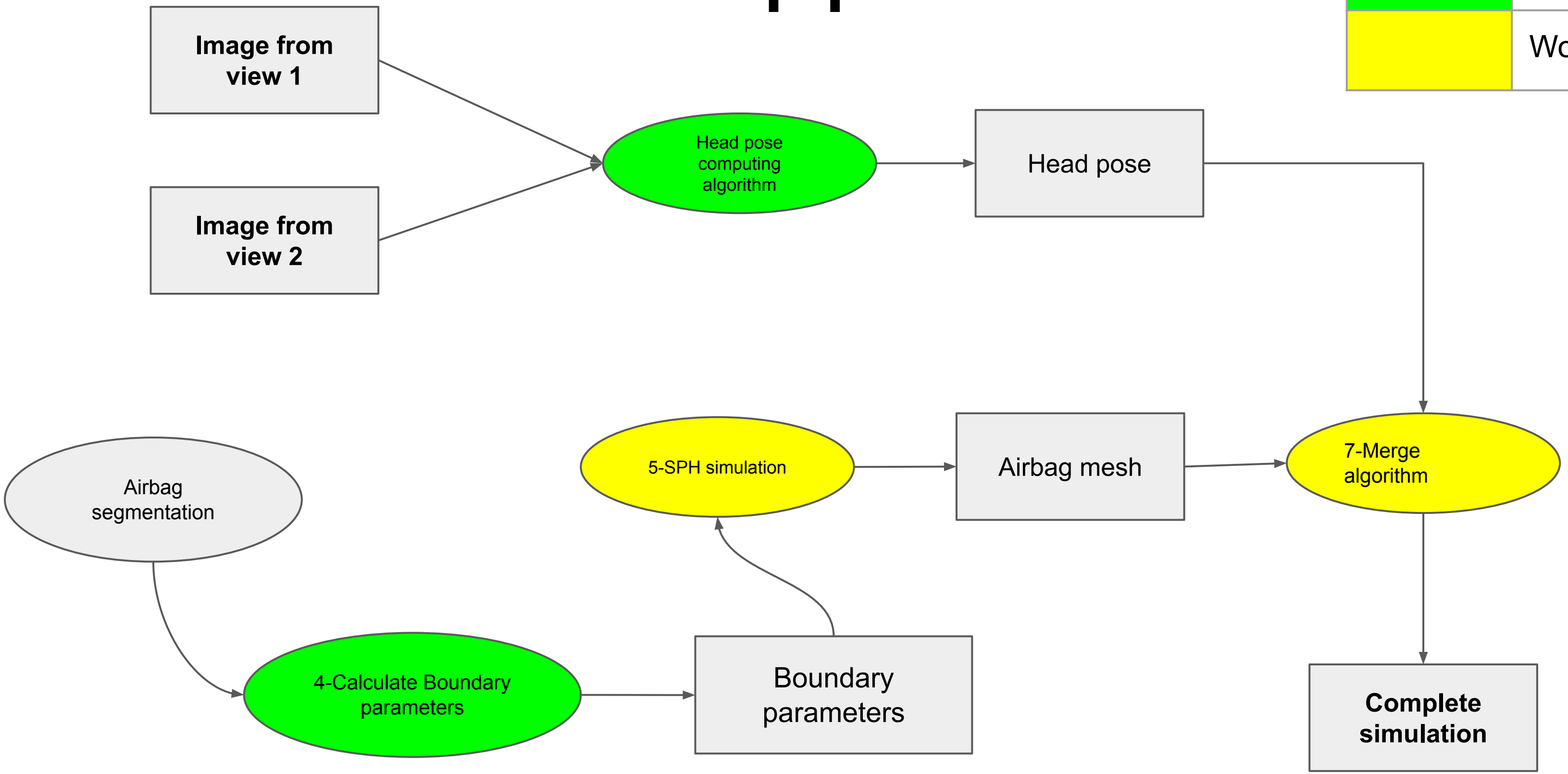
3D-Reconstruction

Overall pipeline

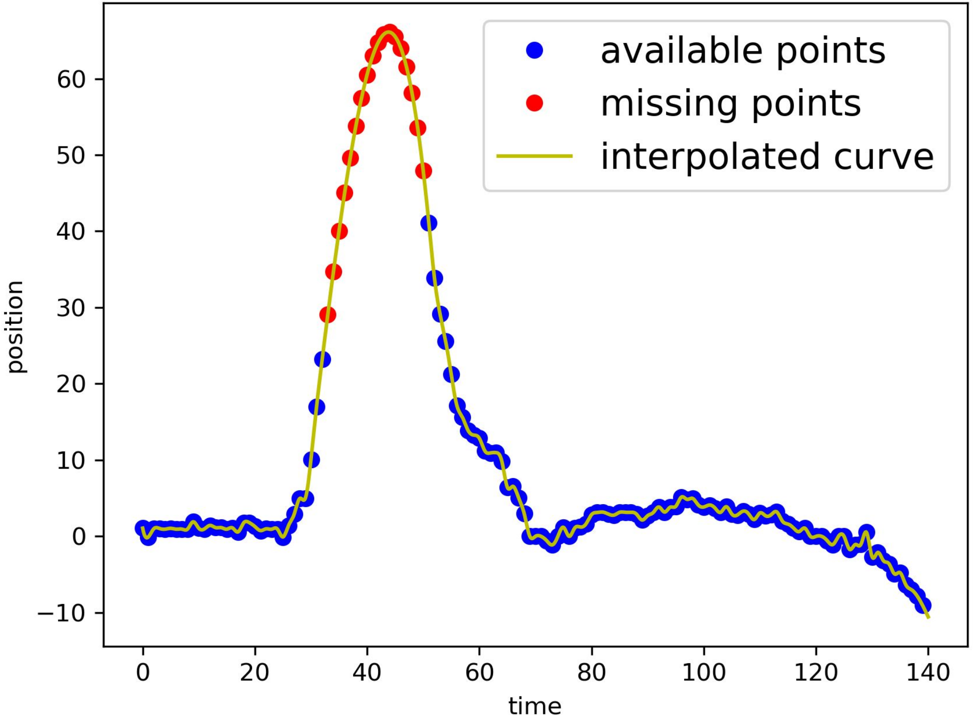
(green)	Done
(yellow)	Working



Head pose computing algorithm

- Three alternatives at the moment
  - 3D reconstruction (*)
    - Slower due to the need of matching pairs.
    - Need intrinsic parameters and ear segmentation.
  - 2D trajectory estimation (**)
    - Fast.
    - Only need ear segmentation.
    - Results are consistent but may not reflect ground-truths
      - Because of projective ambiguities.
  - B-spline interpolation (***)
    - Only use when of ear segmentation is not found.
    - Relied on past computations to predict the missing computations.
    - Accurate when most of the computations is done.

