جامعة نيويورك أبوظبي

NYU | ABU DHABI

NYUAD CAMeL Lab

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Arabic Natural Language Processing *using MADAMIRA*

Prof. Nizar Habash

New York University Abu Dhabi

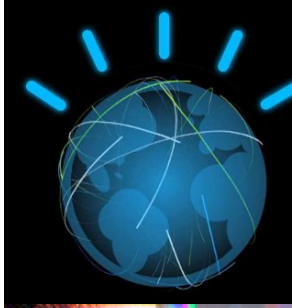
nizar.habash@nyu.edu

Natural Language Processing

- Also known as
  - Computational Linguistics
  - Human Language Technology

- NLP is an interdisciplinary field
  - Computer science, Linguistics, Cognitive science, psychology, pedagogy, mathematics, etc.

- Applications
  - Information Retrieval
  - Machine Translation
  - Automatic Speech Recognition
  - Sentiment Analytics
  - Dialogue Systems
  - Automatic Summarization, Speech Synthesis, Optical Character Recognition, etc.



Challenges to Arabic NLP

	Arabic	English
Orthographic ambiguity	More	Less
Orthographic inconsistency	More	Less
Morphological inflections	More	Less
Dialectal variation	More	Less

وبعقدنا

وَبِعُقَدِنَا وَبِعِقْدِنَا وَبِعَقْدِنَا وْبِعَقِّدْنَا

and he stresses us out | and with our (contract | necklace | psychoses)

