

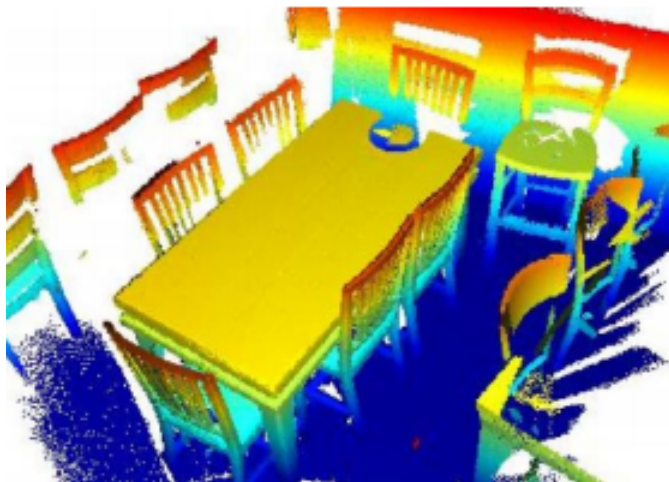
Digital Geometry -Motivations

Junjie Cao @ DLUT

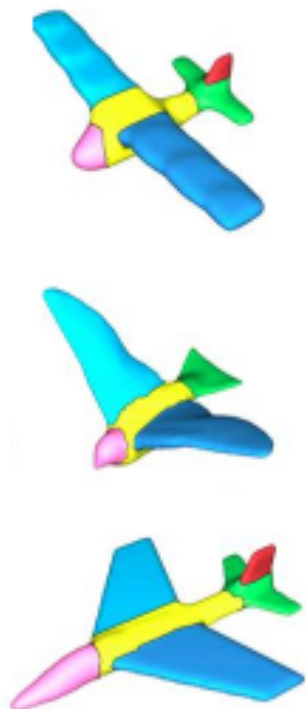
Spring 2019

<http://jjcao.github.io/DigitalGeometry/>

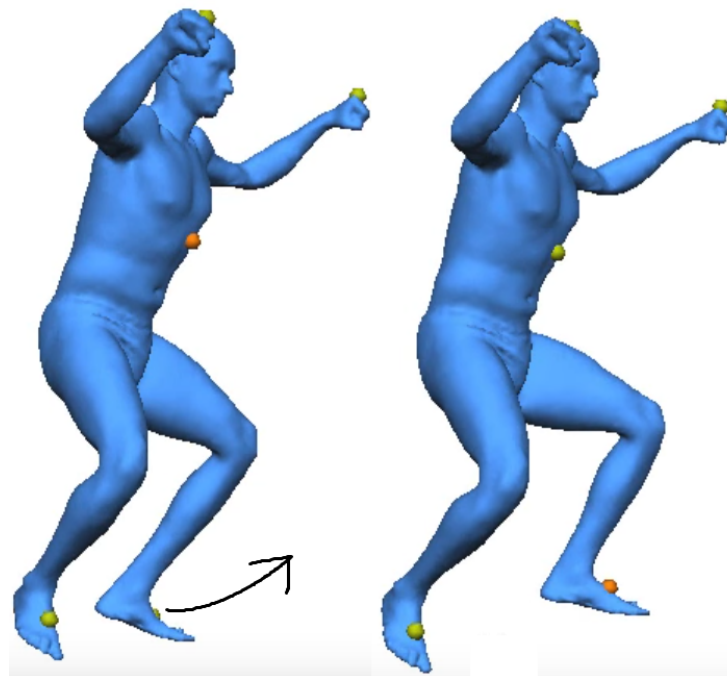
Pleasure may come from illusion, but happiness can come only of reality.



Reconstruction



Analysis



Manipulation/Editing



Synthesis

Geometric Digital Modeling

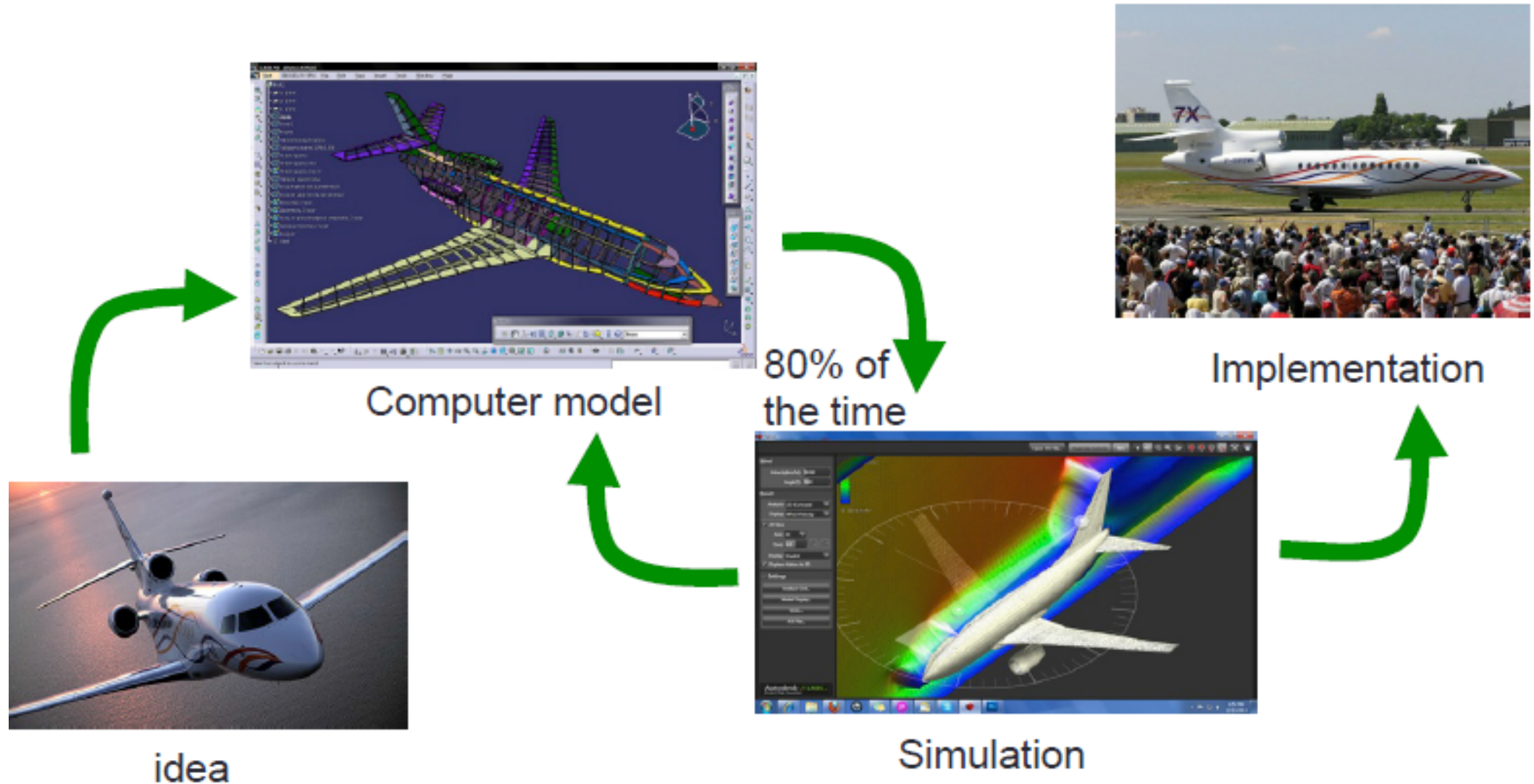
- ✓ Geometric objects in the world are digitally modeled (representation) for
 - ✓ easy manipulation
 - ✓ easy repairing
 - ✓ easy comparison
 - ✓ easy synthesis
 - ✓ cheaper simulation

Digitally modeled
(designed on a computer)

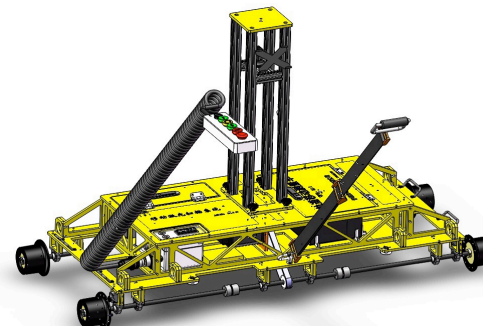
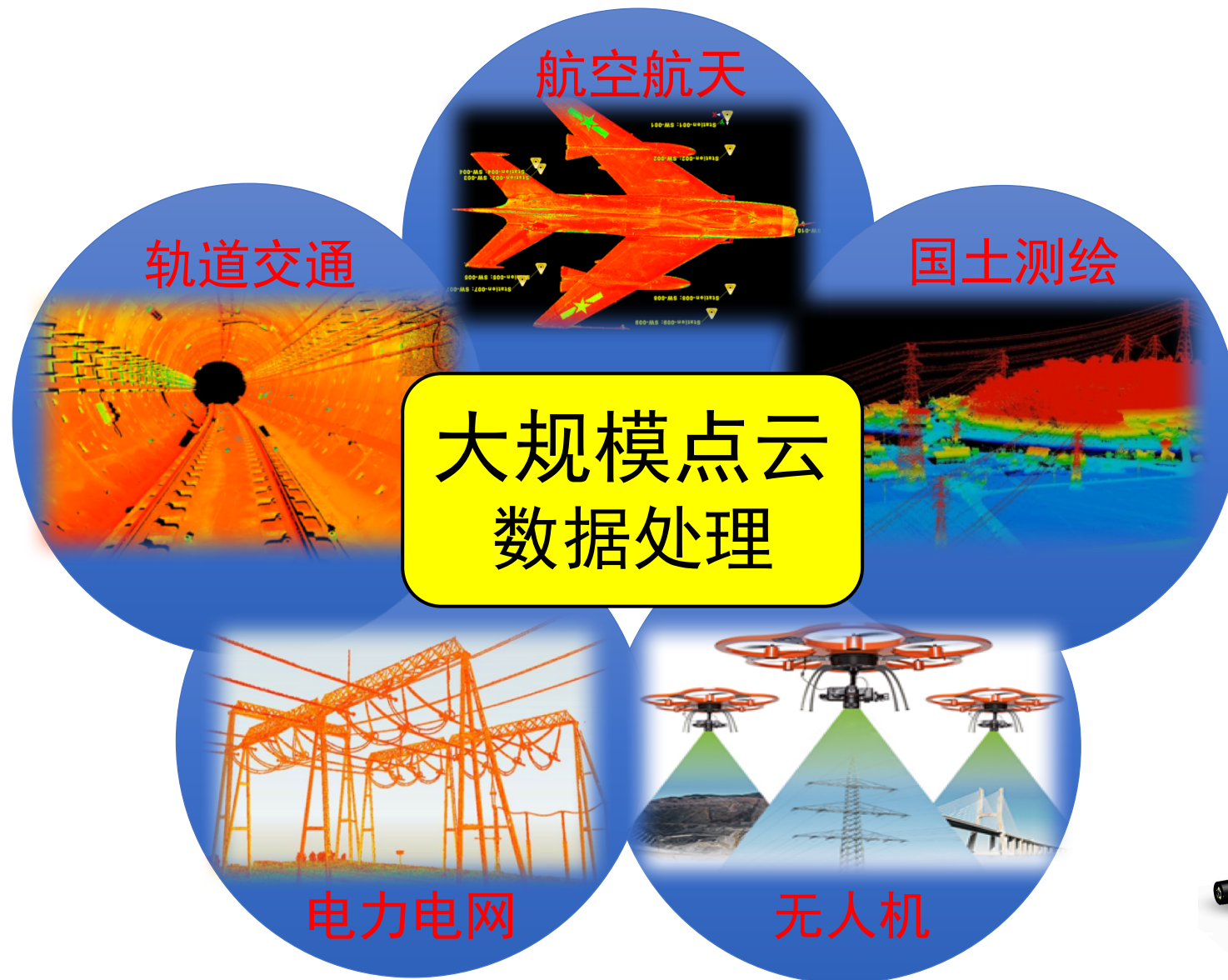


