Adaptive Beamforming for future ITS

A neural network approach to antenna beam steering for mmWave Systems

Clifford Beta
Anne Okemwa

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- multi-gigabit-per second communication

mmWave Communication Potential

- multi-gigabit-per second communication
- very low latency

Applications

- Autonomous driving

Applications

- Autonomous driving
- Immersive gaming

Applications

- Autonomous driving
- Immersive gaming
- Virtual reality

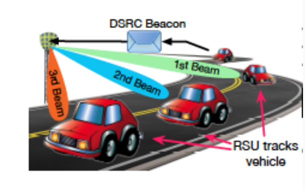
Applications

- Autonomous driving
- Immersive gaming
- Virtual reality
- Augmented reality

Problem

- Increased vehicular mobility

Problem



- Increased vehicular mobility

- Need for constant beam realignment.

Model

Neural Network

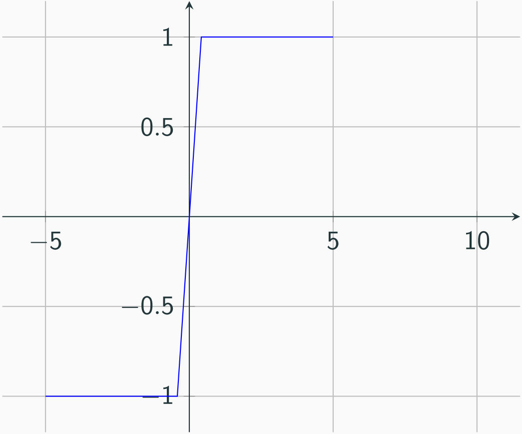
Neural networks have been proven to have the ability to compute any function, even

`{Sequence prediction problems}`

at which *LSTMs* shine ...

