Neural Networks made ridiculously simple

Brendan Clarke, NHS Education for Scotland, brendan.clarke2@nhs.scot

09/08/2024

KIND Learning Network

Welcome

- this session is  - a beginner-friendly introduction
- we'll get going properly at 13.05
- if you can't access the chat, you might need to join our Teams channel: tinyurl.com/kindnetwork
- you can find session materials at tinyurl.com/kindtrp

KIND Learning Network
NHS Education for Scotland

The KIND network

- a social learning space for staff working with **k**nowledge, **i**nformation, and **d**ata across health, social care, and housing in Scotland
- we offer social support, free training, mentoring, community events, …
- Teams channel / mailing list

KIND Learning Network

KIND training sessions

Session	Date	Area	Level
Hacker Stats (AKA Resampling Methods)	14:00-15:00 Wed 14th August 2024	R	🌶🌶🌶 : **advanced-level**
Flexdashboard	13:00-14:30 Thu 15th August 2024	R	🌶🌶 : **intermediate-level**
Excel first steps	09:30-10:30 Tue 3rd September 2024	Excel	🌶 :**beginner-level**

KIND Learning Network
NHS Education for Scotland

What’s this session for?

- neural nets are a core technology for AI/ML systems
- they’ve been around for decades (and probably will go on for decades)
- they’re also particularly helpful for health & care folk as a way of understanding AI/ML tools in general

What this session won’t do

- give a general introduction to AI/ML
- explain how to build a neural net of your very own
- discuss in any detail the (often formidable) maths of neural nets

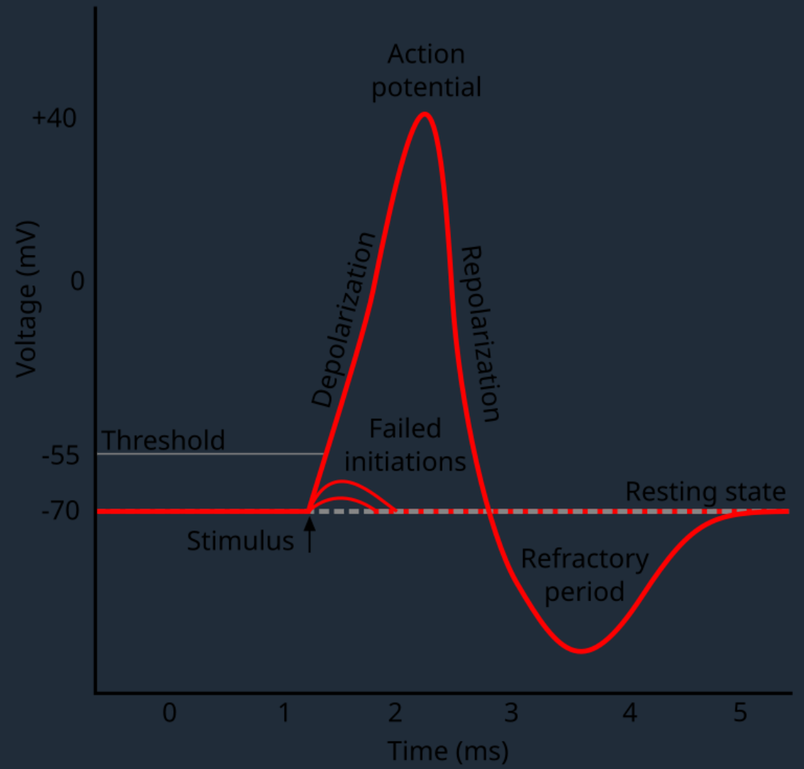
KIND Learning Network
NHS Education for Scotland

Biology: the neurone

KIND Learning Network
NHS Education for Scotland

Biology: activation

KIND Learning Network
NHS Education for Scotland



- neurones respond to stimulii
  - threshold-y
  - approximately digital output (on/off)
  - sometimes complex behaviour about inputs

