

The logo for MDA (Maxar Defence Australia) is displayed in a bold, white, sans-serif font. The letters 'M', 'D', and 'A' are connected, with a small trademark symbol (TM) to the right.

A **MAXAR** COMPANY

The background of the slide features a large, modern grey naval ship, likely a frigate, sailing on the ocean. To the right of the ship, a white autonomous underwater vehicle (AUV) is shown in a vertical orientation, appearing to be deployed from or near the ship. The sky is a mix of blue and orange, suggesting a sunset or sunrise. A semi-transparent grey box is overlaid on the left side of the image, containing the text 'INNOVATION IN SPACE AND DEFENCE'.

INNOVATION
IN SPACE
AND DEFENCE

A solid red square is positioned to the left of the main title.

DEEP LEARNING AND ELECTRONIC INTELLIGENCE

KYLE DAVIDSON

May 14th, 2019

Innovation in Space and Defence



MDA Value Streams



Space Radar

- Satellite-based radar missions and systems
- Radar analytics, services, and imagery
- Mission and infrastructure operations



Earth Observation Systems

- Multi-mission Earth observation ground systems
- Mission planning through reception, processing and analytics
- Enterprise geospatial systems



Robotics, Sensors and Automation

- Robotic manipulators, rovers, and sensor systems
- Ranging, automated docking, inspection and navigation
- Space exploration, satellite servicing, debris removal
- Medical, nuclear and industrial automation



Satellite Antennas, Electronics and Payloads

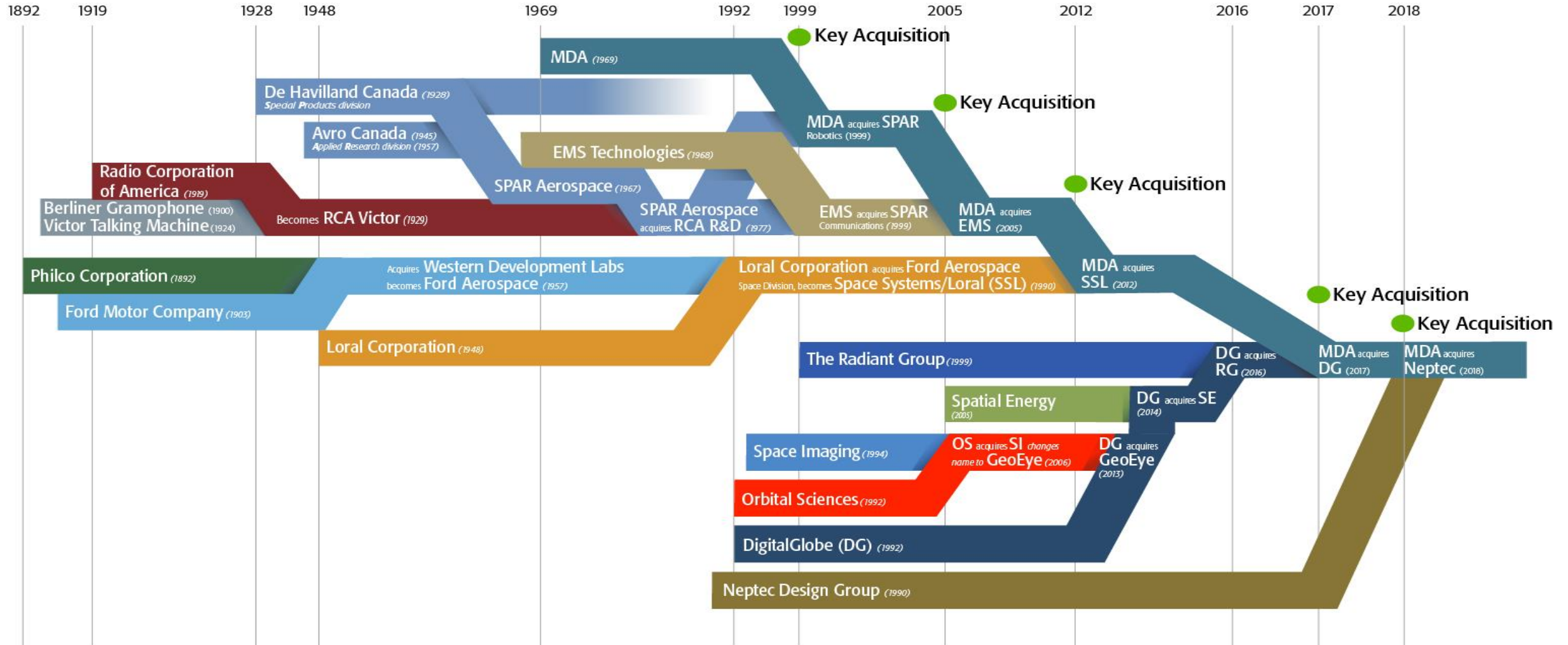
- Engineering, production and testing of equipment and payloads
- Space-based communications, radar, exploration and science
- High-volume production for large satellite constellations



Defence Systems

- System integration and complex system delivery and operations
- Intelligence and Surveillance, Command and Control, and communications
- Engineering, production, in-service support partner

