University of Strathclyde Engineering

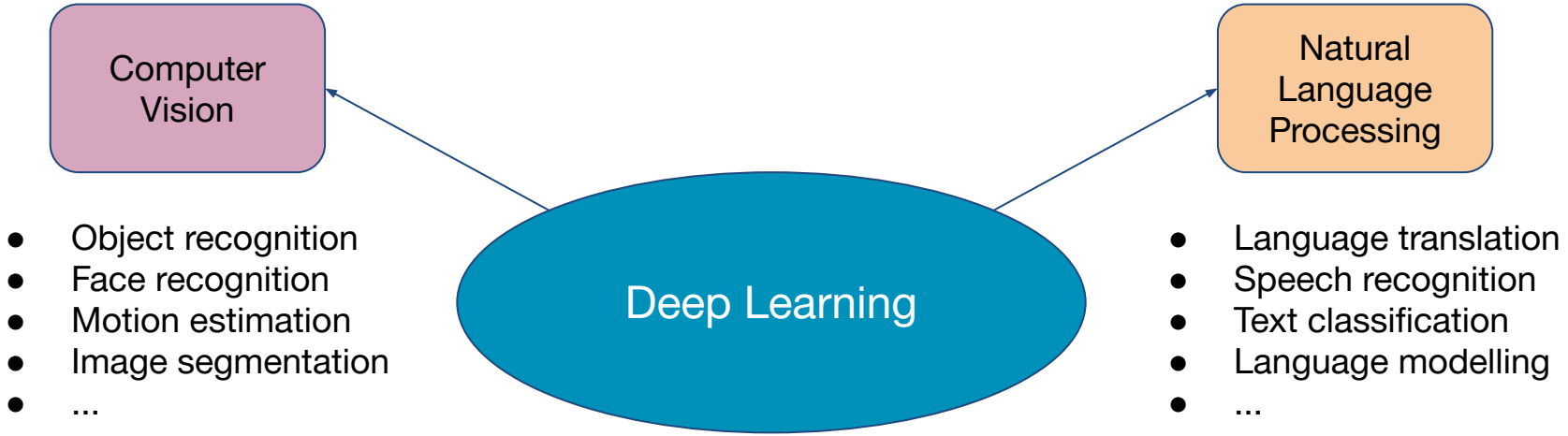
FPL 2019 - PhD Forum

FPGA Accelerated Deep Learning Radio Modulation Classification Using MATLAB System Objects & PYNQ

