JS DayCAN 2017

expero

Machine Learning in Javascript

JSDay Canarias

November 11, 2017

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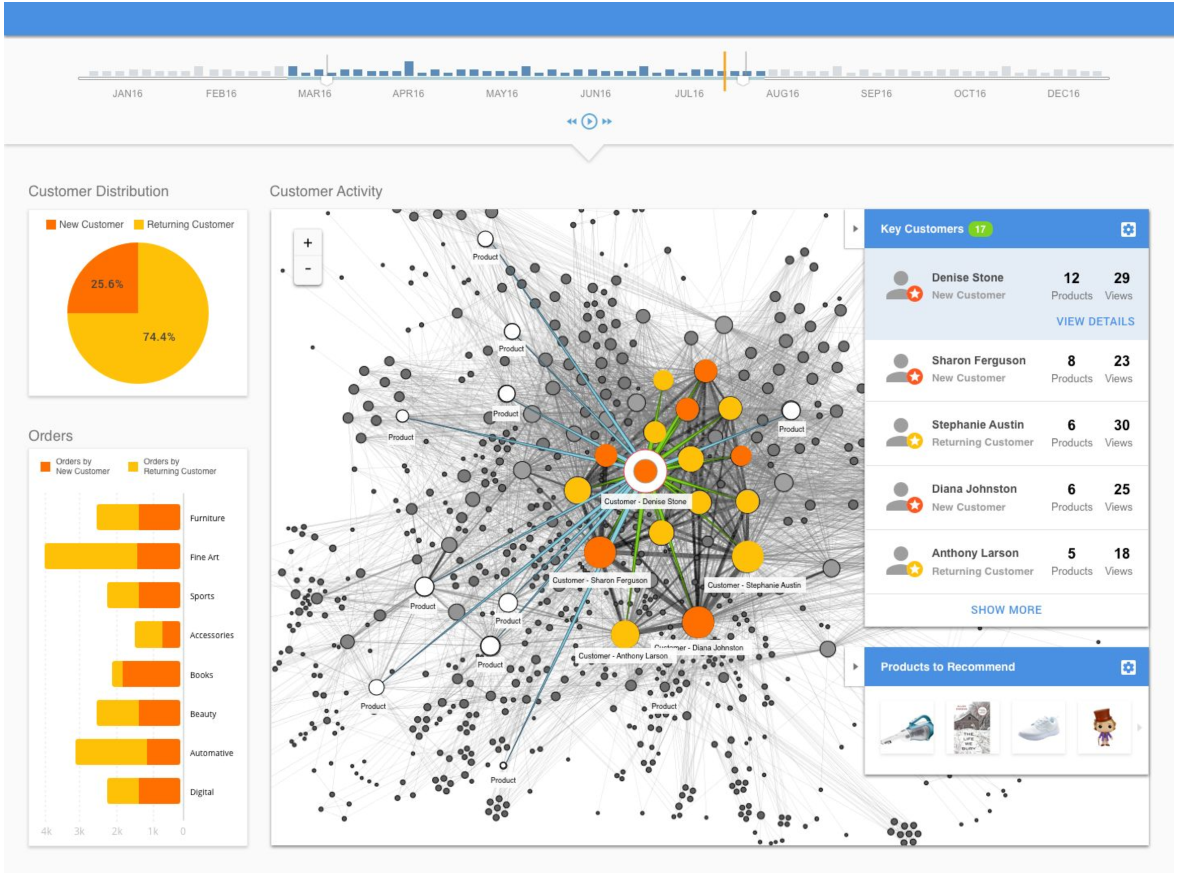


Key Customers 17

Denise Stone New Customer	12 Products	29 Views
VIEW DETAILS		
Sharon Ferguson New Customer	8 Products	23 Views
Stephanie Austin Returning Customer	6 Products	30 Views
Diana Johnston New Customer	6 Products	25 Views
Anthony Larson Returning Customer	5 Products	18 Views

SHOW MORE

What is Machine Learning?
[...these days...]

Machine Learning

...a field of computer science that gives computers the ability to learn without being explicitly programmed...

Machine Learning

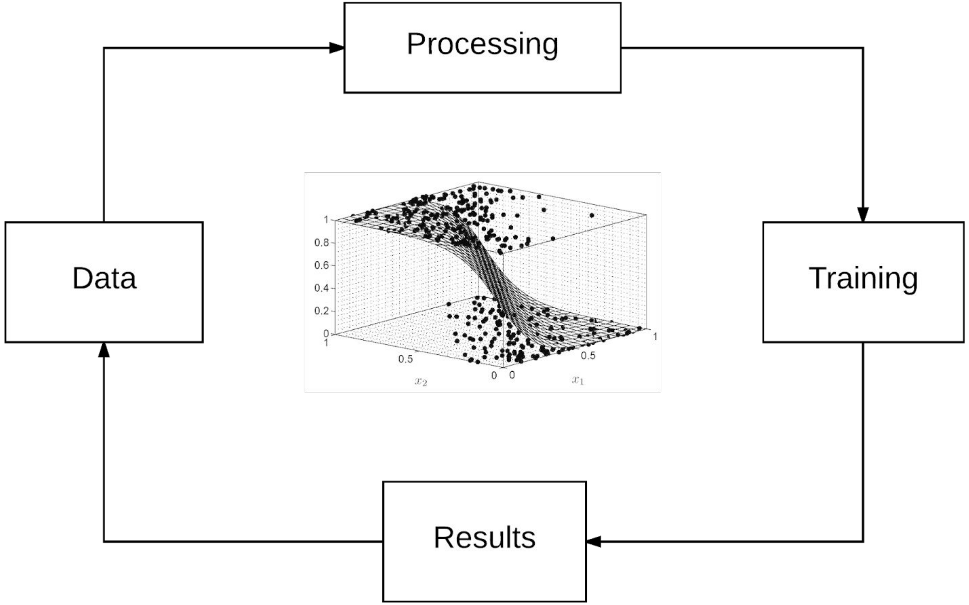
...a field of computer science that gives computers the ability to learn without being explicitly programmed...

logistic regression
neural networks
genetic algorithms
statistical models
stochastic methods
optimisation theory
pattern recognition
inverse problems

… practically any numerical analysis...

Machine Learning “Research/Project Flow”

cleanup, aggregation, conditioning,
transformation, feature engineering,
feature extraction

