Deep learning for character-level text processing

Grzegorz Chrupała

Tilburg University

ATILA 2013

Small steps towards fully autonomous learning

Until recently **feature engineering** was a major bottleneck.

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Manually design, select and tune high-level, informative features.

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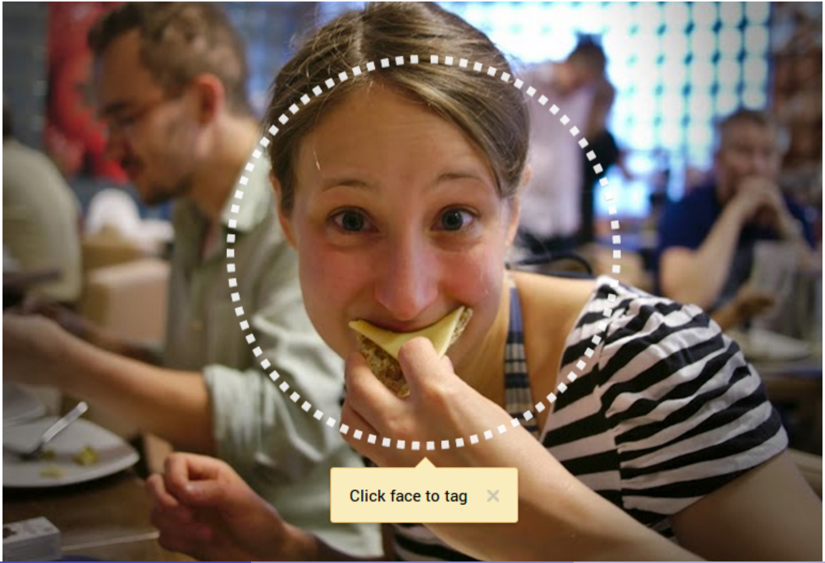
Feed these together with labels to shallow learners

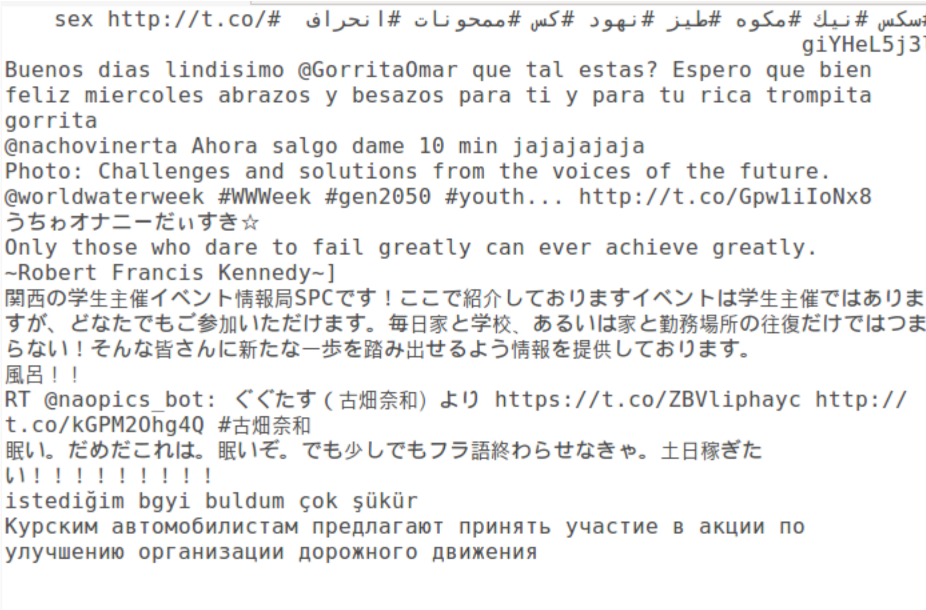
Recent focus on automatic learning of features

