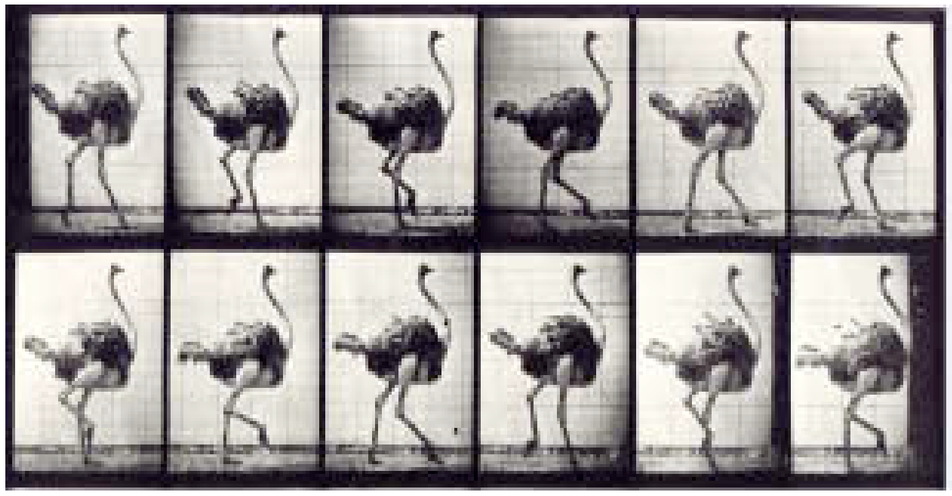
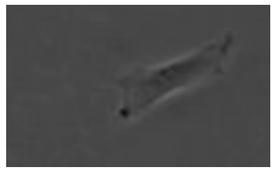




Machine Visual Screening

Arman M. Garakani
Chief Technology Officer Reify Corp

MIT Cambridge 12 14 05

Outline of talk

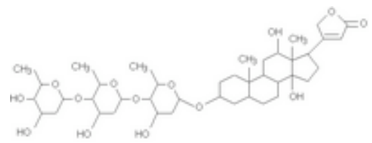
- Motivation
- Why is it hard ?
- Why is interesting ?

