Quick Research Summary
Shape-Inspired Architectural Design

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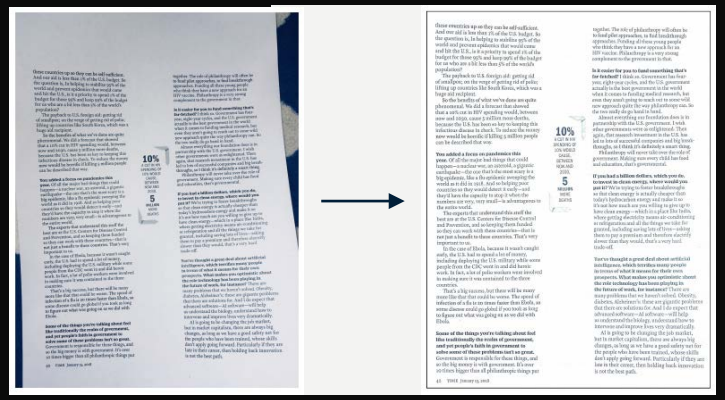
Research Topics

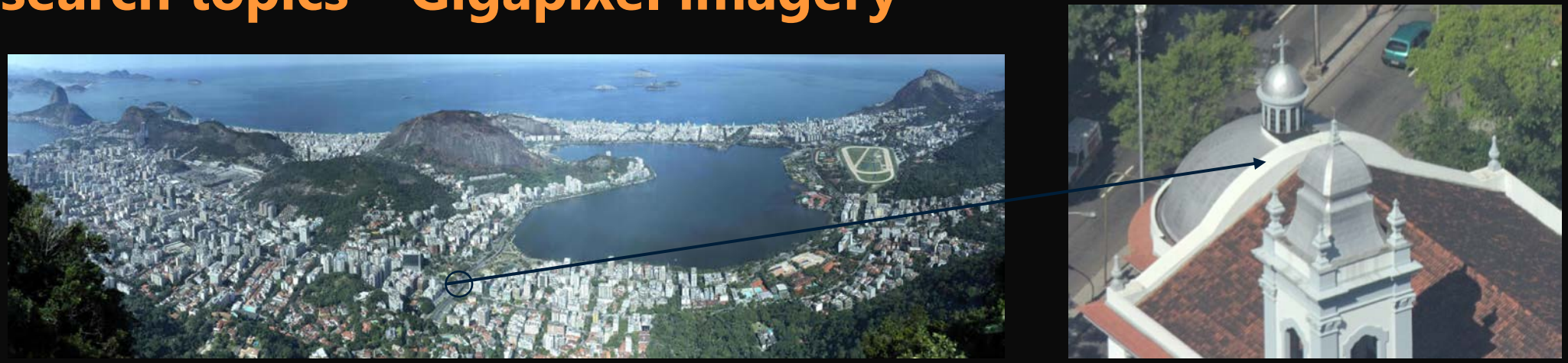
- Rendering optimization
  - *real-time shading algorithms, acceleration techniques*

- Geometry processing
  - *architectural design*

- Imaging
  - *document rectification, image colorization, morphing, gigapixel*



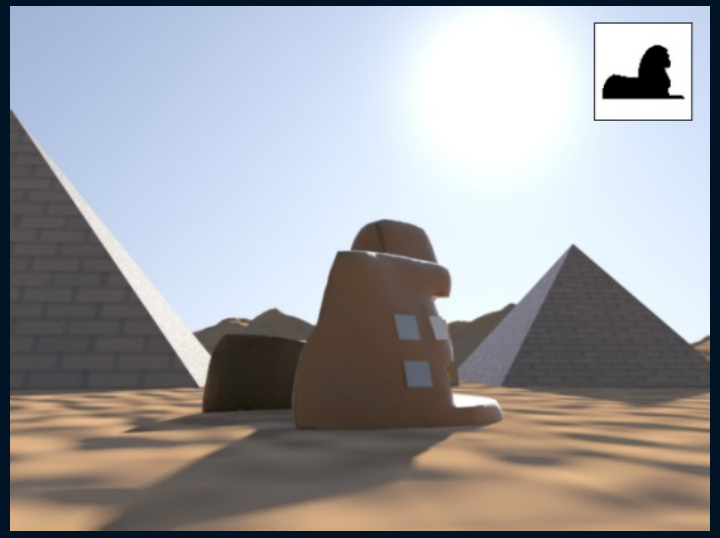
Research topics – Gigapixel imagery

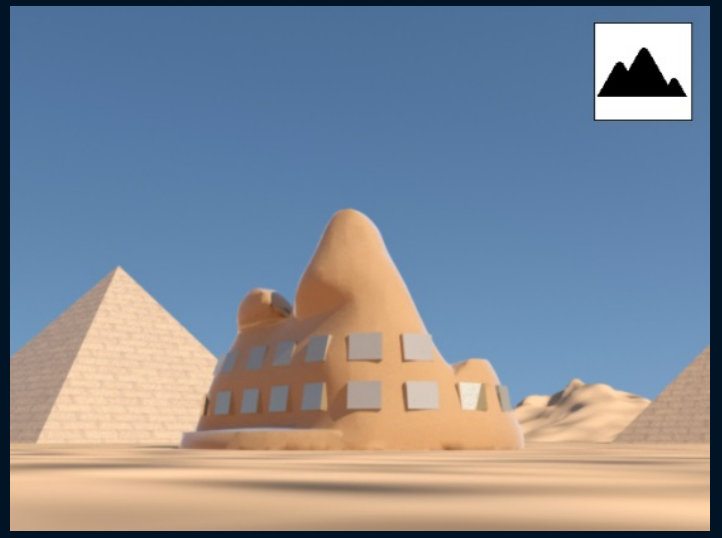


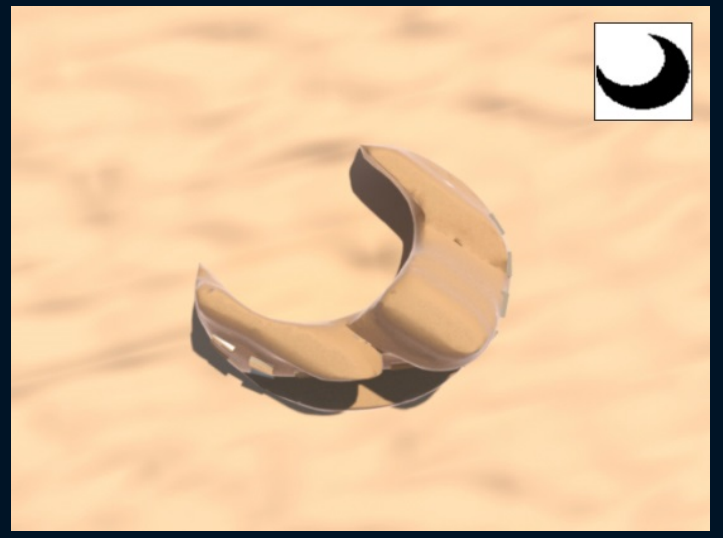
Corcovado 67GP image (former world's largest digital photograph)