Digital Models

- ✓ Geometric objects in the world are digitally modeled (representation).



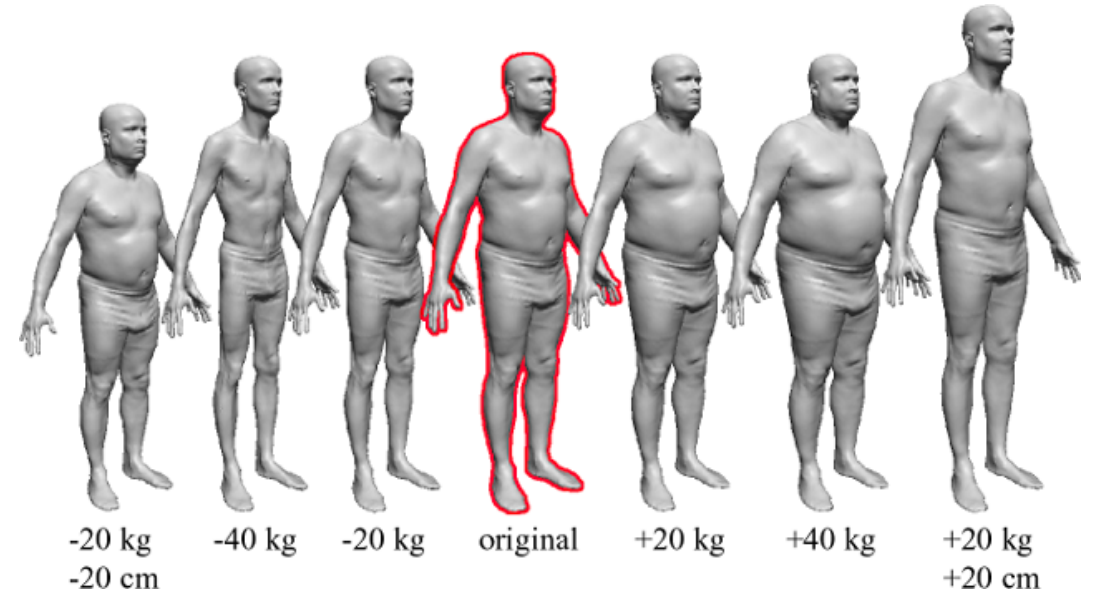
Detection and Analysis



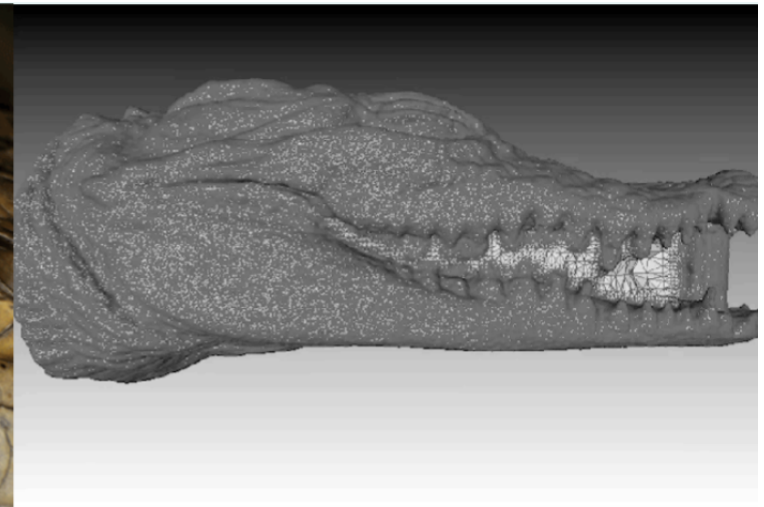
Impacting Science

Digital Models

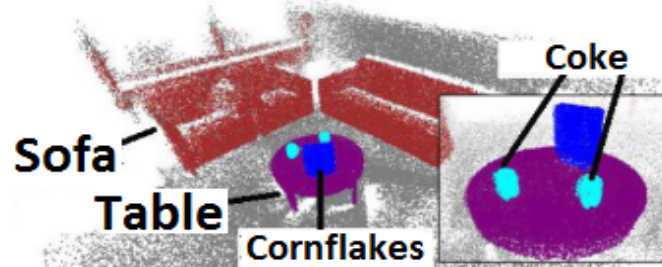
- medicine, esthetics



- Evolutionary Biology



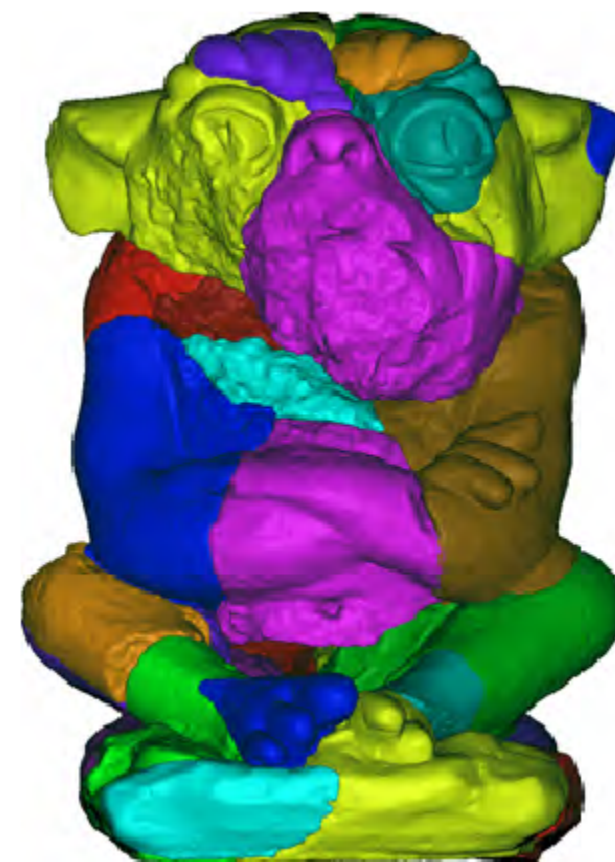
- Robotics, autonomous driving



Computational archaeology



Eg14_Content-Aware Surface Parameterization for Interactive Restoration of Historical Documents



Reassembling a gargoyle statue: photo (bottom left) and 3D models (top left) of the fragments, final assembly (right).

