Feature Functions

Hieu Hoang
Matthias Huck

December 2014

Feature Function

- Calculate score(s) for a translation rule
  - Partial translation
  - Completed translation
- Examples
  - Phrase table
  - Language model
  - Word penalty
  - Phrase penalty
- Many feature functions
  - Weighted linear combination
- What is a translation?
  - Made of multiple ***translation rules***

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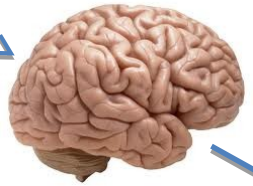
Timeline of a Translation Rule

File

Load

Memory



Apply to input sentence

Translation Option

Search

Hypothesis

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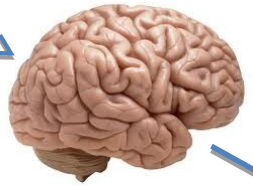
Timeline of a Translation Rule

File

Load

Source phrase
Target phrase

Memory



Apply to input sentence

Input sentence
Input path

Translation Option

Search

Translation context
Segmentation

Hypothesis

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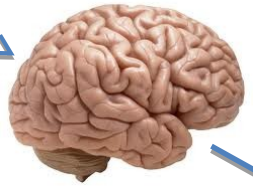
Timeline of a Translation Rule

File

Load

Once

Memory



Apply to input sentence

Per occurrence in sentence

Translation Option

Search

Per hypothesis

Hypothesis

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Feature Function API

Loading

File

Memory

je suis ||| I am

Access to: Source phrase: je suis

Target phrase: I am

```
void EvaluateInIsolation(
            source,
            target,
            scores,
            estimated future scores)
```

Feature functions that use this:

- Word Penalty
- Phrase penalty
- Language model (partial)

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Feature Function API

Apply to input sentence

Memory

Access to: Input sentence: je suis 25 ans .

Input subphrase: je suis 25

```
void EvaluateWithSourceContext(
        input,
        input path,
        target,
        scores,
        estimated future scores)
```

Translation Option

Feature functions that use this:

- Input feature
- Bag-of-word features....

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Feature Function API

Search

Translation Option

Hypothesis

Access to: Current rule (hypothesis)
Previous rules
Segmentation

Stateful features:

```
state EvaluateWhenApplied(hypo,
        previous state,
        scores)
state EvaluateWhenApplied(hypo
          previous state,
          scores)
```

Stateless features:

```
void EvaluateWhenApplied(hypo, scores)
void EvaluateWhenApplied(hypo, scores)
```

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Feature Function API

Decoding

Translation Option

Hypothesis

Feature functions that use this:

- All stateful features
  - Language models
  - Distortion model
  - Lexicalized reordering model
  - …

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Feature Function

Loading:

```
void Evaluate(source,
              target,
                  scores,
              estimated future scores)
```

Apply to Input:

```
void Evaluate(input,
        input path,
                scores)
```

Search:

Stateful features:

```
state Evaluate(hypo,
        previous state,
        scores)
state EvaluateChart(hypo
          previous state,
          scores)
```

Stateless features:

```
void Evaluate(hypo, scores)
void EvaluateChart(hypo, scores)
```

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Strange Features functions (1)

- Language model
  - implement 2 Evaluate()

1. Loading
   - evaluate full n-grams

     reprise de la session ||| resumption of the session
   - estimate future cost
     - partial n-grams
2. Search
   - evaluate overlapping n-grams

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Strange Feature Functions (2)

- Phrase-tables
- Unknown Word Penalty
- Generation Model
  - integral part of decoding process
  - Uses no Evaluate()
    - scores assign by decoder

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Extensions

- Change input
  - Add/delete word
  - Integrate parser/tagger
- Prune
  - Hard constraint
  - Negative infinity score
  - Need positive weight
    - Make FF non-tuneable

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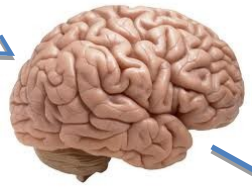
Future Extensions

File

Load

Memory



Apply to input sentence

Translation Option

Evaluate, conditioned on other translation option

Search

Hypothesis

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Feature Functions

Hieu Hoang
Matthias Huck

December 2014

Thanks for inviting me to come

Here to tell you a little about the things I've been doing to Moses
- over the past 2 years
- mainly concentrate of the past year
  - but will quickly tell you about things I did prior to that