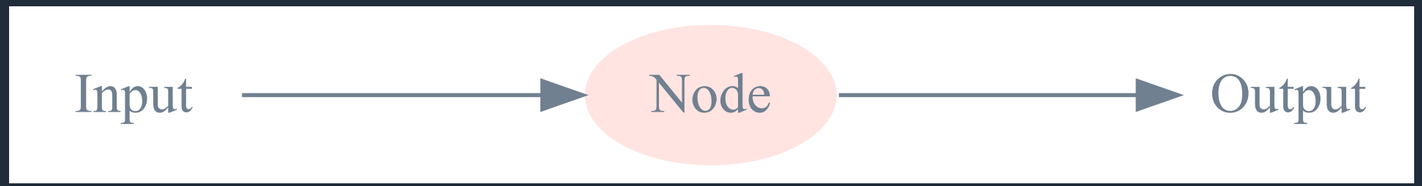
https://upload.wikimedia.org/wikipedia/commons/thumb/4/4a/Action_potential.svg/778px-Action_potential.svg.png

Biology: networks of neurones

KIND Learning Network
NHS Education for Scotland

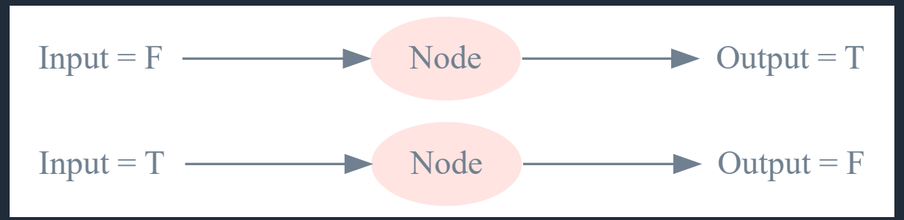
Machines: the node

Here’s a simple representation of a node, implemented in code, that we might find in a neural network:



Machines: activation functions

Here are some example input:output pairs for our node:



- there are lots of possible activation functions
- a simple one: NOT
  - our node outputs TRUE when we input FALSE, and vice versa

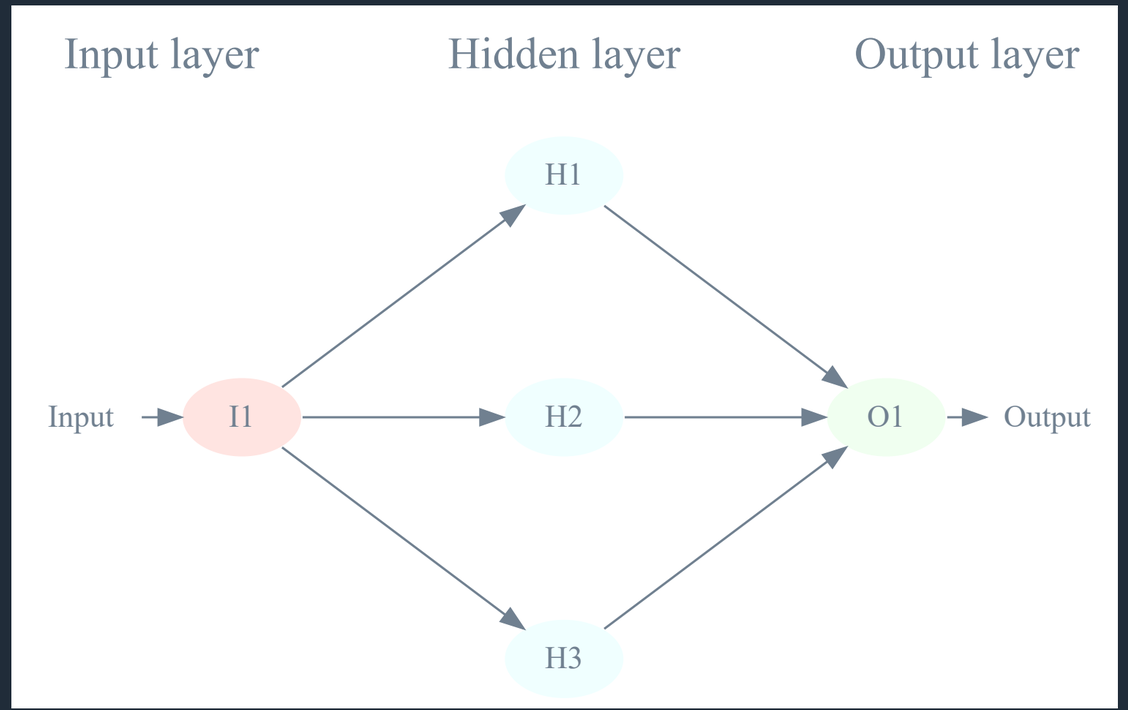
bit of code - nothing fancy!

```
1 node <- function(input){
2   !input
3 }
4
5 node(TRUE)
```