B spline interpolation

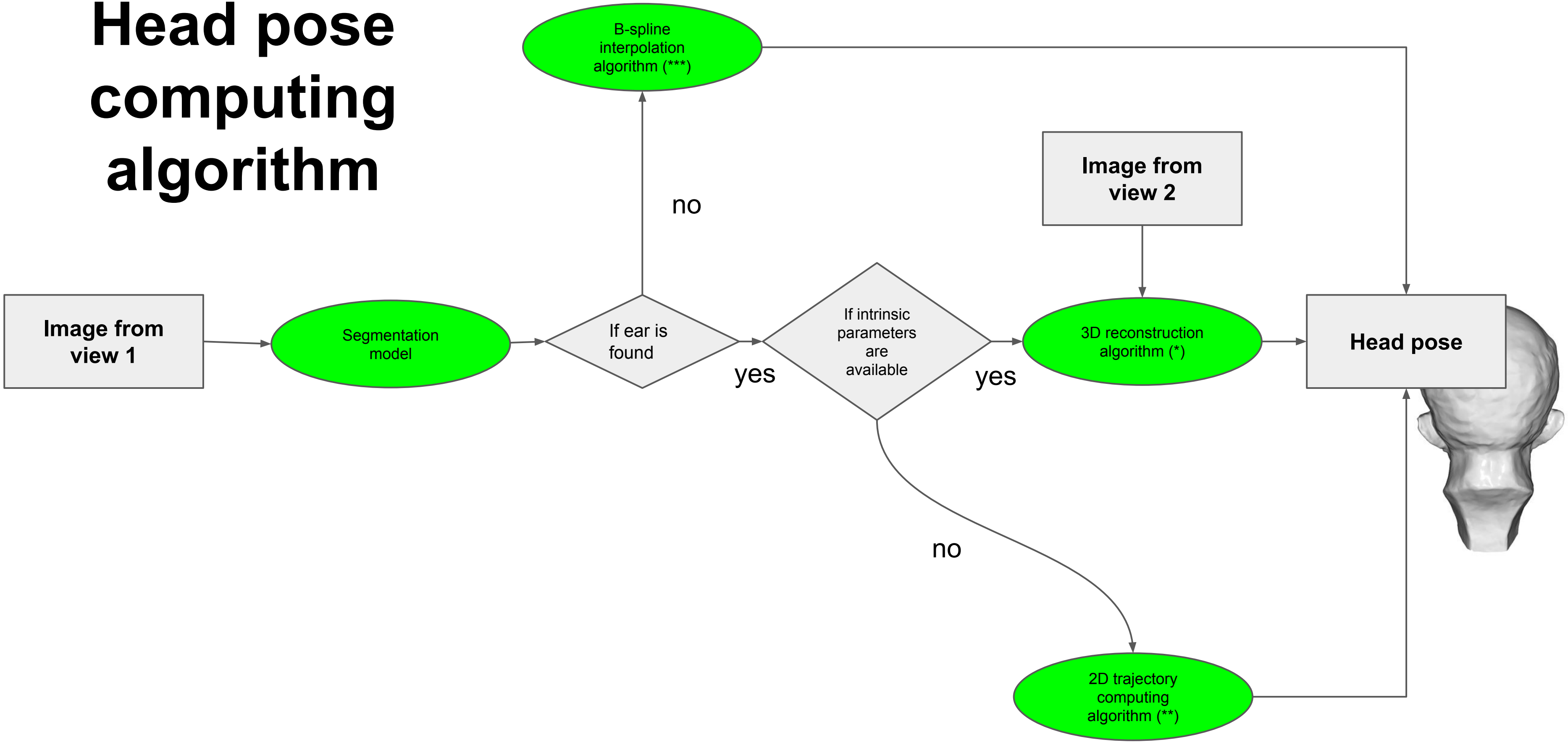


- Blue points: computation results when inputs are available.
- When inputs are not available, what can we do? (red points)

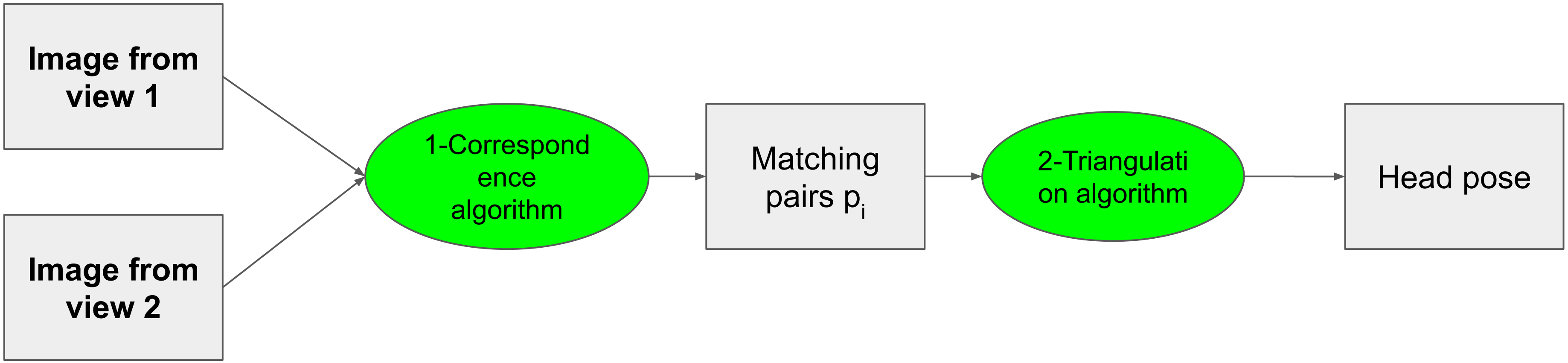
=> using B-spline interpolation, we can:

- Rely on available computations (blue points).
- And compute the interpolated curve (yellow line).
- Missing points simply lies on this curve (red points).

