

Learning neural networks within Jupyter Notebook (part 1/2)



Piotr Migdał
<https://p.migdal.pl>

PiterPy
2-3 Nov 2018, Saint Petersburg





PhD in quantum physics theory
(2014, ICFO, Barcelona)

data science consultant
machine learning
deep learning
interactive data visualisations





$$i\hbar\dot{\psi} = \left(-\frac{\hbar^2}{2m}\nabla^2 + V(x) \right) \psi$$

$$\hat{H}\psi = E\psi$$





Quantum Game with Photons

The screenshot displays the 'Polarizing beam splitter' level (18) of 'The Quantum Game'. The game board is a 10x10 grid. A photon, represented by a red dot, starts at a source (a red starburst) in the top right and moves left through a series of optical components: a beam splitter, a wave plate, and another beam splitter. The photon then moves down through a wave plate and a beam splitter, and finally moves left through a wave plate and a beam splitter to reach a detector. The interface includes a left sidebar with a menu, a question mark, an infinity symbol, and a numeric keypad. A right sidebar shows a 'SUGAR SOLUTION' tip and control buttons. At the bottom, a progress bar shows 0.0% detection and a goal: 'GOAL: Make the photon fall into 4 detectors, some probability to each, total of 100%'.

THE QUANTUM GAME

18 Polarizing beam splitter

0.0% (out of 100.0%) detection □ □ □ □ detectors

GOAL: Make the photon fall into 4 detectors, some probability to each, total of 100%.

SUGAR SOLUTION

Table sugar is a chiral molecule - it does not look the same as its mirror reflection. We put it in an amount, so it rotates polarization by 45°.

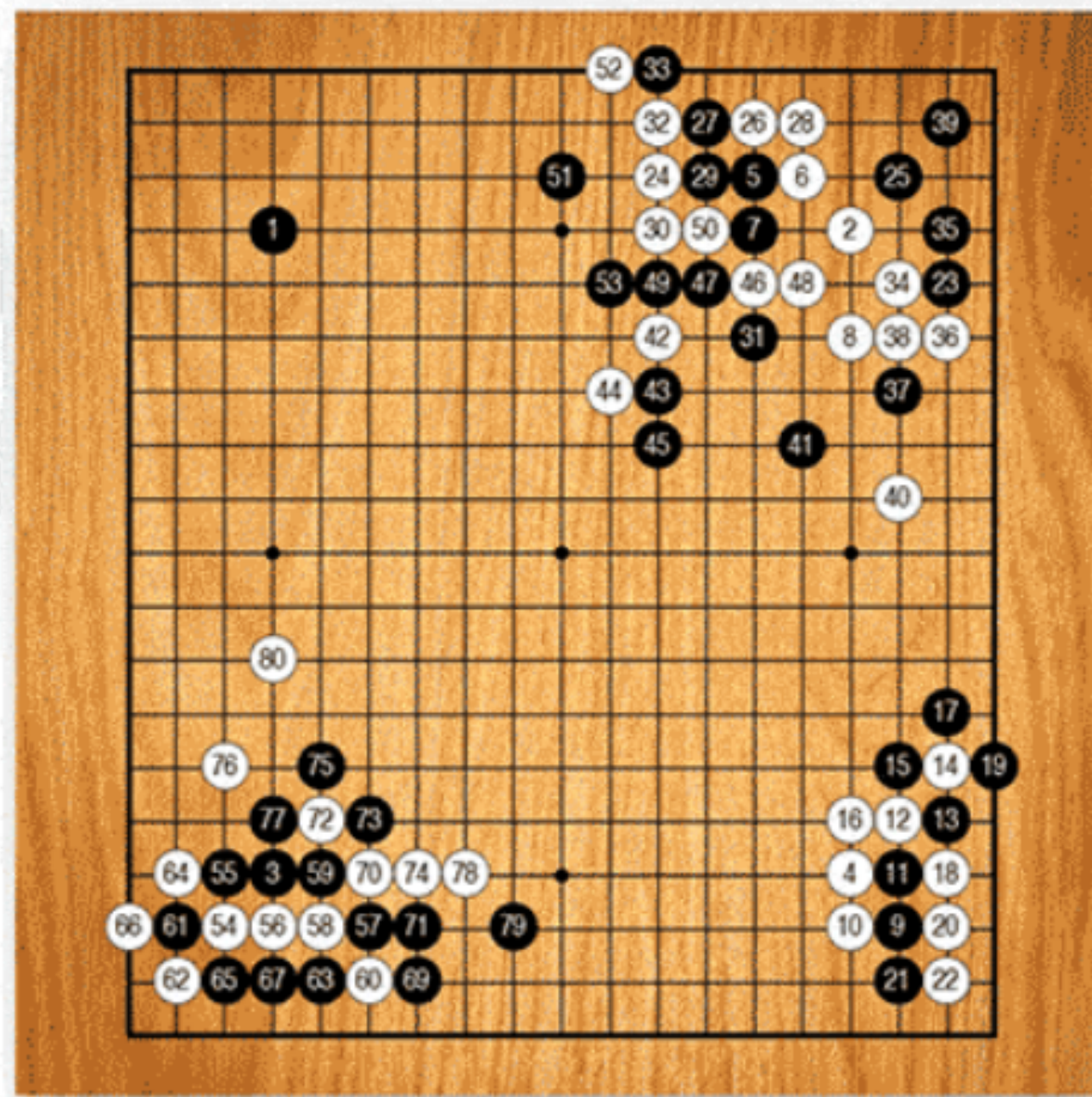
beta version (3 Jun 2016)
by Piotr Migdał, Patryk Hesz, Michał Krupniński

