SI4 - CRÉATION DE MONDES VIRTUELS

THE ANIMATION PIPELINE

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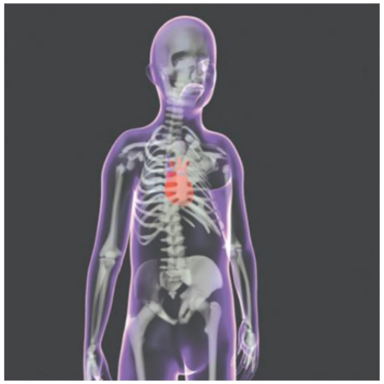
PLAN

1. 3D animation pipeline
2. Squash and stretch
3. Walking, squirming, and swimming

THE 3D ANIMATION PIPELINE

In general, 3D animation is a subfield of 3D computer graphics which uses 3D animation software and hardware for various applications in:

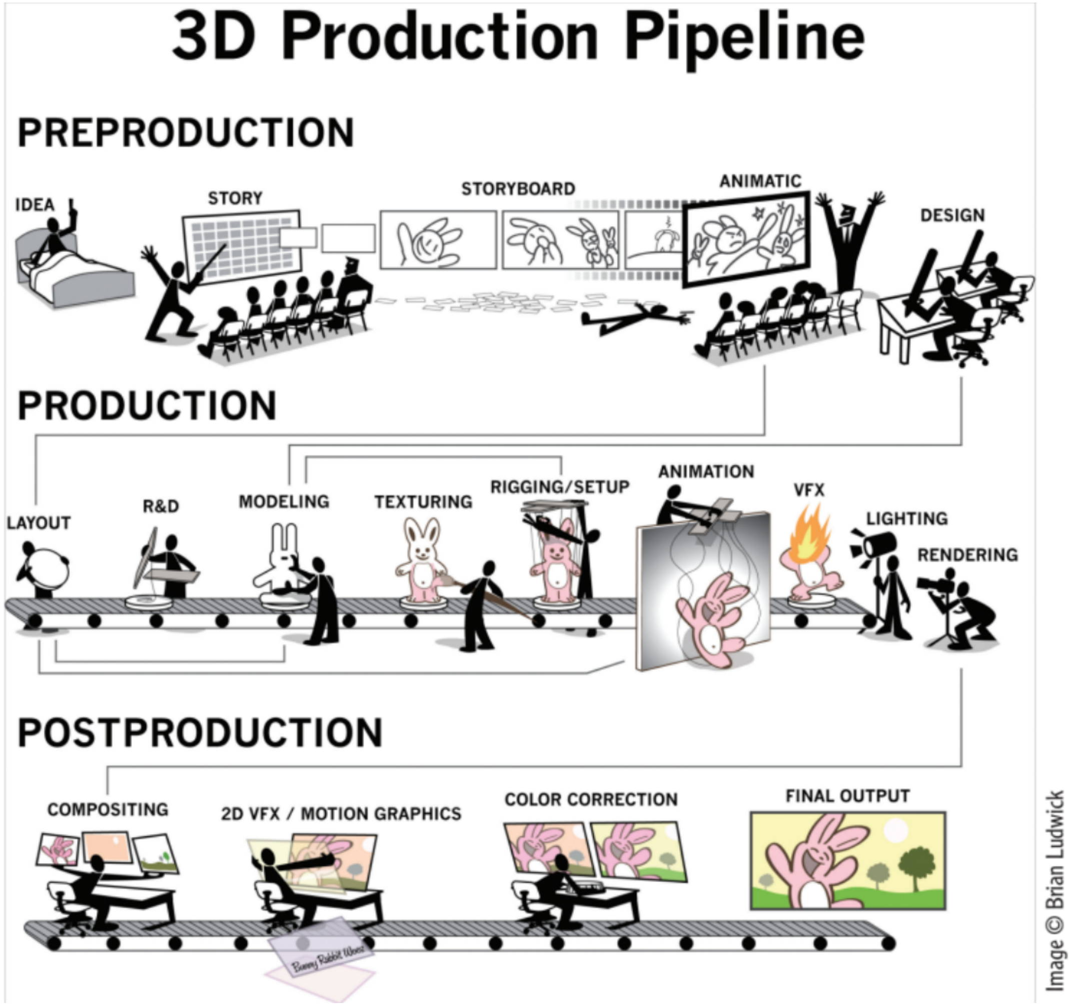
- **Entertainment** such as movies, advertisements, and video games
- **Science and research** such as simulation and visualization
- **Industrial production** such as architecture design and 3D printing
- **Education** such as training and rehabilitation
- Other areas



Example applications in 3D animations from left to right: medical, law forensics, and training

Beane, A. (2012). 3D animation essentials. John Wiley & Sons.

