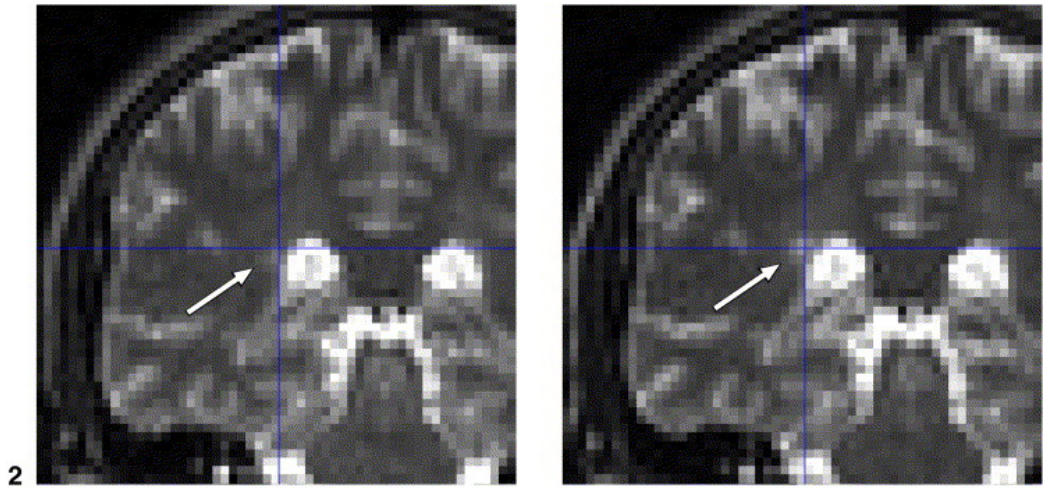
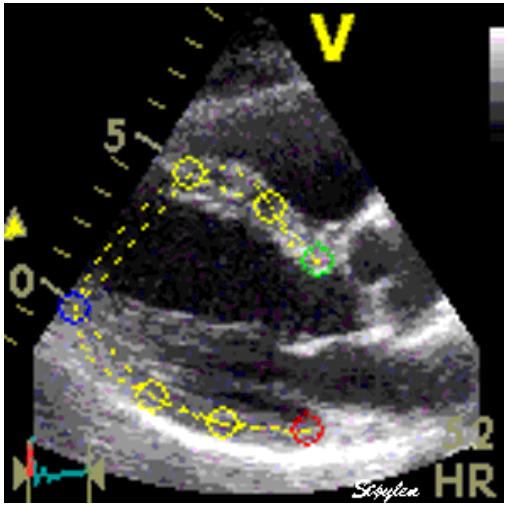
Analysis of temporal sequences

