Bio-Search: Current Practices and Frontiers

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Cyttron

- Goal: The ultimate scientific microscope
  - identifying the molecular causes of disease
  - image search, visualization and connection of different modalities
- 8.8 million euro
- 15 Projects involving bio-physicists, chemists, mathematicians, bio-informatics and image processing specialists, cell biologists, microscopists and medical researchers

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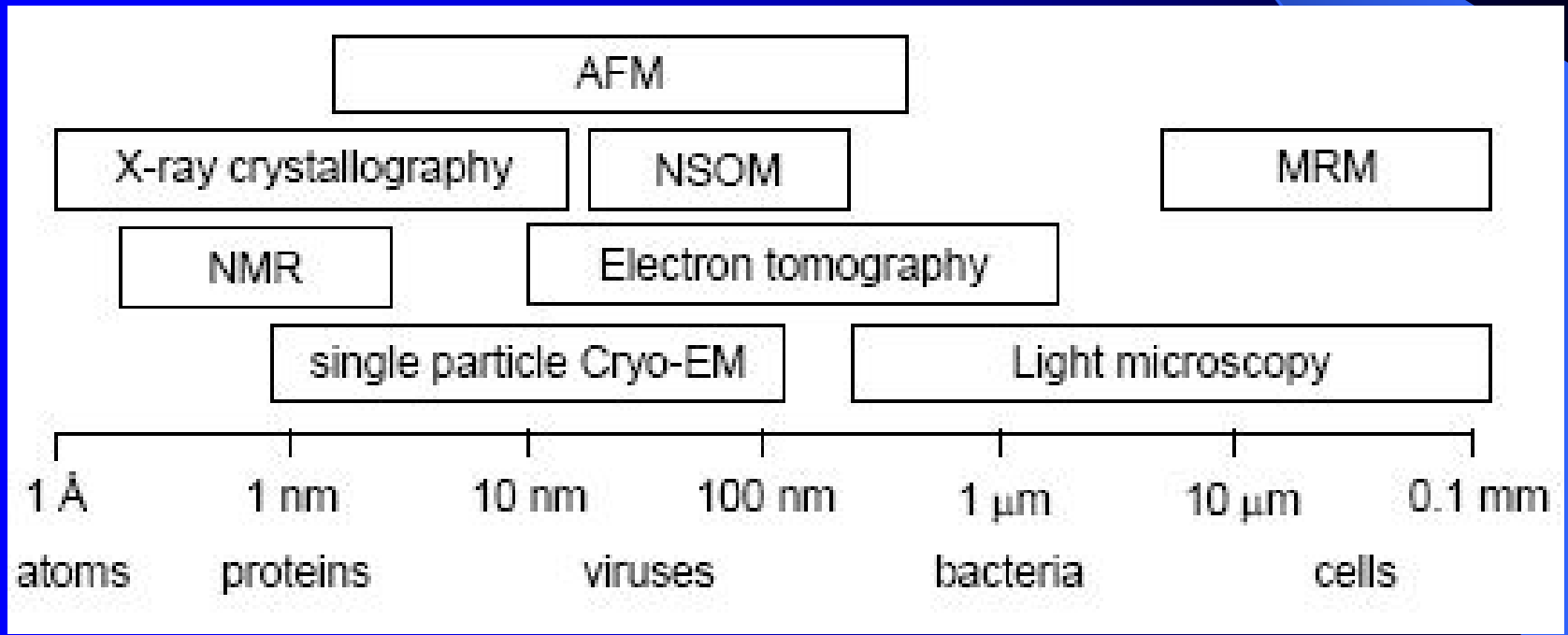
- Bio-Imaging & Search
  - "*Understanding the machinery of life*"



