Project 2:
Language Learning Using Hypernetworks

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• Language Learning using Hypernetworks
• Data set for Language Learning
• Tool for Hypernetworks
• Guide to Writing Reports
  – Style, mandatory contents, optional contents
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Outline

• Goal
  – Understand Hypernetworks & machine learning deeper
  – Practice research and technical writing

• Language Learning (sentence completion)
  – The problem is to predict each word in a sentence based on surrounding words
  – Consider each word as an attribute and train a Hypernetwork with sentences

• Data Set
  – Sentences from ‘Friends’ and BBC documentary
Brief Introduction to Hypernetworks

• Hypernetworks
  – Representation and learning method based on weighted hypergraph
  – Generate hyperedges with sampling and manage a library of weighted hyperedges
  – Learning strategy
    • (explained in pp. 5~8)


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Language Learning with Hypernetworks (1/8)

• Sentence Completion
  – We want to complete a sentence which has some missing words.
    
    I’m gonna make ? move

• How to complete the sentence?
  – Motivation: predict the blank based on the pattern of word co-occurrences in some specific corpus of sentences
Language Learning with Hypernetworks (2/8)

• **Goal : Sentence Completion**
  – Train a hypernetwork to be able to recall any sentence in the given corpus
  – To complete sentences which contain missing words with the trained hypernetwork

  – Target function to be maximized for the sentence completion problem
    • It is the accuracy in basic
    • \( f(x) := \frac{\text{number of correct answers}}{\text{number of whole tests}} \)

• **A test** : try to guess a word in a sentence with a trained hypernetwork, and compare the result with the original sentence in dataset.
  – How? (see the following page)
Language Learning with Hypernetworks (3/8)

• Learning steps
  – Sampling step
    • Randomly choose \( n \) words in each sentence while preserving the order of words.
    • Repeat \( m \) times to get samples per sentence
    • \{\( (1,2,3,4,5,6), (n, m=3) \)\} \( \equiv \) \( (1,3,4), (2,3,5), (4,5,6) \)
  – Weight update step
    • Guess each word with the current Hypernetwork.
Language Learning with Hypernetworks (4/8)

• Learning steps
  – Weight update step(con’t)
    • Weight update
      – Test every word with current Hypernet
      – If correct : do nothing
      – If incorrect
        » Add a constant score (weight update rate) for every related hyperedges.
        » If some hyperedges are not exist in the HN, regard their score as 0
Language Learning with Hypernetworks (5/8)

• How to complete the sentence?
  – Hypernetworks: set of hyperedges with weights
  
  – Assume HN={ (1,2,3 : 3), (2,3,4 : 1), (1,2,4 : 5) }
  
  – Guess (1,2,?,?,4) : see following pages
    • (1,2,3 : 3), (2,3,4 : 1) : score(3) = 4
    • (1,2,4 : 5) : score(4) = 5
    • We assume unknown word as ‘4’ with highest score, 5
Language Learning with Hypernetworks (6/8)

• Sentence Completion

I’m gonna make ? move

make you move

make Tom move

gonna make you

hyperedges in a library
Language Learning with Hypernetworks (7/8)

3 : 1.5
4 : 1.0 + 1.3
6 : 1.6

Answer → 4!!
Language Learning with Hypernetworks (8/8)

- We can also analyze word associations.

- We can enumerate the associativity of words based on the following features of hypernetworks:
  - the co-occurrence of words in a hyperedge
  - the weight of the hyperedge

- For example
  - 4 is associated with
    - 2 with weight 1.0
    - 3 with weight 2.3 (1.0 + 1.3)
    - 5 with weight 1.3

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Data Set (Friends & BBC)

- English sentences from movie subtitles

- Friends
  - Well known TV situation comedy
  - Captions from Season 1~10
  - 5,000 sentences

- BBC Documentary
  - Captions from three series on space, bird, and wild
  - 5,000 sentences
Data Set (cont’d)

• Each sentence is translated to integer form based on dictionary file.
  • “This is not even a date”
  • $\rightarrow$ “33,34,35,36,27,37”

• Experiment with
  – friends_training.cvs, bbc_training.csv

• Original sentence file
  – friends_original.txt, bbc_original.txt
Tool For Hypernetworks

