Machine Learning in Cyber Security

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UMM, Morris

What is Malware

Malicious Software

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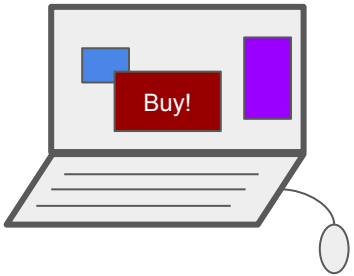
Malicious Software

Adware



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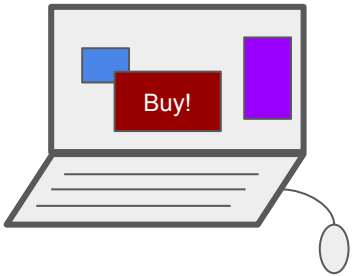
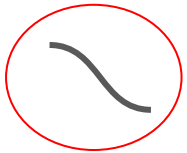
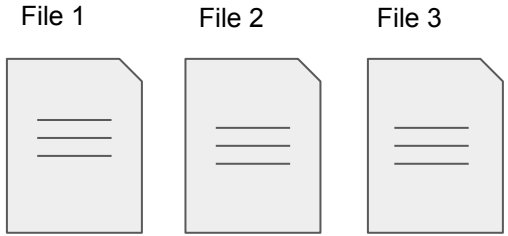


Worm





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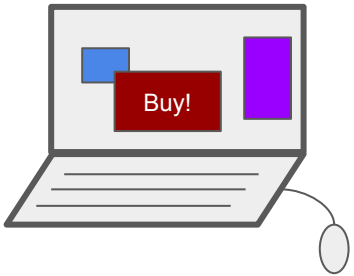

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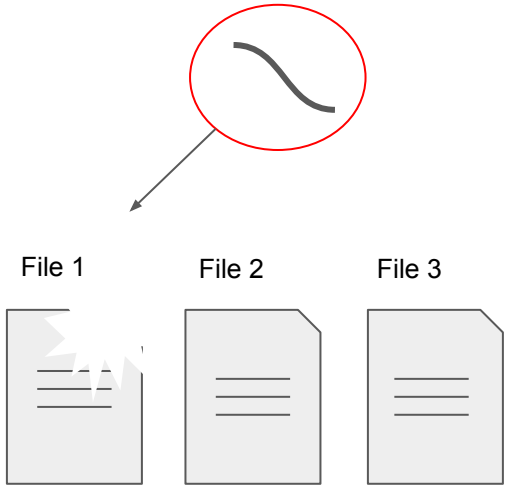

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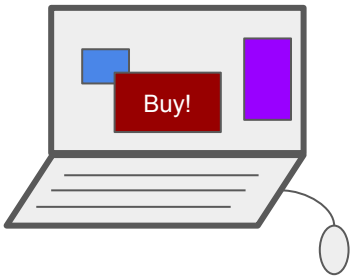

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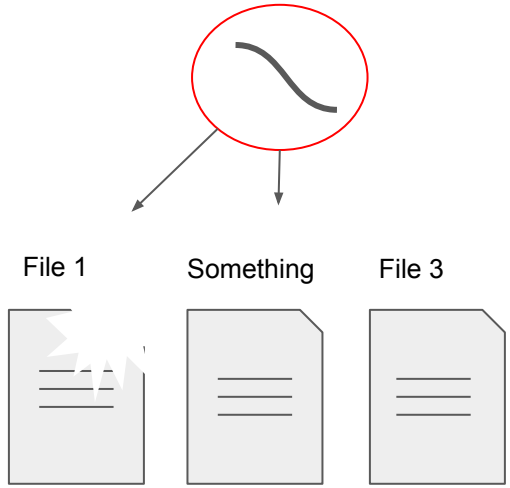

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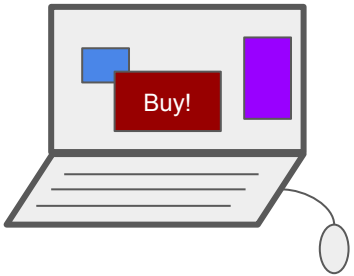

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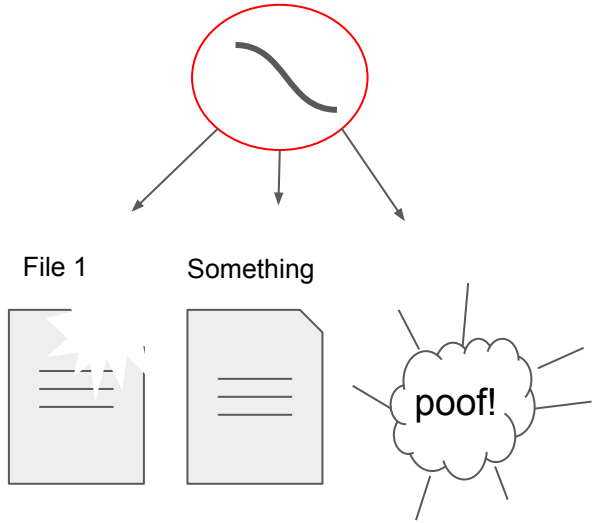

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Malicious Software

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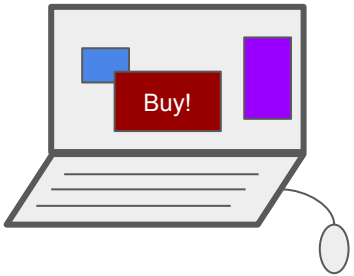