MDA Heritage: Over 120 Years

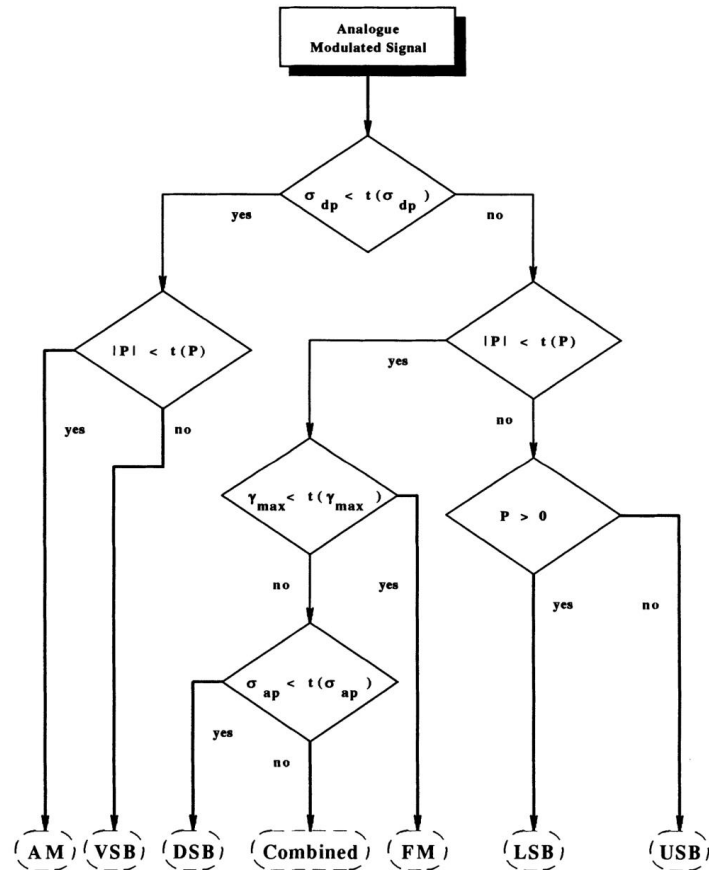


INTRODUCTION TO MACHINE LEARNING

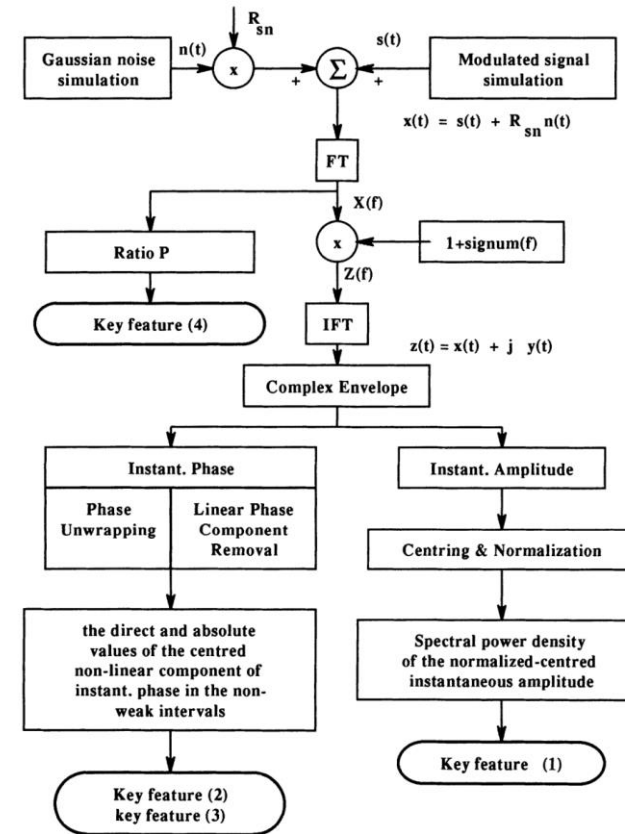
Deep Learning and ELINT



Traditional Signal Classification

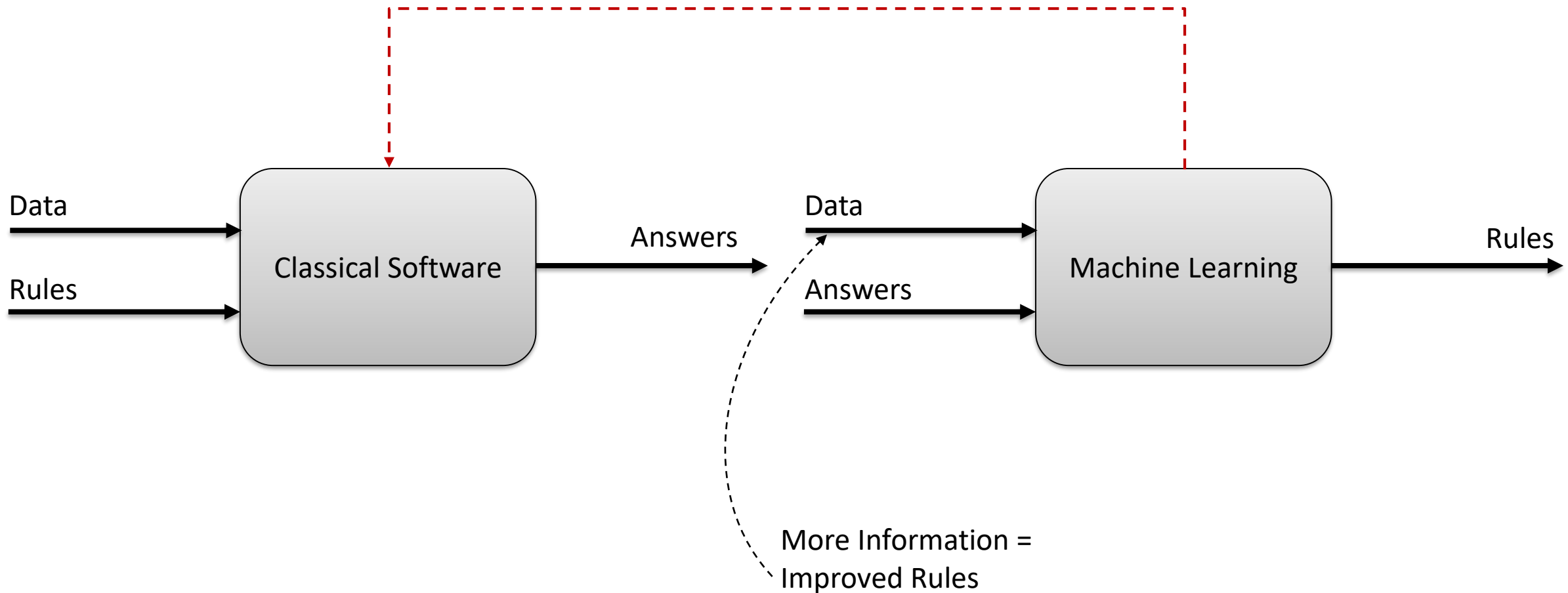


Functional Flowchart for key feature extraction in analogue modulations [1].

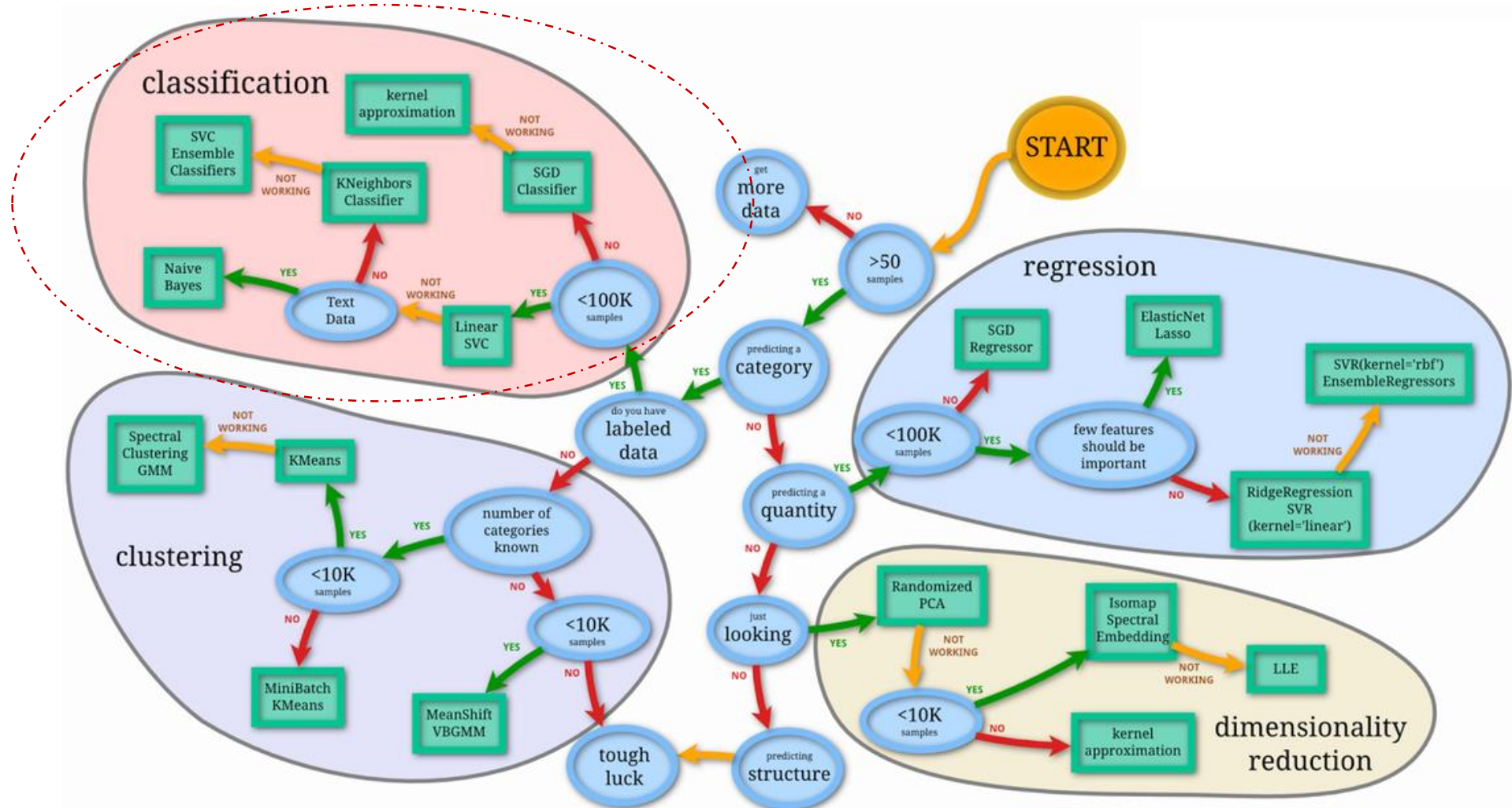


Functional flowchart for modulation classification [1].