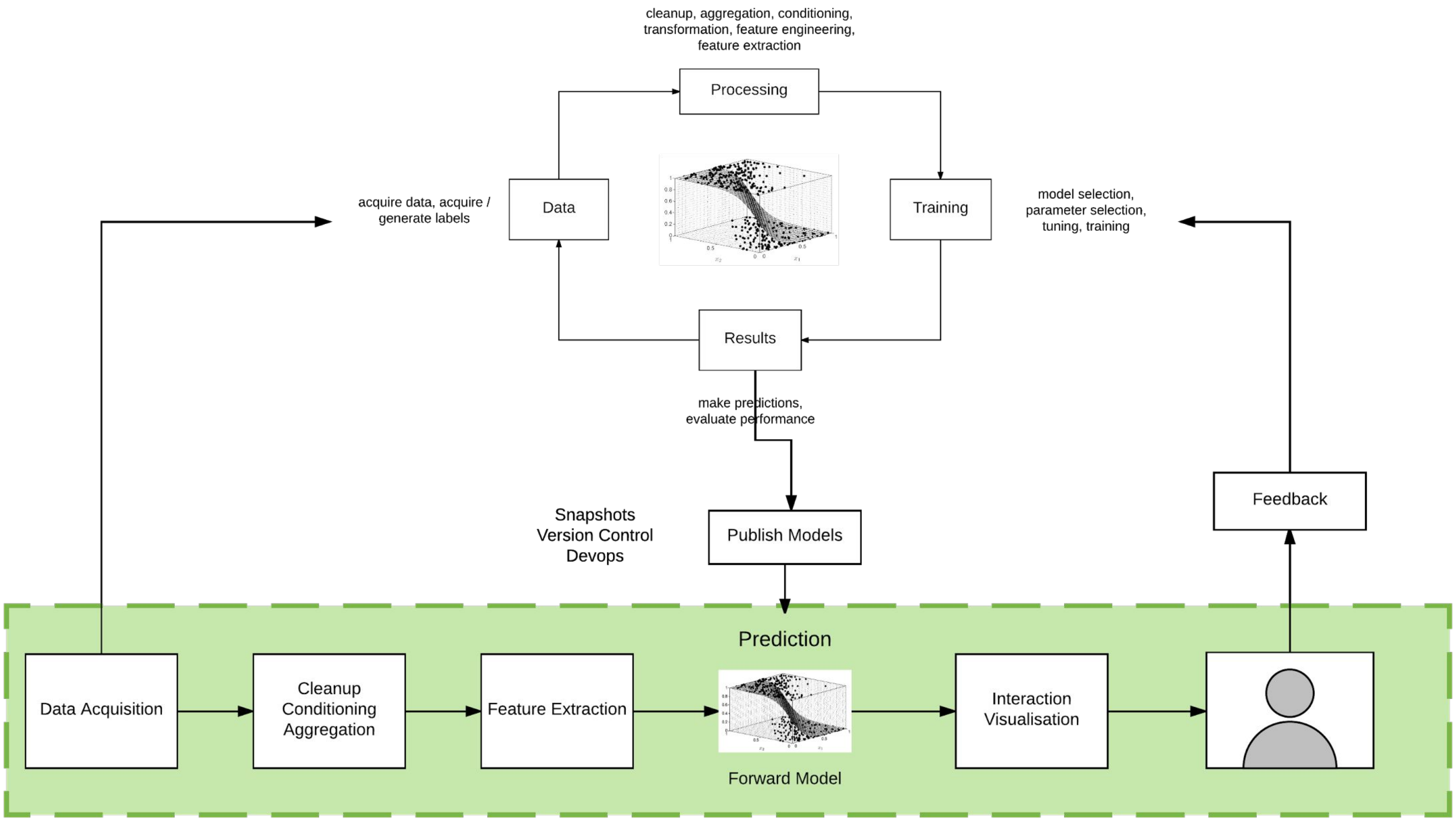


acquire data, acquire /
generate labels

model selection,
parameter selection,
tuning, training

make predictions,
evaluate performance

Machine Learning “in Production”



cleanup, aggregation, conditioning, transformation, feature engineering, feature extraction

Processing

acquire data, acquire / generate labels

Data

Training

model selection, parameter selection, tuning, training

Results

make predictions, evaluate performance

Snapshots
Version Control
Devops

Publish Models

Feedback

Prediction

Data Acquisition

Cleanup
Conditioning
Aggregation

Feature Extraction

Forward Model

Interaction
Visualisation

Machine Learning in Javascript

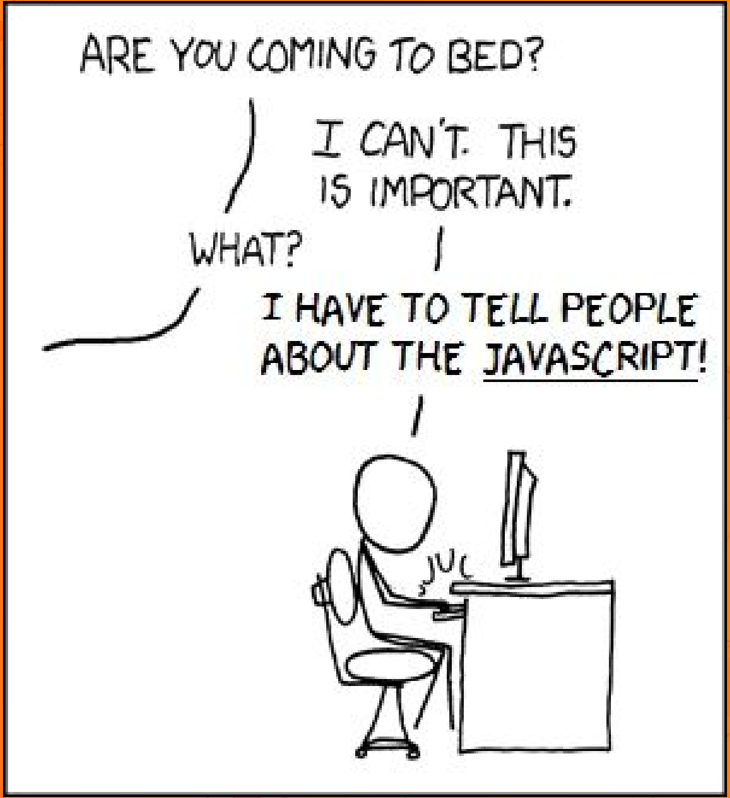
What happens when you say this to someone?

Er, Why?

Seriously?

Javascript, do people still use that?

… and so on …


ARE YOU COMING TO BED?
I CAN'T. THIS IS IMPORTANT.
WHAT?
I HAVE TO TELL PEOPLE ABOUT THE JAVASCRIPT!

©2017 xkcd CC-BY xkcd.com/1831

Any application that can be written in Javascript, will eventually be written in Javascript

