

Contour Grouping using Part Similarity

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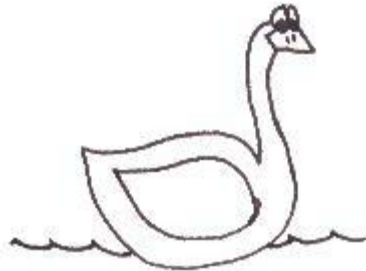
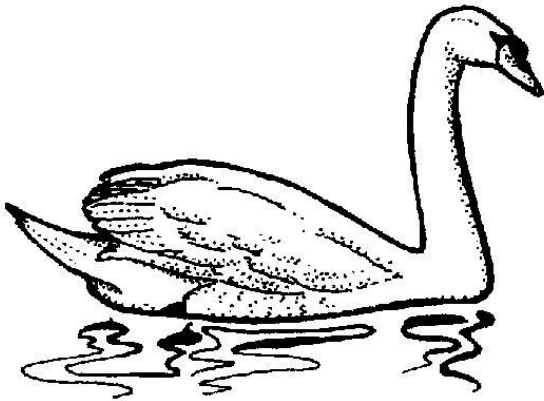
Easy for Human Eyes

- Everybody can find the swan from these images.

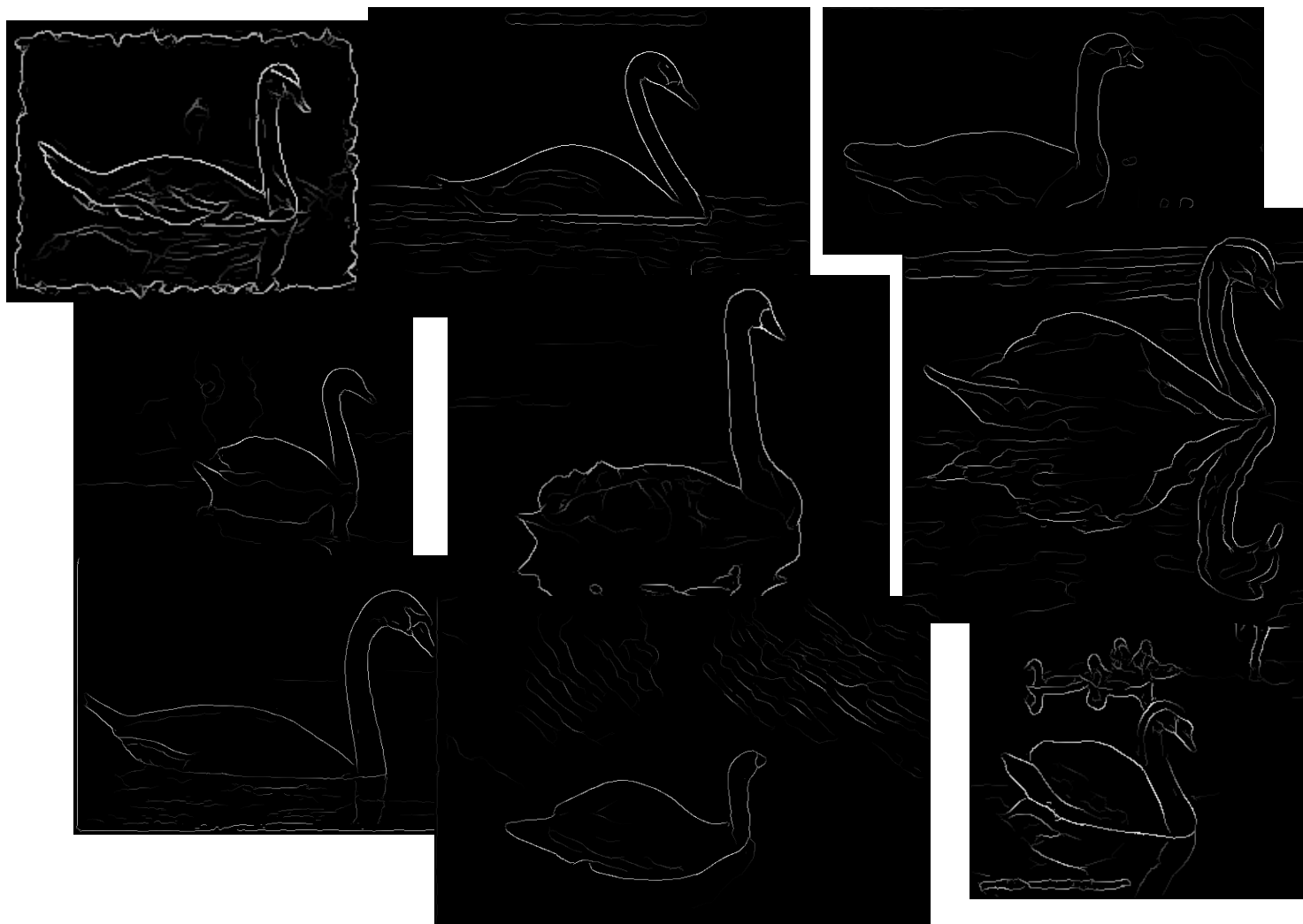


Recall how humans draw swans

- We always draw edges.