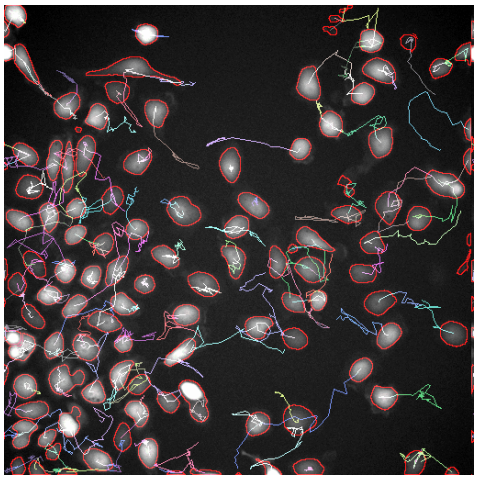
Classes of problems



Change detection



Motion tracking



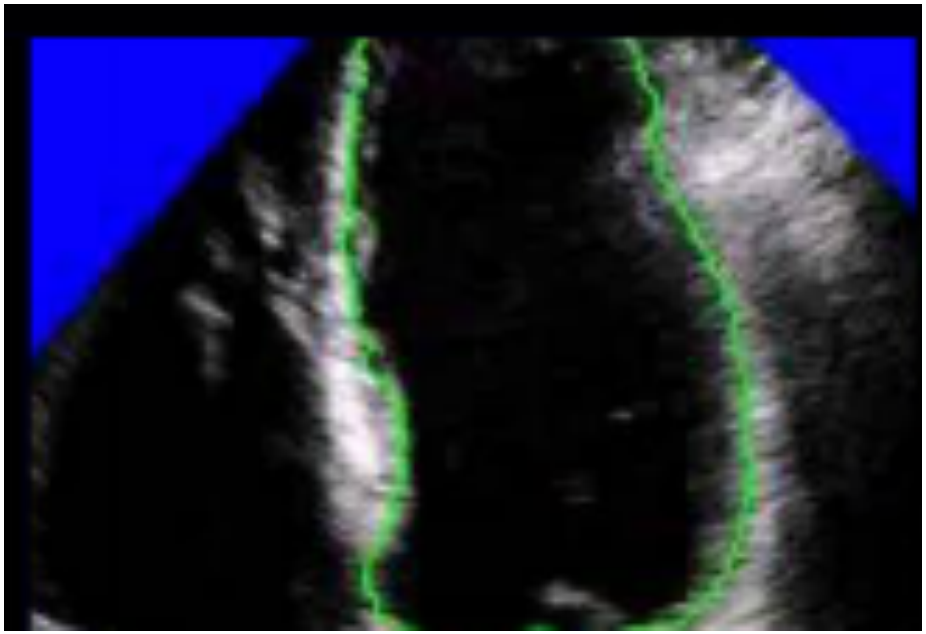
Object tracking

Change detection

- Image subtraction
- May require image registration prior to subtraction
- Affected by non-significant changes in the background