Andrew Maclellan, Lewis McLaughlin, Louise Crockett, Robert W. Stewart

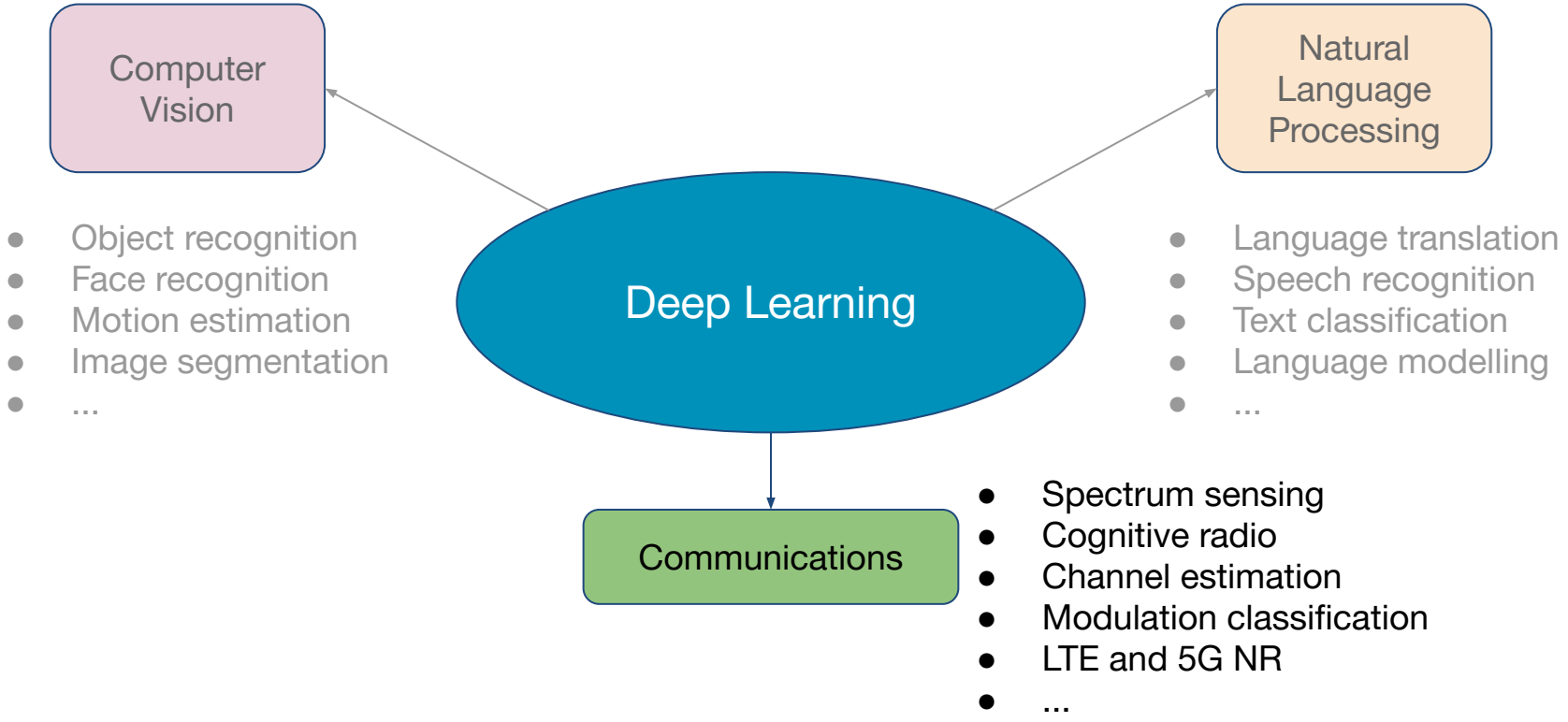
Motivation

Impact of Deep Learning:



Motivation

Impact of Deep Learning:



Our Aim

University of Strathclyde Engineering

Develop a workflow for training, quantising, simulating and implementing CNNs for communications on Zynq

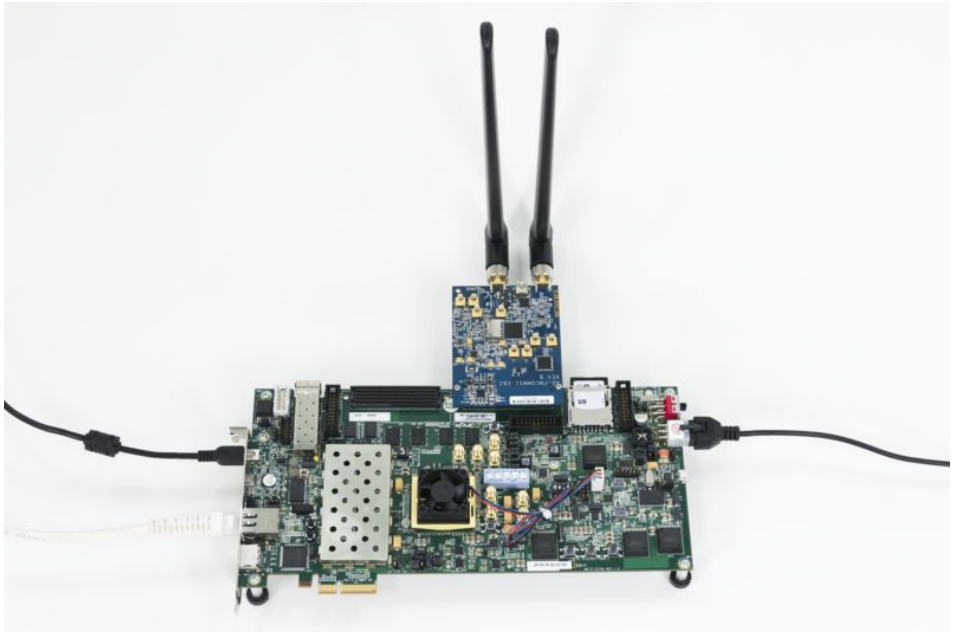
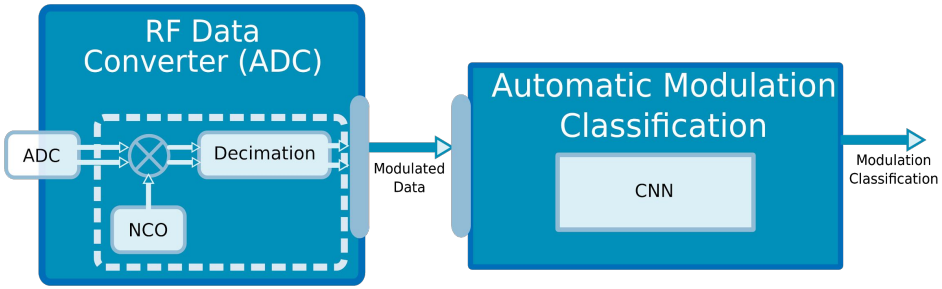