• Language Game (for this project)
  – Sentence Completion
  – Language Classification
  – Word Association

• Multimodal Game
  – Language to Image Generation
  – Image search using language query
Report Contents – Mandatory (1/2)

• System description
  – Used software and running environments

• Result graphs and tables
  – Do several experiments and calculate average & standard deviations

• Analysis & discussion
  – Very Important
Report Contents – Mandatory (2/2)

• Basic experiments
  – Draw learning curves for each training set
    • Graph type 1: accuracy vs. epoch, with orders of hyperedges ex) 3, 4, 5
    • Graph type 2: accuracy vs. epoch, with different weight update parameters ex) 0.01, 0.1, 0.5, 1, 2, 5, 10
      – Note: initial weight is assigned as 1.0 for each hyperedge
  – Comparison between two training sets
    • Graph type 3: learning curves for Friends and BBC sentences in one graph
Report Contents – Optional

• Various experiments and analyses
  – Comparing learning curves
    • w/ various setting (varying order & update parameters & training data)
  – Comparing word associations
    • w/ different training set

– Comparing sentence completion results
  • w/ different training set
  • Test (1,2,?,?,4) (find out suitable queries)
    – For training set A: ? = 3
    – For training set B: ? = 5, why?
Reports Style

- **English only**, Scientific journal-style
  - How to Write A Paper in Scientific Journal Style and Format
    [http://abacus.bates.edu/~qanderso/biology/resources/writing/HTWsections.html](http://abacus.bates.edu/~qanderso/biology/resources/writing/HTWsections.html)

### Experimental process

<table>
<thead>
<tr>
<th>What did I do in a nutshell?</th>
<th>Abstract</th>
</tr>
</thead>
<tbody>
<tr>
<td>What is the problem?</td>
<td>Introduction</td>
</tr>
<tr>
<td>How did I solve the problem?</td>
<td>Materials and Methods</td>
</tr>
<tr>
<td>What did I find out?</td>
<td>Results</td>
</tr>
<tr>
<td>What does it mean?</td>
<td>Discussion</td>
</tr>
<tr>
<td>Who helped me out?</td>
<td>Acknowledgments (optional)</td>
</tr>
<tr>
<td>Whose work did I refer to?</td>
<td>Literature Cited</td>
</tr>
<tr>
<td>Extra Information</td>
<td>Appendices (optional)</td>
</tr>
</tbody>
</table>
Submission Guide

• Due date: May 27, 13:00

• Submit both ‘hardcopy’ and ‘email’
  – Hardcopy submission to the office (301-417)
  – E-mail submission to ykko@bi.snu.ac.kr
    • Subject: [AI Project2 Report] Student number, Name
  – Length: report should be summarized within 12 pages.
  – If you build a program by yourself, submit the source code with comments

• Objective: NOT the accuracy and your programming skill, but your creativity and research ability.

• Individual project! You have to do it by yourself.
Marking Scheme

• 40 points for experiment & analysis
  – Extra 3 points per additional experiment
• 20 points for the report
• 6 points for overall organization
• Late work
  – (- 10%) per one day (8 points)
  – Maximum 7 days
Demo – How to Start

• Execute: MemoryGame_2.0.exe
Setting data and parameters

Load Training File
- friends_training.csv
- or BBC_training.csv

Set learning parameters
- Order
- Epoch
- WeightUpdateRate
Do Learning - Completion

Choose the Objective of Learning: Either Completion (Association)

Warning: it takes much time
Test (sentence completion)

Sentence Completion

Query with only one blank

Result

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Learning for Completion

Word Association

Query with only one word

Association result

i – word
1.900000 – weight sum (strength)
Reset

Remove trained model and File list
If you want to save result, "result.txt" in same the folder.
Warning!!

• Program path can not have any Korean or other language except English
  – “C:\Documents and Settings\바탕 화면\MemoryGame2.0”
    • Not accepted.
  – “C:\Documents and Settings\MemoryGame2.0”
    • It’s OK.

• Current program does not allow making new training files
  – Dictionary file is fixed.
  – If you want to, make dictionary file too.

• If you have any question about the program, visit the office 301-417 (Tel. 880-1835)
  – Youngkil, Ko (ykko@bi.snu.ac.kr)