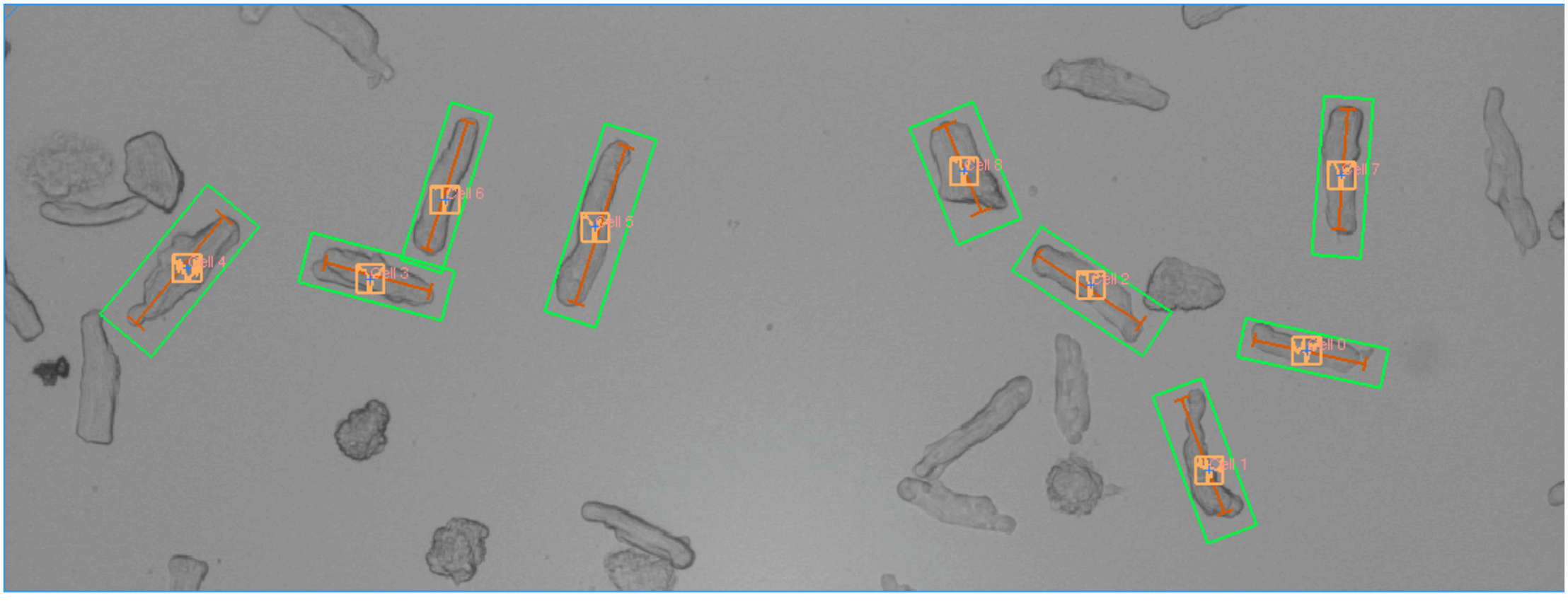
From bedsides to cells

Video by Dr del Monte

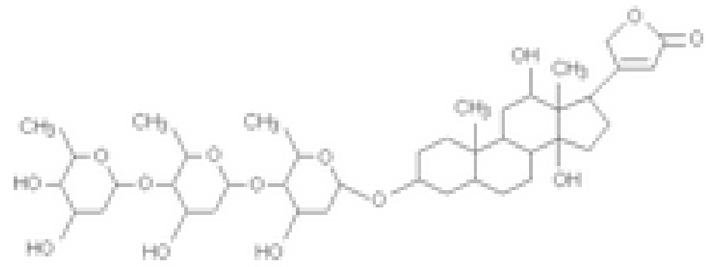
One of the few treatments for CHF

Digitoxin