Training vs. Programming

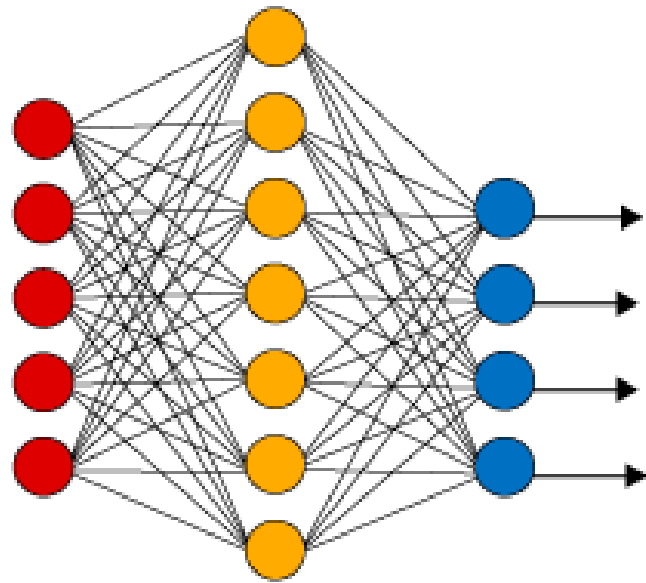


Machine Learning

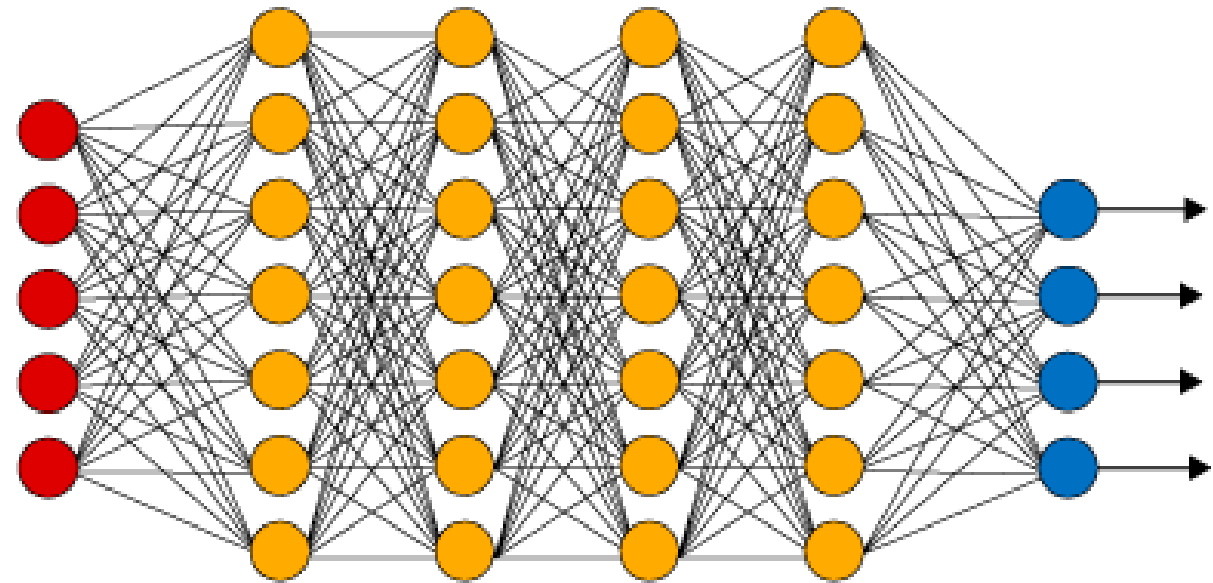


Deep Learning

Simple Neural Network



Deep Learning Neural Network

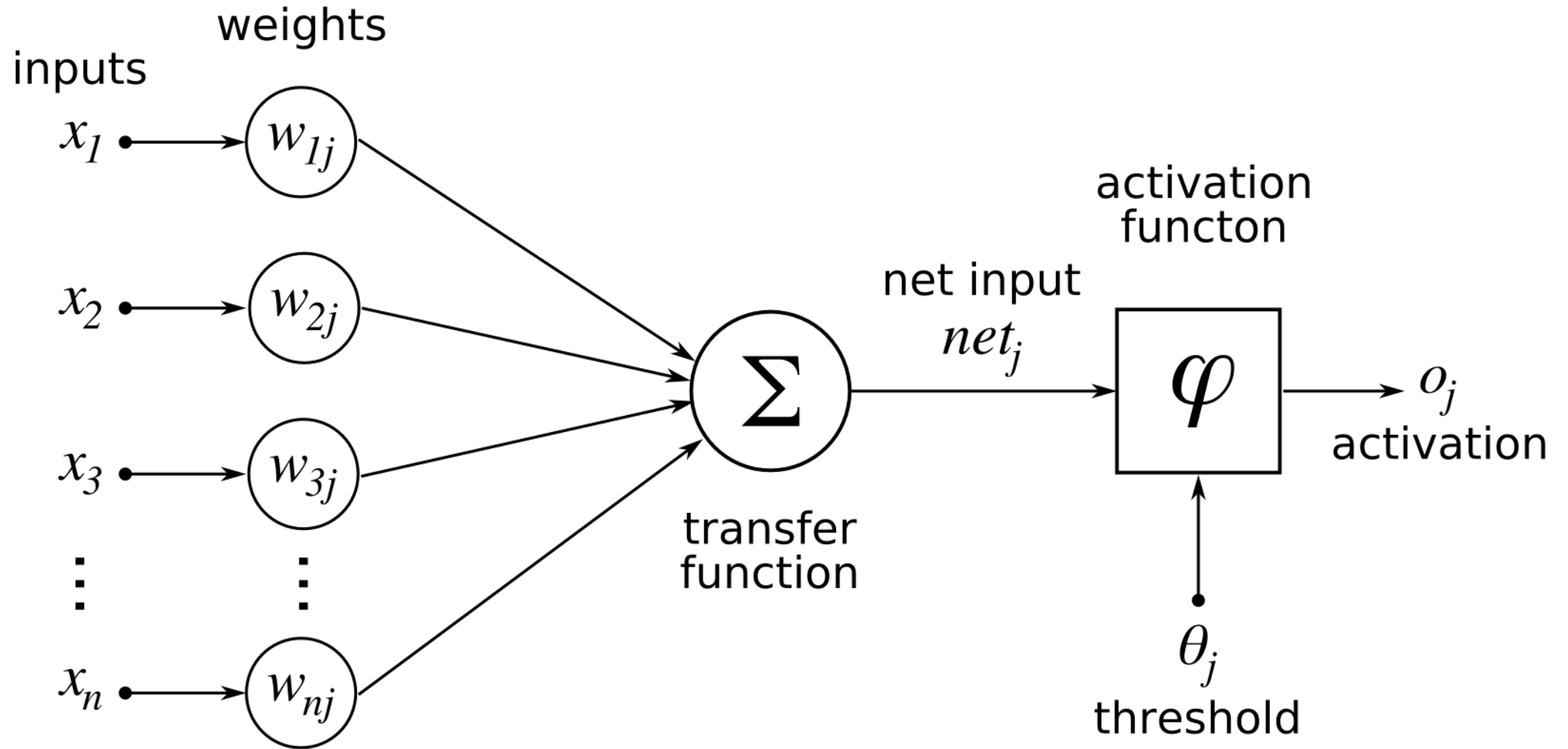


● Input Layer