Gigapixel video of HKUST

Shape Inspired Architectural Design







Architectural Design


Taipei 101

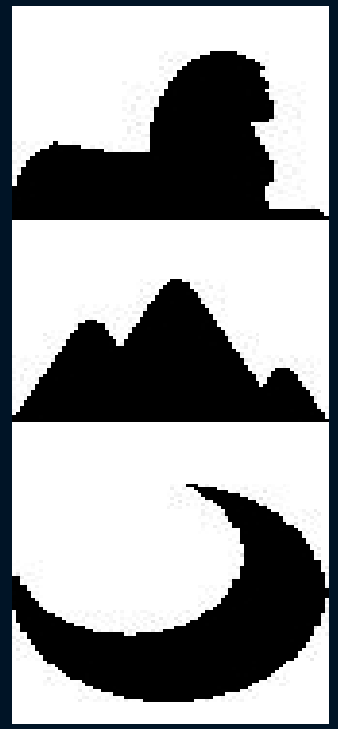

Heydar Aliyev Centre

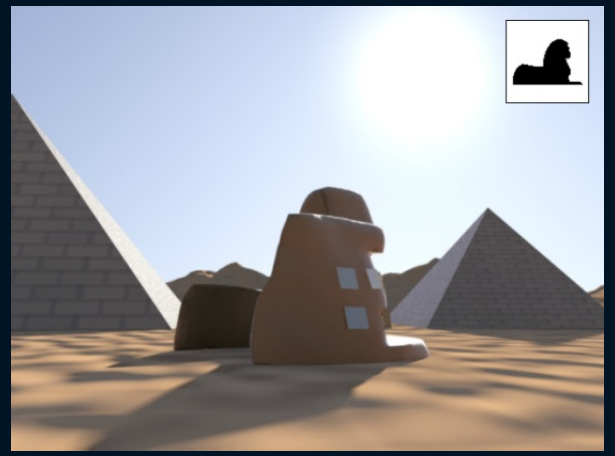

Burj Al Arab

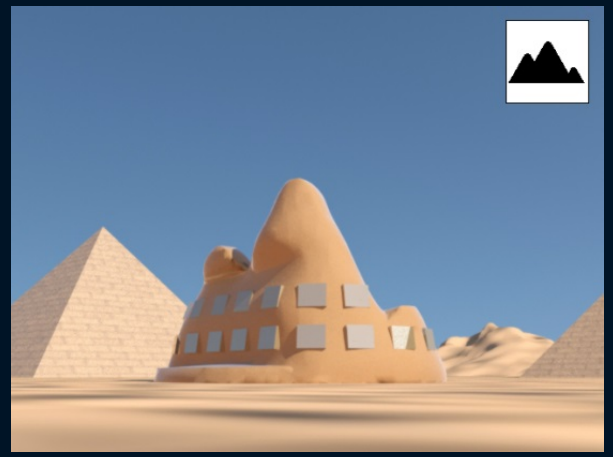

Olympic Pavilion in Barcelona

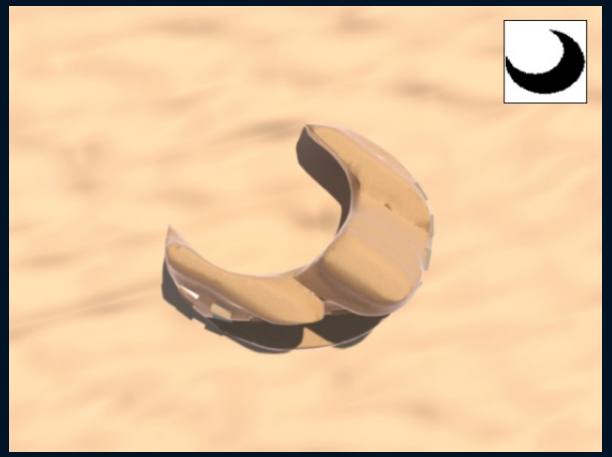
Architectural Design

- Input: Three shape templates
- Optimize the building shape so that silhouette from three different viewpoints match each of the three templates