Neural networks in vision and speech

Machine vision: from pixels to labels via learned features



NLP: from characters to labels via learned features



#سكس #نيك #مكوه #طيز #نهود #كس #ممحونات #انحراف #sex http://t.co/giYHeL5j3
Buenos dias lindisimo @GorritaOmar que tal estas? Espero que bien
feliz miercoles abrazos y besazos para ti y para tu rica trompita
gorrita
@nachovinerta Ahora salgo dame 10 min jajajajaja
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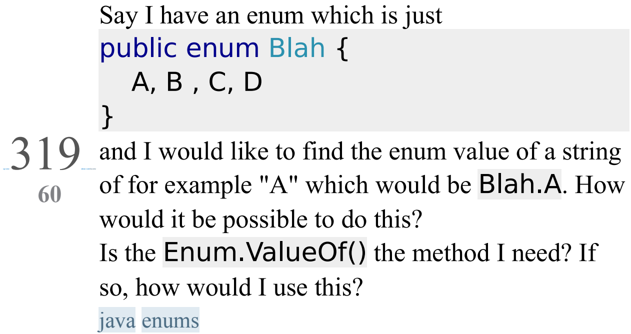
Java - Convert String to enum



319

60

Say I have an enum which is just

```
public enum Blah {
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}
```

and I would like to find the enum value of a string of for example "A" which would be `Blah.A`. How would it be possible to do this?

Is the `Enum.ValueOf()` the method I need? If so, how would I use this?

java enums

Common approaches to representation learning for language

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- Word classes

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- Topics

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- Word classes
- Topics
- Word embeddings

Alternative

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Learn text representations from raw character streams.

- Train a simple recurrent network to predict the next symbol in a sequence of characters (or bytes).

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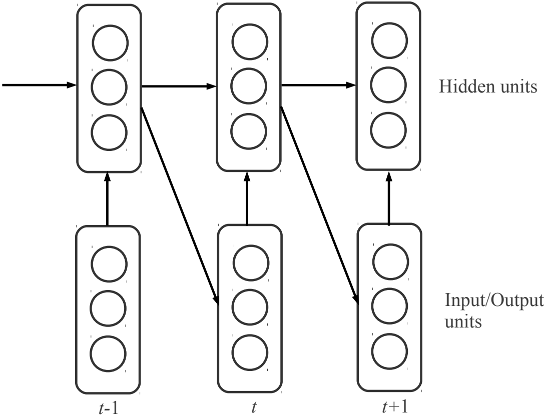
- Text representation: Activation of hidden layer at each position.

Finding Structure in Time, Elman 1990



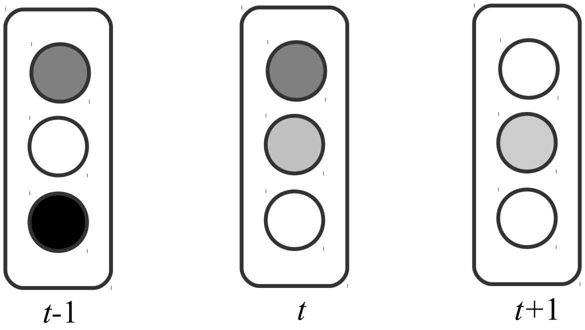
Hidden units

Hidden units

- Encode history

Hidden units

- Encode history
- Hopefully, generalize


t-1
t
t+1

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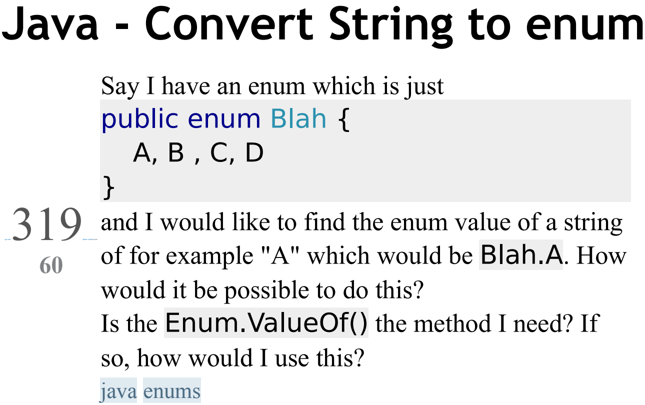
  - Use a supervised shallow learner (e.g. CRF) with the union of **baseline** features and **learned** features