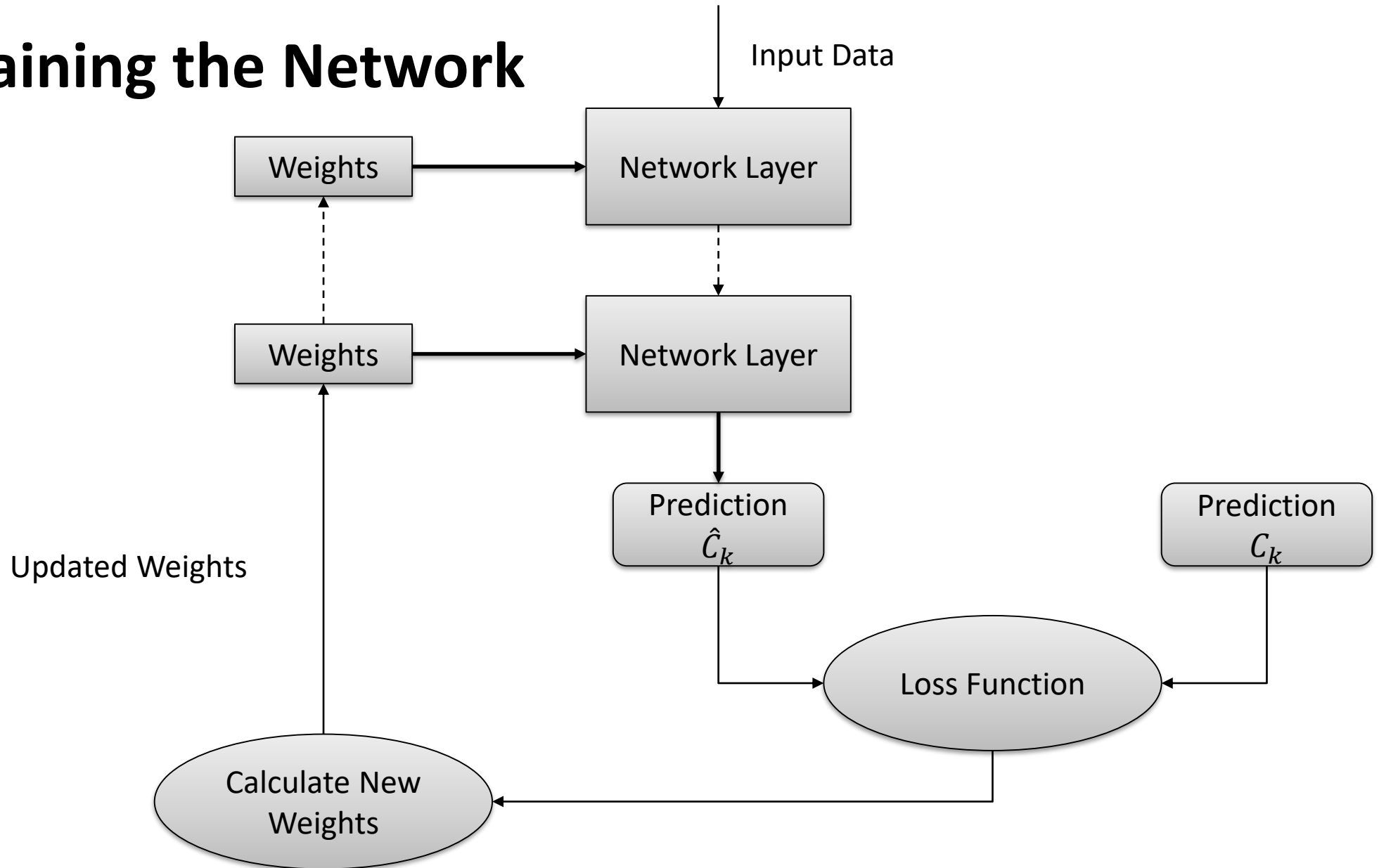
● Hidden Layer

● Output Layer

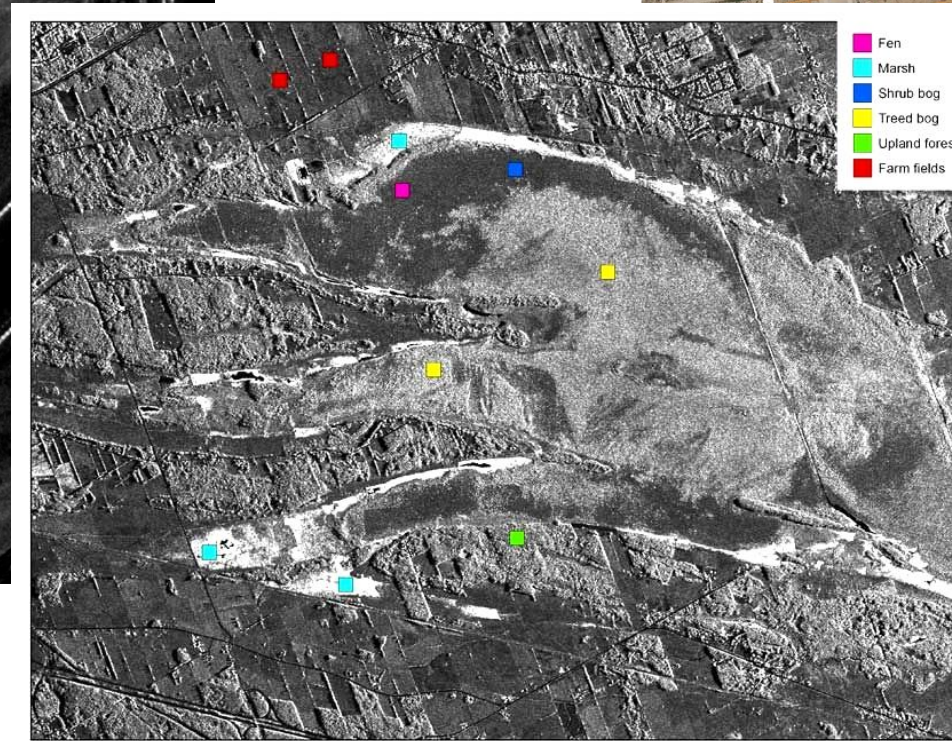
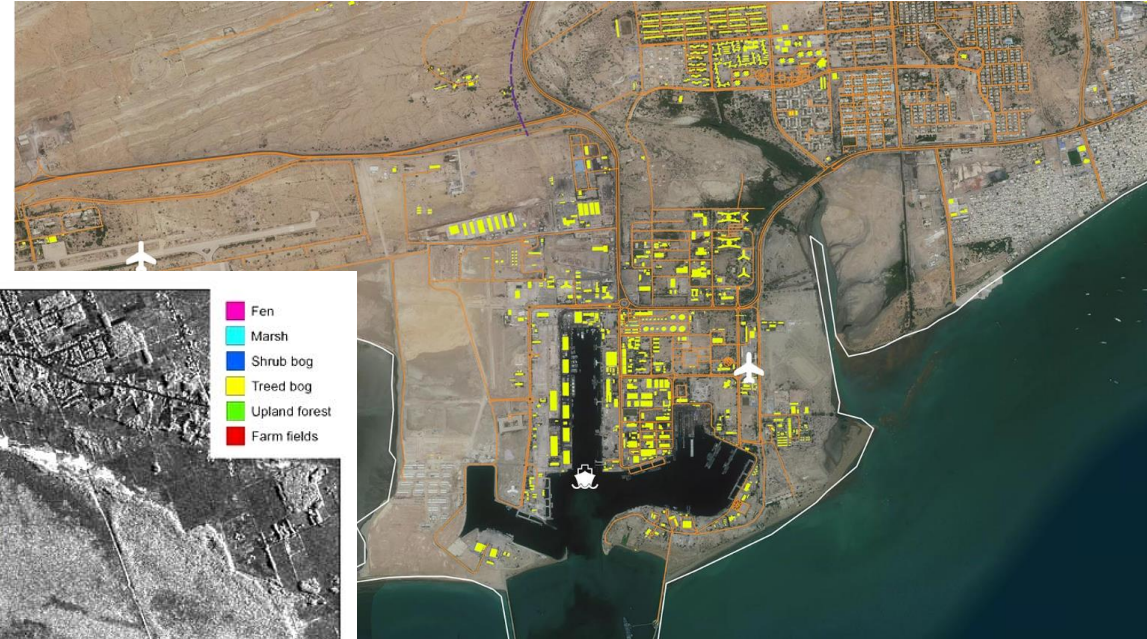
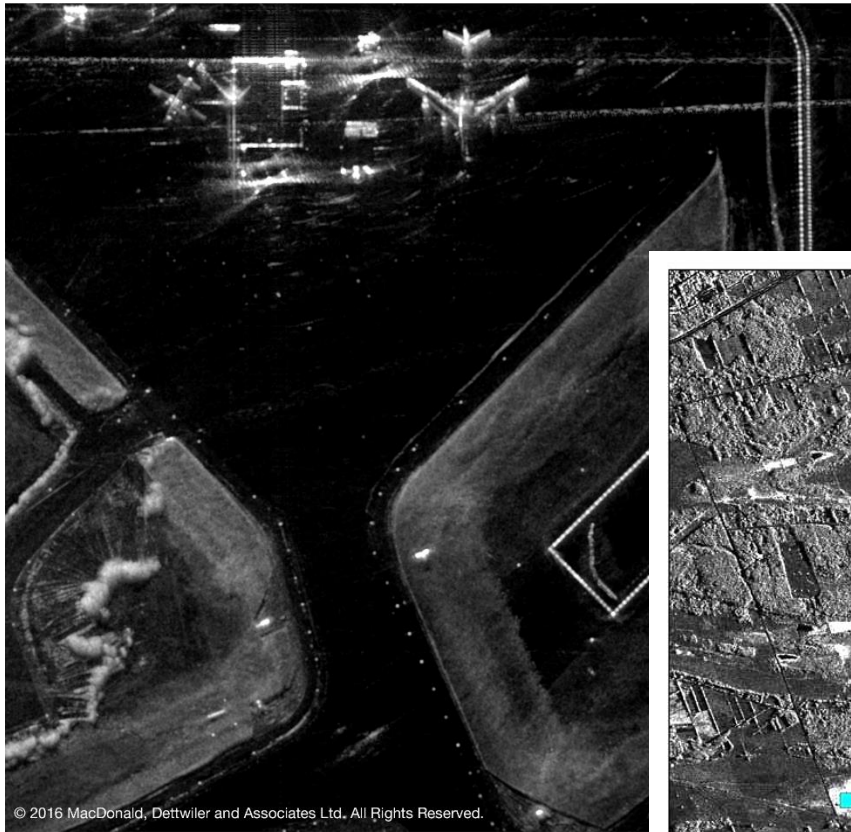
Neuron



Training the Network



Where do we see this applied?