THE 3D ANIMATION PIPELINE



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THE 3D ANIMATION PIPELINE

ANIMATION PRE-PRODUCTION

Ideation: project-level brainstorming of an animation project

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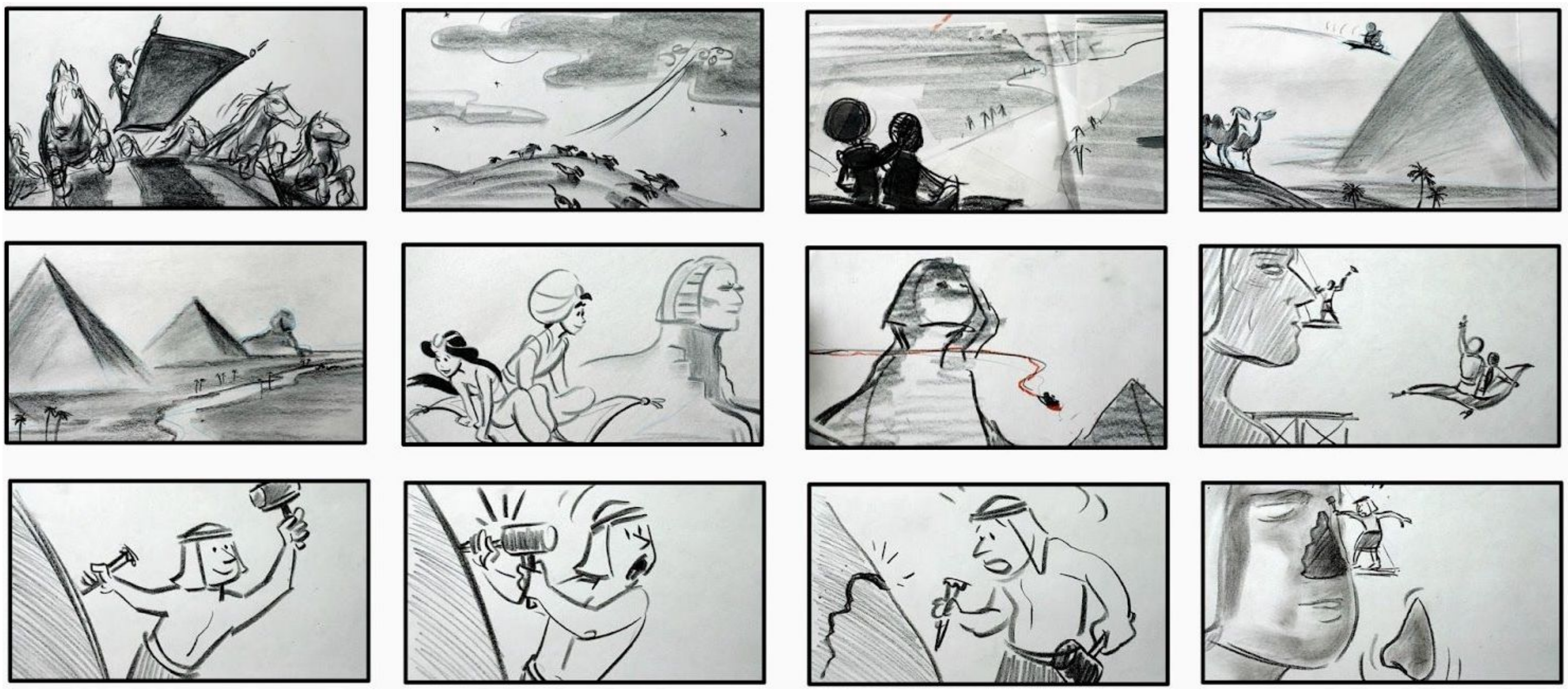
ANIMATION PRE-PRODUCTION