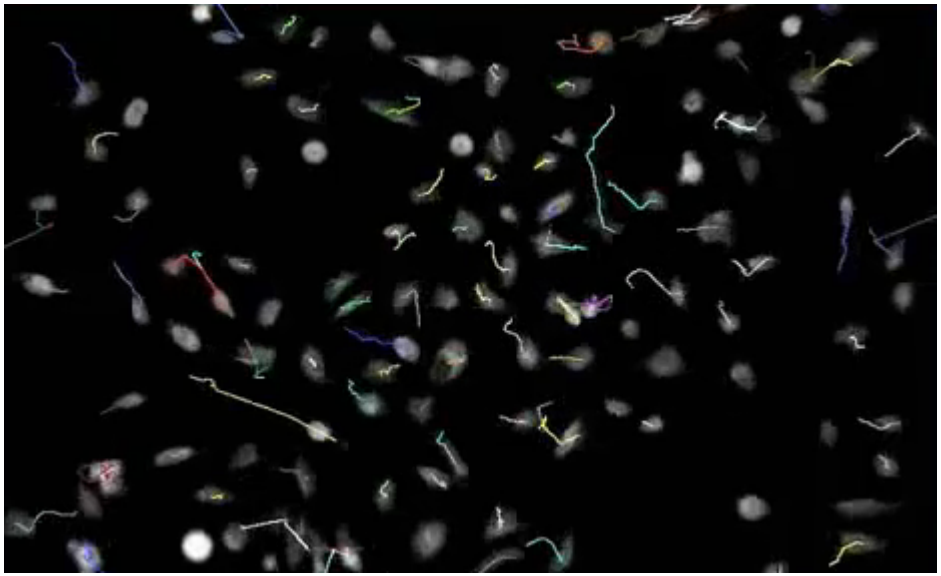
Motion tracking

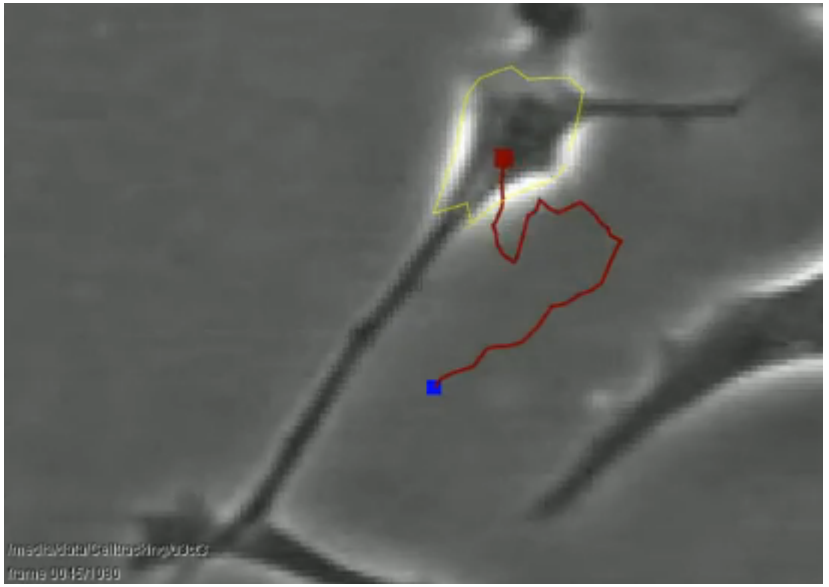
Example: left heart ventricle tracking



Motion tracking

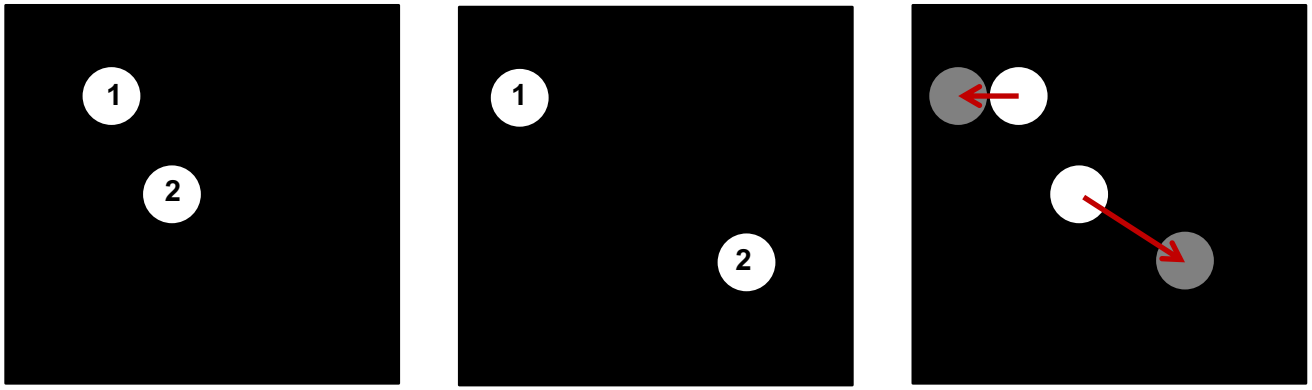
Object tracking