[1] FALSE

KIND Learning Network
NHS Education for Scotland

Machines: networks of nodes



KIND Learning Network
NHS Education for Scotland

Machines: networks of nodes

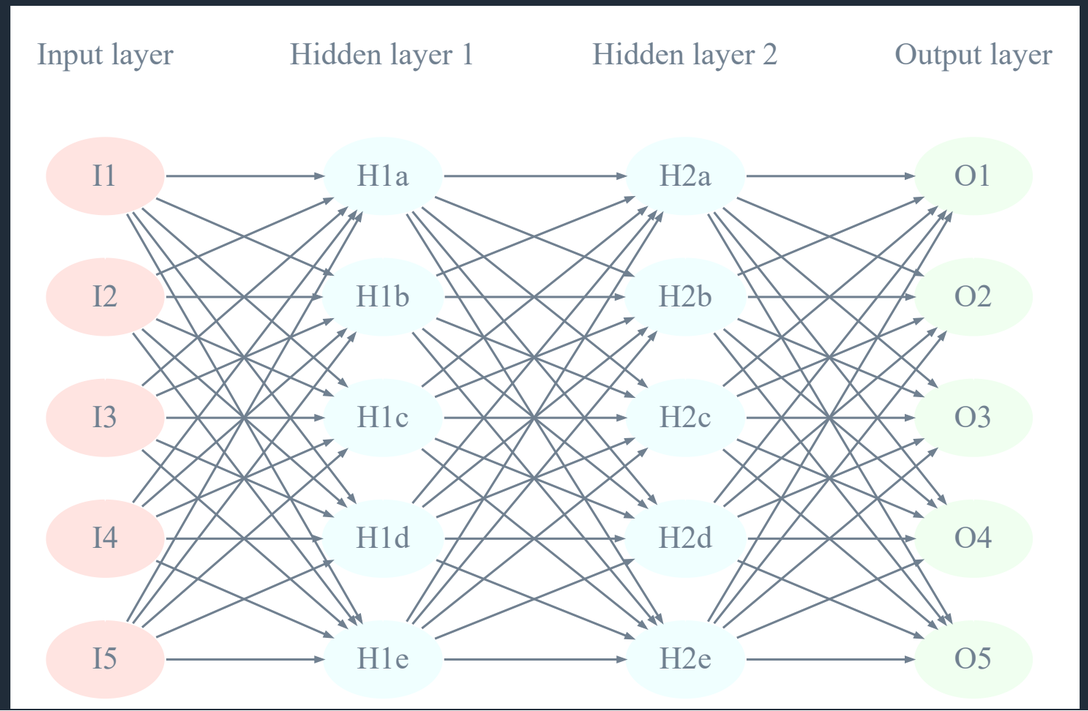
KIND Learning Network
NHS Education for Scotland

Several kinds of networks

- there are lots of ways that neural networks can be arranged
- our example above = feed-forward
  - all the nodes are connected from left-to-right
- but more complex architectures - like recurrent neural networks - might have feedback looks and other biological-ish features
- different numbers of layers
- lots of different design tendencies since the first intro of neural nets in the 1950s (Rosenblatt 1958)
- most fancy ANNs are currently architecturally simple

Why ANNs?