Storyboarding: shot-to-shot sequence showing the motion

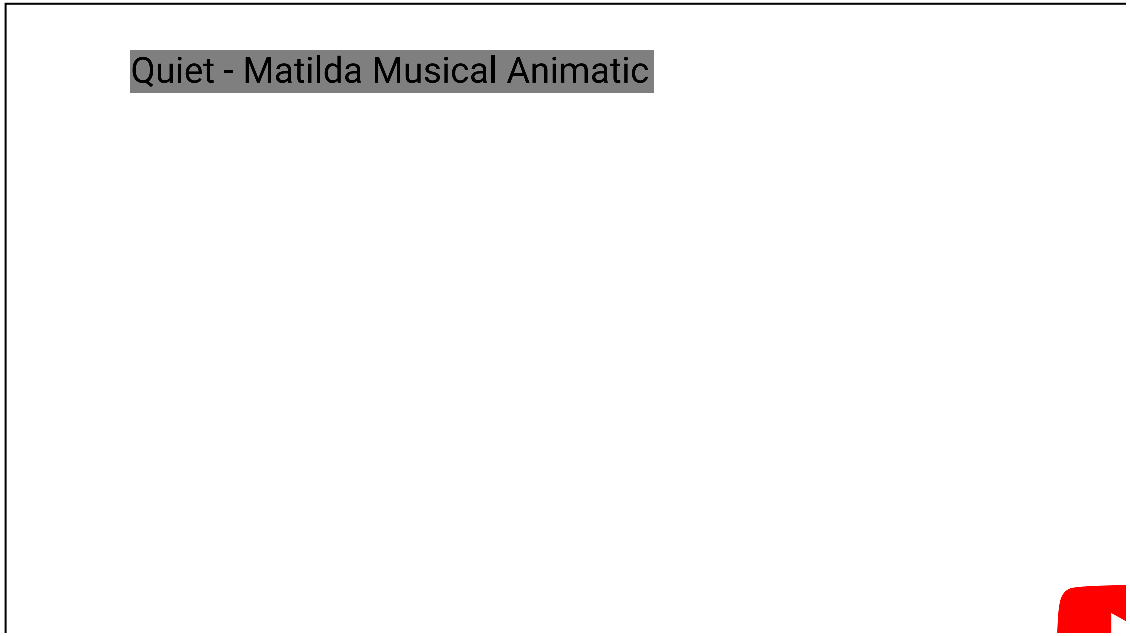


Storyboard of Aladdin (1992)

THE 3D ANIMATION PIPELINE

ANIMATION PRE-PRODUCTION

Animatic: A first draft of the animation



A fan-made animatic for the musical Mathilda

THE 3D ANIMATION PIPELINE

PRODUCTION

Layout (Final): Using simple geometry (boxes, spheres for example) to pre-visualize the animation

Modeling & Texturing: Creating the 3D mesh and adding materials and textures (TD1 + TD2)

THE 3D ANIMATION PIPELINE

PRODUCTION

Rigging: Adding the bone structure to prepare for animation (TD2)

Animation: Keyframing movements to create motion (TD2)

VFX, Lighting, Rendering: Final steps of using the 3D animation software (TD3)

THE 3D ANIMATION PIPELINE

POST-PRODUCTION

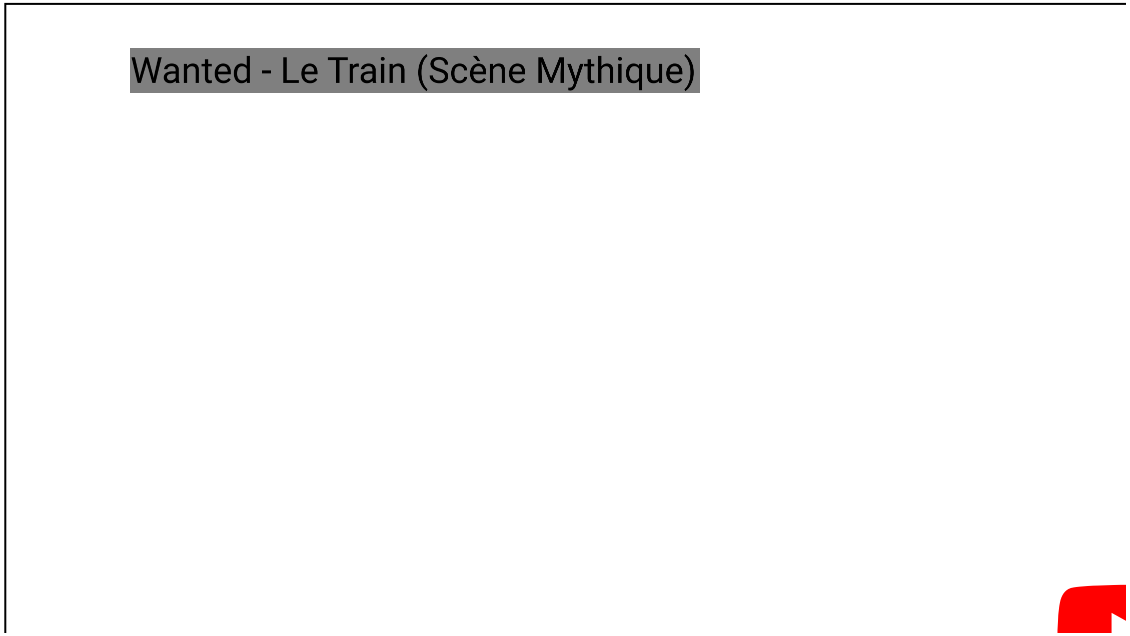
Compositing: Layers that will adjust the rendered scene