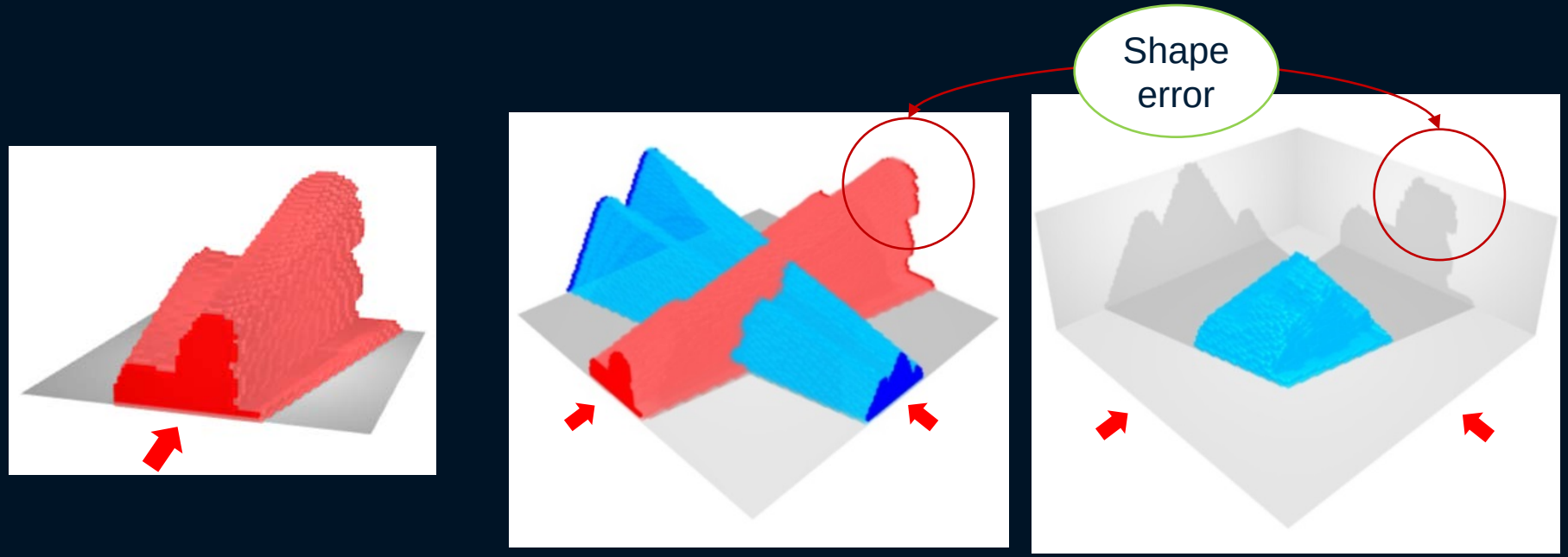






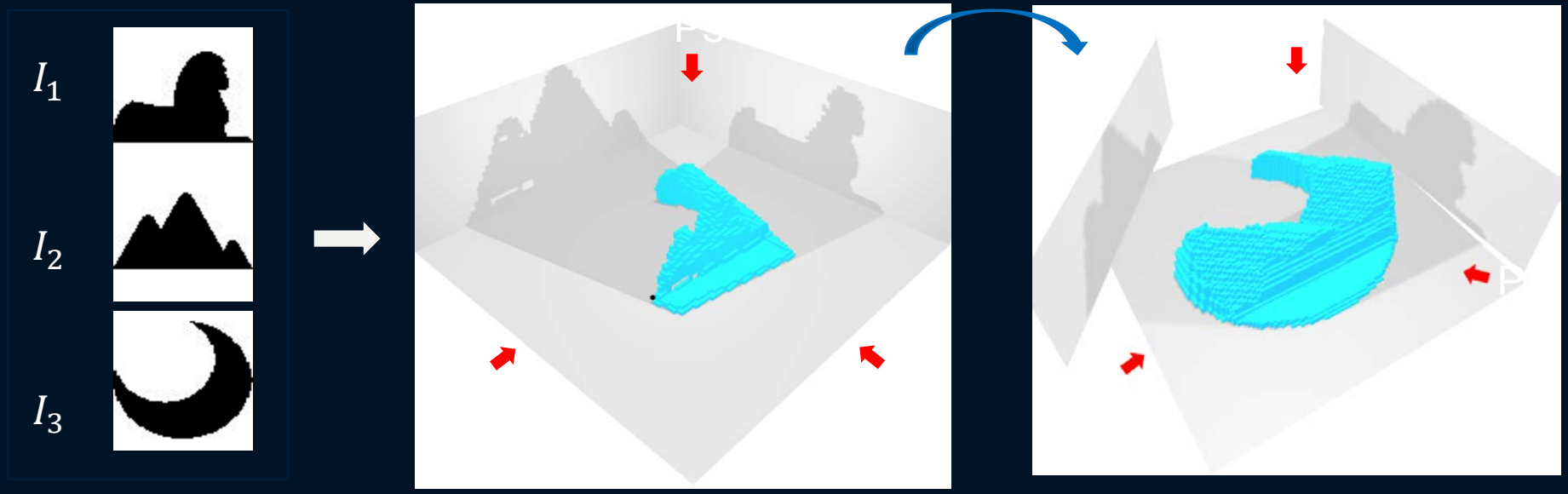
Exterior Objectives

- Single view: silhouette cone by projecting image from camera position.
- Multi-view: intersection of single view silhouette cones.



Objectives

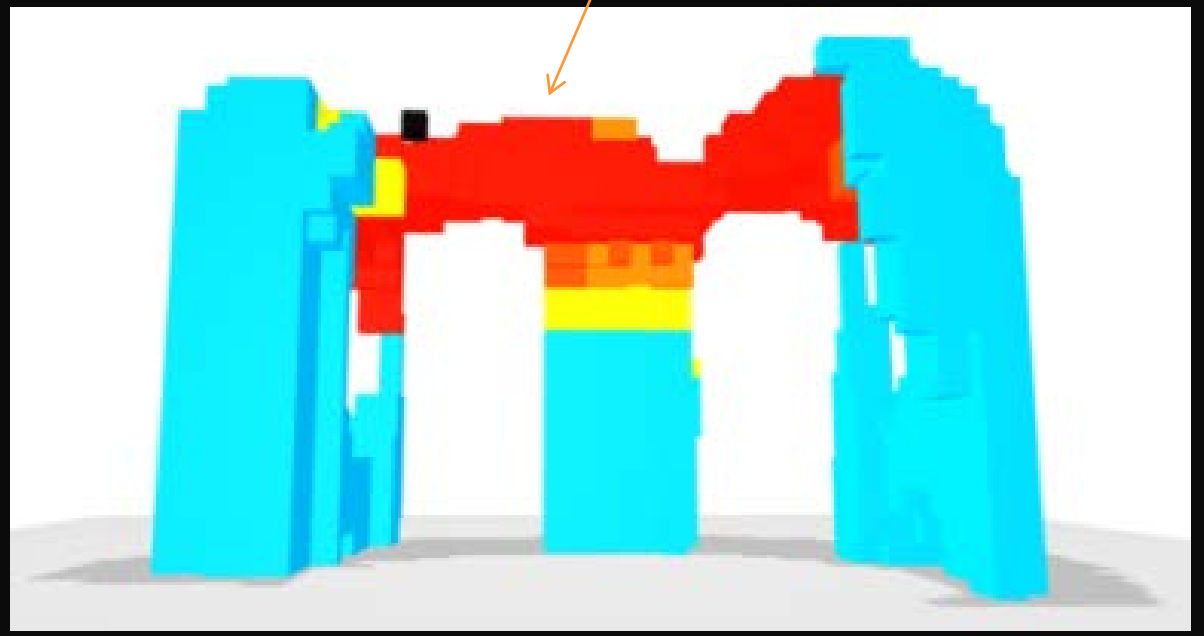
- Find camera position, image position and scale that can generate a satisfying model.



What defines a good model?