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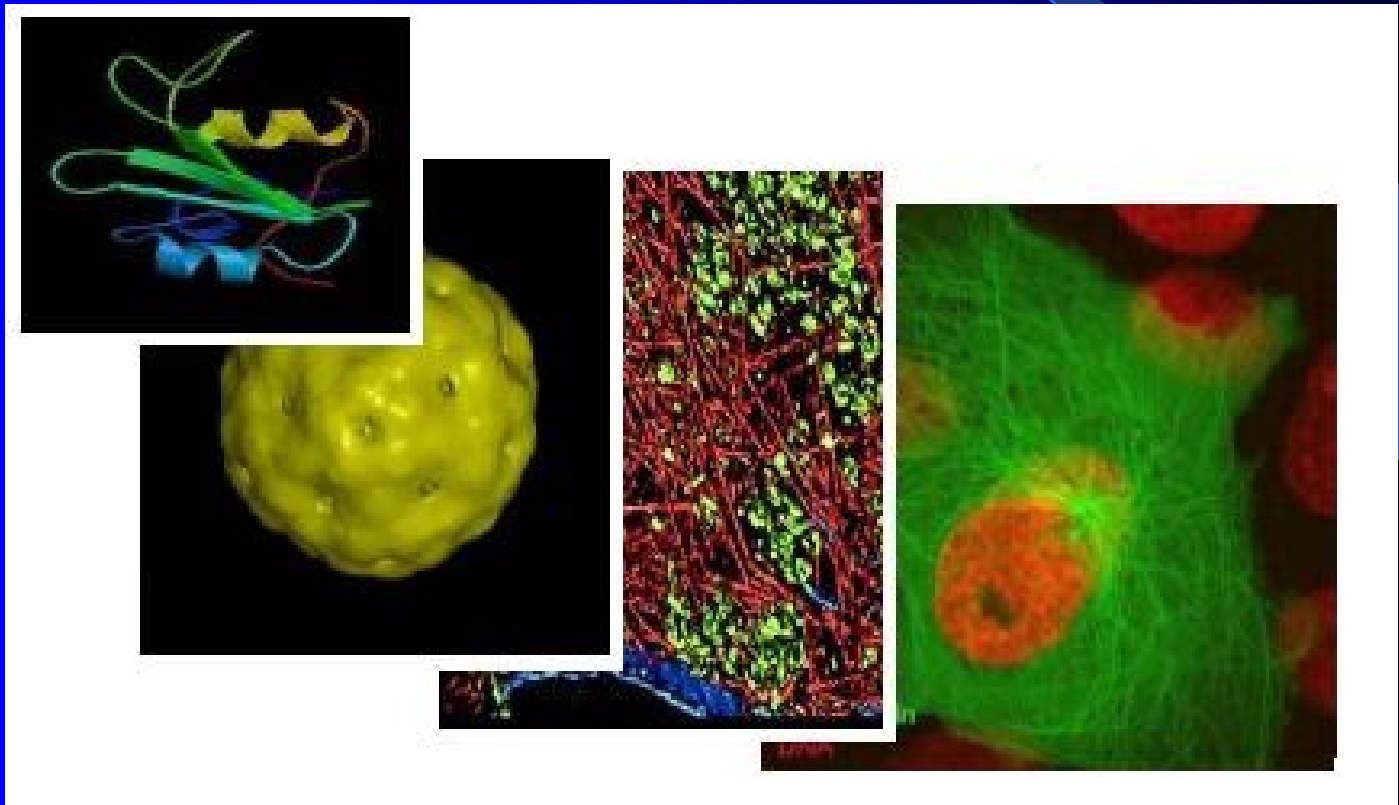

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What if you could seamlessly combine all of the different imaging modalities (EM, MRI, X-ray, etc.) and create the ultimate super microscope?

Peek into the machinery of life

Challenges

- Common Scientific Challenges
- Current Practices and Surprises
- Frontier Challenges

Common Scientific Challenges

- Registration
  - Alignment spatially
  - Alignment rotation
  - Alignment scale

Current Practices & Surprises

Its a matter of different scientific cultures:

I was trying to think of a fair way of phrasing this (and would be happy for better, fairer phrasing):

Images for bio-related scientists are like source code for computer scientists

Identification & Registration of Microtubules

Microtubules are critical to many fundamental cell processes, including chromosome movement and mitosis

Identification & Registration of Microtubules

- Methods tried
  - SIFT - famous for "robustness"
  - SURF - a faster SIFT alternative
  - Snakes - commonly used in medical research
  - Template (FFT pyramid) - textbook
  - MOD Salient Regions - maximization of distinctiveness