Other treatments: 2D VFX, color correction, film-editing

THE 3D ANIMATION PIPELINE

TWO THINGS TO NOTE

1. It is a **highly technical** domain



Observe the particles of the train scraping against the cliff wall: that is the work of 1 person over 2-3 months

THE 3D ANIMATION PIPELINE

TWO THINGS TO NOTE

2. It is a **highly interdisciplinary and labor intensive** domain

Take a look at the VFX credits of Dr. Strange Multiverse of Madness: https://youtu.be/fYjuFa3JNZo?t=409

THE 3D ANIMATION PIPELINE

There are therefore strong intuitives for R&D to develop more **automated** approaches to content creation, including:

- object or scene reconstruction from lidar cameras
- physics particles: hair, liquids, fire
- cinematography: real-time camera motion (e-sports)

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SQUASH AND STRETCH

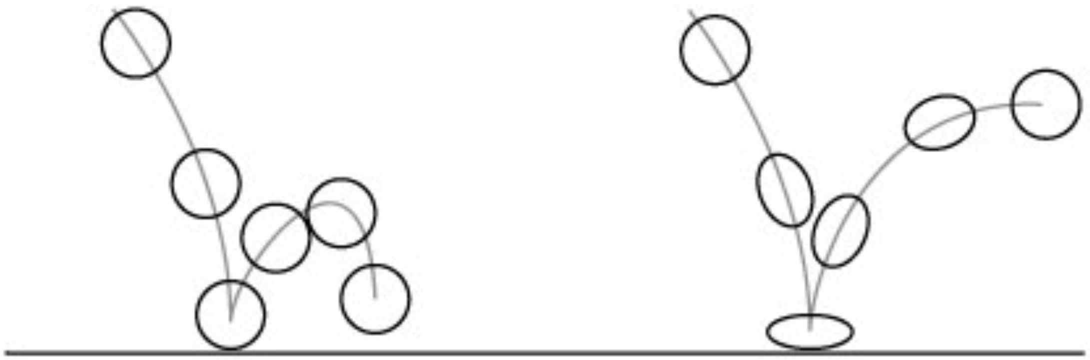
Motivation:

- take into account the physics of real world
- give life to characters and objects

Squash and stretch of Scrat from the animation Ice Age (Source:Animation mentor)

SQUASH AND STRETCH

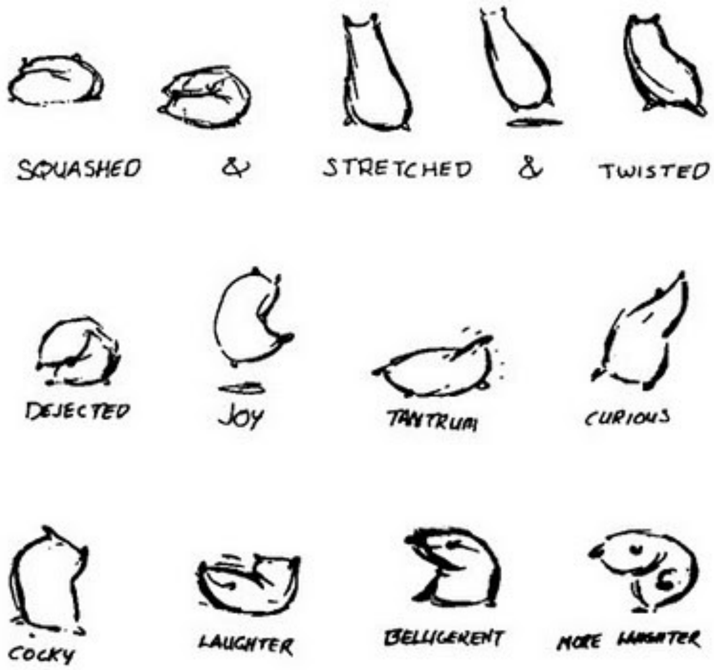
Classical example:



A simple ball with and without squash and stretch

SQUASH AND STRETCH

Classical example:



Squash and stretch of Disney's flour sack

SQUASH AND STRETCH

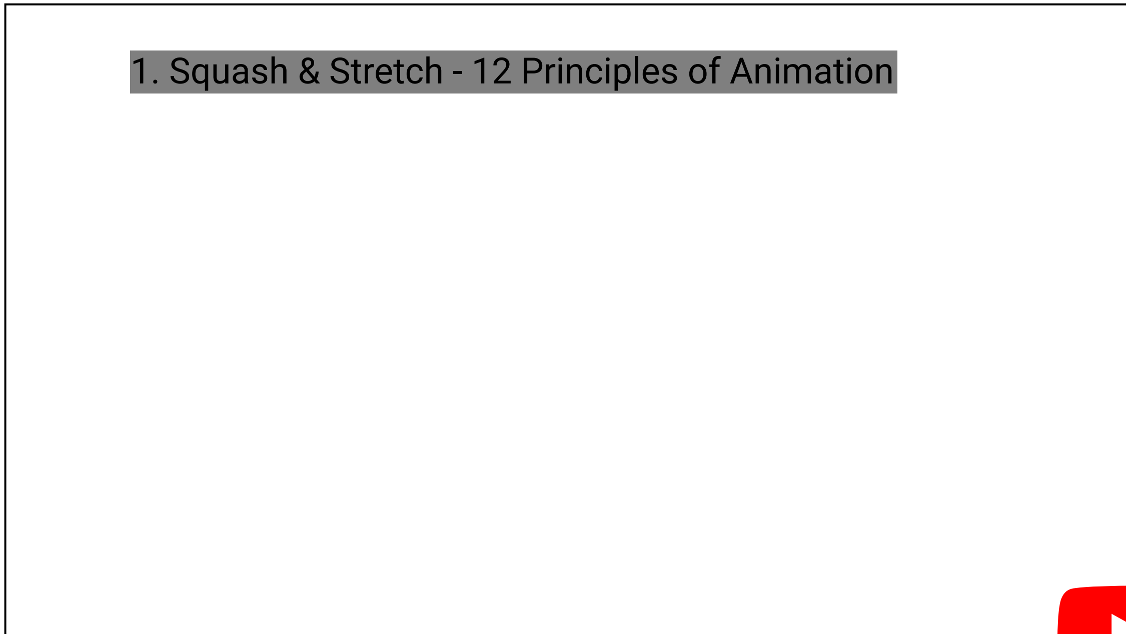
What elements go into a squash and stretch animation?

- **Volume**: the overall models should be preserved to ensure realism
- **Gravity**: influencing the ballistic trajectory of the object (realistic physics)
- **Restitution**: taking into account energy loss on collision
- **Maximum stretch/minimum squash**: how much the object can be squashed and stretched
- **Stretch/squash rate**: how fast the object stretches/squashes before and after the collision

Chenney, S., Pingel, M., Iverson, R., & Szymanski, M. (2002, June). Simulating cartoon style animation. In Proceedings of the 2nd International Symposium on Non-photorealistic Animation and Rendering (pp. 133-138).

SQUASH AND STRETCH

Explanation video:



Squash and stretch explanation by Alan Becker

SQUASH AND STRETCH

TD for today: squash and stretch in Blender while maintaining volume

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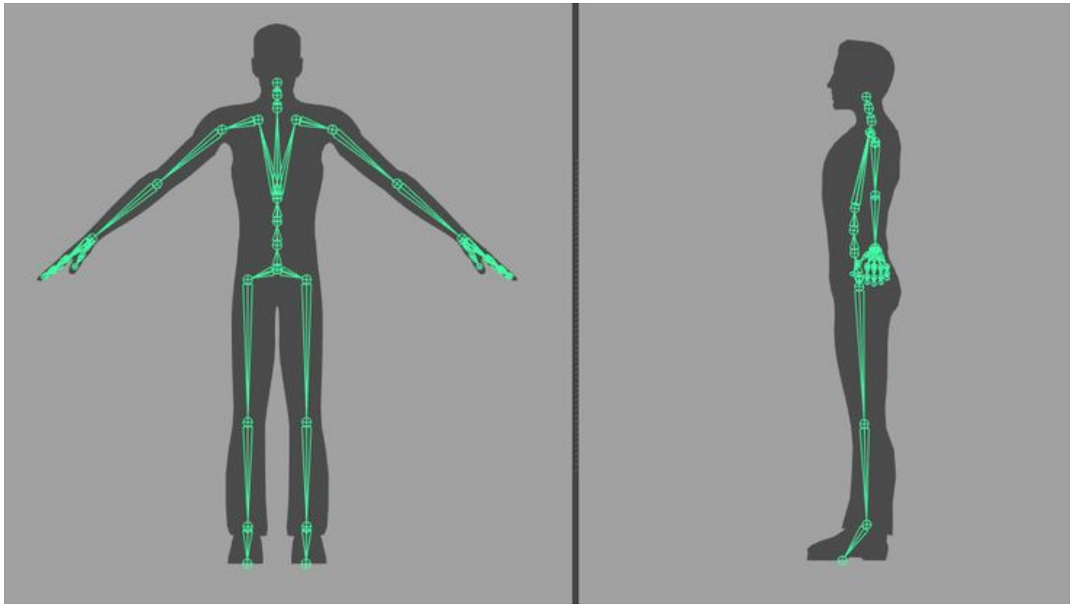
WALKING, SQUIRMING, AND SWIMMING