Figure 1. Credit Mathworks - Zynq SDR Support from Communications Toolbox

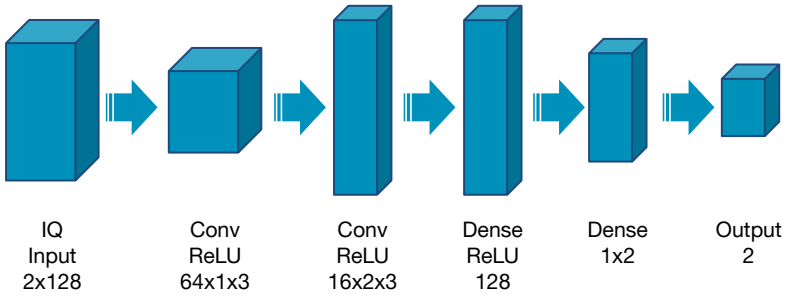
MathWorks®

XILINX

Application - Automatic Modulation Classification

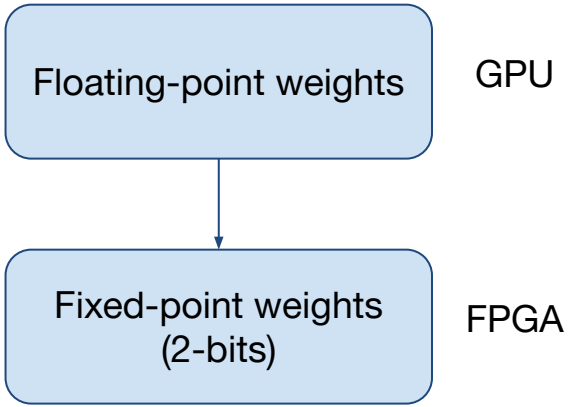


- Application for **Spectrum Sensing**
- Paper outlining this CNN structure by T. O'shea 2016
- Apply already proven structure and transfer it to hardware.
- Reduced modulation schemes to 2 for implementations simplicity

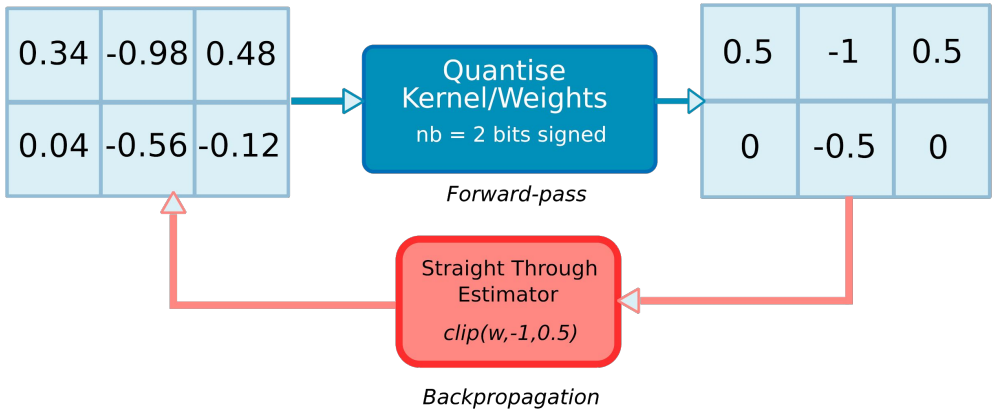


Layer #	Layer type	Neurons	Activations	MACs
1	Input	2*128	-	-
2	Conv	64*1*3	ReLU	48384
3	Conv	16*2*3	ReLU	761856
4	Dense	128	ReLU	253952
5	Dense	2	Softmax	256
6	Output	2	-	-

