Recurrent neural networks (RNN)

Applications

- document classification
  - sentiment analysis
  - author identification
  - plagiarism detection
  - ...
- token classification
  - POS tagging
  - NER
  - ...
- machine translation

ignore the output of all the step except the last step

look at the output at every step (at every step we have all the information from the sequence that came before)

Problems

- want to incorporate context
- inputs are not fixed length
    - and *cannot* be - the data has theoretically unbounded information content
- outputs are not fixed length
- outputs are not necessarily 1-to-1 with inputs

Concept

we don’t want to assume a bag words model(sequence matters!) we need to be able to get all of he information into the network)

1. Run a FFNN for the first input
2. Take the output and concatenate it with the second input
3. Run a second FFNN for the augmented second input
    - except, make them the same FFNN
4. Repeat for the entire sequence of inputs

Simple RNN

- "input" of size N
- "message" of size M
- "output" of size P
- single matrix of update weights $(N + M) \times M$
    - this is sometimes split into two
- single matrix of output weights $(N + M) \times P$
    - this is sometimes split into two

How is this legal?

- "unrolling"
- BPTT

Manual FFNN example

https://www.draw.io/

Exercise

Design an RNN that operates on word sequences from the vocabulary:
["good", "bad", "uh"].
Its output at each position should be the cumulative net sentiment $s = n_{good} - n_{bad}$.