Feature Function

- Calculate score(s) for a translation rule
  - Partial translation
  - Completed translation
- Examples
  - Phrase table
  - Language model
  - Word penalty
  - Phrase penalty
- Many feature functions
  - Weighted linear combination
- What is a translation?
  - Made of multiple ***translation rules***

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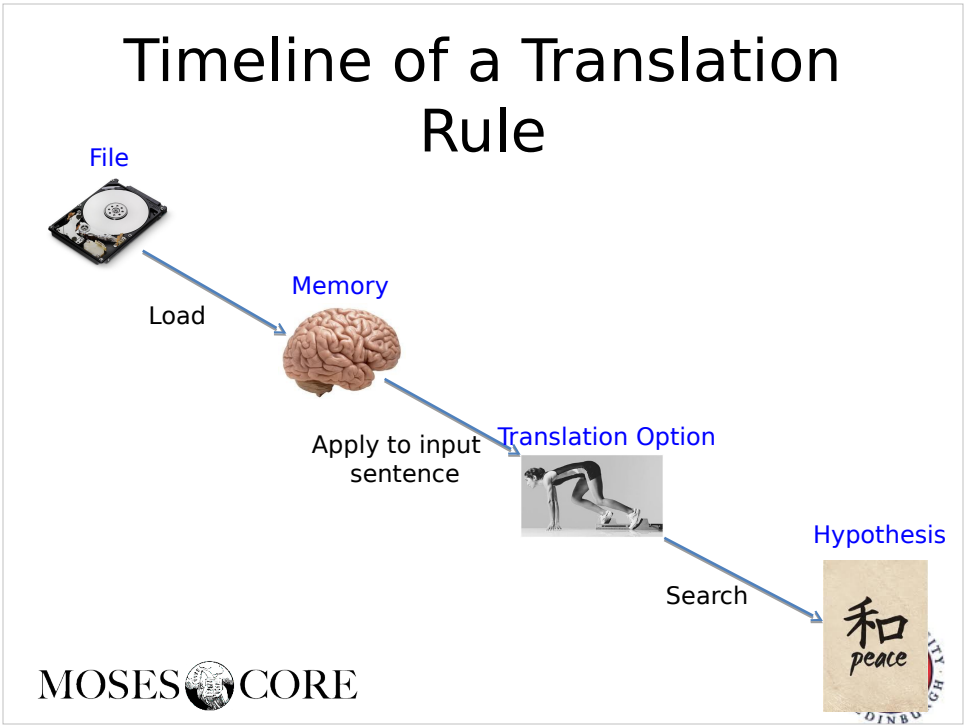
What is the task of a feature function
- it's task is to give score to a translation rule
  - the thing you see in a phrase-table
- FF calculate 1 or more scores

These are examples of FF

There can be many scores

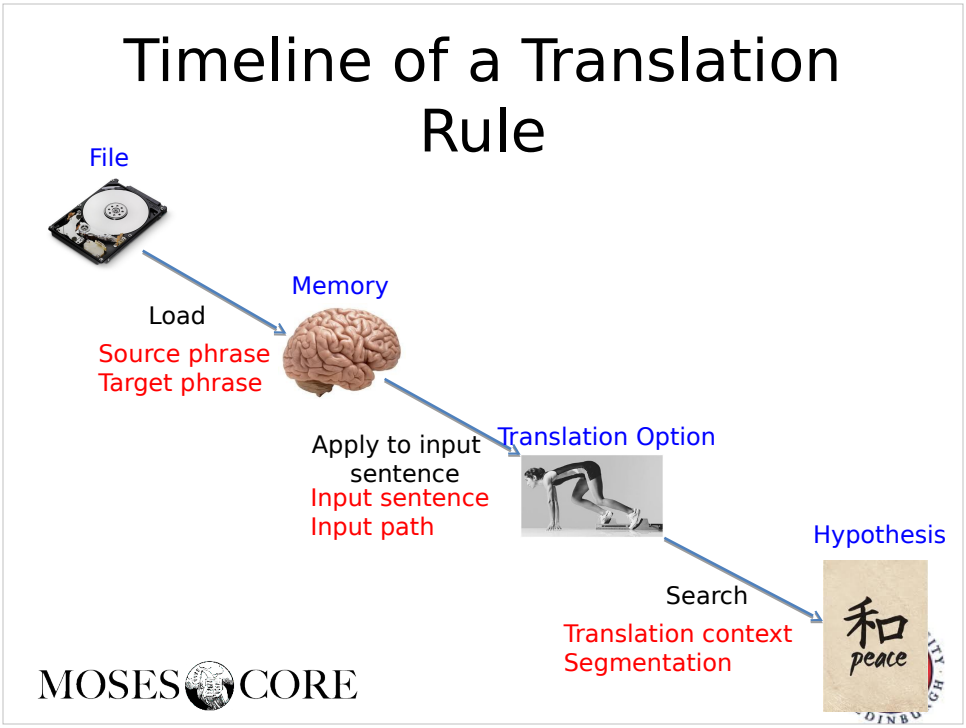
Total score for the translation
- weighted sum of all scores