- Shape template integrity
- Structural integrity
- Total volume
- …

poor structural integrity

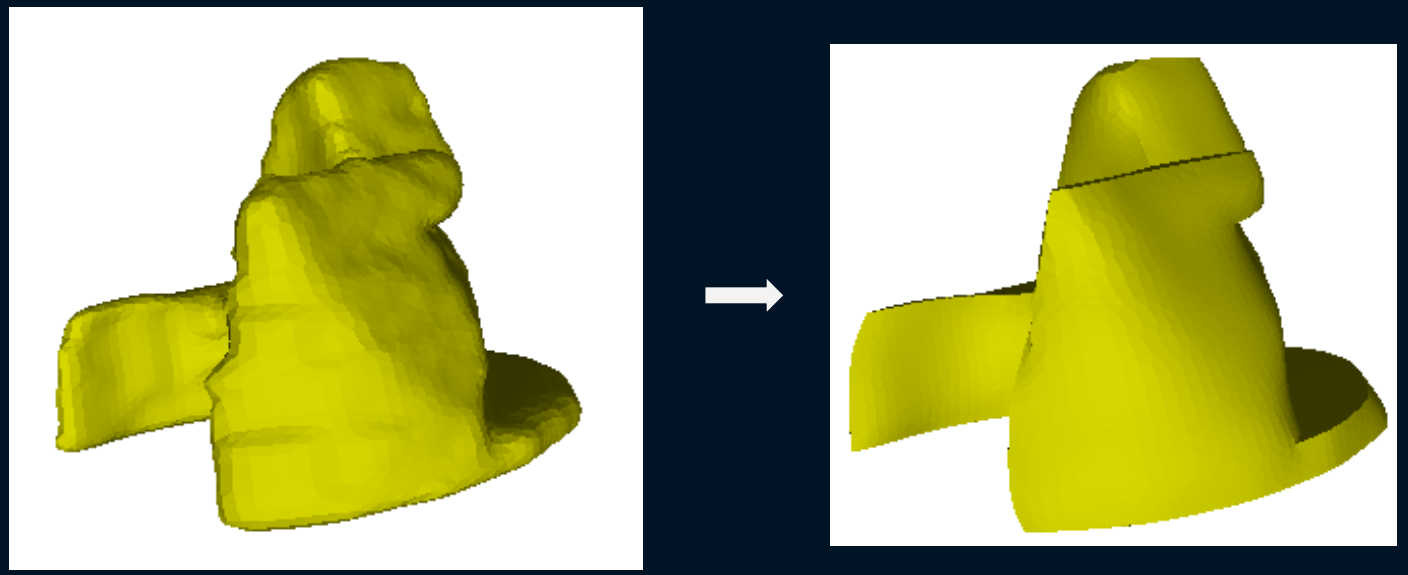


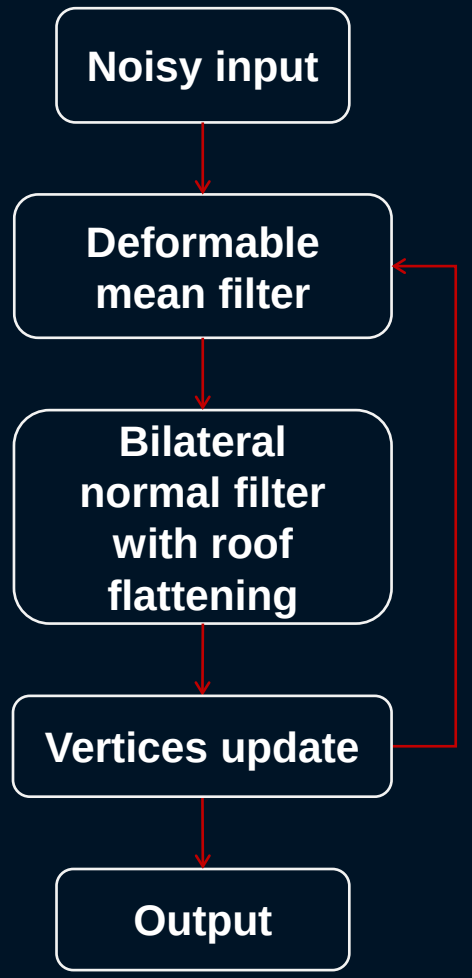
Optimization algorithm

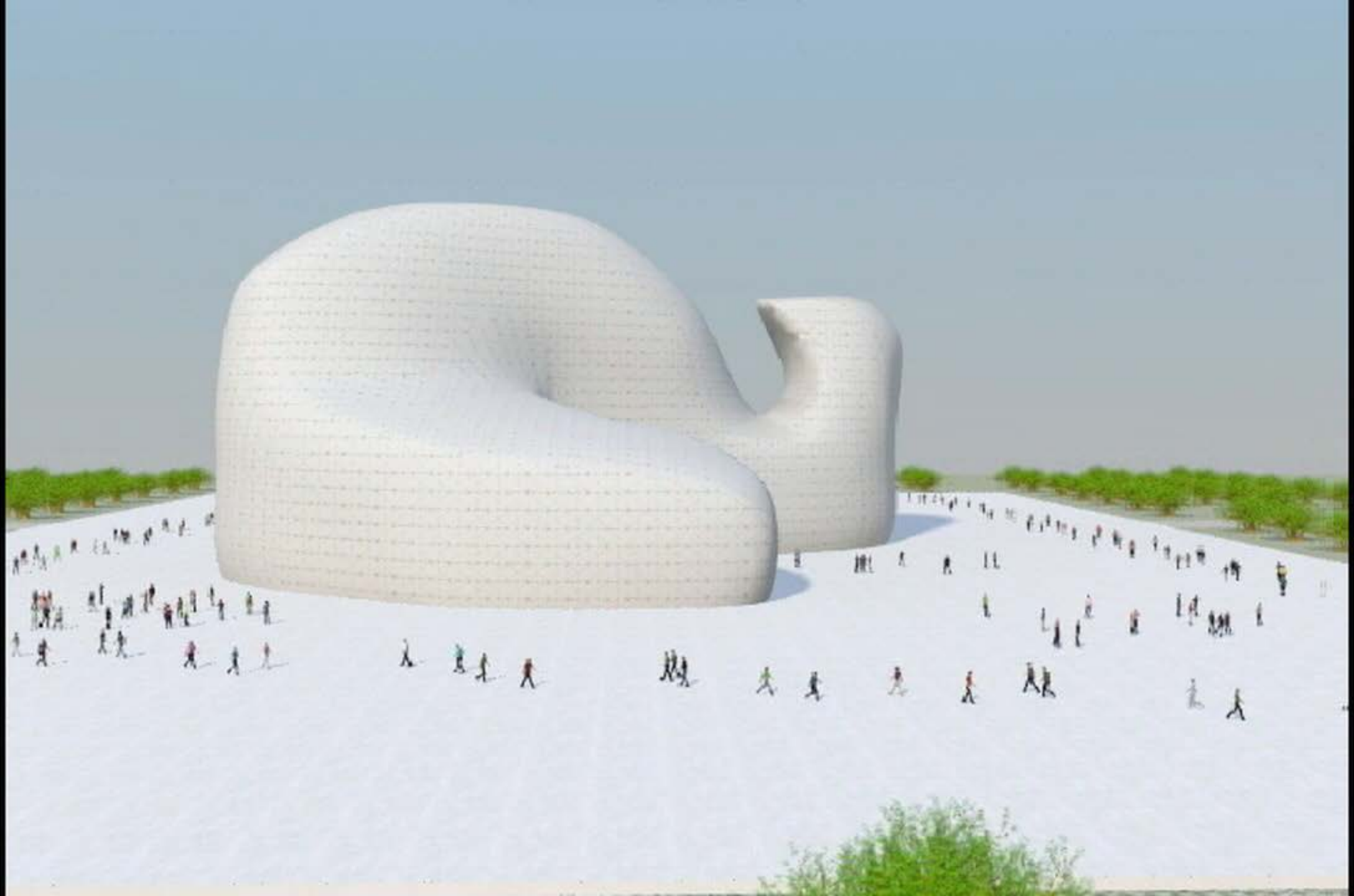
- Non-linear, non-convex optimization
- Considered different probabilistic techniques, metaheuristics
  - Simulate Annealing (SA)
  - Genetic Algorithm (GA)
  - Particle Swarm Optimization (PSO)
  - **Cuckoo Search**
- We used a modified version of cuckoo search
  - Maintains multiple solutions at any stage
  - Tries to mutate solutions and provides random restarts

Smoothing

- Convert from voxels to a mesh surface using marching cubes
- New specialized smoothing algorithm based on bilateral filtering with roof flattening