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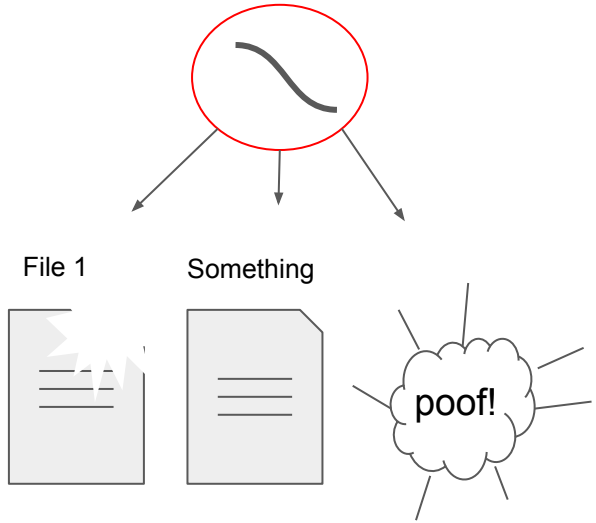
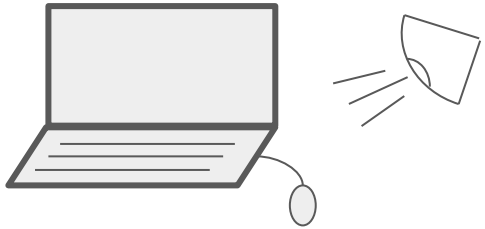


Spyware



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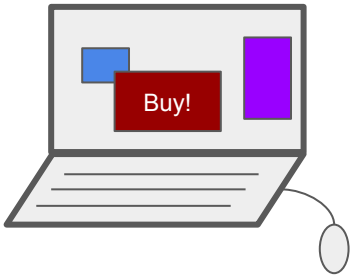

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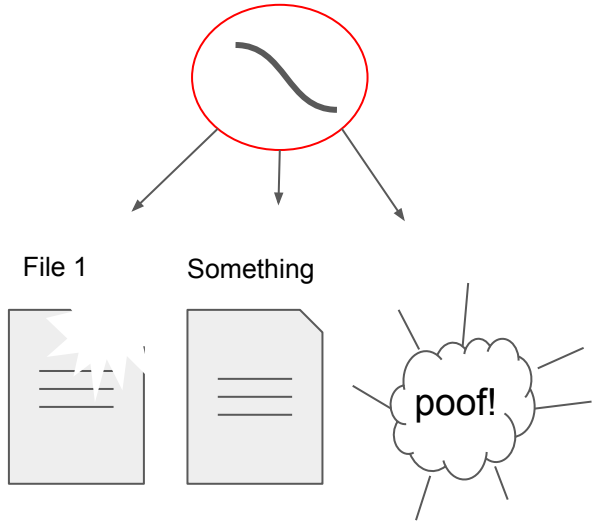
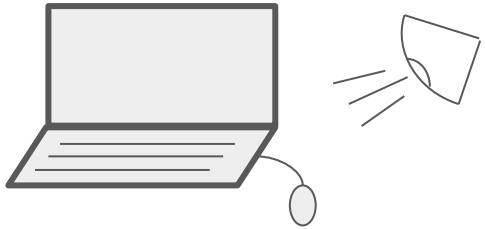


Spyware



- KeyLogger

Why use Machine Learning for Detecting Malware?

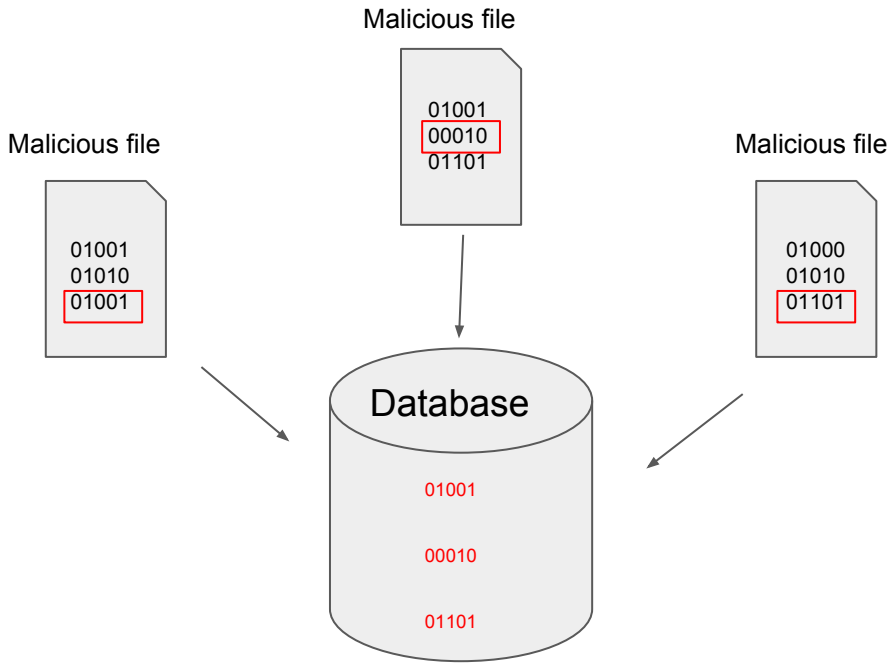
- Dynamic Environment
- More Advanced types of Malware
- New Efficient Detection Systems

