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CS 4328

PARALLEL COMPUTING IN NATURAL LANGUAGE PROCESSING

Natural Language Processing

- Attempt to process language like humans
- Natural language processing: receives and analyzes
- Natural language generating: performs function on given text

Natural Language Processing

- Machine Translation was first area of research in NLP. Suggested by Warren Weaver
- Flaws in solely rearranging dictionary words
- Resulted in syntactic structures, grammars, parsing algorithms, speech recognition

NLP levels of language

- **Phonology**: audible sounds
- **Morphology**: prefixes, root, suffixes etc.
- **Lexical**: lexicon, arguments and classes
- **Syntactic**: grammar, parsing
- **Semantic**: use of sentence to solve disambiguation
- **Discourse**: sentences as functions
- **Pragmatic**: outside of text, real world knowledge

NLP approaches

- **Statistical:** probability, collections of language data and statistical data
- **Symbolic:** rules and logic of language, facts, rule-base, semantic networks, decision trees
- **Connectionist:** statistical models + representation
- all approaches are viable

Uses for NLP

- Information retrieval
- Information extraction
- Summarization
- Dialogue systems

Parallel cost efficiency

- Parallel systems don't always achieve linear speedup
- Costup won't likely reach linear (parallelizing a job rarely requires m x p)

Parallel cost efficiency

$$\text{speedup}(p) = \frac{\frac{1}{time(p)}}{\frac{1}{time(1)}} = \frac{time(1)}{time(p)}$$

$$\text{costup}(p) = \frac{cost\ p}{cost(1)}$$

$$\text{cost/performance} = \frac{cost(p)}{1/time(p)}$$

$$\text{speedup}(p, m, m') = \text{time}(1,m)/\text{time}(p, m')$$

$$\text{costup}(p, m, m') = \text{cost}(p, m')/\text{cost}(1, m)$$

Parallel cost efficiency

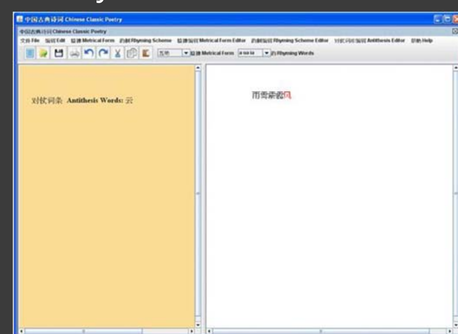
$$\text{cost}(1, m) = f(1) + g(m),$$

$$\text{cost}(p, m') = f(p) + g(m')$$

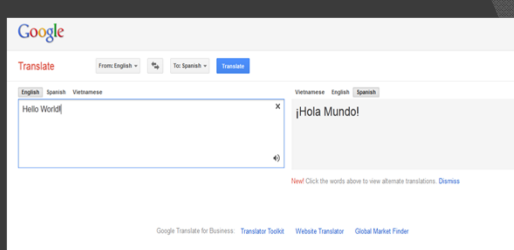
$$\text{costup}(p, m, m') = \frac{f(p) + g(m')}{1 + g(m)}$$

$$\text{costup}(p, m, m') = \frac{f(p) + 1}{1+1} = \text{costup}(p, m, m') = \frac{f(p)}{2} + \frac{1}{2}$$

Poetry Wizard



Google Translate



Rule-based translation

- Uses existing language rules
- Tree structures break down sentences
- Logic forms
  - Example: (< PAST HAPPY> (NAME j1 "Joe"))

Anaphora

- Anaphora resolution couples anaphor and antecedant
- Example: “Joe is not yet here but he is expected to arrive in the next one hour.”
- Requires knowledgebase

Parallel decision trees

- Can use numerous lightweight posix threads
- Thread scheduler to control threads
- Two levels of parallelization
  - Parallelize building of tree
  - Quicksort data into nodes
- High level for scheduler

Conclusion

- Parallel systems more efficient with large memory – NLP is good candidate
- NLP requires processing large amounts of information, various functions, need to think about speed