Atwoods Law,
https://blog.codinghorror.com/the-principle-of-least-power/

Good Reasons

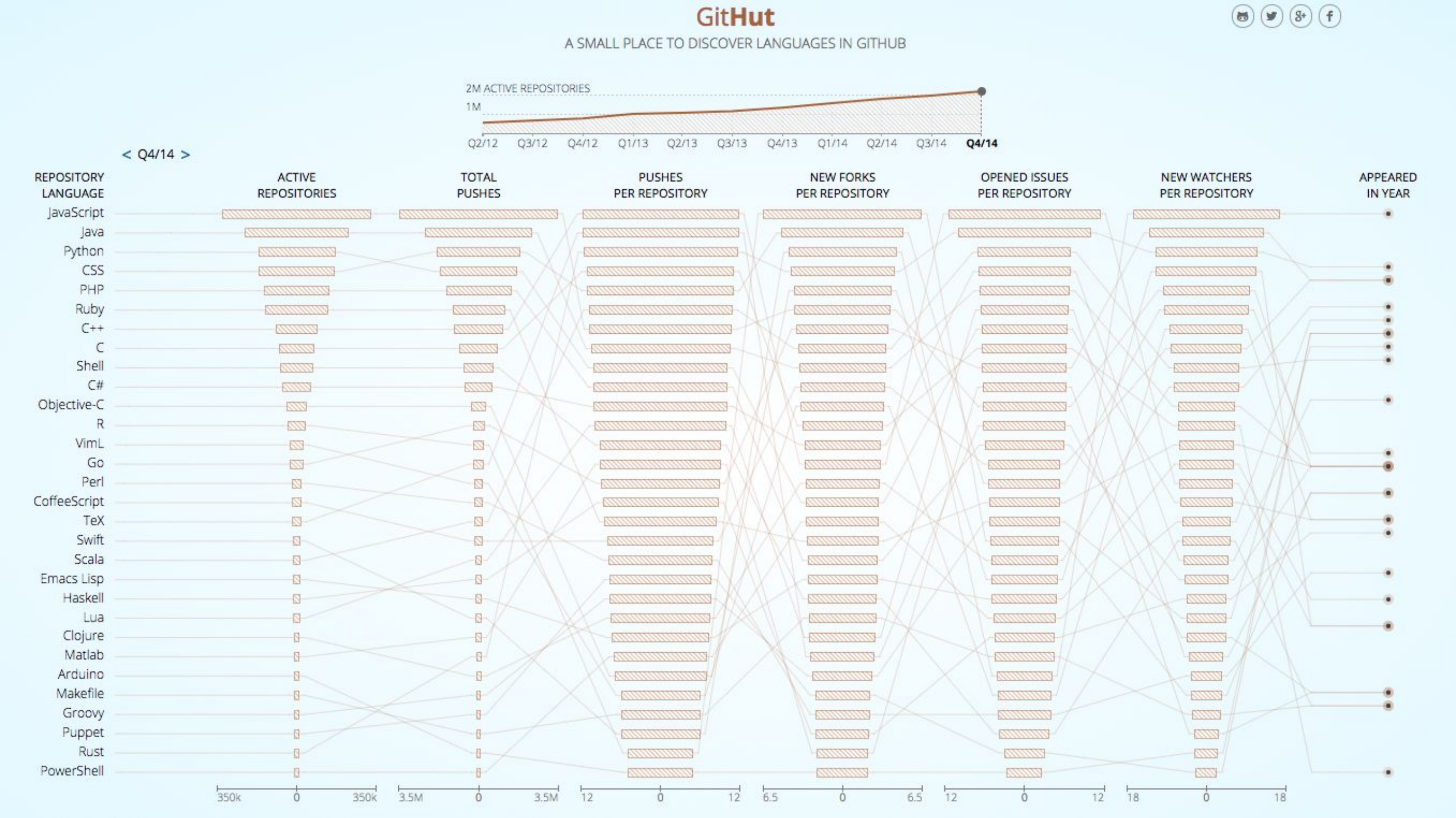
Community

Deployability

Portability

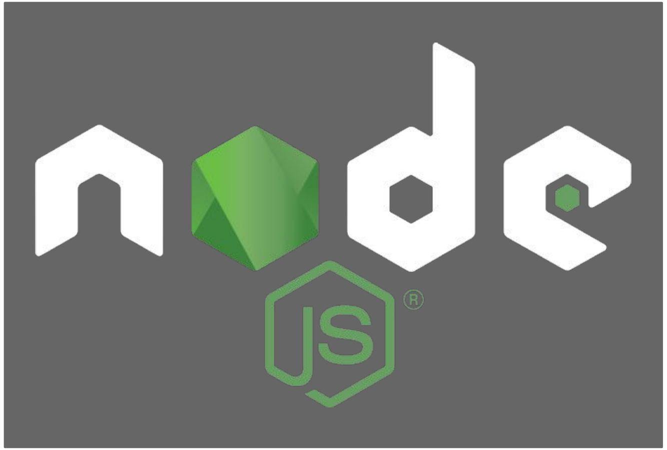
Interactivity

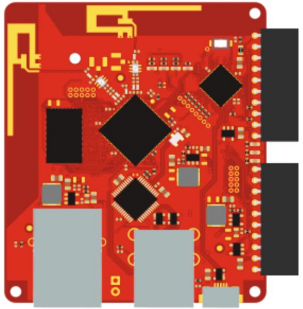
Community


GitHut
A SMALL PLACE TO DISCOVER LANGUAGES IN GITHUB
2M ACTIVE REPOSITORIES
1M
Q2/12
Q3/12
Q4/12
Q1/13
Q2/13
Q3/13
Q4/13
Q1/14
Q2/14
Q3/14
Q4/14
< Q4/14 >
REPOSITORY LANGUAGE
ACTIVE REPOSITORIES
TOTAL PUSHES
PUSHES PER REPOSITORY
NEW FORKS PER REPOSITORY
OPENED ISSUES PER REPOSITORY
NEW WATCHERS PER REPOSITORY
APPEARED IN YEAR
JavaScript
Java
Python
CSS
PHP
Ruby
C++
C
Shell
C#
Objective-C
R
VimL
Go
Perl
CoffeeScript
TeX
Swift
Scala
Emacs Lisp
Haskell
Lua
Clojure
Matlab
Arduino
Makefile
Groovy
Puppet
Rust
PowerShell
350k
0
350k
3.5M
0
3.5M
12
0
12
6.5
0
6.5
12
0
12
18
0
18

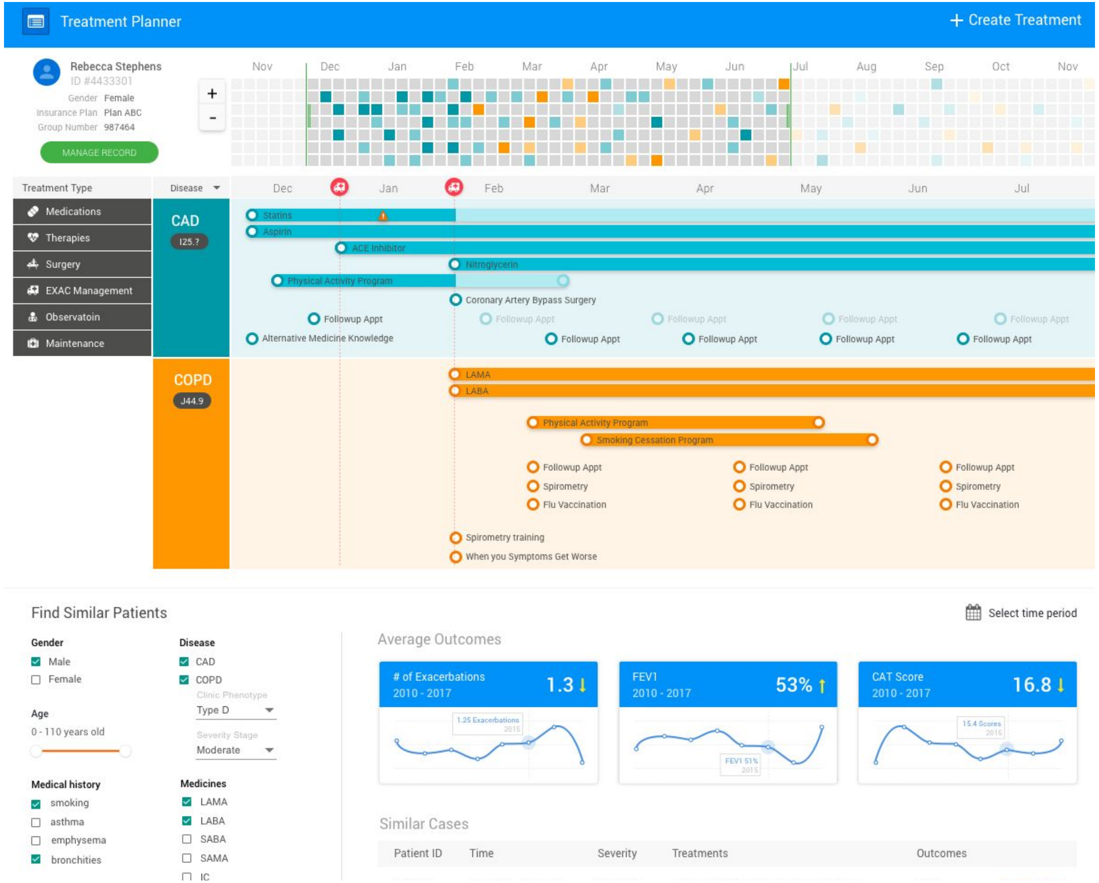
Deployability

Portability





Interactivity



Treatment Planner

+ Create Treatment

Rebecca Stephens
ID #4433301
Gender Female
Insurance Plan Plan ABC
Group Number 987464