Identification & Registration of Microtubules

- Salient point methods (SIFT, SURF) are highly susceptible to noise in Electron Microscopy and Ultrasound
- Snakes are difficult to use automatically. Presumably they are excellent for interactive usage

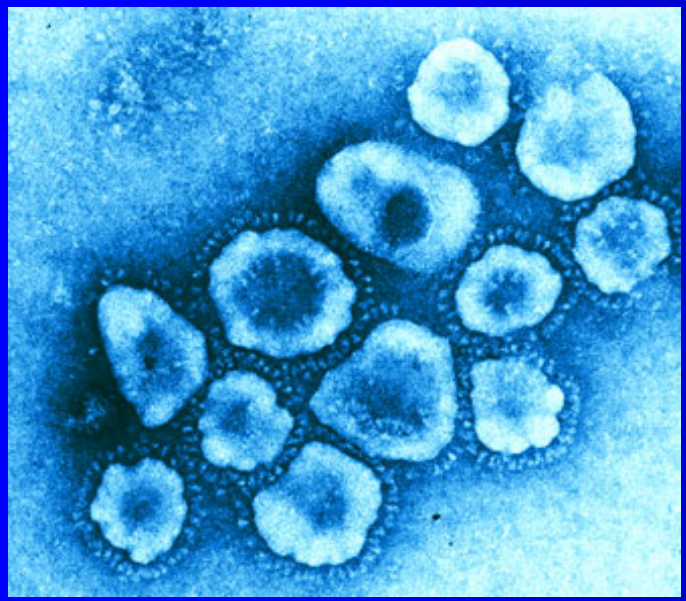
Frontier Challenges

Computer Aided Diagnosis of Viruses

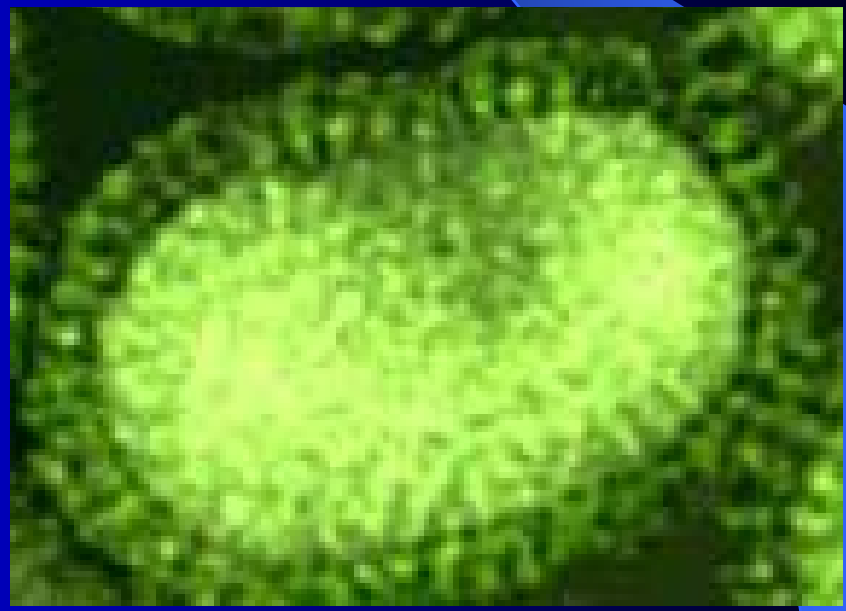
- Periodic worldwide epidemics
  - Spanish Flu (1918)~ 100 million
  - SARS (2003) ~ 1000
  - HIV (current) ~ 25 million
  - Seasonal Influenza ~ 500,000 per year