Segmenting STACKOVERFLOW posts



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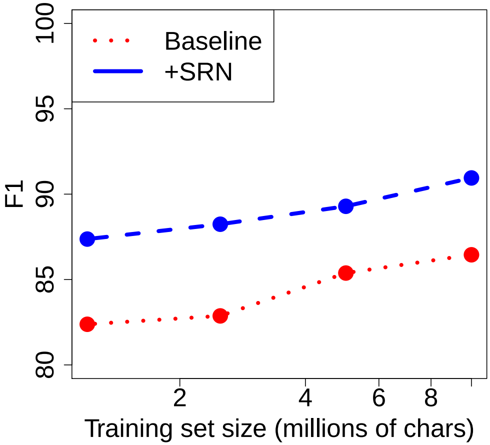
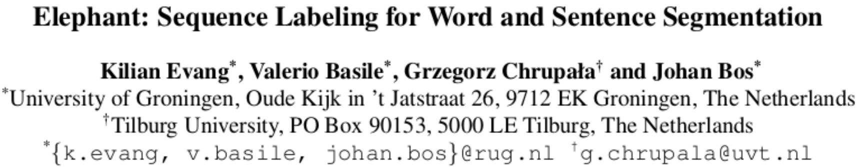


Baseline
+SRN
F1
80
85
90
95
100
2
4
6
8
Training set size (millions of chars)



Elephant: Sequence Labeling for Word and Sentence Segmentation

Kilian Evang*, Valerio Basile*, Grzegorz Chrupała† and Johan Bos*
*University of Groningen, Oude Kijk in ’t Jatstraat 26, 9712 EK Groningen, The Netherlands
†Tilburg University, PO Box 90153, 5000 LE Tilburg, The Netherlands
*{k.evang, v.basile, johan.bos}@rug.nl †g.chrupala@uvt.nl

```
It didn’t matter if the faces were male,
SIOTIITIIOTIIIIIOTIOTIIOTIIIIOTIIIOTIIITO
female or those of children. Eighty-
TIIIIIOTIOTIIIIOTIOTIIIIIIIITOSIIIIIIO
three percent of people in the 30-to-34
IIIIIOTIIIIIIOTIOTIIIIIOTIOTIIOTIIIIIIIO
year old age range gave correct responses.
TIIIOTIIOTIIOTIIIIOTIIIOTIIIIIIOTIIIIIIIIIT
```

- Character-wise sequence labeler (CRF)

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- Baseline features: characters and their Unicode categories in a window around current position

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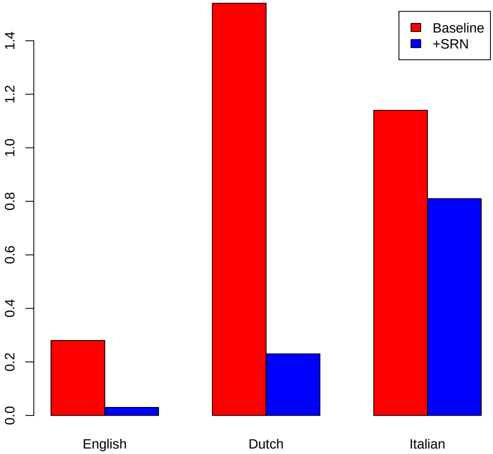
- Baseline features: characters and their Unicode categories in a window around current position
- SRN features: discretized activations of hidden layer
- English, Dutch and Italian