MANAGE RECORD

Find Similar Patients

Select time period

Gender
☑ Male
□ Female

Age
0 - 110 years old

Medical history
☑ smoking
□ asthma
□ emphysema
☑ bronchities

Disease
☑ CAD
☑ COPD

Clinic Phenotype
Type D

Severity Stage
Moderate

Medicines
☑ LAMA
☑ LABA
□ SABA
□ SAMA
□ IC

Average Outcomes

# of Exacerbations 2010 - 2017	FEV1 2010 - 2017	CAT Score 2010 - 2017
1.3 ↓	53% ↑	16.8 ↓

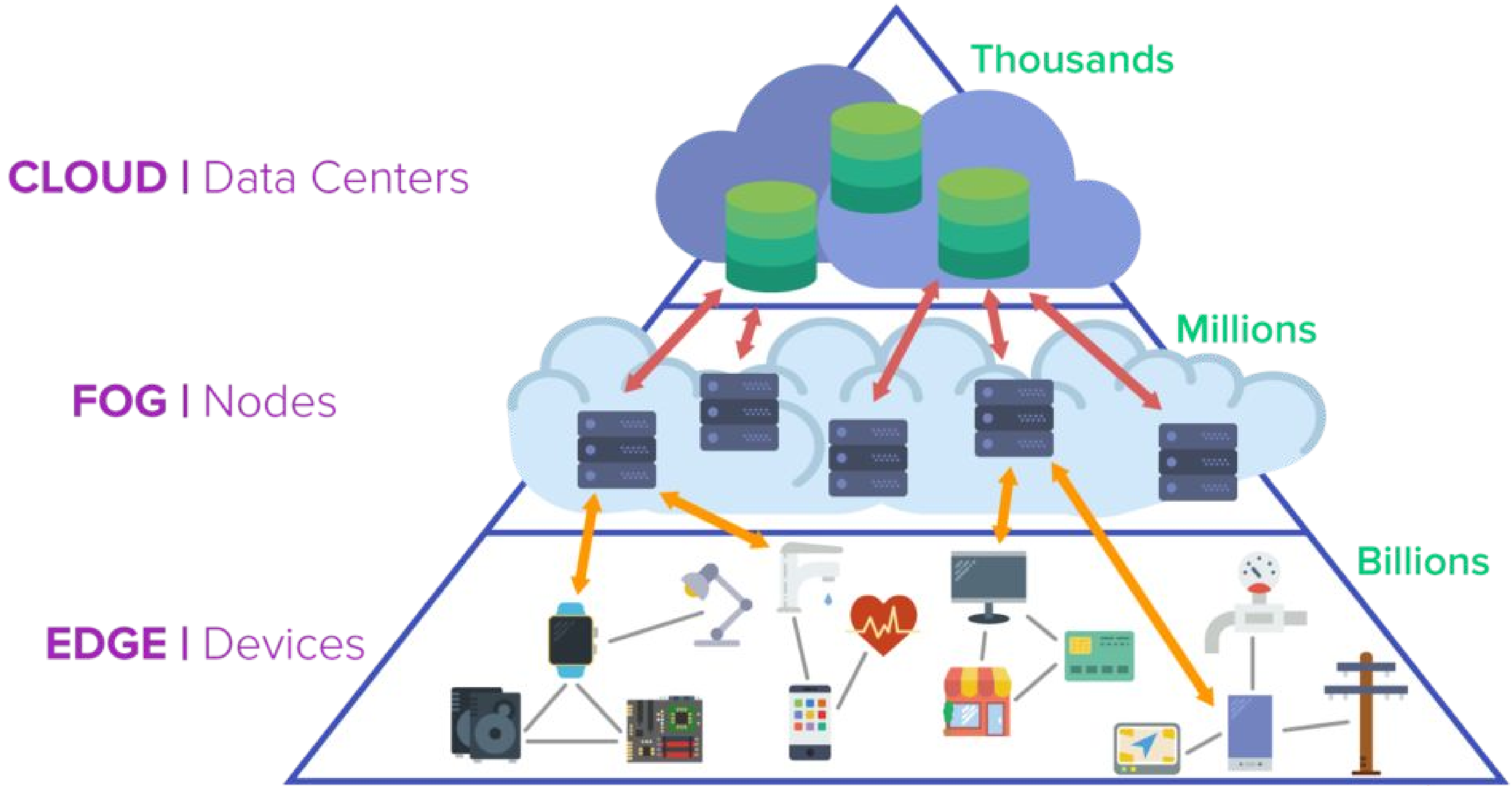
Similar Cases

Patient ID	Time	Severity	Treatments	Outcomes

Application spaces where JS can contribute / dominate

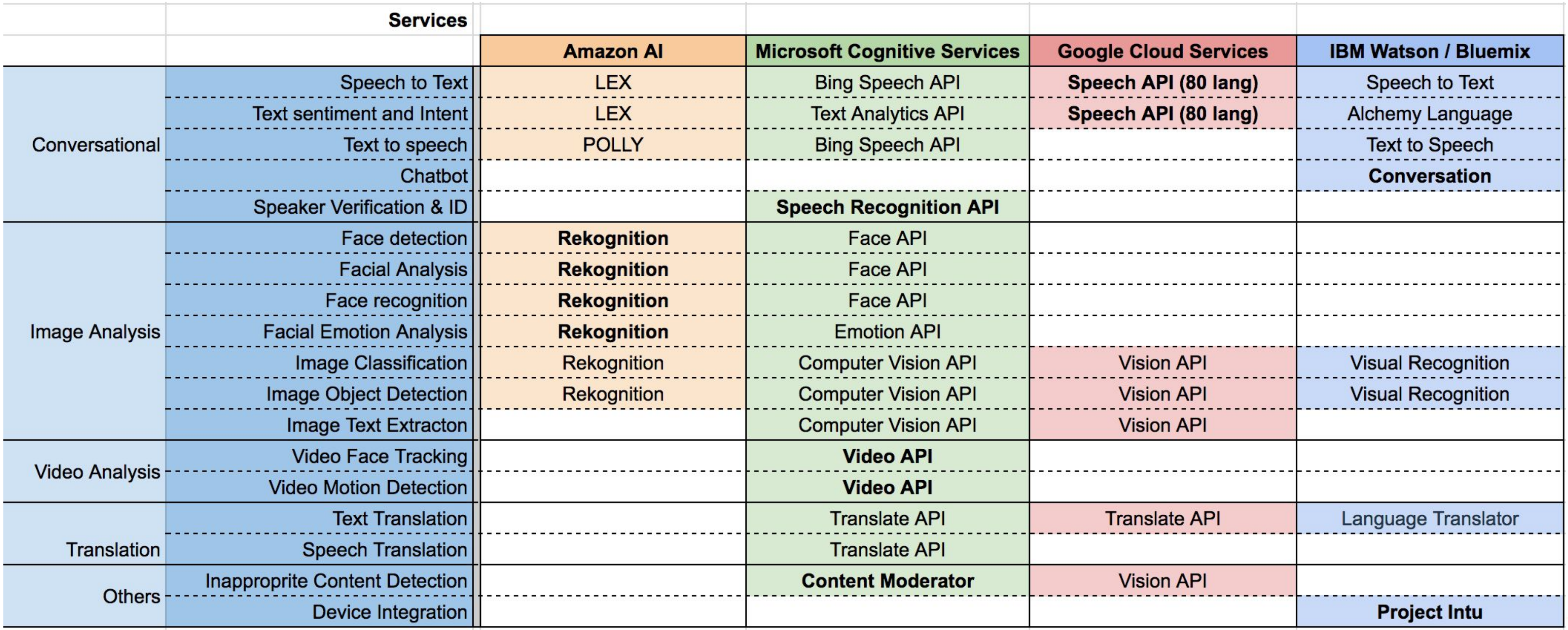
- Education
- Edge Computing
  - IOT
  - Data Collection Apps
  - Offline Applications
  - Low Latency
  - ...

Edge Computing



Time for some code...

First of all is there a Web Service?



	Services				
		Amazon AI	**Microsoft Cognitive Services**	**Google Cloud Services**	**IBM Watson / Bluemix**
Conversational	Speech to Text	LEX	Bing Speech API	**Speech API (80 lang)**	Speech to Text
	Text sentiment and Intent	LEX	Text Analytics API	**Speech API (80 lang)**	Alchemy Language
	Text to speech	POLLY	Bing Speech API		Text to Speech
	Chatbot				**Conversation**
	Speaker Verification & ID		**Speech Recognition API**		
Image Analysis	Face detection	**Rekognition**	Face API		
	Facial Analysis	**Rekognition**	Face API		
	Face recognition	**Rekognition**	Face API		
	Facial Emotion Analysis	**Rekognition**	Emotion API		