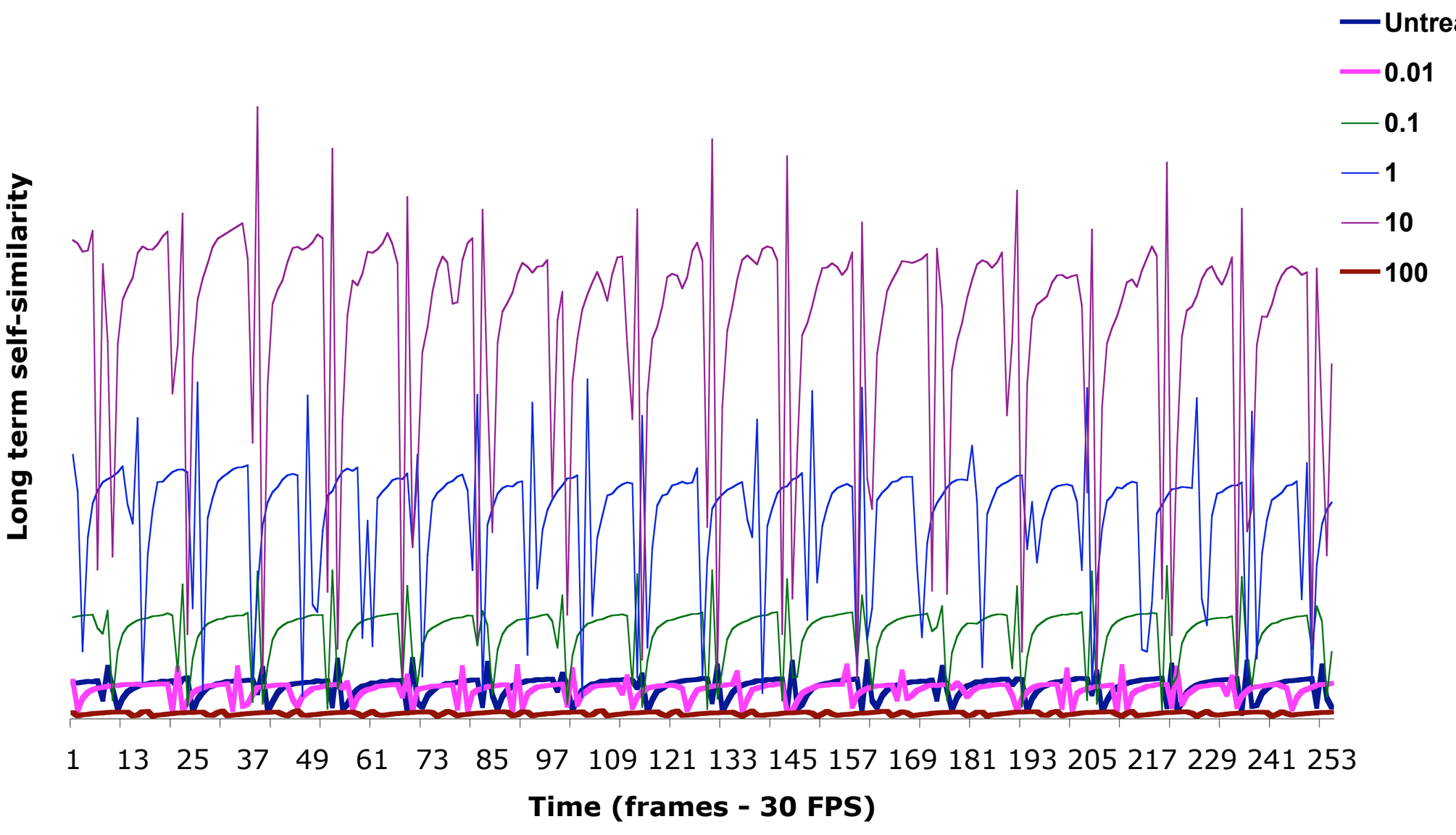




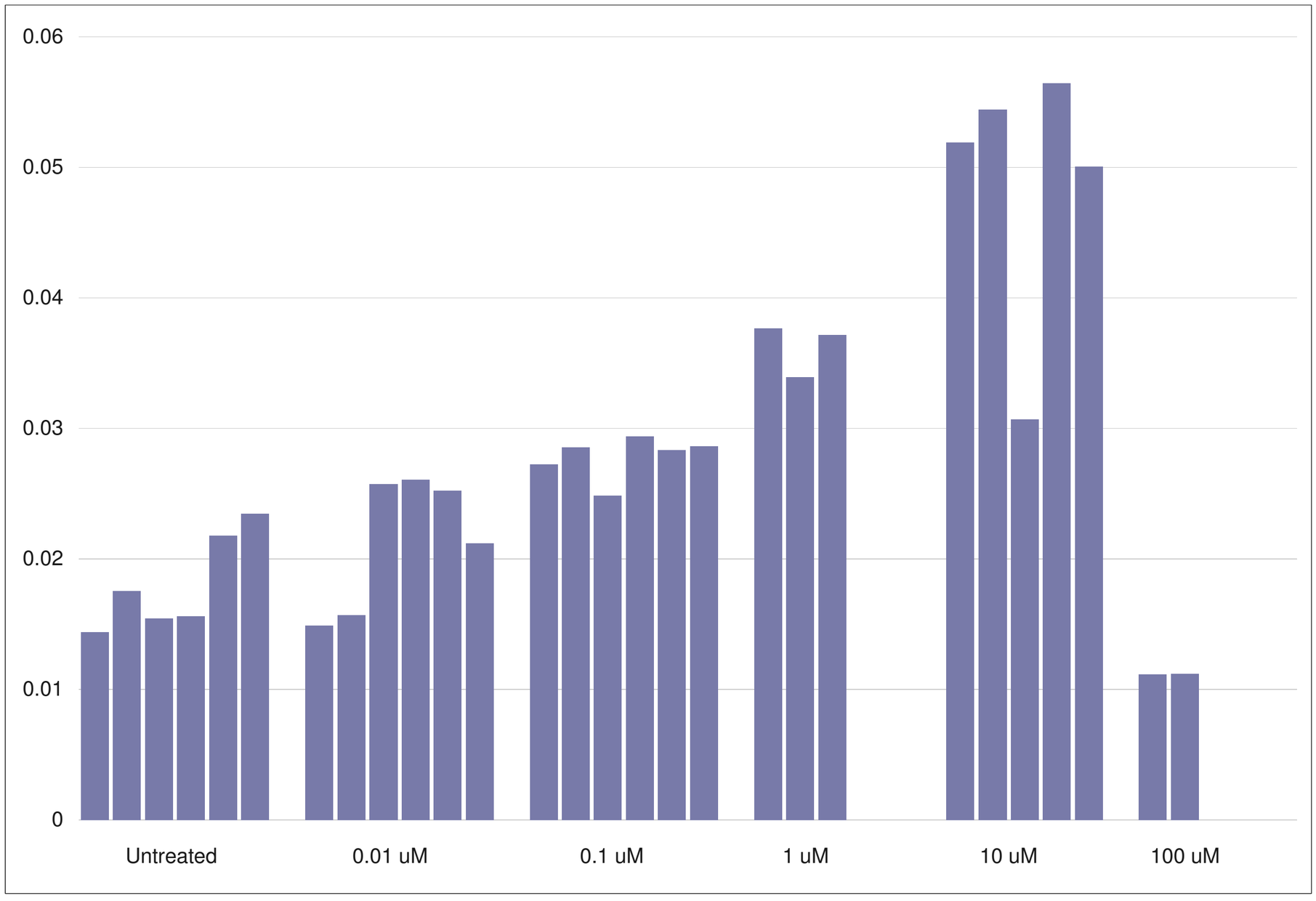
Digitoxin



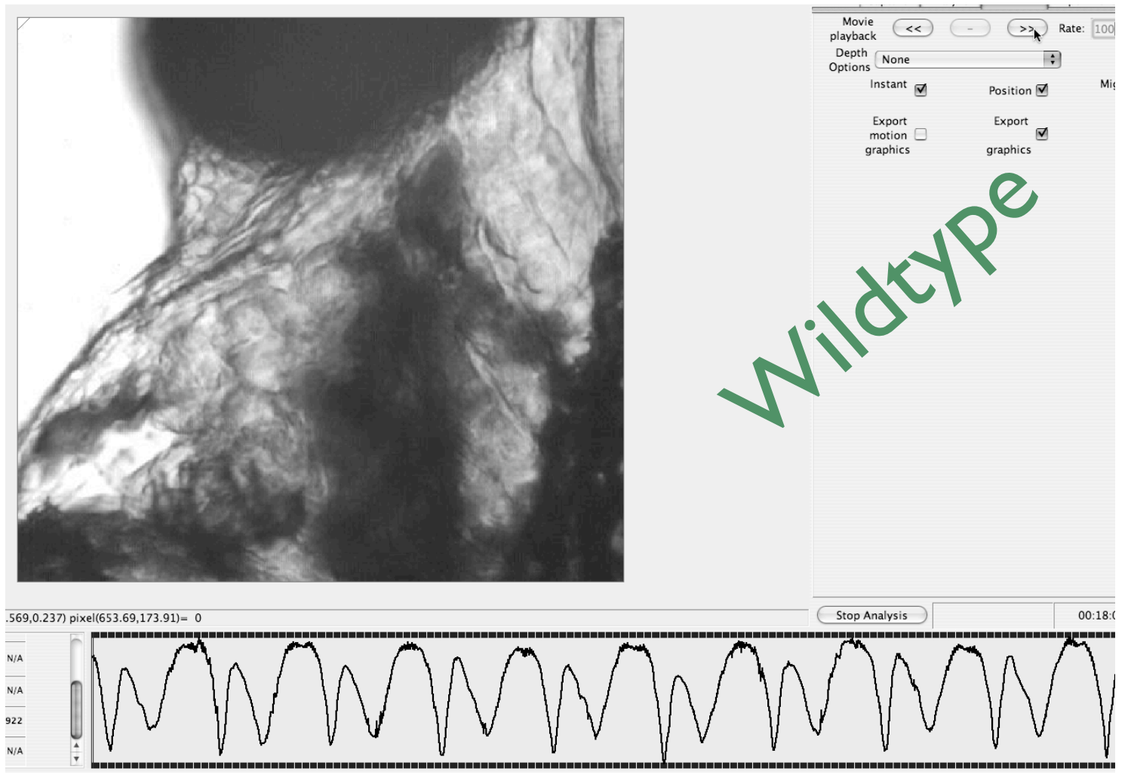
Digitoxin Paced Cardiomiocyte Dose Experiments
Whole Plate Readout (uM)