Translation rule has a lifespan
- starts off in a file on disk
- gets loaded into memory

- before a sentence is decoded
  - translation rules are looked up
    - fitted to a specific place in the source sentence
  - name of translation rules
    - changes to translation option
    - all intents and purposes
      - is a trans rule

When it's being used in search
- it's name changes to hypothesis
  - again, wrapper around a translation rule



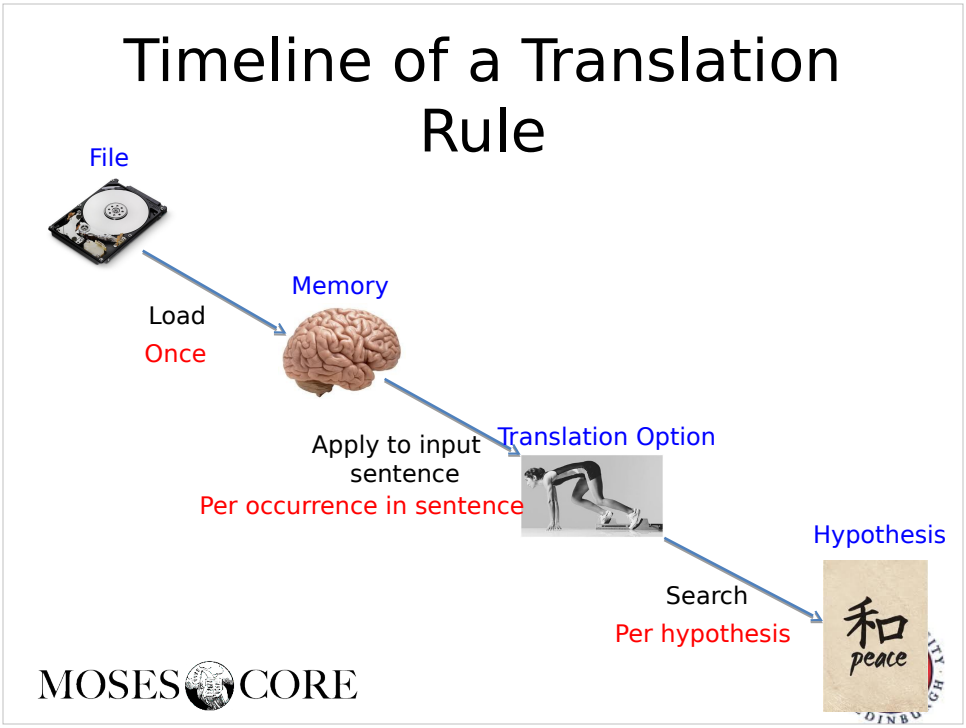
at each step
- feature function has access to different kinds of side information
  with which to score the rule

During loading
- only know what the rule is, without context

When it is being applied to a sentence
- it know the sentence

During search
- it know what other rules have been used

These are the information it can use to score



Point of showing you this timeline

sooner you caclulate it, the better

1. efficiency
   - not repeated
2. more accurate
   - each stage – subject to pruning
     - some rules are thrown away
     - if the feature function can give a good score
     - the rule can say
       ‘hey I’ll be really useful to you, don’t throw me away!”

Feature Function API

Loading

File

Memory

je suis ||| I am

Access to: Source phrase: je suis

Target phrase: I am

```
void EvaluateInIsolation(
        source,
        target,
        scores,
        estimated future scores)
```

Feature functions that use this:

- Word Penalty
- Phrase penalty
- Language model (partial)

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During load

- this is the translation rule

- If you want your FF to score the rule now
    - implement this function
    - it takes are arguments
        - source + target parts of the rule
        - you return the scores and estimated future score

Feature Function API

Apply to input sentence

Memory

Access to: Input sentence: je suis 25 ans .
Input subphrase: je suis 25

```
void EvaluateWithSourceContext(
        input,
        input path,
        target,
        scores,
        estimated future scores)
```

Feature functions that use this:
- Input feature
- Bag-of-word features....

