Introduction to Machine Learning

M. Kundegorski

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IAFIG-RMS - Bioimage Analysis With Python

Cambridge Bioinformatics Training Centre

Is it just statistics?

- different aim: explanation vs prediction
- effective engineering to allow for mathematical description of environment.
- If it works – it works.

What is machine “learning”?

“A computer program is said to ***learn*** *from* ***experience E*** *with respect to some* ***task T*** *and some* ***performance measure P****, if its performance on* ***T****, as measured by* ***P****, improves with experience* ***E****.”*

Tom Mitchel, 1998

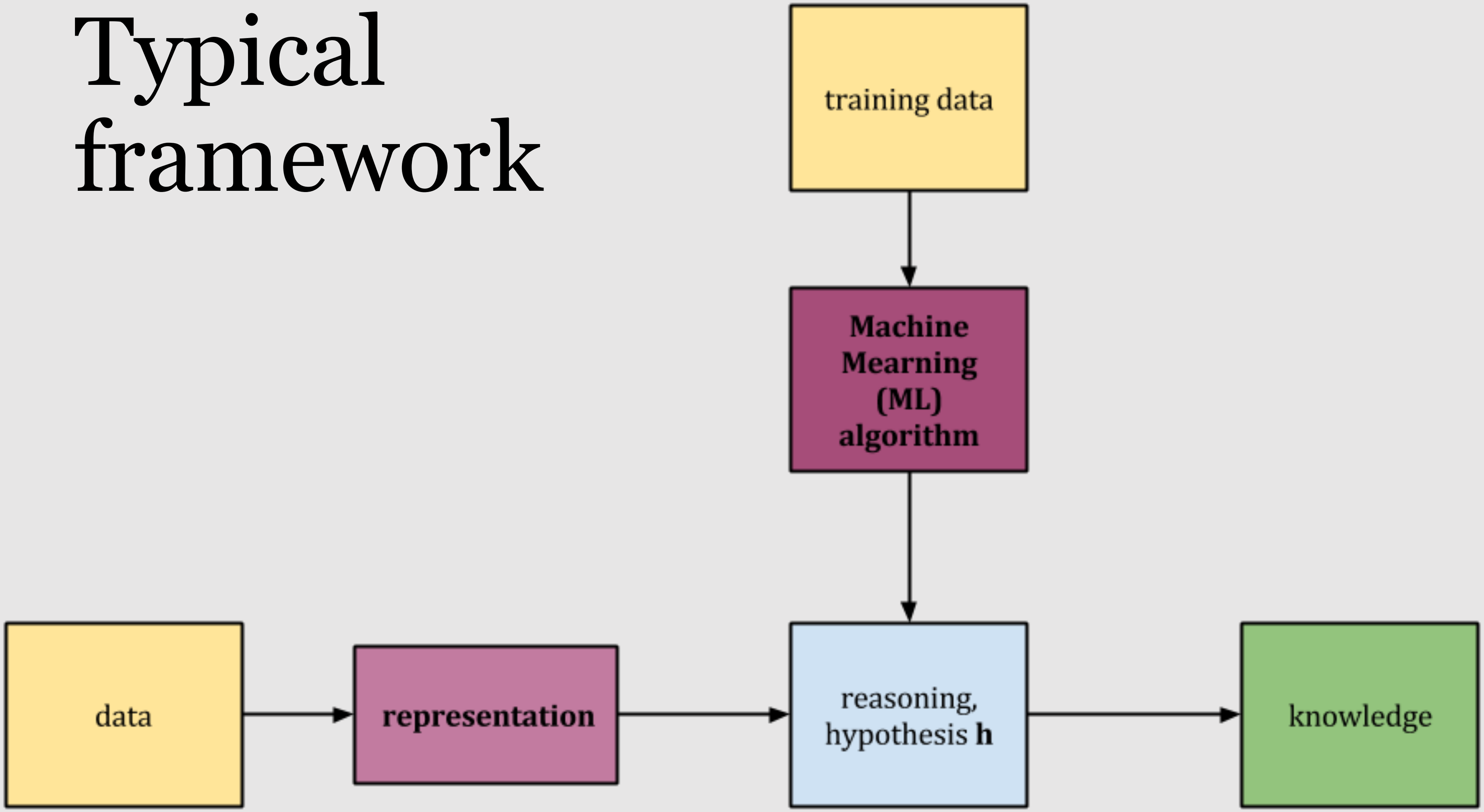
Types of ML

- Supervised – **task T** with ground-truth labels
  - goal: predict label from data