Quantised CNN

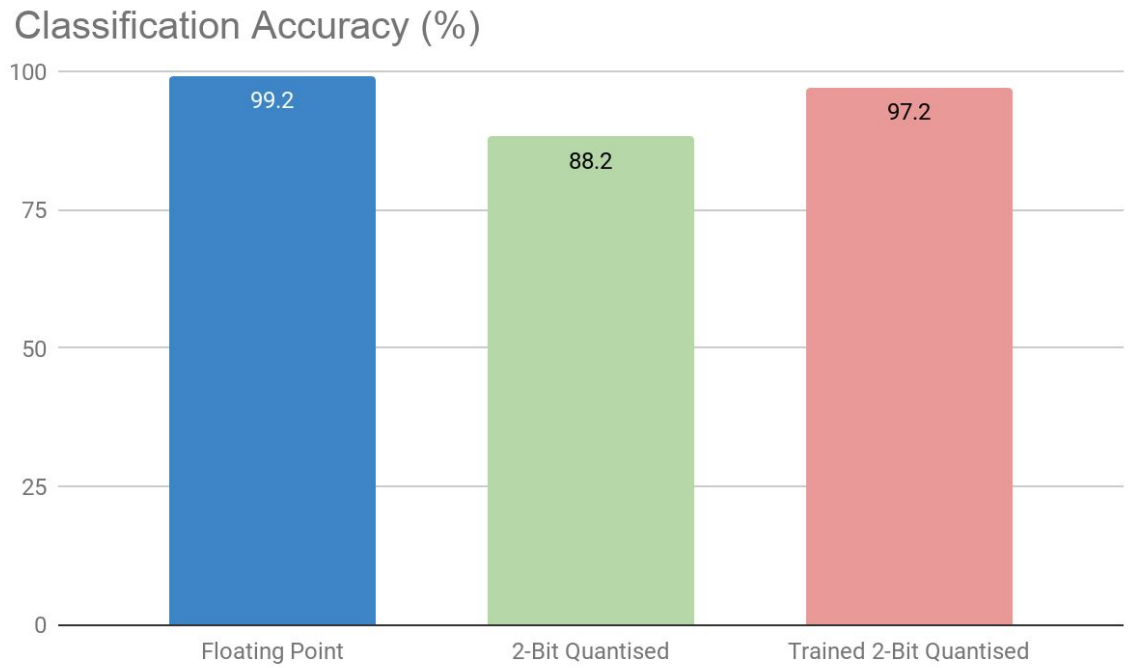


- Avoid quantising from trained floating-point weights
  - Massive reduction in accuracy
- Altered our training process to train with quantisation limitations