	Image Classification	Rekognition	Computer Vision API	Vision API	Visual Recognition
	Image Object Detection	Rekognition	Computer Vision API	Vision API	Visual Recognition
	Image Text Extracton		Computer Vision API	Vision API	
Video Analysis	Video Face Tracking		**Video API**		
	Video Motion Detection		**Video API**		
Translation	Text Translation		Translate API	Translate API	Language Translator
	Speech Translation		Translate API		
Others	Inapproprite Content Detection		**Content Moderator**	Vision API	
	Device Integration				**Project Intu**

compiled early 2017 - there is now [exponentially] more available

ML in JS - 1 Day Workshop Outline

Part 1 - Hello World

1. Smoke Test
2. **Hello Notebook**
3. Hello Plotly
4. **Hello Datasets**

Part 2 - Key Concepts

1. Vectors & Spaces
2. Distances, Similarity & Cost
3. **Exploring some data**
4. My first classifier
5. My first regression

Part 3 - Classical Techniques

1. Unsupervised
    a. **Clustering**
    b. Dimensionality
    c. Dimensionality Reduction
    d. Hyperparameter Tuning
2. Supervised
    a. **Classification (SVM)**
    b. Cross Validation
3. All the things!

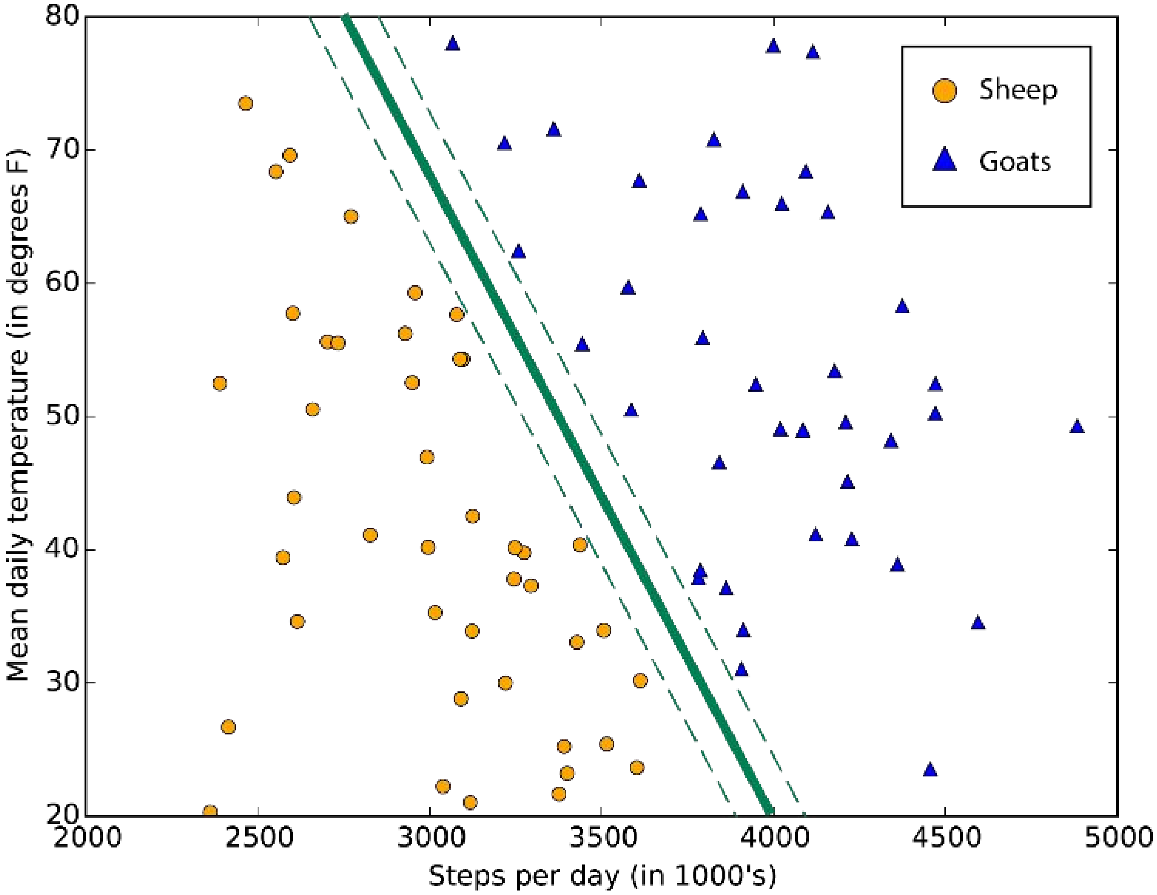
Part 4 - Deep[ish] Neural Networks

1. Hello Convnet.js - XOR
2. Understanding capacity
3. Playground - inside the NN
4. **Classifying Wine**
5. Convnet Demo Playtime
    a. CNN
    b. Autoencoder
    c. Image Painting