<http://quantumgame.io>

<https://github.com/stared/science-based-games-list> - more games

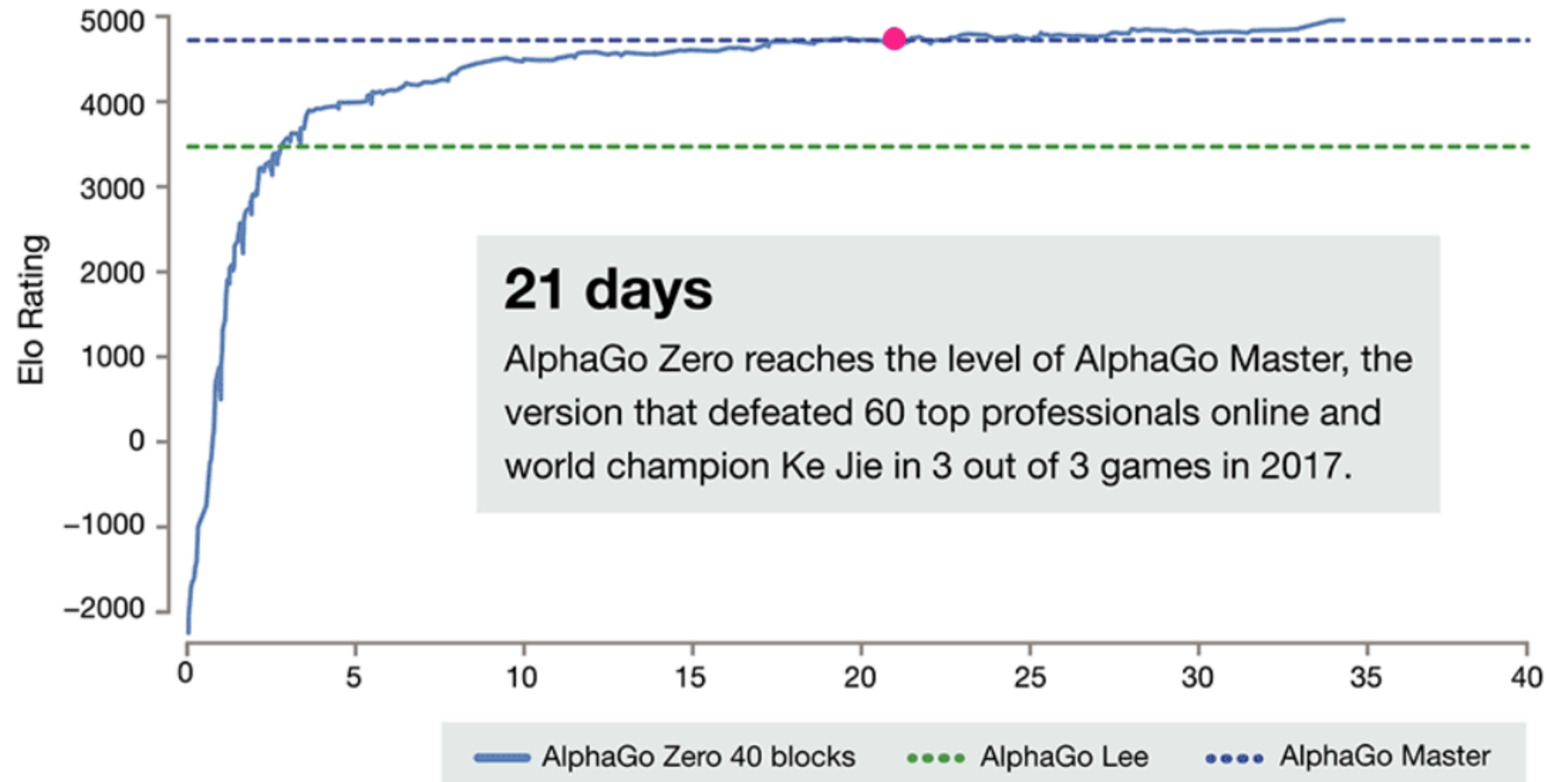
Deep learning
is powerful

AlphaGo

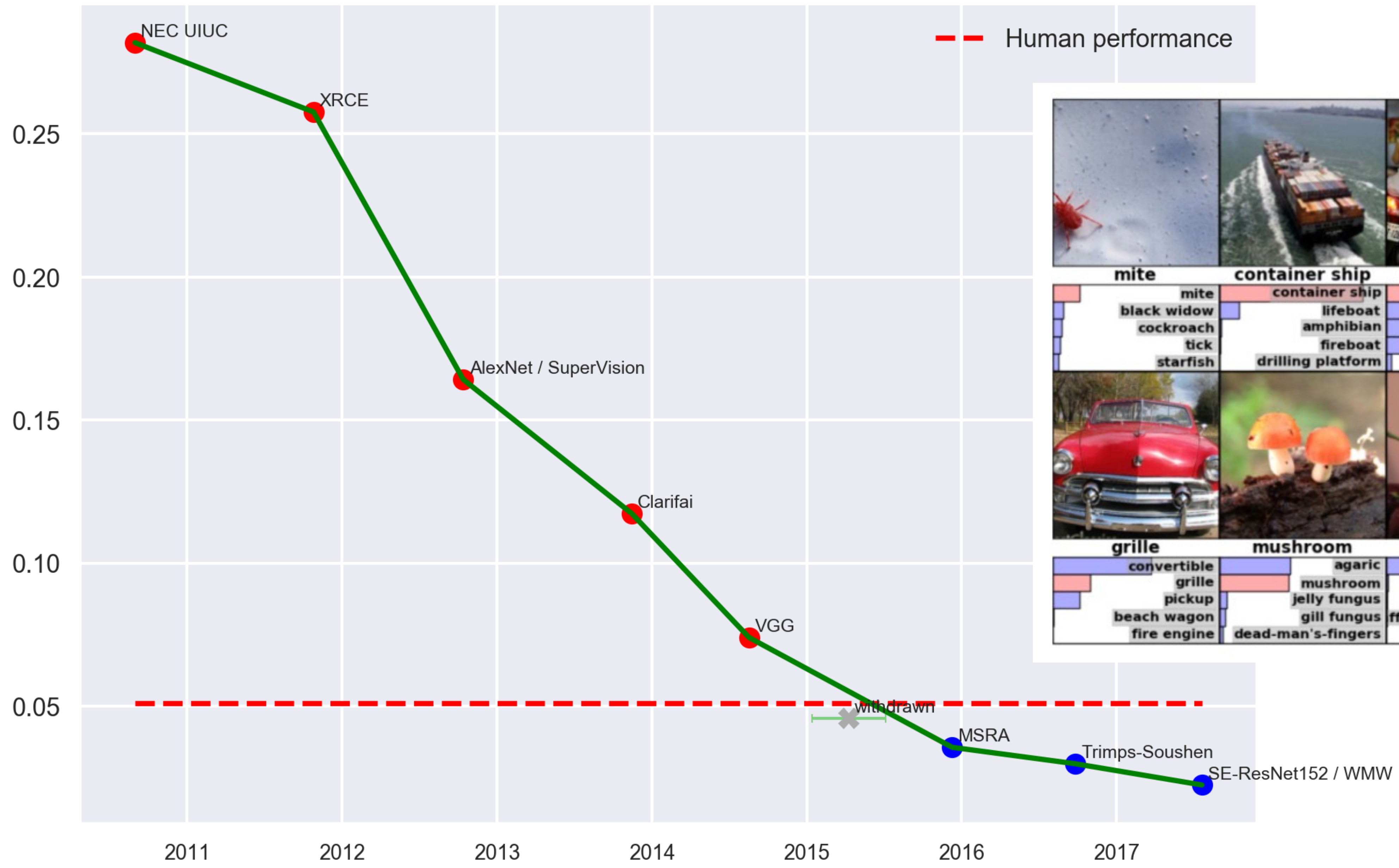


68 at 61

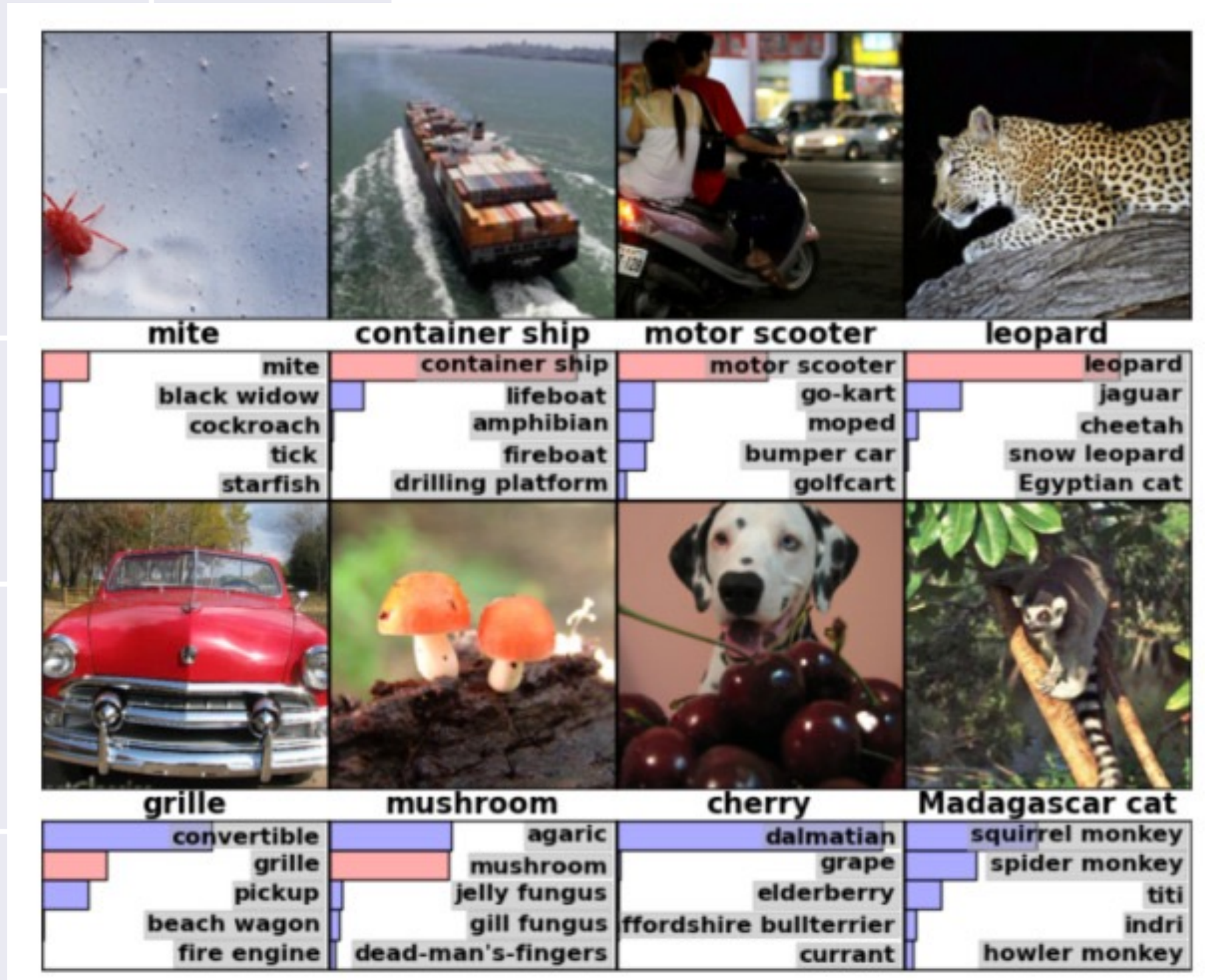
Captured Stones



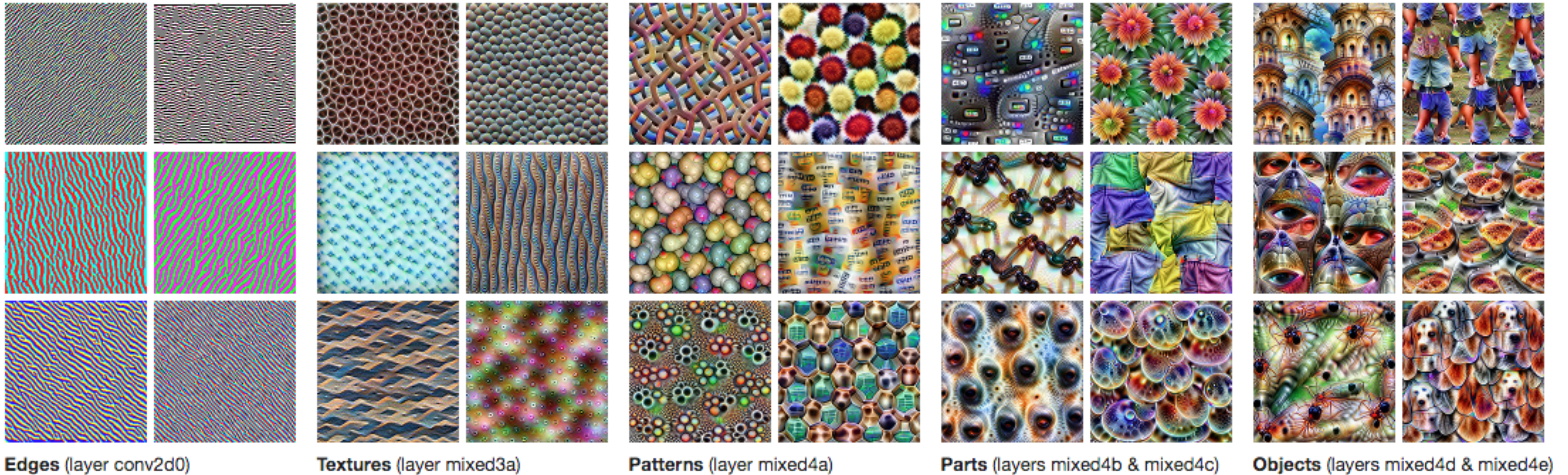
<https://deepmind.com/blog/alphago-zero-learning-scratch/>



--- Human performance



What do they see?



Feature visualization allows us to see how GoogLeNet [1], trained on the ImageNet [2] dataset, builds up its understanding of images over many layers. Visualizations of all channel are available in the [appendix](#).

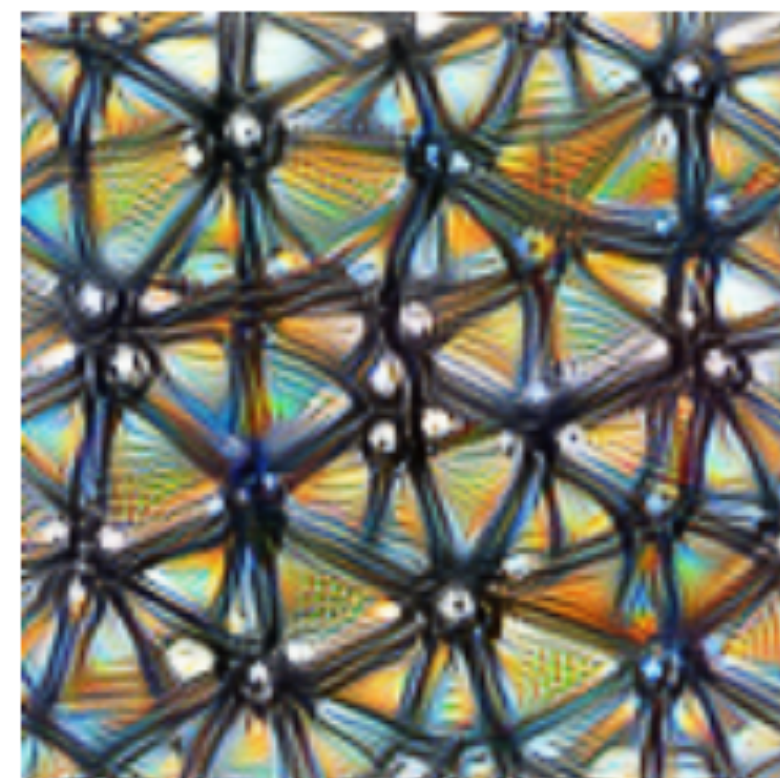
<https://distill.pub/2017/feature-visualization/>
<https://tools.google.com/seedbank/seed/5086441721823232>

What do they see?



Neuron

`layern[x,y,z]`



Channel

`layern[:, :, z]`



Layer/DeepDream

`layern[:, :, :]2`



Class Logits

`pre_softmax[k]`



Class Probability

`softmax[k]`

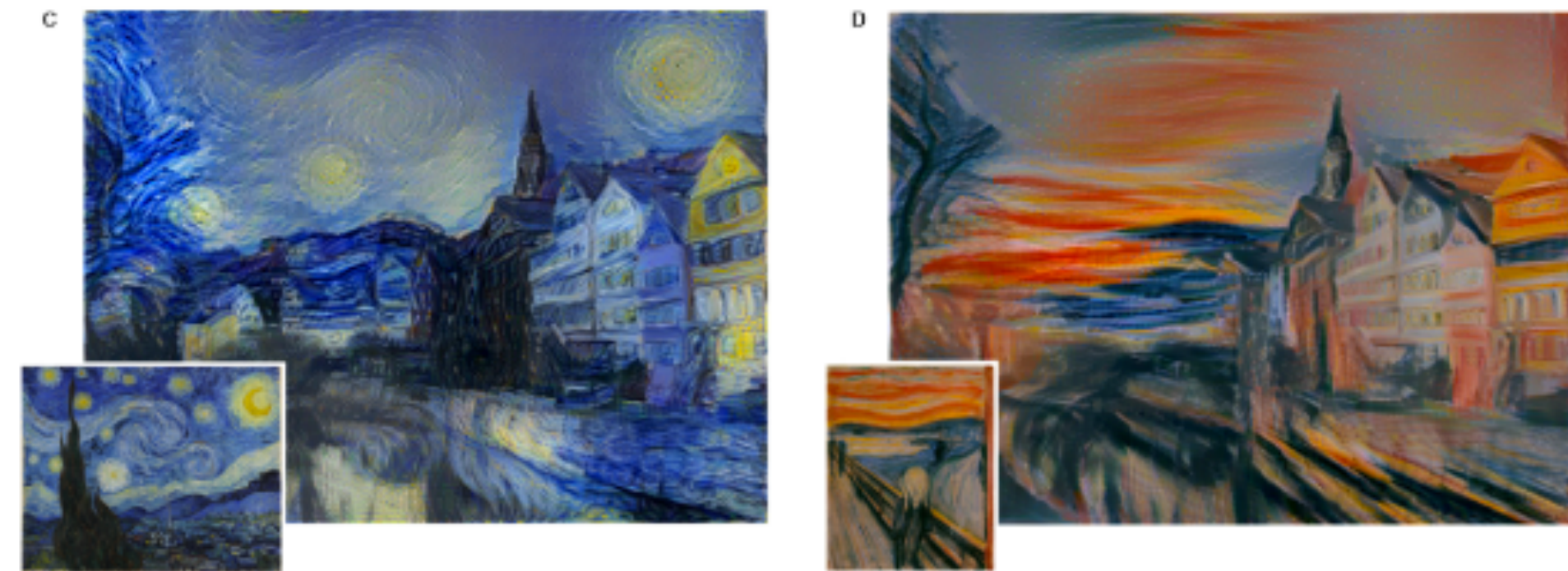
research paper
on arXiv

Aug '15



code
on GitHub

Oct '15



online tools
(e.g. deepart.io, PRISMA)

Dec '15

movies

Apr '16

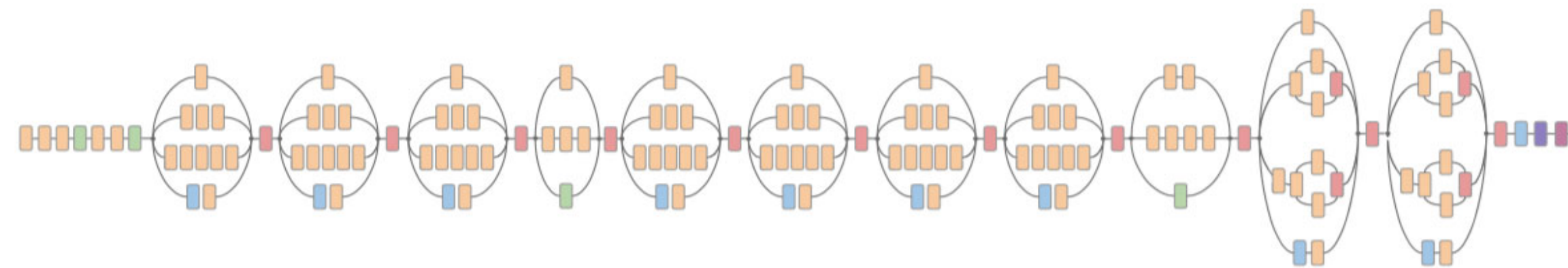


Skin cancer detection

Skin lesion image



Deep convolutional neural network (Inception v3)



- Convolution
- AvgPool
- MaxPool
- Concat
- Dropout
- Fully connected
- Softmax

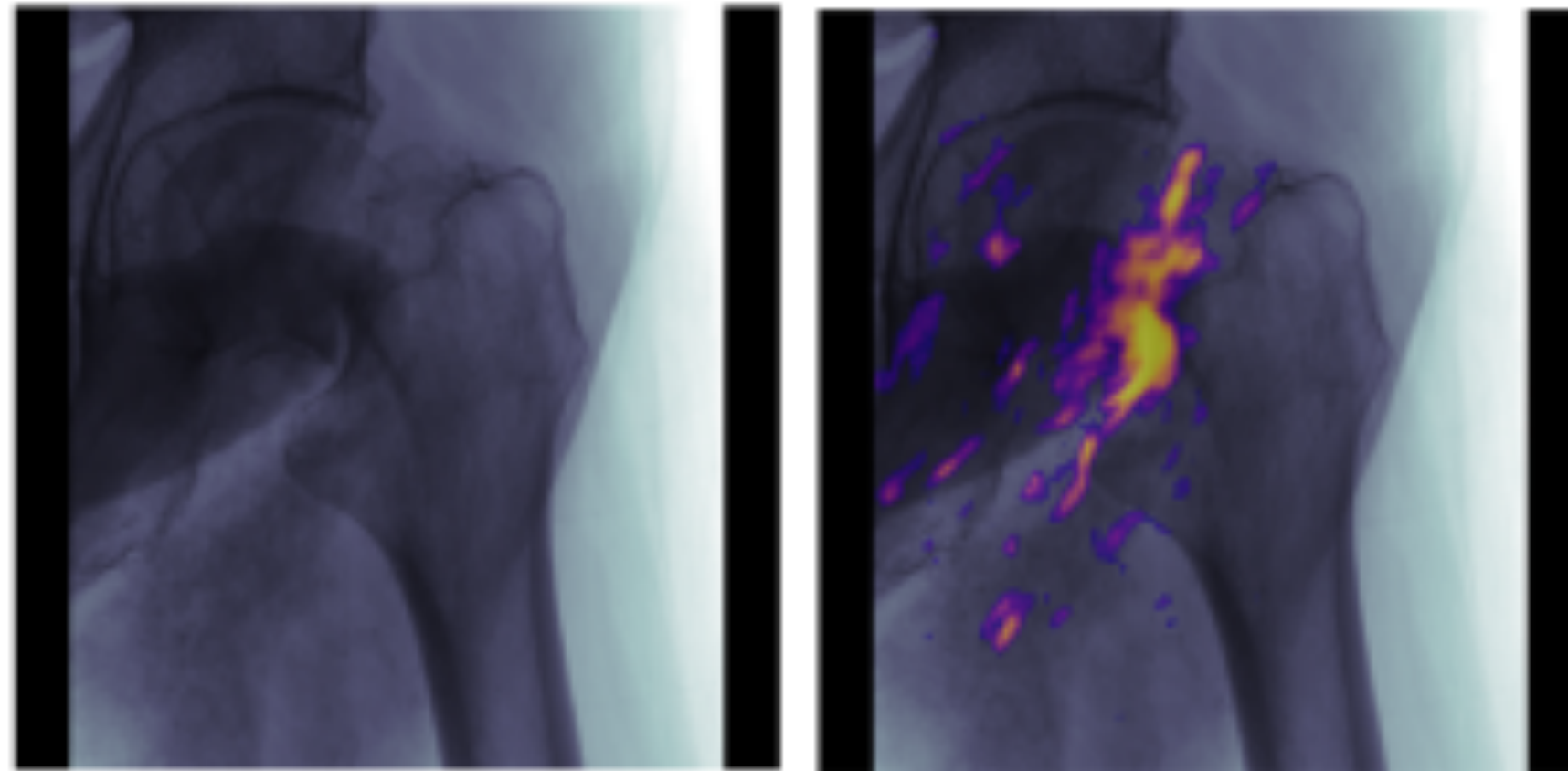
Training classes (757)

- Acral-lentiginous melanoma
- Amelanotic melanoma
- Lentigo melanoma
- ...
- Blue nevus
- Halo nevus
- Mongolian spot
- ...
- ...
- ...