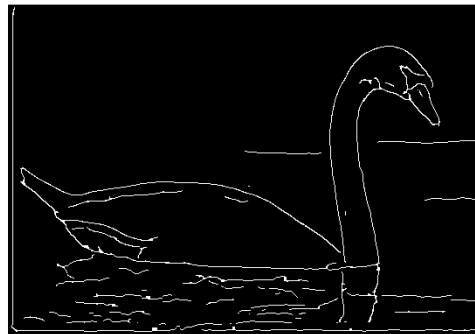
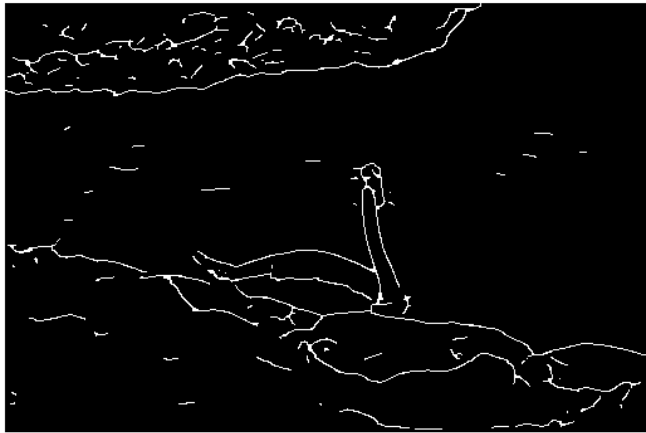


A computer can also capture edges



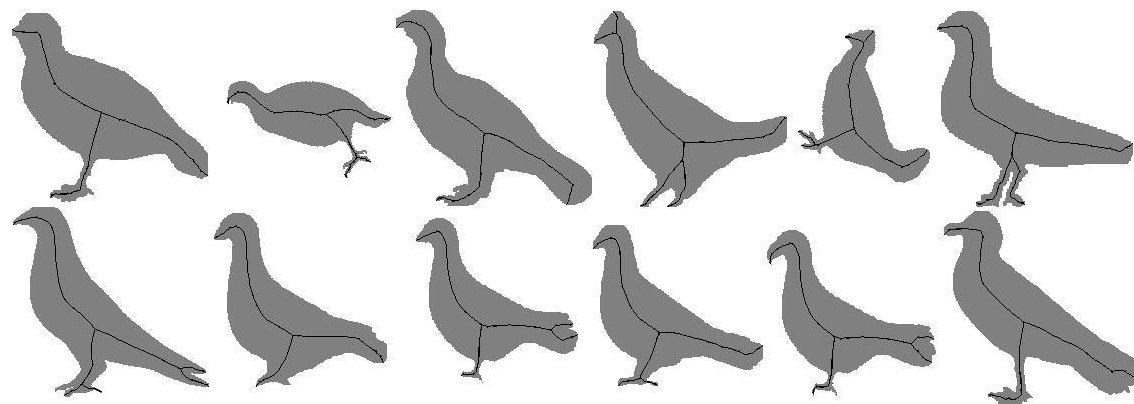
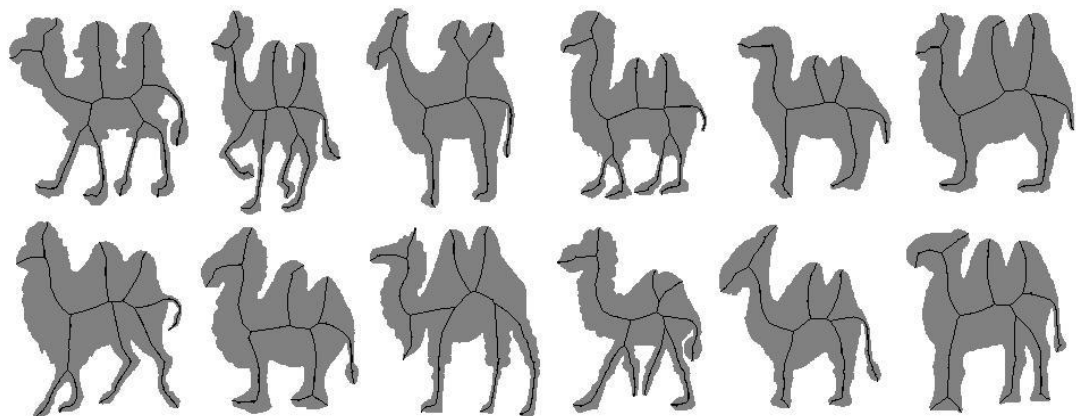
Problem: Separating Noise

- Too much noise, and the computer can't tell which edges belong to object of interest.



How to find contour parts of interest in images?

- All shapes contain local symmetry represented by a skeleton.



How to find contour parts of interest in images?

- Due to uncertainty of which contour parts belong together (form a given contour),
- we use probabilistic grouping based on local symmetry.