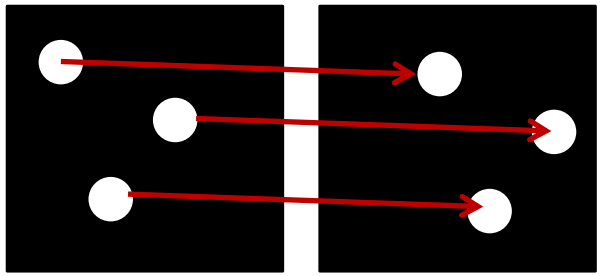


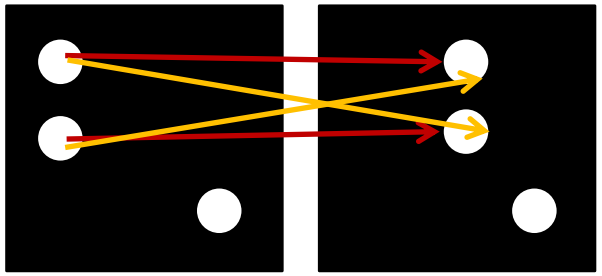
Object tracking – key processes

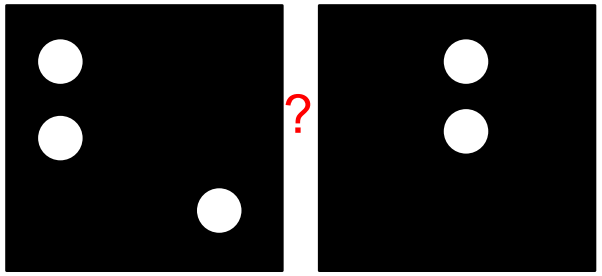
- Object detection
- Assigning a unique label to each object (labelling)
- Trajectory linking