Old Traditional Way for Detecting Malware

Signature Based Detection System

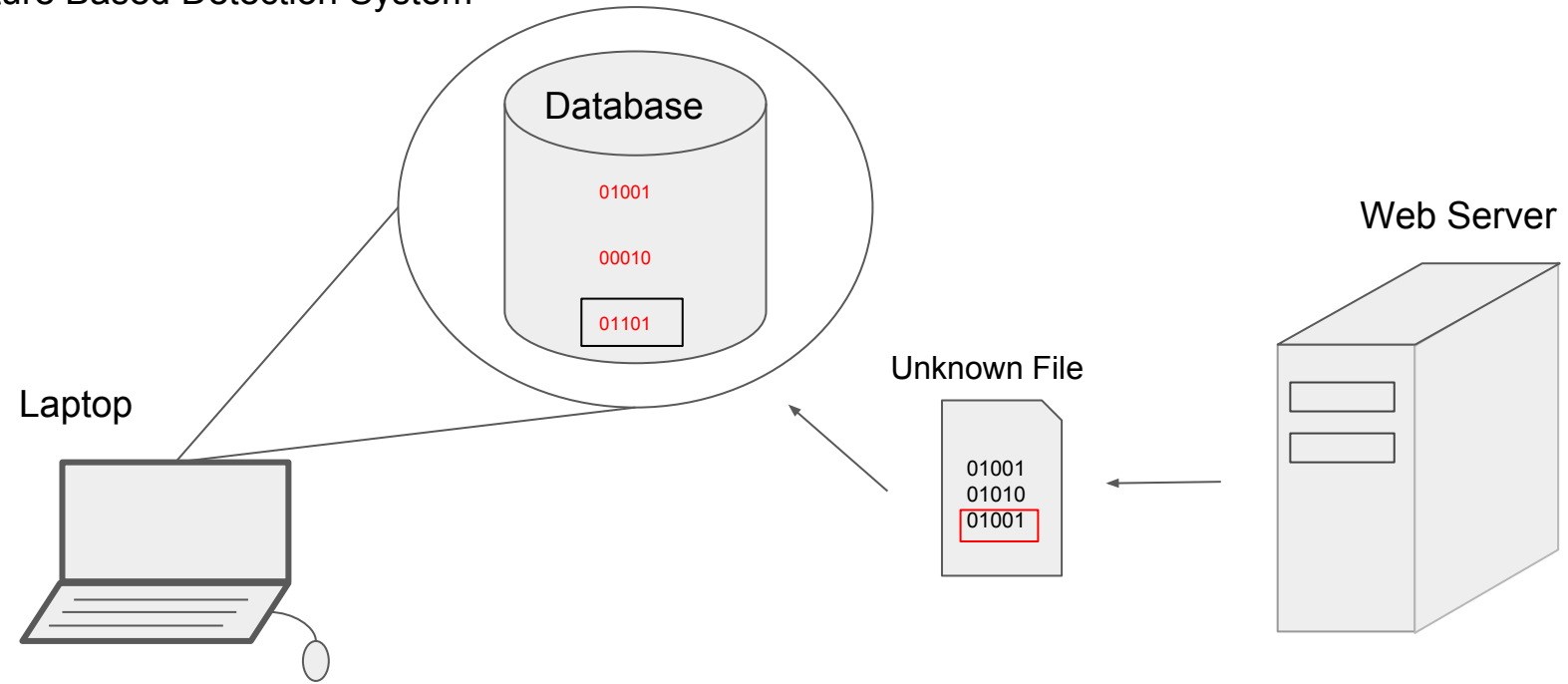
Signature

- Instruction Sequences
- Binary Sequences



Old Traditional Way for Detecting Malware

Signature Based Detection System



Old Traditional Way for Detecting Malware

Signature Based Detection System

Weaknesses

- Zero Day Attacks
- Polymorphic Malwares

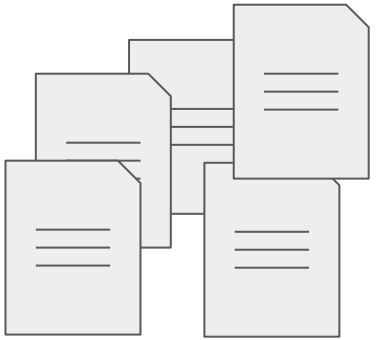
Outline

- Background
  - Machine Learning
  - Deep Neural Network
- Deep Neural Network Approach
  - Data Gathering
  - Structure Data Generation
  - Feature Extraction
  - Modeling
  - Results
- Conclusion

Background

Machine Learning

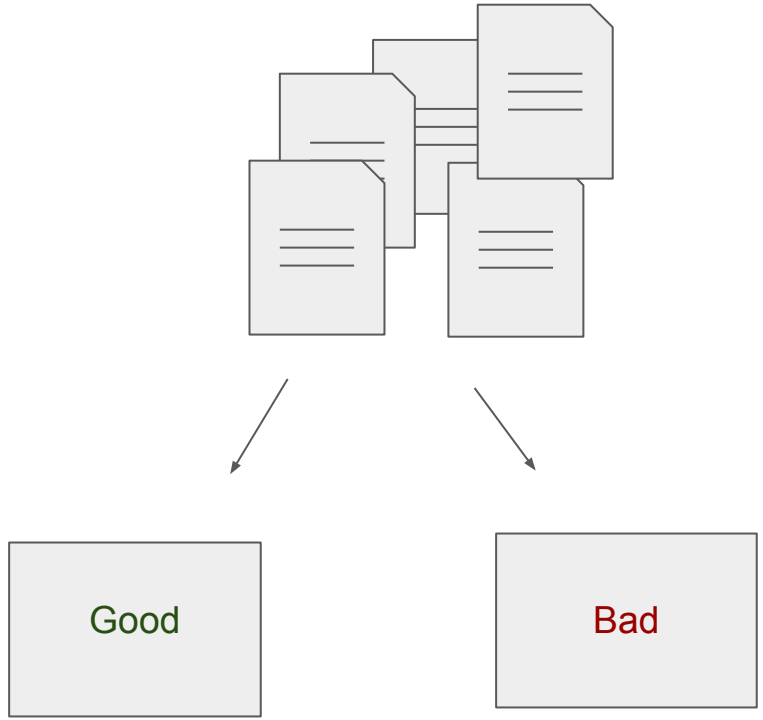
- Process Big Multidimensional Data



Background

Machine Learning

- Process Big Multidimensional Data
- Categorization of Data



Background

Machine Learning

- Supervised
  - Labeled Data
  - Classification

Background

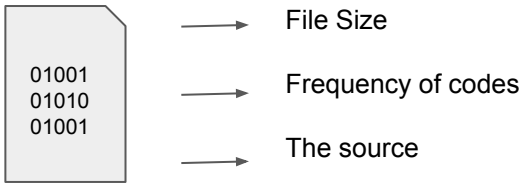
Machine Learning

- Supervised
  - Labeled Data
  - Classification
- Unsupervised
  - Unlabeled Data
  - Clustering