Inference classes (varies by task)

- + 92% malignant melanocytic lesion
- + 8% benign melanocytic lesion

X-ray for detecting broken bones

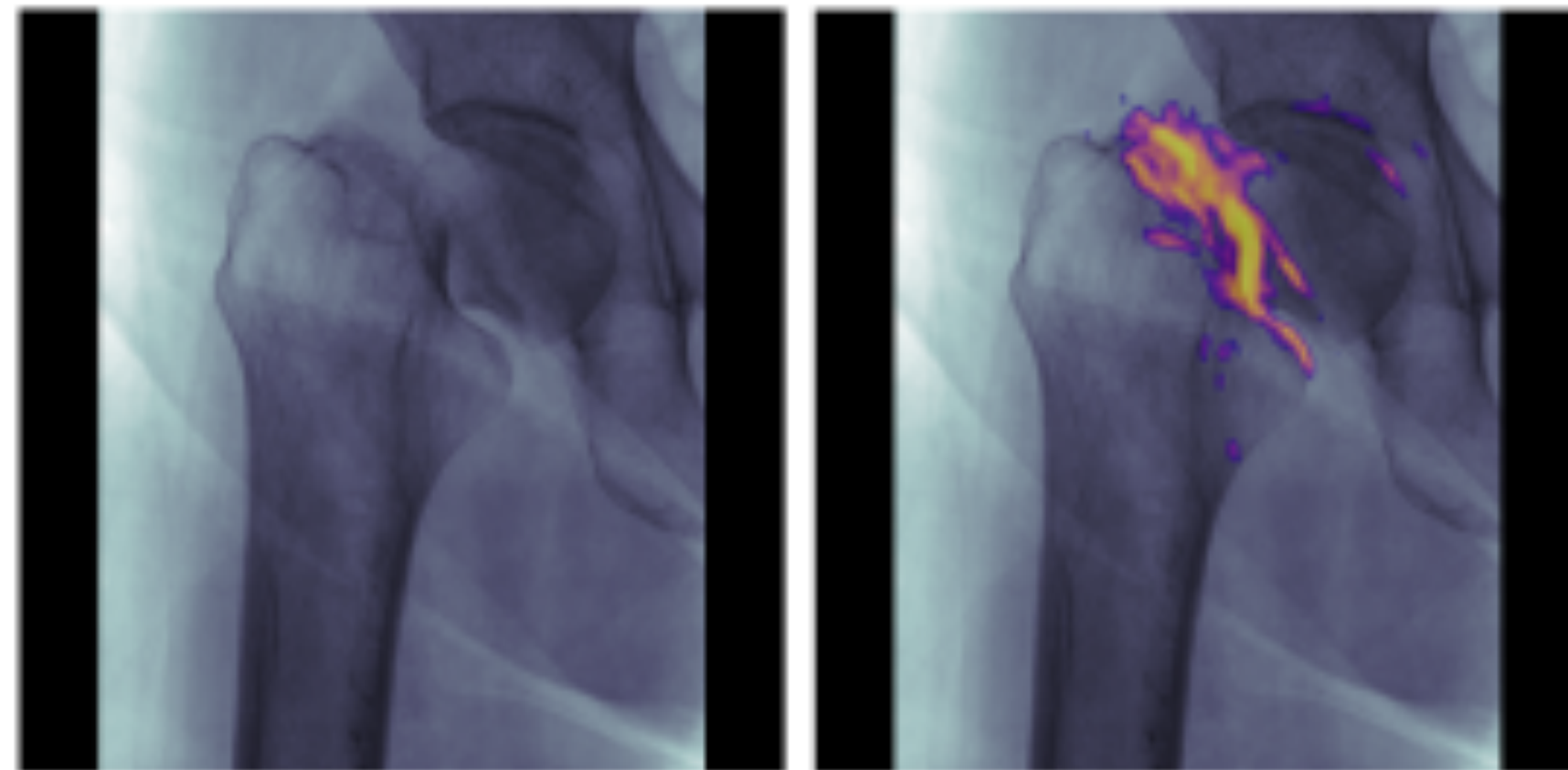


Original report

There is a **transcervical** fracture through the left neck of femur.

Generated report

There is a moderately displaced subcapital fracture of the left neck of femur.



Original report

Subcapital fracture of the right neck of femur with associated shortening.

Generated report

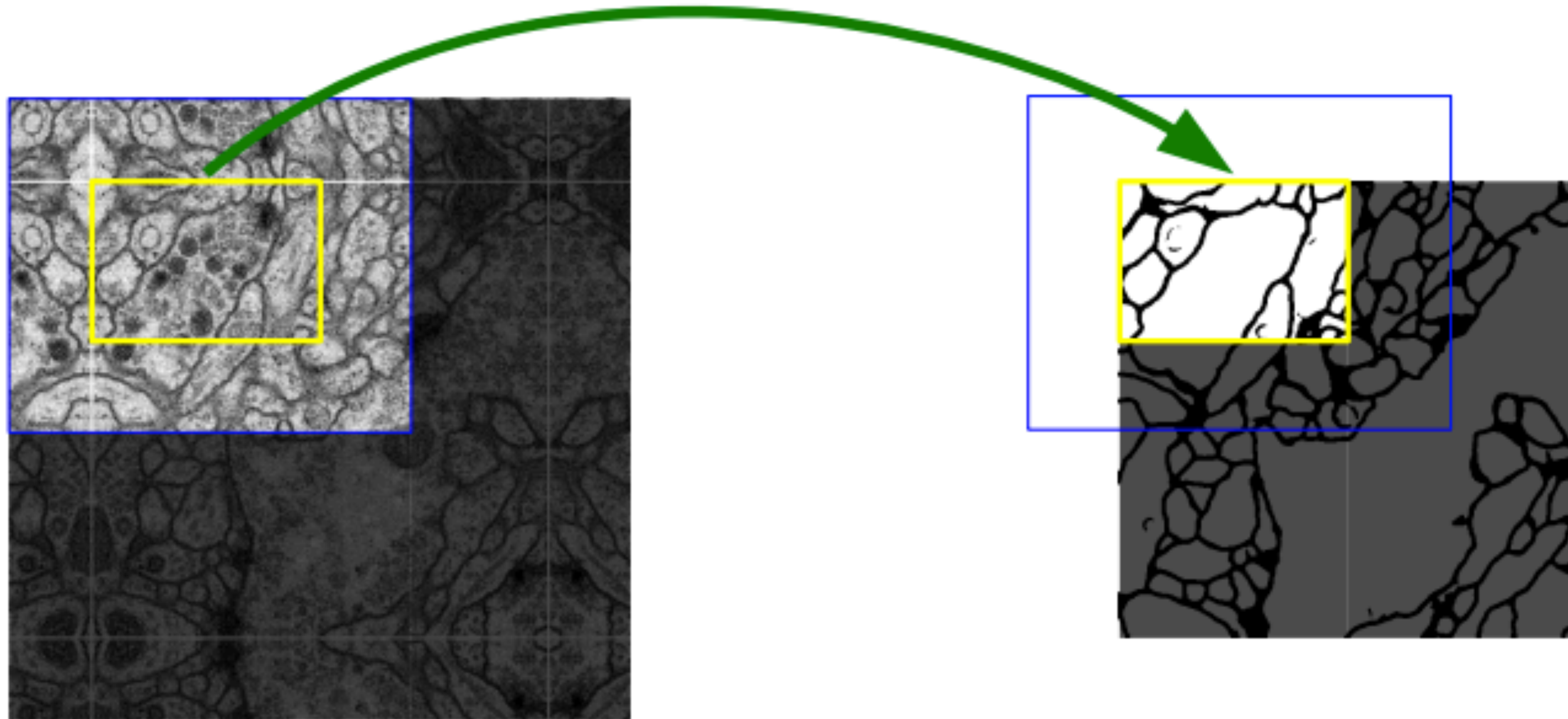
There is a significantly displaced subcapital fracture of the right neck of femur.

Satellite images to maps

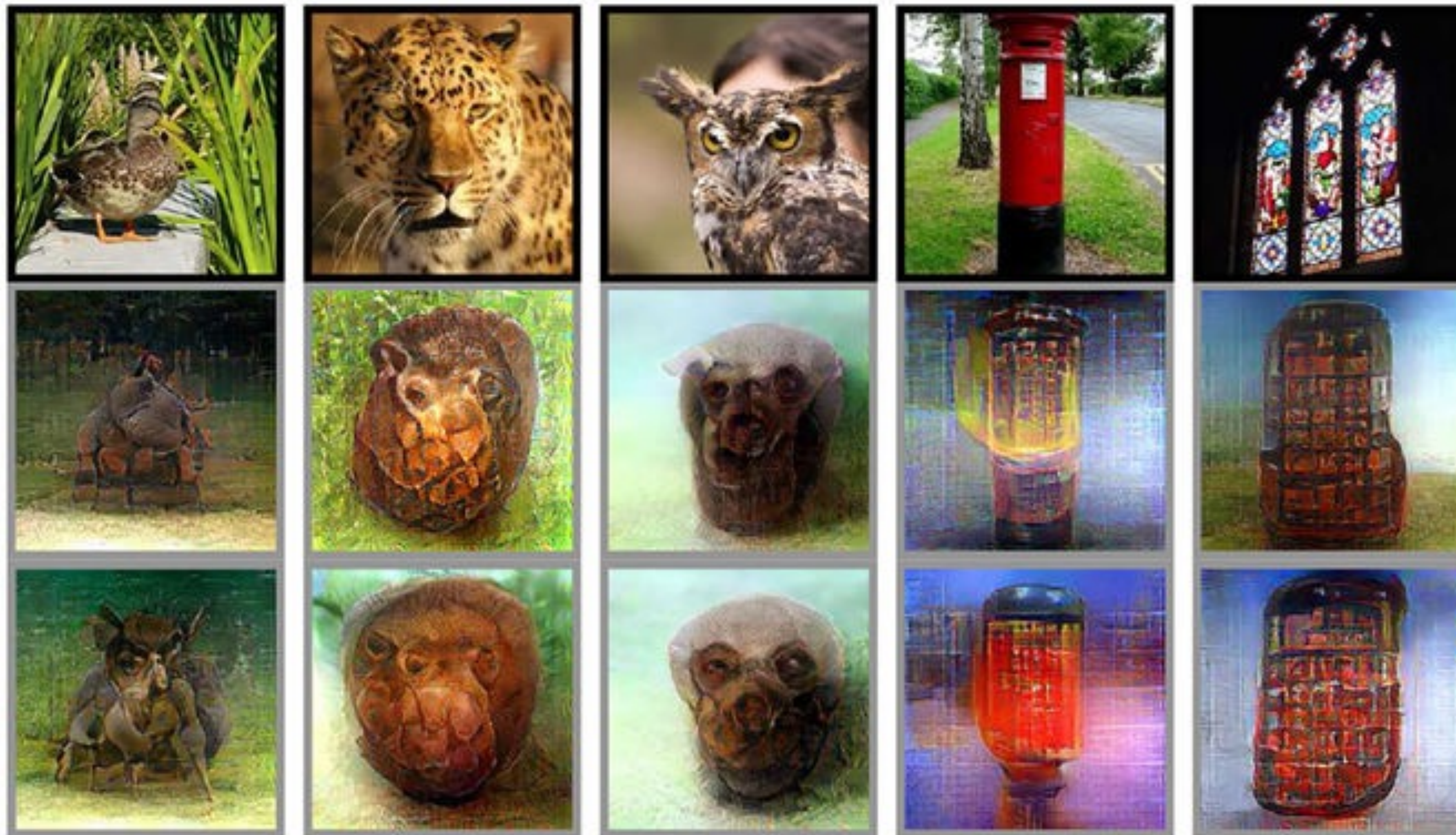


<https://deepsense.ai/deep-learning-for-satellite-imagery-via-image-segmentation/>

Image segmentation



functional magnetic resonance
-> picture in your mind

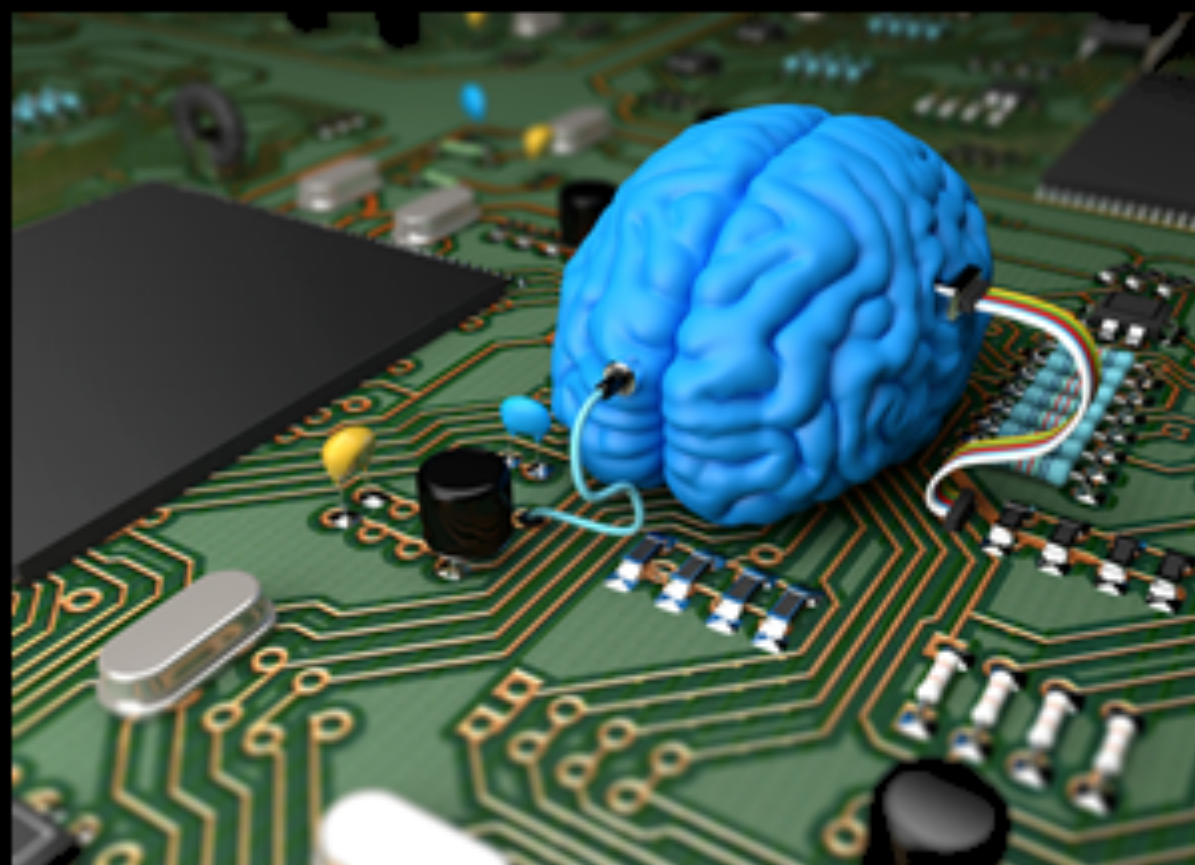


So it is difficult, right?