Where is the technology now?

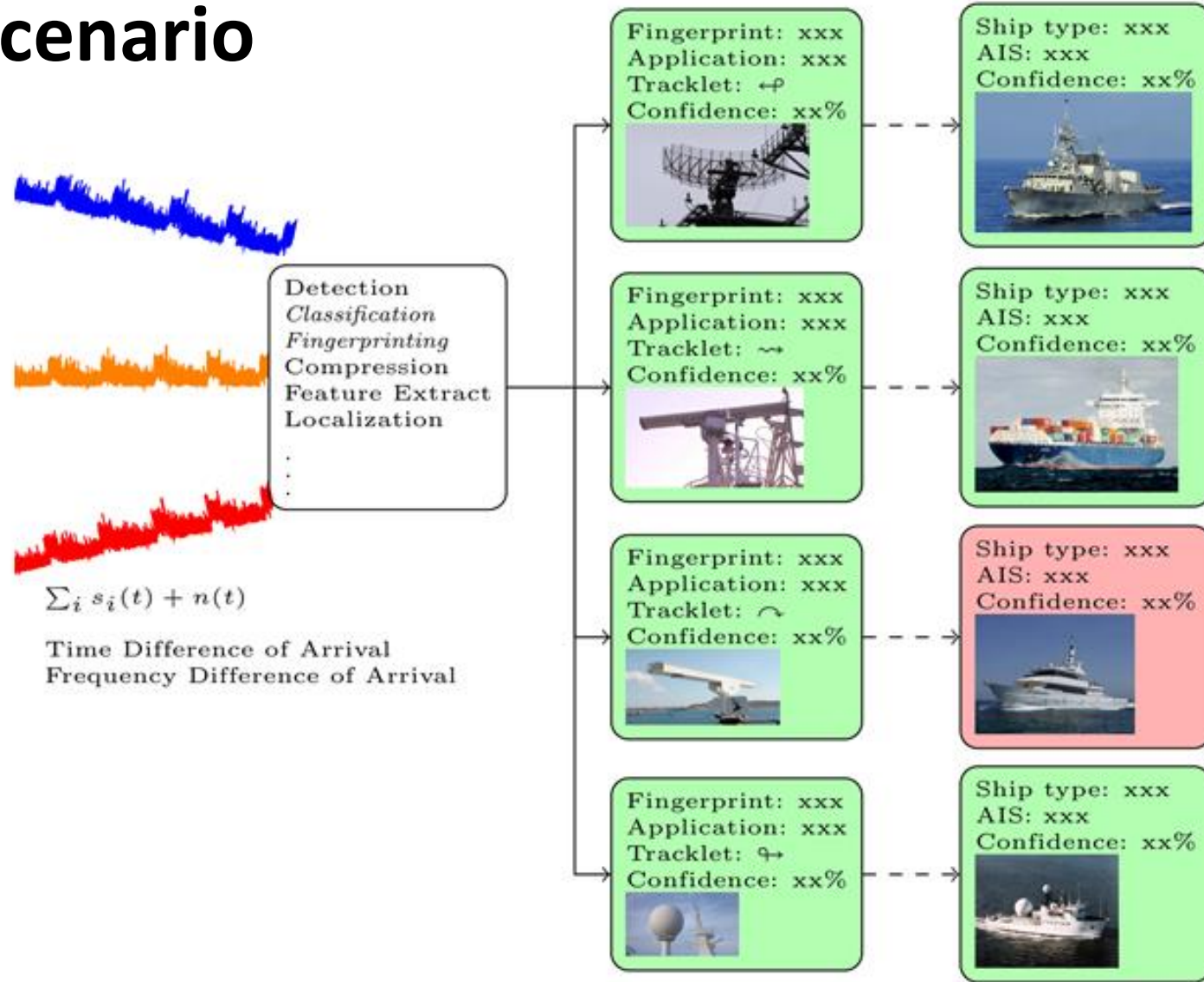
- Deep learning is the prevalent method.
 - Deep learning does not require feature engineering.
 - Classification is a mature technology.
 - Rapidly changing field.
 - It has major limitations.
- Image Net Challenge
 - 1000 categories
 - 1.4 million colour images
 - 2011 winner = 74 %
 - 2012 winner = 84 % (Hinton & U of T)
 - 2015 winner = 96.4 %