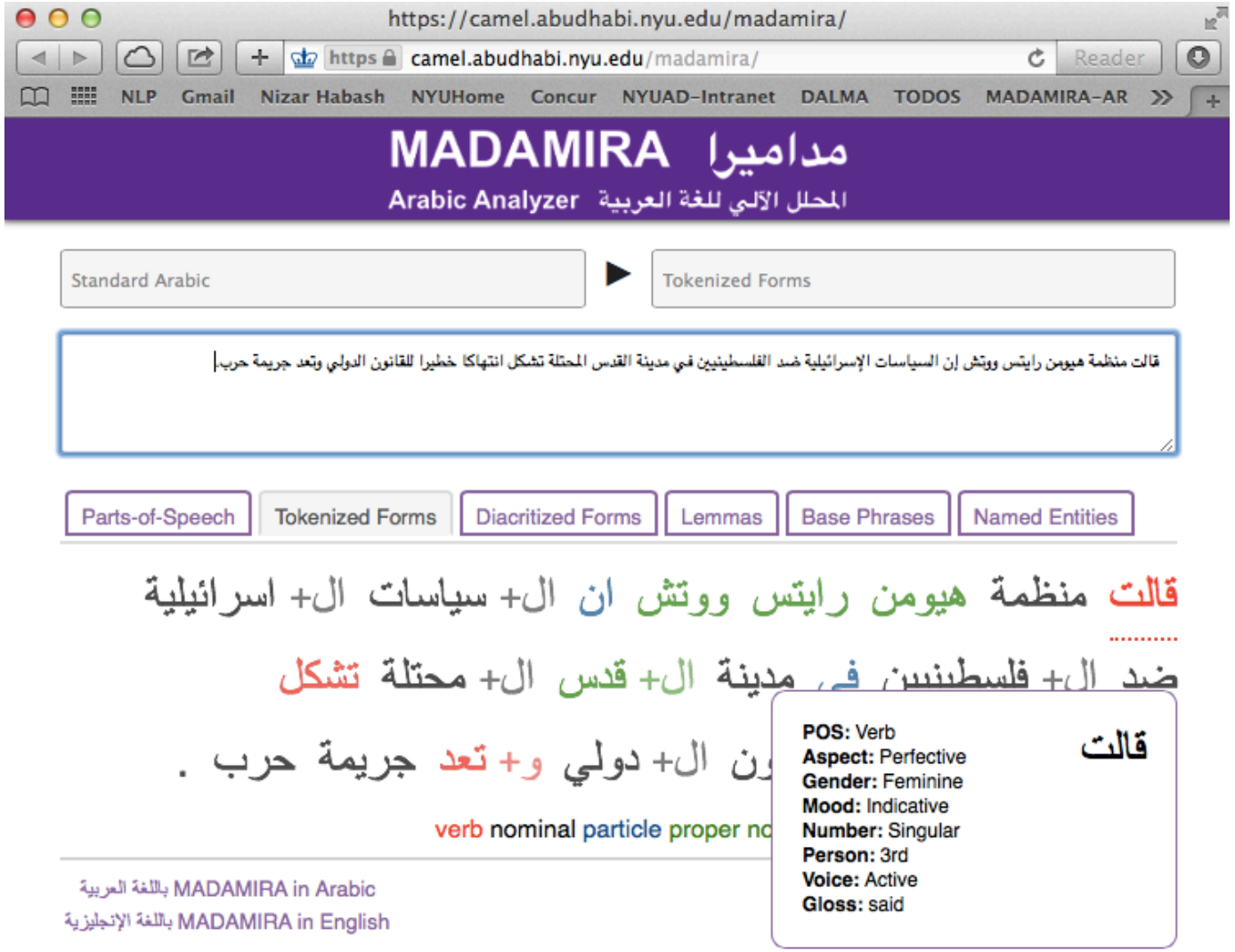
MADAMIRA

http://camel.abudhabi.nyu.edu/madamira/

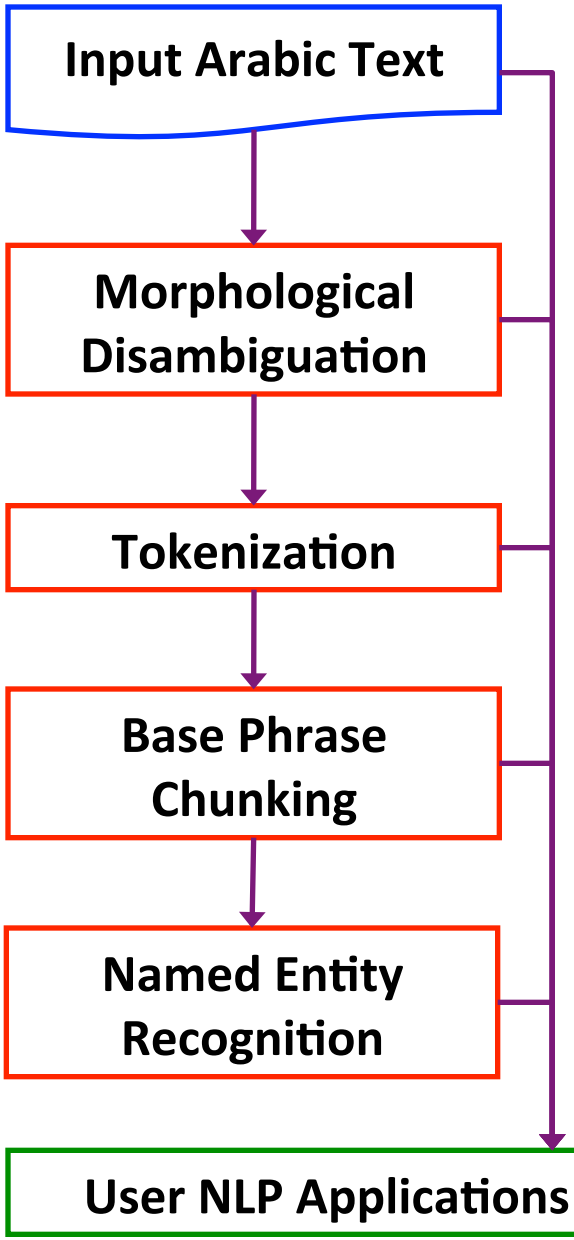
- State-of-the-art Arabic and Arabic Dialect Processing tool (Pasha et al., 2014)
  - Morphological disambiguation
  - Tokenization
  - Base phrase chunking
  - Named entity recognition
- Current release: Standard Arabic and Egyptian Arabic
- Under construction: Palestinian, Syrian, Moroccan, Yemeni, Gulf