Multi-View Stereo

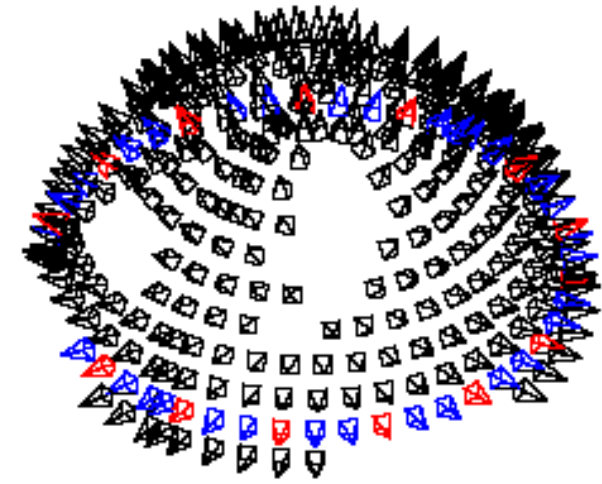
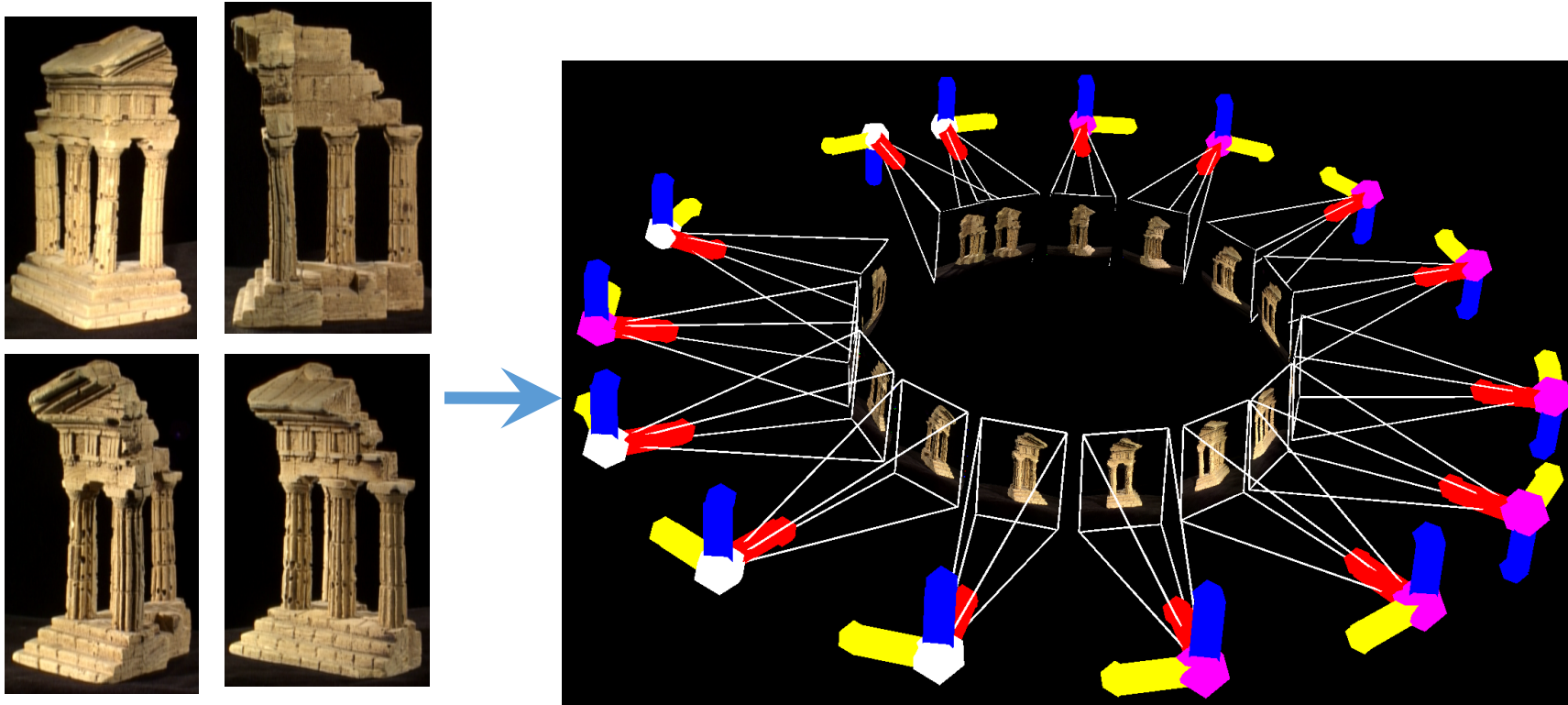
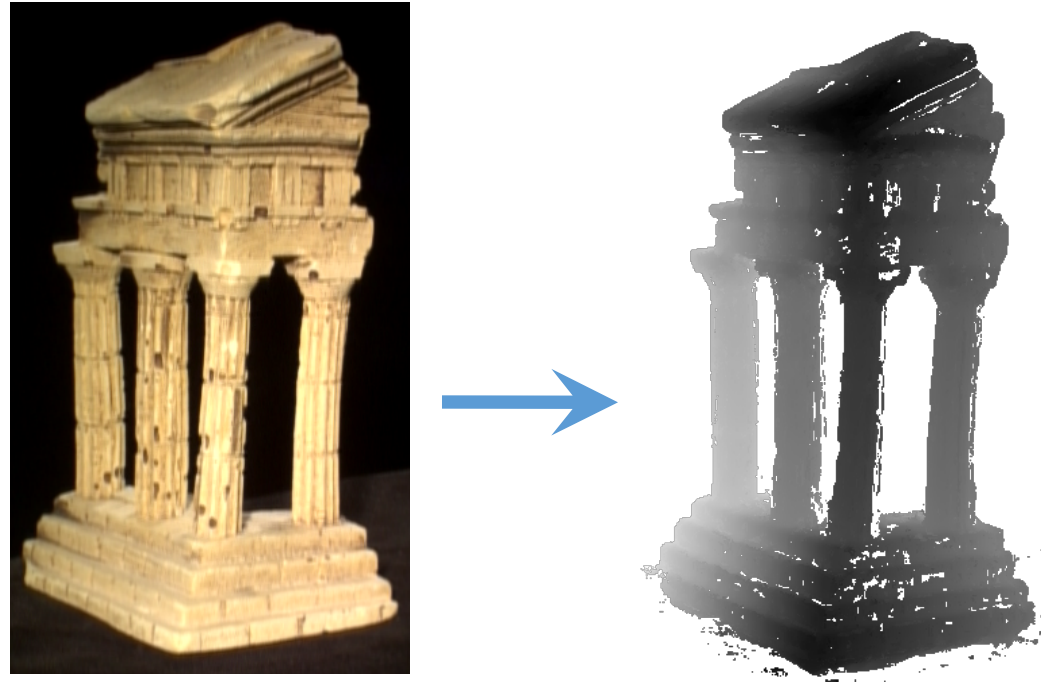


Image Calibration



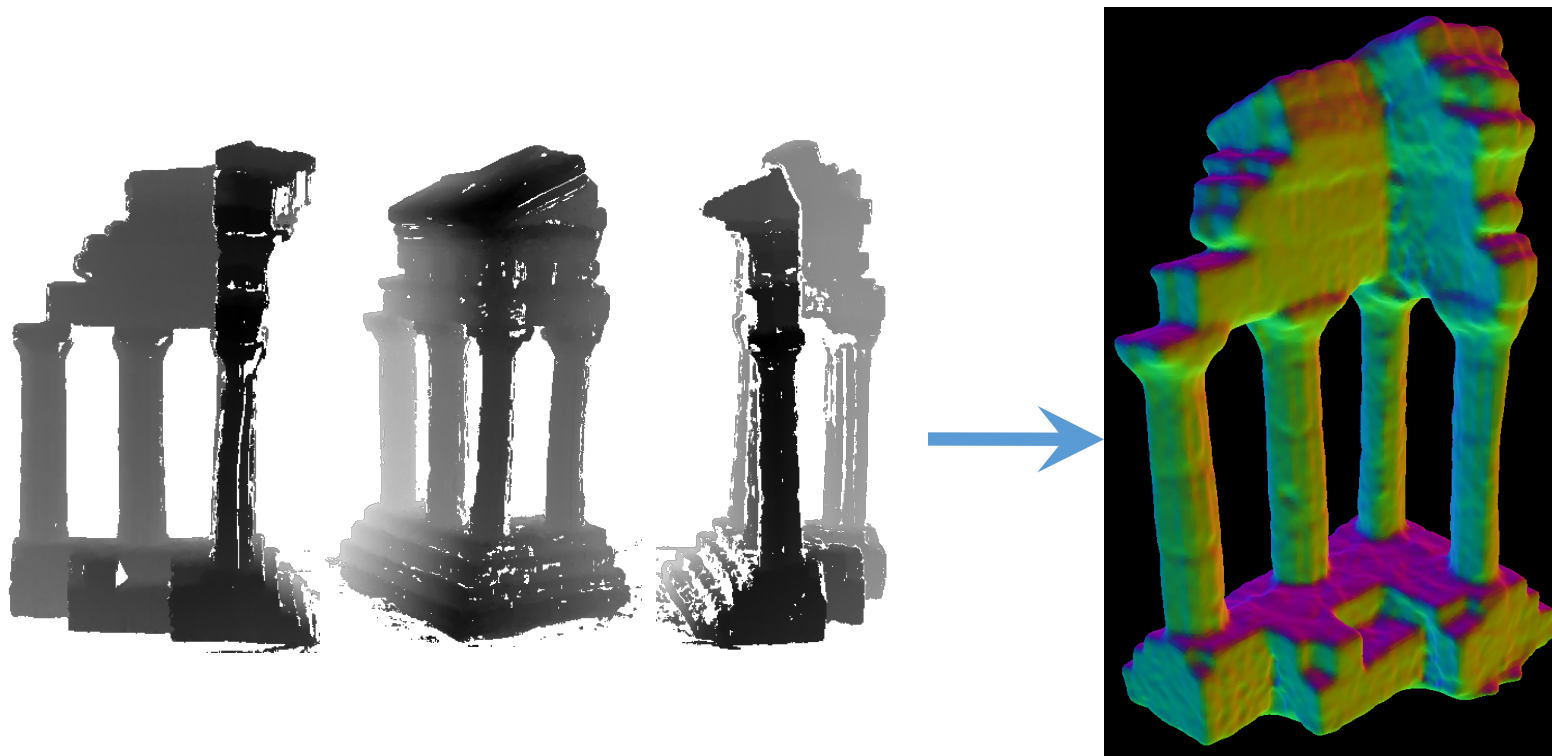
- Input: set of pictures
- Output: camera position, orientation, intrinsic parameters (focal length, optical center)