Background

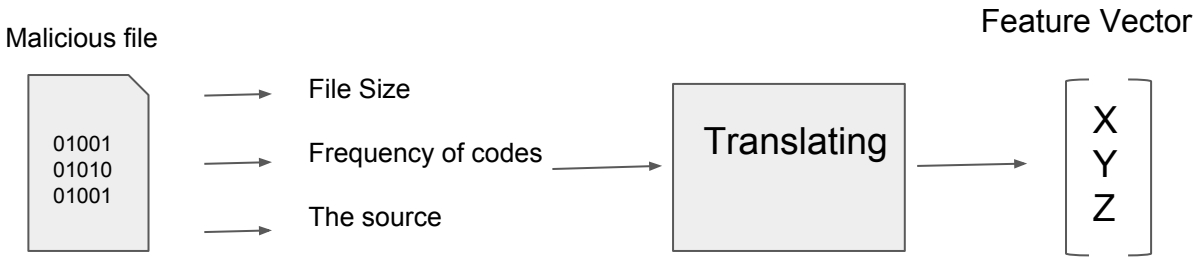
Machine Learning

Malicious file



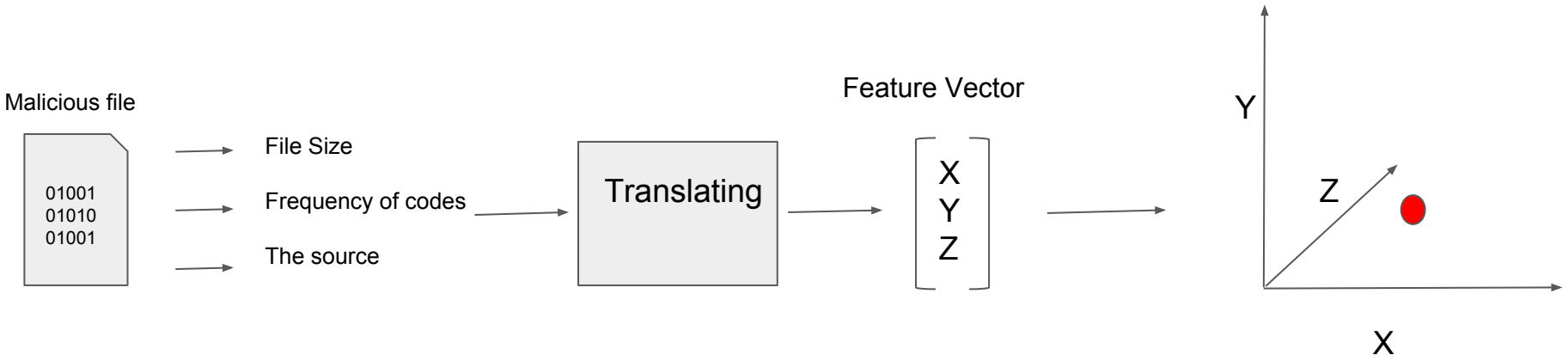
Background

Machine Learning



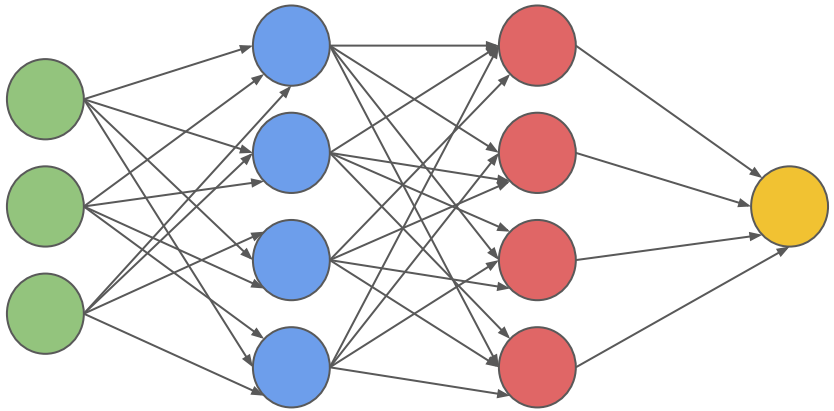
Background

Machine Learning



Background

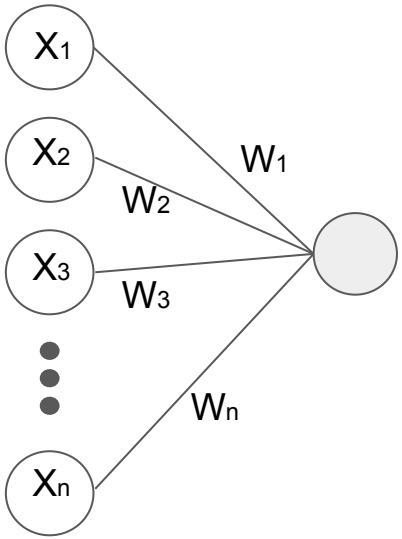
Deep Neural Network



Input layer Hidden layer 1 Hidden Layer 2 Output Layer

Background

Deep Neural Network



Activation Function ($W_1 * X_1 + W_2 * X_2 + W_3 * X_3 + .. + W_n * X_n$)