Frontier Challenges

- Computer Aided Diagnosis of Viruses



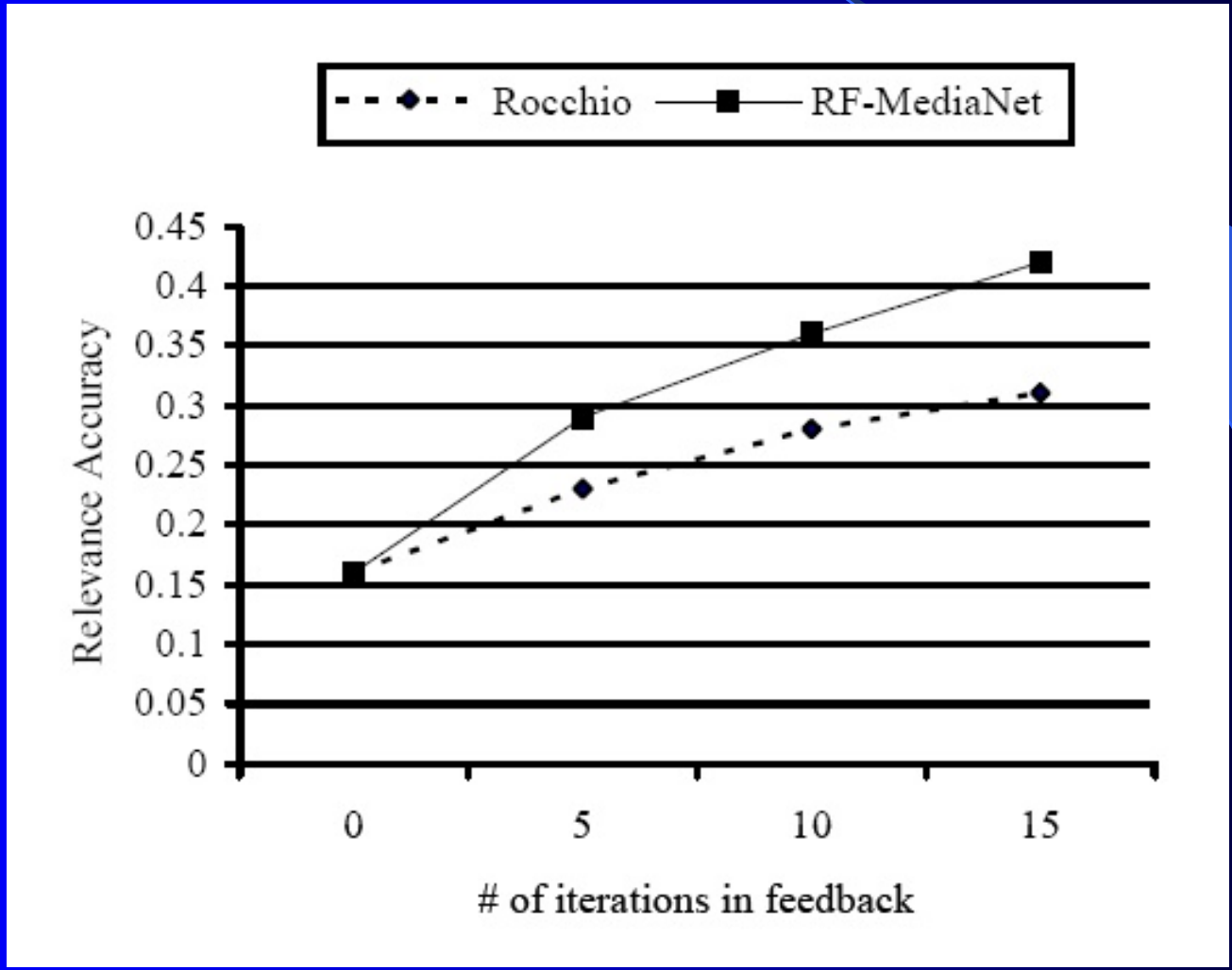
SARS



Influenza

Frontier Challenges

9 categories of viruses



Frontier Challenges

- Multi-Modal Retrieval
  - Connecting spatial location between two different types of images
  - Propagation of features between two different types of images

Frontier Challenges

- Multi-Modal Retrieval

Frontier Challenges

- Multi-modal retrieval: Current State
  - minimal work so far
  - a few methods using template matching but not considered usable yet.
  - nobody really knows how to solve it.

Summary

- Bio-Science has many challenges for image analysis and content-based retrieval scientists.
- Bio-related scientists may have their own culture and you should expect some miscommunication...
- Lots of new frontier challenges - widening the ways in which we think of image analysis