Course Plan

lec. 1: **Introduction**
lec. 2: **Mathematics** for 3D Games
lec. 3: **Scene Graph**
lec. 4: Game **3D Physics** +
lec. 5: Game **Particle Systems**
lec. 6: Game **3D Models**
lec. 7: Game **Materials**
lec. 8: Game **Textures**
lec. 9: Game **3D Animations**
lec. 10: **3D Audio** for 3D Games
lec. 11: **Networking** for 3D Games
lec. 12: **Interactive Agents** for 3D Games
lec. 13: **Rendering Techniques** for 3D Games

computer animation

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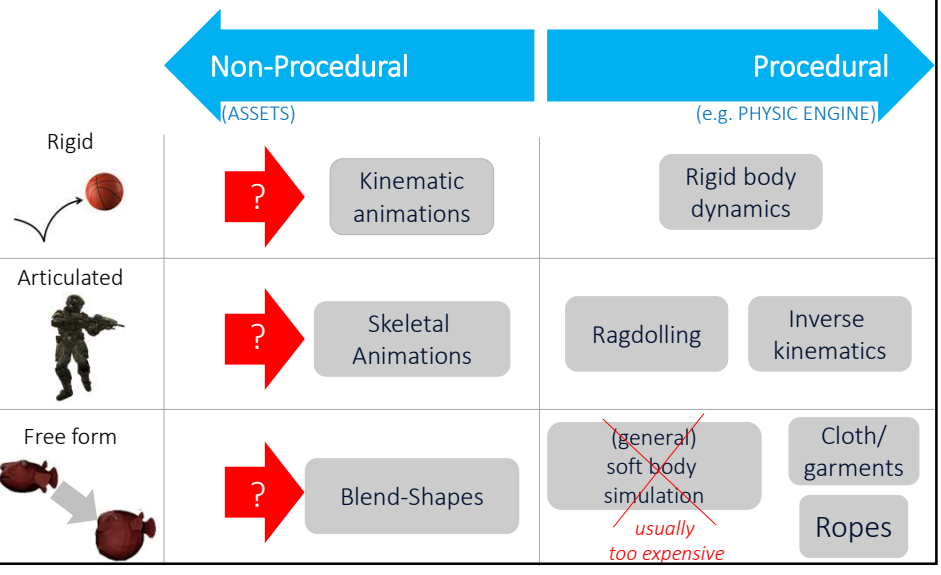
Representations for animations: which type to choose?



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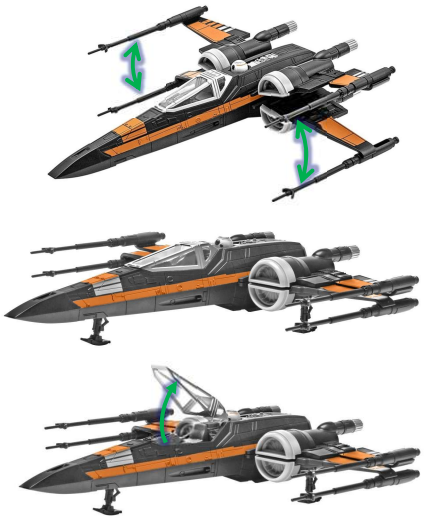
Representations for animations: which type to choose?

EXERCISE:
say we want
a model capable of
doing this:

(& combinations!)



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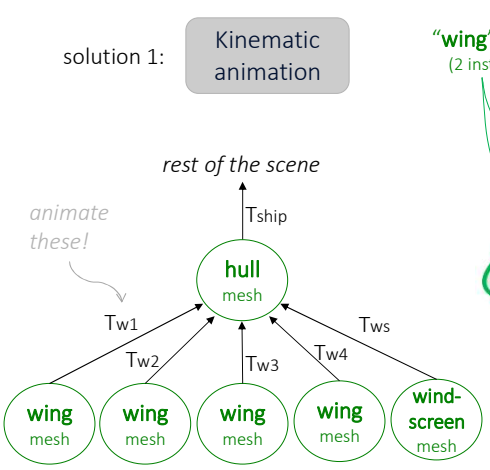
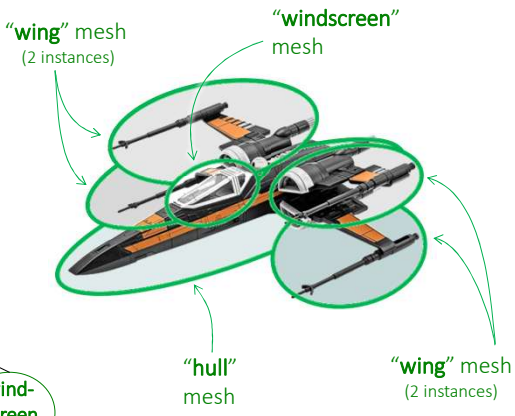
Representations for animations: which type to choose?

