Drones

Artificial Intelligence

“All our knowledge begins with the senses, proceeds then to the understanding, and ends with reason. There is nothing higher than reason.”

- Immanuel Kant

Autonomous Navigation of Forest Trails

In this example we will look at a drone trained using a Deep Neural Network to navigate a forest trail.

Useful for allowing a robot to explore an isolated area, maybe during a search and rescue situation.

The only sensor the drone has in this is example is an ordinary color camera.

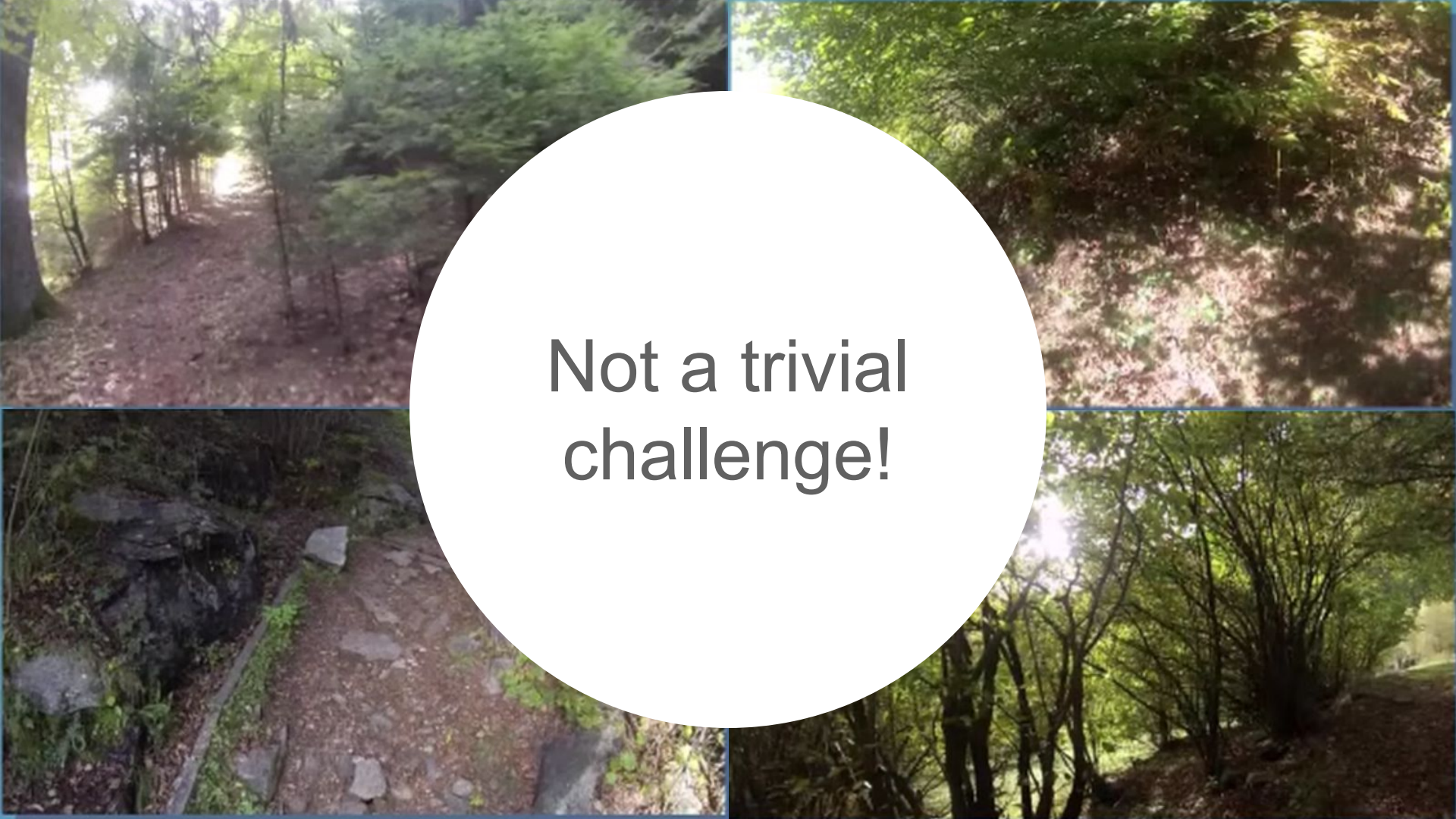
Perception of real world from complex imagery.