- ANNs can can potentially replicate *any* input-output ransformation
- we do that by a) increasing complexity and b) allowing them to ‘learn’

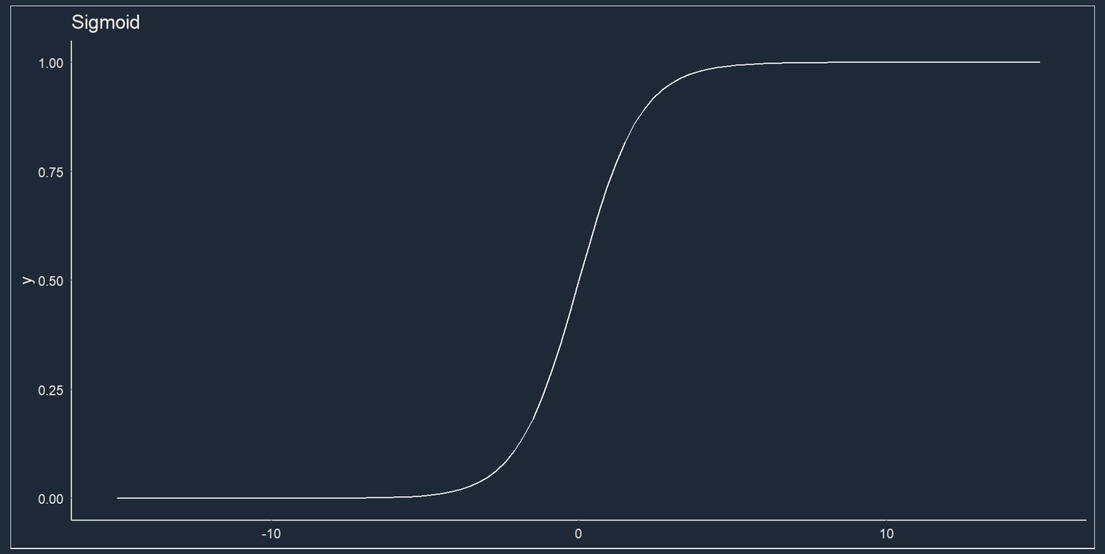


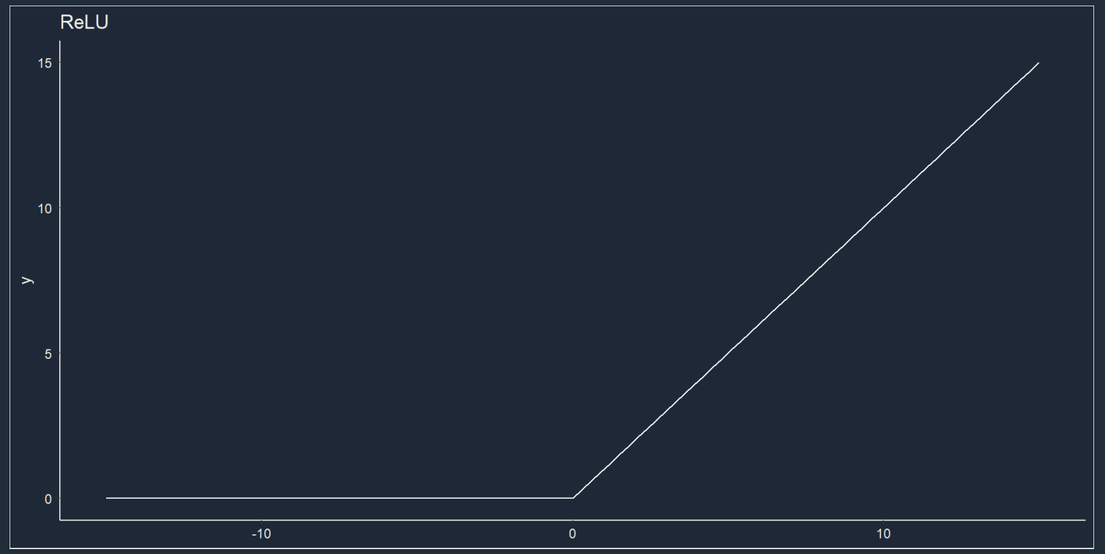
KIND Learning Network
NHS Education for Scotland

