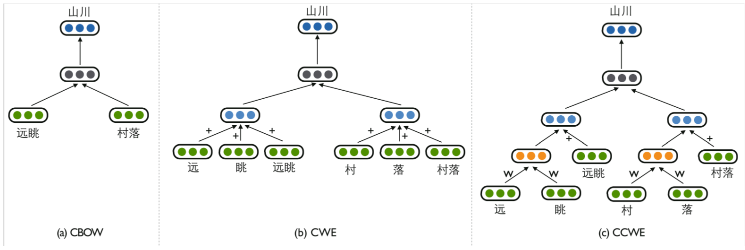
20170928

Original Hypotheses

- We can avoid maintaining a dictionary by man power
- We can catch more out-of-vocabulary words
- Chinese in character unit can have meanings
- We can find out valid 2-character words from frequency information

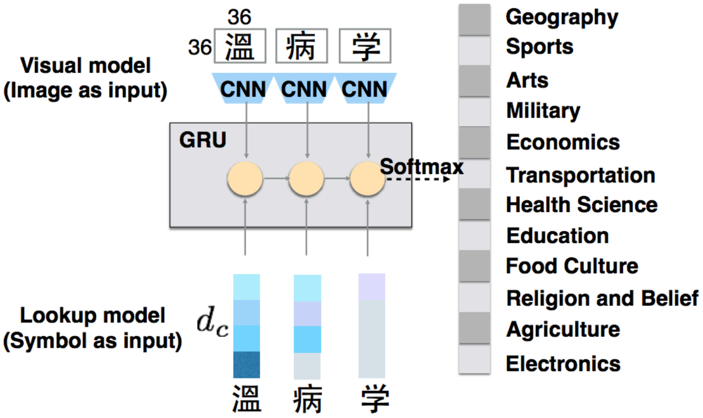
Related work

1. Morpheme & character-based word embeddings
   - English
     - **Better Word Representations with Recursive Neural Networks for Morphology**, CoNLL 2013
     - **Compositional Morphology for Word Representations and Language Modelling**, ICML 2014
   - Chinese
     - **Joint Learning of Character and Word Embeddings**, IJCAI 2015
       - Internal characters + external contexts (`CWE`)
     - **Improved Learning of Chinese Word Embeddings with Semantic Knowledge**, CCL 2015 & NLP-NABD 2015
       - New composition functions using the semantic relations between characters (instead of addition) (`CCWE`)



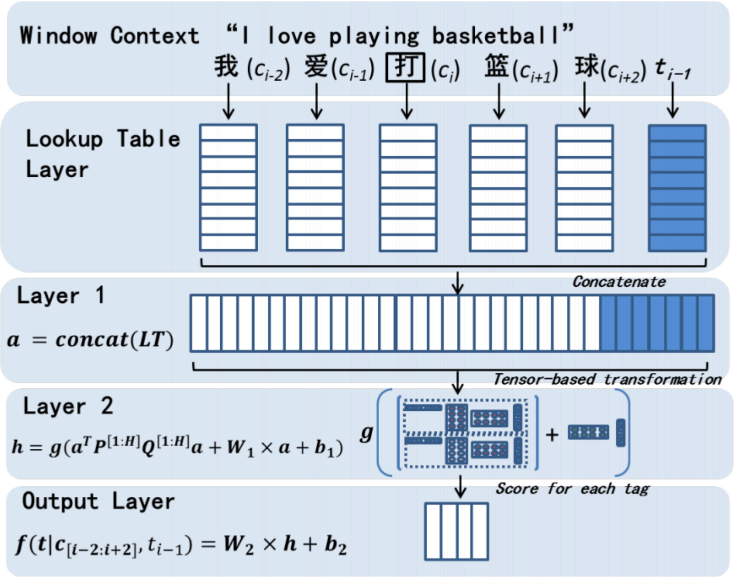
(a) CBOW (b) CWE (c) CCWE

     - **Learning Character-level Compositionality with Visual Features**, ACL 2017
       - Adding shape of characters as feature



2. Chinese segmentation
   - Summery
     - Purely dictionary-based
     - Purely statistical approach
     - Statistical dictionary-based
     - Supervised machine-learning
     - Neural network models
   - Papers
     - **Chinese Word Segmentation as Character Tagging**, IJCLCLP 2003
     - **HHMM-based Chinese lexical analyzer ICTCLAS**, SIGHAN 2003
     - **Chinese Segmentation and New Word Detection using Conditional Random Fields**, COLING 2004
       - Statistical sequence modeling framework
     - **Character-Level Dependencies in Chinese: Usefulness and Learning**, EACL 2009
       - Character-level dependency can be a good alternative to word boundary representation for Chinese

- **Parsing the Internal Structure of Words: A New Paradigm for Chinese Word Segmentation**, HLT 2011
- **Chinese Parsing Exploiting Characters**, ACL 2013
  - Parsing character-level syntax trees for jointly performing word segmentation, POS tagging & parsing, using a CKY-style or shift-reduce algorithm
- **Max-Margin Tensor Neural Network for Chinese Word Segmentation**, ACL 2014
  - Explicitly models the interactions between tags & context characters by exploiting tag embeddings and tensor-based transformation (`MMTNN`)


Window Context "I love playing basketball"
我 (c_{i-2}) 爱(c_{i-1}) 打 (c_i) 篮(c_{i+1}) 球(c_{i+2}) t_{i-1}
Lookup Table Layer
Concatenate
Layer 1
$a = concat(LT)$
Tensor-based transformation
Layer 2
$h = g(a^T P^{[1:H]} Q^{[1:H]} a + W_1 \times a + b_1)$
g
+
Score for each tag
Output Layer
$f(t|c_{[i-2:i+2]}, t_{i-1}) = W_2 \times h + b_2$

- **Segmentation-Free Word Embedding for Unsegmented Languages**, EMNLP 2017
  - Training word embeddings on **word co-occurrence statistics** & **frequent character n-grams**

Proposed method

1. Train character embeddings
   - Is context-enhanced model still meaningful?
   - Component information, word context, etc.
2. Cluster results
3. Learn word list by counting
4. Build connections between words
5. Observe cluster-to-cluster connections
   - Linguistics knowledge?
   - Not semantically compositional Chinese words?
     - Transliterated words, single-morpheme multi-character word (聯綿詞), entity names, etc.
   - If not exhaustive enough, should we enhance with dictionaries?
6. Apply to Chinese word segmentation
   - Graphical knowledge or statistical knowlege?
   - Sequence labelling on **spaces between characters** as `SEG`/`NON-SEG`?

Goals

- Avoid maintaining a dictionary by man power
- Catch more out-of-vocabulary words
- Embedding-based word segmentation
- Linguistic knowledge observation from patterns of distributed character representations

Difficulties

- Long studied topic with high-accuracy baselines
- New attempt, feasibility unknown
- Lack of experience