Animations on animate characters such as humans and other creatures are done through a process called **rigging**, which is adding a skeleton to the character.



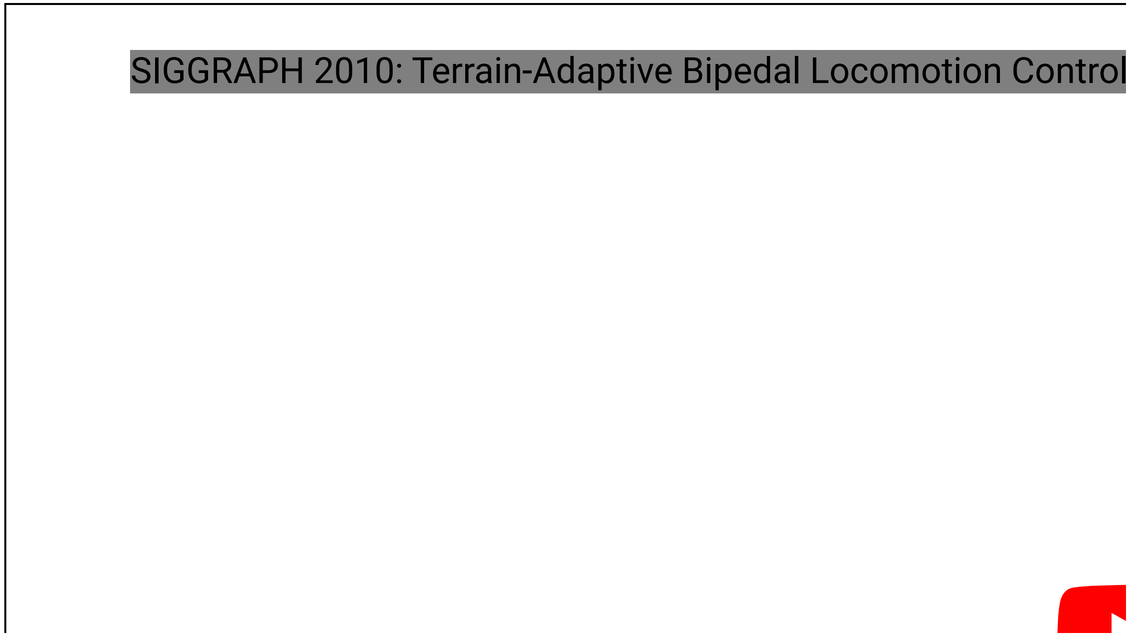
Example human rig

WALKING, SQUIRMING, AND SWIMMING

Procedural animation: instead of manually defining each keyframe of the animation (for hundreds of bones!), we can try to programmatically generate animations!

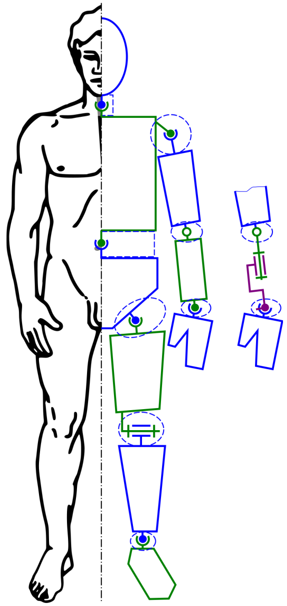
WALKING, SQUIRMING, AND SWIMMING

Evolution of biped animation (2010): planner with fine-grained control to take as input terrain, and plan trajectory, foot swings and positions, joint motions...