DEVELOPING THE DEEP LEARNING CLASSIFIER

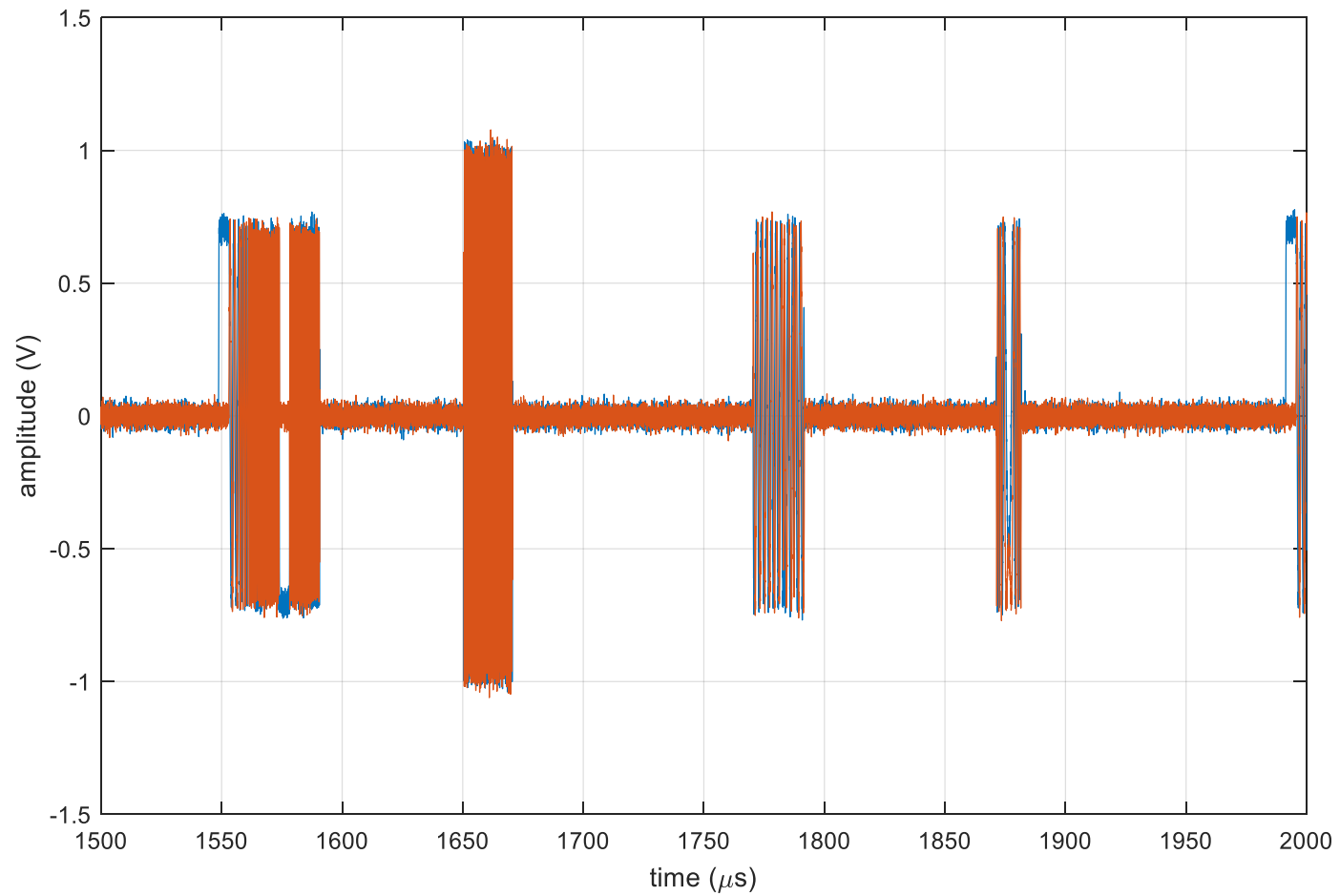
Deep Learning and ELINT



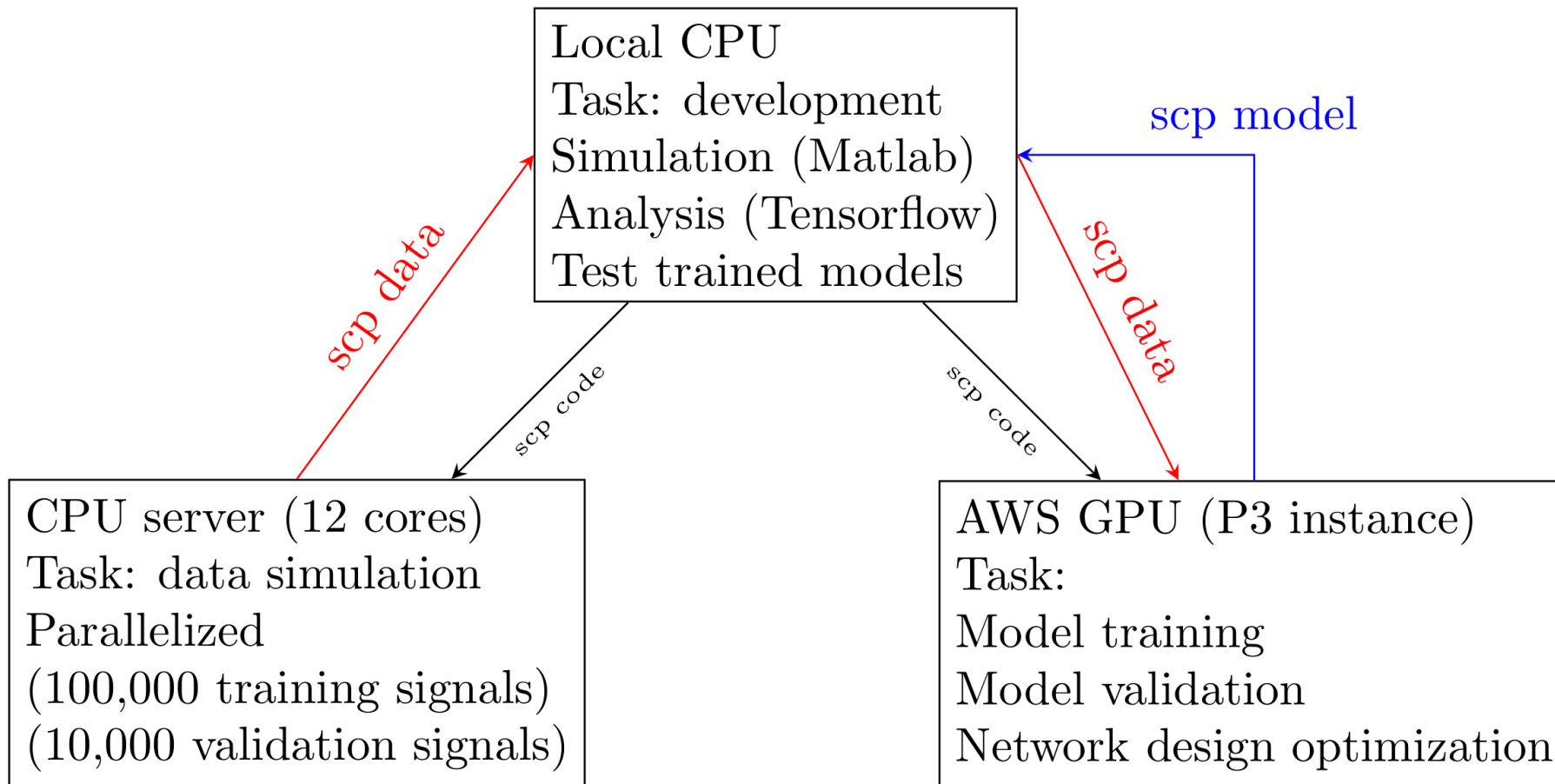
ELINT Scenario



Training Data



Training and Testing the Network



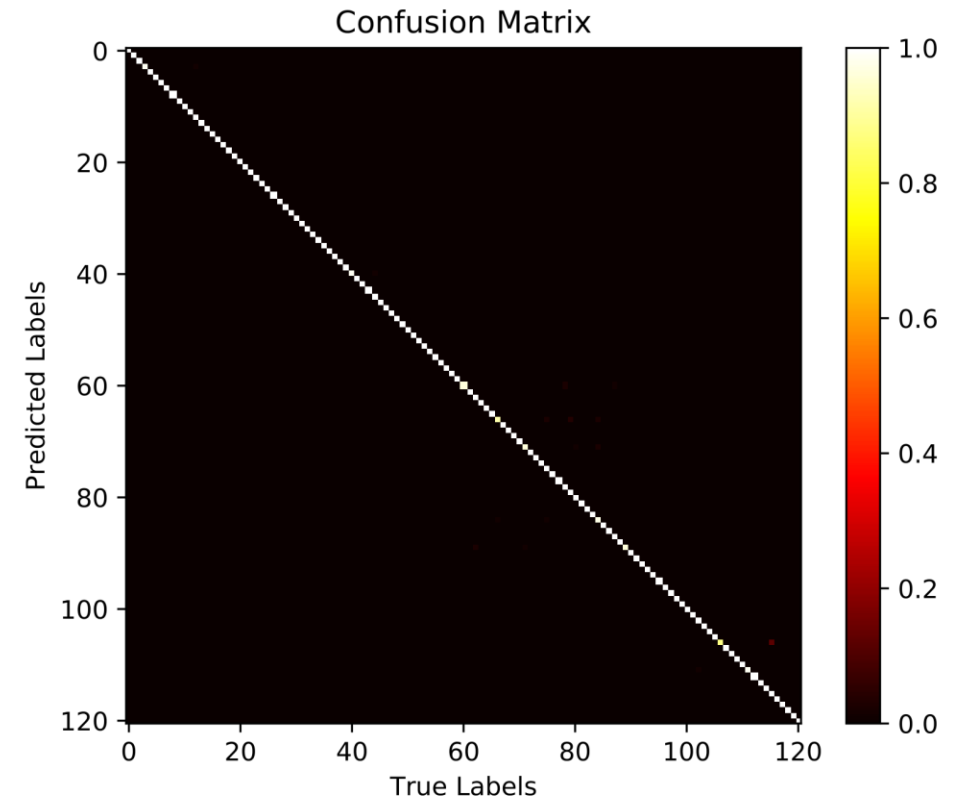
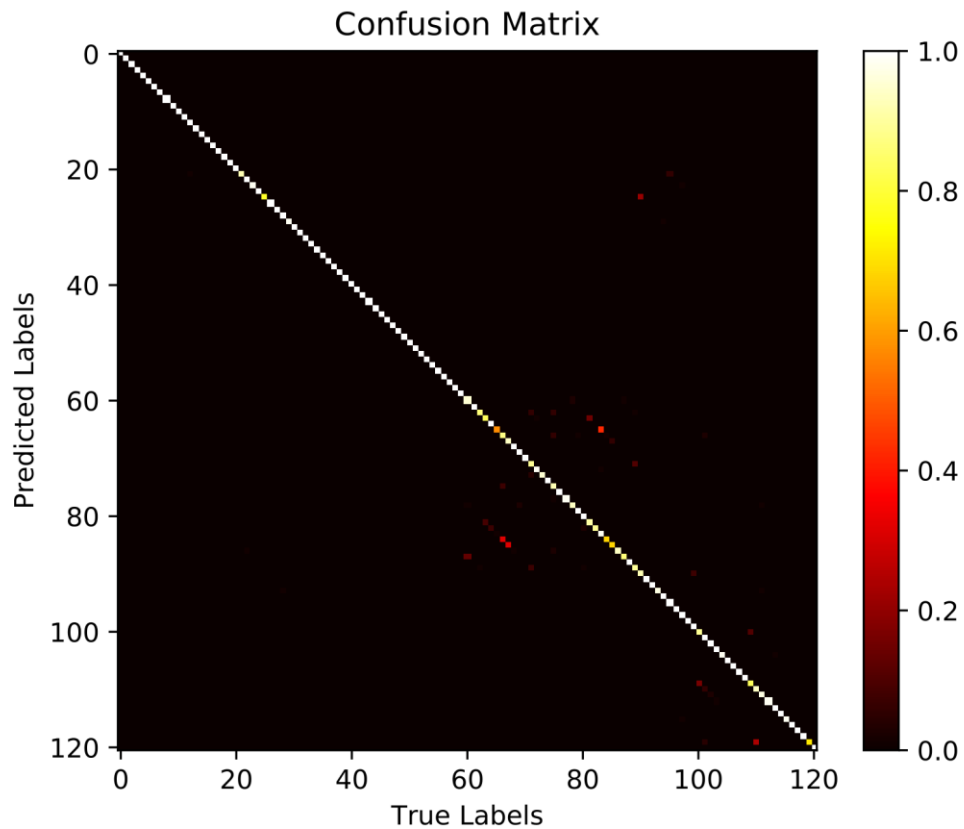
RESULTS