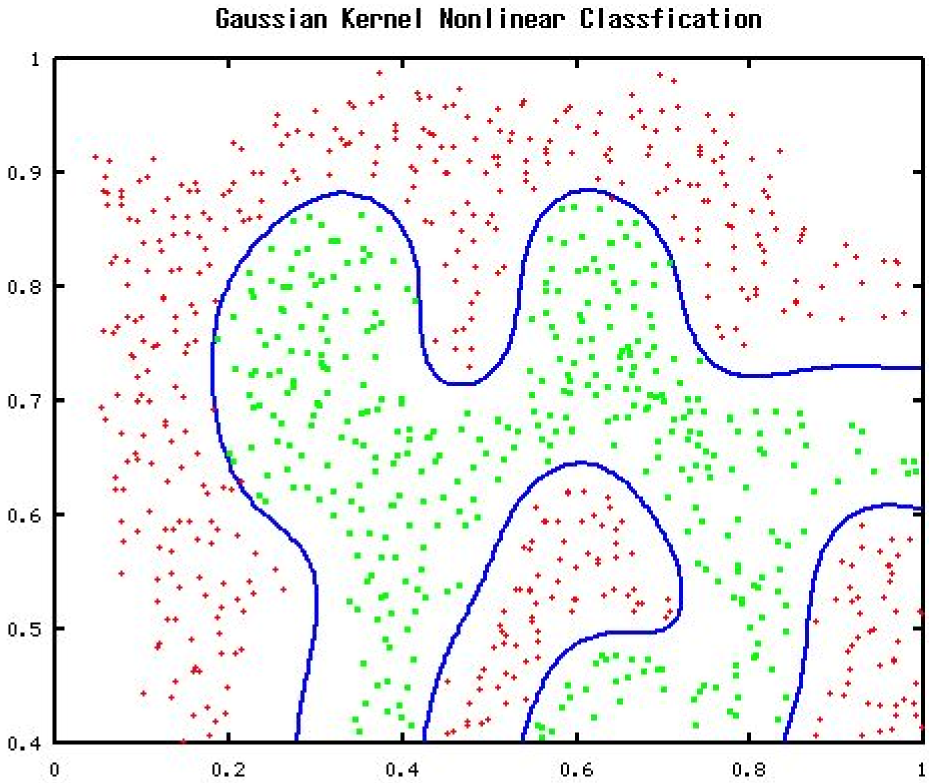
Part 5 - Keras.js - TODO

https://github.com/experoinc/machine-learning-in-javascript

Problem: Classification



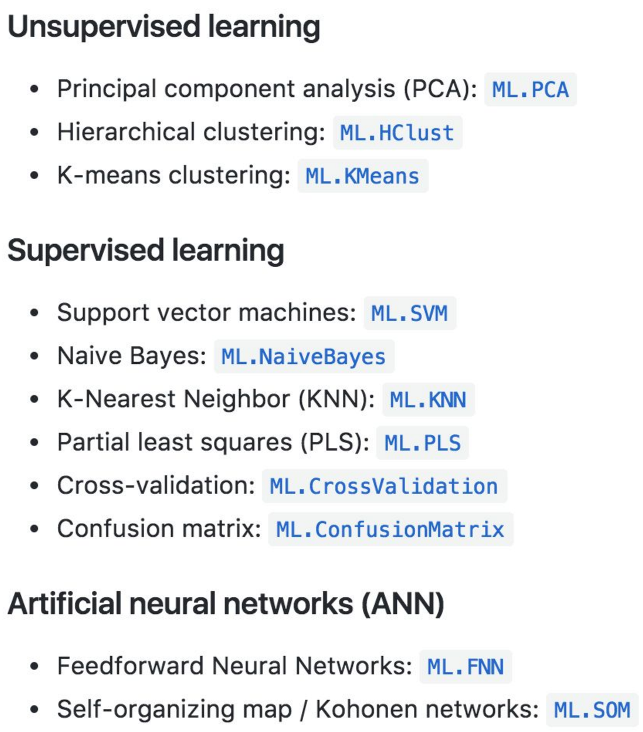
Problem: Classification



Juypter

http://jupyter.org/

mljs



Unsupervised learning

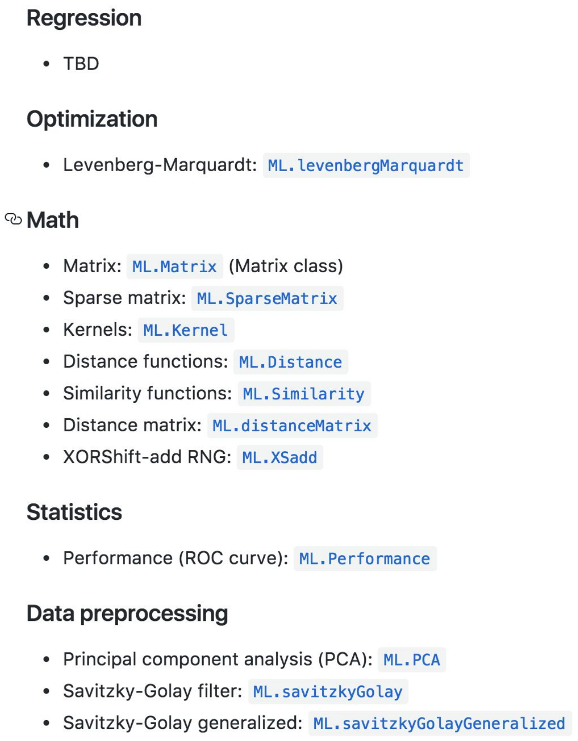
- Principal component analysis (PCA): `ML.PCA`
- Hierarchical clustering: `ML.HClust`
- K-means clustering: `ML.KMeans`

Supervised learning

- Support vector machines: `ML.SVM`
- Naive Bayes: `ML.NaiveBayes`
- K-Nearest Neighbor (KNN): `ML.KNN`
- Partial least squares (PLS): `ML.PLS`
- Cross-validation: `ML.CrossValidation`
- Confusion matrix: `ML.ConfusionMatrix`

Artificial neural networks (ANN)

- Feedforward Neural Networks: `ML.FNN`
- Self-organizing map / Kohonen networks: `ML.SOM`



Regression

- TBD

Optimization

- Levenberg-Marquardt: `ML.levenbergMarquardt`

Math

- Matrix: `ML.Matrix` (Matrix class)
- Sparse matrix: `ML.SparseMatrix`
- Kernels: `ML.Kernel`
- Distance functions: `ML.Distance`
- Similarity functions: `ML.Similarity`
- Distance matrix: `ML.distanceMatrix`
- XORShift-add RNG: `ML.XSadd`