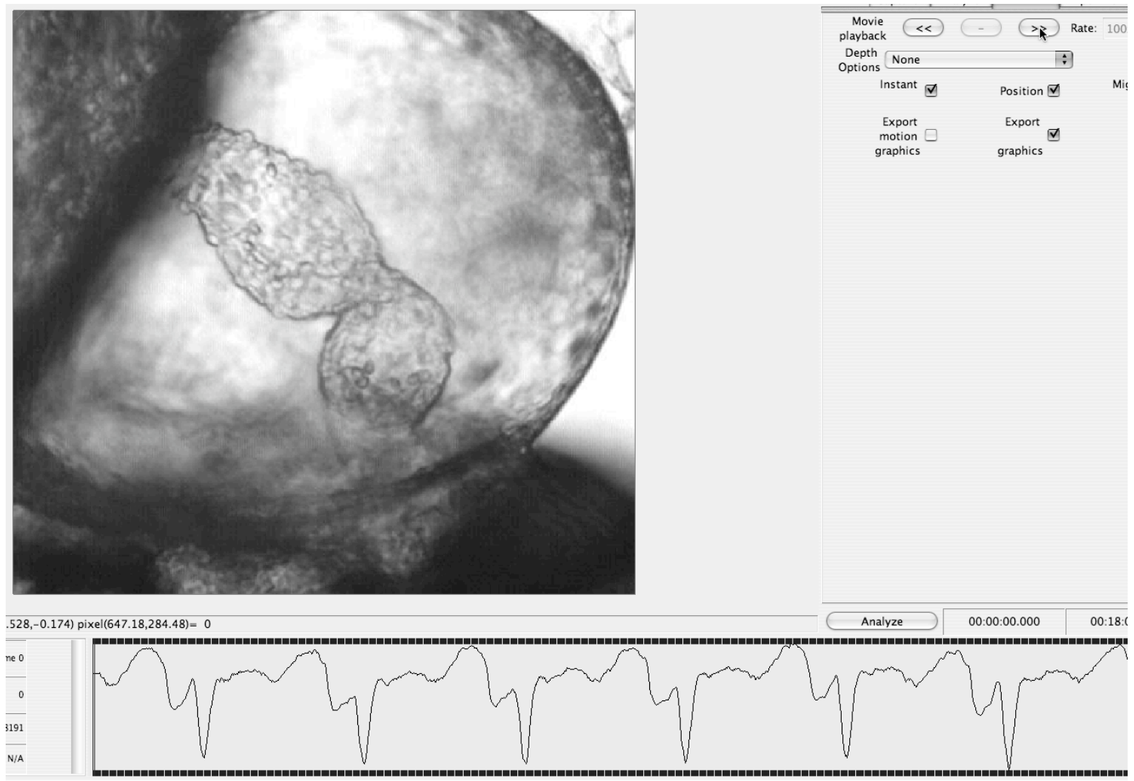


Geometric vs Morphometric

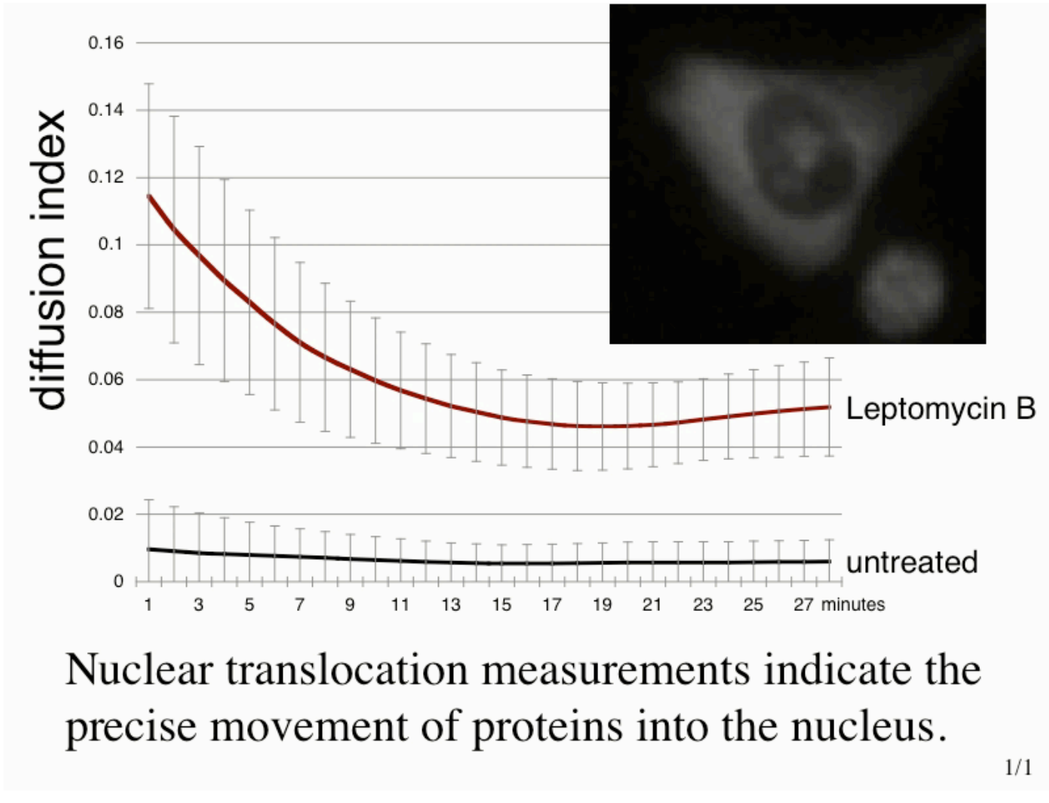


Same Organ Different Specie
Same Algorithm Same Parameters



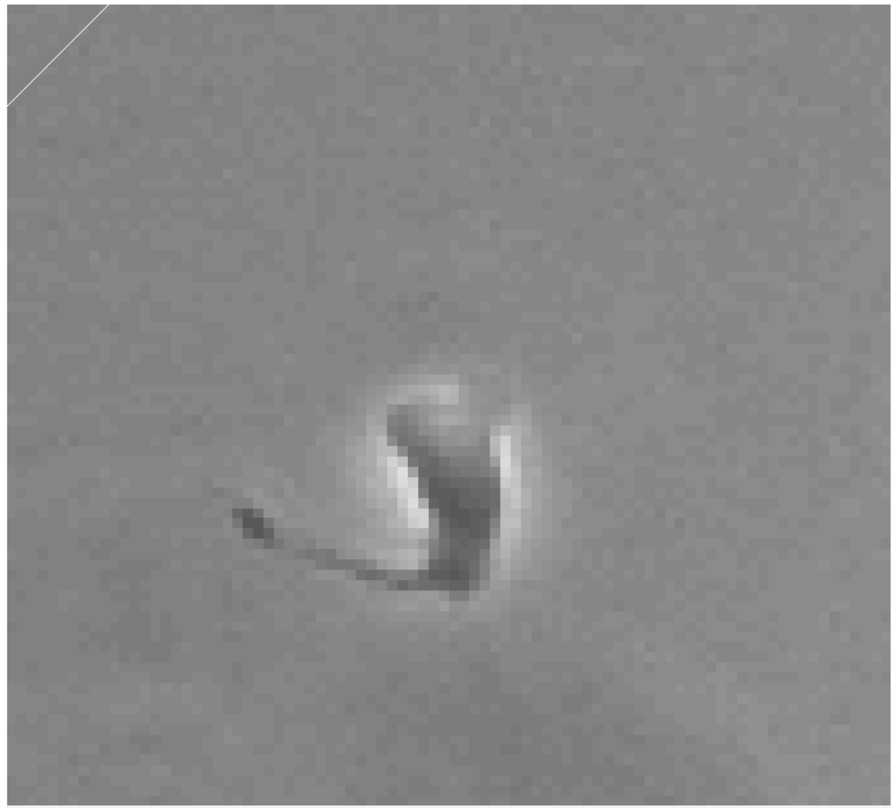


Movement is the phenotype



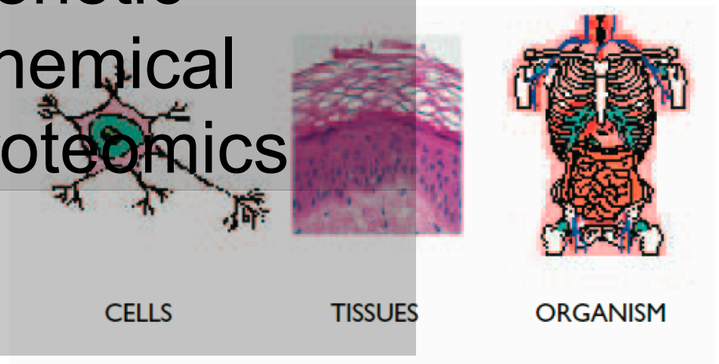
Nuclear translocation measurements indicate the precise movement of proteins into the nucleus.

1/1



Machine Visual Screening
Better screening...faster

Genetic
Chemical
proteomics

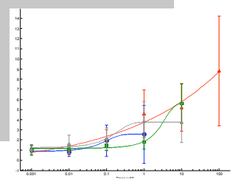


Capture

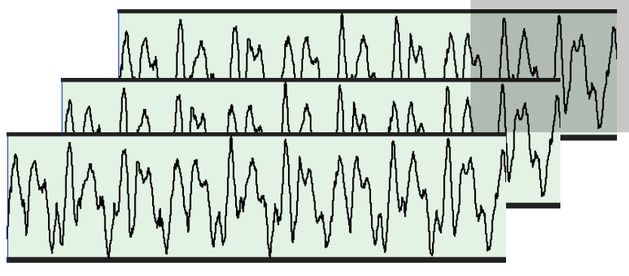
Real-time feedback
QC of Capture
Adaptive Capture /
Display and Storage

Biological
Function

Compare



Quantitate



“Gestalt” whole plate
functional
localization based on Motion
Morphometric speed and
acceleration

History

Industry

Thresholding/Binary

Scale Space

Assisted Tracking

Differences (DIAS)