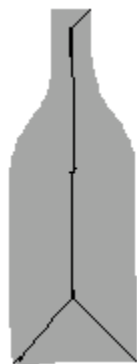
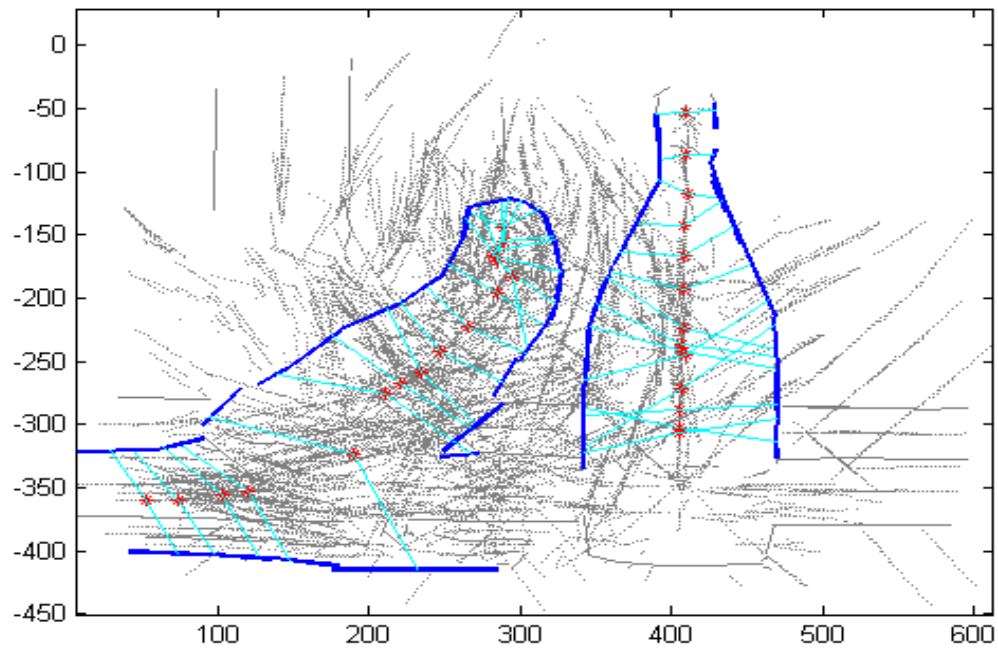


What does contour grouping have to do with robotics?

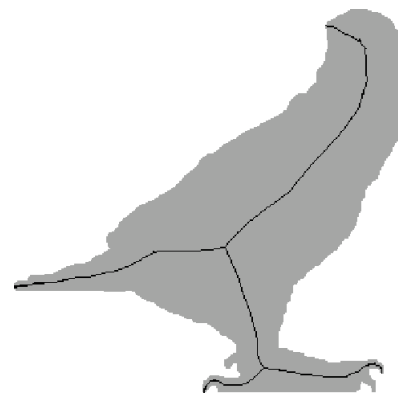
- Very similar to map-acquisition problem in robotics.
- Hence we formulate contour grouping as map-acquisition of a virtual robot.
- The virtual robot walks around “acquiring the contour”.

Contour acquisition using virtual robot

- The virtual robot walks along “center points” constructed from segments on edge image.
- The contour is a sequence of segment-pairs associated with the center points on the edge image.
- A reference shape model guides the robot’s motion and gives sensor information of what to look for.



Bottle model



Bird model

Reference Model

- Contour grouping has been a low-level vision problem.
- By using a reference model, we cast it as a high-level vision problem.
- Our reference model is based on skeletal paths. Each path is a sequence of skeleton points and the associated radii of the maximal discs.
- Hence our grouping process can be viewed as using part similarity from the reference model.

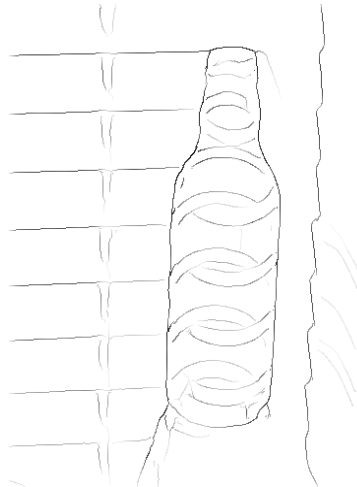
Probabilistic map/contour acquisition

- Map acquisition problem is called SLAM in robotics community.
- Any solution to that problem *has* to deal with uncertainties in sensor information.
- Rao-Blackwellized particle filtering has been successfully applied for the problem in practice.
- We adopt that approach for contour grouping.