Challenge

Perceiving a real world trail from images without a brain is extremely difficult!

This is a pattern recognition problem





Not a trivial
challenge!

Solution: Use an award winning image analysis algorithm.

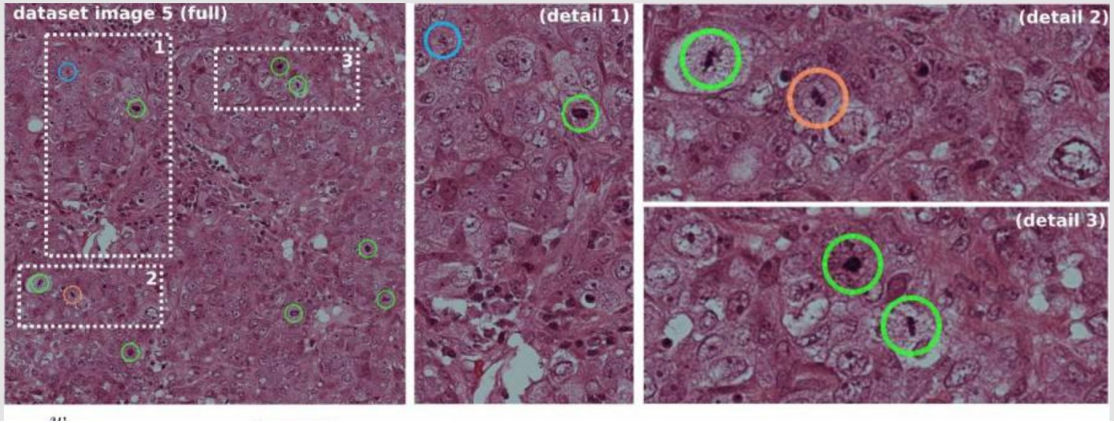
Mitosis Detection in Breast Cancer Histology Images using Deep Neural Networks

Joint work with Dan Ciresan.

News:

- **Nov, 2014**: The Medical Image Analysis paper describing the MICCAI 2013 Grand Challenge "Assessment of Mitosis Detection Algorithms" has been accepted (preprint, pubmed, arxiv).
- **Jan, 2014**: The user testing website for the paper "A Comparison of Algorithms and Humans for Mitosis Detection" is online. Take the test!
- **Sept, 2013**: With Dan Ciresan, we won the MICCAI 2013 Grand Challenge "Assessment of Mitosis Detection Algorithms", with a significant advantage over the closest competitor (results).
- **Oct, 2012**: With Dan Ciresan, we won the ICPR 2012 challenge on mitosis detection in breast cancer histology images. The paper describing the approach was published at MICCAI 2013.

- Images using Deep Neural Networks
- Segmentation of Neural Structures from Electron Microscopy Stacks using Deep Neural Networks
- Image Analysis (and Statistical Modeling) for Human Embryo Grading
  - Zygote Segmentation and 3D Reconstruction
  - 4-Cell Embryo Segmentation and 3D Reconstruction
  - Statistics
- Novel Statistical Methods for Analyzing Images of Fibre-like Structures
- Other work



Neural Network Elements

- Neural networks are a set of algorithms, modeled loosely after the human brain.

- That are designed to recognize patterns. They interpret sensory data through a kind of machine perception, labeling or clustering raw input.

- The patterns they recognize are numerical, contained in vectors, into which all real-world data, be it images, sound, text or time series, must be translated.

- Neural networks help us cluster and classify.

Deep Neural Network Elements

- Deep learning is the name we use for “stacked neural networks”; that is, networks composed of several layers.

- The layers are made of *nodes*. A node is just a place where computation happens, loosely patterned on a neuron in the human brain, which fires when it encounters sufficient stimuli.

- A node combines input from the data with a set of coefficients, or weights, that either amplify or dampen that input, thereby assigning significance to inputs for the task the algorithm is trying to learn.