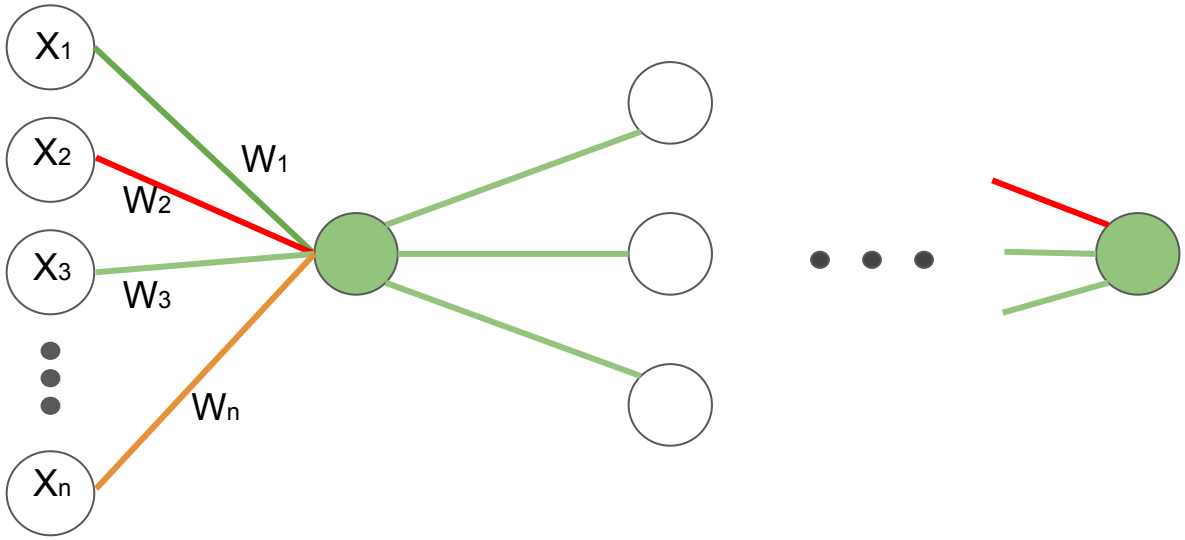
Example
Activation Function - ELU

$$f(x) = \begin{cases} x & if\ x \geq 0 \\ a(e^x - 1) & if\ x < 0 \end{cases}$$

Input Layer Hidden Layer

Background

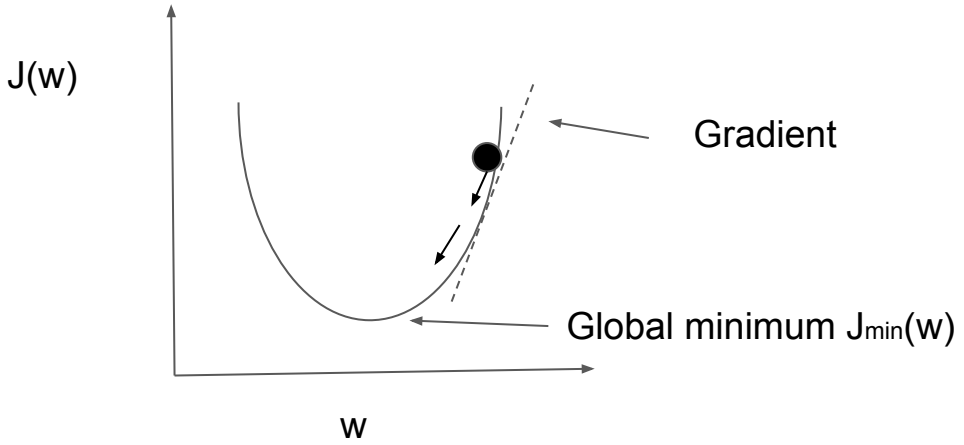
Deep Neural Network



Background

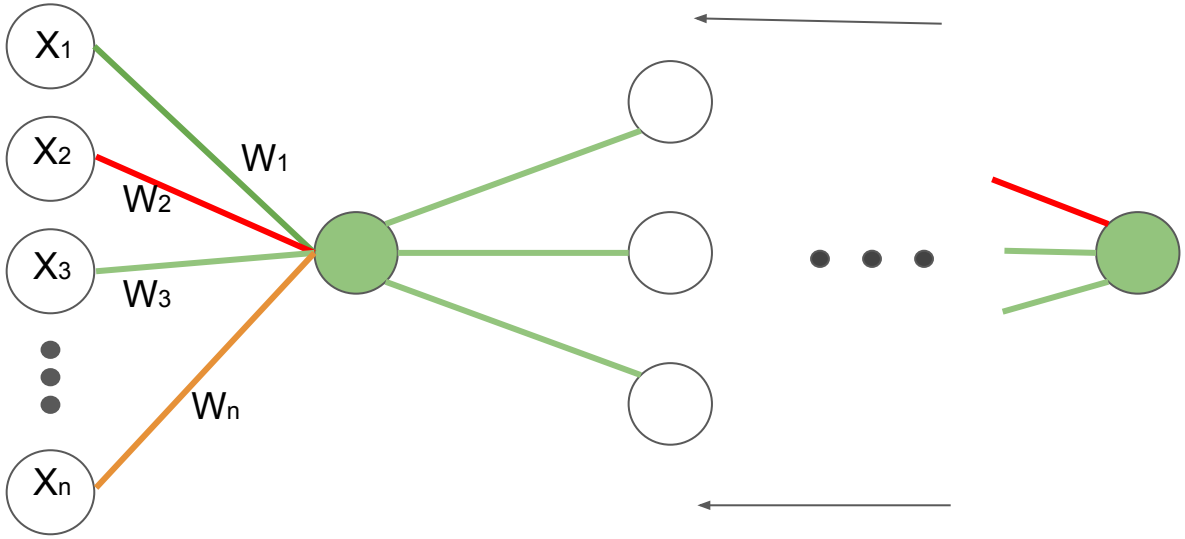
Deep Neural Network

- Loss Function - J(w)
- Back Propagation



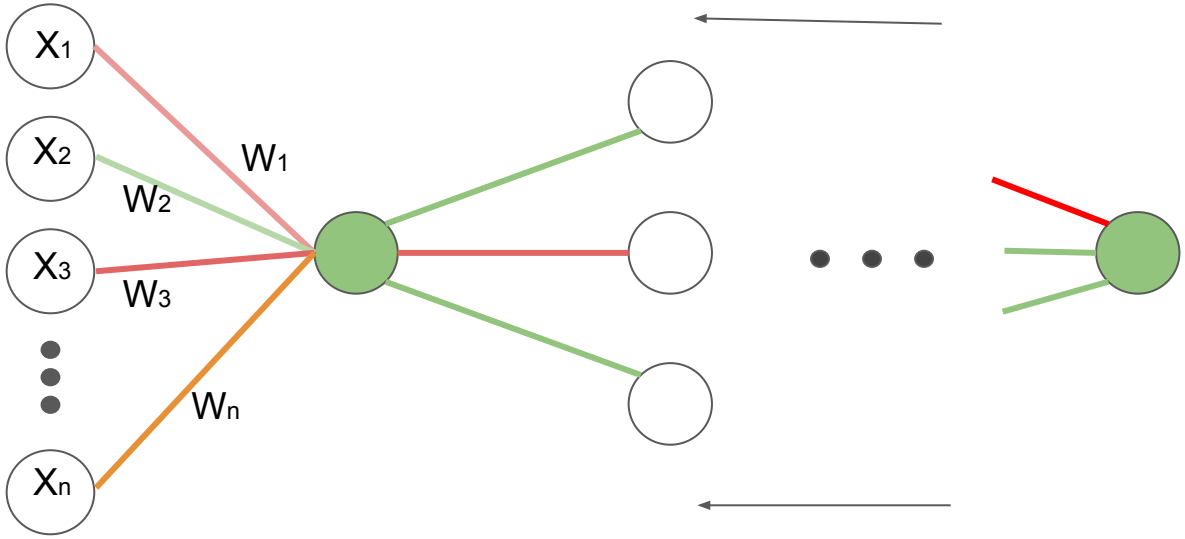
Background cont.