Deep Learning



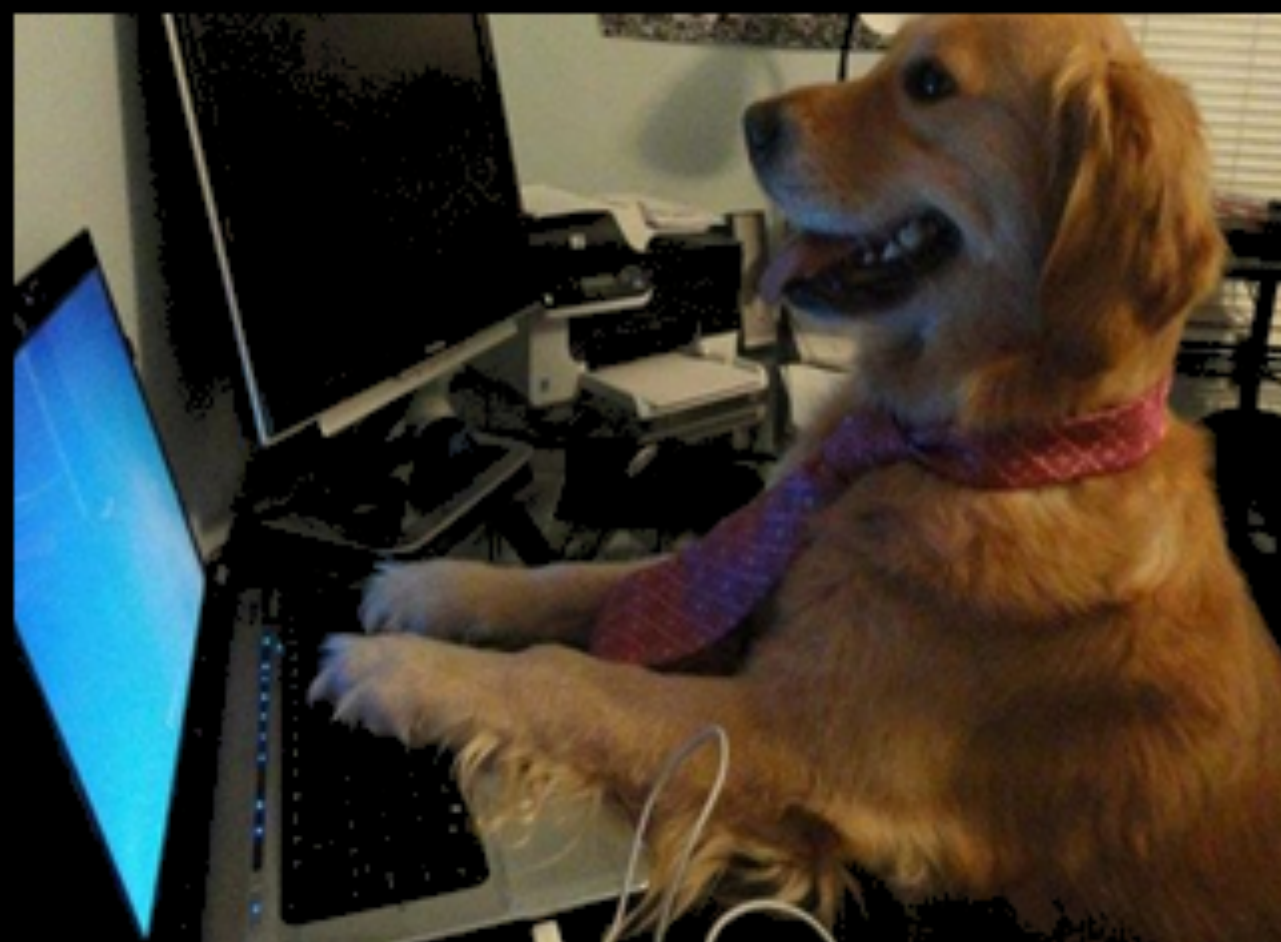
What society thinks I do



What my friends think I do



What other computer scientists think I do



What mathematicians think I do



What I think I do

```
In [1]:  
import keras  
Using TensorFlow backend.
```

What I actually do

Just learn it (pick Keras or PyTorch)

```
# create neural network architecture
model = Sequential()

model.add(Conv2D(32, (3, 3), activation='relu',
                input_shape=(32, 32, 3)))
model.add(MaxPool2D())

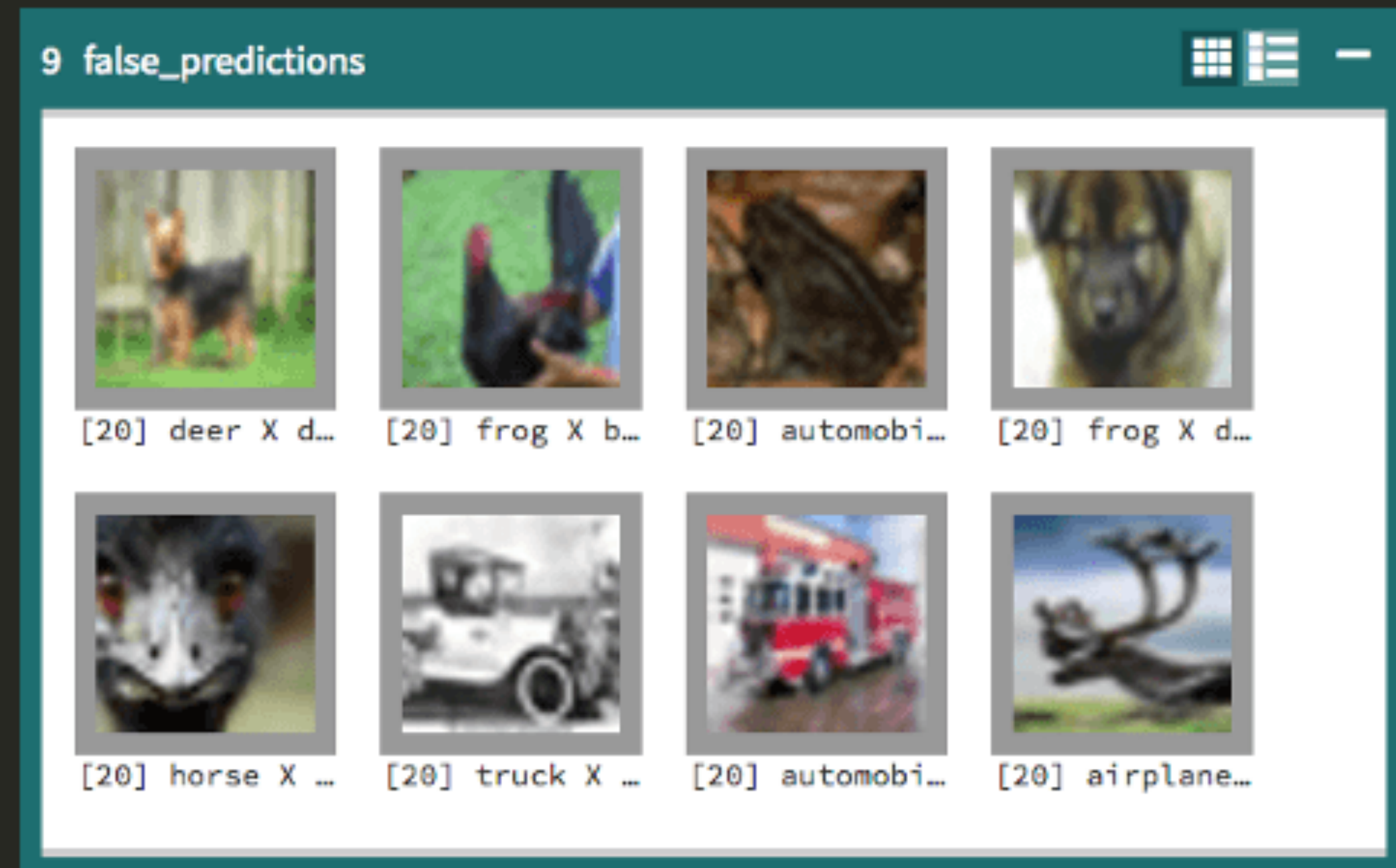
model.add(Conv2D(64, (3, 3), activation='relu'))
model.add(MaxPool2D())

model.add(Flatten())
model.add(Dense(10))
model.add(Activation('softmax'))

model.compile(optimizer='adam',
              loss='categorical_crossentropy',
              metrics=['accuracy'])

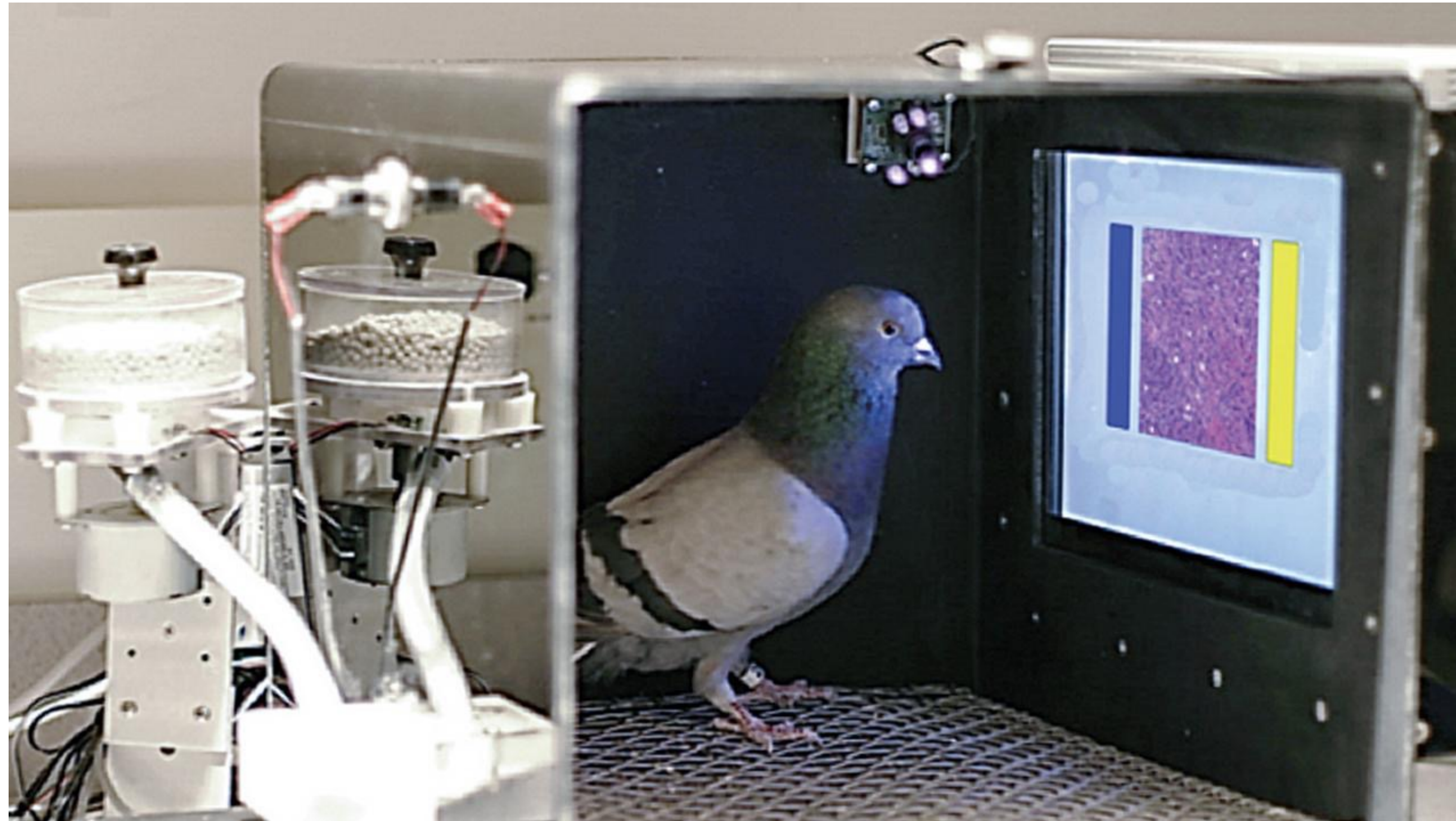
model_summary(model)

# loading data
(x_train, y_train), (x_test, y_test) = load_cifar10()
```



<https://deepsense.ai/deep-learning-hands-on-image-classification/>
<https://deepsense.ai/keras-or-pytorch/>