Average Template

Academic Research

cell migration: Lauffenberger

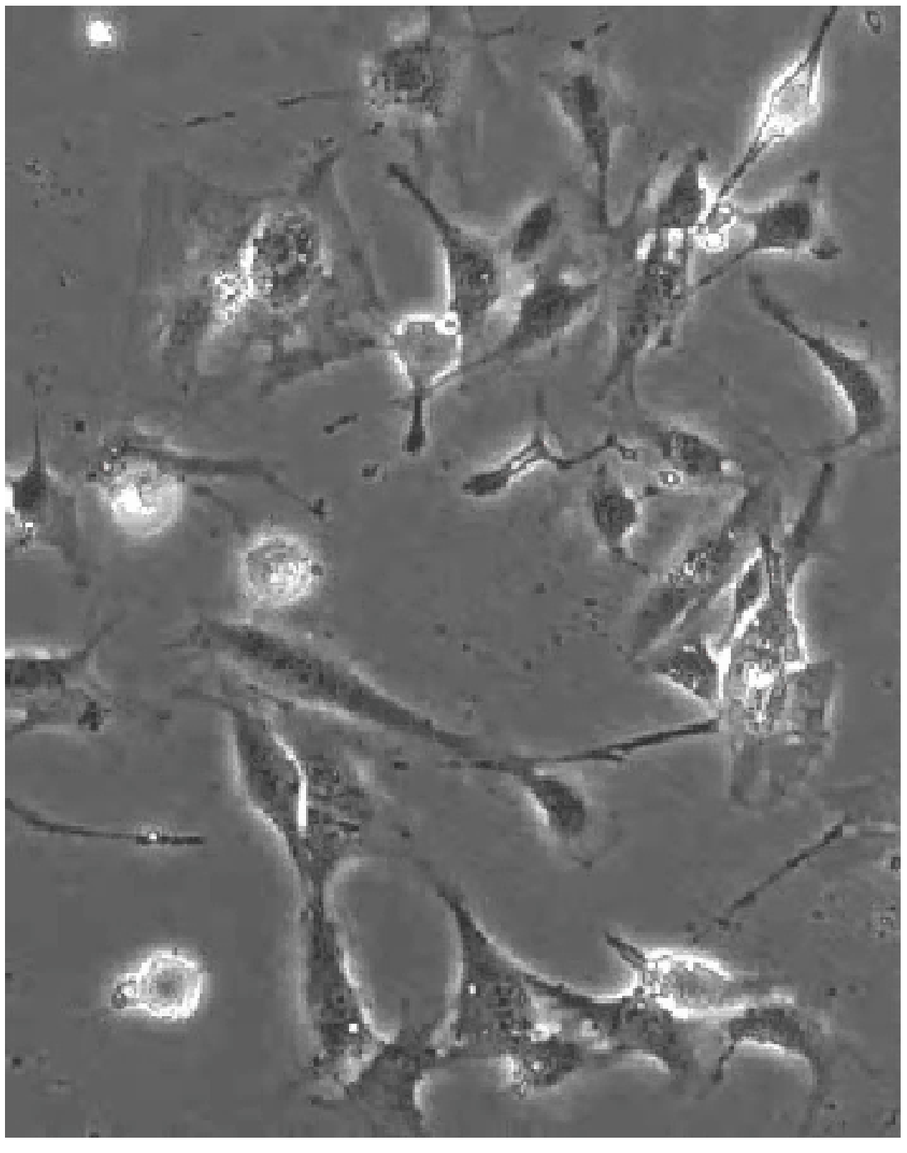
Mathematical Modeling: Blum, Zucker,

Random walks: Brown, Turing

Population Alignment:Lutscher

Phenomological .vs.biophysical: Dunn / brown

Why is it hard ?



What

where &

when

Video by Dr Marc Sitbon

Sampling

To optimize the balance between sampling rate and data volume, *attentive capture* continuously modifies temporal sampling parameters (i.e. frame rate, shutter speed, exposure, etc...) based on events of interest in the scene.

Attribute of interest

Under sampled

Over sampled

Attentive capture

Morphological Change Over Time

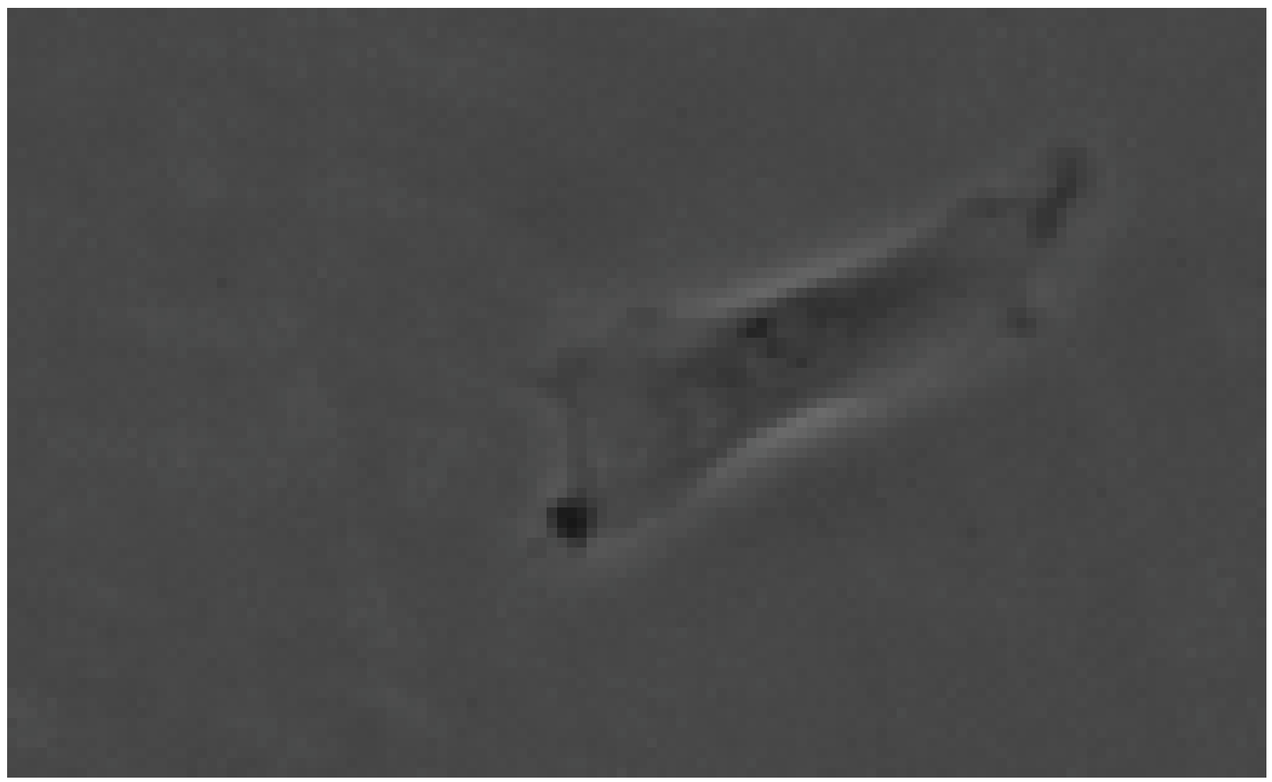
- Imaging relationship:
  - $I(P(x)) = M(P^{-1}(x)) + noise$
    - I image pixel data
    - P pose of an object
    - x position vector
    - F function image formation function: lighting + shape + etc
  - $I(P(x, t)) = M(P^{-1}(x, t))) + noise$
    - t time