Back Propogation



Background cont.

Back Propagation



Outline

- Background
  - Machine Learning
  - Deep Neural Network
- Deep Neural Network Approach

Deep Neural Network Approach

Data Gathering

Deep Neural Network Approach

Data Gathering

- Malicious Files
  - Malicia Project
  - 11,064 Assembly Files

Deep Neural Network Approach

Data Gathering

- Malicious Files
  - Malicia Project
  - 11,064 Assembly Files
- Benign Files
  - Windows Systems
  - 2,800 Assembly Files
  - Adaptive Synthetic oversampling technique (ADASYN)

Deep Neural Network Approach

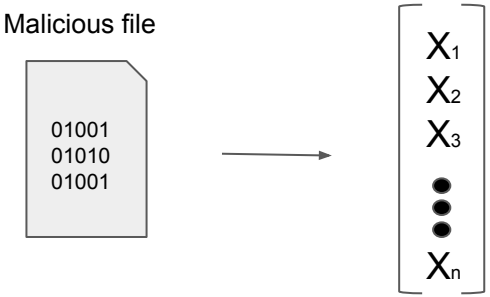
Data Gathering

- Malicious Files
  - Malicia Project
  - 11,064 Assembly Files
- Benign Files
  - Windows Systems
  - 2,800 Assembly Files
  - Adaptive Synthetic oversampling technique (ADASYN)
- Total around 22,000 Assembly Files
  - ~ 15,000 Files for Training
  - ~ 7,000 Files for Testing

Deep Neural Network Approach cont.

Structure Data Generating

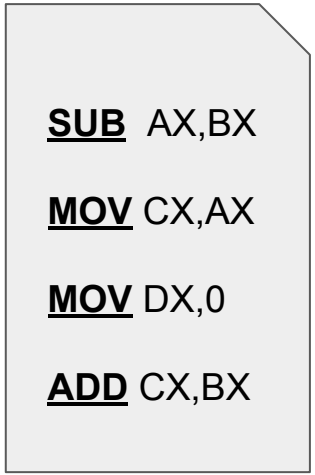
- Opcode
- Frequency Tables



Deep Neural Network Approach cont.

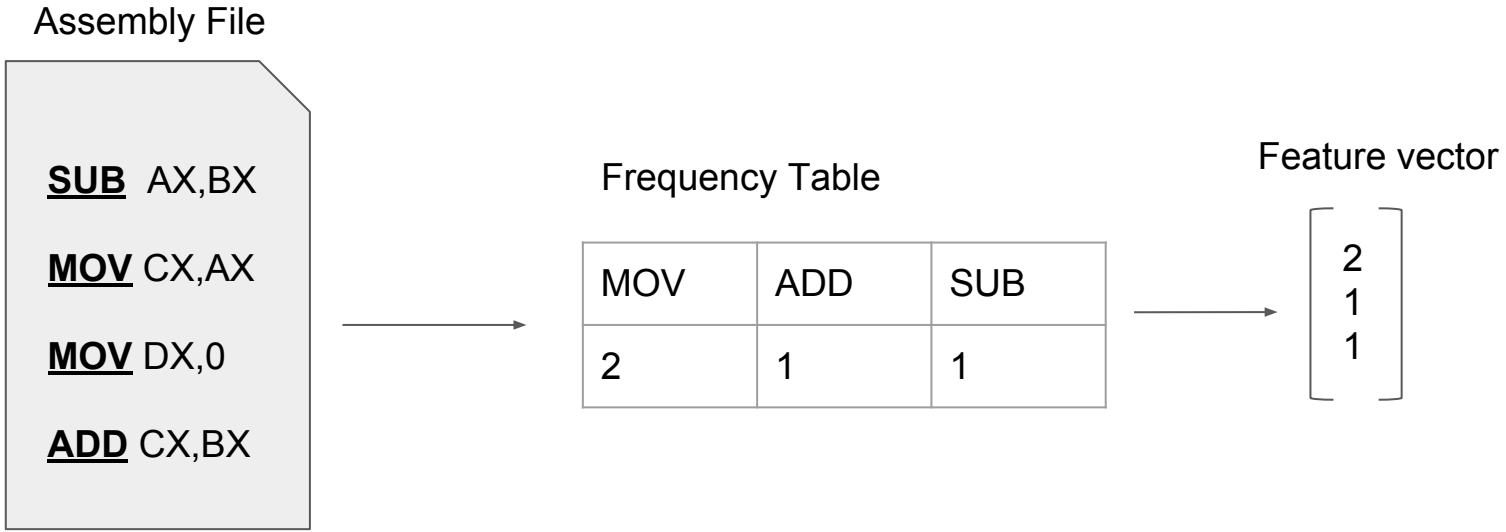
Operation Code (Opcode)

Assembly File



Deep Neural Network Approach cont.