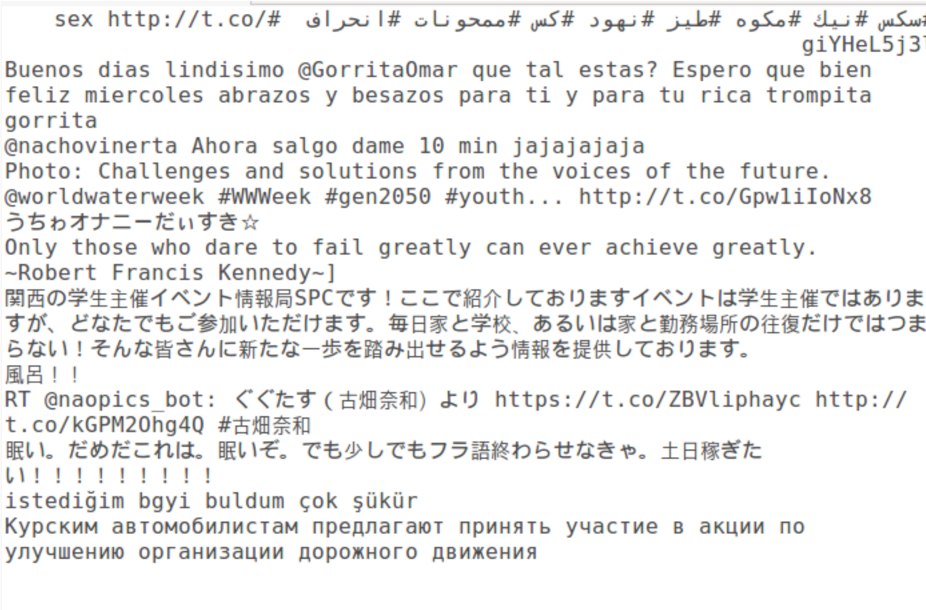
Errors per thousand characters



	Ms. Hughes will joi
	SIIOSIIIIIOTIIIOTII
+SRN	SIIOTIIIIIOTIIIOTII
	$ 3.9 trillion by t
	TOTTIOTIIIIIIIOTIOT
+SRN	TOTIIOTIIIIIIIOTIOT
	prof. Teulings het
	TIIITOSIIIIIIIOTIIO
+SRN	TIIIIOTIIIIIIIOTIIO
	bleek 0,4 procent
	OTIIIIOTTIOTIIIIIIO
+SRN	OTIIIIOTIIOTIIIIIIO
	per costringerlo al
	TIIOTIIIIIIIIIIIOTI
+SRN	TIIOTIIIIIIIIITIOTI

Work in progress: labeling tweets

Add / suggest hashtags to tweets or other user generated content



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- Multitude of languages and scripts
- Nonstandard spelling and punctuation
- Abbreviations, slang etc.

Can features learned from raw bytes strings help?

Train SRN on a stream of tweets.

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- Baseline character n-gram features + SRN features
- Activation vectors recorded at valleys in entropy profile, and averaged together

Very preliminary results

on 5000 items

Features	Mean Average Precision
char. n-grams	31.1
char. n-grams +SRN	**34.8**

Thank you

Sample of nearest neighbors according to cosine of the hidden layer activation in a span of 10.000 characters

```
n-laptop": {"last_share": 130738
ierre-pc": {"last_share": 130744
d-laptop": {"last_share": 130744
laptop": {"last_share": 13074434
erre-pc": {"last_share": 1307441

 data table has integer values a
,2,3,4,5. For all these values I
ere i can add more connections s
eating lots of private methods a
or more different data sources c

e given URL.I'd like to change t
e = SqlPersist¶¶¶When I remove t
sources explaining how to save f
basic knowledge doesn't enable m
eDirectory, but I need to save t
```