- Unsupervised – **task T** without labels
  - goal: find groupings and patterns in data

- Reinforcement Learning – **task T** is exploratory
  - goal: optimise processes
  - often RL elements are parts of Supervised and Unsupervised algorithms
  - often agent based (e.g. “game of life”)

Typical framework



Machine Learning areas

- **Big Data** – allowing us, humans to learn from data otherwise too sparse or huge to analyse with ordinary statistics .
- **Patter Recognition**: Exploring possible correlations in data which are elusive to ordinary analysis.
- **Computer Vision:** Understanding of visual data (video understanding, object detection, tracking, etc.)
- **Robotics:** physical presence of computers in the real world

Types of Computer Vision problems:

1. classification (binary and non-binary):
   - image recognition
2. regression
   - object localisation
   - object counting
3. association / clustering
   - texture clustering (object segmentation)
   - data mining
4. combination:
   - object detection (localisation + recognition)
   - object tracking (localisation + recognition + association)

Examples

Counting via detection

The application of support vector machine classification to detect cell nuclei for automated microscopy

Ji Wan Han · Toby P. Breckon · David A. Randell · Gabriel Landini

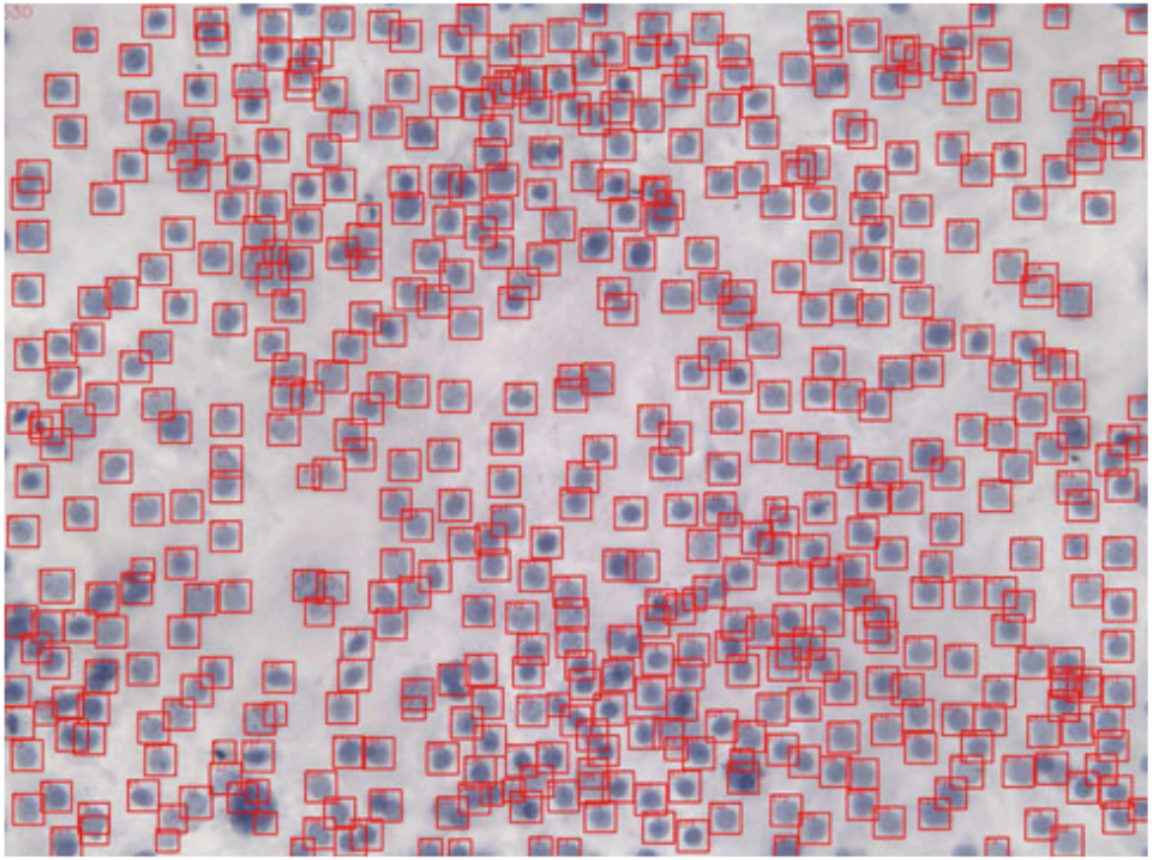


Fig. 9 Detection of 3t3-H-20× cell nuclei

Segmentation

https://github.com/zhixuhao/unet

U-Net: Convolutional Networks for Biomedical Image Segmentation

Olaf Ronneberger, Philipp Fischer, and Thomas Brox

Computer Science Department and BIOSS Centre for Biological Signalling Studies,
University of Freiburg, Germany
ronneber@informatik.uni-freiburg.de,
WWW home page: http://lmb.informatik.uni-freiburg.de/

