Introduction to Artificial Intelligence for CyberSecurity Applications

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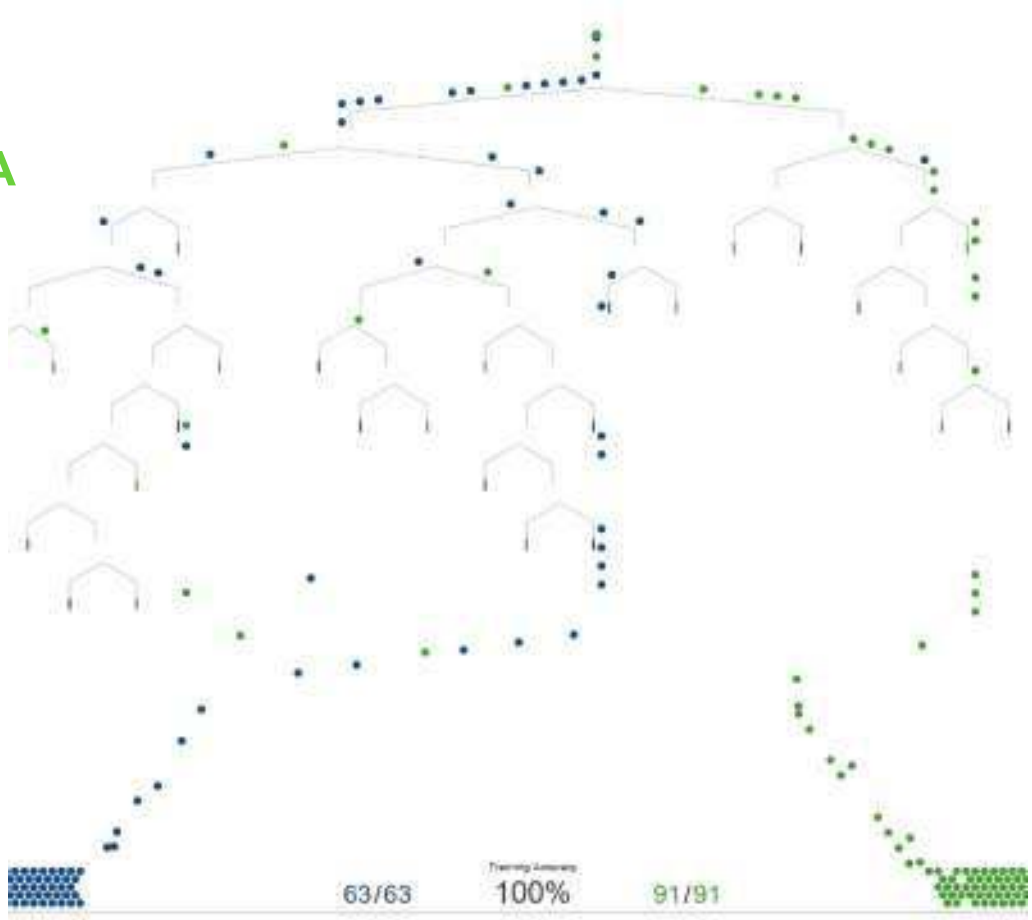
GLOSSARY