Deep Learning and ELINT

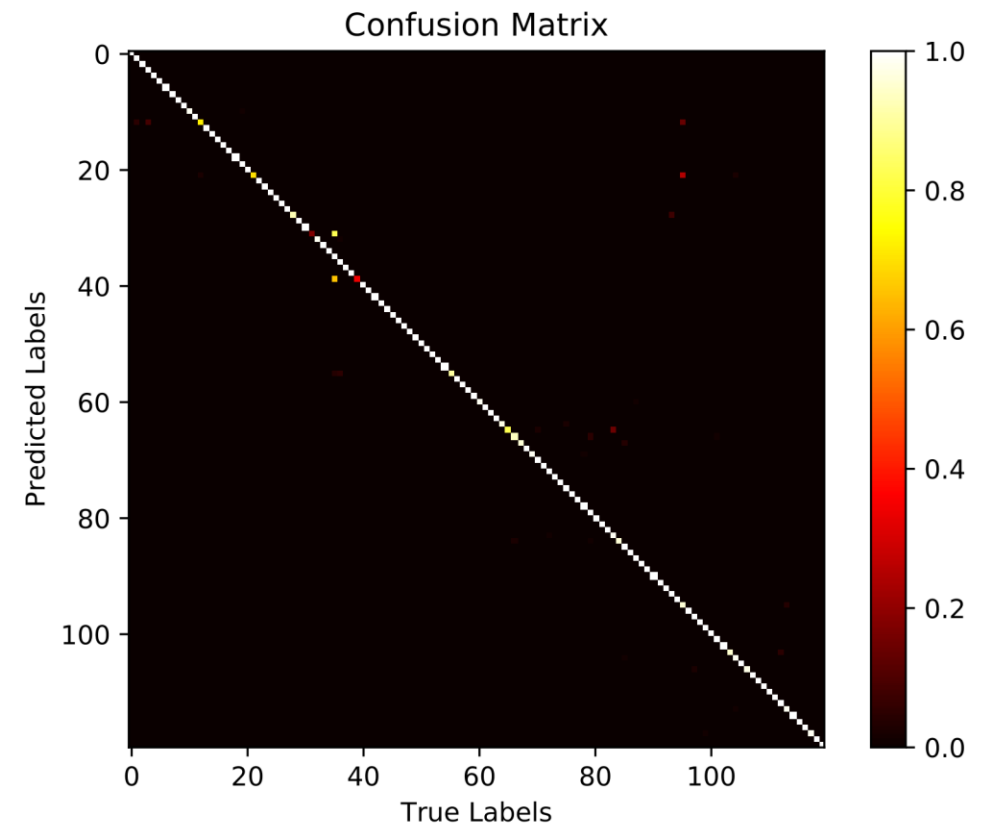
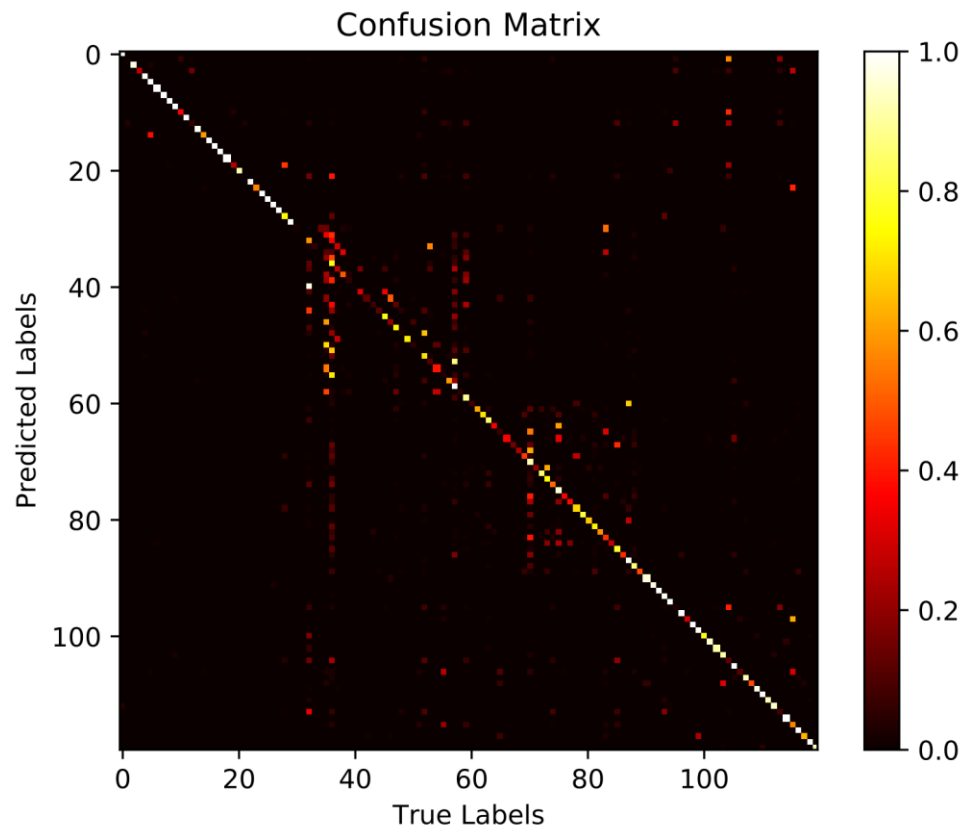