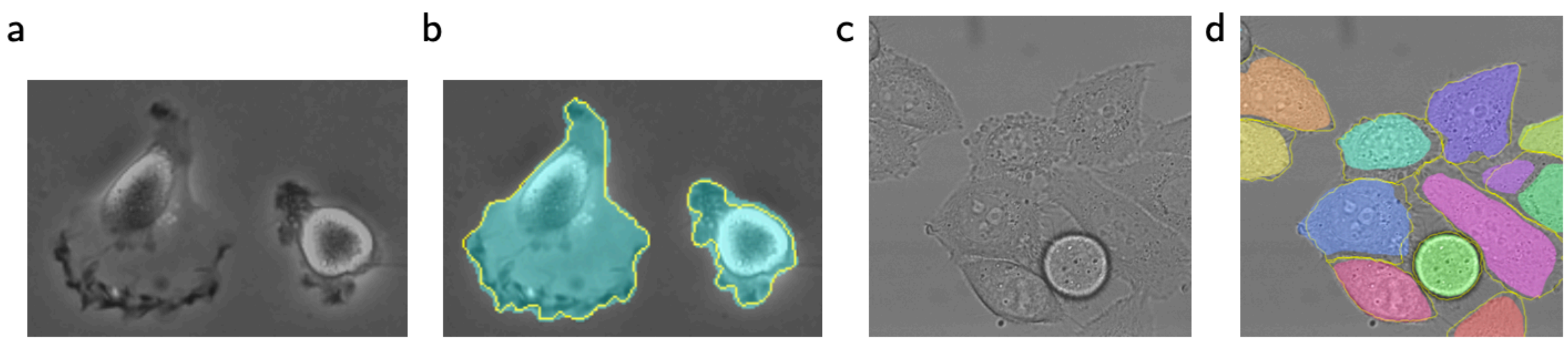


Fig. 4. Result on the ISBI cell tracking challenge. (**a**) part of an input image of the "PhC-U373" data set. (**b**) Segmentation result (cyan mask) with manual ground truth (yellow border) (**c**) input image of the "DIC-HeLa" data set. (**d**) Segmentation result (random colored masks) with manual ground truth (yellow border).

Object (phenotype) recognition

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Machine learning in cell biology – teaching computers to recognize phenotypes

Christoph Sommer and Daniel W. Gerlich*
Institute of Molecular Biotechnology of the Austrian Academy of Sciences (IMBA), 1030 Vienna, Austria
*Author for correspondence (daniel.gerlich@imba.oeaw.ac.at)