Register:
Fine but not finder

$$I(P(x, t)) = M(P^{-1}(x, t)) + \text{noise}\ ?$$

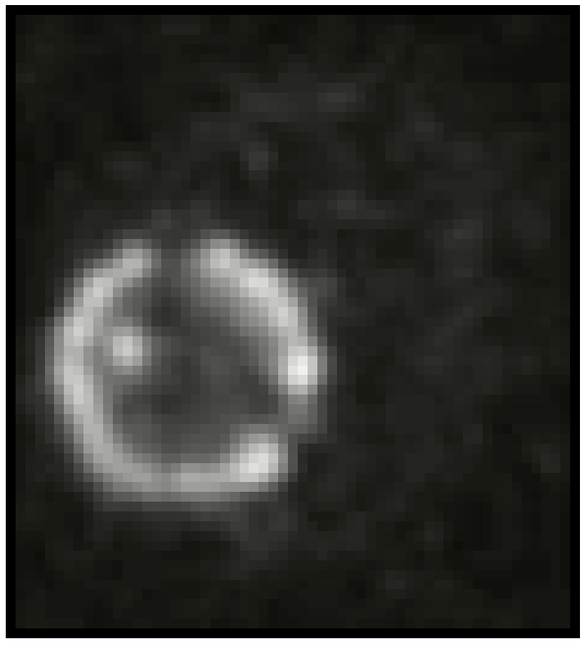
discrete pixel data

Mapping Function
surface orientation, reflection, ...



Morhological Change Over time

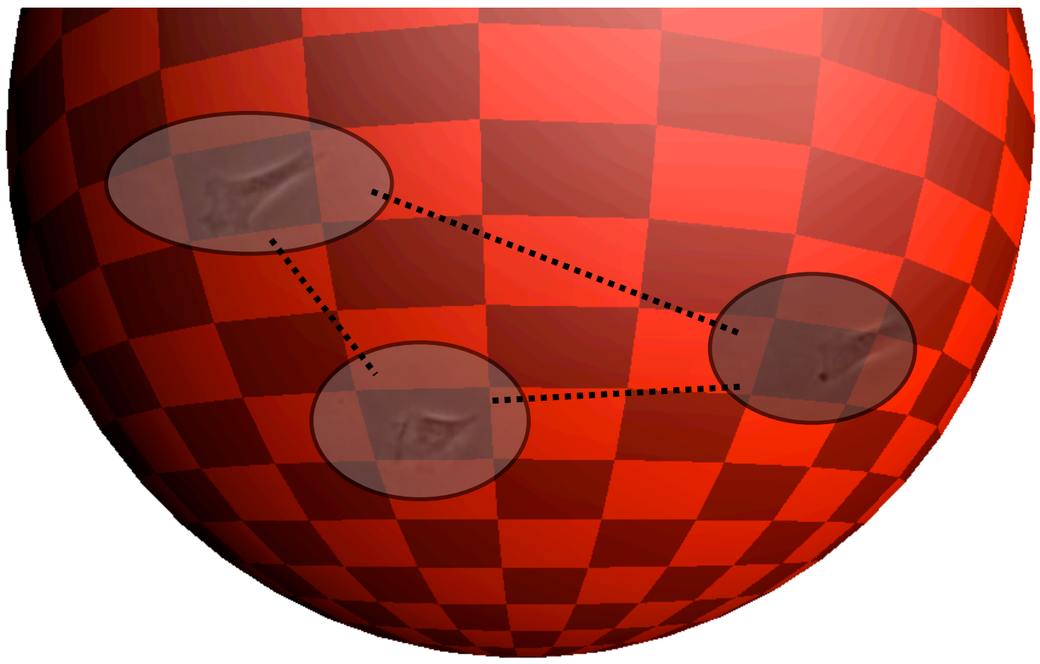
$$I(P(x, t)) = M(P^{-1}(x, t)) + \text{noise}$$