MADAMIRA Demo

http://camel.abudhabi.nyu.edu/madamira/



MADAMIRA Overview



Morphological Disambiguation (MADA)

- Extracts Morphological Features (e.g. POS, gender)
- Uses statistical models with context to disambiguate
- **Output**: Fully disambiguated text with full morphology

Tokenization (TOKAN)

- General, highly-customizable generator of tokenized forms and/or morphological features
- **Output**: Tokenized text and/or feature forms according to a defined scheme

Base Phrase Chunking (BPC)

- Groups and labels sequences of words to form syntactic phrases (e.g. NPs, VPs, ADJPs, ADVPs)
- **Output**: Input text grouped into base phrases

Named Entity Recognition (NER)

- Identifies Named Entities (people, organizations, locations, etc.) mentioned in input text
- **Output**: Input text with Named Entities tagged

Morphological Disambiguation *in English*

- Select a morphological tag that fully describes the morphology of a word
- Complete English morphological tag set (Penn Treebank): 48 tags

  Verb:

VB	VBD	VBG	VBN	VBP	VBZ
go	went	going	gone	go	goes

- Same as “POS Tagging” in English

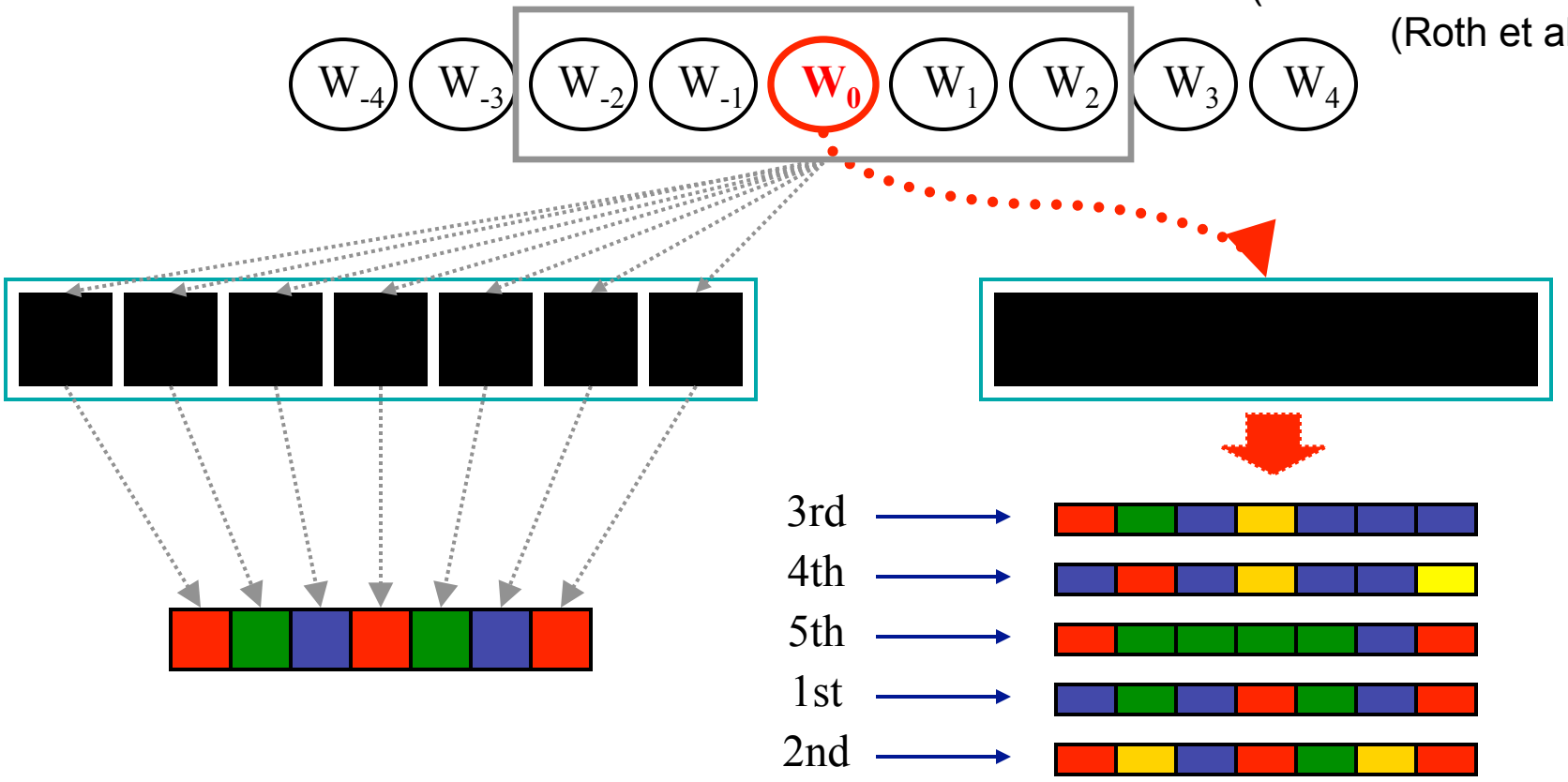
Morphological Disambiguation *in Arabic*