WALKING, SQUIRMING, AND SWIMMING

Inverse kinematics (IK): mathematical procedure to calculate joint parameters in a kinematic chain from the end desired position



Human kinematic chain (image from Wikipedia)

WALKING, SQUIRMING, AND SWIMMING

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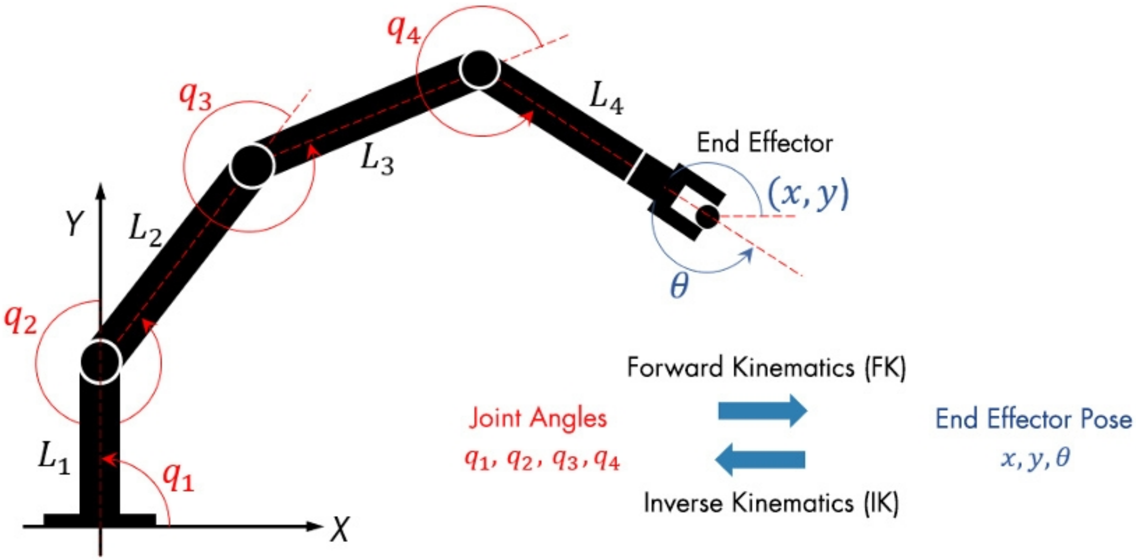
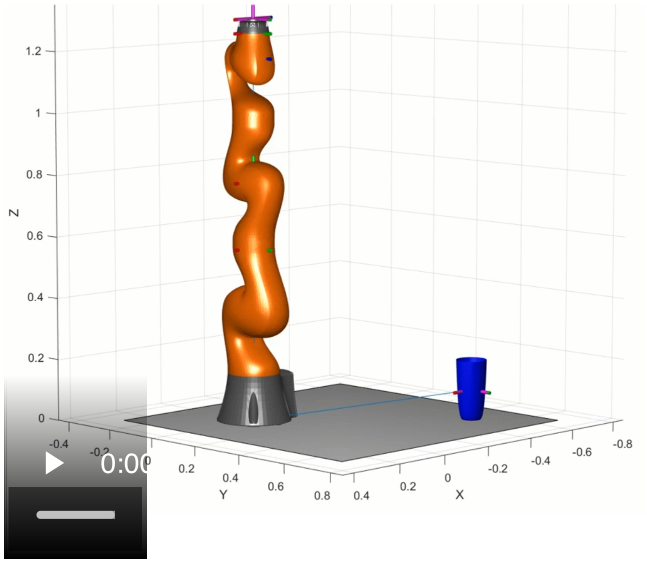


Inverse kinematics of robot arm (image from Mathworks)