Depth Map Construction



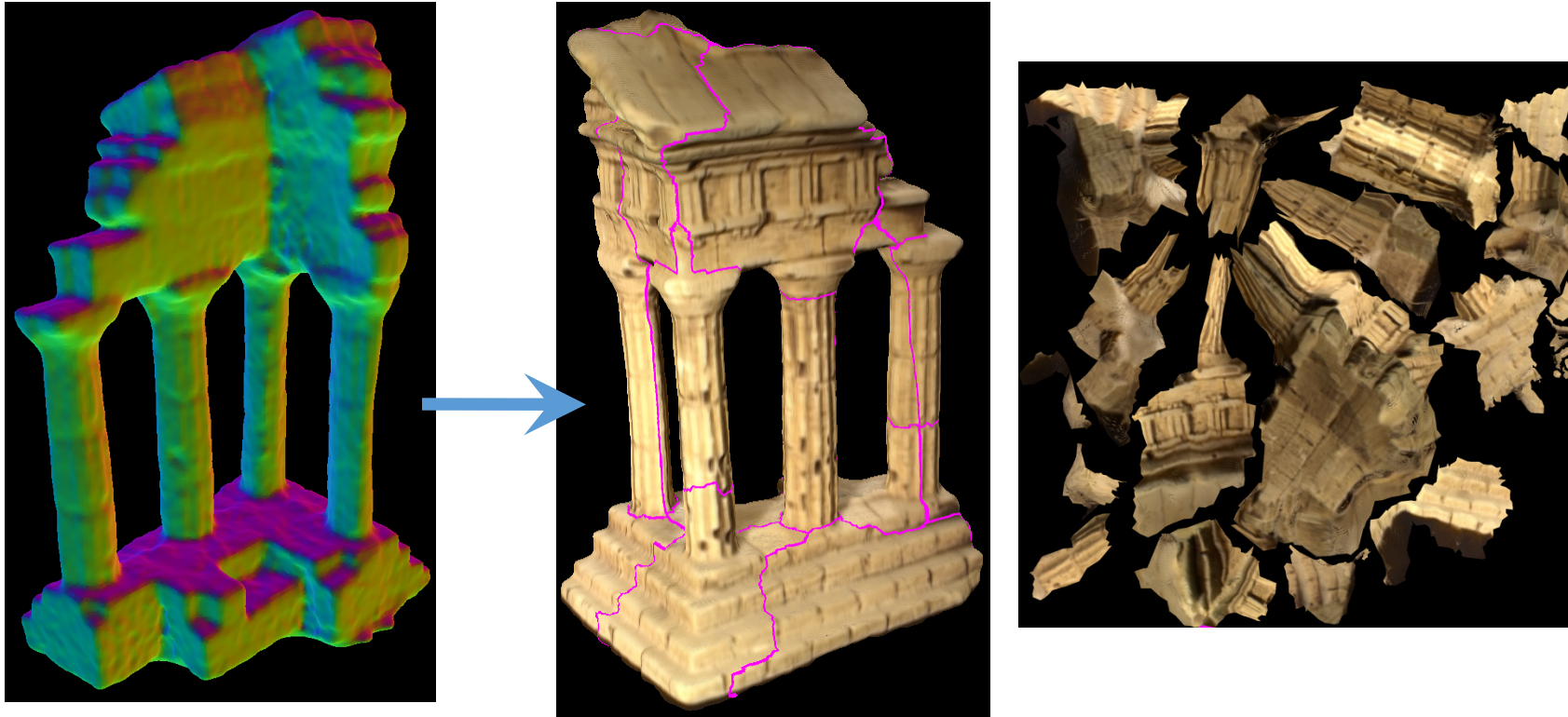
- Input: set of calibrated images
- Output: distance to object for each pixel in the image

Mesh Registration & Reconstruction



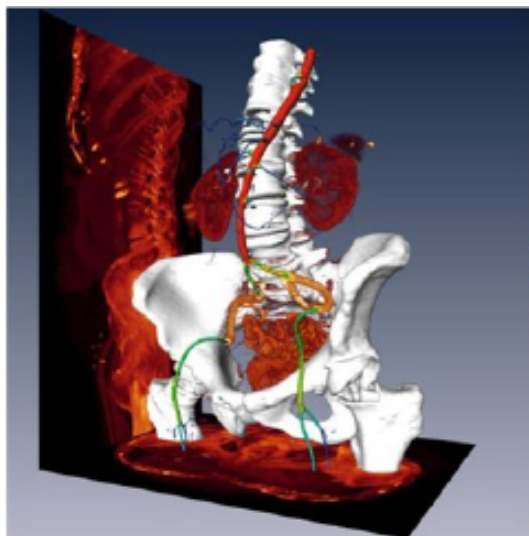
- Input: set of calibrated images & depth maps
- Output: mesh of object

Texture Generation

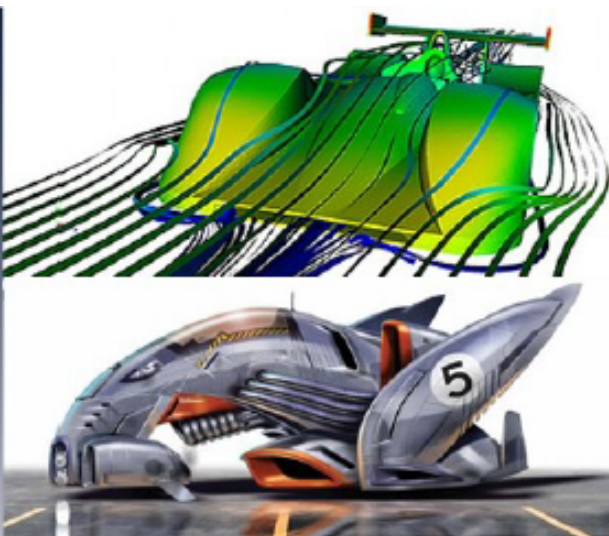


- Input: set of calibrated images and mesh of object
- Output: atlas and texture

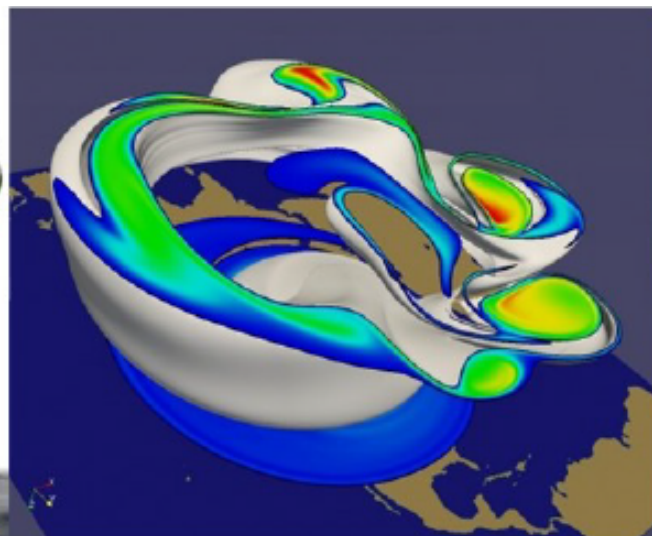
Applications



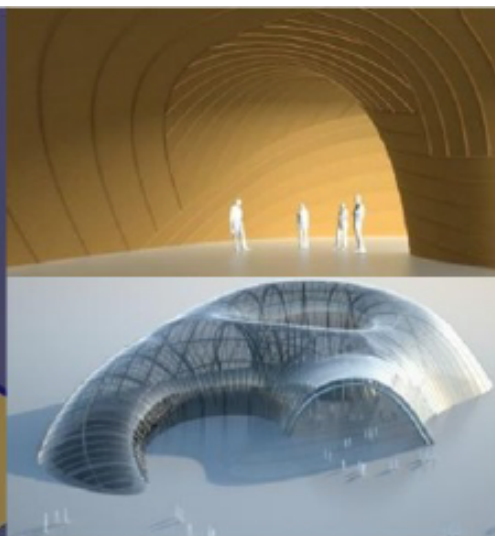
(a) 数字医疗



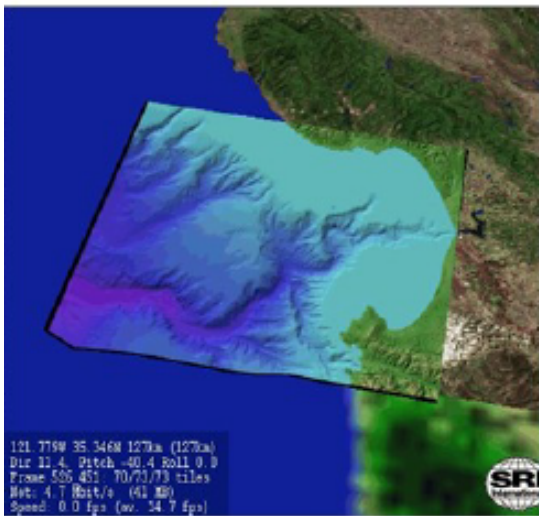
(b) 汽车设计



(c) 大气模拟



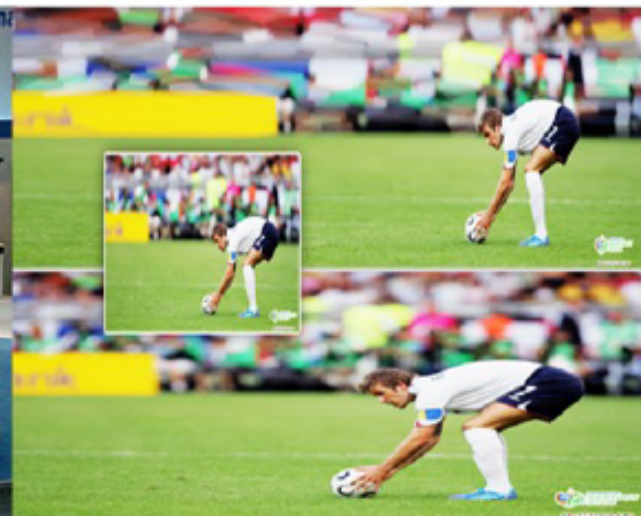
(d) 建筑设计



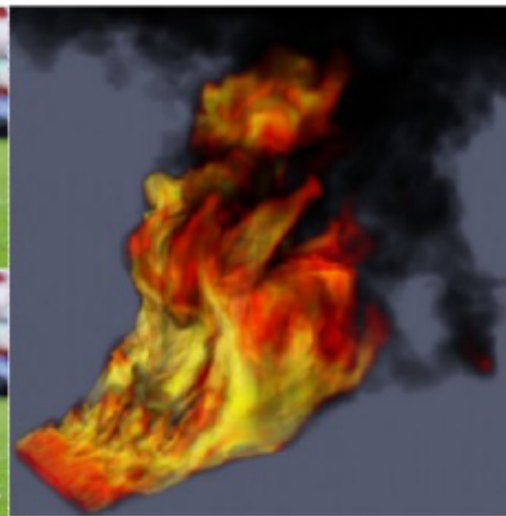
(e) 地形分析



(f) 虚拟现实



(g) 影视娱乐



(h) 虚拟科学实验

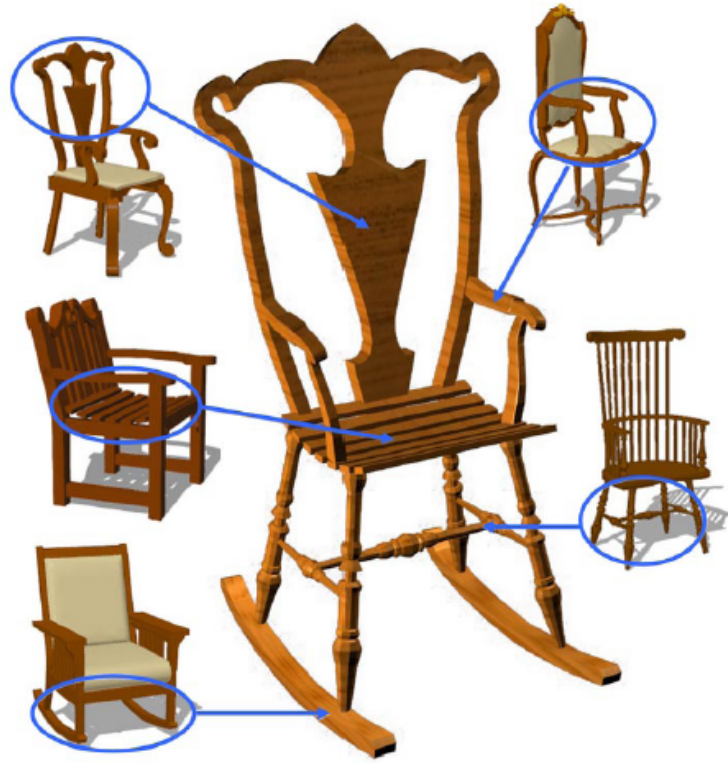
What is graphics?