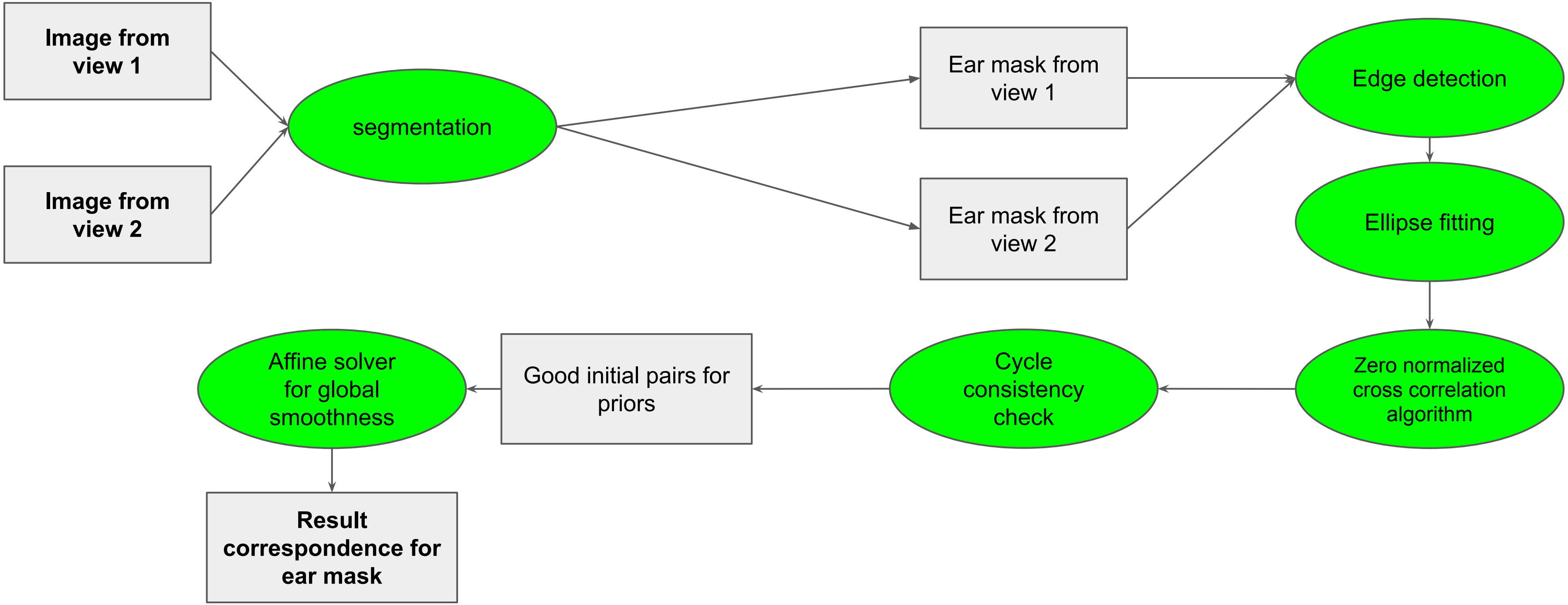
Head pose computing algorithm



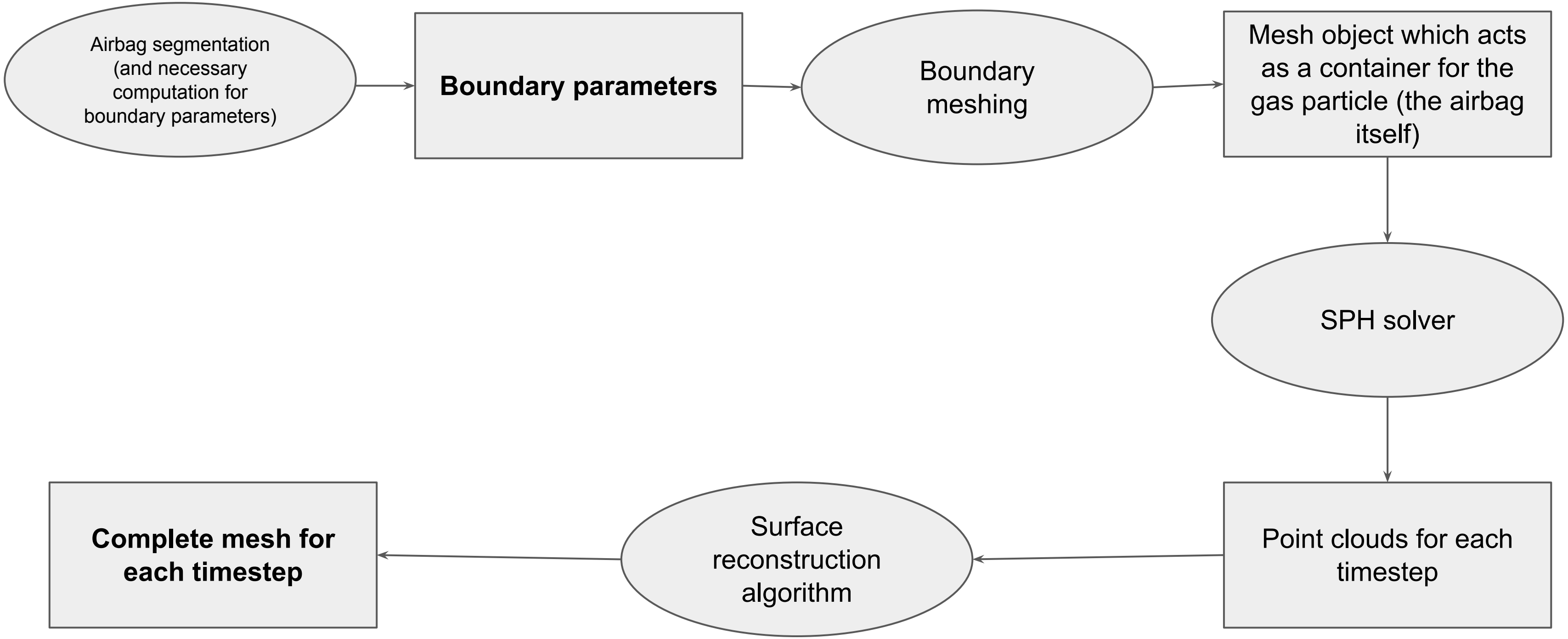
3D reconstruction algorithm



Correspondence algorithm



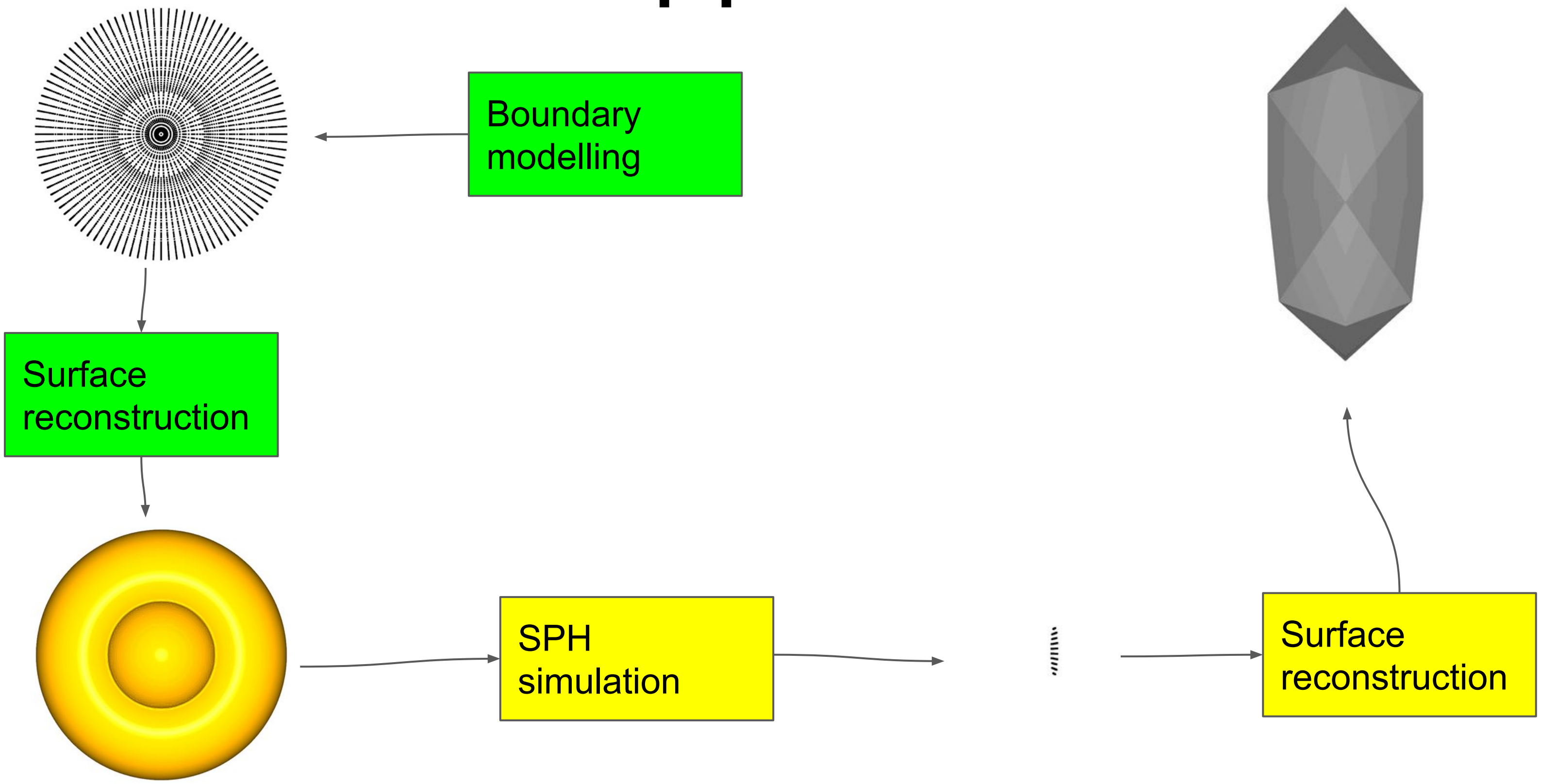
Pipeline of airbag simulation



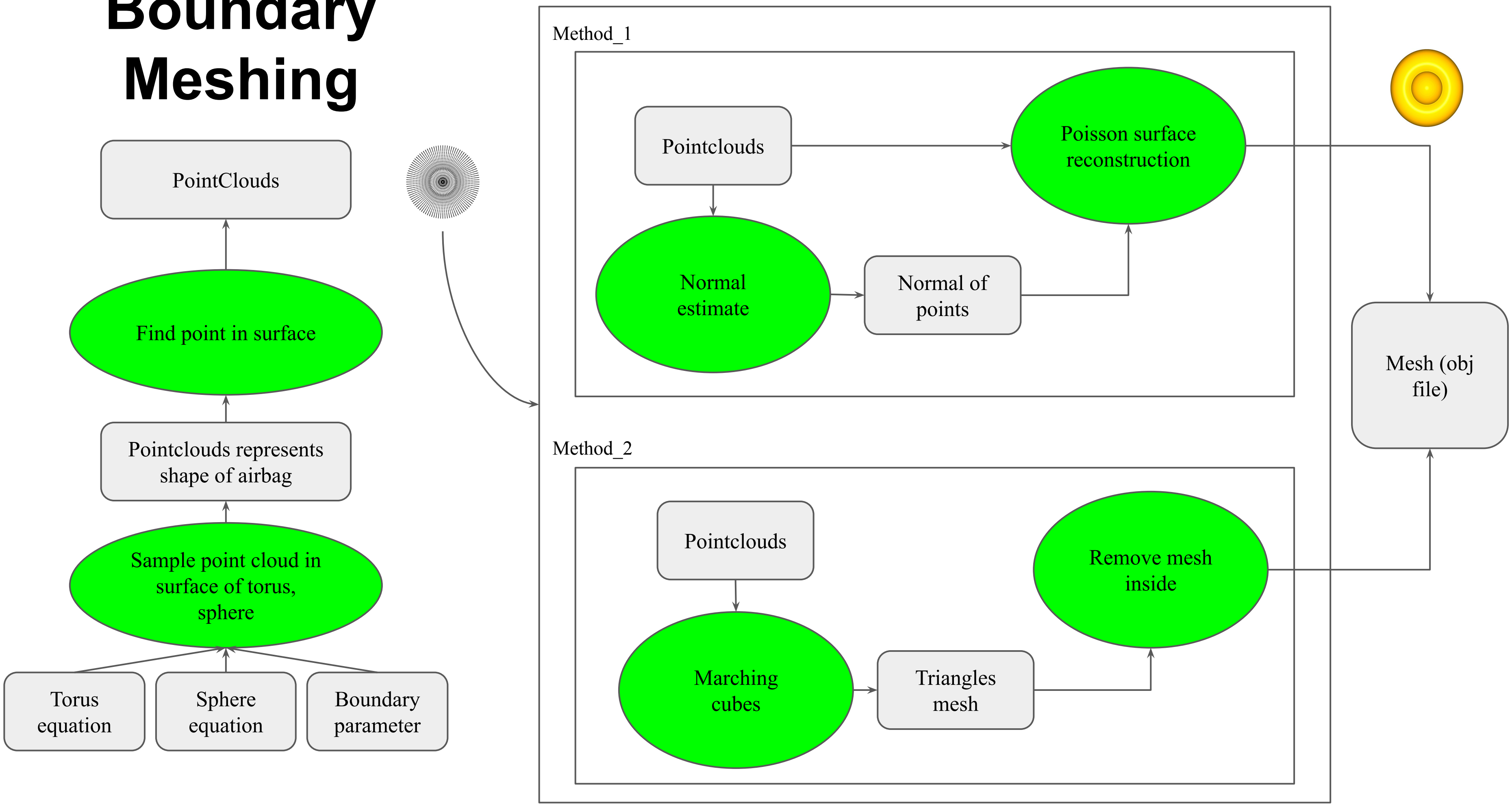
Airbag simulation

1. We sample a point cloud to represent the airbag at fully occupied stage.
2. We mesh this point cloud into a closed surface using:
    a. Marching cube (here)
        i. Very fast
        ii. Needs repairing to remove artifacts
        iii. Needs good parameters specified by the user
    b. Poisson reconstruction (here)
        i. Slower (~22 secs)
        ii. Needs to compute normals if not available
        iii. No need user-specified parameters
3. SPH solver to simulate the airbag blow
    a. We selected and tuned 2 sets of physics => 2 possible simulations to choose (here).
    b. The solver returns a set of point cloud which evolves and moves along some time steps.
        i. The evolution and movements obey the law of physics (i.e. the Navier-Stokes equation)
        ii. The boundary of the point cloud is modelled as the airbag.
    c. We then mesh all the point cloud to form a surface.