WALKING, SQUIRMING, AND SWIMMING

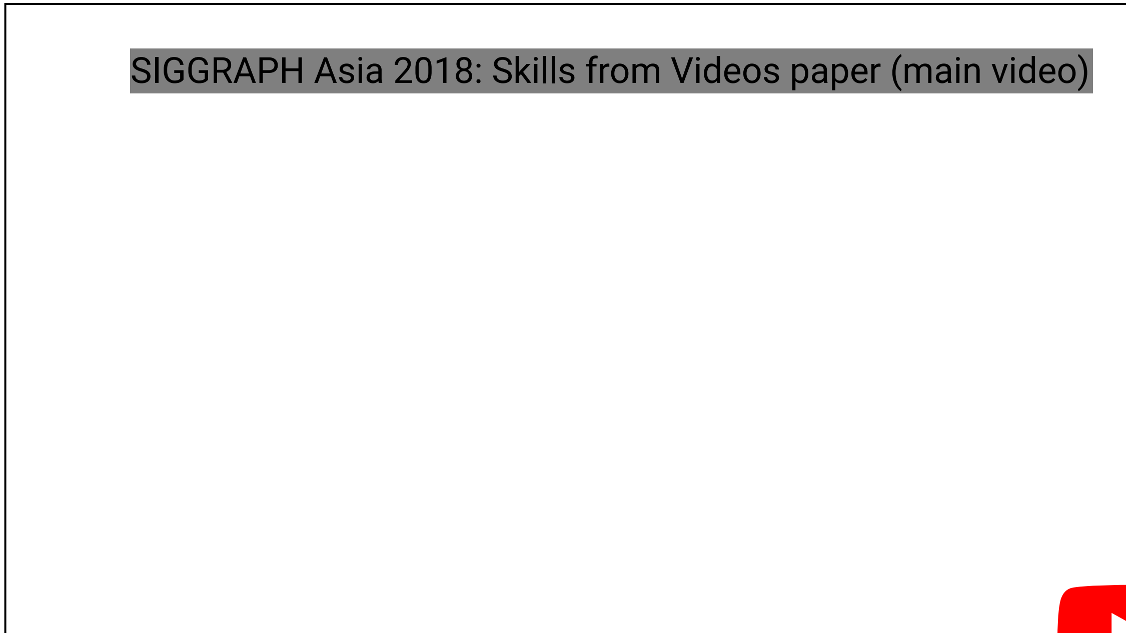
Inverse kinematics (IK): mathematical procedure to calculate joint parameters in a kinematic chain from the end desired position



Inverse kinematics of robot arm (video from Mathworks)

WALKING, SQUIRMING, AND SWIMMING

Evolution of biped animation (2018): pose extraction from videos, and then using deep reinforcement learning, learn animations and allow retargeting



WALKING, SQUIRMING, AND SWIMMING

Karl Sims, Evolving virtual creatures (1994): swimming, "walking" and grabbing

- Goal to create virtual creatures that move in 3D physical worlds
- Genetic language for representing primitive elements as directed graphs
- Various complex locomotion strategies

WALKING, SQUIRMING, AND SWIMMING

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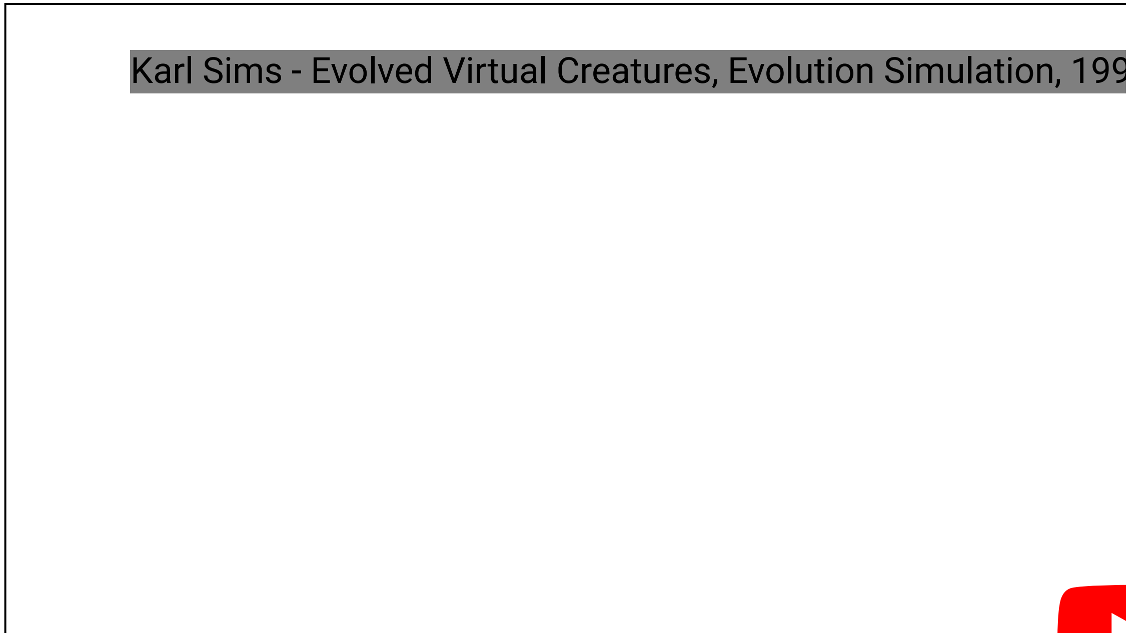

TD2: BLENDER SCRIPTING AND ANIMATION DEMO