- **Creation**, display, storage, and animation of visual content

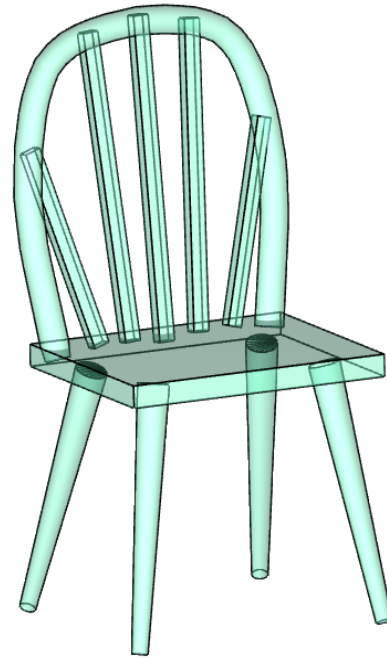
First step, perhaps least well known: content creation



3D Content Creation

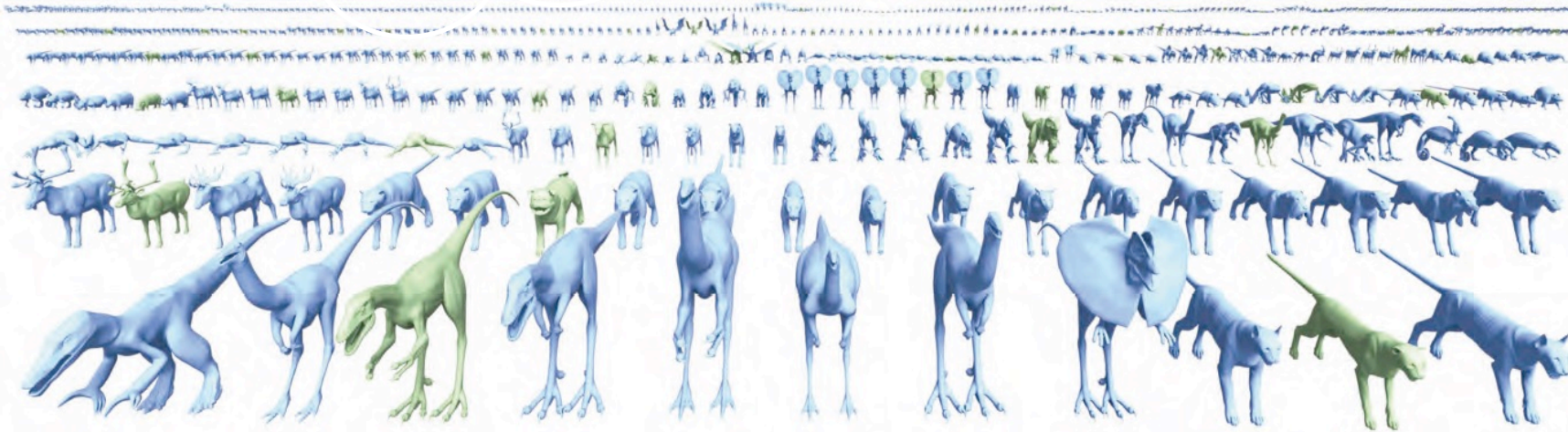
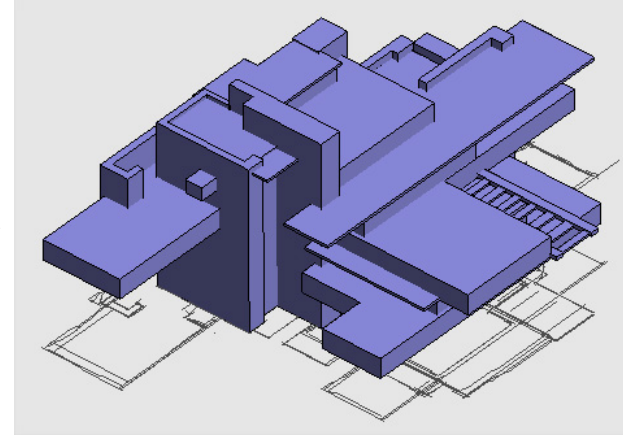
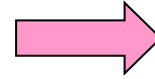
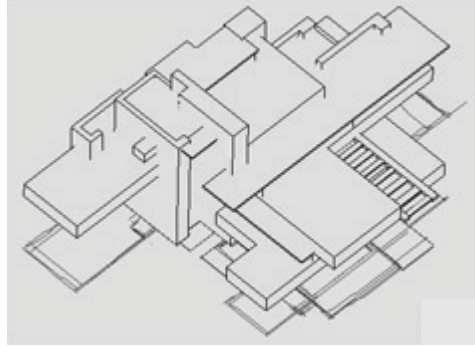


Modeling via **part re-assembly**
[Funkhouser et al., SIG 2004]



Warping to photo [Xu et al., SIG 2011]

3D Content Creation

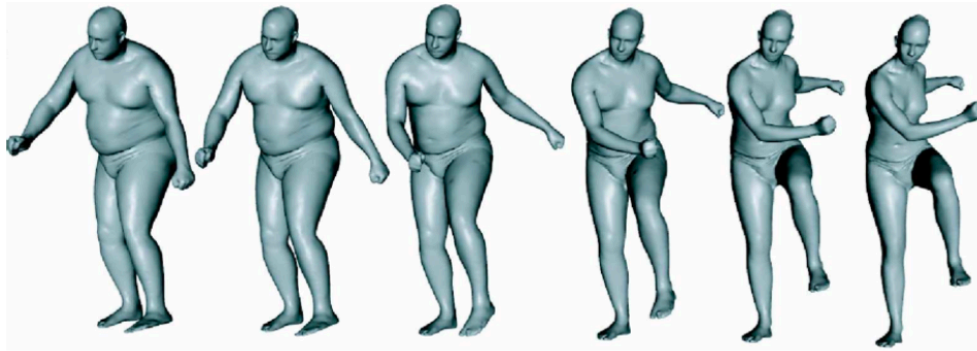


sig12_A Probabilistic Model for Component-Based Shape Synthesis

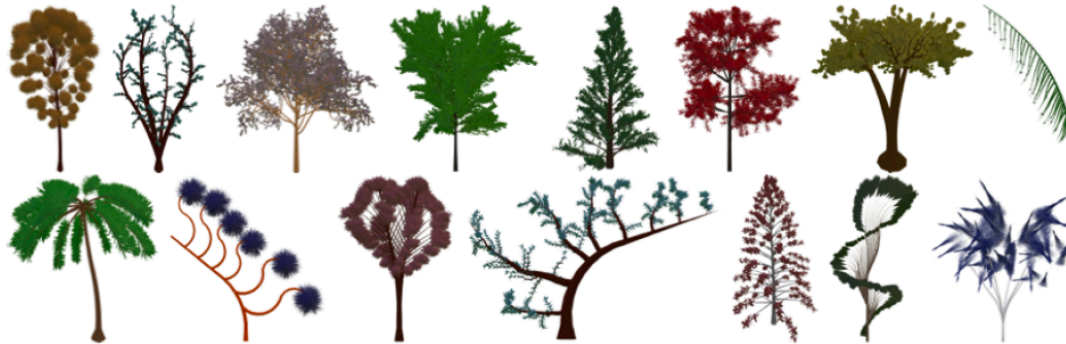


sig12_Fit and Diverse-Set Evolution for Inspiring 3D Shape Galleries

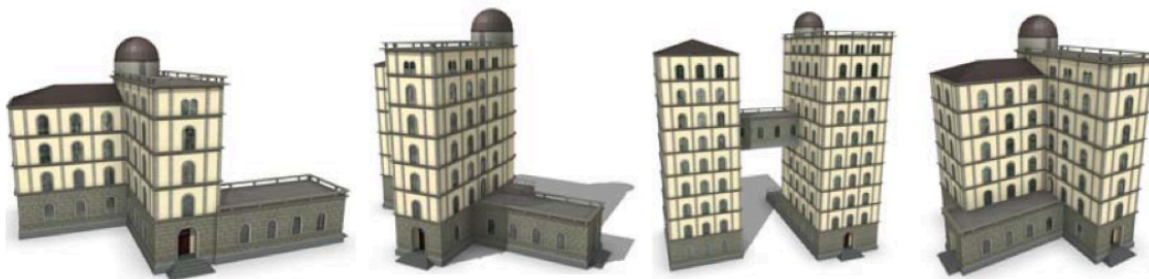
Statistical Shape Models



Template



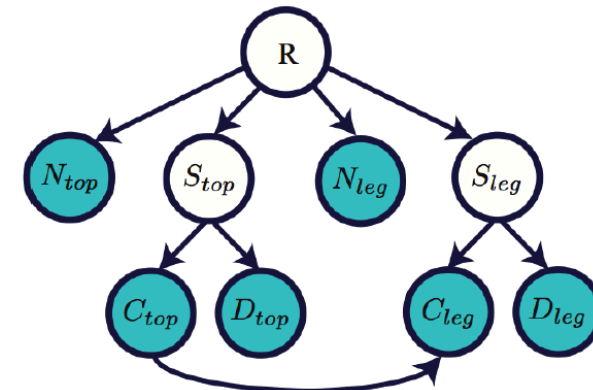
Procedure



Grammar



Exemplars



Probabilistic Graphical Model

High-level shape understanding

- Structure, function, semantics, attributes, materials,
- human and environmental impact, local context,
- manufacturability, sustainability, cost...