Classification – with and without noise

SNR	Accuracy
∞	99.7
1 (0 dB)	97.8
0.5 (-6 dB)	89.5
0.3 (-10dB)	61.1

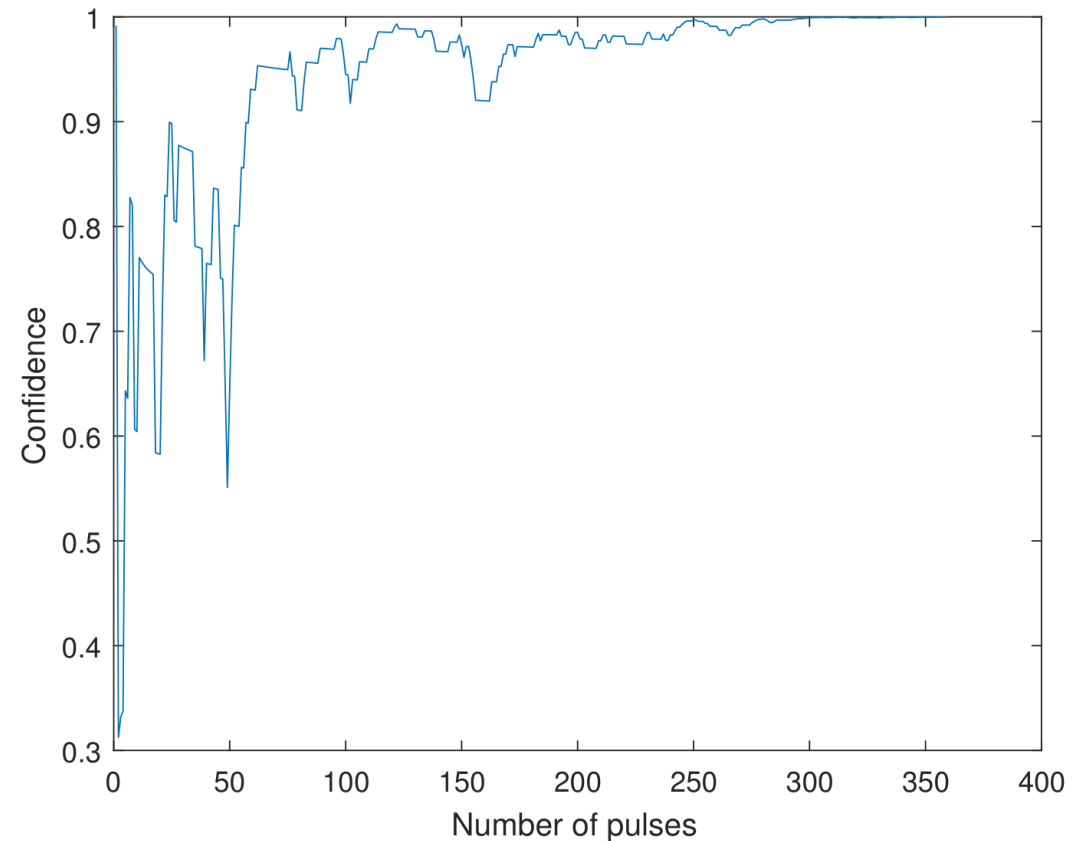


Multiple Signal Classification

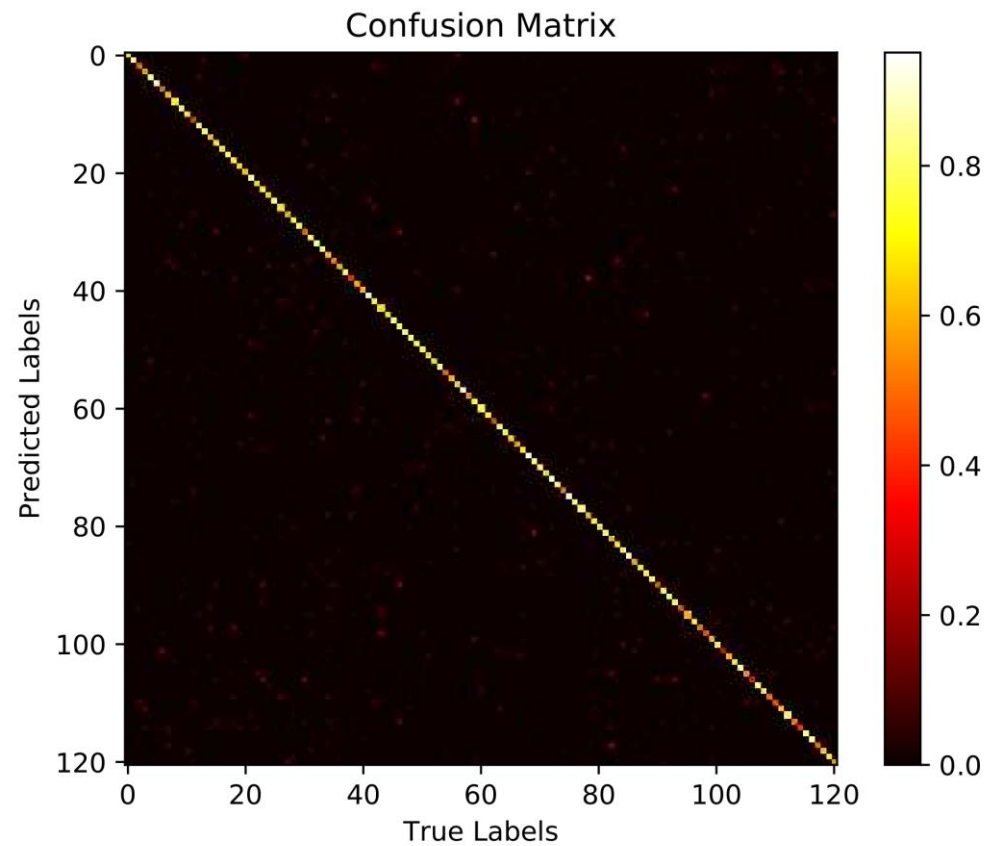
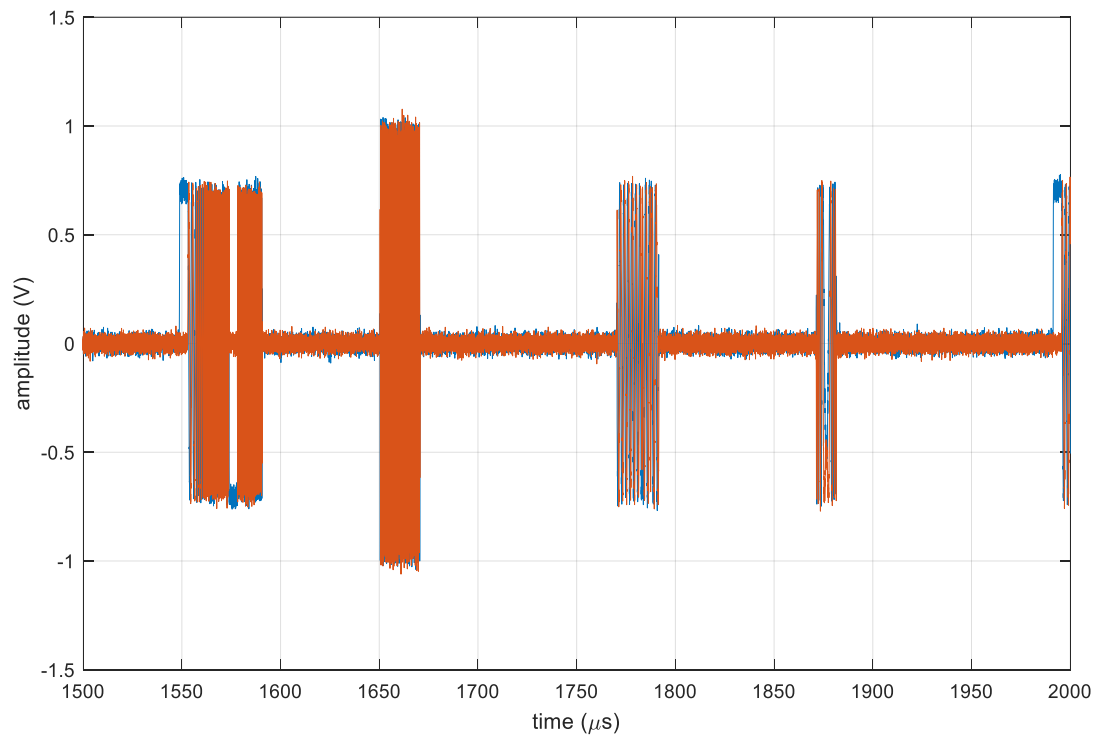


Effects of Numerous Pulses

- Classifying a pulse in isolation.
- Using the information from a sequence of pulses.

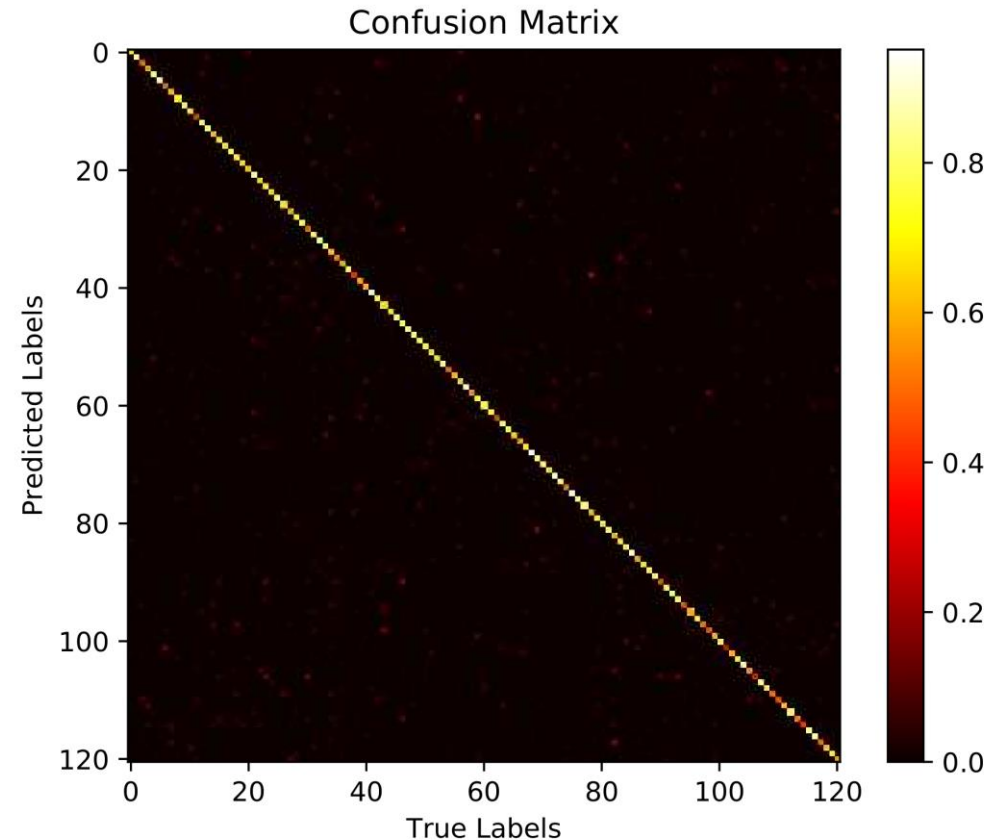


RF Fingerprinting



Conclusion

- ML can offer significant performance gains in ELINT classifiers.
- Training the NN using cloud computing.
- Real-time implementation.



QUESTIONS?

Deep Learning and ELINT



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