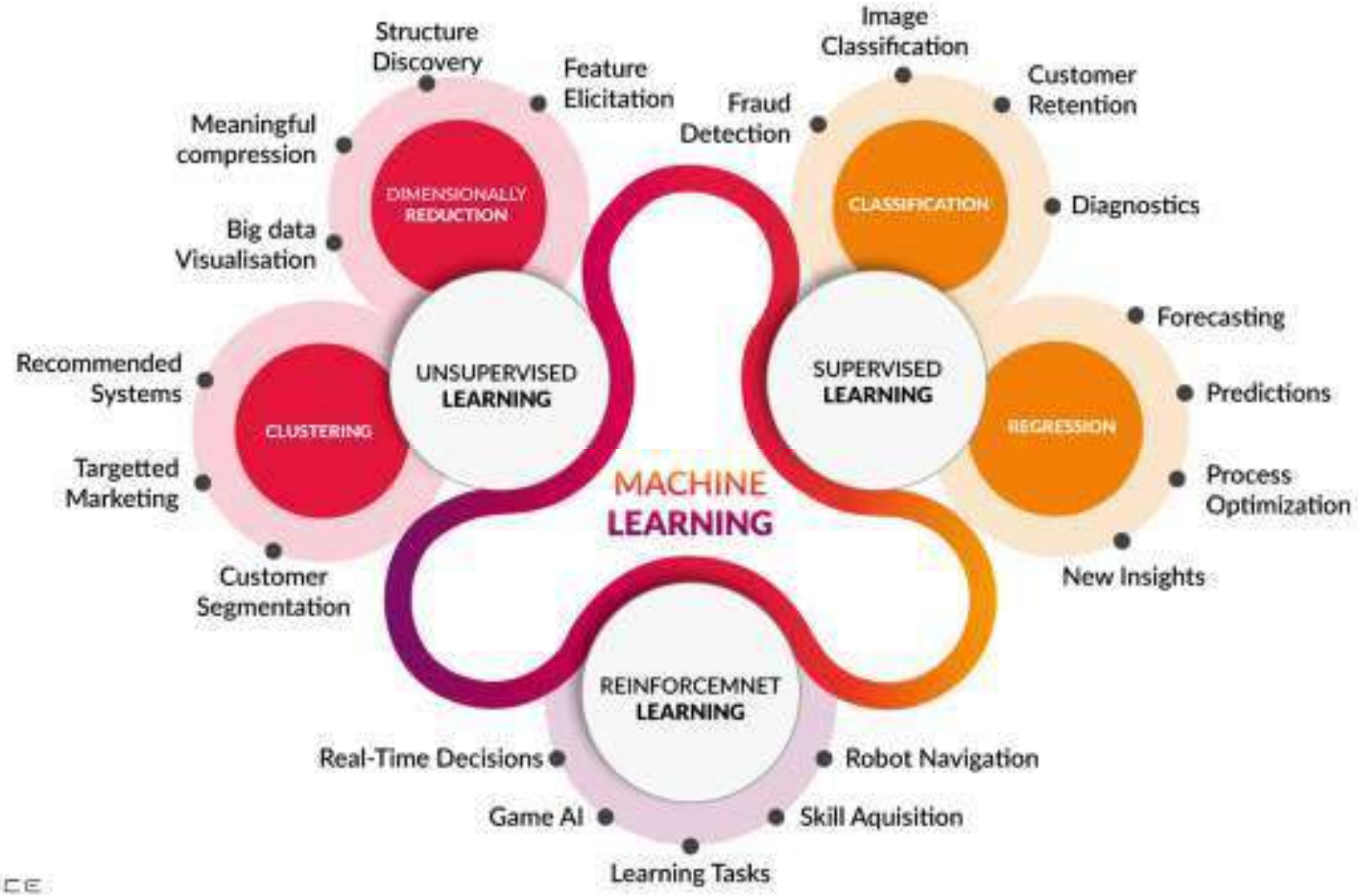
- k-means – simple clustering algorithm
- DBSCAN – more advanced clustering algorithm
- NB – Naïve Bayes classifier model
- GMM – Gaussian Mixture Model clustering algorithm
- LSTM – Long Short-Term Memory Neural Network algorithm
- CNN – Convolutional Neural Network
- RNN – Recurrent Neural Network
- LR – Logistic Regression classifier
- DT – Decision Tree

MACHINE LEARNING IS A FIELD OF STUDY THAT GIVES COMPUTERS THE ABILITY TO LEARN WITHOUT EXPLICITLY BEING PROGRAMMED

- Arthur Samuel, 1959



MACHINE LEARNING WILL BE EVERYWHERE



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PANDORA

MACHINE LEARNING WILL BE EVERYWHERE

The trend to incorporate ML capabilities into new and existing security products will continue apace. According to an April 2016 Gartner report:

- By 2018, 25% of security products used for detection will have some form of machine learning built into them.
- By 2018, prescriptive analytics will be deployed in at least 10% of UEBA products to automate response to incidents, up from zero today.

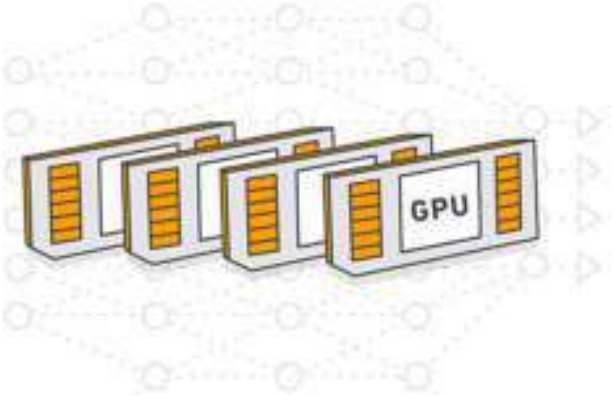
Gartner Core Security, *The Fast-Evolving State of Security Analytics, April, 2016*, Report ID: G00298030 accessed at https://hs.coresecurity.com/gartnerreprint-2017

TWO THINGS CAME TOGETHER TO ENABLE AI

- **Big Data**
  - Large collections of Spam, malware, exploits, network traffic, user behaviors