Statistics

- Performance (ROC curve): `ML.Performance`

Data preprocessing

- Principal component analysis (PCA): `ML.PCA`
- Savitzky-Golay filter: `ML.savitzkyGolay`
- Savitzky-Golay generalized: `ML.savitzkyGolayGeneralized`

https://github.com/mljs/ml

Deep Learning in the Browser with ConvNet.js

ConvNetJS

Deep Learning in your browser

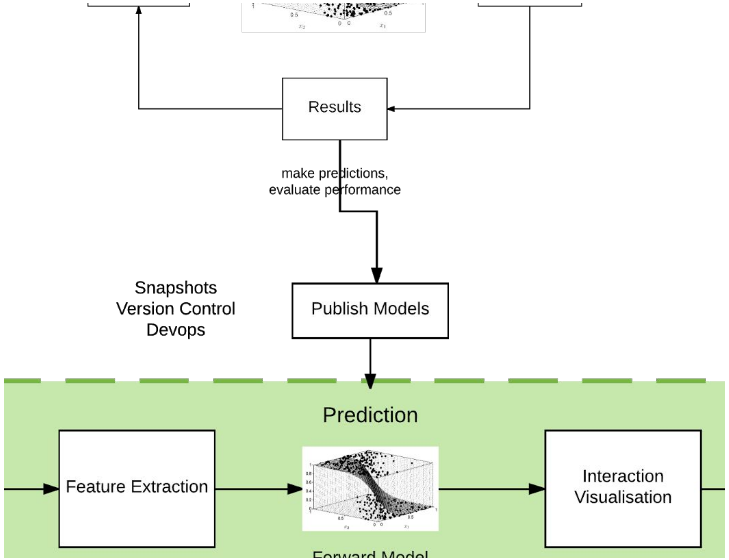
http://cs.stanford.edu/people/karpathy/convnetjs/

https://github.com/karpathy/convnetjs

Classify CIFAR-10 with Convolutional Neural Network

Model Deployment

Pretrained Models



Leverage 1000s cpu hrs of existing training time with pre-trained networks

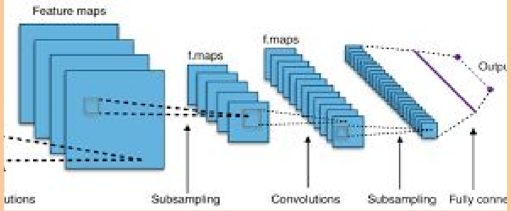
https://github.com/google/inception

this is the forward pass of your NN production pipeline

Kera.js run trained models in the browser / javascript

training data (image net)

http://keras.io



“snapshot”

keras.js

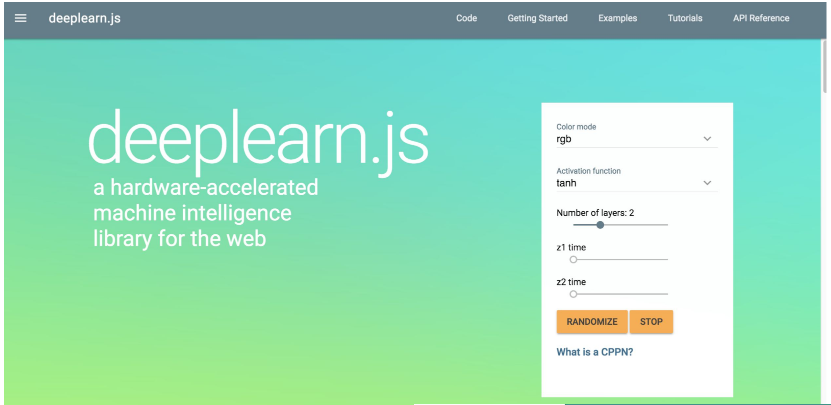
- cat: 98%
- dog: 21%
- hot dog: 3%

Keras.js Demos

https://transcranial.github.io/keras-js/#/

https://github.com/transcranial/keras-js

More in-browser forward passes



deeplearn.js

Code | Getting Started | Examples | Tutorials | API Reference

deeplearn.js

a hardware-accelerated machine intelligence library for the web

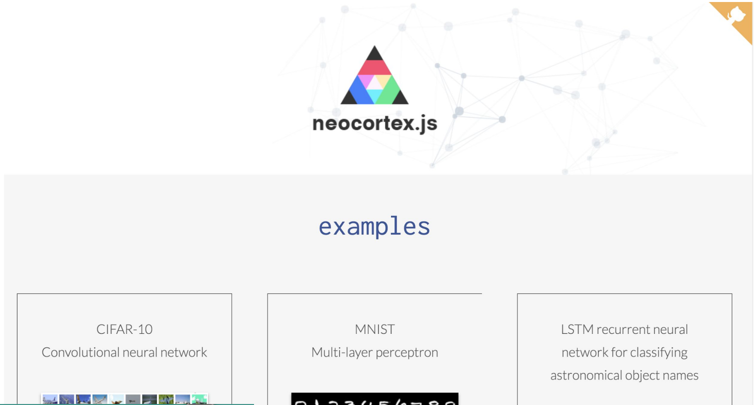
Color mode: rgb

Activation function: tanh

Number of layers: 2

z1 time

z2 time



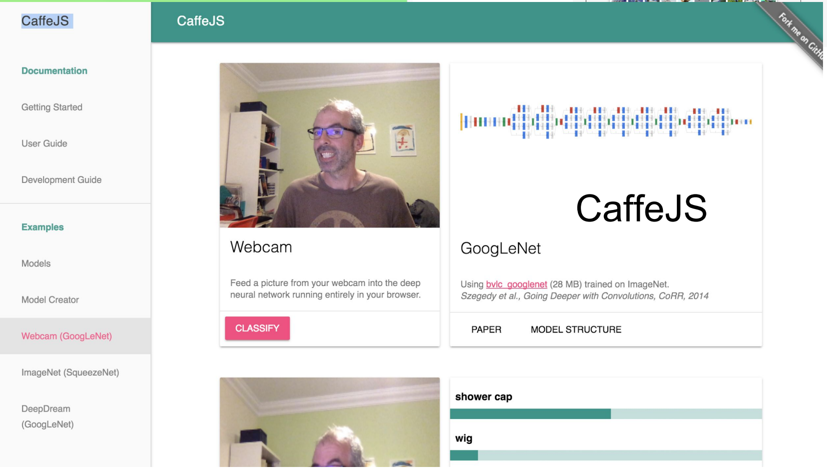
neocortex.js

examples

CIFAR-10
Convolutional neural network

MNIST
Multi-layer perceptron

LSTM recurrent neural network for classifying astronomical object names



CaffeJS

Documentation
- Getting Started
- User Guide
- Development Guide

Examples
- Models
- Model Creator
- Webcam (GoogLeNet)
- ImageNet (SqueezeNet)
- DeepDream (GoogLeNet)

Webcam

Feed a picture from your webcam into the deep neural network running entirely in your browser.

CaffeJS

GoogLeNet

Using bvlc_googlenet (28 MB) trained on ImageNet.
Szegedy et al., Going Deeper with Convolutions, CoRR, 2014

shower cap

wig

Summing Up

Summary: Machine Learning in JS is:

- Great for education
- Has real application uses in ML production deployments
- The broader ML workflow has elements that are likely essential to implement in Javascript
- Jupyter can be used for exploratory work, prototyping and that same code can be transferred to a browser environment
- There is a small but growing eco-system of libraries that is supported by some large projects
- npm is your friend for ML too
- not all about python…. but python is on our future too.

slides & notebooks online at:

github.com/experoinc/machine-learning-in-javascript

!We are hiring JS developers in Tenerife!