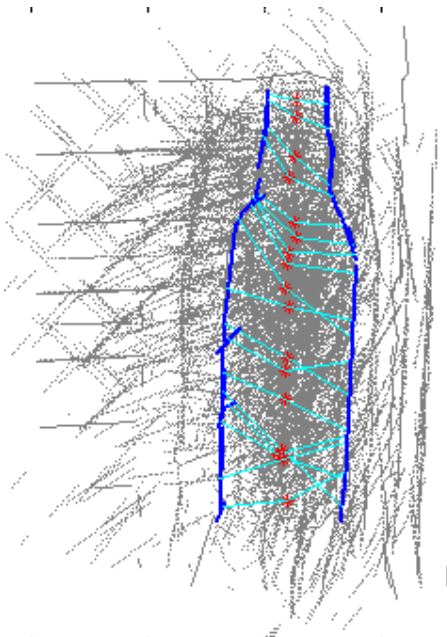
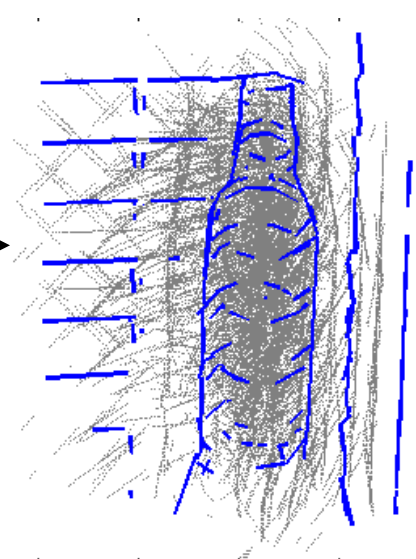
Algorithmic flow