+

- **Cloud Computing Power**
  - Possible to consume over 100,000 CPU/GPU cores



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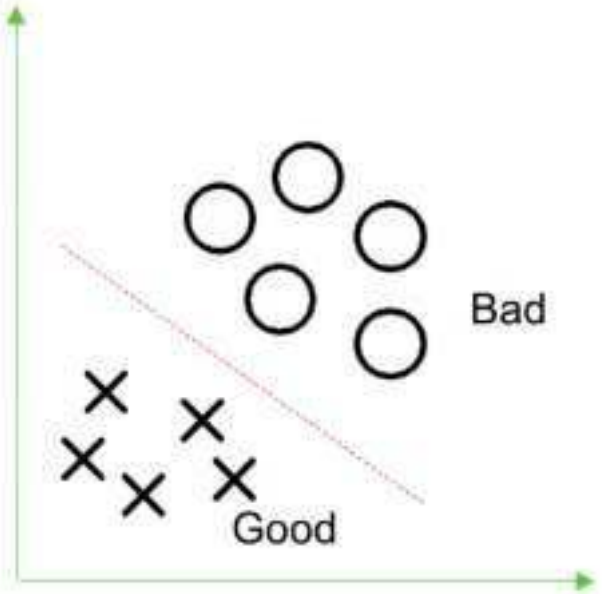

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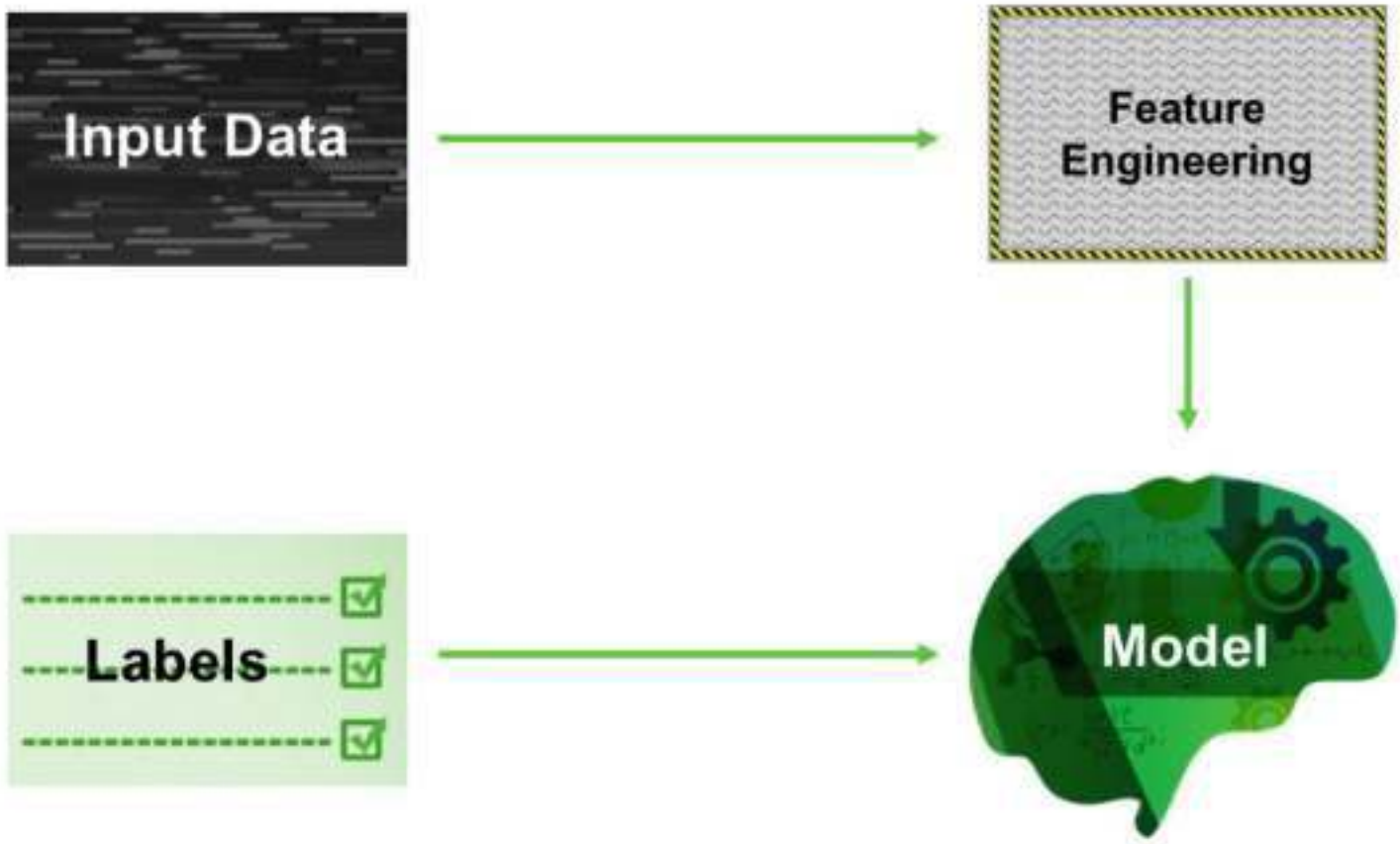