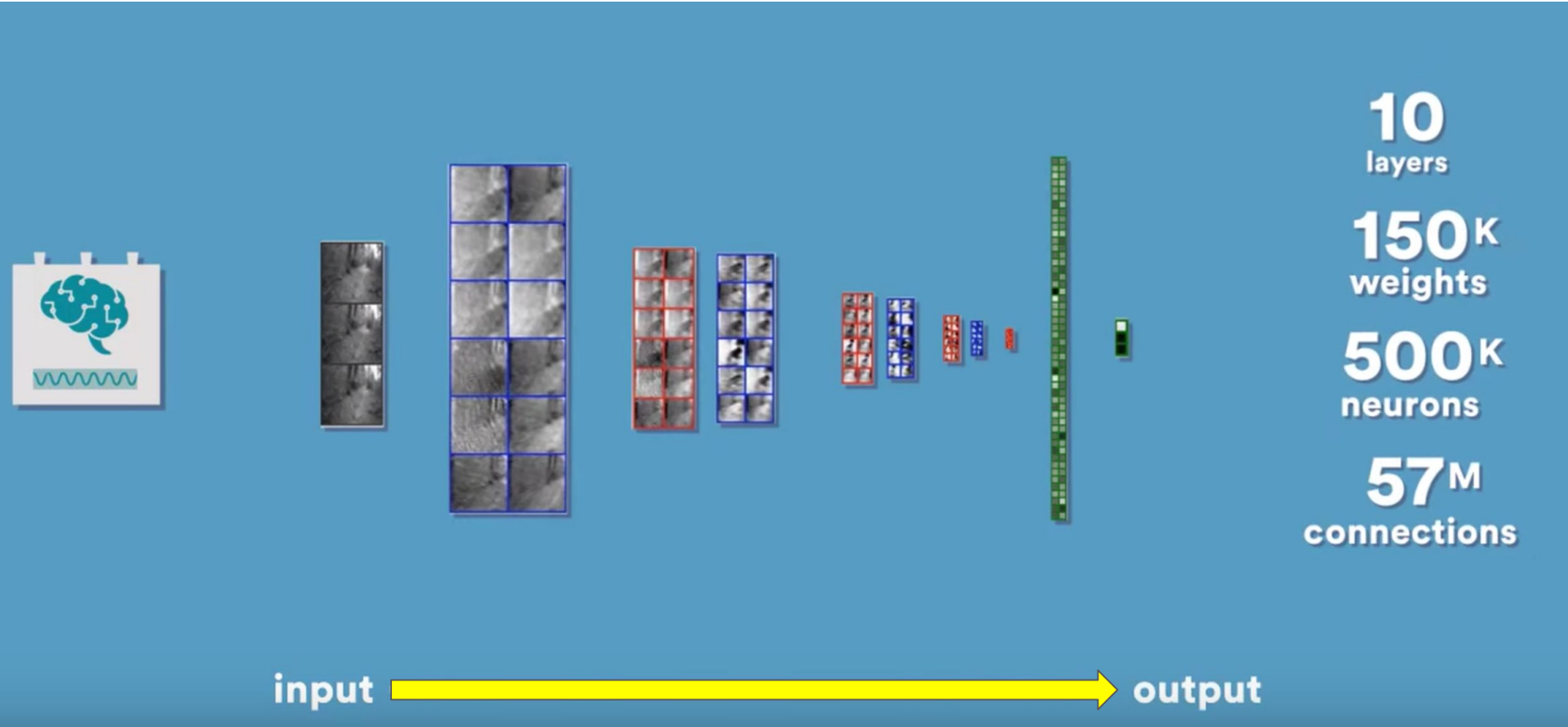
- These input-weight products are summed and the sum is passed through a node’s so-called activation function, to determine whether and to what extent that signal progresses further through the network to affect the ultimate outcome.

Input

DNN

Output
3 Class

How the classifier works



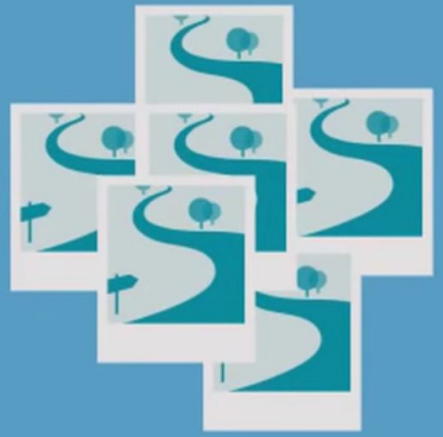
Training the Classifier

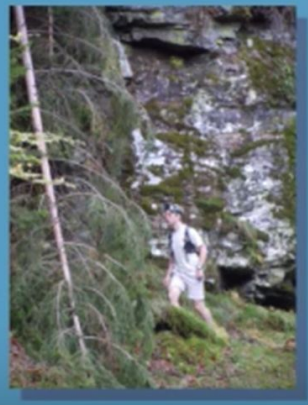
Video was taken while hiking trails in the Alps.