Generating Frequency Table

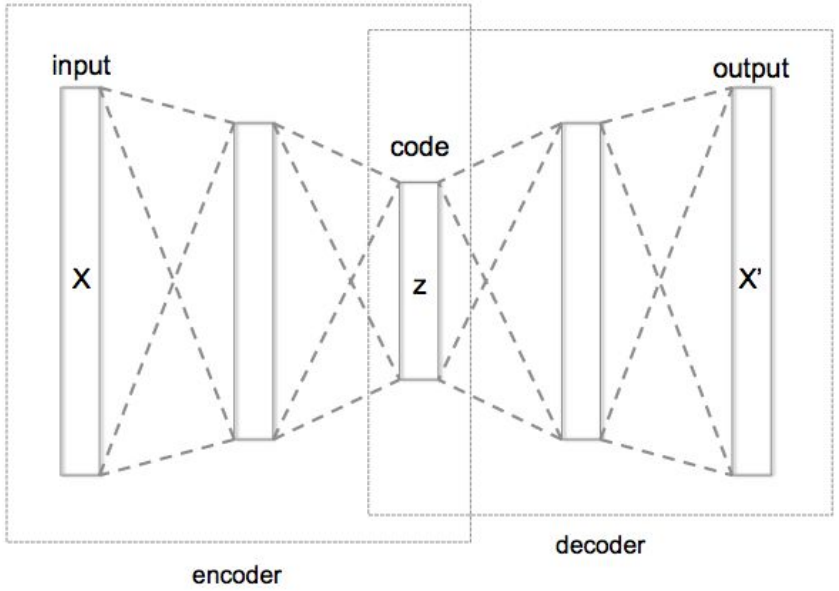


Deep Neural Network Approach cont.

Feature Extraction

Autoencoder (AE)

- Encoder
- Decoder
- Bottleneck Layer

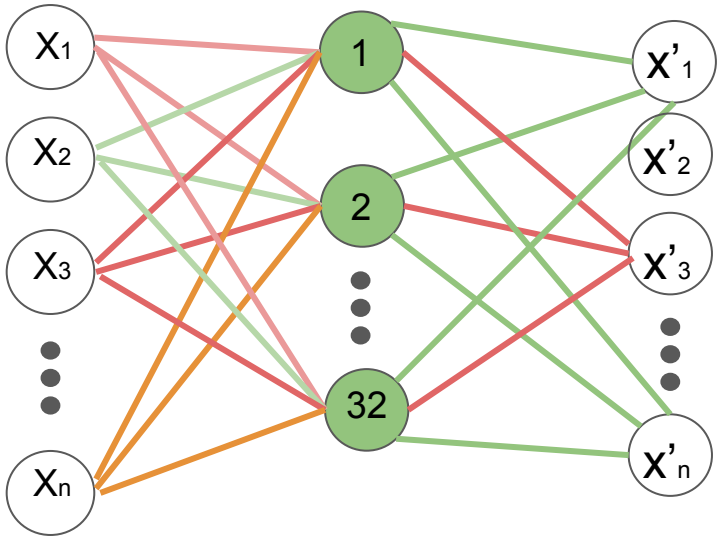


Deep Neural Network Approach cont.

Feature Extraction

Autoencoder (AE)

- 1-Layer Autoencoder

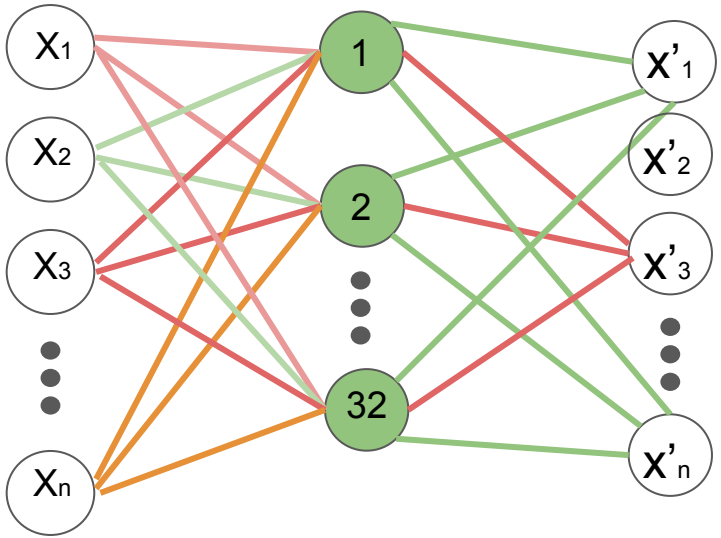


Deep Neural Network Approach cont.

Feature Extraction

Autoencoder (AE)

- 1-Layer Autoencoder
- 3-Layer Autoencoder

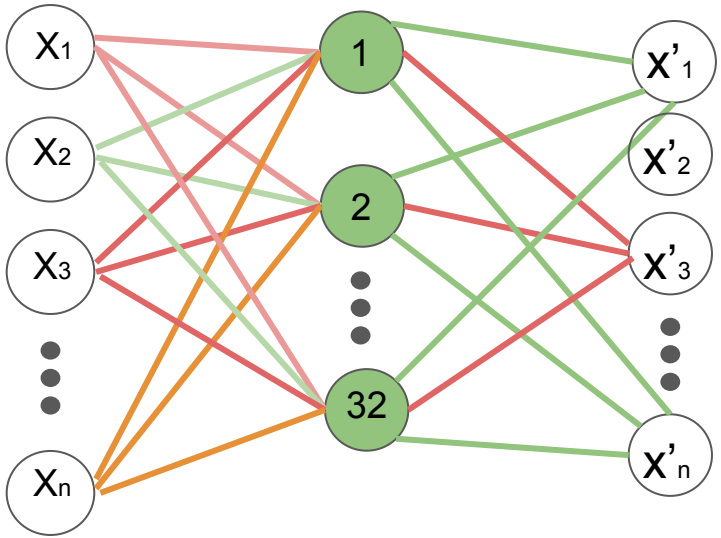


Deep Neural Network Approach cont.