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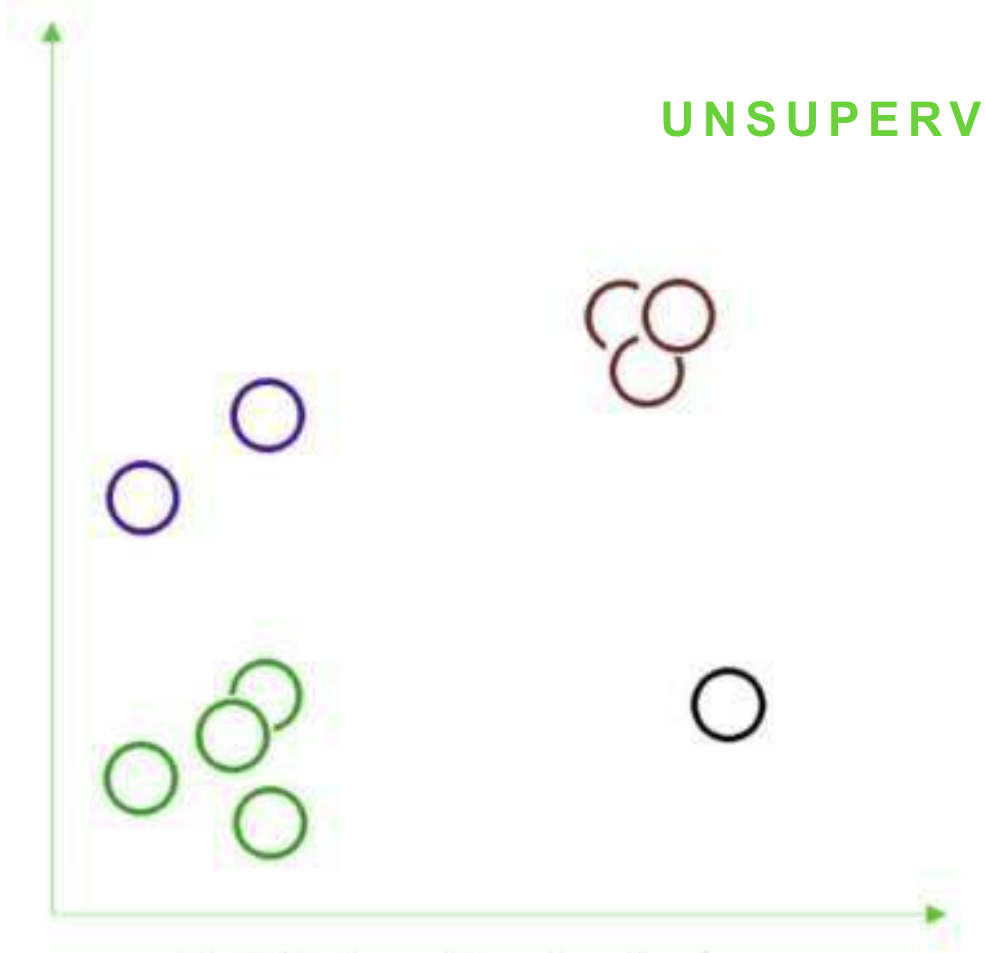

