Averaged perceptron tagger

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https://www.github.com/frankier/perceptron-tagger-slides/

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Outline

- Averaged structured perceptron with beam search
- A DSL for features
- Results for Kazakh

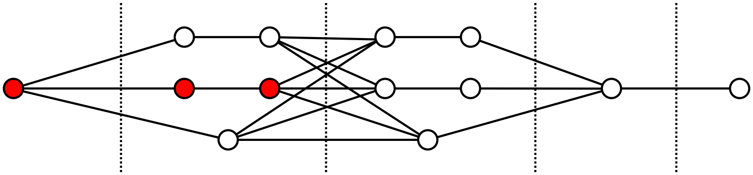
Averaged structured perceptron with beam search 1/2

- **Structured prediction** is breaking down prediction of a large structure into subproblems and using results from earlier stages in later stages (like dynamic programming). For POS tagging the simplest approach is break the problem down to per-token tagging and then tag left to right.
- **The perceptron** stores a sparse linear vector of (feature, weight) pairs. Observations are scored by taking the dot product of their feature vector with the perceptron. Training is done trying a prediction, and updating incorrect weights by reenforcing or penalising them depending on whether they correspond with the correct observation.
- With the **structured perceptron** the score from each update is accumulated to get the score of the (partial) output.

Averaged structured perceptron with beam search 2/2

- The perceptron only converges for linearly separable inputs, otherwise its weights oscilate. To get the best weights the perceptron is trained for several iterations on reshuffled observations and the **averaged** weights across the whole training period are saved as the final weights.
- With **beam search**, the n-best candidates are considered and updated at each stage as opposed to a pure-greedy strategy which would only keep one intermediate result.

Eurovision ән конкурсы 2010 .



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A DSL for features 1/3

```
spectie: How's it going?

frankier: Been coding like a maniac

frankier: I've ended up creating a sort of lisp in XML
based on a stack VM

spectie: O___O
```

A DSL for features 2/3

A DSL for features 3/3

- Greenspun's tenth rule of programming: Any sufficiently complicated C or Fortran program contains an ad hoc, informally-specified, bug-ridden, slow implementation of half of Common Lisp.
- Neither easy nor desirable to try and define every possible useful feature up front.
- Seems likely that any feature language will be subject to feature creep (pun intended) so an expression language is a reasonable starting point.
- Bytecode interpreter design is faster and more modular than a tree walking interpreter and is usually the same or less code. Also it's easy to serialise.
- Hopefully the flexibility empowers language authors more than it confuses them. (In the worst case people can just copy-paste.)

Example of DSL 1/2

```
<def-global as=''major_tag_0''>
  <subscript idx=''0''>
    <ex-tags>
      <ex-wordoid><wrdaddr /></ex-wordoid>
    </ex-tags>
  </subscript>
</def-global>

<def-global as=''is_dmorph''>
  <neq>
    <int val=''0'' />
    <wrdidx />
  </neq>
</def-global>
```

Example of DSL 2/2

```
<feat>
  <pred><var name=''is_headword'' /></pred>
  <out><var name=''major_tag_0'' /></out>
</feat>

<feat>
  <pred><var name=''is_headword'' /></pred>
  <out><var name=''lemma_0'' /></out>
  <out><var name=''major_tag_0'' /></out>
</feat>

<feat>
  <pred><var name=''is_dmorph'' /></pred>
  <out><var name=''headword_major_tag_0'' /></out>
  <out><var name=''major_tag_0'' /></out>
</feat>
```

Results for Kazakh 1/2

Sample mean + std-dev from 10-fold cross validation.

	Acc	Adj acc
0-gram	72.08%	77.72%
CG->0-gram	81.56%	87.95%
Best unigram	$82.45 \pm 3.80\%$	$88.99 \pm 2.83\%$
CG->Best unigram	$84.71 \pm 3.54\%$	$91.43 \pm 2.26\%$

Results for Kazakh 2/2

No lt-toolbox	Acc
Uni mtx	$91.08 \pm 2.13\%$
CG->Uni mtx	87.47 ± 3.10
Kaz mtx	$91.41 \pm 2.08\%$
CG->Kaz mtx	$87.68 \pm 3.11\%$

lt-toolbox	Acc	Adj acc
Uni mtx	$82.87 \pm 3.45\%$	$89.45 \pm 2.46\%$
CG->Uni mtx	$84.53 \pm 3.59\%$	$91.23 \pm 2.40\%$
Kaz mtx	$83.01 \pm 3.78\%$	$89.58 \pm 2.70\%$
CG->Kaz mtx	$84.57 \pm 3.57\%$	$91.27 \pm 2.37\%$

Future work

- Extend globals to macros/templates.
- Constructor for scanning/selecting a previous or subsequent wordoid or surface form or wordoid based on a predicate, eg to get the previous verb.
- Allow easy generation of multiple prefix/postfix features with special construct
- Improve handling of sentinels and ability to stop a feature firing when data isn't available.
- Allow reusage of coarse tags from tsx as well as provide some kind of similar tag coarsening

References

★ *Syntactic Processing using the Generalized Perceptron and Beam Search*. Zhang & Clark 2011. Includes general formulation and multiple worked examples. Most of the implementation is based on this paper.

- *Discriminative Training Methods for Hidden Markov Models*. Michael Collins 2002. Original Collins perceptron paper.
- *A Good Part-of-Speech Tagger in about 200 Lines of Python*, Matthew Honnibal (blog post). Plus: Easily understandable reference implementation. Minus: Formulation varies from rest of the literature.