Overall pipeline



Boundary Meshing

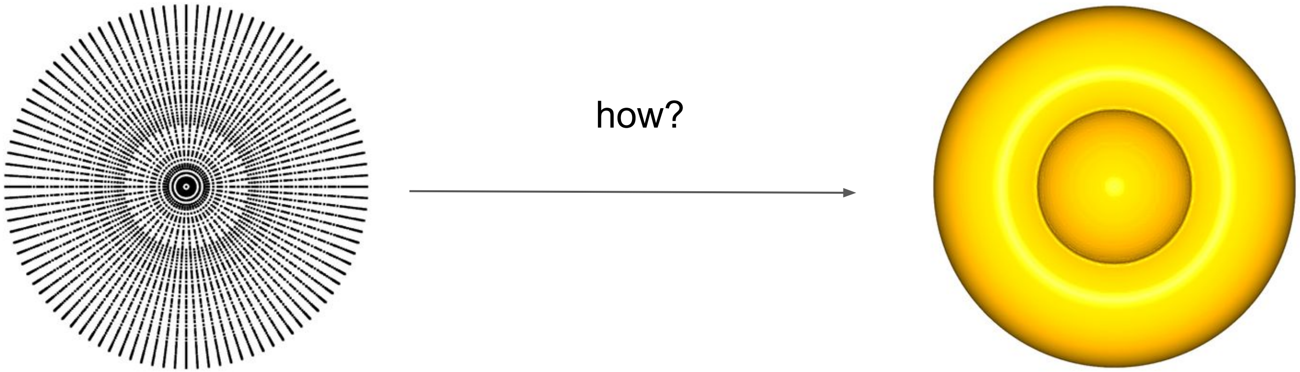


Sampled point clouds

Surface reconstruction

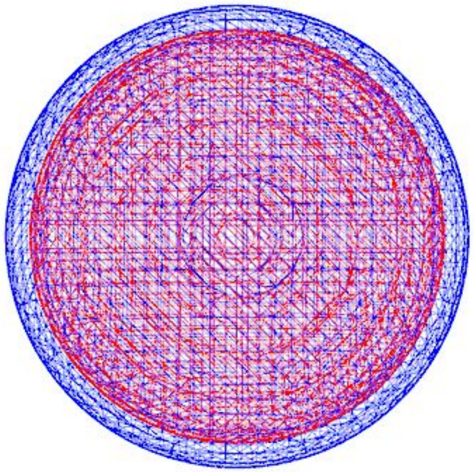
How to do surface reconstruction

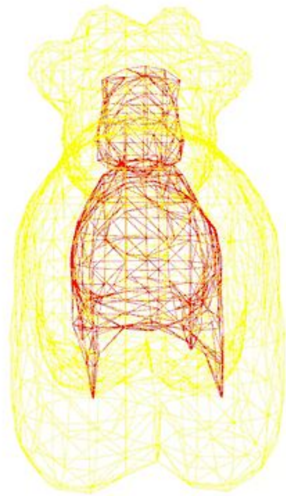
- Simulation and airbag modelling output point clouds
- We need to mesh them into surface



Surface reconstruction - marching cube

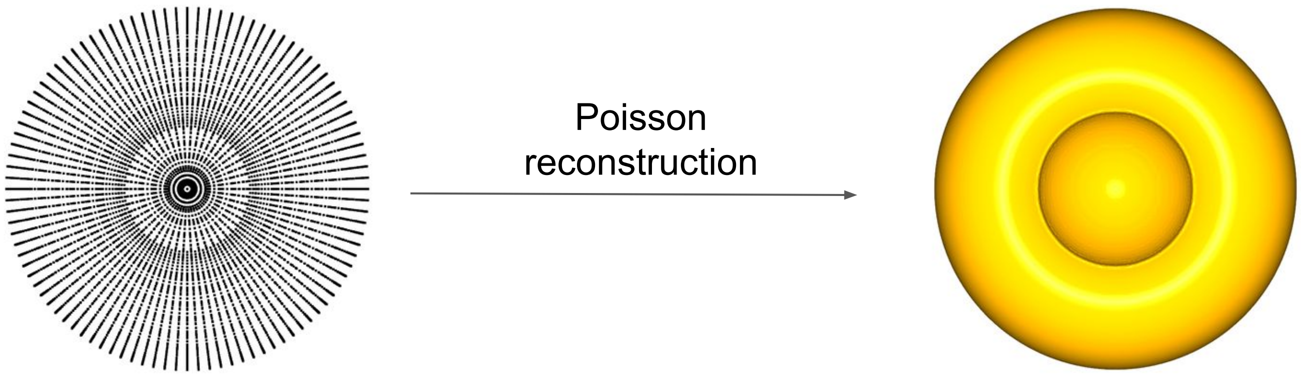
- Need to specify 2 parameters: cube size and isovalue
- Very fast due to extensive profiling and optimizing.
- Need repairing after since two meshes are produced (see below).



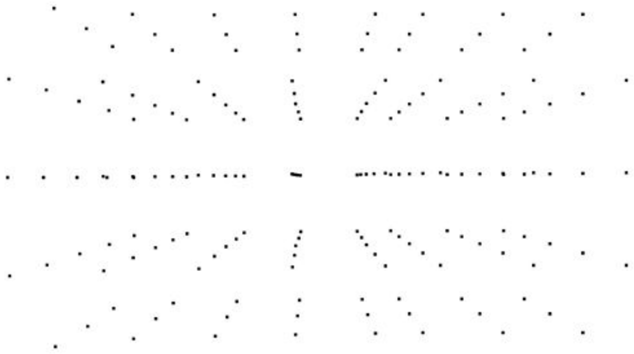


Surface reconstruction - poisson reconstruction

- Slow.
- No need for user-specified values.
- Need normal estimation, hence not really appropriate for dense point cloud.



Two possible SPH simulations



Option 1

Option 2