solution 1: Kinematic animation



scene graph



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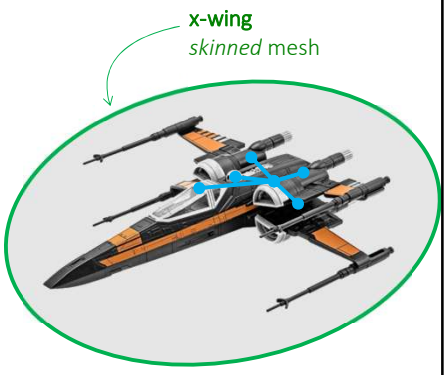
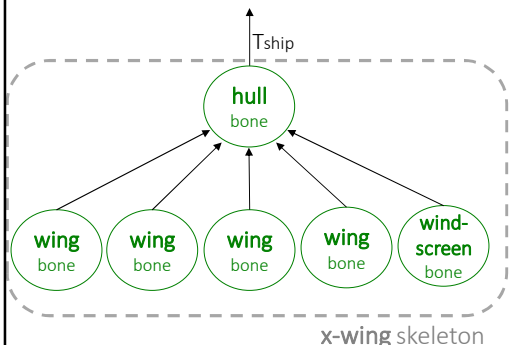
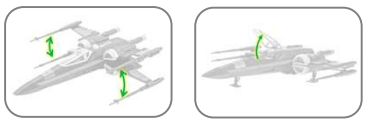
Representations for animations: which type to choose?

solution 2: Skeletal animation







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Representations for animations: which type to choose?

solution 3: Blend-shape

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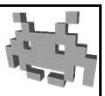

Representations for animations: which type to choose? In this example…

- Kinematic animation:
  - *how:* 3 (rigid) meshes, 6 instances, animate 5 scene-graph local transforms (e.g. via scripts)
  - can reuse meshes (geometry+attr+connectivity) for all wings: most compact on V-RAM ☺
  - simpler rendering (just rigid meshes) ☺
  - 6 individual draw calls! ☹
  - limitation: no deformable bits (e.g., no leather pieces connecting the windscreen)
- Skeletal animation:
  - *how:* one skeleton (6 bones) + one skinned mesh + 2 skeletal animations (1 pose each, maybe)
  - (in this case, single bone per-vertex is enough for the skinning)
  - open-windscreen with both open OR closed wings? Still possible! (layering of animations)
  - rendering: small increase of per-vertex computation burden: LBS or DQS ☹
  - single draw-call! ☺
  - deformable bits: allowed ☺ (triangles connecting vertices linked to ≠ bones, or blend skinning)
- Blend-shape:
  - *how:* one base-shape + 2 morphs
  - bad quality of interpolation: linear
    - vertices follow straight paths
  - heaviest on V-RAM ☹
    - not a bit problem, if low-res
  - a single draw call! ☺
    - but to different geometry buffers at each frame

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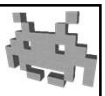
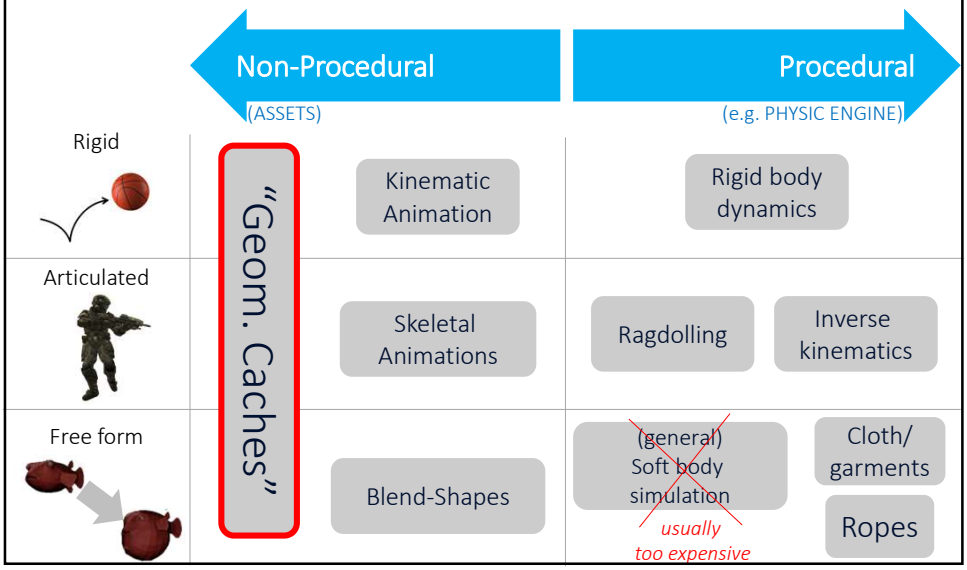