3 GoPro cameras were strapped to a hiker’s head.

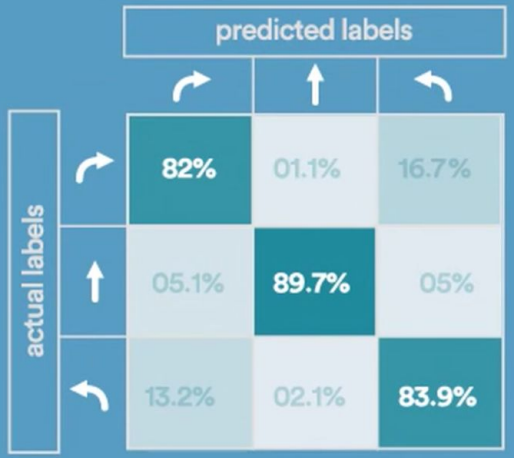
The hiker acquires imagery that is assigned to the three classes simultaneously.

20k images



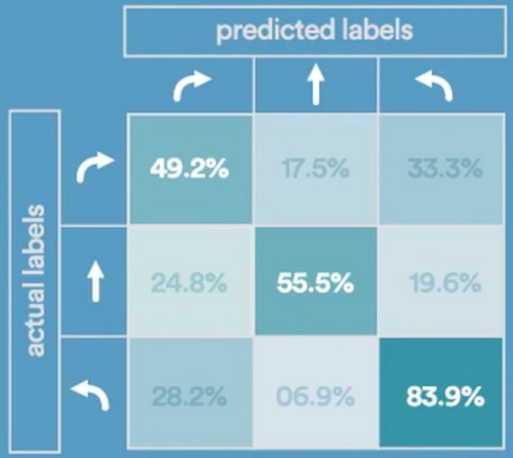


Single-image accuracy



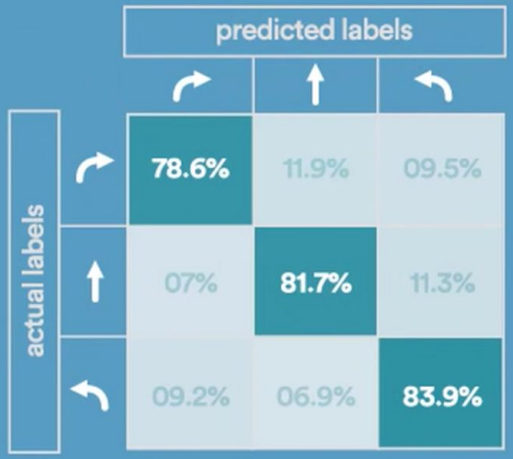
Our classifier accuracy:

85.23%



Saliency accuracy:

52.32%



Human accuracy:

82.00%

Autonomous flight

Exciting Implications

- Drone swarms
- Smart Farming
- Monitor Wildlife
- Deliver Pizza
- Deliver all sorts of things
- Monitoring & mapping Railways
- Monitoring & mapping NG pipelines
- Creating Art
- Monitor Skyscraper Fabrication
- Construct 3d environments.
- Sports Video
- Catastrophe Disaster Relief
- Forestry Health Monitoring
- Fighting Fires
- etc..


GMT 341 : 01 : 04 : 00
MET 005 : 00 : 01 : 01
JMK 083 : 08 : 08 : 01
VID ON 22
MODE FOL
R2_H1_1
F_1_1
P4 READYAUTO
ES
LAT
ELV
0.3
0.6
0.2
1.3
0.8
0.4
Thanks!

Resources:

A. Giusti et al.: "A Machine Learning Approach to the Visual Perception of Forest Trails for Mobile Robots". IEEE Robotics and Automation Letters (2016) and ICRA 2016

https://www.newscientist.com/article/mg23130842-600-how-drones-are-learning-to-find-their-own-way-in-the-world/

http://news.mit.edu/2016/algorithm-robot-teams-moving-obstacles-0421

http://people.idsia.ch/~guzzi/DataSet.html #Download the dataset

http://www.leet.it/home/giusti/website/doku.php?id=wiki:biomedical_image_analysis #DNN used

http://people.idsia.ch/~giusti/forest/web/ #actual video of autonomous drone

http://deeplearning4j.org/neuralnet-overview.html