Translation Option

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Have a sentence
- looking up rules that can be used in that sentence
- once you find a rule that can be applied
  - to a specific substring in a specific sentence
  - create translation option

At this point
- have another opportunity to evaluate the scores of the rules

Feature Function API

Search

Translation Option

Hypothesis

Access to: Current rule (hypothesis)
Previous rules
Segmentation

Stateful features:

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        previous state,
        scores)
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Stateless features:

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```

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search

when you have a translation rule
- you know exactly where it's going to be applied to
- and you actually apply it

Implement 1 of these functions

Only place where calculating the feature function is different for phrase-based or syntax models
- slightly different for stateless and stateful features

This function has access to the hypothesis

Feature Function API

Decoding

Translation Option

Hypothesis

Feature functions that use this:

- All stateful features
  - Language models
  - Distortion model
  - Lexicalized reordering model
  - ...

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all the translation rules that were used, the total output phrase segmentation

- derivation tree if hiero/syntax model

Feature Function

Loading:

```
void Evaluate(source,
              target,
                  scores,
              estimated future scores)
```

Apply to Input:

```
void Evaluate(input,
        input path,
                scores)
```

Search:

Stateful features:

```
state Evaluate(hypo,
        previous state,
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          previous state,
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```

Stateless features:

```
void Evaluate(hypo, scores)
void EvaluateChart(hypo, scores)
```

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Recap

- you can score translation rule at 3 stages in the decoding process
  - Loading
  - Appying to the input sentence
  - Search
- Implement 1 of these functions if you do

However, a FF can score the same rule in more than 1 stage

- ie. It can implement more of these functions

Strange Features functions (1)

- Language model
  - implement 2 Evaluate()
  1. Loading
     - evaluate full n-grams

       reprise de la session ||| resumption of the session
     - estimate future cost
       - partial n-grams
  2. Search
     - evaluate overlapping n-grams

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For those who know Moses

- this is nothing new
- this is the way Moses has always computed language model scores
  - if you had a trigram LM
  - store trigrams in the target phrase upon loading
  - store overlapping n-gram during search

- the new framework enable this optimisation to be used by every other feature function

Strange Feature Functions (2)

- Phrase-tables
- Unknown Word Penalty
- Generation Model
  - integral part of decoding process
  - Uses no Evaluate()
    - scores assign by decoder

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Extensions

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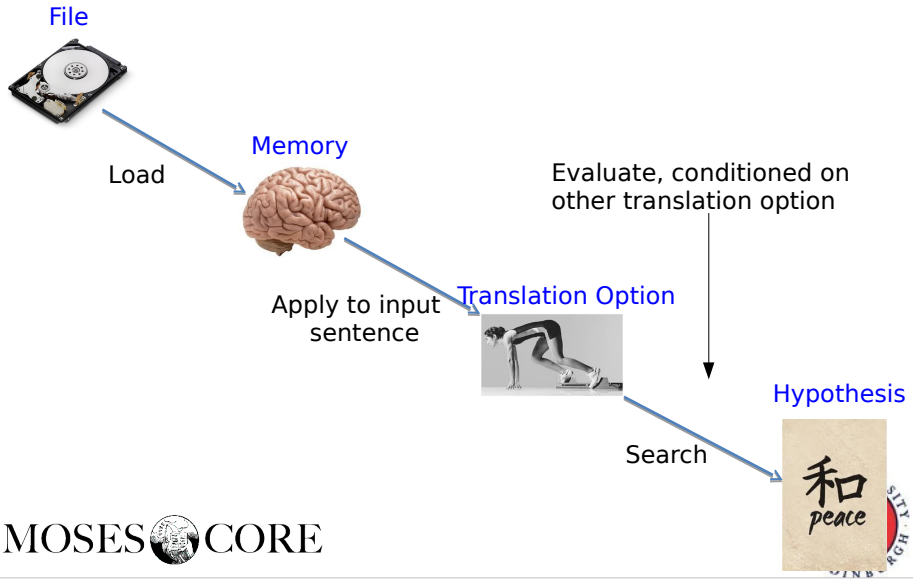
Future Extensions



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