Feature Extraction

Autoencoder (AE)

- 1-Layer Autoencoder
- 3-Layer Autoencoder
- ADAM optimizer

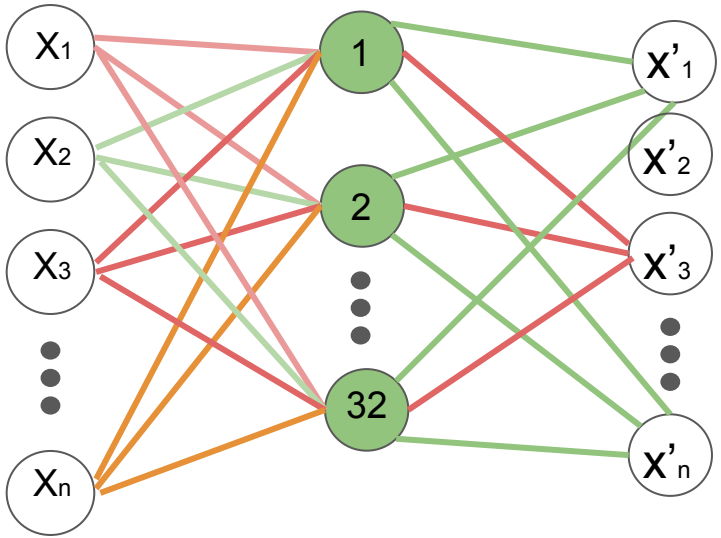


Deep Neural Network Approach cont.

Feature Extraction

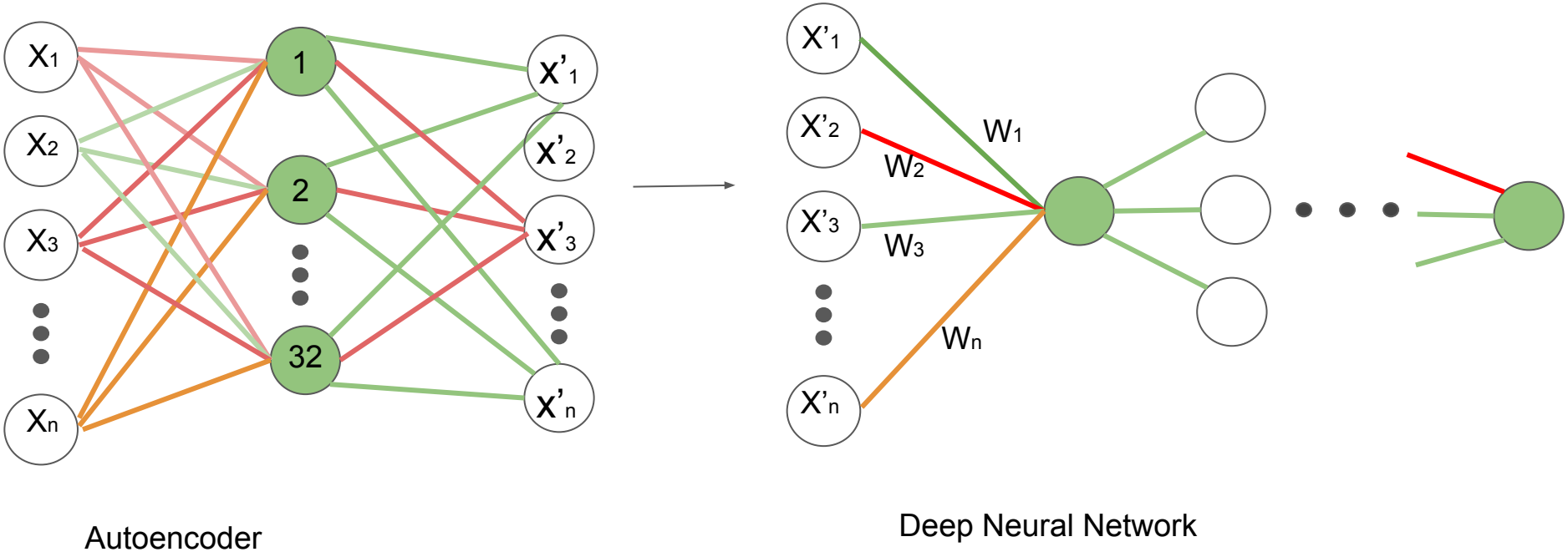
Autoencoder (AE)

- 1-Layer Autoencoder
- 3-Layer Autoencoder
- ADAM optimizer
- ELU Activation Function



Deep Neural Network Approach cont.

Modeling



Autoencoder

Deep Neural Network

Deep Neural Network Approach cont.

Modeling

Deep Neural Network

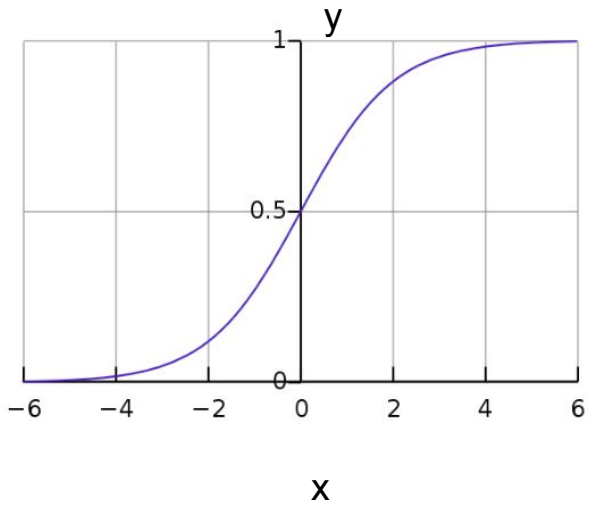
- 2-hidden layer DNN
- 4-hidden layer DNN
- 7-hidden layer DNN
- ELU (Activation Function)
- Output Layer - Sigmoid Activation
- ADAM optimizer

Deep Neural Network Approach cont.

Modeling

Deep Neural Network

- 2-hidden layer DNN
- 4-hidden layer DNN
- 7-hidden layer DNN
- ELU (Activation Function)
- Output Layer - Sigmoid Activation
- ADAM optimizer



Deep Neural Network Approach cont

Results

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Conclusion

- Cyber Security is really important
- Deep Neural Network shows good performance
- There are still more techniques to explore

Acknowledgements

Thank you for your time and attention!

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References

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