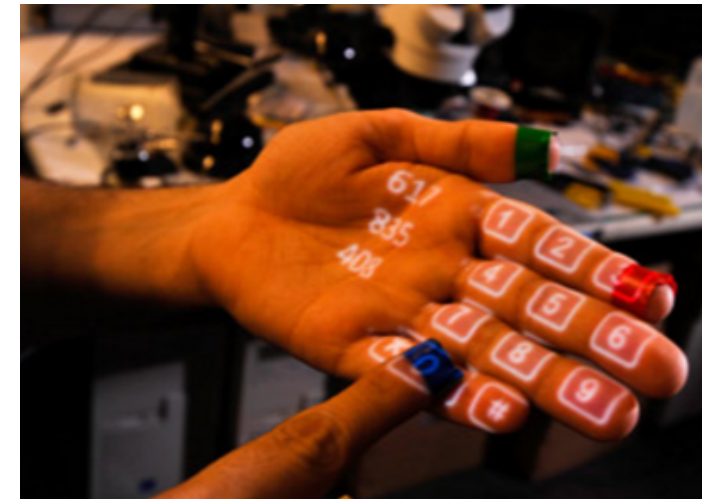
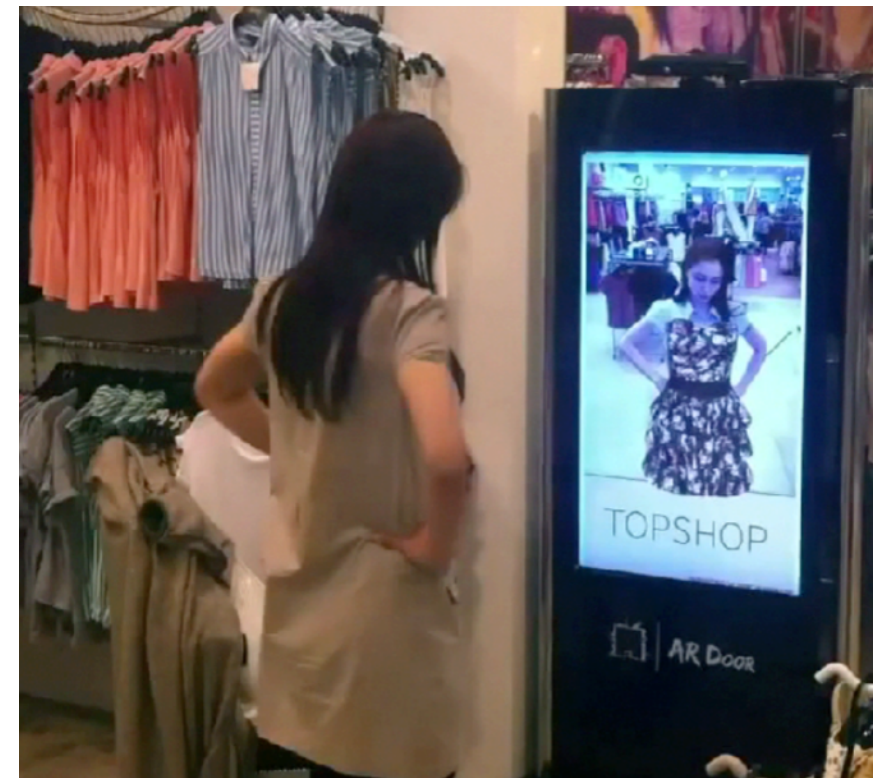
Evolutionary Design



Karl Sims, “Evolved Virtual Creatures”, SIGGRAPH 1994, https://youtu.be/JBgG_VSP7f8

Digitized Future

Webcam Social Shopper: the virtual dressing room



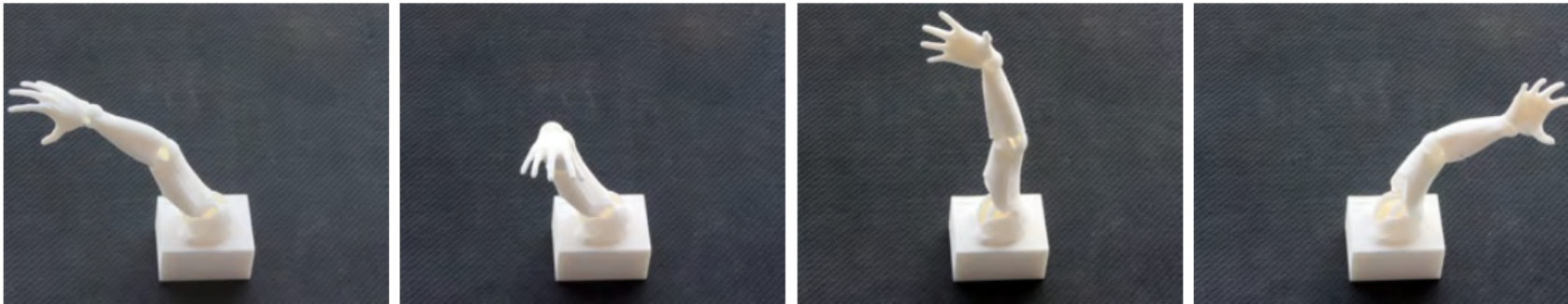
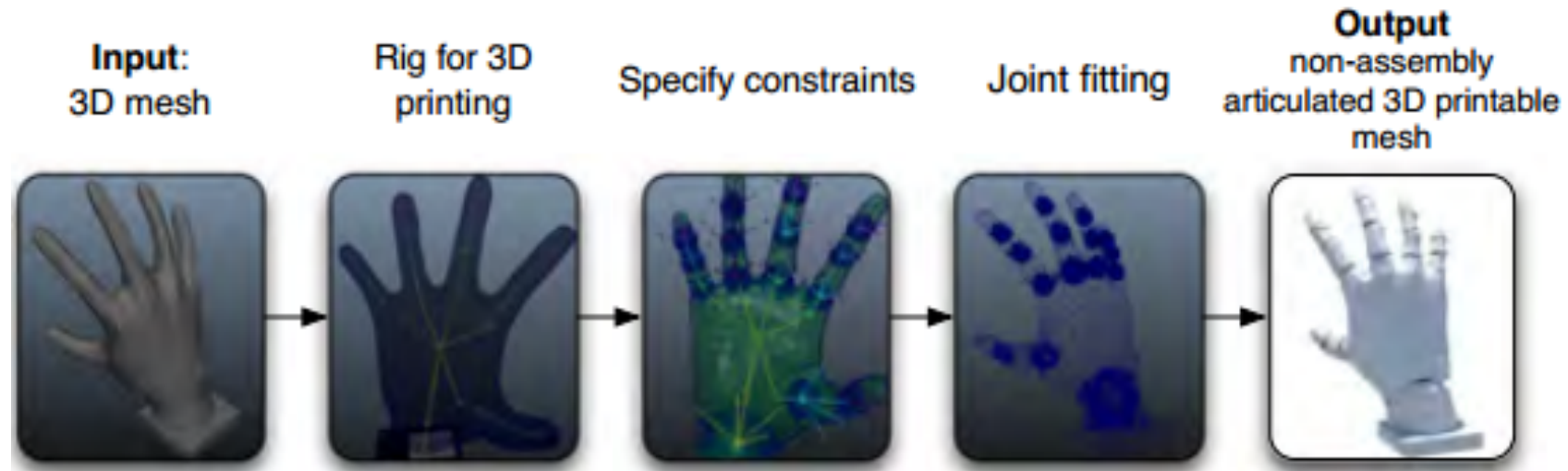
In laptops, tablets, smartphones



From Capture to Fabrication



Siga12_3D-Printing of Non-Assembly, Articulated Models



Real-time Future

Why Realtime?