Other neural networks are fine

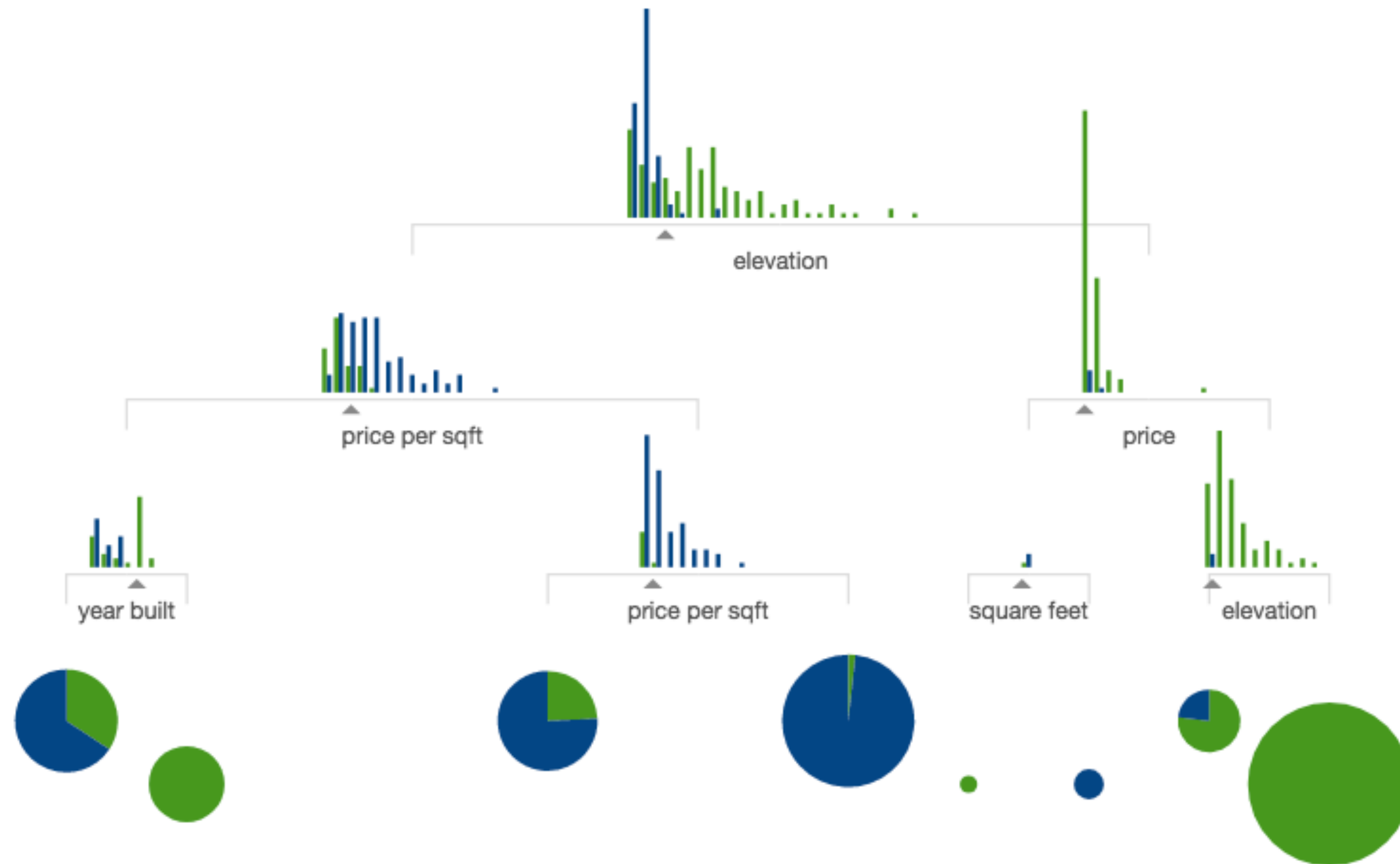


<http://www.sciencemag.org/news/2015/11/pigeons-spot-cancer-well-human-experts>

<https://www.youtube.com/watch?v=flzGjnJLyS0>

And interactively

Decision trees, visually

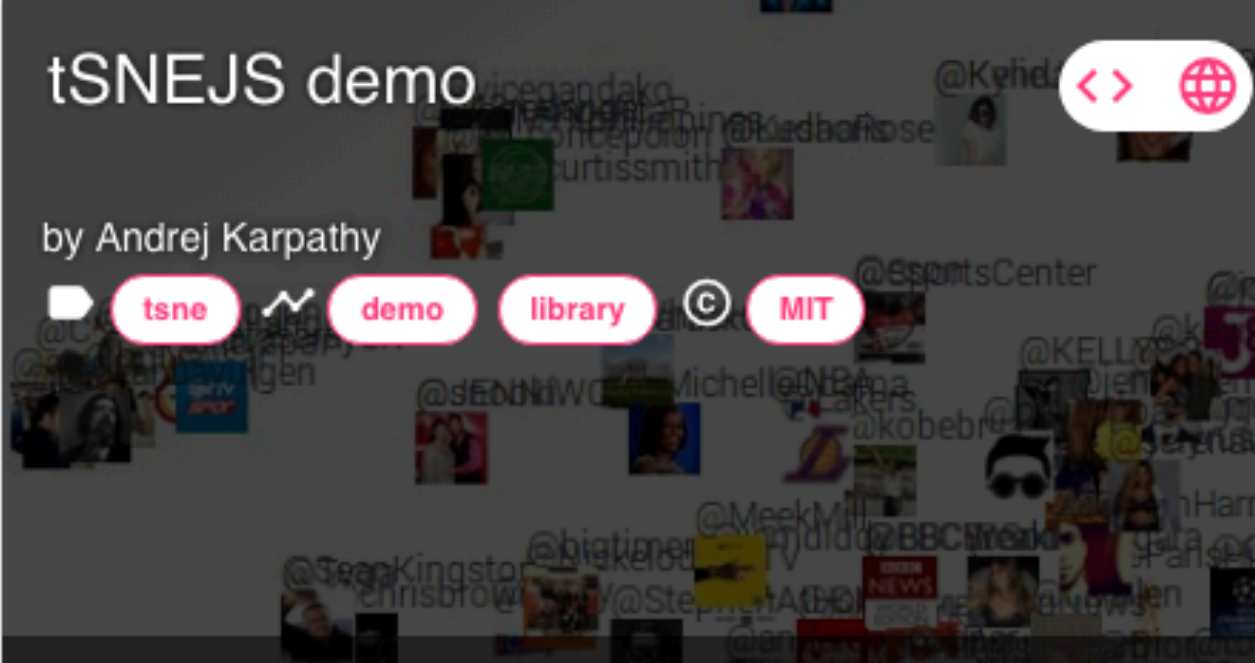


Interactive ML

tSNEJS demo

by Andrej Karpathy

tsne demo library MIT

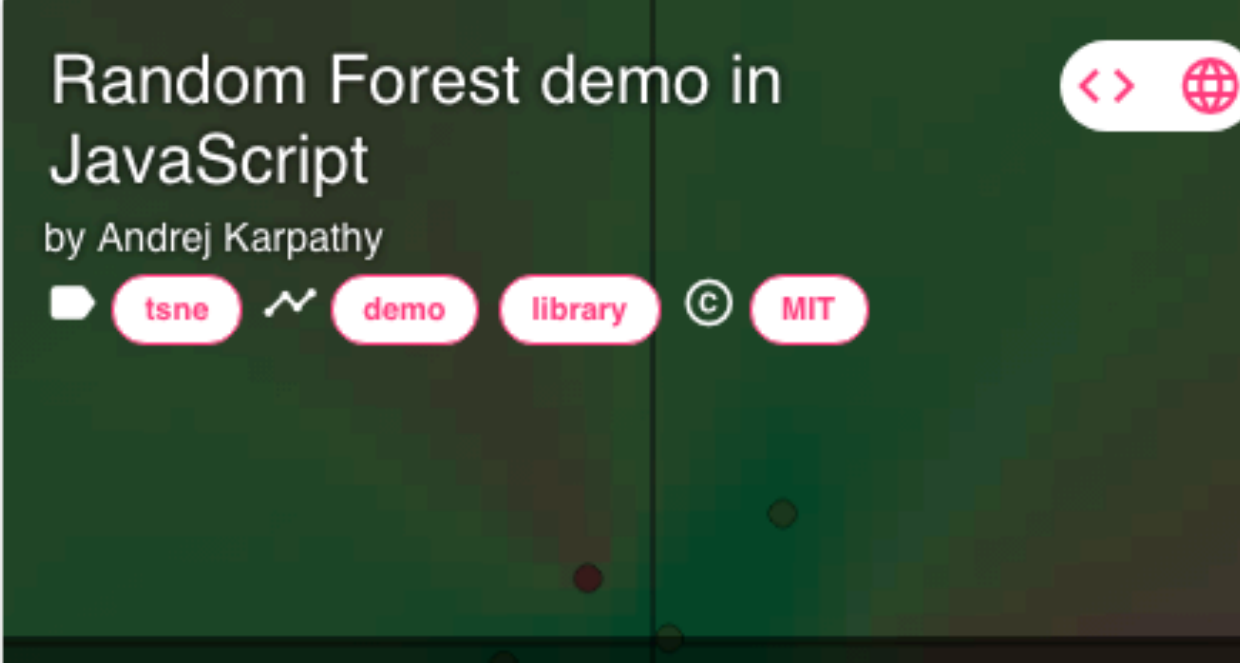


tSNE used for clustering the 500 most-followed accounts on Twitter. [see also this article](#)

Random Forest demo in JavaScript

by Andrej Karpathy

tsne demo library MIT

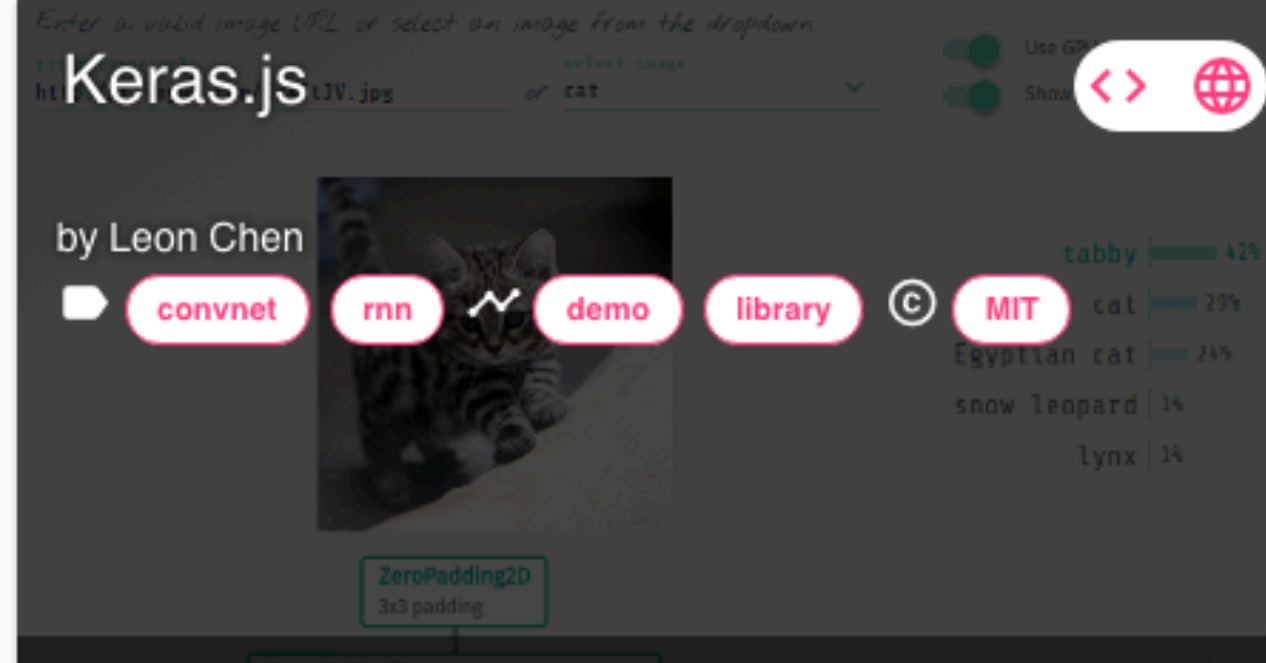


Random Forest implementation for JavaScript. Supports arbitrary weak learners.

Keras.js

by Leon Chen

convnet rnn demo library MIT



Keras.js is a library enabling running Keras models in the browser, with GPU support provided by WebGL 2.

Interactive visualization of word analogies in GloVe

by Julia Bazińska, Piotr Migdał

nlp word2vec demo MIT

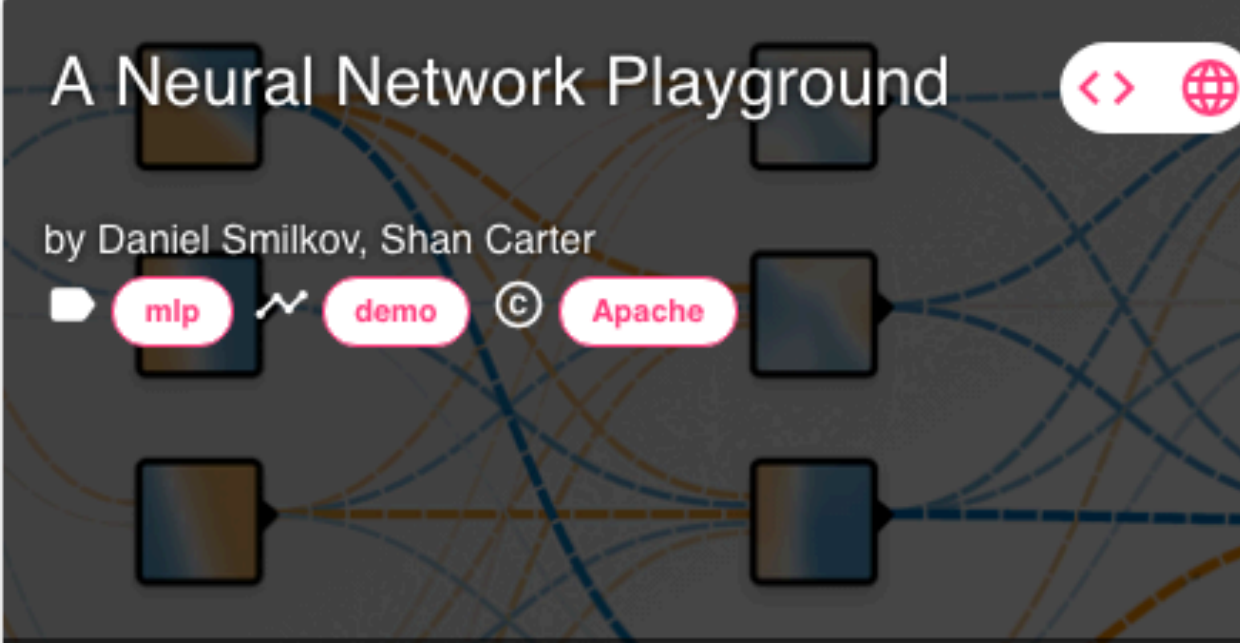


king - man + woman is queen; but why? Explore word vectors interactively. [see also this article](#)

A Neural Network Playground

by Daniel Smilkov, Shan Carter

mlp demo Apache

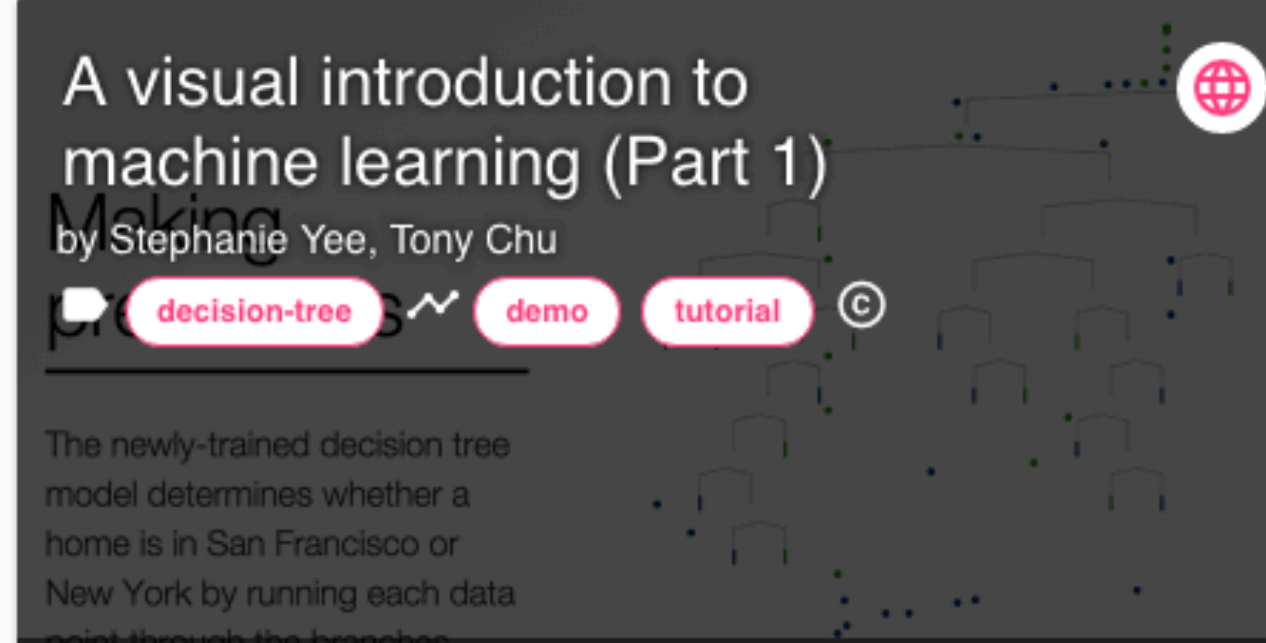


Interactive visualization of simple neural networks, written in typescript using d3.js.