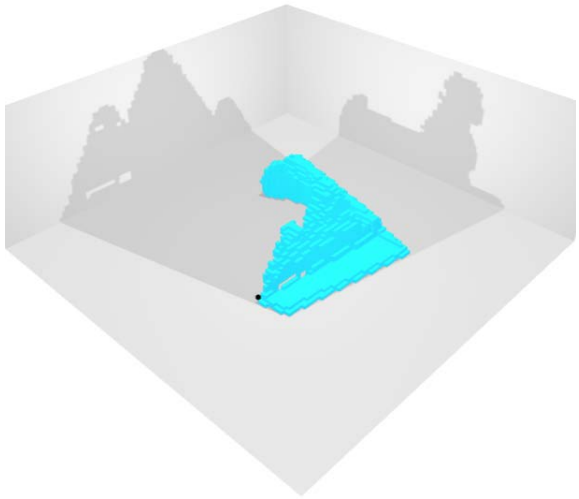


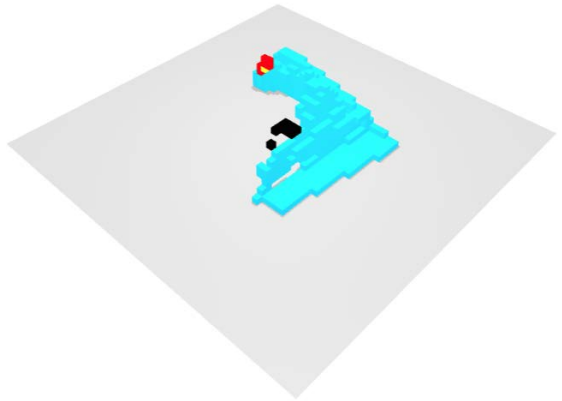


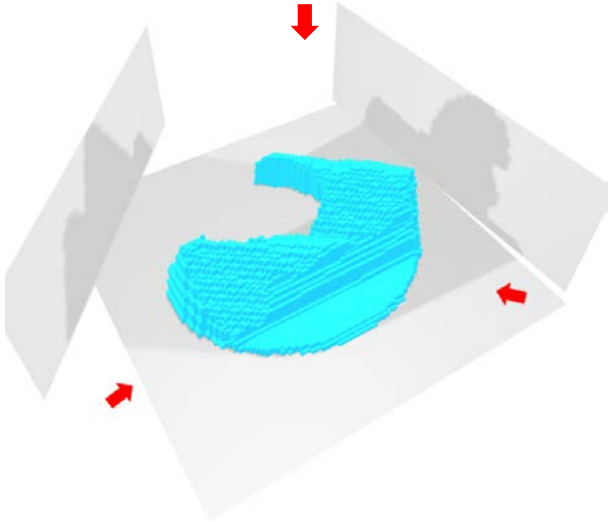
Egypt Museum

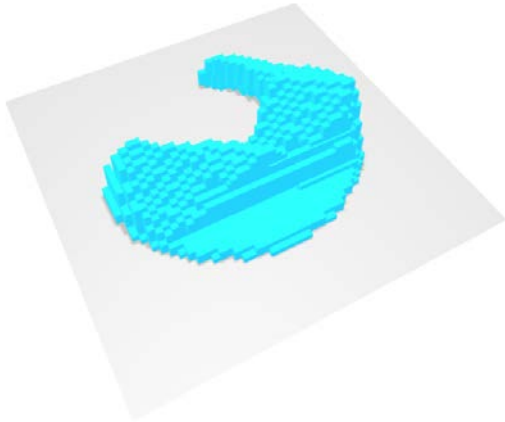
Default parameters

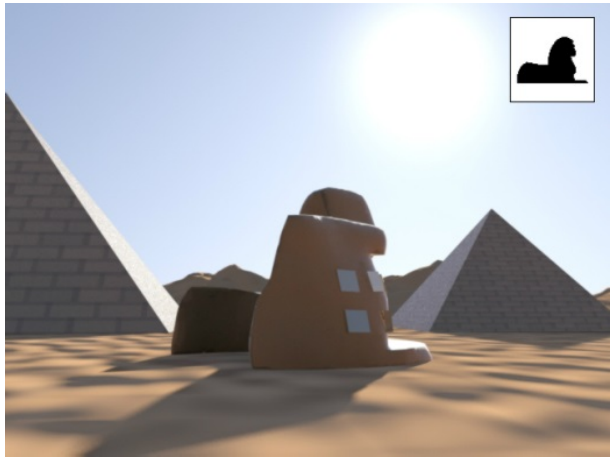
Optimized parameters

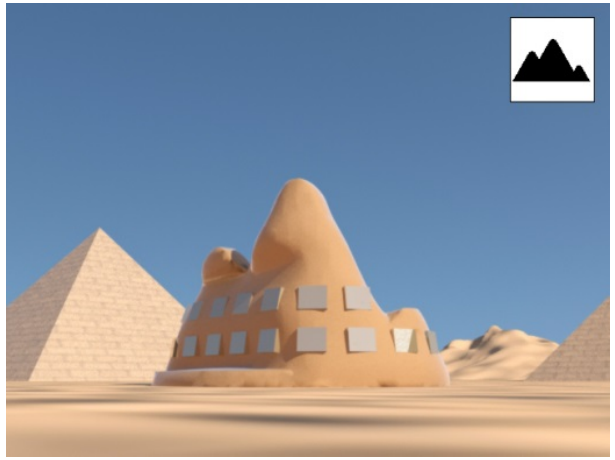


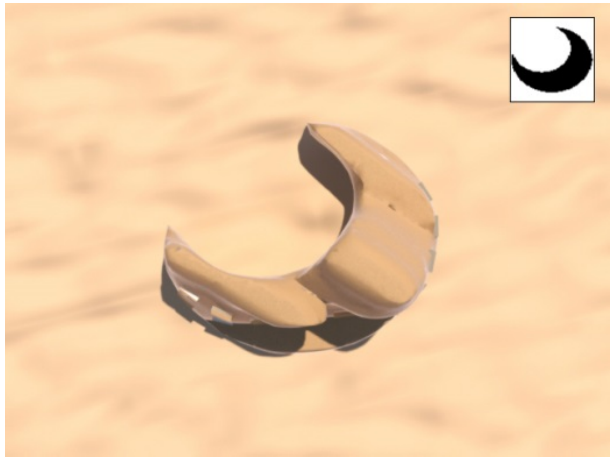


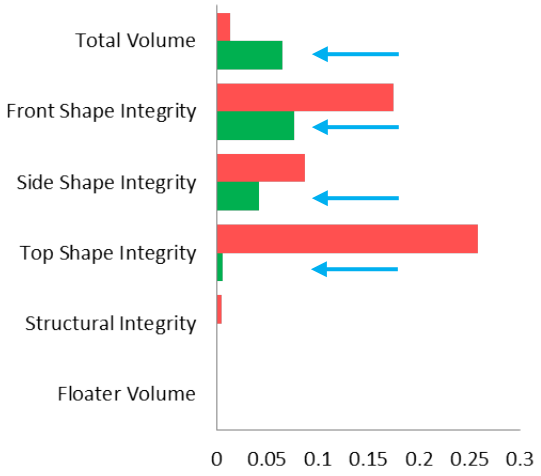








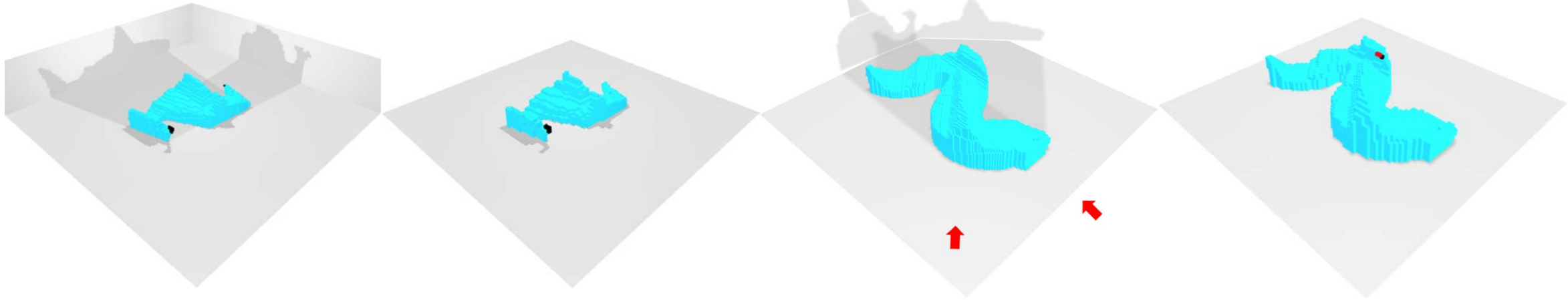


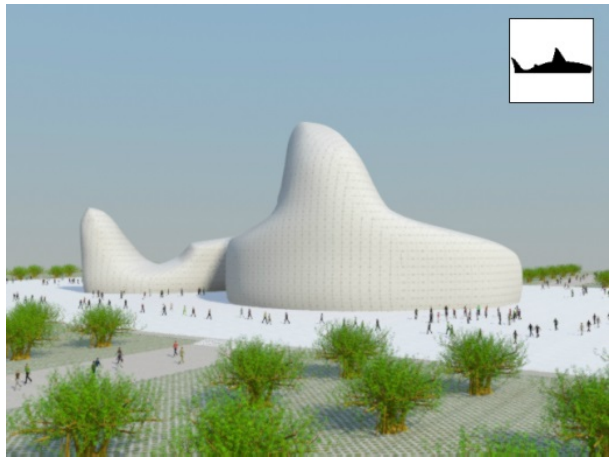