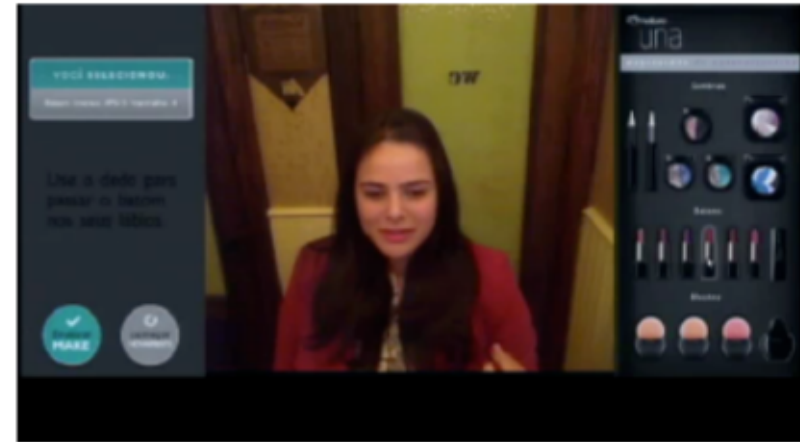
VFX/Game Production



Virtual Avatars



Robotics



AR/Virtual Mirror

Realtime Facial Performance capture



Siga10_A Practical Appearance Model for Dynamic Facial Color



Geometry, motion, 2D or 3D texture

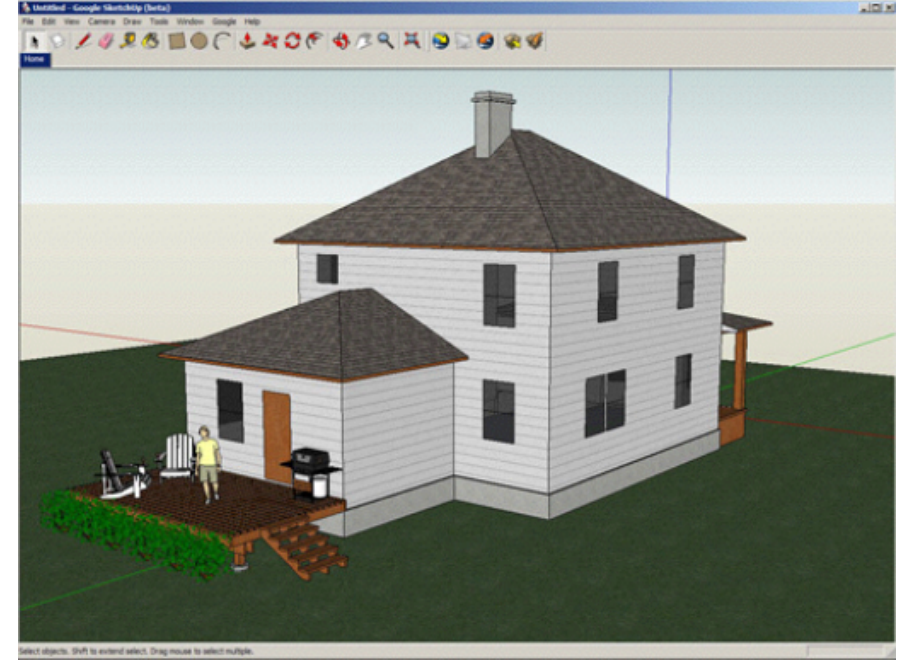
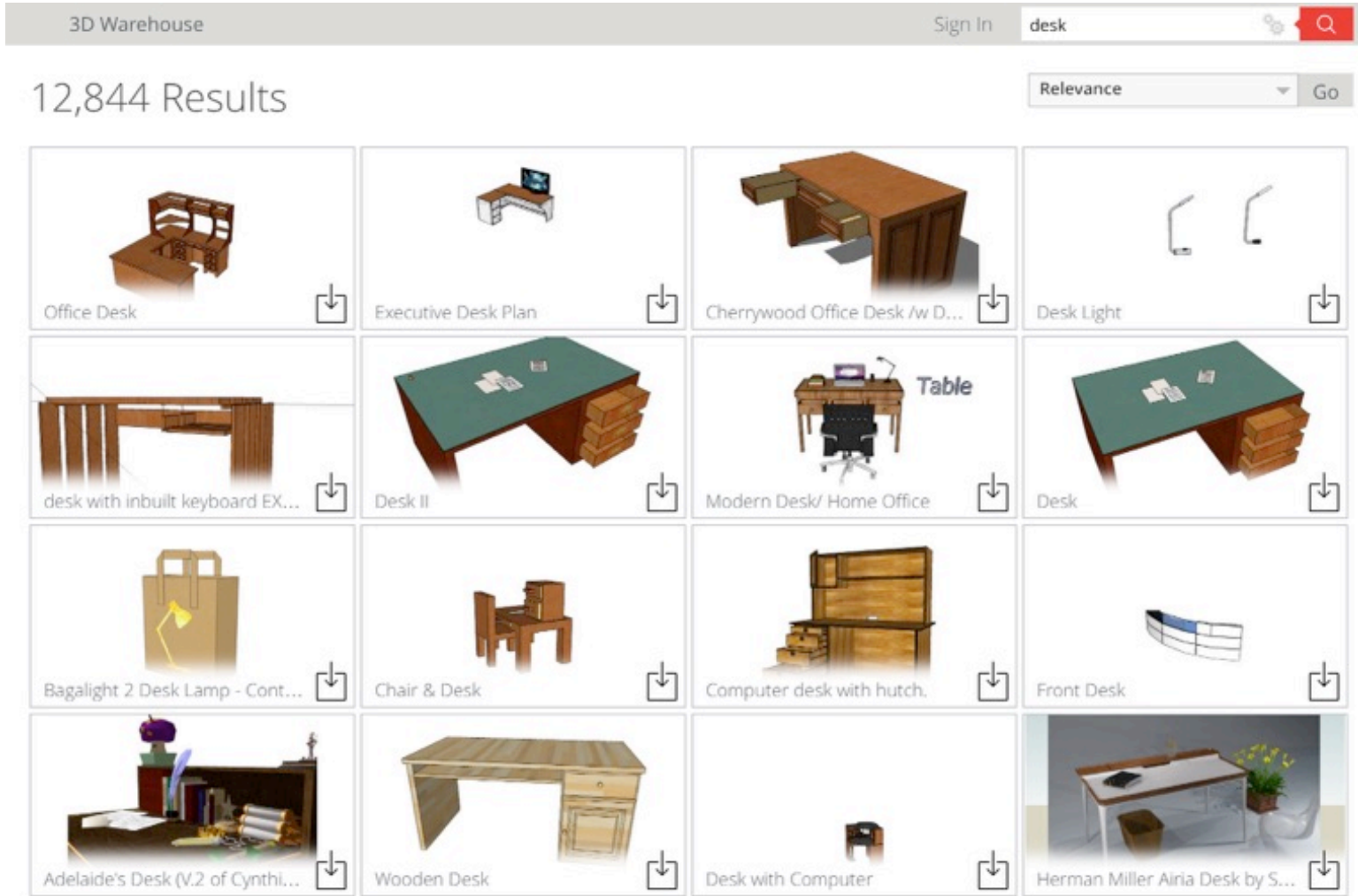
Realtime Facial Animation



Snappers Facial Rig for Maya (also available for 3dsMax) by snappers mocaps

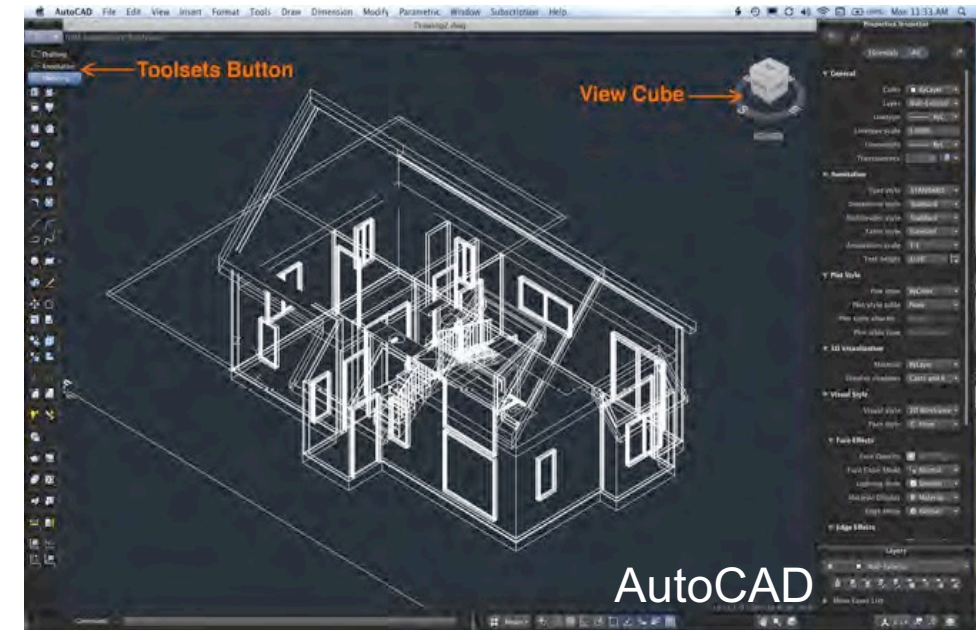
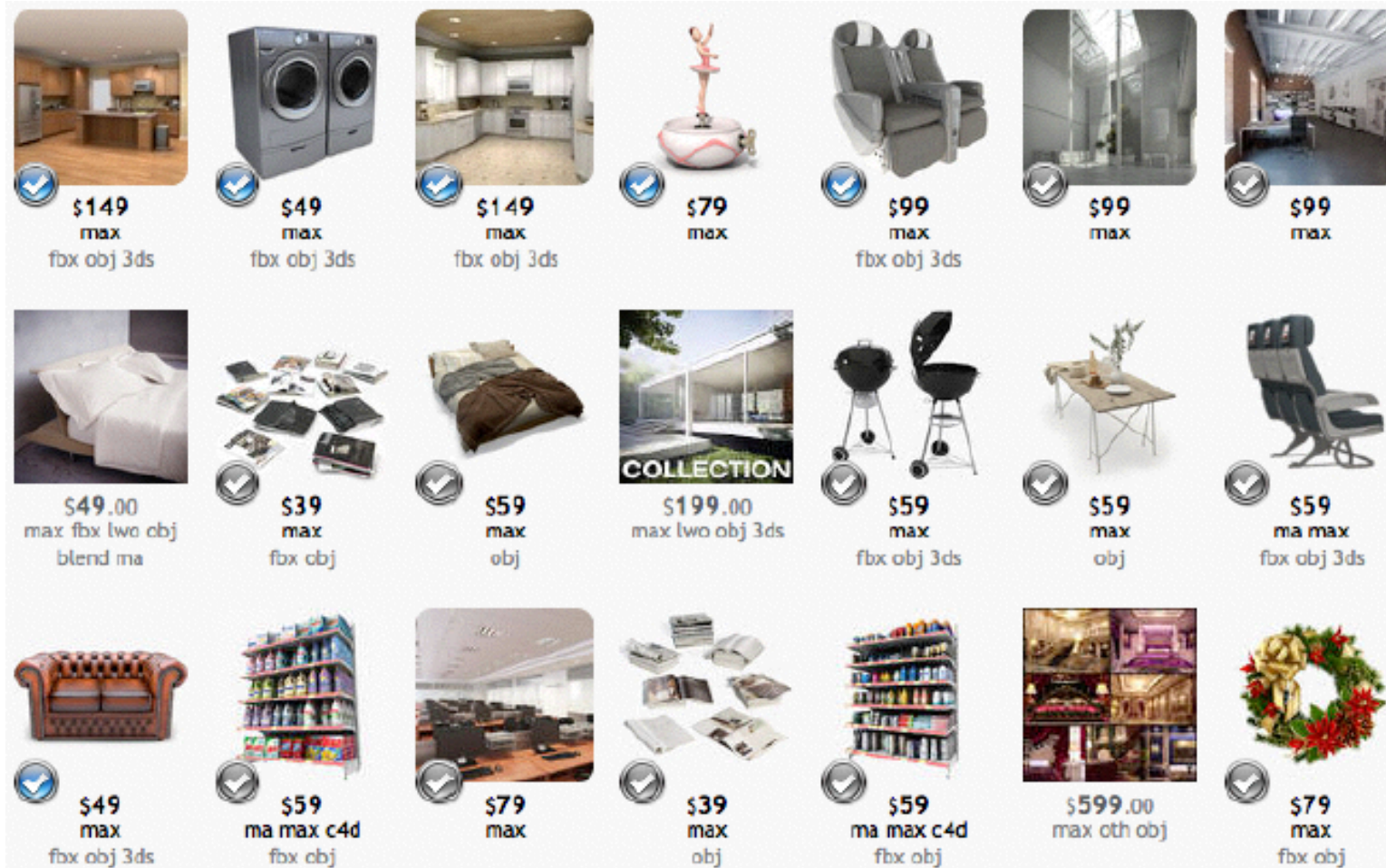
Big data