Animations in games (of 3D Solid Objects)



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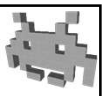
Geometry Caches
(for lack of a better name)



- Baked, optimized animations
  - of a mixture of types, like
    - blend shapes
    - kinematic animations
    - skinned animations
  - optimized
    - compressed, streamed…
  - Can be used to bake results of a physical simulation
    - i.e., convert it from procedural to kinematic

one used file format: .abc

by 

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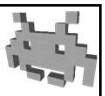
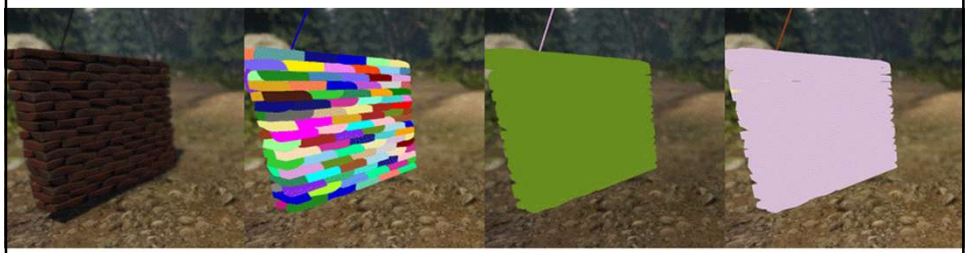
Geometry Caches
(for lack of a better name)



- Baked, optimized animations
  - of the appropriate types including mixtures



Input:
170 Meshes
88400 Verts

as Pre-made Tansforms:
Meshes: 170
Data rate: 0.13 MB/s
Draw calls: 170
(same ones each frame)

as a Blend Shape:
Meshes: 1, with N shapes
Data rate: 4.3 MB/s
Draw calls: 1
(different one each frame)

as a Skeletal Animation
Meshes: 1, w skinning (*)
Data rate: 0.13 MB/s
Draw calls: 1
(same one each frame)
(*) just 1 bone per vertex

Geometry Caches
(a subset of Alembic)

by 

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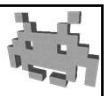
Animations in games: authored, procedural… or a mix? [summary]



- A few examples of current commonly used mixes:
  1: *"primary"* animations: authored
  "secondary" animations: physically generated
  2: *alive* characters: authored
  dead characters: physically generated ("ragdolls")
  3: walk cycle: authored (skeletal animation)
  exact *feet placement*: procedural (inverse kinematic)
  4: normal "behavior", such as sparring: authored
  gaze control during sparring: procedural
  5: normal "behaviors" such as jumping, running: authored
  modifications / transitions: AI generated
  and more!
- mixing AI-generated with authored animations is a frontier in the field of Computer Animation

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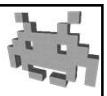
Mecanim Animations System in Unity [practical notes]



- Assets (models, animation, skeletons) imported as formats:
  - fbx, collada
- Keyframe sparsification, or reduction of num of links per vertex
  - available as operation at assent import time
- «Animator Controller» module → deals with:
  - blending between animations: «transitions»
  - compositing animations: «layers»
    - e.g.: a layer overwrites upper body bones
  - and is nicely WYSIWYG and has a nice graph GUI
- Inverse Kinematic: with scripts (`Avatar.SetIKPoistion`)
- Skeletons:
  - custom skeletons can be used (imported as assets)
  - OR, a standard built-in humanoid skeleton provided
    - ~21 bones
    - simplifies: rigging, ragdolling (predefined constrains), layers (predef. labelling)

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