



Problem

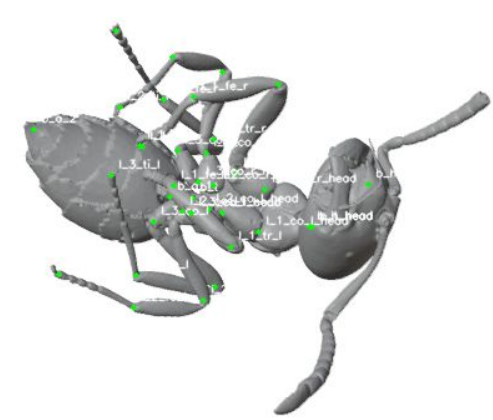
Micro-CT scanning captures ant specimens with microscopic detail, but scans are difficult to analyze.

To animate or repose a specimen, the mesh must be **rigged** with an internal, anatomically accurate armature. Doing this by hand is slow, tedious, and hard to scale.

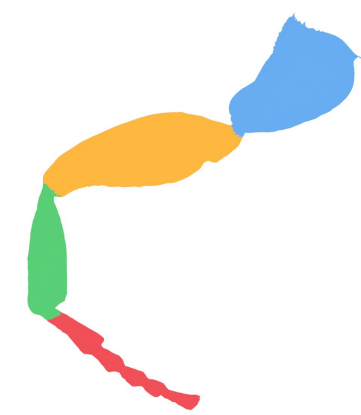
Objective

- Build on the work of the **Antscan**¹ project, a database of thousands of micro-CT scans of ants.
- Automatically convert a static ant meshes into **rigged, poseable 3D models**.

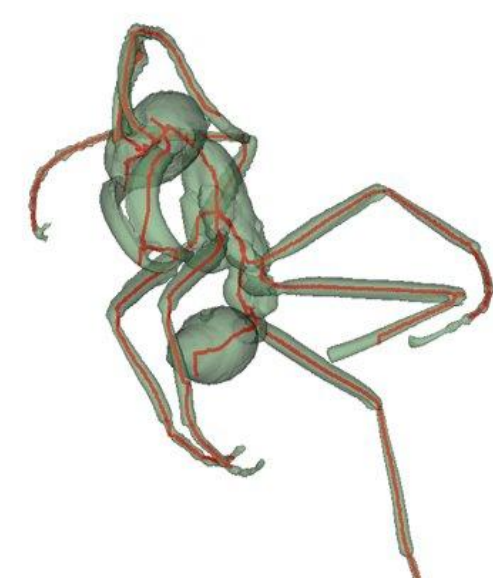
Methods Evaluated



DeepLabCut² pose estimation
Machine learning approach which required training and did not generalize reliably across specimens.



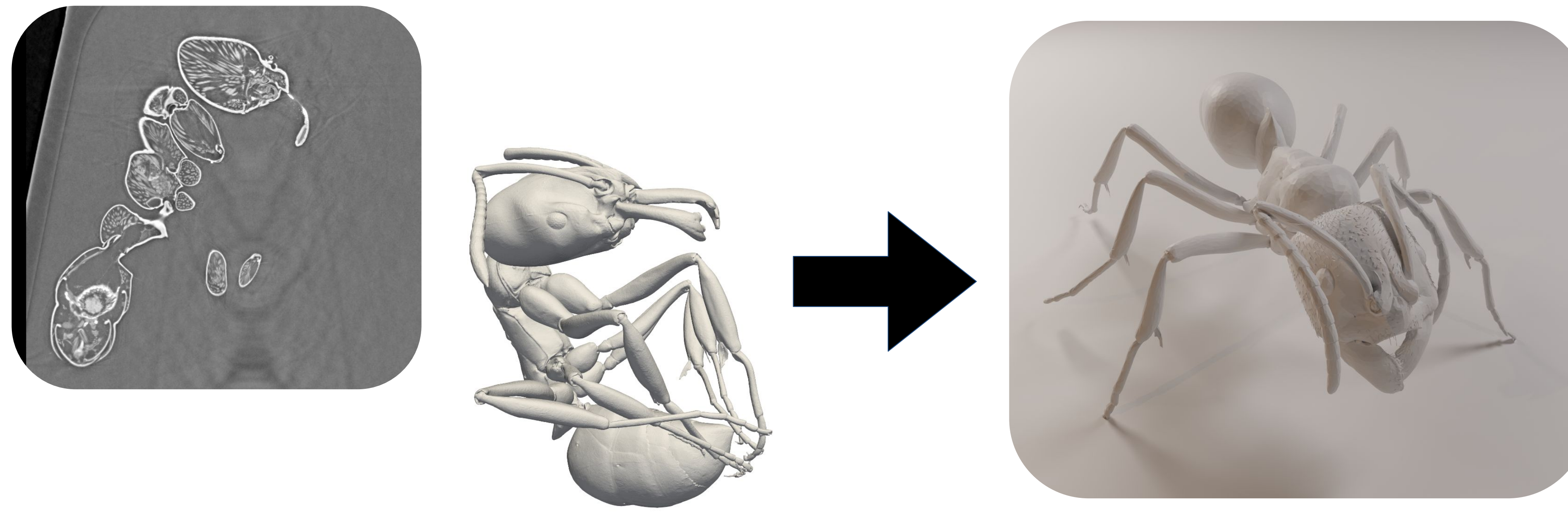
Spectral segmentation⁵
Effectively separated major structures, especially legs, but was too inconsistent for the final solution.