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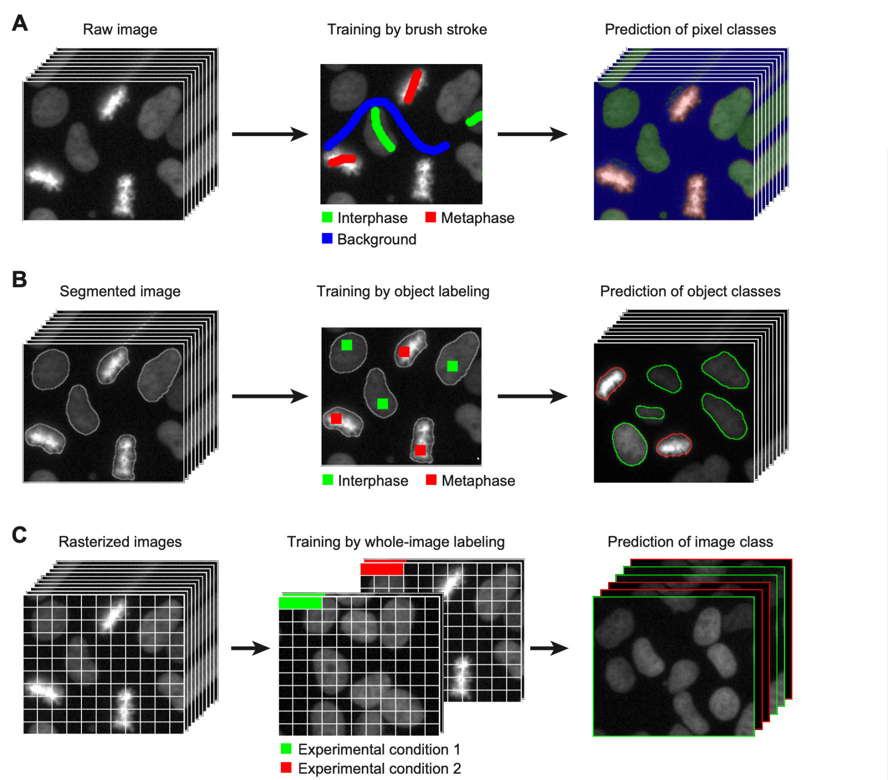