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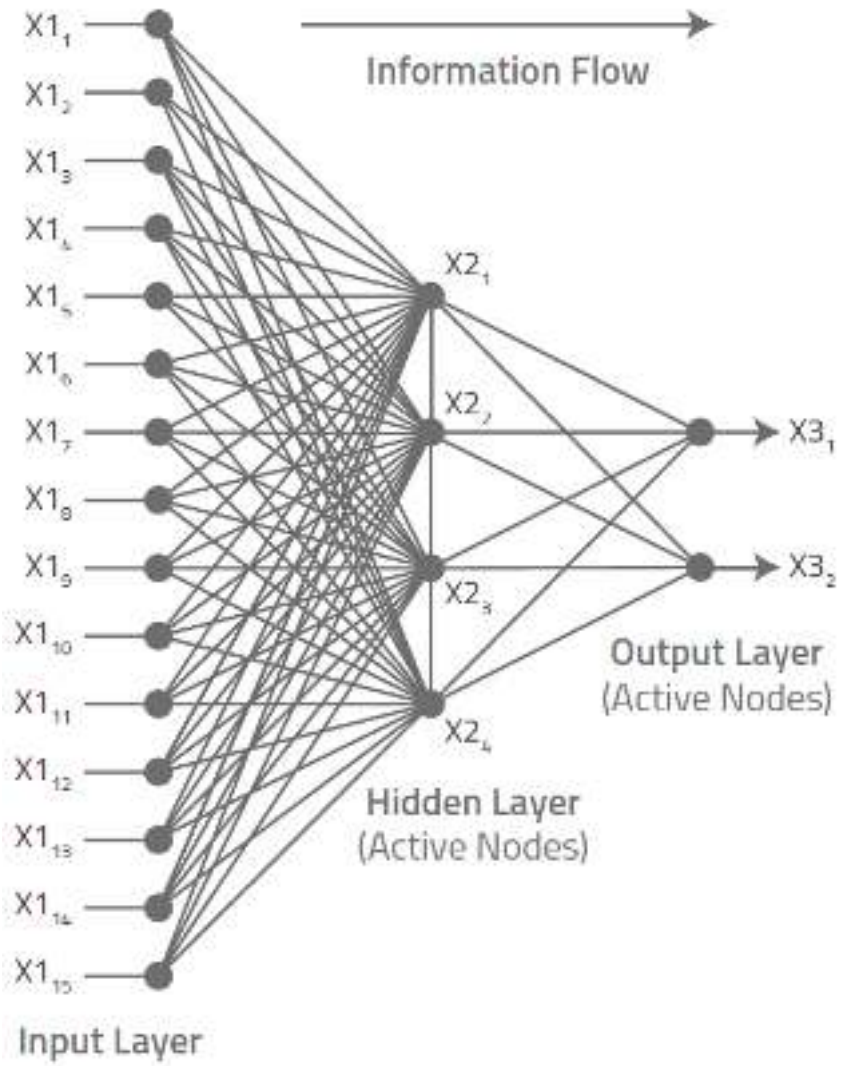