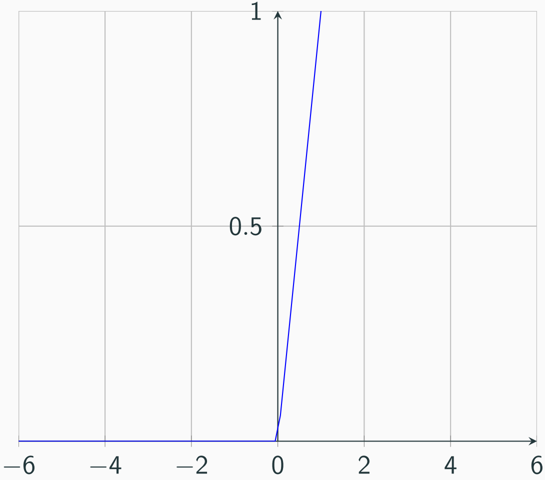
tanh Neuron

$$\sigma(z) \equiv \tanh(x)$$



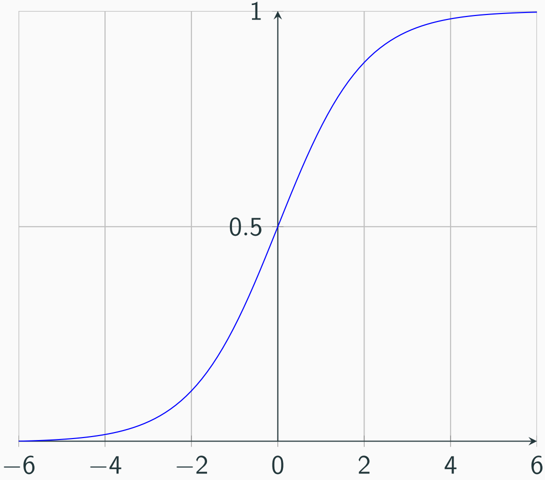
ReLU Neuron

$$\sigma(z) \equiv max(0, z)$$

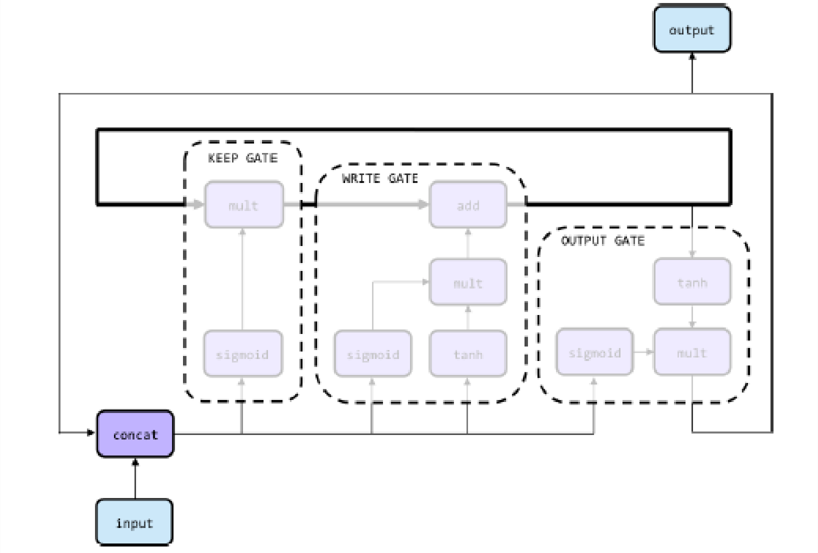


Sigmoid Neuron

$$\sigma(z) \equiv \frac{1}{1 + e^{-z}}$$



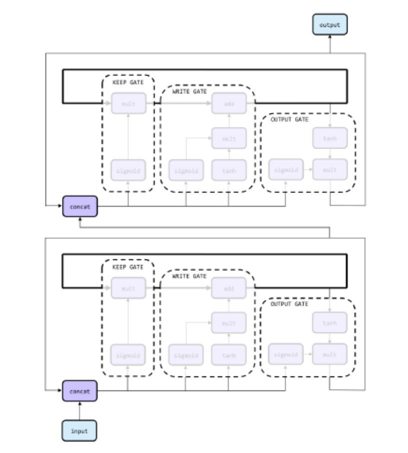
LSTM



output
KEEP GATE
mult
sigmoid
WRITE GATE
add
mult
sigmoid
tanh
OUTPUT GATE
tanh
sigmoid
mult
concat
input

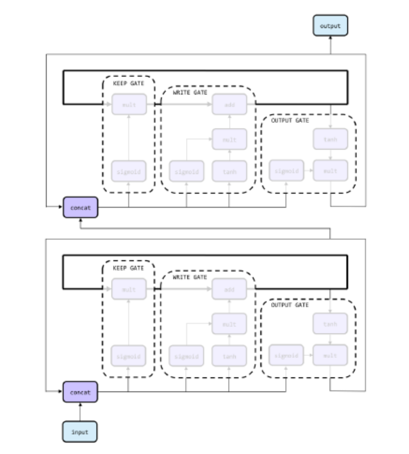
Neural Network

- Feed forward Neural Networks



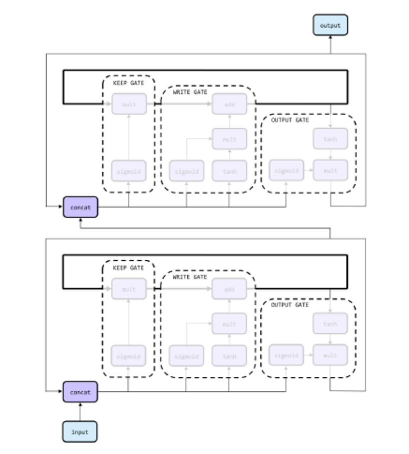
Neural Network

- Feed forward Neural Networks
- Recurrent Neural Networks



Neural Network

- Feed forward Neural Networks
- Recurrent Neural Networks
  - Long short term memory RNN (LSTM)



Algorithm

Require: Vehicles encapsulate position, motion and velocity in beacons
Ensure: Serving node has not changed after every update interval.
  if New beacon received **then**
  Find Closest node
    if $Receivedposition \neq Predictedposition$ **then**
  Beamforming: Align beam based on received position
    else
  Predict current position of vehicle
  Beamforming: Align beam based on predicted position
    end if
  end if

Merits

Higher SNR

Interference avoidance and rejection

Higher network efficiency

Questions?