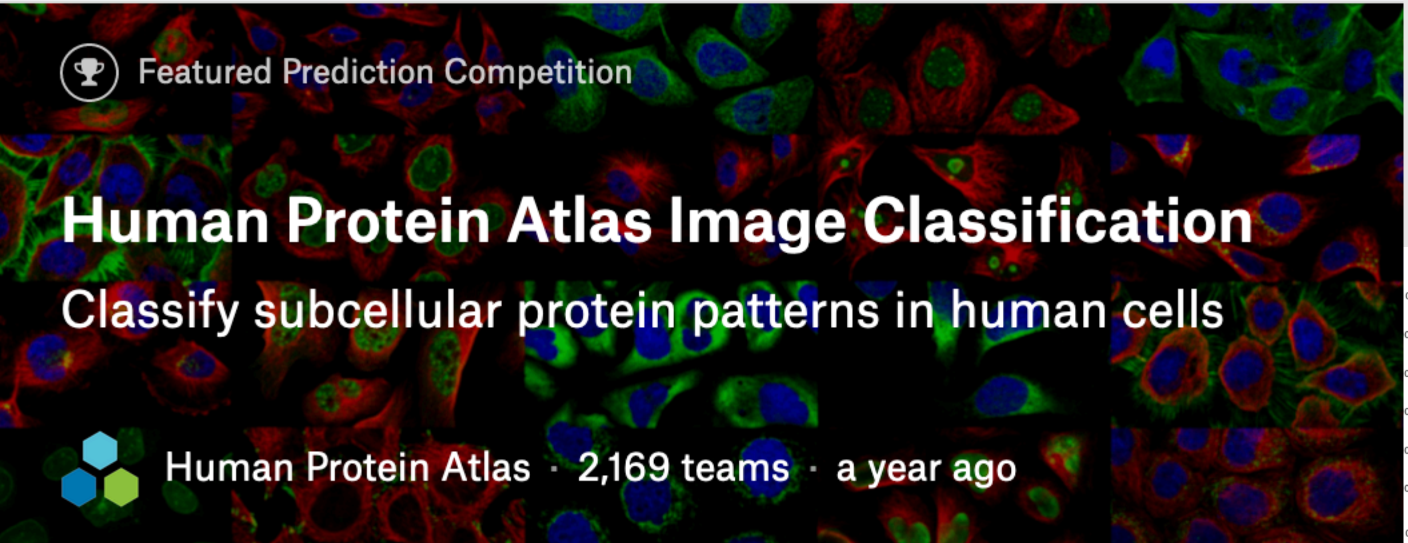
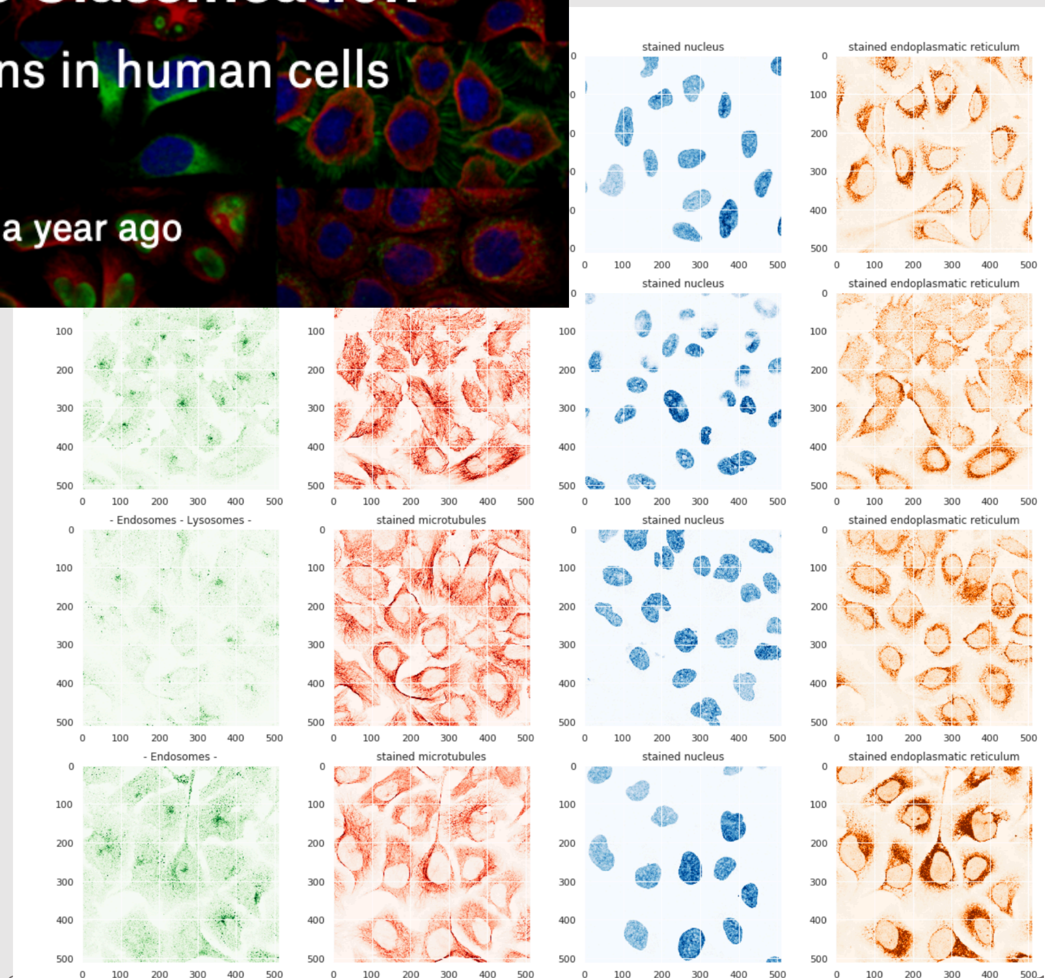