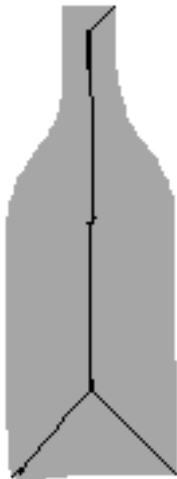
Edge extraction



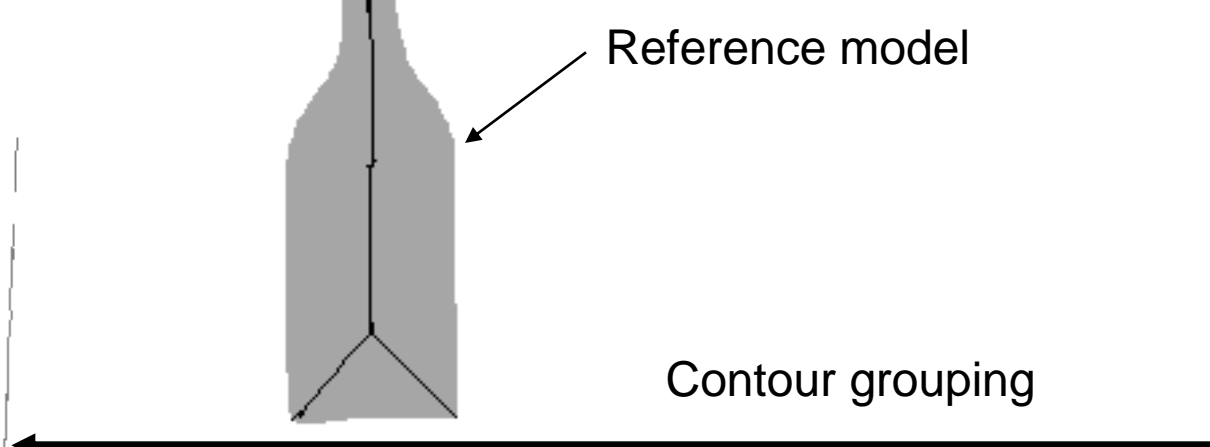
CP extraction

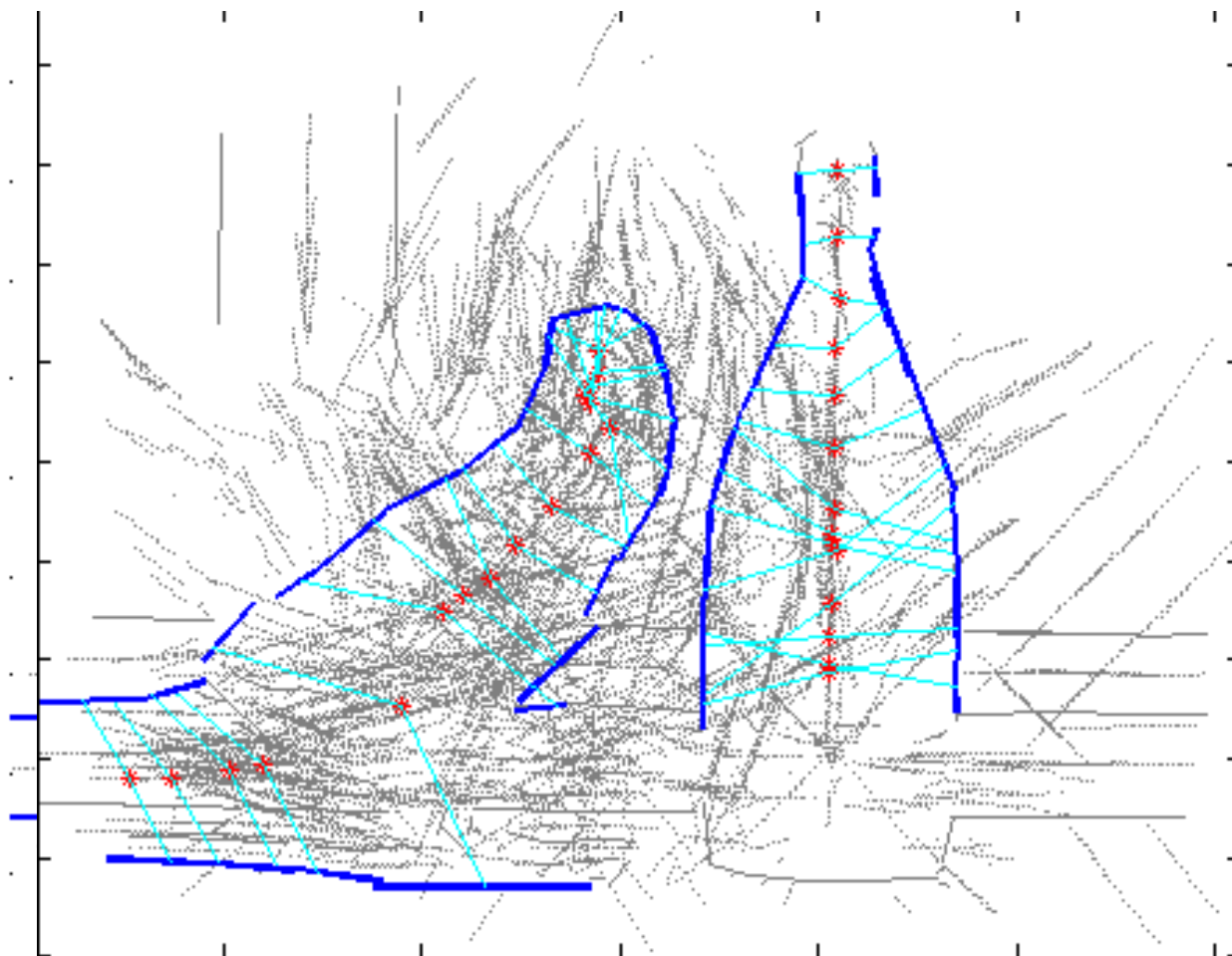


Reference model



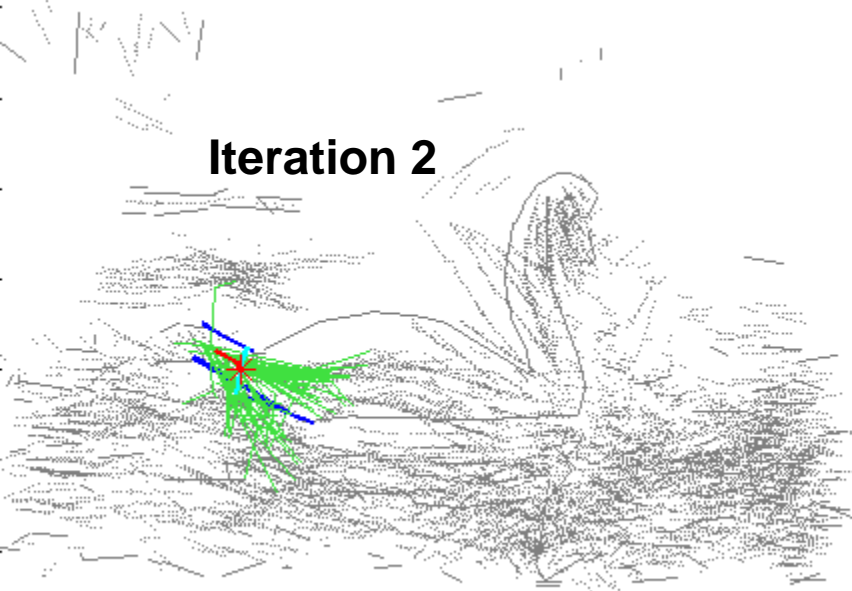
Contour grouping



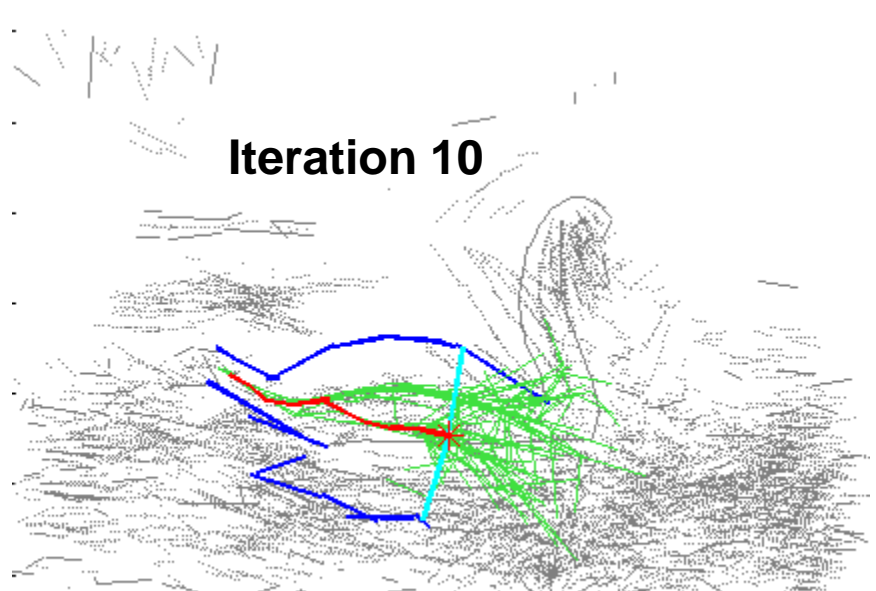