- Morphological tag has 14 subtags corresponding to different linguistic categories
  - Example:Verb
    Gender(2), Number(3), Person(3), Aspect(3), Mood(3), Voice(2), Pronominal clitic(12), Conjunction clitic(3)
- 22,400 possible tags
  - Different possible subsets

وسنقولها
/wasanaqūluhā/
و+ س+ ن+ قول + ها
wa+sa+na+qūl+u+hā
and+will+we+say+it
And we will say it

قال، قالت، قالا، قالوا ،قلتَ، قلتِ، قلتما، قلتم، قلتن،
يقولُ، يقولَ، يقل، تقولُ، تقولَ، تقل، تقولين، تقولي،
... فقال، فقالت، فقالا
... وسأقولها، **وسنقولها**، ...

MADA (Habash&Rambow 2005)
(Habash&Rambow 2007)
(Roth et al. 2008)



MORPHOLOGICAL CLASSIFIERS	RANKER	MORPHOLOGICAL ANALYZER
• Multiple independent classifiers • Corpus-trained	• Heuristic or corpus-trained	• Rule-based • Human-created

Inflectional Morphology
Terminology

Word	A space/punctuation delimited string	lilmaktabapi	لِلْمَكْتَبَةِ
Lexeme	The **set** of all inflectionally related words	maktabap, lilmaktabapi, Almaktabapu, walimaktabatihA, etc.	مَكْتَبَة لِلْمَكْتَبَةِ اَلْمَكْتَبَةُ وَلِمَكْتَبَتِها الخ
Lemma	An ad hoc word form used to represent the lexeme	maktabap	مَكْتَبَة
Features	The space of variation of words in a lexeme	Clitics: li_prep, Al_det, Gen:f, num:s, stt:d, cas:g	
Root جذر	The root of the Lexeme	k-t-b	ك–ت–ب
Stem جذع	The core root+pattern substring; it does not include any affixes	maktab	مَكْتَب
Segmentation	A shallow separation of affixes	li+l+maktab+ap+i	لِ+ل+مَكْتَب+َة+ِ
Tokenization	Segmentation + morpheme recovery	li+Al+maktab+ap+i	لِ+ال+مَكْتَب+َة+ِ