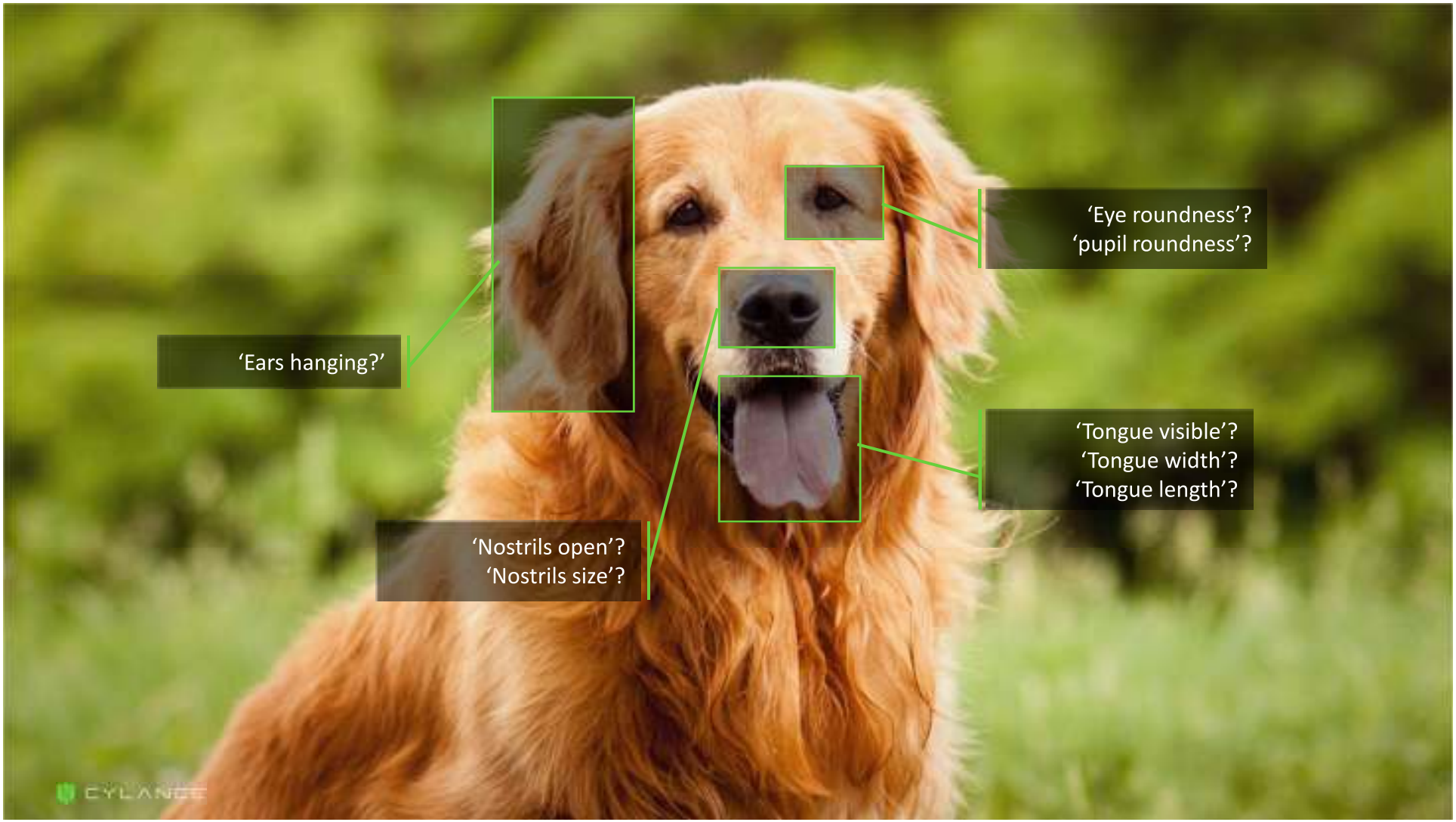
