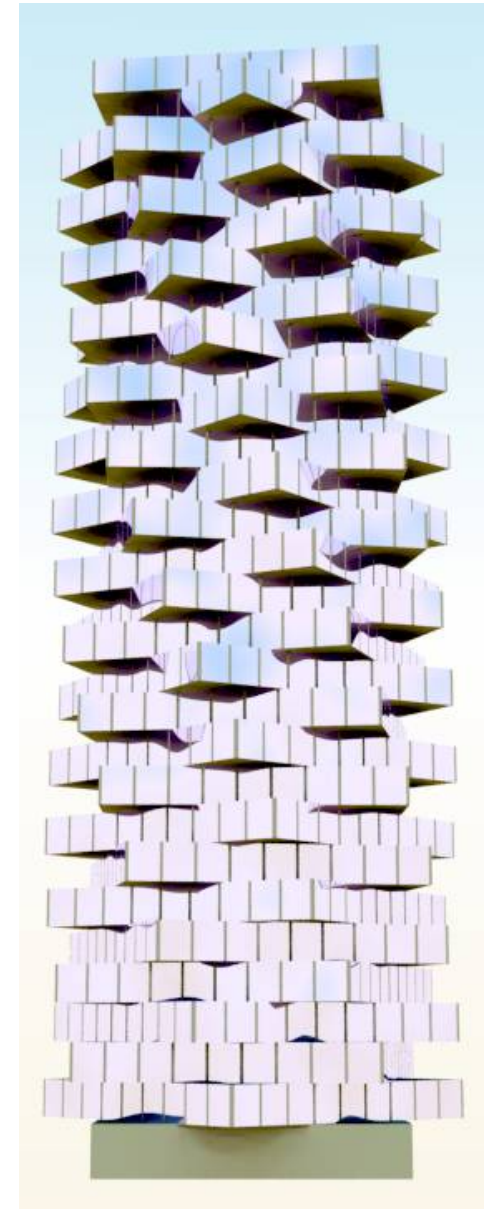
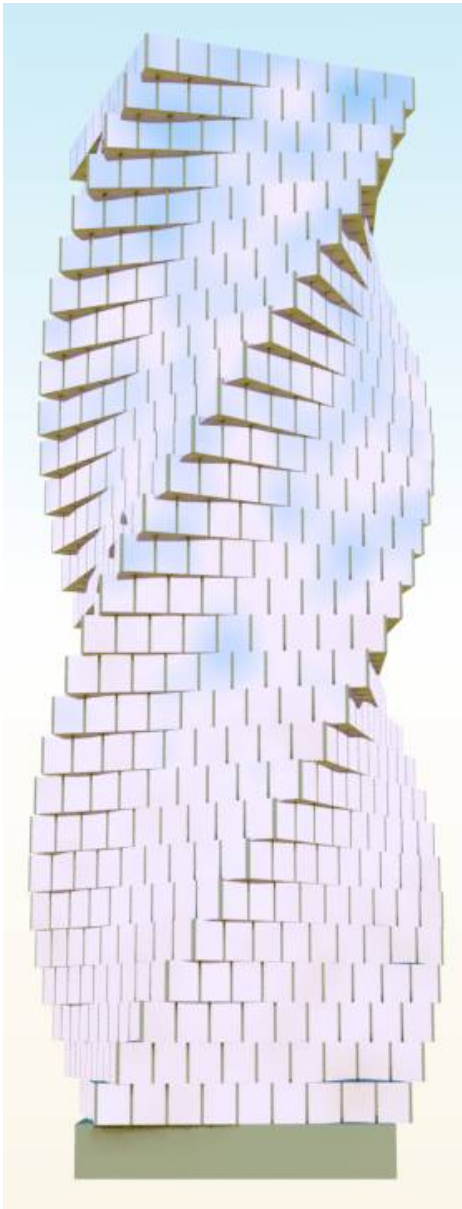
KinematicRotation(**RotLimits**,**CurrentRot**)