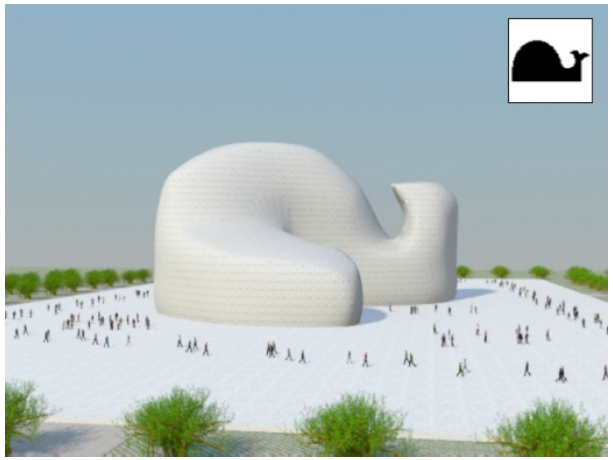
Aquarium

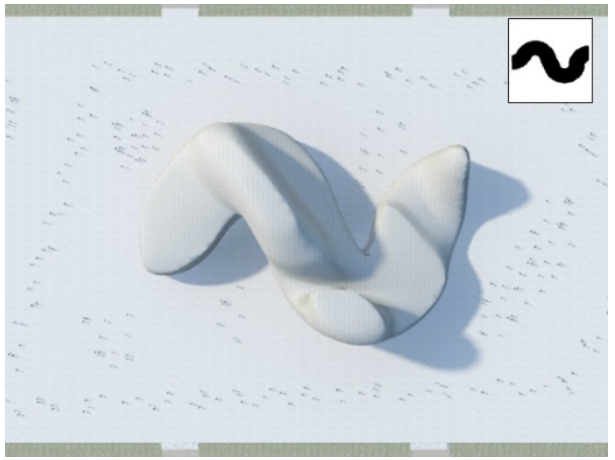
Default parameters

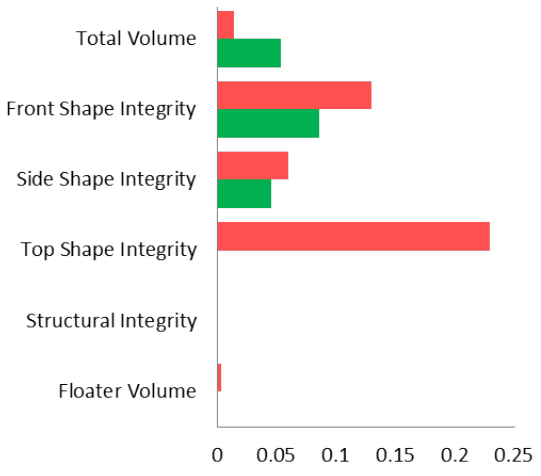
Optimized parameters







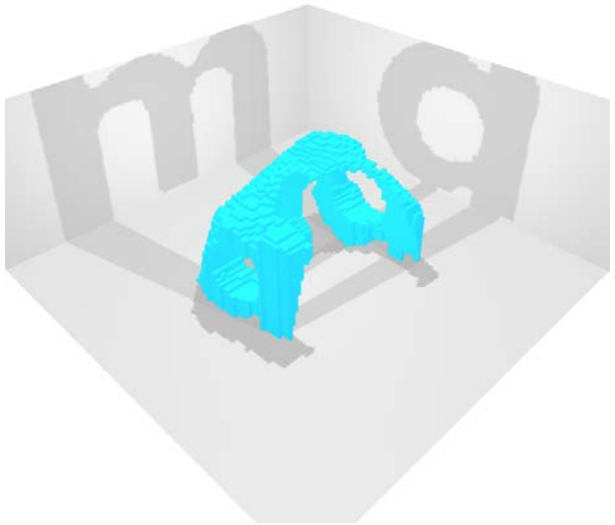


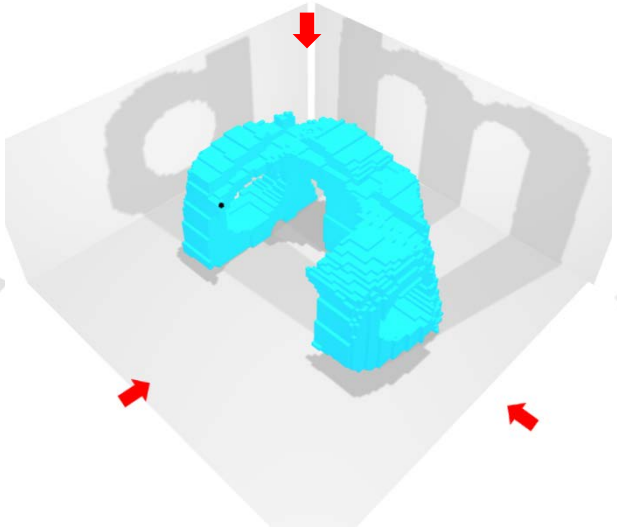


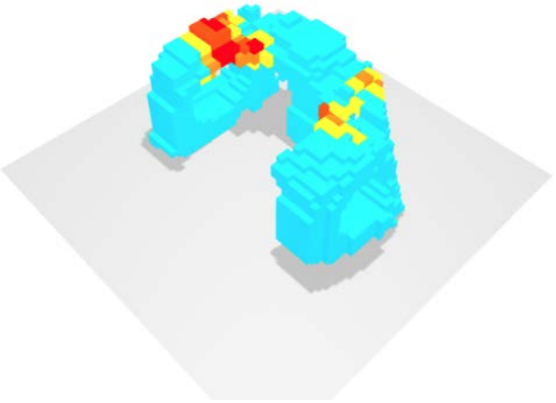
Design for Possible ACM Headquarters

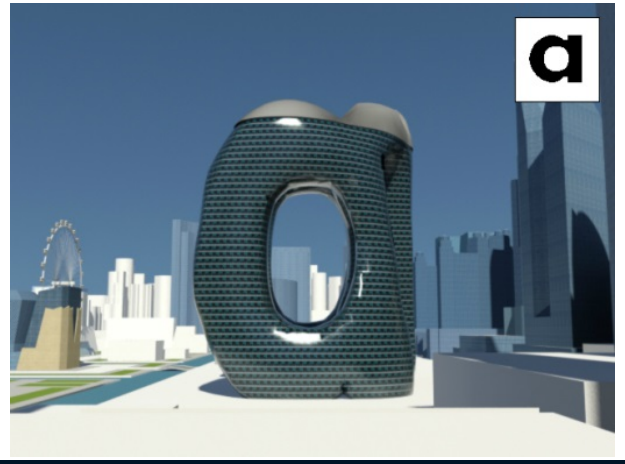
Default parameters

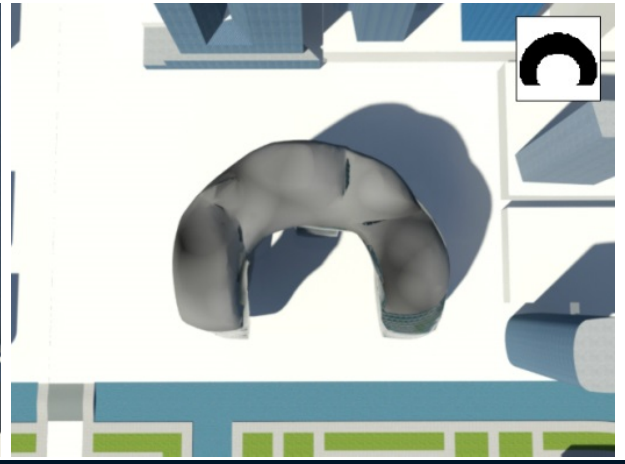
Optimized parameters