Large and growing repositories of 3D Models



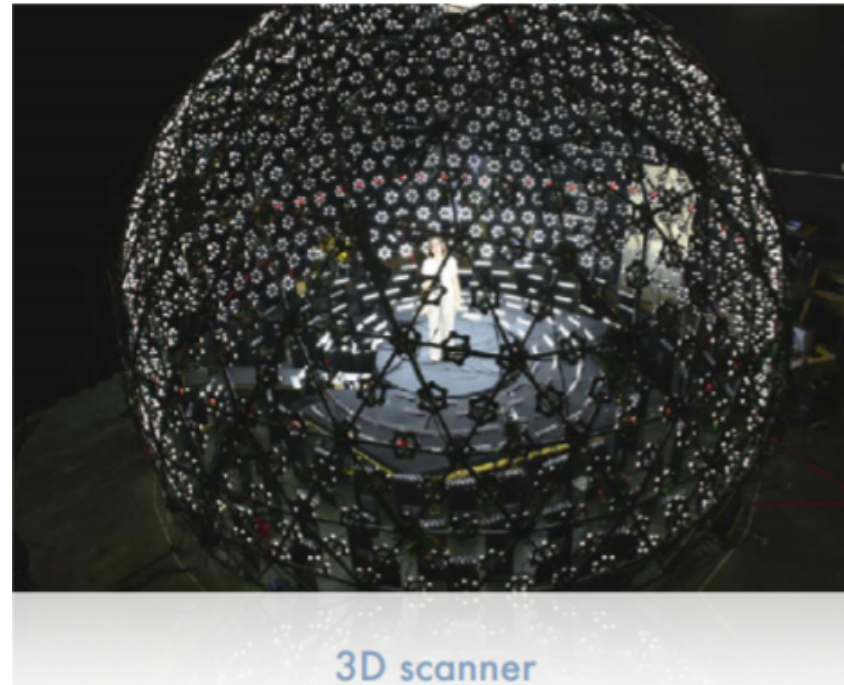
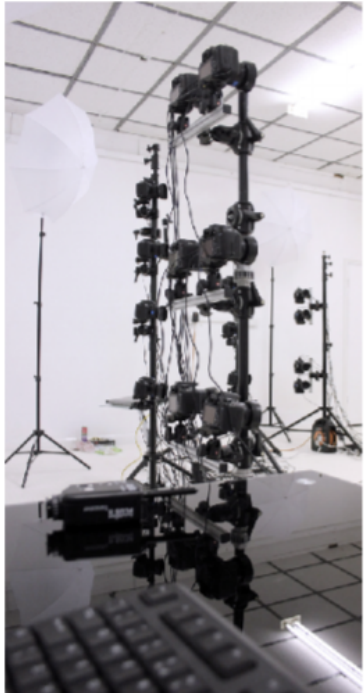
Trimble 3D Warehouse
powered by Google

Large and growing repositories of 3D Models





Large and growing repositories of 3D Models



3D acquisition

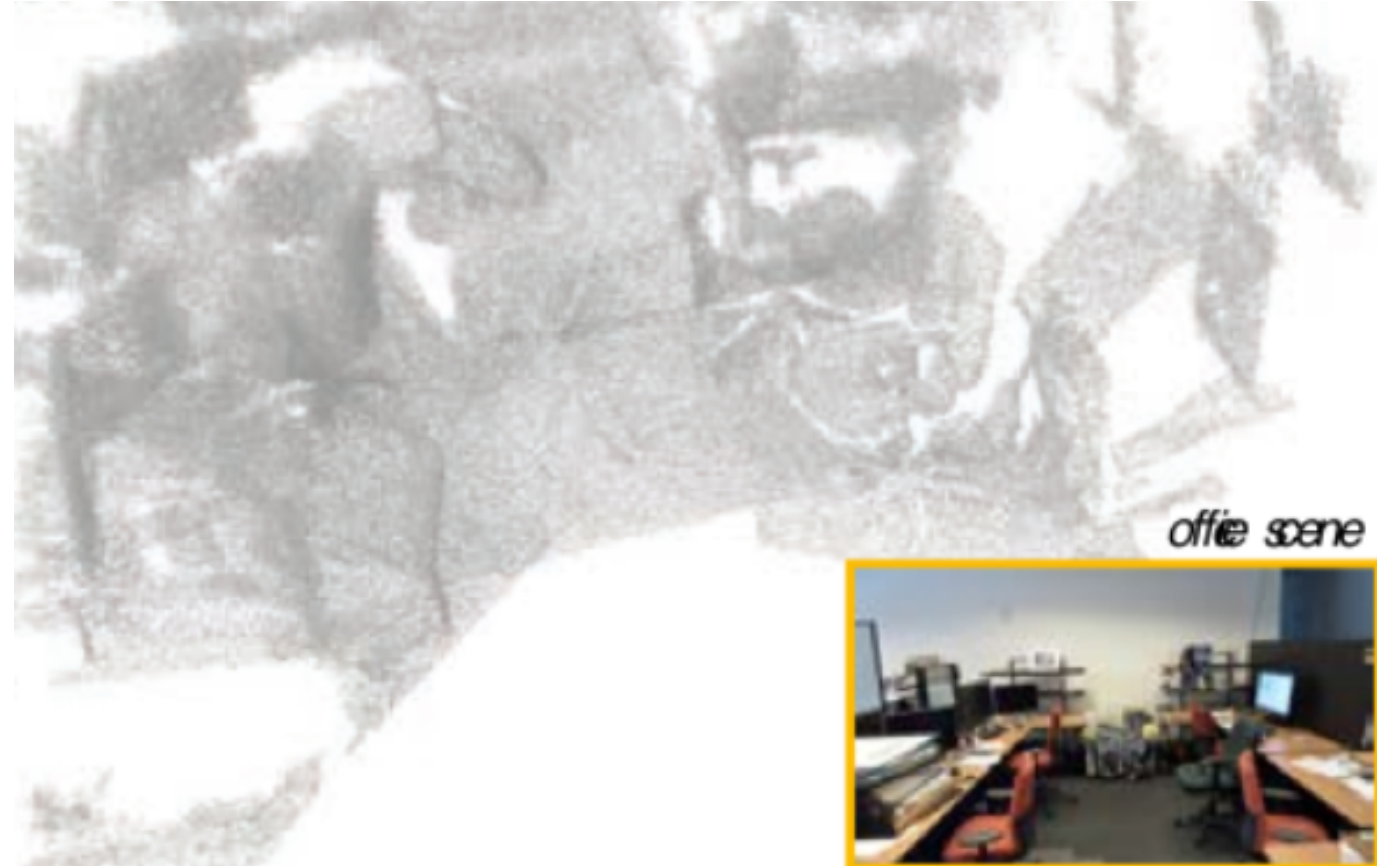
Large and growing repositories of 3D Models



Large and growing repositories of 3D Models



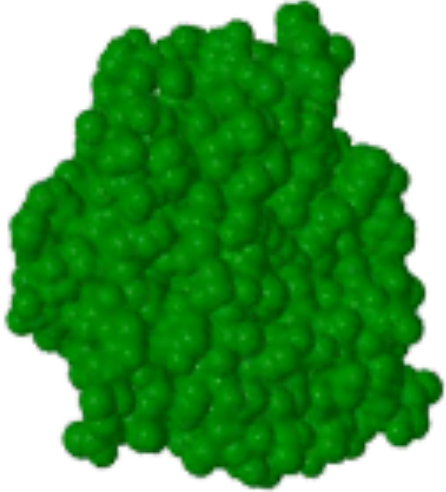
For Everyone



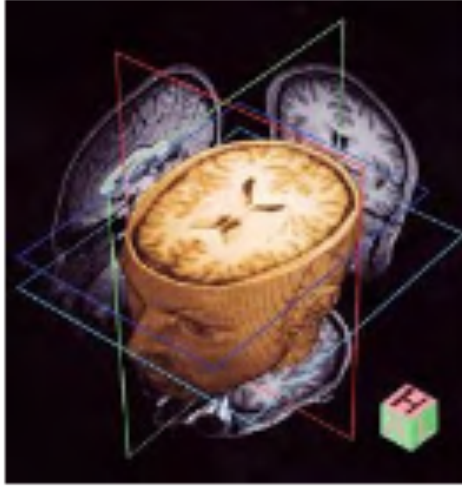
RGB-D data

Motivation

- **Lots** of geometric data in different domains!



Molecular Biology



Medicine



Engineering



Cultural Heritage



Paleontology



Computer Graphics



microscope



ultrasound



MRI scanner



x-ray diffractometer

Geometry

γεωμετρία



stereo camera



radio telescope



laser scanner



time-of-flight scanner

Digital models are useful because

- ✓ A digital model allows easy manipulation.
- ✓ Digital simulation is much cheaper.
- ✓ Model optimization and repair is possible.
- ✓ Comparison across models is easy.
- ✓ Creation of new models from other ones is easy.

References

- Yusuf Sahillioğlu, **CENG 789 – Digital Geometry Processing**