Sample evolution of particles

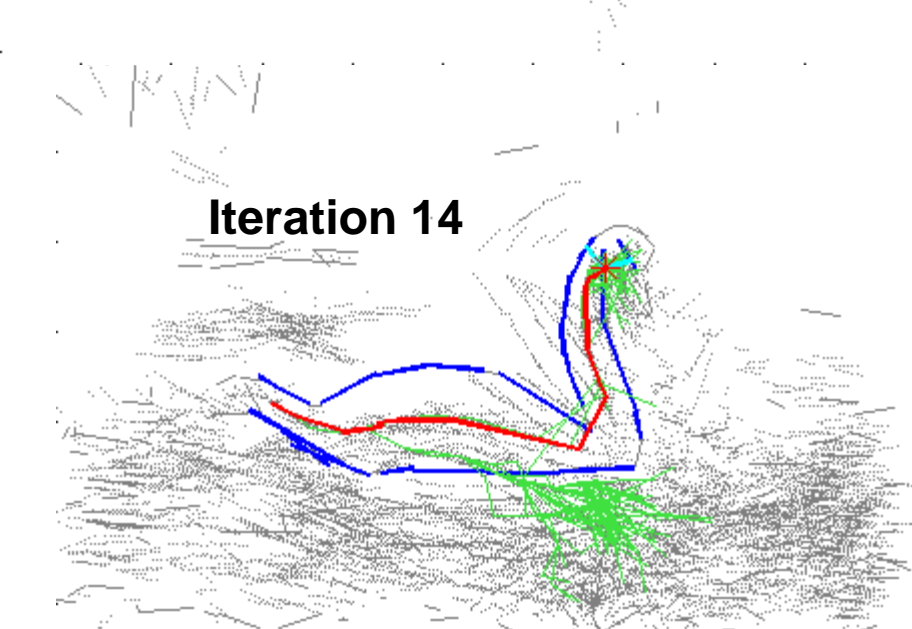
Iteration 2



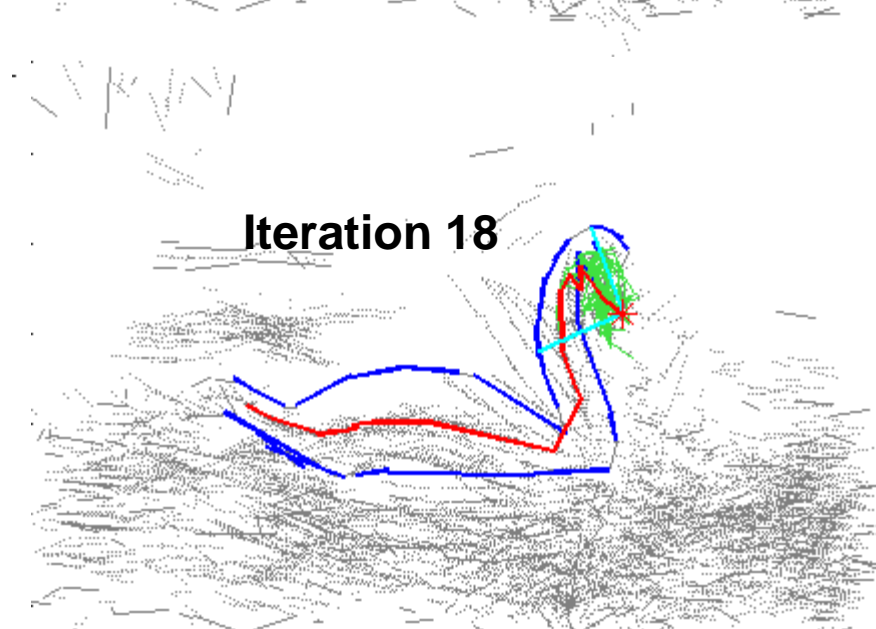
Iteration 10



Iteration 14



Iteration 18





Right by Sue Pacheco Miller 2004



Find the swans from this model