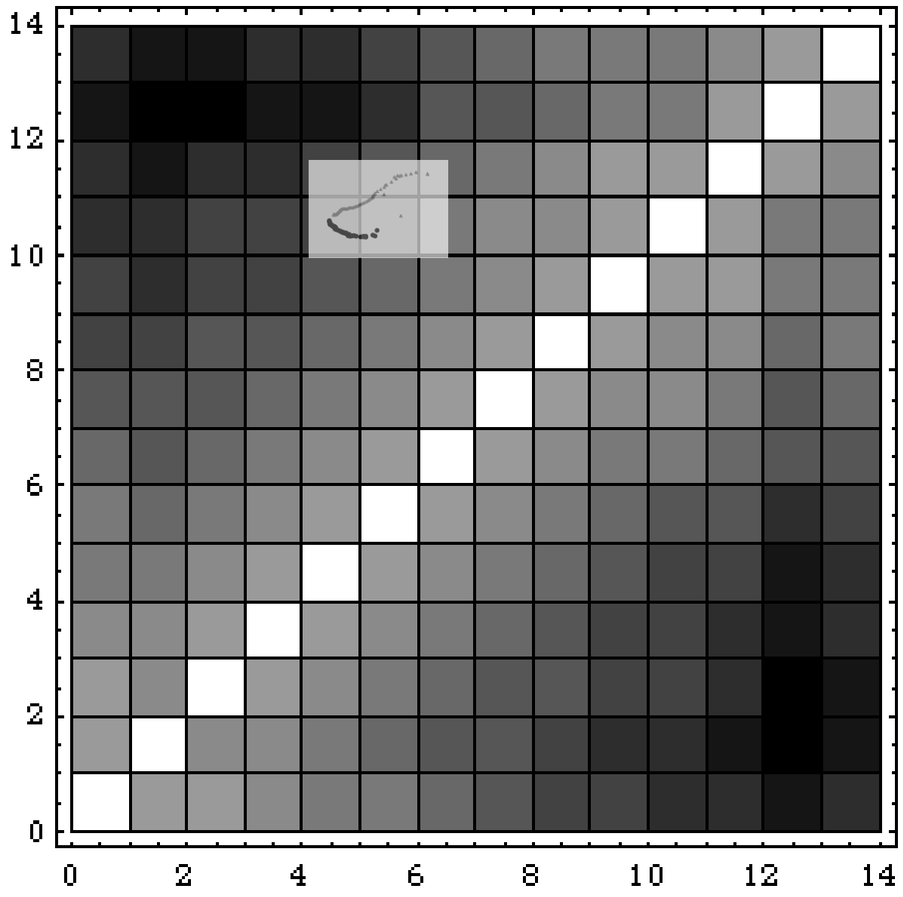


Diffusions
Oscillations

Cockell M. & Gasser S.M., "Nuclear Components and genetic regulation", Curr Op Genetic Dev, 1999

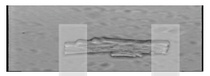
Morhological Change Over time



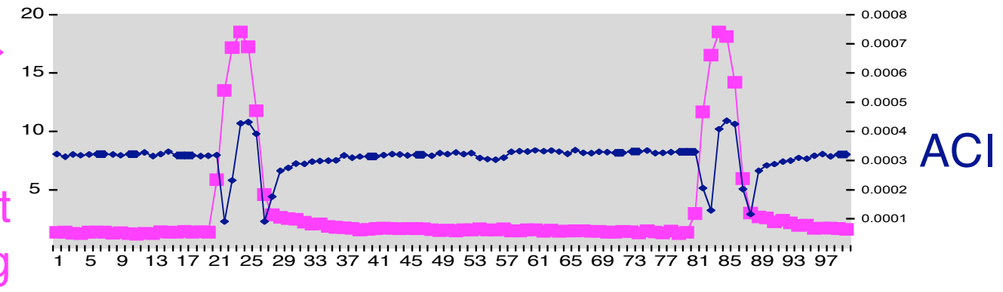


Muscle length vs. Aggregate Change Index

Use information from all the frames for the unsupervised ACI measurement.



Measure the length directly using a supervised approach that involves identifying the cell boundaries.



percent shortening

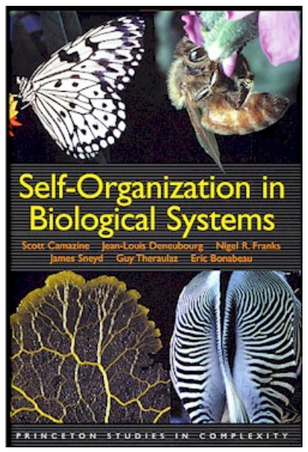
ACI

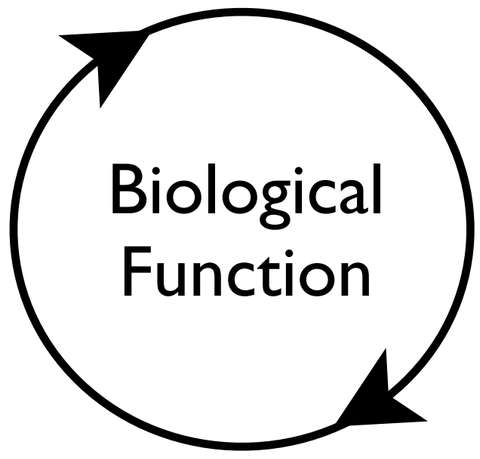
Self-Similarity

"A time varying phenmomena is called self-similar if the spatial distribution of its properties at various moments can be obtained from one another by a similarity transformation" (Barenblatt in "Scaling, self-similarities, and intermediate asymptotics")

"Equality Reynolds Numbers imply geometric similarities in flow patterns " (Steven Vogel in "Life in Moving Fluid")

Why is it interesting ?





Capture to maximize
mutual information
or joint statistics
over time

Self-similarity
Locally and
globally

Thank you for listening!

- Collaborators
- Everyone at Reify
- Bill Silver and Marilyn Matz at Cognex