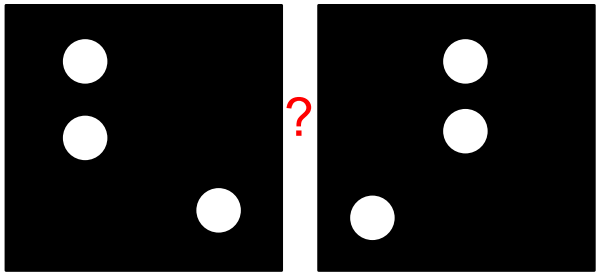


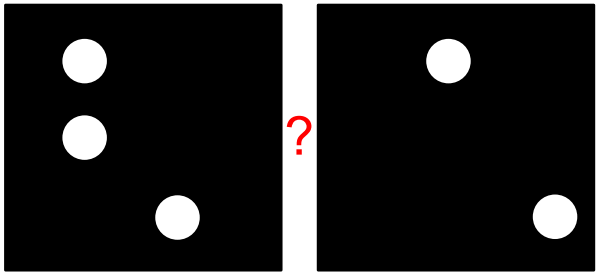
Trajectory linking - problems

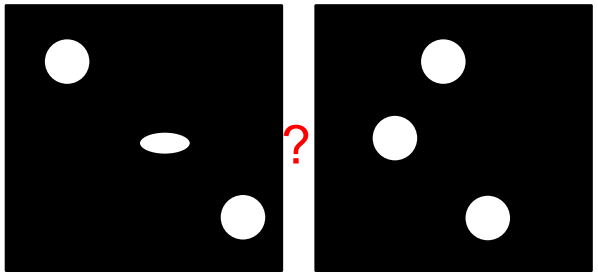




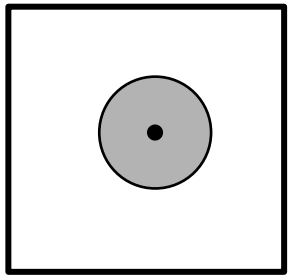




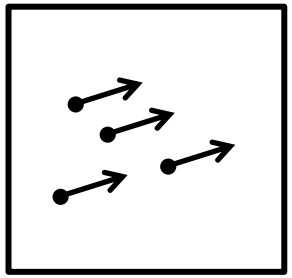




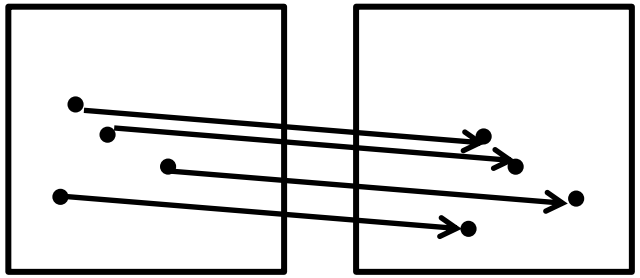
Trajectory linking - heuristics



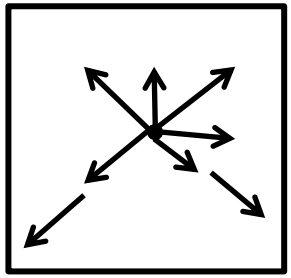
Maximum velocity



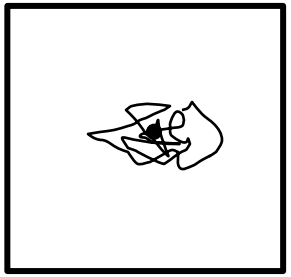
Common motion



Consistent match



Model



Model

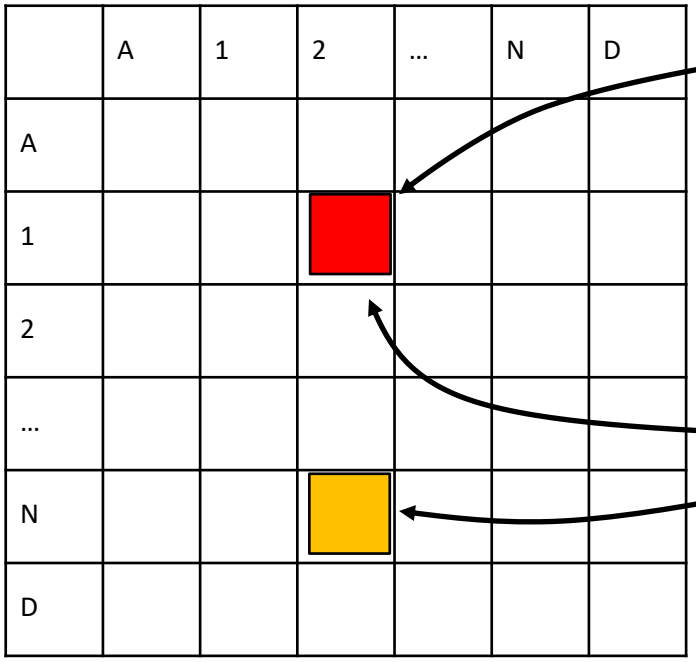
Trajectory linking - probabilistic models

- Distribution, for example Gaussian with a given mean and standard deviation, to characterise
  - Velocity
  - Angular change of direction
  - Motion model (linear, brownian, expansion, contraction)
  - Change in brightness (e.g. bleaching)
  - Change in size or shape
  - Transition probability from one model to another
  - ….
- Markov models

Trajectory linking via optimisation

- Trajectory linking amounts to finding the most likely match between the detected objects in two or more frames
- Probabilistic methods using motion and object models are most successful but quite complex
- In simpler scenarios the use of association matrix can work well.