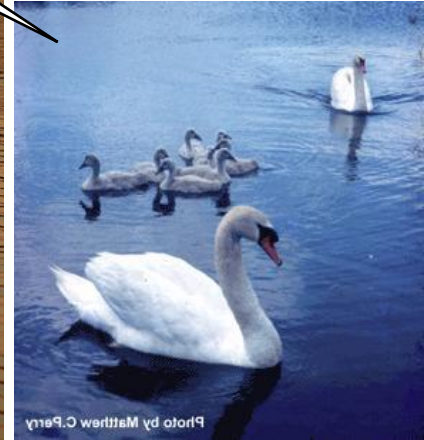
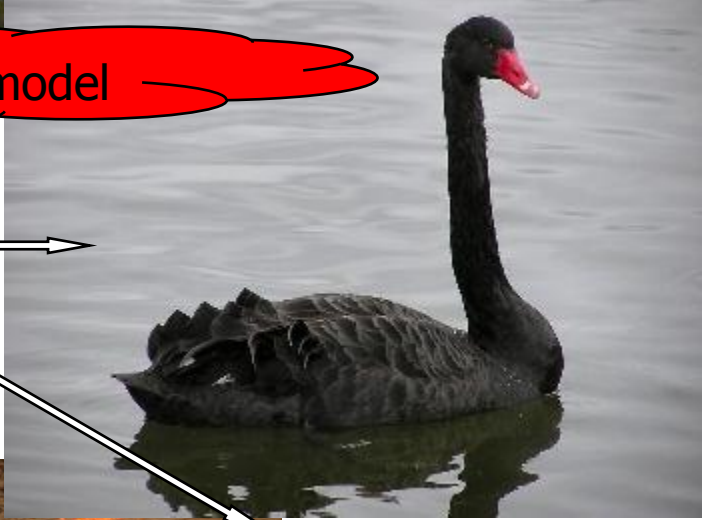
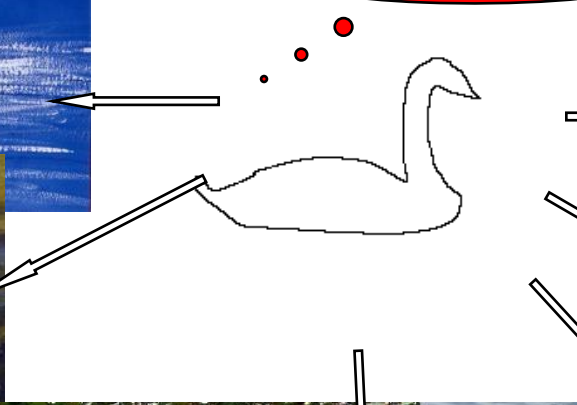
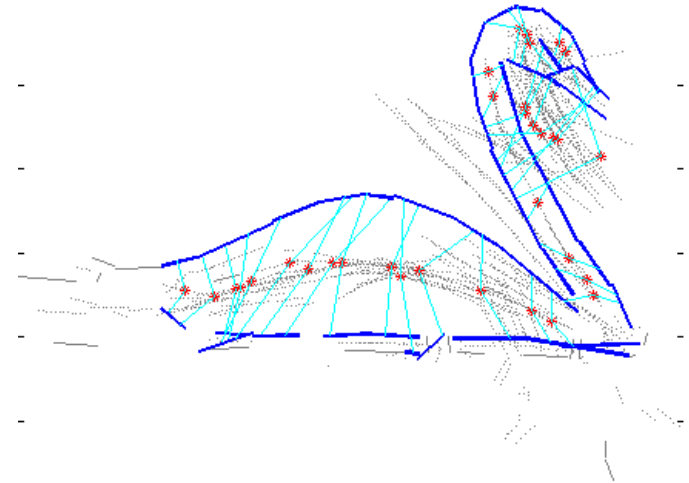
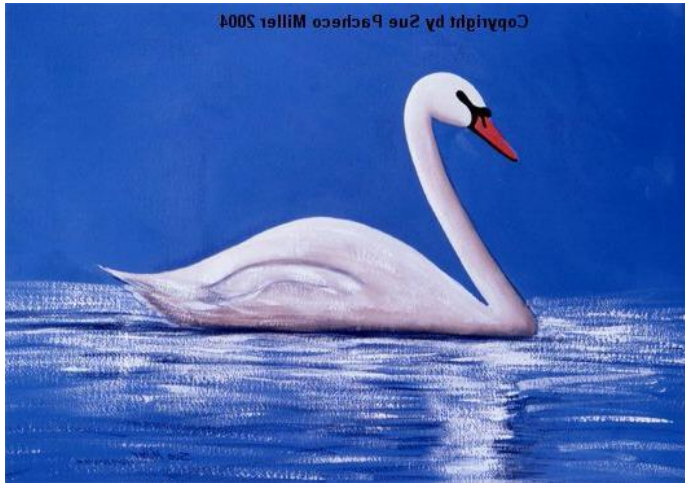
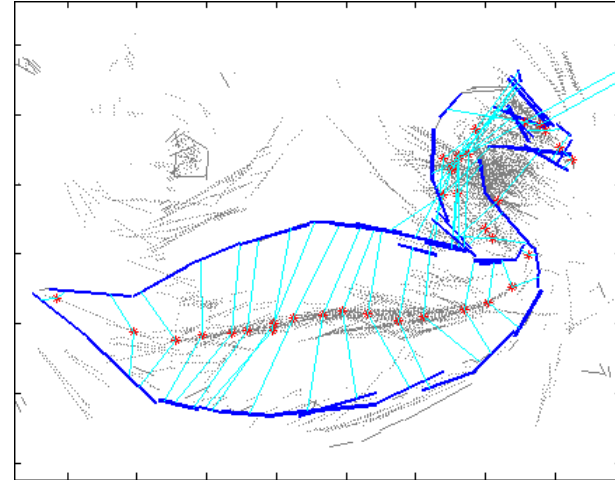