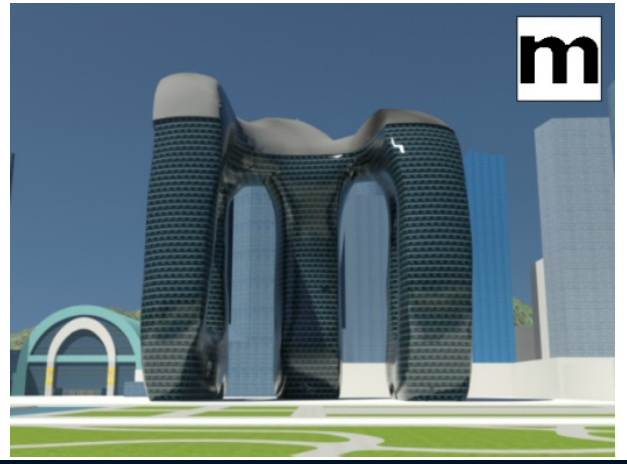


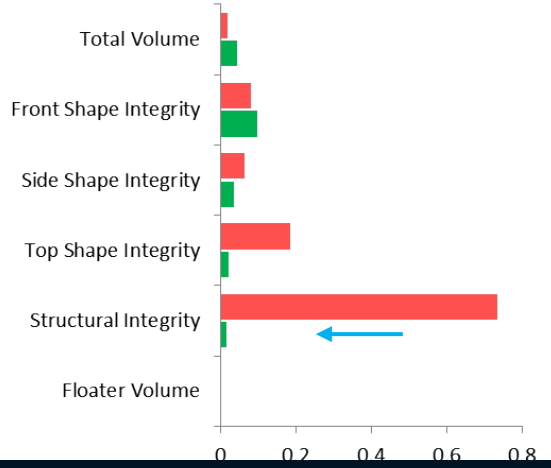








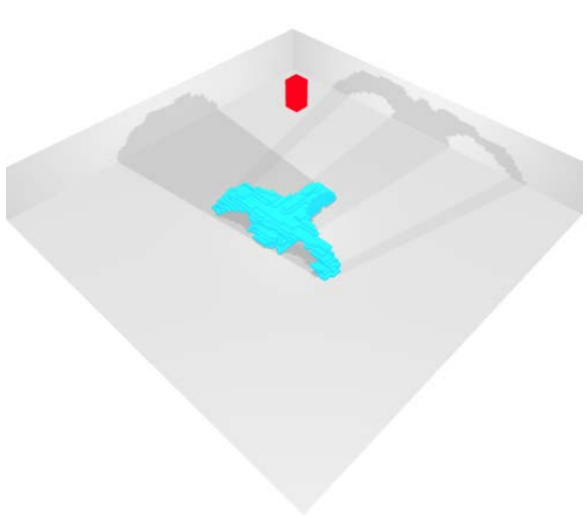


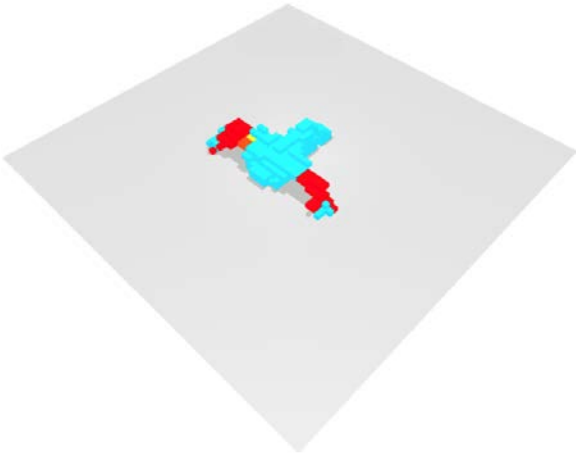


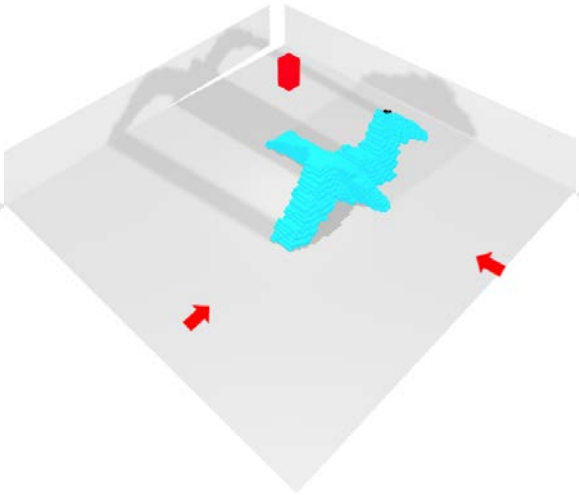
Bird Shape Building

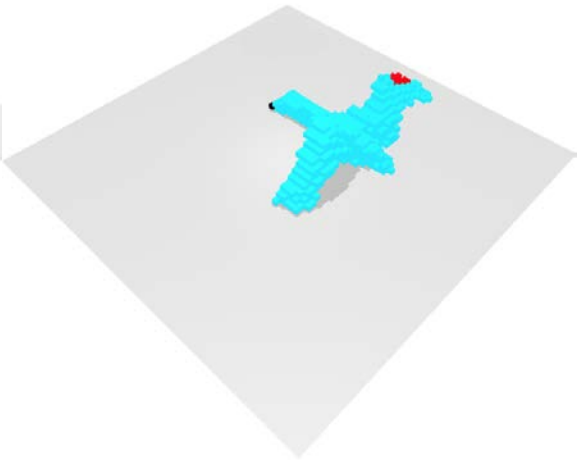
Default parameters

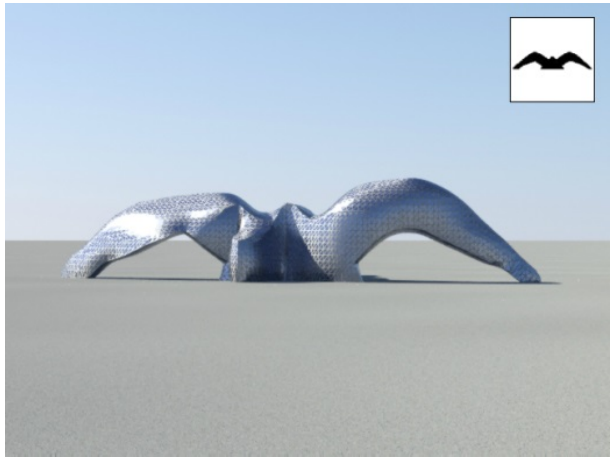
Optimized parameters

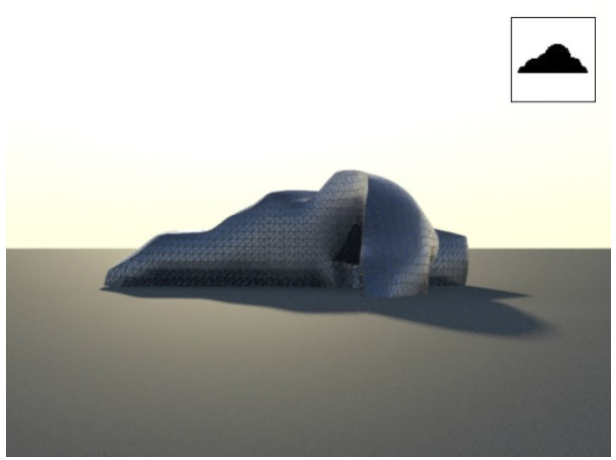


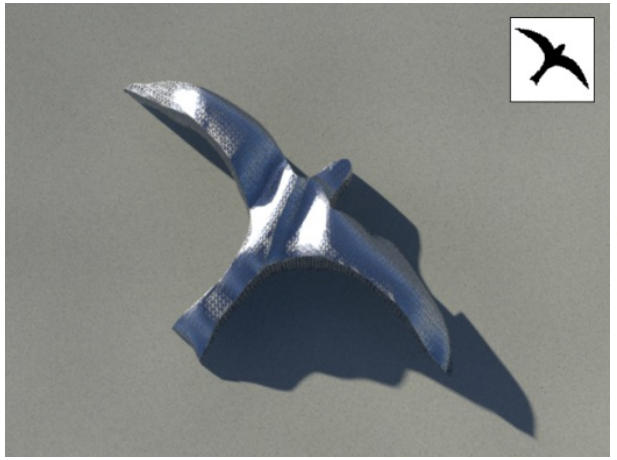