Association matrix

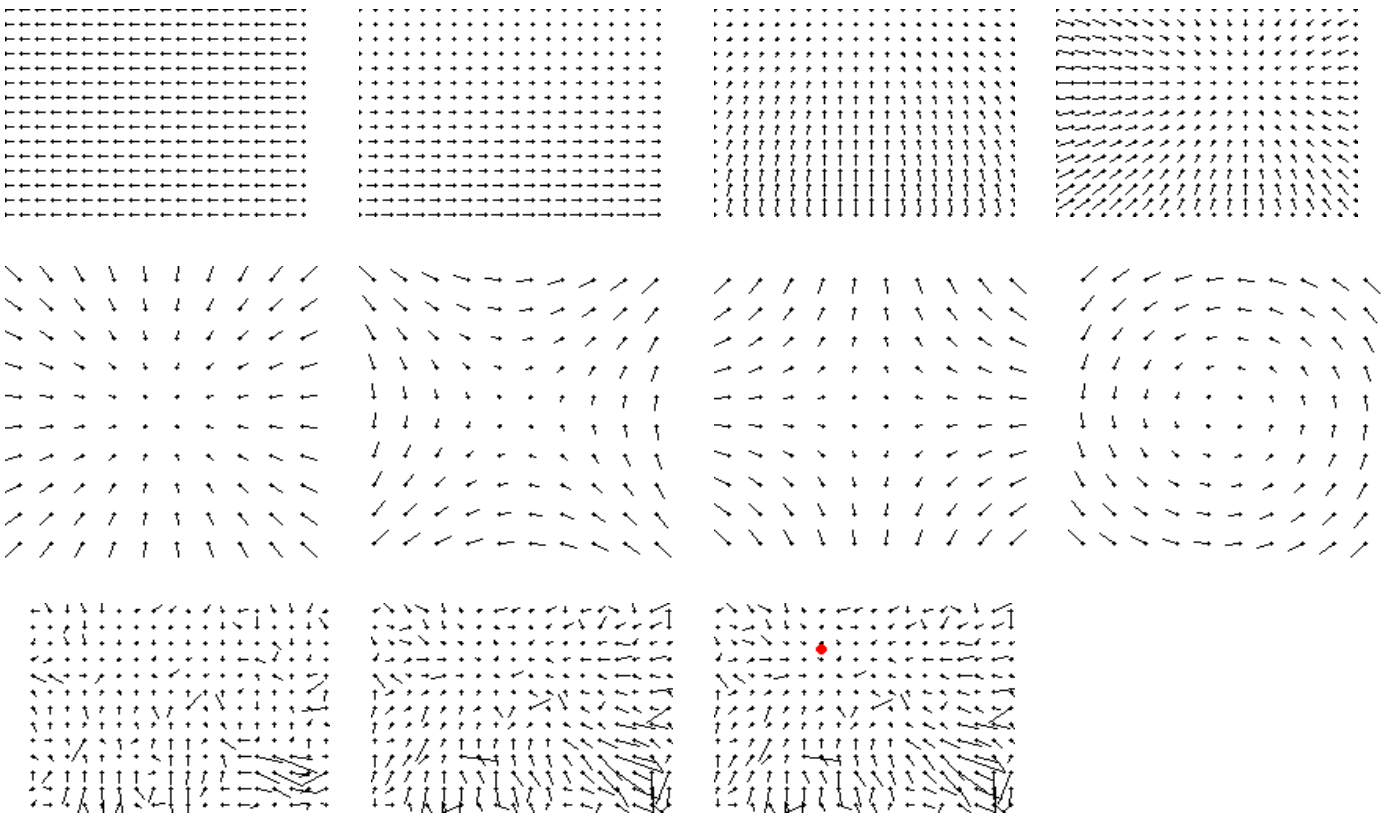


Cost associated with linking object m (2) with object n (1) based, for example, on difference in position, velocity, brightness.

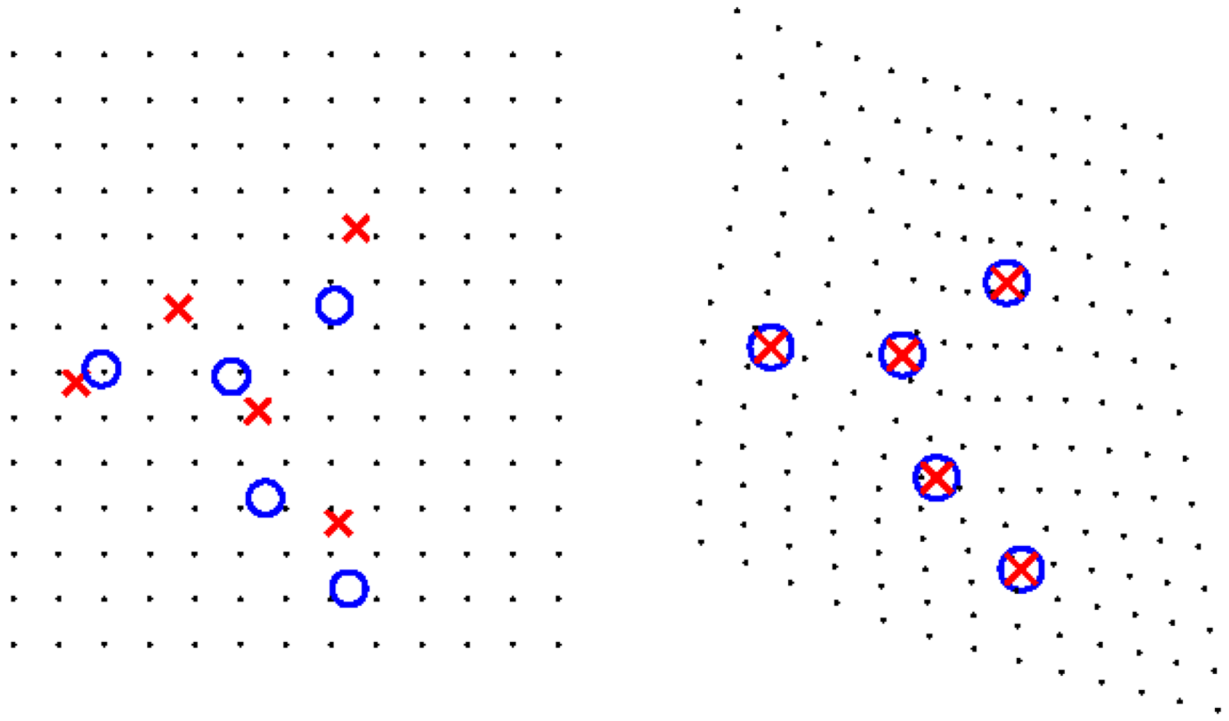
If there are several potential matches, the one with the lowest cost wins.