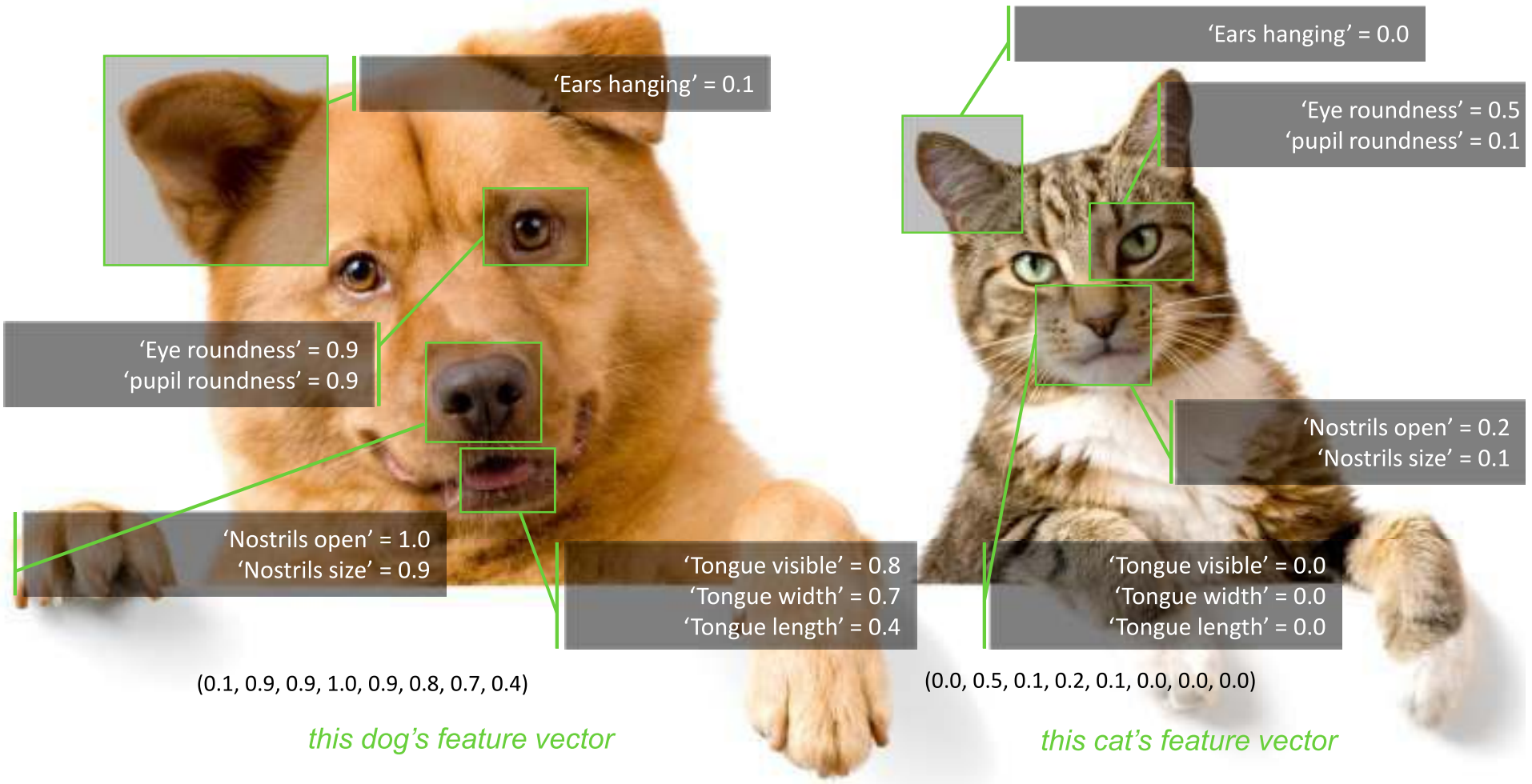
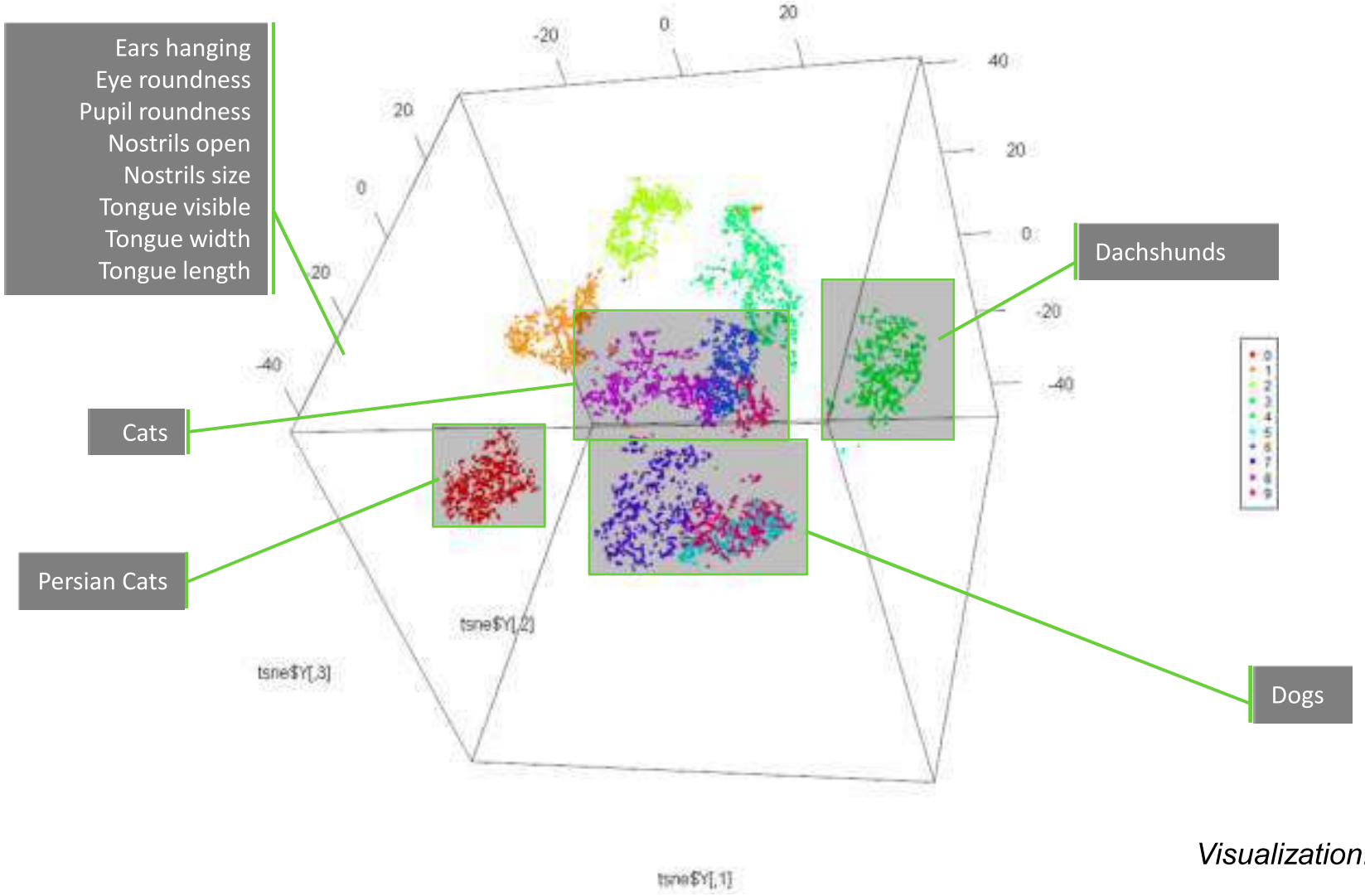
NEURAL NETWORK

