Neural networks

Natural language processing - tree inference
Topics: recursive neural network (RNN)

- Idea: recursively merge pairs of word/phrase representations

- We need 2 things
  - a model that merges pairs of representations
  - a model that determines the tree structure

Socher, Lin, Ng and Manning, 2011
RECURSIVE NEURAL NETWORK

**Topics:** recursive neural network (RNN)

- Given two input representations \( c_1 \) and \( c_2 \), the recursive network computes the merged representation \( p \) as follows:

  \[
  s = W^{\text{score}} p \\
  p = f(W[c_1; c_2] + b)
  \]

- The network also computes a score \( s \)
  - it estimates the quality of the merge
  - it will be used to decide which pairs of representations to merge first

...
**RECURSIVE NEURAL NETWORK**

**Topics:** recursive neural network (RNN)
- The score of the full tree is the sum of all merging scores

**Parse tree**

```
  “The” “cat” “is” “here”
```

**Recursive network**

```
Score: \[ S_{(1,2)} + S_{(3,4)} + S_{((1,2),(3,4))} \]
**Topics:** recursive neural network (RNN)

- The score of the full tree is the sum of all merging scores

**Score:** $s_{(1,2)} + s_{((1,2),3)} + s_{(((1,2),3),4)}$
**Topics:** recursive neural network (RNN)

- Approximate best tree by locally maximizing each subtree

```
  A[1,4]
 /   \
   /   /   \
```

"The" "cat" "is" "here"
**Topics:** recursive neural network (RNN)

- Approximate best tree by locally maximizing each subtree
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**RECURSIVE NEURAL NETWORK**

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RECURSIVE NEURAL NETWORK

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```
\begin{align*}
S_{(1,2)} & + A_{[1,2]} \\
S_{(1,2)} & + A_{[1,2]} \\
S_{(1,2)} & + A_{[1,2]} \\
S_{(1,2)} & + A_{[1,2]} \\
S_{(2,3)} & + A_{[2,3]} \\
S_{(2,3)} & + A_{[2,3]} \\
S_{(2,3)} & + A_{[2,3]} \\
S_{(2,3)} & + A_{[2,3]} \\
S_{(3,4)} & + A_{[3,4]} \\
S_{(3,4)} & + A_{[3,4]} \\
S_{(3,4)} & + A_{[3,4]} \\
S_{(3,4)} & + A_{[3,4]} \\
\end{align*}
```

“The” “cat” “is” “here”
Topics: recursive neural network (RNN)

• Approximate best tree by locally maximizing each subtree

The "cat" "is" "here"
**Topics:** recursive neural network (RNN)

- Approximate best tree by locally maximizing each subtree
RECURSIVE NEURAL NETWORK

Topics: recursive neural network (RNN)

• Approximate best tree by locally maximizing each subtree

```
\  \  /  /  /
S_{(1,2),3}+A[1,2] S_{(1,2,3)}+A[1,3] S_{((1,2),3),(2,3),(4)}
\ /  \  \  /  /
\  /  /
S_{(1,3),2}+A[2,3] \  \  \  /
```

"The" "cat" "is" "here"