Characterising motion

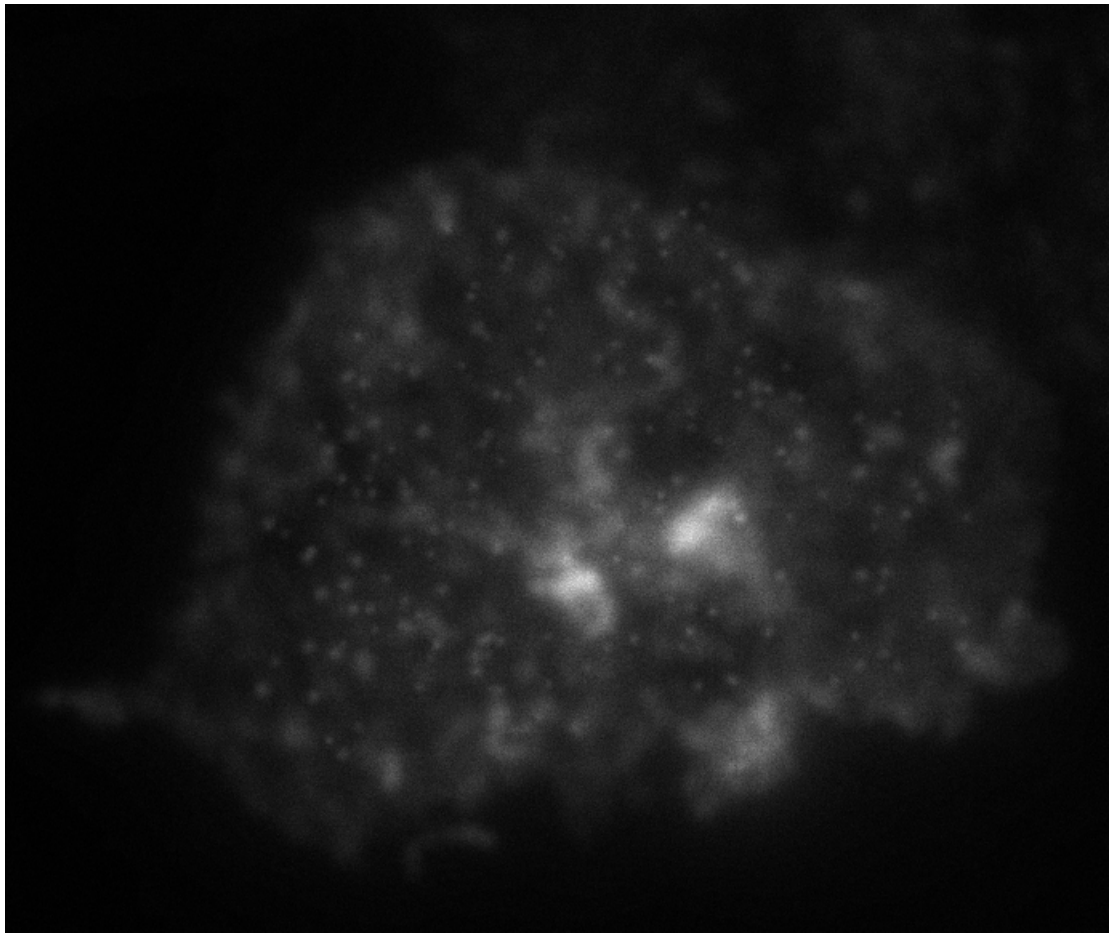
- Once tracking is completed motion can be characterised, for example using vector flow fields