A visual introduction to machine learning (Part 1)

by Stephanie Yee, Tony Chu

decision-tree demo tutorial



The newly-trained decision tree model determines whether a home is in San Francisco or New York by running each data point through the branches.

A demo of using a decision tree algorithm to distinguish houses in New York from houses in San Francisco

Draw any digit (0-9) here



use GPU



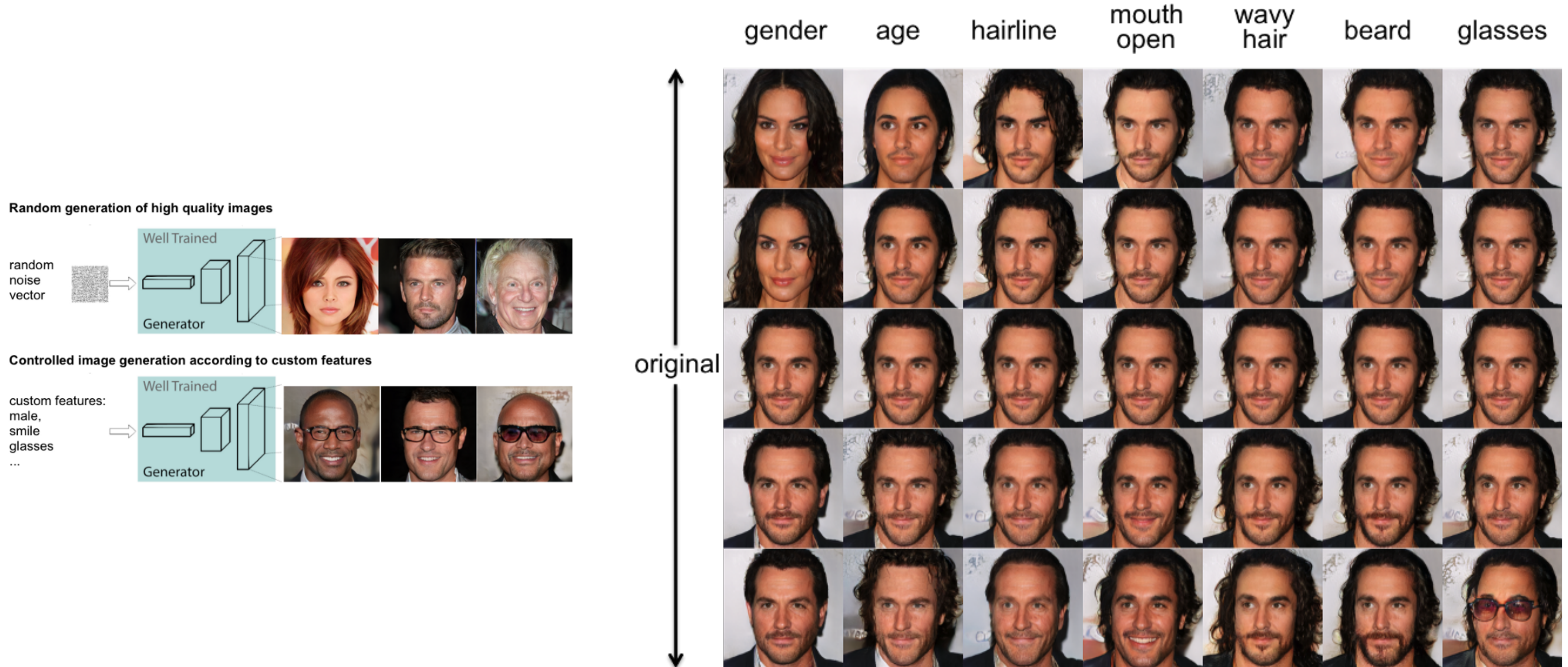
✕ CLEAR

Conv2D

32 3x3 filters, padding valid, 1x1 strides

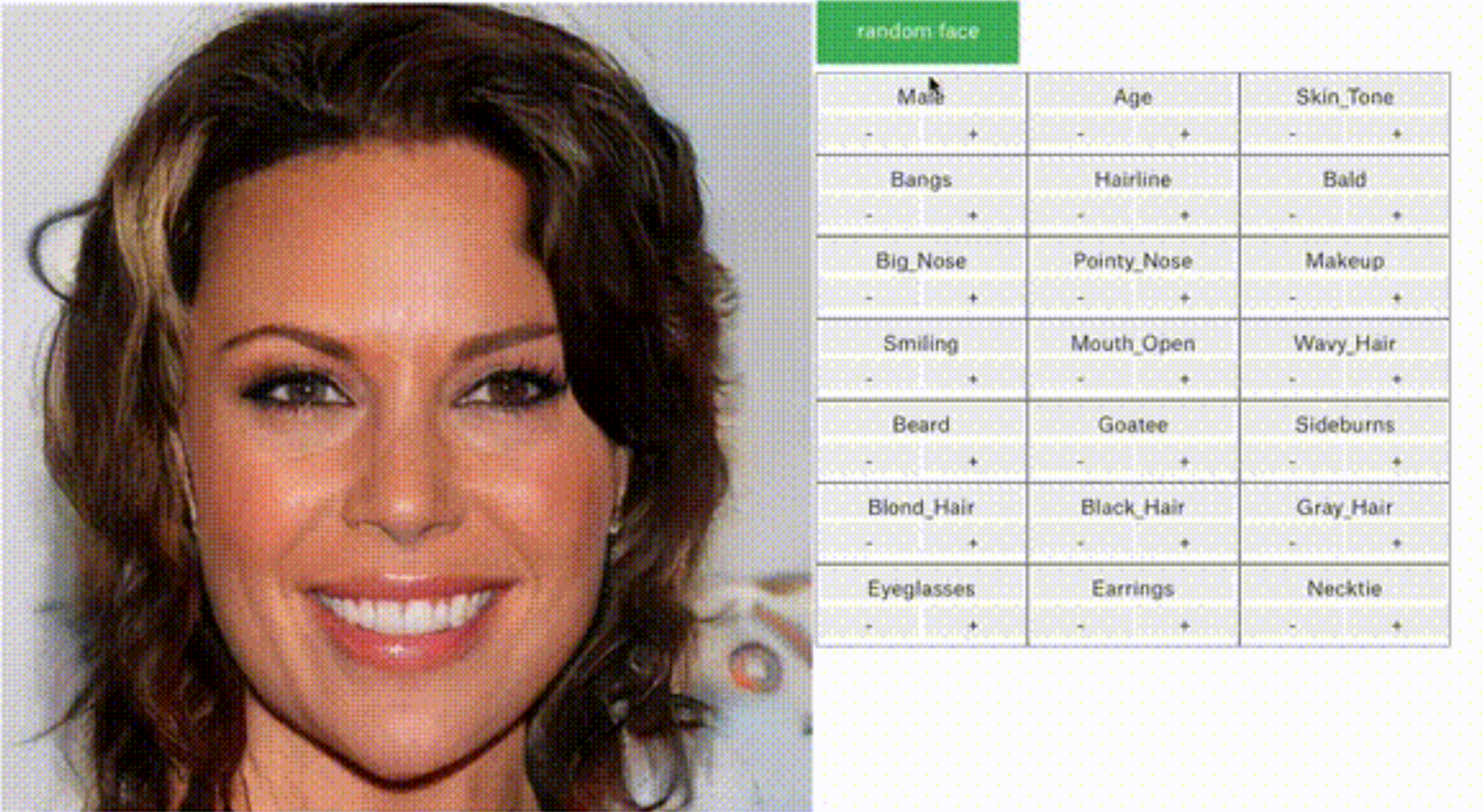


Generating faces



Generating faces... online

INSTRUCTION: press +/- to adjust feature, toggle feature name to lock the feature



random face		
Male	Age	Skin_Tone
- +	- +	- +
Bangs	Hairline	Bald
- +	- +	- +
Big_Nose	Pointy_Nose	Makeup
- +	- +	- +
Smiling	Mouth_Open	Wavy_Hair
- +	- +	- +
Beard	Goatee	Sideburns
- +	- +	- +
Blond_Hair	Black_Hair	Gray_Hair
- +	- +	- +
Eyeglasses	Earrings	Necktie
- +	- +	- +

<https://blog.insightdatascience.com/generating-custom-photo-realistic-faces-using-ai-d170b1b59255>
play interactively in a Jupyter Notebook: <https://www.kaggle.com/summitkwan/tl-gan-demo>

Let's learn it!

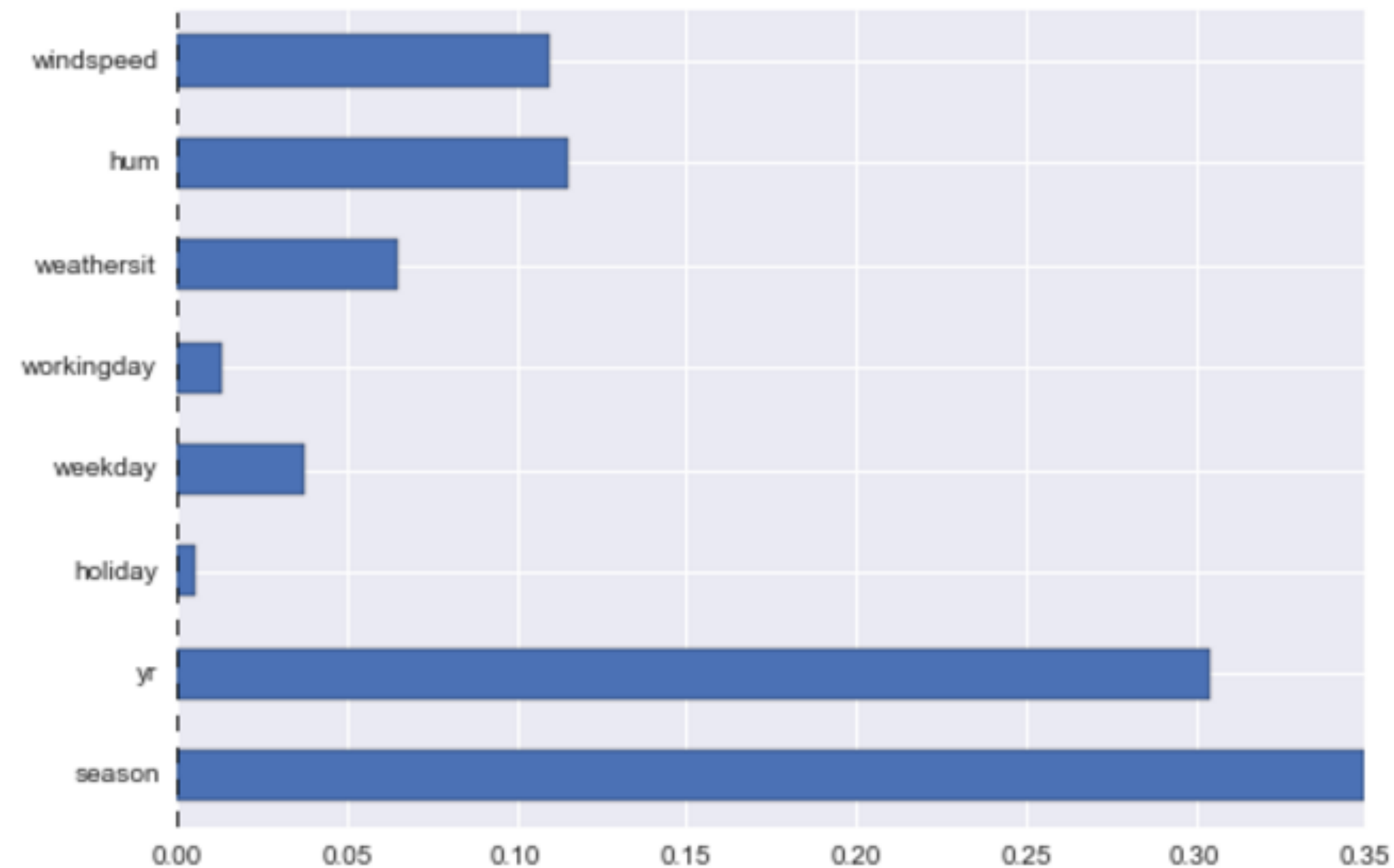
Real data, plots > arrays

```
In [10]: # feature (variable) importance  
rfr.feature_importances_
```

```
Out[10]: array([ 0.34966593,  0.30402689,  0.00540573,  0.03778628,  0.01359446,  
                0.06506118,  0.11507385,  0.10938569])
```

```
In [11]: # but we want to plot it  
pd.Series(rfr.feature_importances_, index=X.columns).plot(kind="barh")
```

```
Out[11]: <matplotlib.axes._subplots.AxesSubplot at 0x111427290>
```





François Chollet

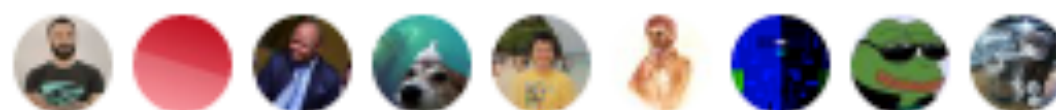
@fchollet

Following

Many good ideas will not work well on MNIST (e.g. batch norm). Inversely many bad ideas may work on MNIST and no transfer to real CV.