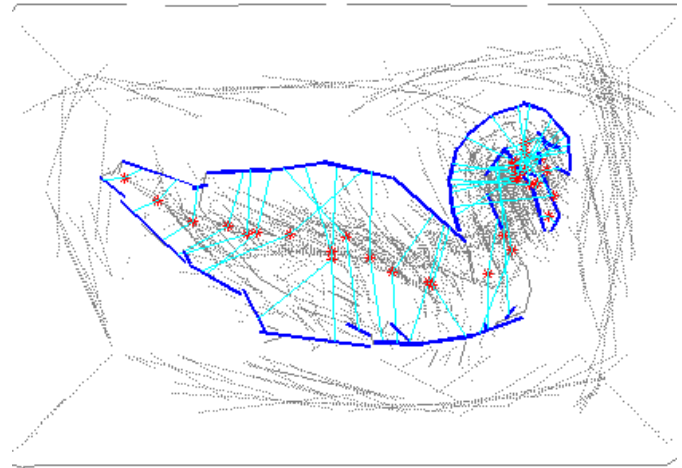
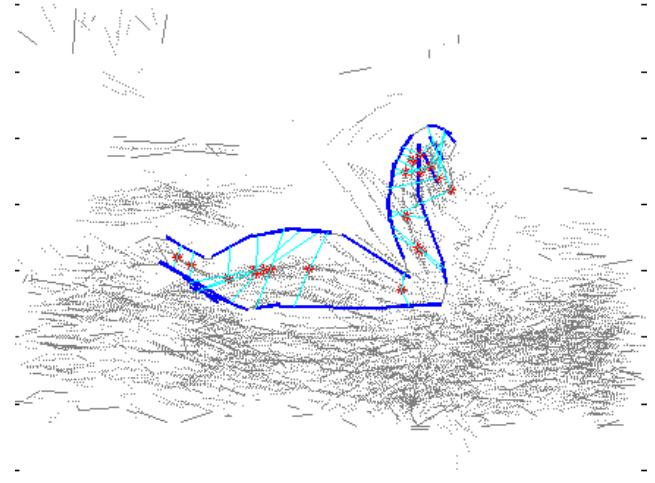
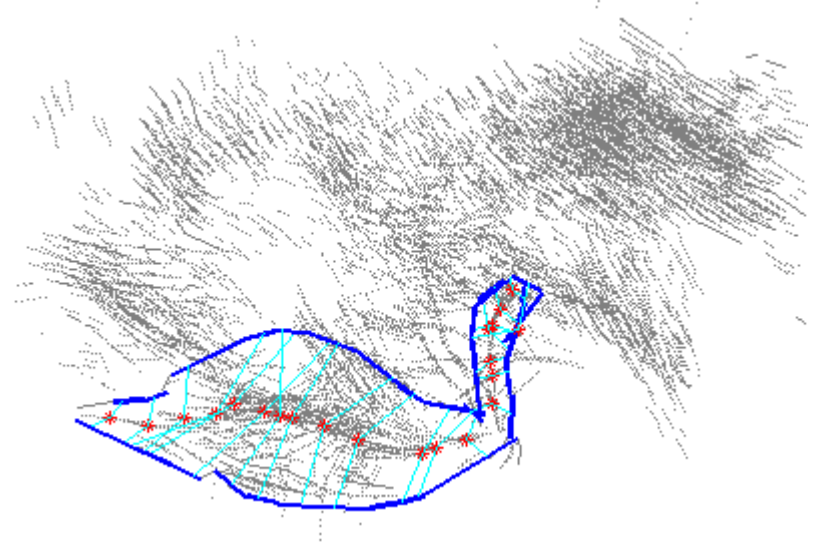
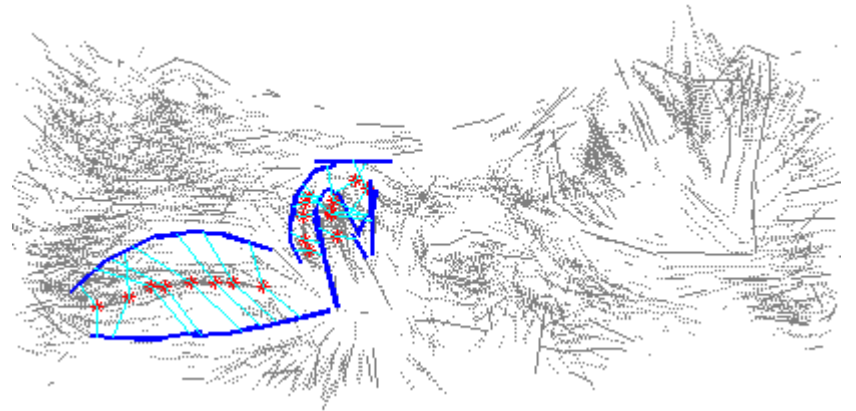


Photo by Matthew C. Perry

Experimental results







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