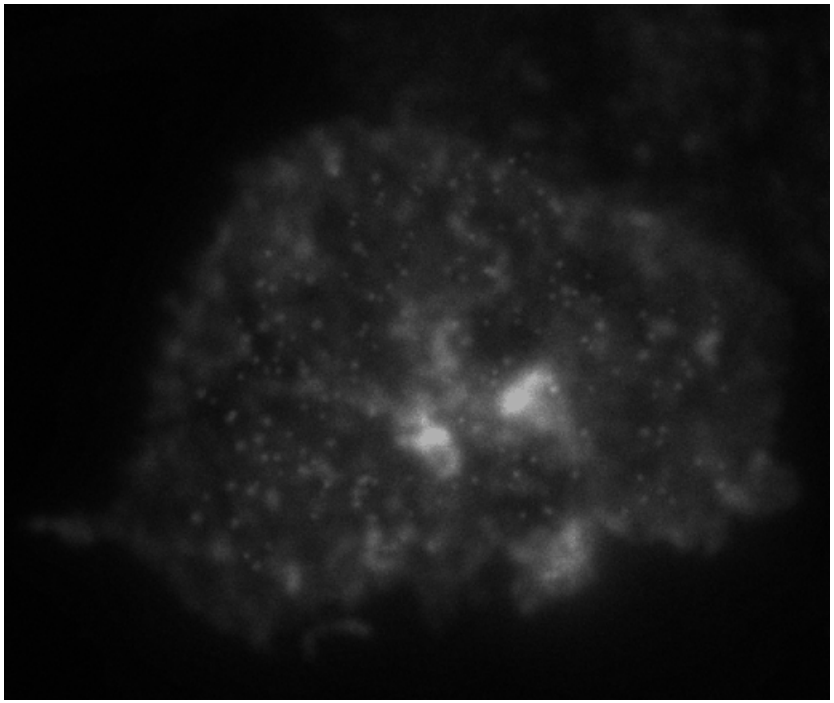
Tracking via registration
(elastic matching)



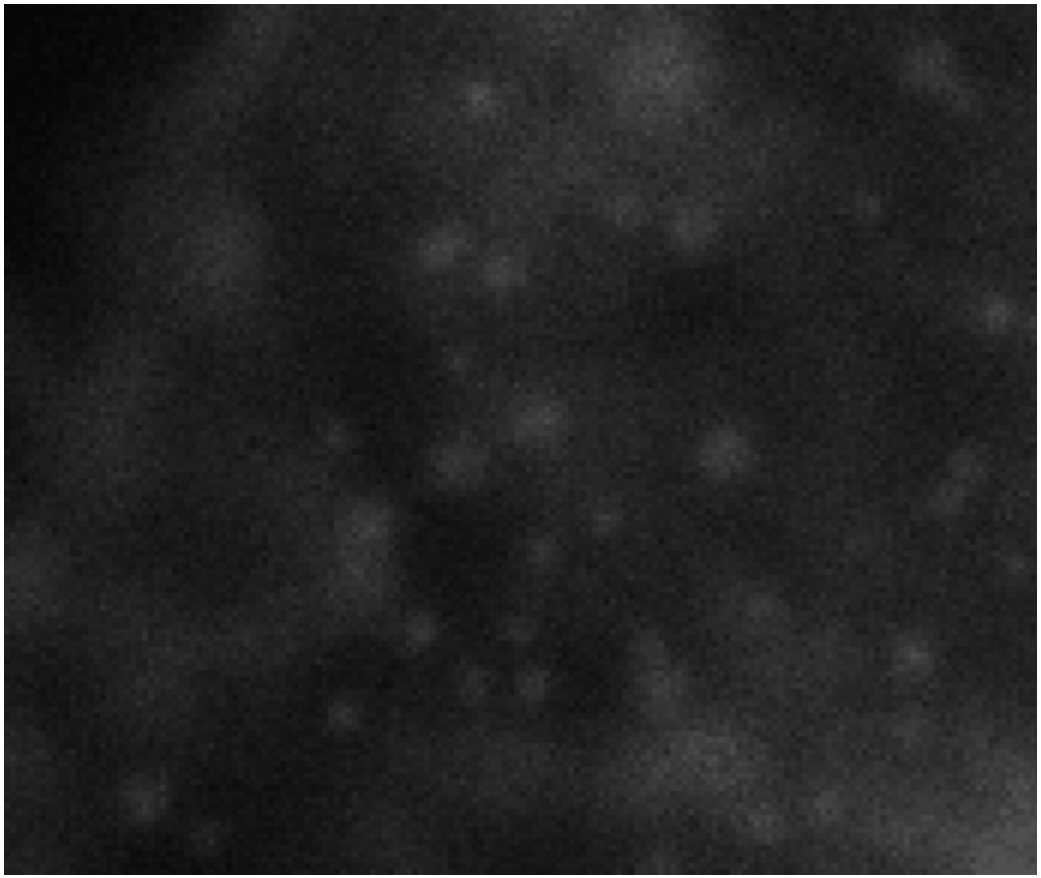
Examples



Examples



Example



Matlab demo