11:51 AM - 13 Apr 2017

8 Retweets 24 Likes



1



8



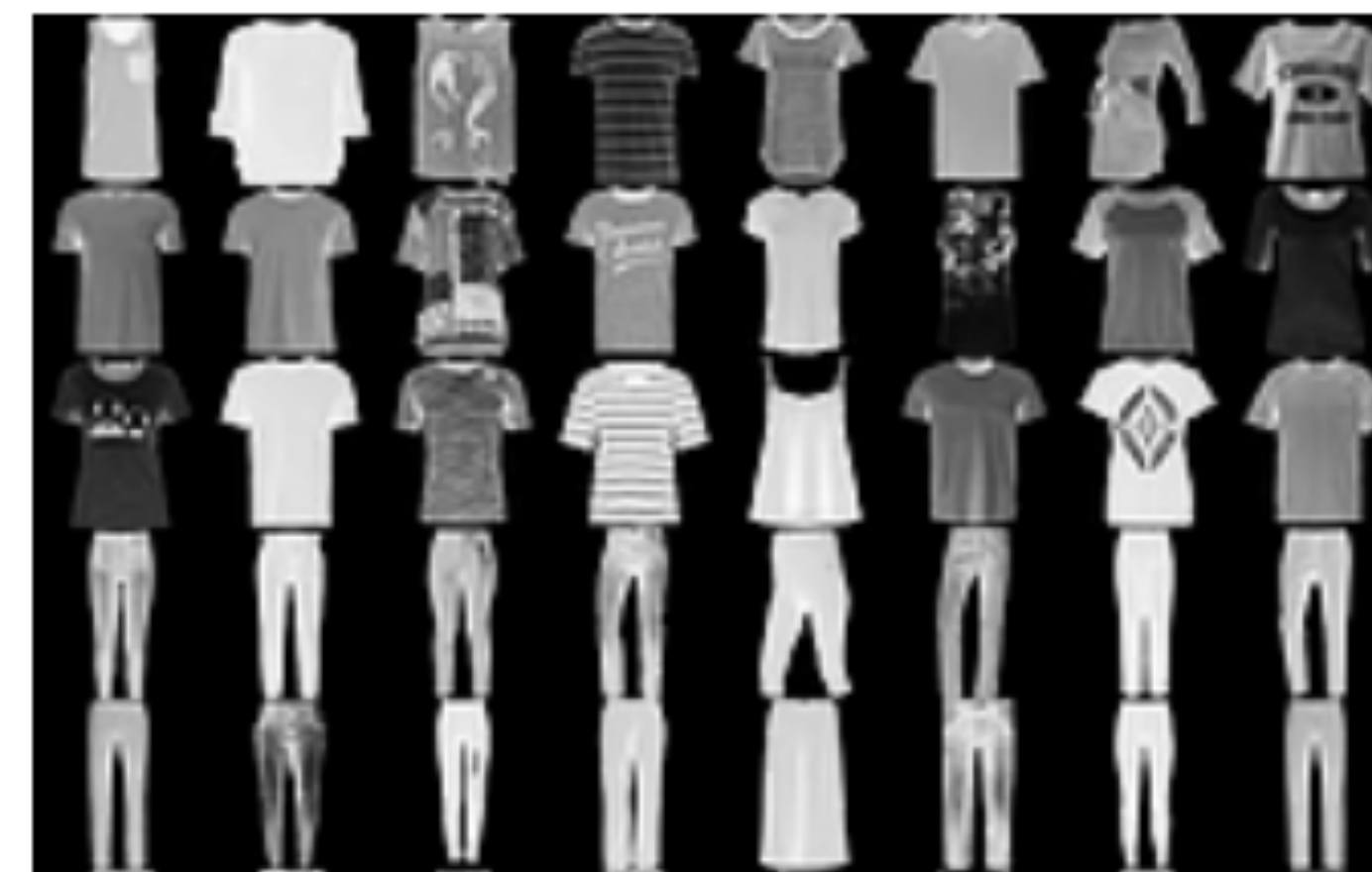
24



not-MNIST



fashion-MNIST



<https://twitter.com/fchollet/status/852594987527045120>

<https://github.com/zalandoresearch/fashion-mnist>

Ok, so maybe on a
nicer dataset?



Drawing 5/6

Draw
angel

in under 20 seconds

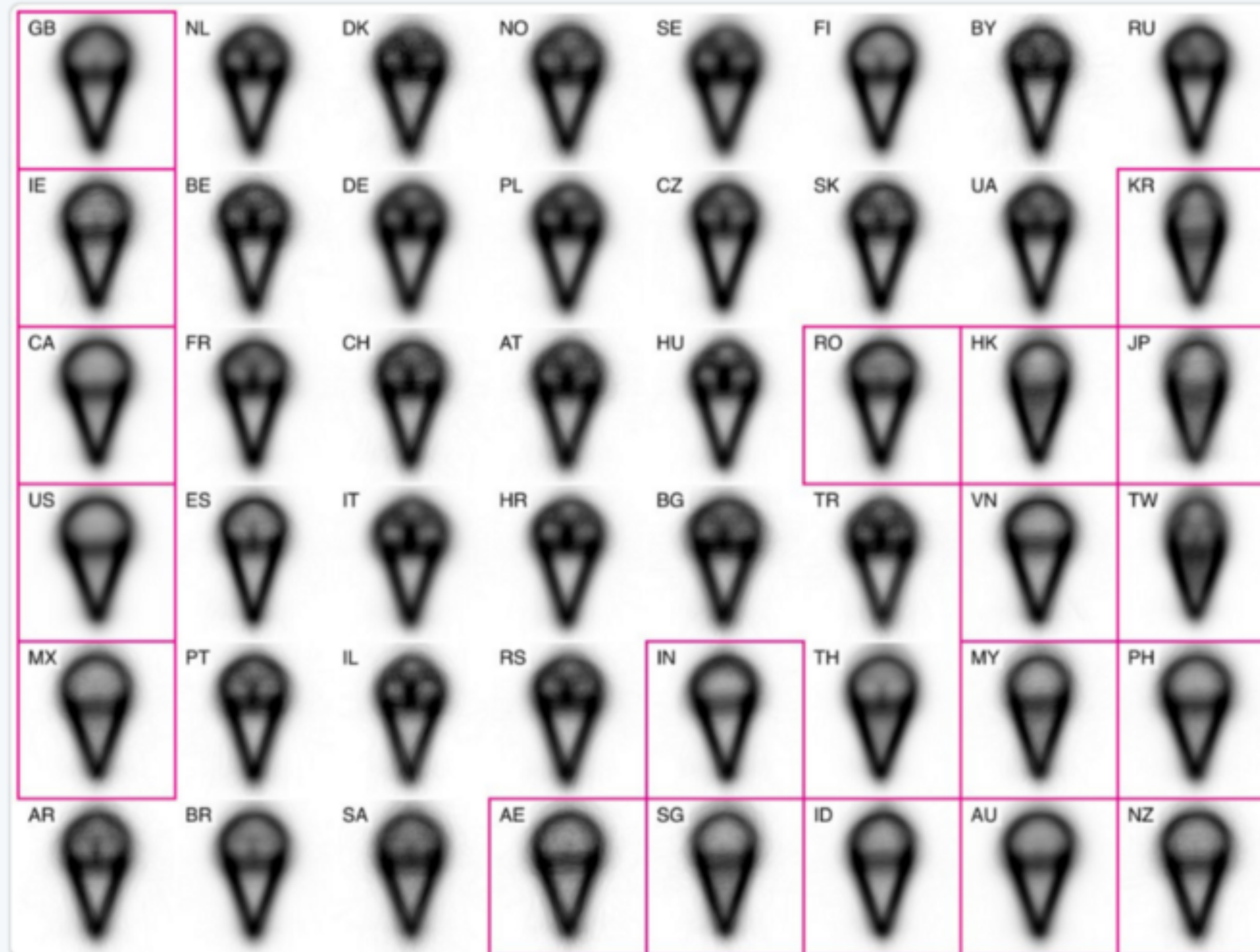
Got It!





Kyle McDonald @kcimc · 28 Aug 2017

or why are some ice cream cones three scoops, and others one? the world is pretty divided on this one.



8 53 97

<https://twitter.com/kcimc/status/902229612666658816> - more example of averages
<https://medium.com/@enjalot/machine-learning-for-visualization-927a9dff1cab> - Ian Johnson



[https://github.com/stared/
keras-interactively-piterpy2018](https://github.com/stared/keras-interactively-piterpy2018)



Thank you!

Questions?

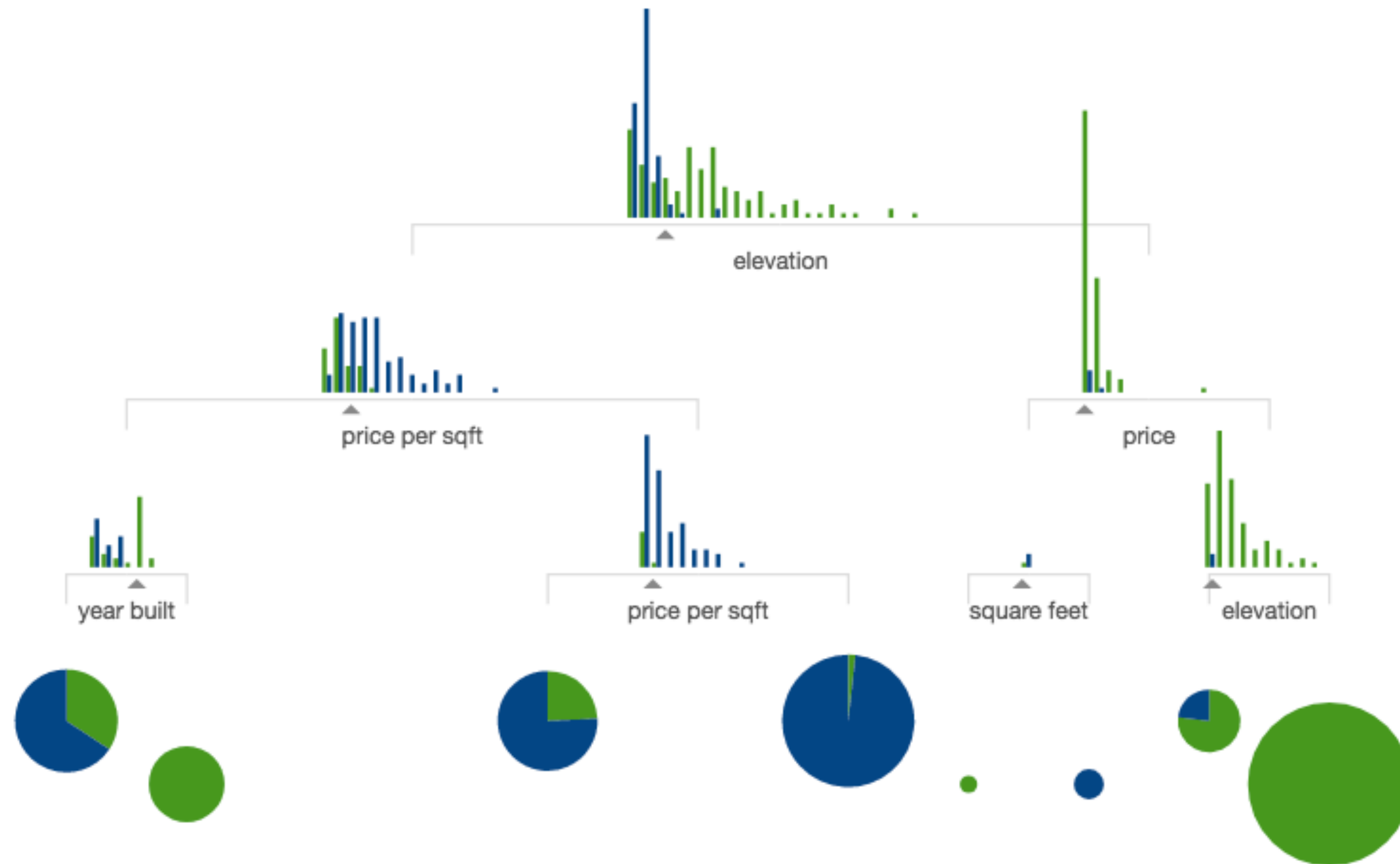
blog: p.migdal.pl

email: pmigdal@gmail.com

twitter: [@pmigdal](https://twitter.com/pmigdal)

In Browser AI: inbrowser.ai / [@InBrowserAI](https://twitter.com/InBrowserAI)

Decision trees, visually



<http://www.r2d3.us/visual-intro-to-machine-learning-part-1/>

Thank you!