Comp("sidefaces") {**FloorFacade**}

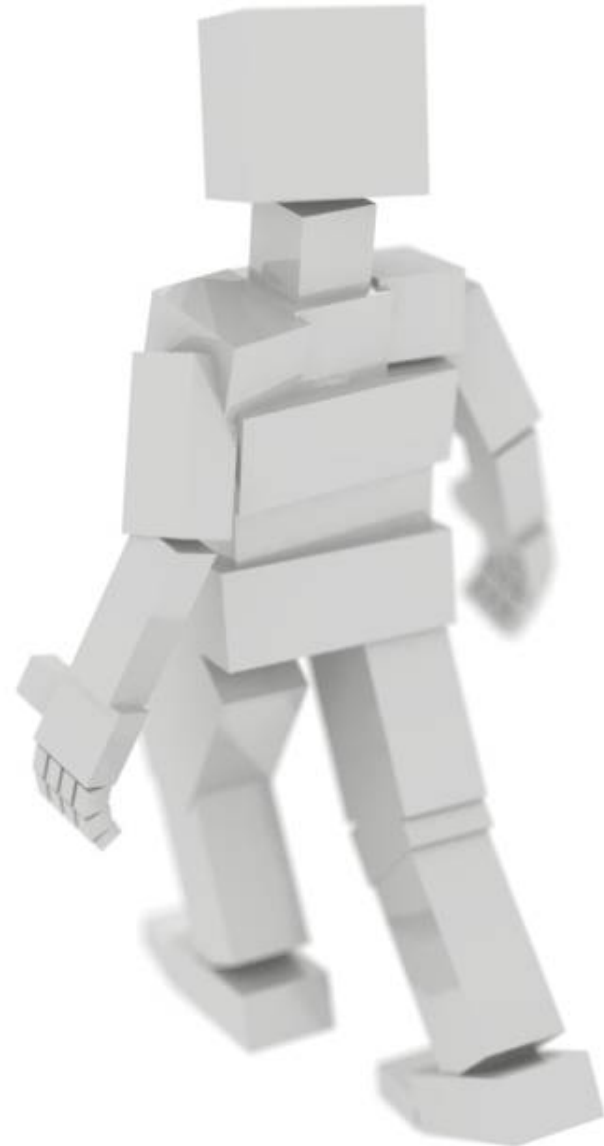
FloorFacade →

Repeat("Y", 1.5a) {**WindowPane**}

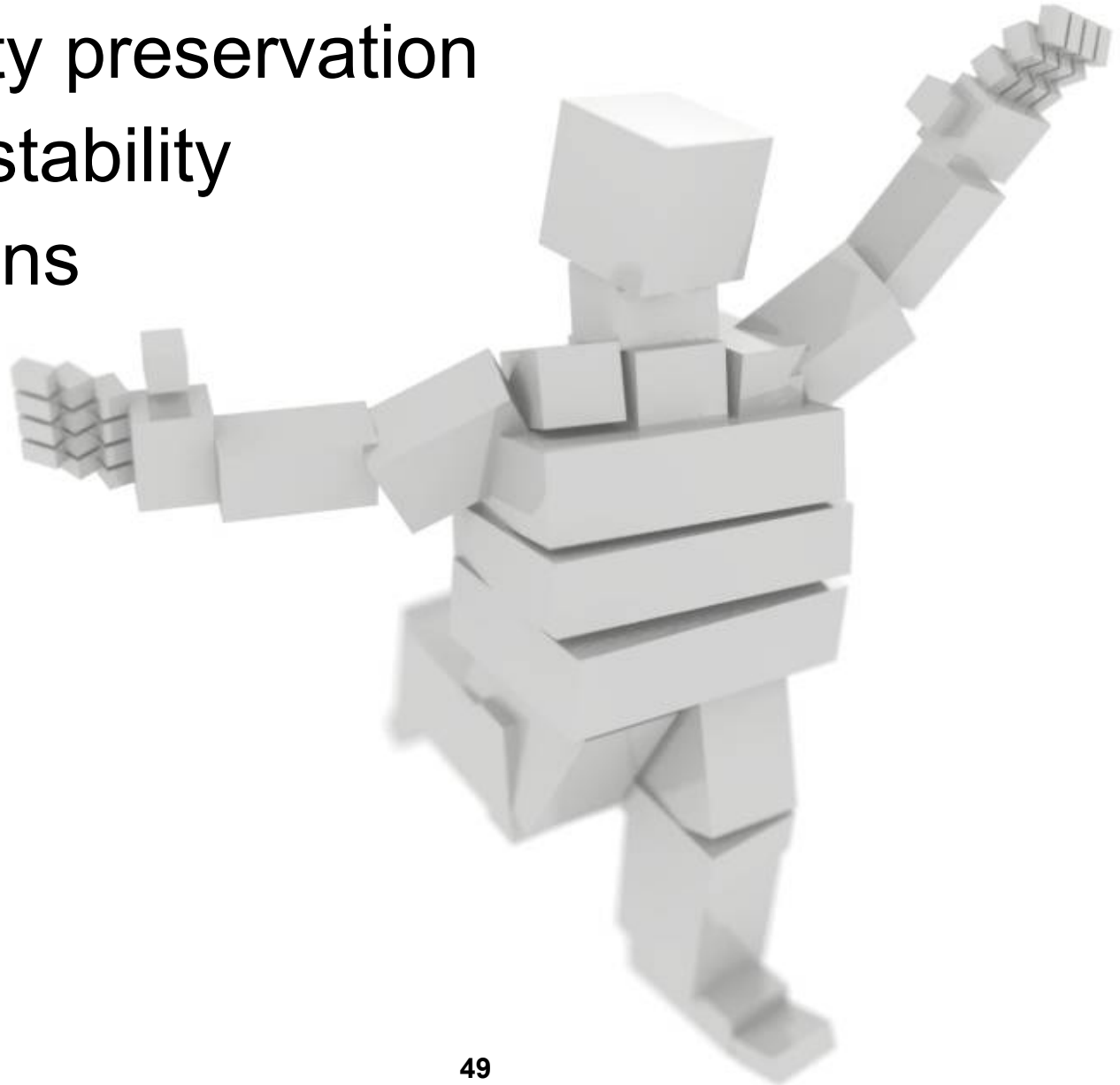




- Poses enrich semantics
 - ◆ Rule based
- Simple extension to CGA
 - ◆ Integration
 - ◆ Interactivity
- Rigging for free
 - ◆ Post-processing



- Connectivity preservation
- Mass and stability
- Deformations
- Animation
- IK



- Johannes Kühnreiter, Frederico Dusberger
- Daniel Scherzer, Markus Lipp
- Reviewers

- FIT-IT Visual Computing Initiative
- GameWorld Project