- Works like a human brain – useful connections remain, others dropped

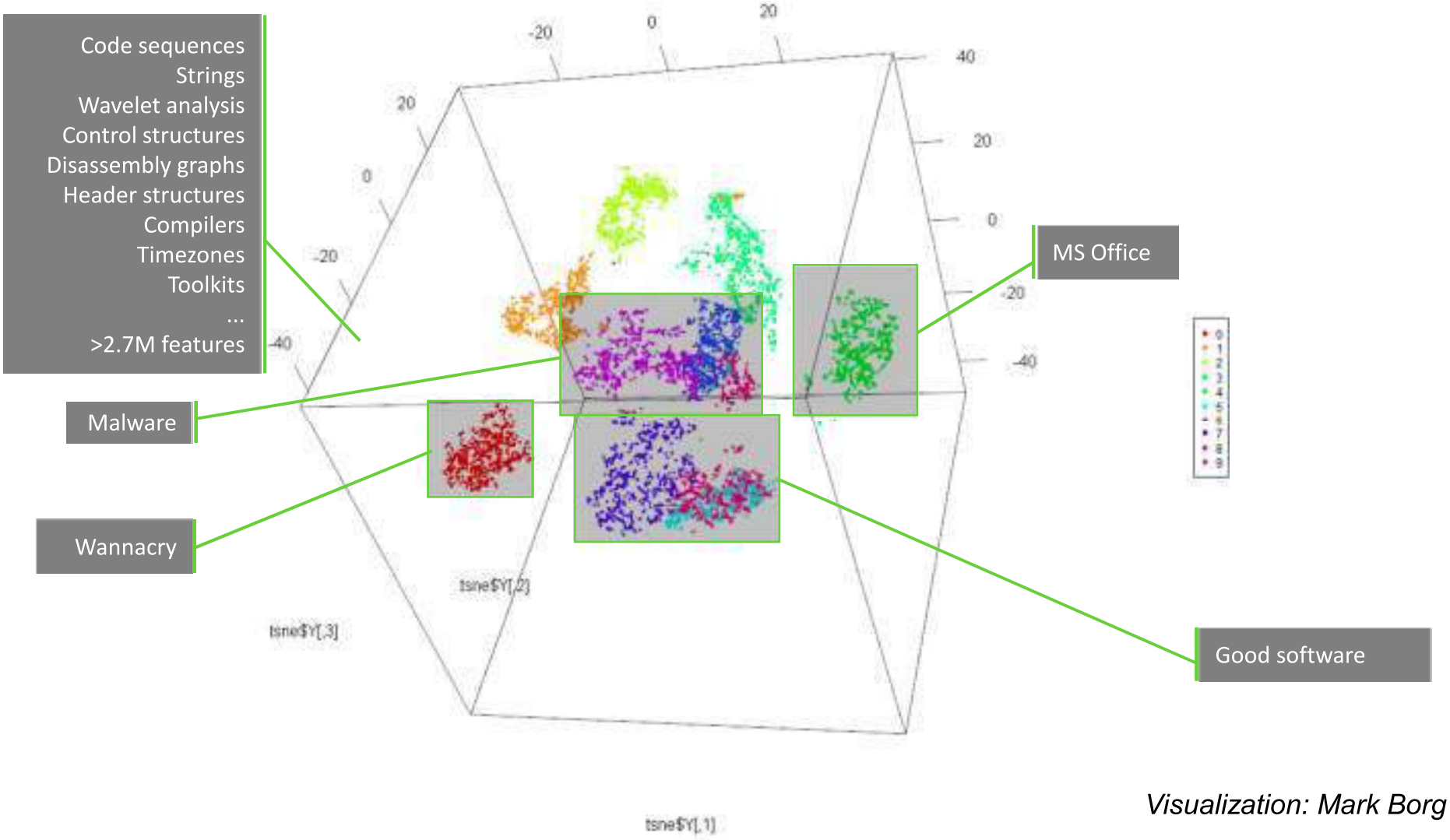



‘Eye roundness’?
‘pupil roundness’?
‘Ears hanging?’
‘Tongue visible’?
‘Tongue width’?
‘Tongue length’?
‘Nostrils open’?
‘Nostrils size’?


'Ears hanging' = 0.1
'Eye roundness' = 0.9
'pupil roundness' = 0.9
'Nostrils open' = 1.0
'Nostrils size' = 0.9
'Tongue visible' = 0.8
'Tongue width' = 0.7
'Tongue length' = 0.4
(0.1, 0.9, 0.9, 1.0, 0.9, 0.8, 0.7, 0.4)
this dog's feature vector
'Ears hanging' = 0.0
'Eye roundness' = 0.5
'pupil roundness' = 0.1
'Nostrils open' = 0.2
'Nostrils size' = 0.1
'Tongue visible' = 0.0
'Tongue width' = 0.0
'Tongue length' = 0.0
(0.0, 0.5, 0.1, 0.2, 0.1, 0.0, 0.0, 0.0)
this cat's feature vector



Visualization: Mark Borg



Visualization: Mark Borg

5 GENERATIONS OF ML FOR CYBERSECURITY

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY

Generational Factors

- Runtime
- Features
- Datasets
- Human Interaction
- Goodness of Fit

DARPA's Three AI Waves: **DESCRIBE** → **CATEGORIZE** → **EXPLAIN**

1

R: Cloud only training / prediction
F: Small features (~1,000)
D: Small samples (~1M)
D: Hand picked and human labeled
H: Easily interpretable
G: High FPs / Underfit / Easy to bypass

2

R: Cloud training / local prediction
F: Medium features (~100,000)
D: Medium samples (~100M)
D: Mostly human labeled / some heuristic
H: Largely uninterpretable
G: Misleading FP rate / Overfit

3

R: Cloud enhanced models
F: Large features (~3M)
D: Large samples (~1B)
D: Largely heuristic labeled
H: Some interpretability with visualization
G: Fit appropriately / accuracy metrics generalize

4

R: Models learn from local training
F: Large features (>3M)
D: Online learning
H: Model explains strategy & gets feedback
G: Model fits current and future inputs

5

R: Unsupervised local training
F: Unlimited with semi-supervised discovery and data collection
D: Active learning
H: Human input optional
G: Model identifies and adapts to concept drift

QUESTIONS

AND

ANSWERS


THANK YOU
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