Questions?

blog: p.migdal.pl

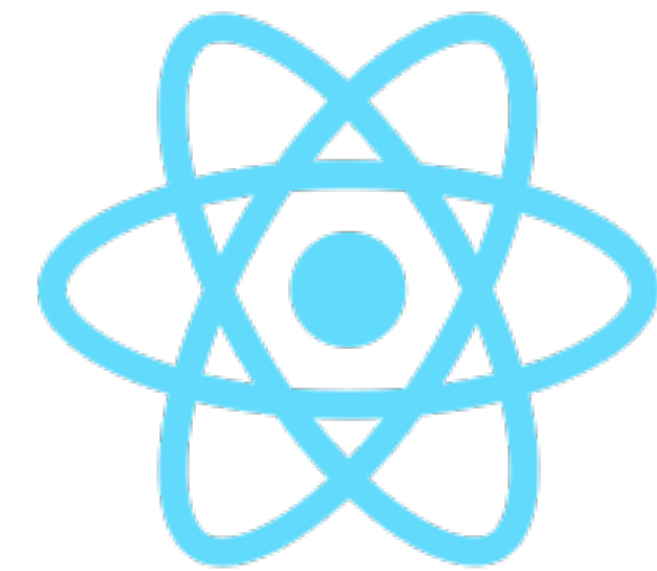
email: pmigdal@gmail.com

twitter: [@pmigdal](https://twitter.com/pmigdal)

In Browser AI: inbrowser.ai / [@InBrowserAI](https://twitter.com/InBrowserAI)

Additional slides

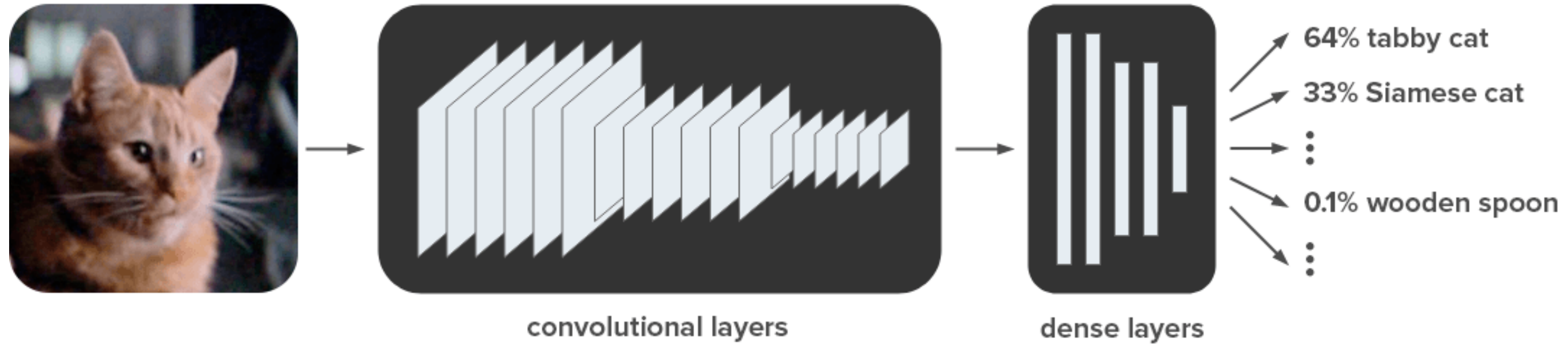
Open-source community



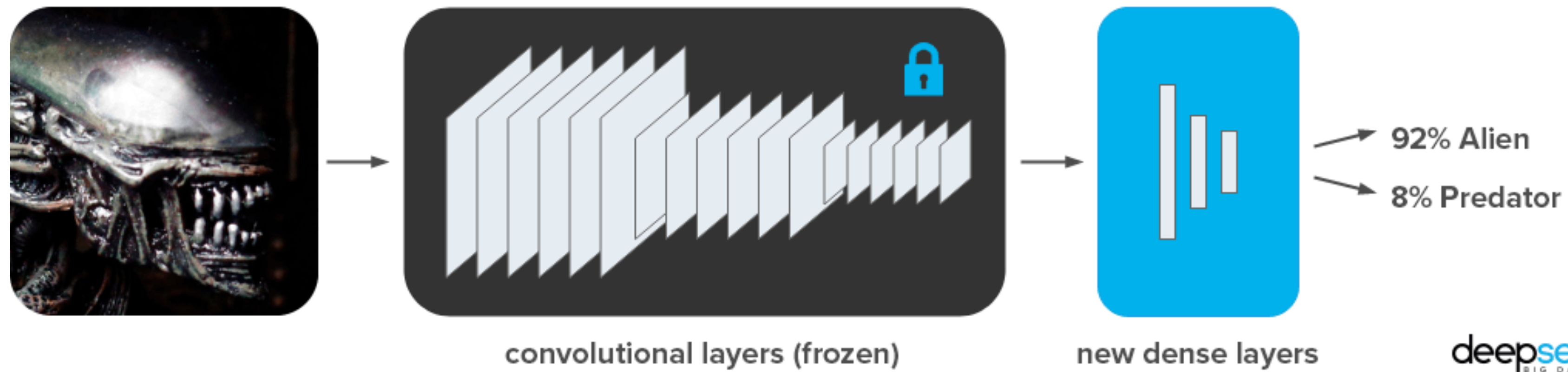
InBrowser.AI

<https://inbrowser.ai/>
<https://twitter.com/InBrowserAI>

Pre-training



Transfer learning



deepsense.ai
BIG DATA SCIENCE

<https://deepsense.ai/keras-vs-pytorch-avp-transfer-learning/>

Machine Learning events



PyData Warsaw 2018

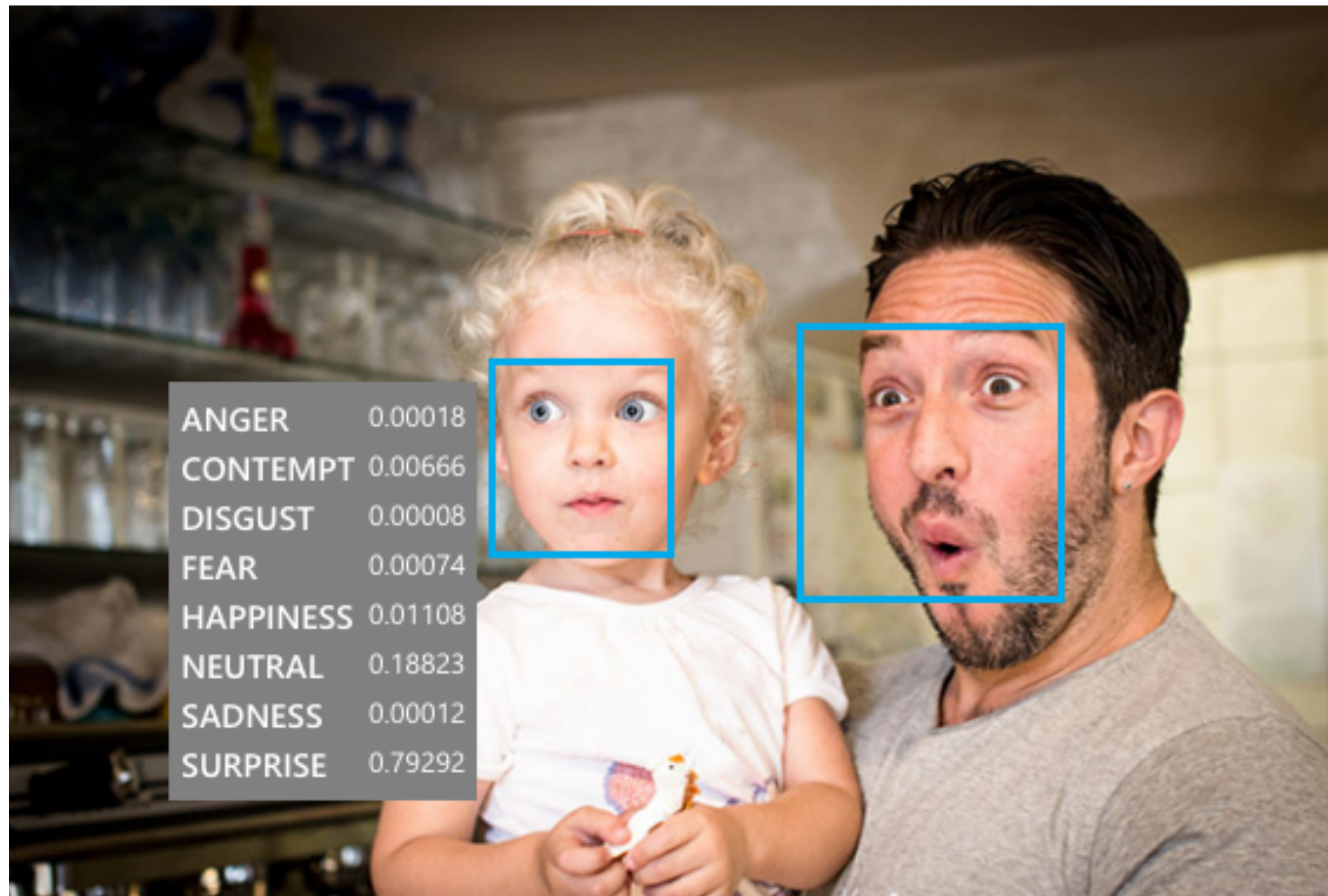
19-20 November 2018

<https://pydata.org/warsaw2018/>



<http://plinml.mimuw.edu.pl/>

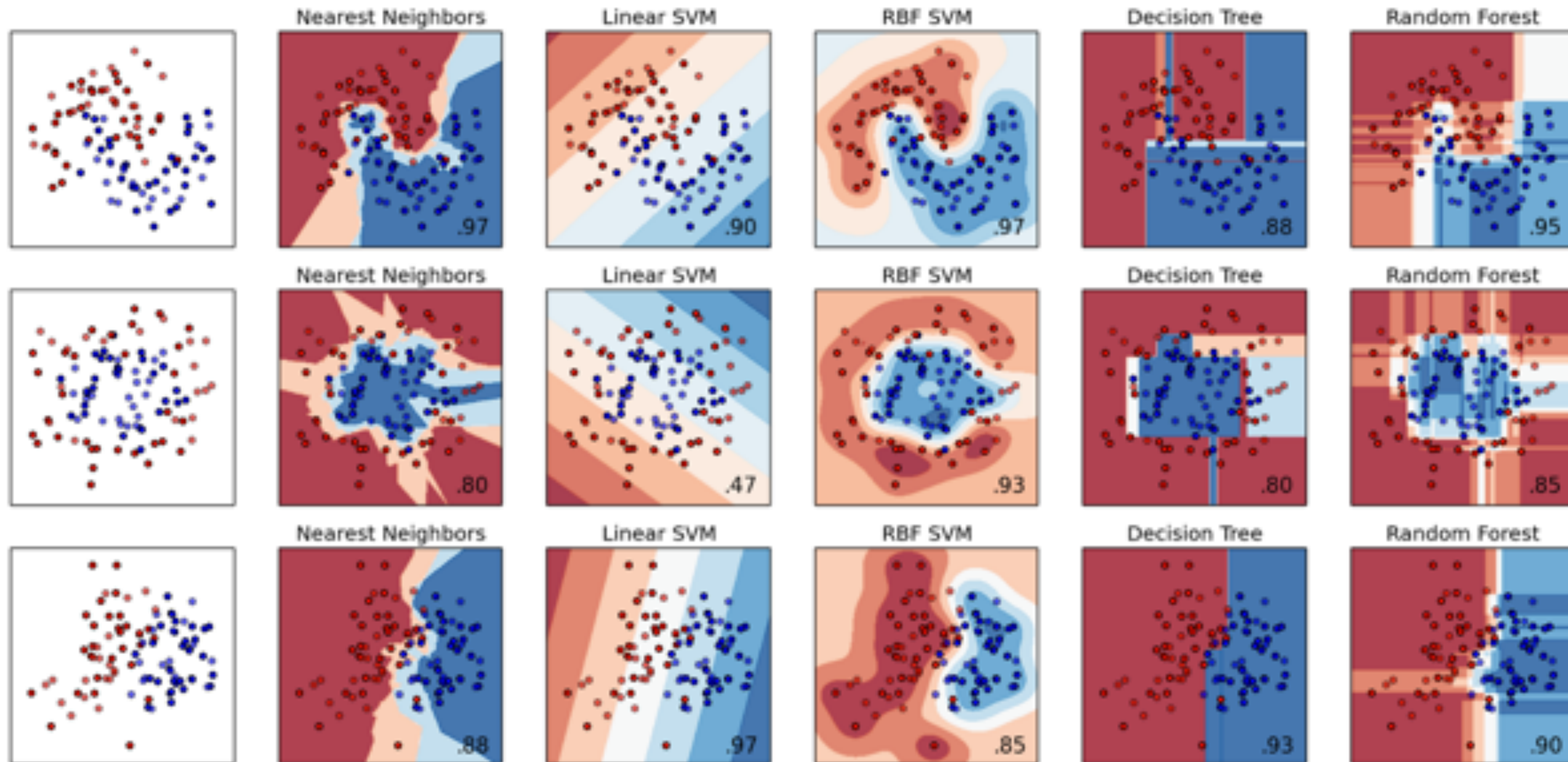
Services accessible via API



```
Detection result:  
2 faces detected  
  
JSON:  
[  
  {  
    "faceRectangle": {  
      "top": 141,  
      "left": 356,  
      "width": 123,  
      "height": 123  
    },  
    "scores": {  
      "anger": 2.45541414E-05,  
      "contempt": 0.000249862962,  
      "disgust": 4.51454434E-05,  
      "fear": 0.001153976,  
      "happiness": 5.58101638E-05,  
      "neutral": 0.004939176,  
      "sadness": 1.091316E-05,  
      "surprise": 0.993520558  
    }  
  },  
]
```

<https://azure.microsoft.com/en-us/services/cognitive-services/face/#recognition>
<https://goberoi.com/comparing-the-top-five-computer-vision-apis-98e3e3d7c647>

Machine learning models





Jan Rzymkowski

1 February · 🌐

Najczęstsze kłamstwo każdego rodzica, właściciela zwierzęcia i programisty sztucznej inteligencji: "Nigdy go tego nie uczyłem"

😂 **Haha**

💬 **Comment**

➦ **Share**

*The biggest lie of every
parent, pet owner
and neural network trainer:*

*"I've never shown it that,
it must have learned it by itself!"*

Science-based games



<https://github.com/stared/science-based-games-list>

Thank you!

Questions?

p.migdal.pl - blog

pmigdal@gmail.com

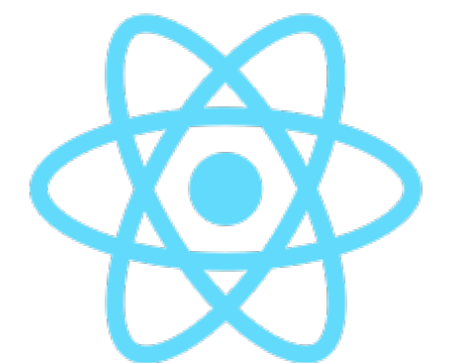
[@pmigdal](https://twitter.com/pmigdal)

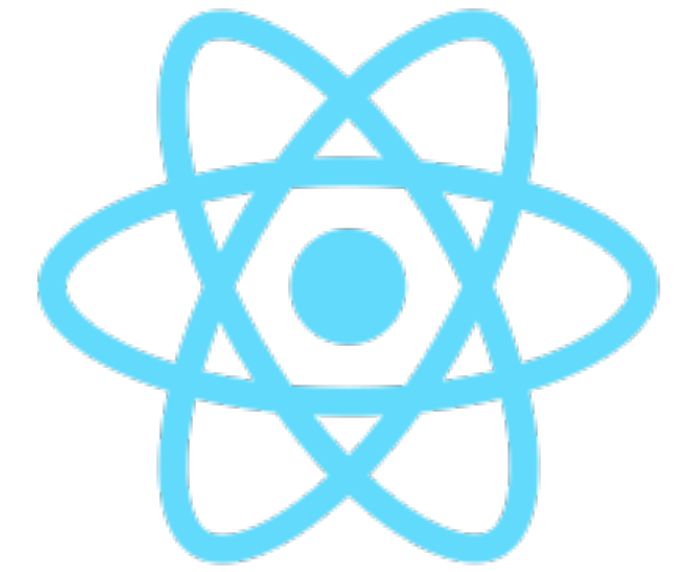
[github/stared](https://github.com/pmigdal)

- inbrowser.ai / Twitter: [@InBrowserAI](https://twitter.com/InBrowserAI)
- Simple diagrams of convolved neural networks
- Keras or PyTorch as your first deep learning framework
- Learning Deep Learning with Keras
- king - man + women is queen; but why?



InBrowser.AI





InBrowser.AI

<https://inbrowser.ai/>
<https://twitter.com/InBrowserAI>