Cliticization Features

Feature Name			(Some Important) Feature Values	
PRC3	Proclitic 3	سابقة 3	>a_ques, 0	أداة استفهام، 0
PRC2	Proclitic 2	سابقة 2	fa_conj, wa_conj, 0	حروف عطف، 0
PRC1	Proclitic 1	سابقة 1	bi_prep, li_prep, sa_fut, 0	حروف جر، سين الاستقبال، 0
PRC0	Proclitic 0	سابقة 0	Al_det, mA_neg, 0	ال التعريف، أداة نفي، 0
ENC0	Enclitic	لاحقة 0	3ms_dobj, 3ms_poss, …, 0	ضمير مفعول به مباشر مفرد مذكر للغائب، ضمير ملكية مفرد مذكر للغائب، ... ، 0

Inflectional Features

	Feature Name		(Some Important) Feature Values	
PER	Person	الشخص	1st, 2nd, 3rd, na	متكلم، مخاطب، غائب، غ/م
ASP	Aspect	الزمن	perfect, imperfect, command, na	ماضي، مضارع، أمر، غ/م
VOX	Voice	البناء	active, passive, na	للمعلوم، للمجهول، غ/م
MOD	Mood	الصيغة	indicative, subjunctive, jussive, na	مرفوع، منصوب، مجزوم، غ/م
GEN	Gender	الجنس	feminine, masculine, na	مؤنث، مذكر، غ/م
NUM	Number	العدد	singular, dual, plural, na	مفرد، مثنى، جمع، غ/م
STT	State	التعريف	indefinite, definite, construct, na	نكرة، معرفة، مضاف، غ/م
CAS	Case	الحالة	nominative, accusative, genitive, na	مرفوع، منصوب، مجرور، غ/م

MADAMIRA
Morphological Disambiguation

System:	MSA	MSA	EGY
Test:	MSA	EGY	EGY
Full Analysis	84.3%	27.0%	75.4%
Diacriticization	86.4%	32.2%	83.2%
Lemmatization	96.1%	67.1%	86.3%
Base POS-tagging	96.1%	82.1%	91.1%
Segmentation	99.1%	90.5%	97.4%

wkAtbh وكاتبه

and his writer

wakAtibuhu

kAtib_1

pos:noun

prc3:0 prc2:wa_conj prc1:0 prc0:0 per:3 asp:na vox:na mod:na gen:m num:s stt:c cas:n enc0:pron3ms

w+ kAtb +h

Tokenization (TOKAN)

- Deterministic, generalized tokenizer
- **Input:** disambiguated morph. analysis + tokenization scheme
- **Output:** highly-customizable tokenized text

```
wsyktbhA = lex:katab-u_1 gloss:write pos:verb prc3:0
     prc2:wa_conj prc1:sa_fut prc0:0 enc0:3fs_dobj
```

Example	Scheme	Specification
w+ syktbhA	D1	prc3 prc2 REST
w+ s+ yktbhA	D2	prc3 prc2 prc1 REST
w+ s+ yktb +hA	D3	prc3 prc2 prc1 prc0 REST enc0
w+ syktb +hA	ATB	prc3 prc2 prc1 prc0:lA prc0:mA REST enc0
w+•w+•wa+ syktbhA•syktbhA•katab	D1-3tier	prc3 prc2 REST ::FORM0 WORD ::FORM1 WORD NORM:AY ::FORM2 LEXEME

Running MADAMIRA in Standalone Mode

- cd to MADAMIRA directory
- put input files in ~/demo directory
- Run Madamira in standalone mode

```
java -Xmx2500m -Xms2500m -XX:NewRatio=3
     -jar MADAMIRA-release-20170403-2.1.jar
     -rawinput <input.txt>
     -rawoutdir <dir>
     -rawconfig <config.xml>
```

Thank you!

If you have any questions, email

nizar.habash@nyu.edu