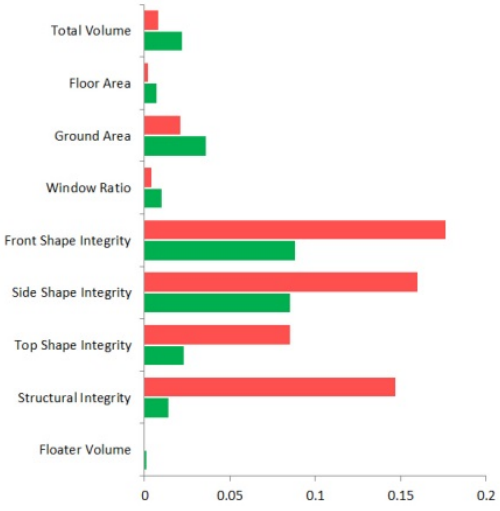








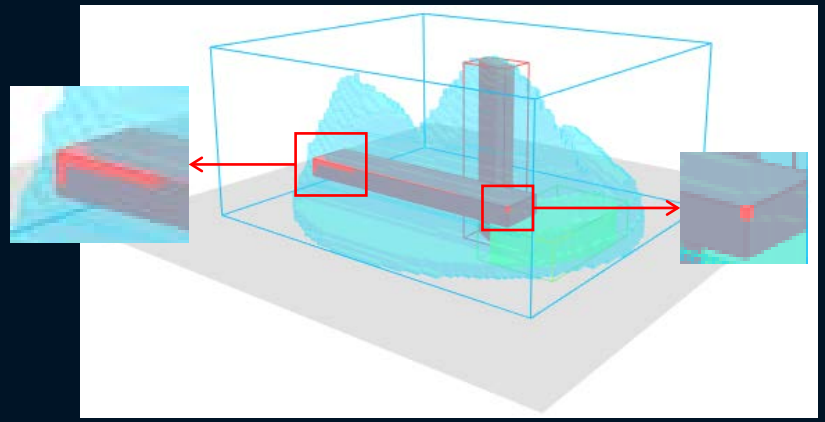




Conclusion

- Architectural concept design system
  - Initial design from three input shapes
  - Building silhouettes consistent with input shapes
  - Incorporates architectural requirements
  - Modified cuckoo search algorithm

- Later work explored interior planning:
- Discussing exploring interesting real-world uses with architects



More info:

http://www.cse.ust.hk/~psander/

Thank you!