Generated random text

```
I·only·make·event·glds.

so,·on·the·cell·proceedclicks·like·completed,·with·color?

····st·potention,
‘column’]HeaderException=ID·=·new·Put="True"·MetadataTemplate,
·grwTrowerRow="SELECTEMBRow"·on?

All·clearBeanLockCollection="#7293df3335b-E9"·/&gt;
············&lt;Image:DataKey="BackgroundCollectionC2UTID"·
onclick="Nore"·
```

Labels

Block

w	r	o	n	g	?	¶	t	r	y
O	O	O	O	O	O	O	B-BL	I-BL	I-BL

Inline

e	r	·	.	.	/	i	m	g
O	O	O	B-IN	I-IN	I-IN	I-IN	I-IN	I-IN

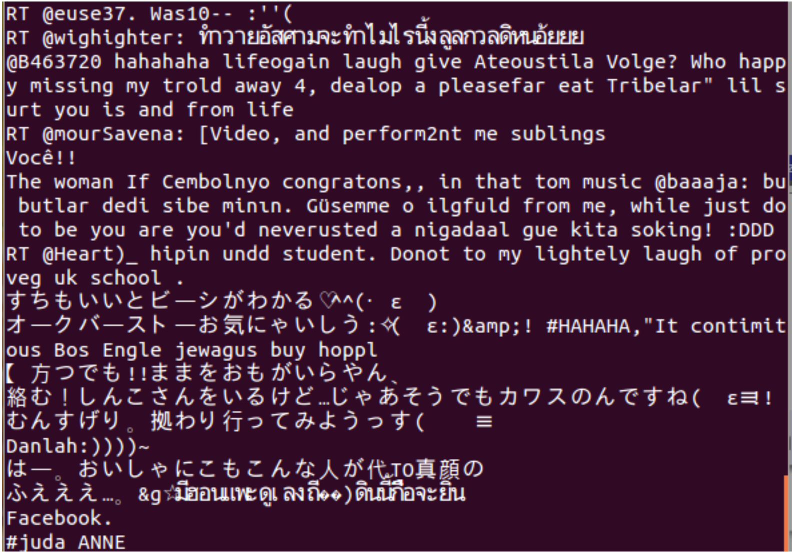
Baseline feature set

...wrong?¶try {...

Unigram	n g ? ¶ t
Bigram	g? ?¶
Trigram	g?¶
Fourgram	ng?¶ g?¶t
Fivegram	ng?¶t

Augmented feature set

- Baseline features
- 400-unit hidden layer activation
    - For each of 10 most active units
        - Is the activation > 0.5?



```
RT @euse37. Was10-- :''(
RT @wighighter: ทำวายอัสศามจะทำไม่ไรนี้งลูลกวลดิหน้อ้ยยย
@B463720 hahahaha lifeogain laugh give Ateoustila Volge? Who happ
y missing my trold away 4, dealop a pleasefar eat Tribelar" lil s
urt you is and from life
RT @mourSavena: [Video, and perform2nt me sublings
Você!!
The woman If Cembolnyo congratons,, in that tom music @baaaja: bu
 butlar dedi sibe minın. Güsemme o ilgfuld from me, while just do
 to be you are you'd neverusted a nigadaal gue kita soking! :DDD
RT @Heart)_ hipin undd student. Donot to my lightely laugh of pro
veg uk school .
すちもいいとビーシがわかる♡^^(· ε  )
オークバースト—お気にゃいしう:✧(  ε:)&amp;! #HAHAHA,"It contimit
ous Bos Engle jewagus buy hoppl
【 方つでも!!ままをおもがいらやん、
絡む！しんこさんをいるけど…じゃあそうでもカワスのんですね(  ε≡!
むんすげり。 拠わり行ってみようっす(    ≡
Danlah:))))~
はー。おいしゃにこもこんな人が代TO真顔の
ふええええ…。&g☆มีฮอนแพะดูเ ลงถี◆◆)ดินนี้ก็อจะยิน
Facebook.
#juda ANNE
```