Voxel methods (CT)
Added preprocessing cost and did not outperform direct mesh-based methods.



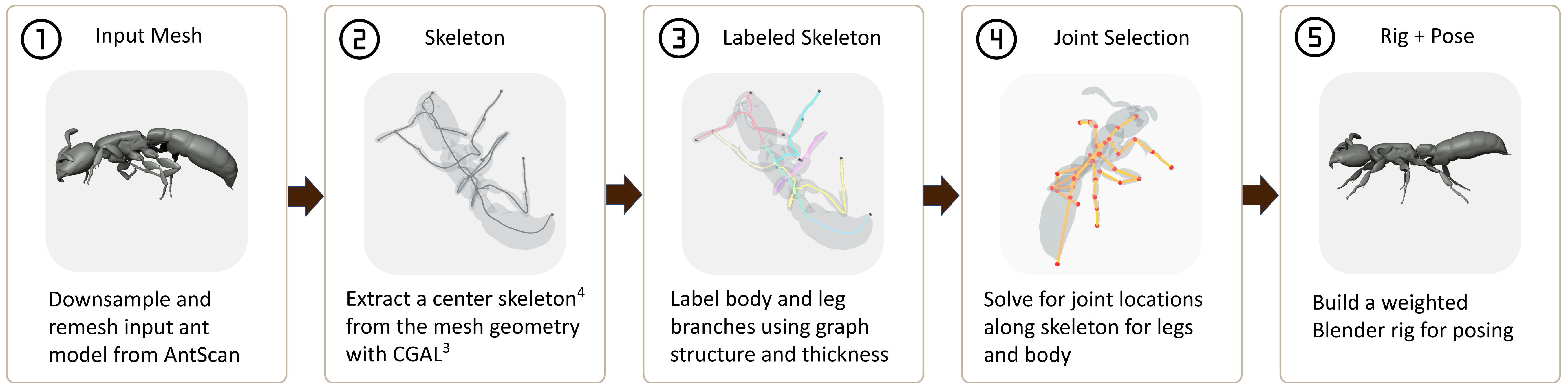
CGAL skeletonization⁴
Produced the most accurate centerline graph and became the basis of the final pipeline.



Applications

- Entomology**
Research using detailed models of ants
- Biodiversity/Museum Collections**
Make 3D specimen collections dynamic
- Animation, Games, VR**
Use realistic models for rigged assets

Final Skeleton-based Pipeline



Our Results

| | | |
|-----------------------------------|-------------------------------|--------------------------------|
| Average Runtime* 143.9s | Successful Rigs 15+ | Specimens Tested 30+ |
|-----------------------------------|-------------------------------|--------------------------------|

We built a **geometry-based** pipeline that converts static ant meshes into **rigged, poseable 3D models** directly from cues such as skeleton structure, thickness, curvature, and anatomical heuristics. This transforms a process that might take hours by hand to one that automatically runs in minutes.

Future Work

- Improve preprocessing and upstream CT-to-mesh extraction so legs are separated before rigging
- Connected or fused legs can distort skeletonization, which then affects part labeling and joint placement.
 - Only a minority of raw AntScan meshes have fully separated legs, so input mesh quality remains a major bottleneck.

Scan to view our project website:



References

1. Katzke, J. et al. High-throughput phenomics of global ant biodiversity. *Nature Methods* 23, 663–672 (2026).
2. Mathis, A. et al. DeepLabCut: markerless pose estimation of user-defined body parts with deep learning. *Nature Neuroscience* 21, 1281–1289 (2018).
3. The CGAL Project. CGAL User and Reference Manual. CGAL Editorial Board, 6.1.1 edition (2026).
4. Tagliasacchi, A. et al. Mean curvature skeletons. *Computer Graphics Forum* 31(5), 1735–1744 (2012).
5. Wang, H. et al. Spectral 3D mesh segmentation with a novel single segmentation field. *Graphical Models* 76(5), 440–456 (2014).
6. Google Material Icons / Symbols, Apache License 2.0.

* Tested on an i5-13600K CPU across 18 specimens from the Antscan database