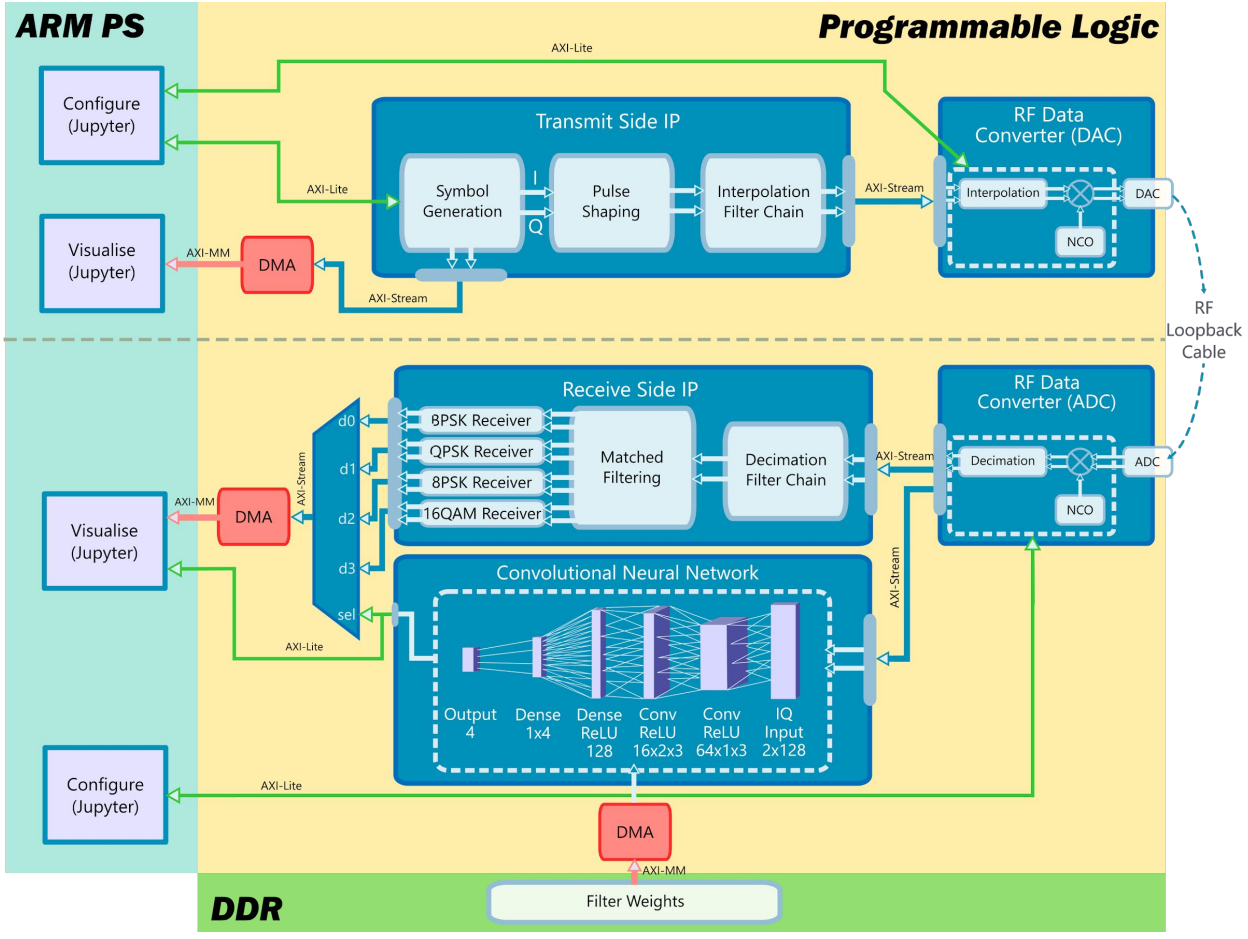


Example of kernel quantised training

Quantised CNN



Preliminary Proposed System



RFSoC

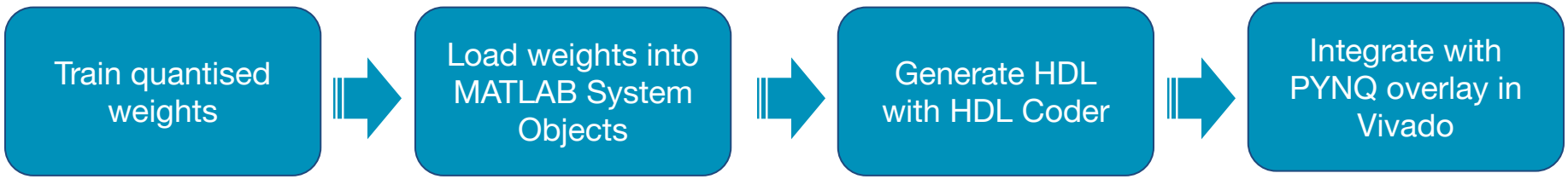
(Zynq UltraScale+ ZCU111 Evaluation Platform)

Single chip transmit/receive

PYNQ

- Python productivity on Zynq
- Dynamically change modulation scheme
- Visualise the CNN decision making in real-time

Proposed Workflow



- Train quantised weights on DL frameworks
- Tensorflow/Keras
- PyTorch
- MATLAB Deep Learning Toolbox

- Configurable System Objects
- Adjustable CNN dimensions
- Simulate quantised network using Simulink

- Integrate with other MATLAB HDL IP
- Generate HDL for both CNN & communications applications

- Generate PYNQ bitstream for deployment
- Interface with Jupyter notebook

University of Strathclyde Engineering

Thank you!

Questions can be answered at the poster.

Feel free to come and discuss with us :)