A more complex feed-forward neural network

Different activation functions

- binary (true/false)
- continuous
  - linear
  - non-linear (like sigmoid, ReLU)



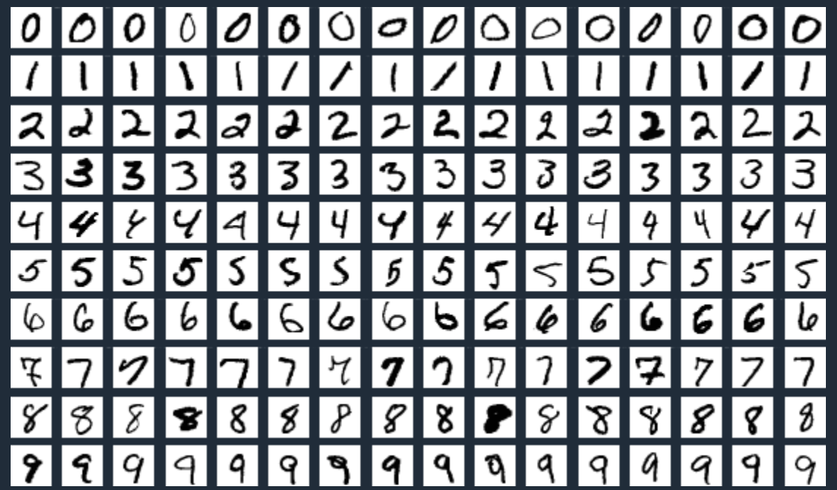


Training in neural networks

- ANNs can be trained
  - take a dataset
  - split it into training and test parts
    - classify (by hand) the training data
  - then train
    - feed your ANN the training data and evaluate how well it performs
    - modify the ANN based on that evaluation
    - repeat until done/bored/perfect
  - finally, test your model with your unlabelled test data and evaluate

MNIST

- a classic dataset



- recognizing handwritten numbers = actually-important task
- 60000 labelled training images
- 10000 test images
- each is a 28*28 pixel matrix grey values encoded as 0-255

MNIST data example

V10	V11	V12	V13	V14	V15	V16	V17	V18	V19	V20
0	0	0	0	0	0	0	0	0	0	0
0	0	0	3	18	18	18	126	136	175	26
36	94	154	170	253	253	253	253	253	225	172
253	253	253	253	253	253	253	253	251	93	82
253	253	253	253	253	198	182	247	241	0	0
156	107	253	253	205	11	0	43	154	0	0

Train for MNIST

- take your training data
- put together a neural network (number of nodes, layers, feedback, activation functions)
- run the training data, and evaluate based on labelling
- modify your neural network, rinse, and repeat
- …
- when happy, try the unlabelled test data

MNIST examples

- lots of different examples
- why do this?
  -

MNIST in R

An aside here for the R enthusiasts - we can plot the handwritten numbers back out of the data using `ggplot()`:

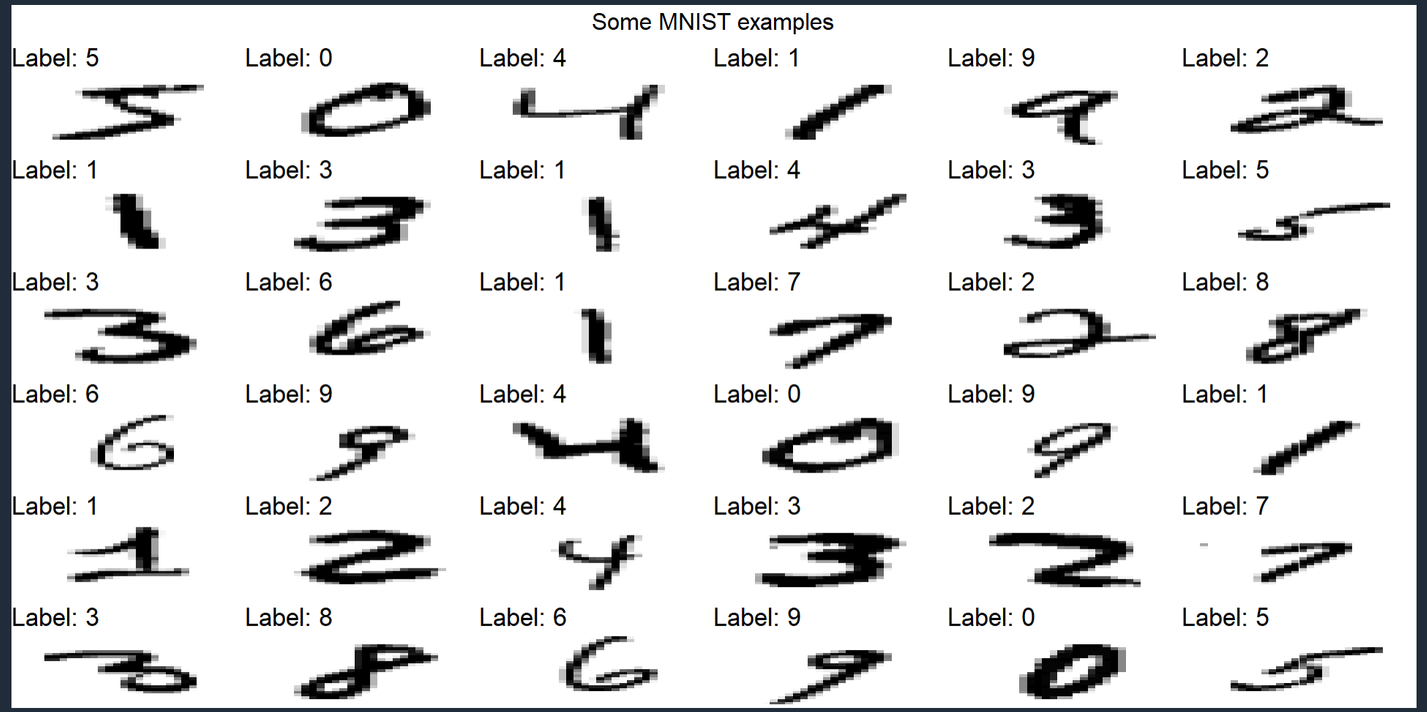
```r
mnist_plot_dat <- function(df) {
   # matrix to pivoted tibble for plotting
  df |>
      as_tibble() |>
      mutate(rn = row_number()) |>
      pivot_longer(!rn) |>
      mutate(name = as.numeric(gsub("V", "", name)))
}

mnist_main_plot <- function(df) {
  df |>
    ggplot() +
    geom_tile(aes(
      x = rn,
      y = reorder(name,-name),
      fill = value
    )) +
    scale_fill_gradient2(mid = "white", high = "black")
}
```

KIND Learning Network

NHS Education for Scotland

MNIST in R



Feedback

- please can I ask for some feedback - takes less than a minute, completely anonymous, helps people like you find the right training for them

Session	Date	Area	Level
Hacker Stats (AKA Resampling Methods)	14:00-15:00 Wed 14th August 2024	R	🌶🌶🌶 : **advanced-level**
Flexdashboard	13:00-14:30 Thu 15th August 2024	R	🌶🌶 : **intermediate-level**
Excel first steps	09:30-10:30 Tue 3rd September 2024	Excel	🌶 :**beginner-level**

Rosenblatt, Frank. 1958. “The Perceptron: A Probabilistic Model for Information Storage and Organization in the Brain.” *Psychological Review* 65 (6): 386.

KIND Learning Network
NHS Education for Scotland