Object (protein) detection





Predicting protein organelle localization labels for each sample.

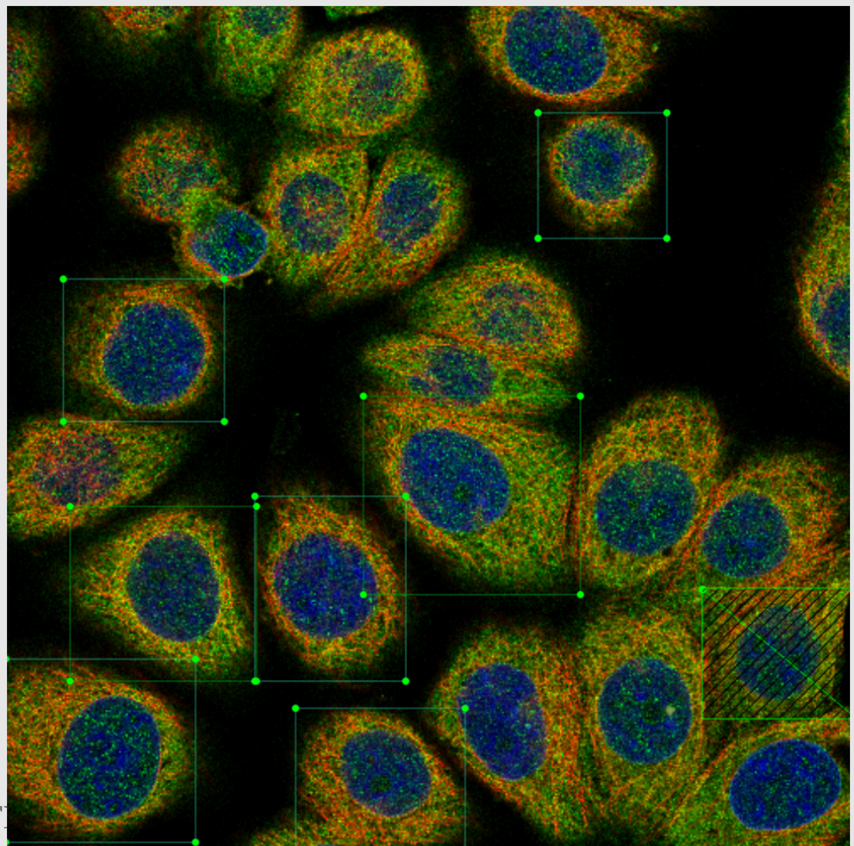
DEEP LEARNING FOR LIFE SCIENCES

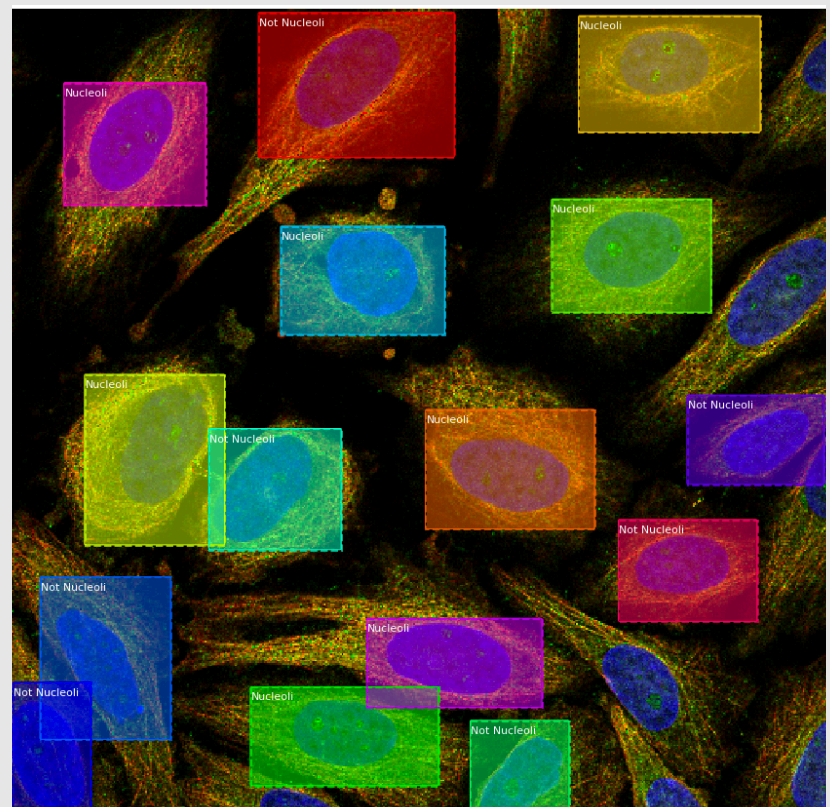
Deep Learning on Microscopy Imaging

Detecting Good, Bad and Ugly Cells with Deep Learning

Nikolay Oskolkov Follow
Jul 7 · 9 min read ★

https://towardsdatascience.com/deep-learning-on-microscopy-imaging-865b521ec47c





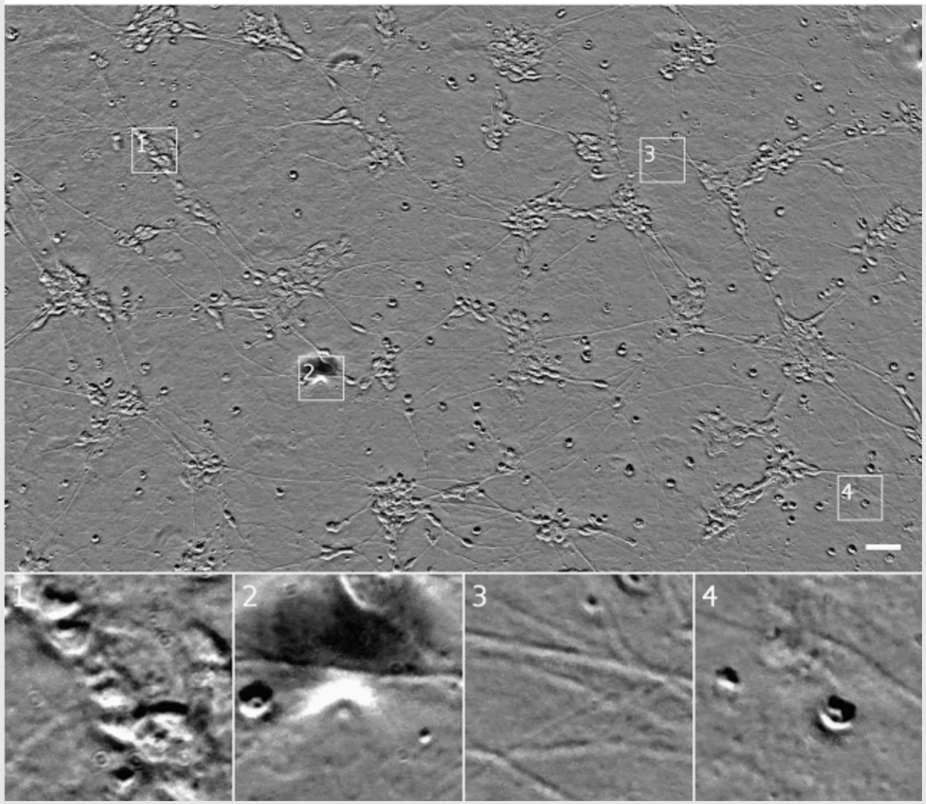
https://ai.googleblog.com/2018/04/seeing-more-with-in-silico-labeling-of.html

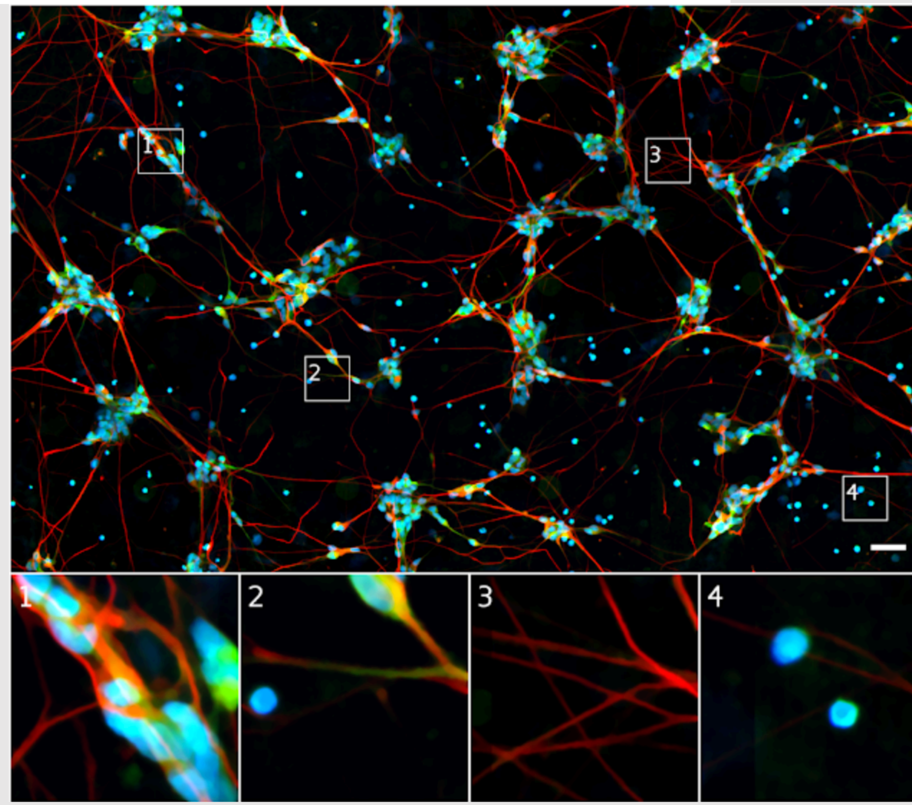
Deep Learning prediction

Seeing More with In Silico Labeling of Microscopy Images

Thursday, April 12, 2018

Eric Christiansen, Senior Software Engineer, Google Research





History of ML

- Early 20th century – Modern Statistics
- 1950's – Artificial Intelligence
- 1990's – Traditional Machine Learning
- 2000's – Deep Learning

Plan for today

- Session 1: **Basic Predictive Models** (statistics differently)
- Session 2: **Features** (representing images in computer world)
- Session 3: **Unsupervised learning**
- Session 4: **Supervised learning**
- Session 5: **Deep Learning**