Thank you

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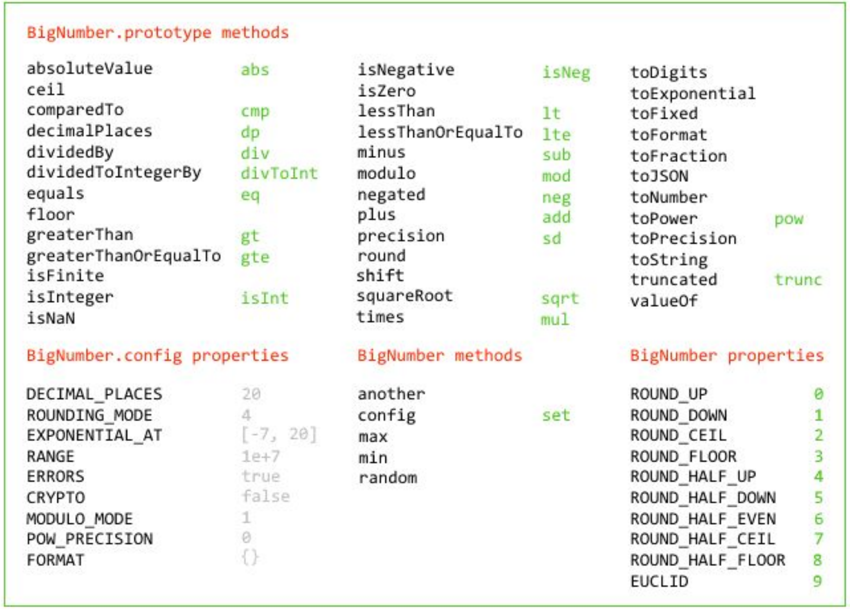
info@experoinc.com

Arbitrary Precision with bignumber.js & decimal.js



BigNumber.prototype methods

absoluteValue	abs	isNegative	isNeg	toDigits	
ceil		isZero		toExponential	
comparedTo	cmp	lessThan	lt	toFixed	
decimalPlaces	dp	lessThanOrEqualTo	lte	toFormat	
dividedBy	div	minus	sub	toFraction	
dividedToIntegerBy	divToInt	modulo	mod	toJSON	
equals	eq	negated	neg	toNumber	
floor		plus	add	toPower	pow
greaterThan	gt	precision	sd	toPrecision	
greaterThanOrEqualTo	gte	round		toString	
isFinite		shift		truncated	trunc
isInteger	isInt	squareRoot	sqrt	valueOf	
isNaN		times	mul		

BigNumber.config properties

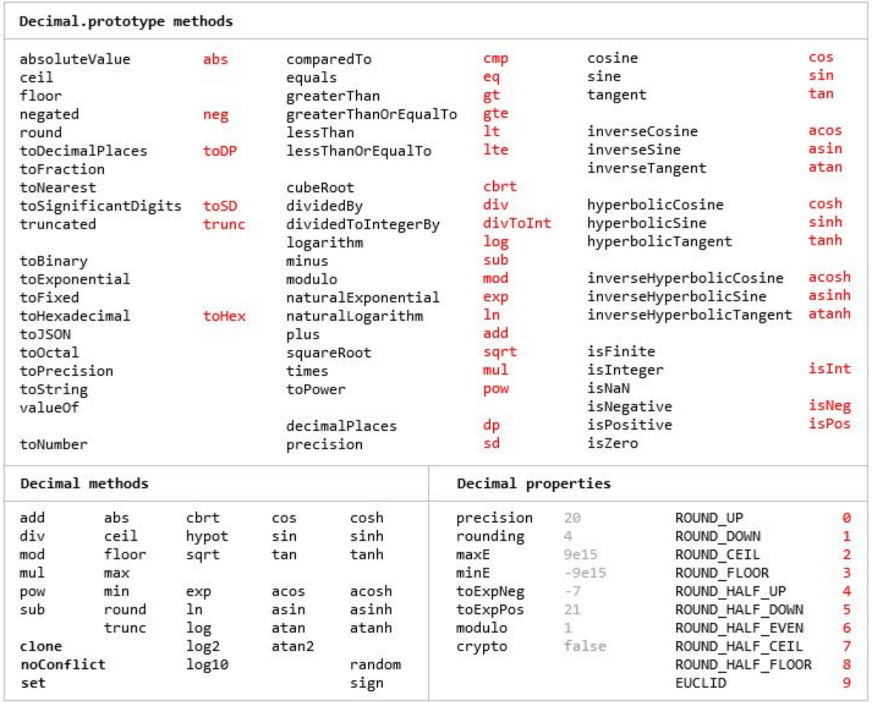
DECIMAL_PLACES	20
ROUNDING_MODE	4
EXPONENTIAL_AT	[-7, 20]
RANGE	1e+7
ERRORS	true
CRYPTO	false
MODULO_MODE	1
POW_PRECISION	0
FORMAT	{}

BigNumber methods

another	
config	set
max	
min	
random	

BigNumber properties

ROUND_UP	0
ROUND_DOWN	1
ROUND_CEIL	2
ROUND_FLOOR	3
ROUND_HALF_UP	4
ROUND_HALF_DOWN	5
ROUND_HALF_EVEN	6
ROUND_HALF_CEIL	7
ROUND_HALF_FLOOR	8
EUCLID	9



Decimal.prototype methods

absoluteValue	abs	comparedTo	cmp	cosine	cos
ceil		equals	eq	sine	sin
floor		greaterThan	gt	tangent	tan
negated	neg	greaterThanOrEqualTo	gte		
round		lessThan	lt	inverseCosine	acos
toDecimalPlaces	toDP	lessThanOrEqualTo	lte	inverseSine	asin
toFraction				inverseTangent	atan
toNearest		cubeRoot	cbrt		
toSignificantDigits	toSD	dividedBy	div	hyperbolicCosine	cosh
truncated	trunc	dividedToIntegerBy	divToInt	hyperbolicSine	sinh
		logarithm	log	hyperbolicTangent	tanh
toBinary		minus	sub		
toExponential		modulo	mod	inverseHyperbolicCosine	acosh
toFixed		naturalExponential	exp	inverseHyperbolicSine	asinh
toHexadecimal	toHex	naturalLogarithm	ln	inverseHyperbolicTangent	atanh
toJSON		plus	add		
toOctal		squareRoot	sqrt	isFinite	
toPrecision		times	mul	isInteger	isInt
toString		toPower	pow	isNaN	
valueOf				isNegative	isNeg
		decimalPlaces	dp	isPositive	isPos
toNumber		precision	sd	isZero	

Decimal methods

add	abs	cbrt	cos	cosh
div	ceil	hypot	sin	sinh
mod	floor	sqrt	tan	tanh
mul	max			
pow	min	exp	acos	acosh
sub	round	ln	asin	asinh
	trunc	log	atan	atanh
clone		log2	atan2	
noConflict		log10		random
set				sign

Decimal properties

precision	20	ROUND_UP	0
rounding	4	ROUND_DOWN	1
maxE	9e15	ROUND_CEIL	2
minE	-9e15	ROUND_FLOOR	3
toExpNeg	-7	ROUND_HALF_UP	4
toExpPos	21	ROUND_HALF_DOWN	5
modulo	1	ROUND_HALF_EVEN	6
crypto	false	ROUND_HALF_CEIL	7
		ROUND_HALF_FLOOR	8
		EUCLID	9

decimal.js - https://github.com/MikeMcl/decimal.js/

bignumber.js - https://github.com/MikeMcl/bignumber.js

biginteger.js - https://github.com/peterolson/BigInteger.js