Accelerated Natural Language Processing
Lecture 1
Introduction

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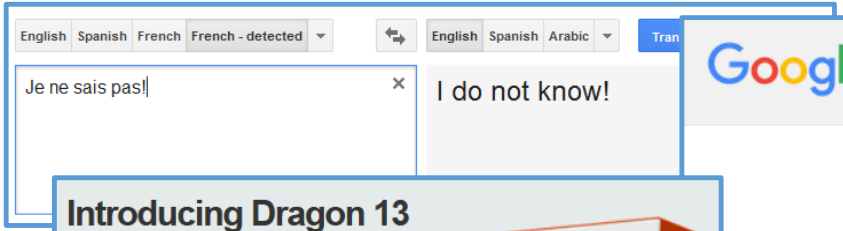
(based on slides by Philipp Koehn)
Other lecturer: Shay Cohen

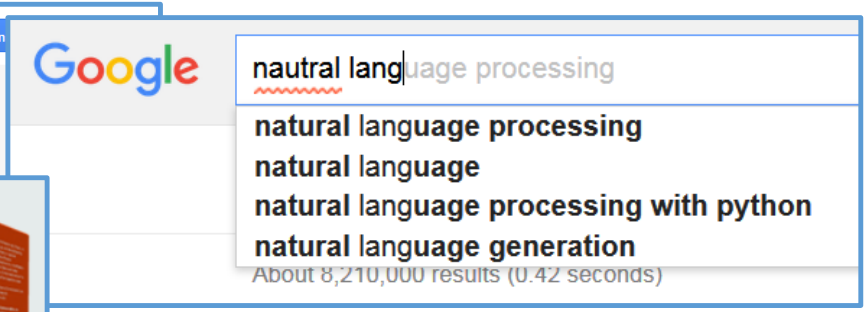
16 September 2019

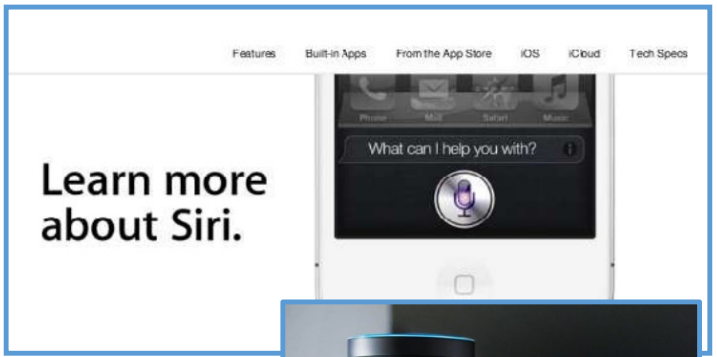
Lecture recording

- **Lectures for this course are recorded.**
- The microphone picks up my voice, but not yours. (I will repeat questions/comments from students so they are recorded.)
- Signal to me if you want me to pause the recording at any time.
- Normally recording works, but can fail. Don't rely on it.

What is Natural Language Processing?







Sources: google.co.uk, nuance.co.uk, apple.com, www.amazon.co.uk, cnet.com

What is Natural Language Processing?

Applications

- Machine Translation
- Information Retrieval
- Question Answering
- Dialogue Systems
- Information Extraction
- Summarization
- Sentiment Analysis
- ...

Core technologies

- Morphological analysis
- Part-of-speech tagging
- Syntactic parsing
- Named-entity recognition
- Coreference resolution
- Word sense disambiguation
- Textual entailment
- ...

This Course

Linguistics

- words
- morphology
- parts of speech
- syntax
- semantics
- (discourse?)

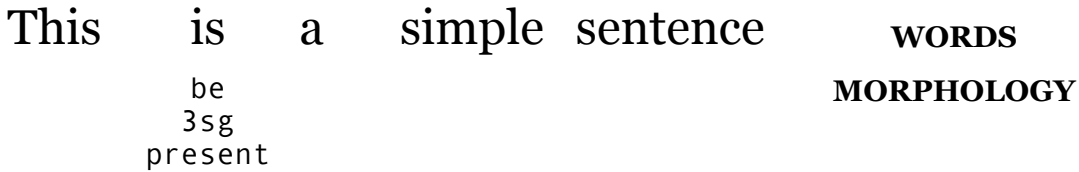
Computational methods

- finite state machines (morphological analysis, POS tagging)
- grammars and parsing (CKY, statistical parsing)
- probabilistic models and machine learning (HMMS, PCFGs, logistic regression, neural networks)
- vector spaces (distributional semantics)
- lambda calculus (compositional semantics)

Words

This is a simple sentence **WORDS**

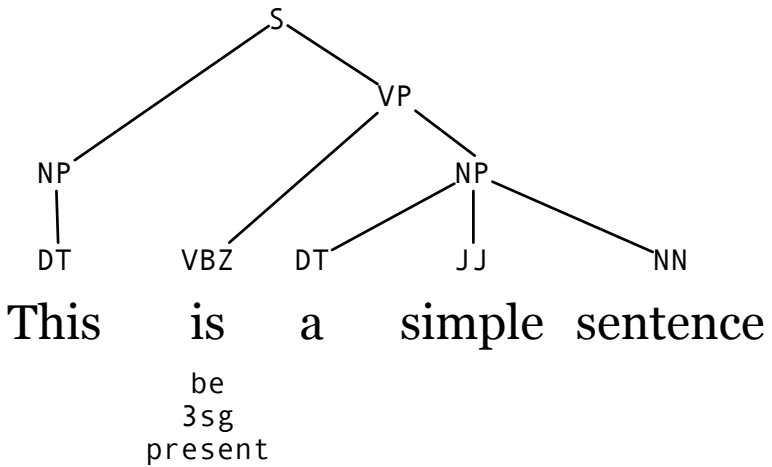
Morphology



Parts of Speech

DT	VBZ	DT	JJ	NN	**PART OF SPEECH**
This	is	a	simple	sentence	**WORDS**
	be 3sg present				**MORPHOLOGY**

Syntax



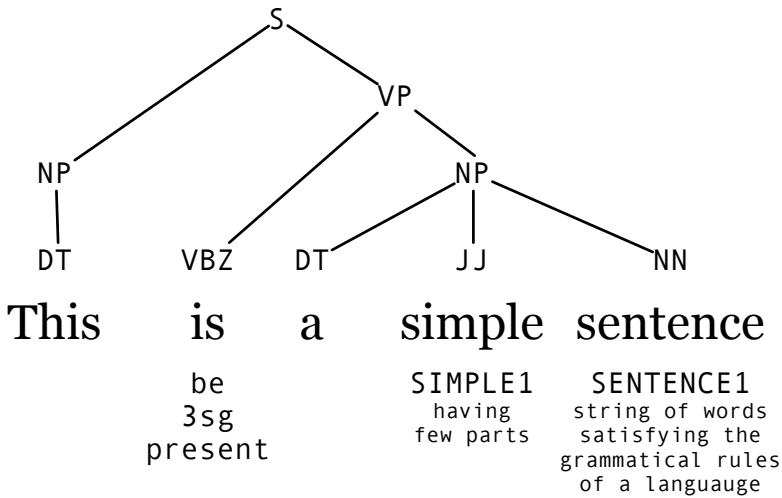
SYNTAX

PART OF SPEECH

WORDS

MORPHOLOGY

Semantics



SYNTAX

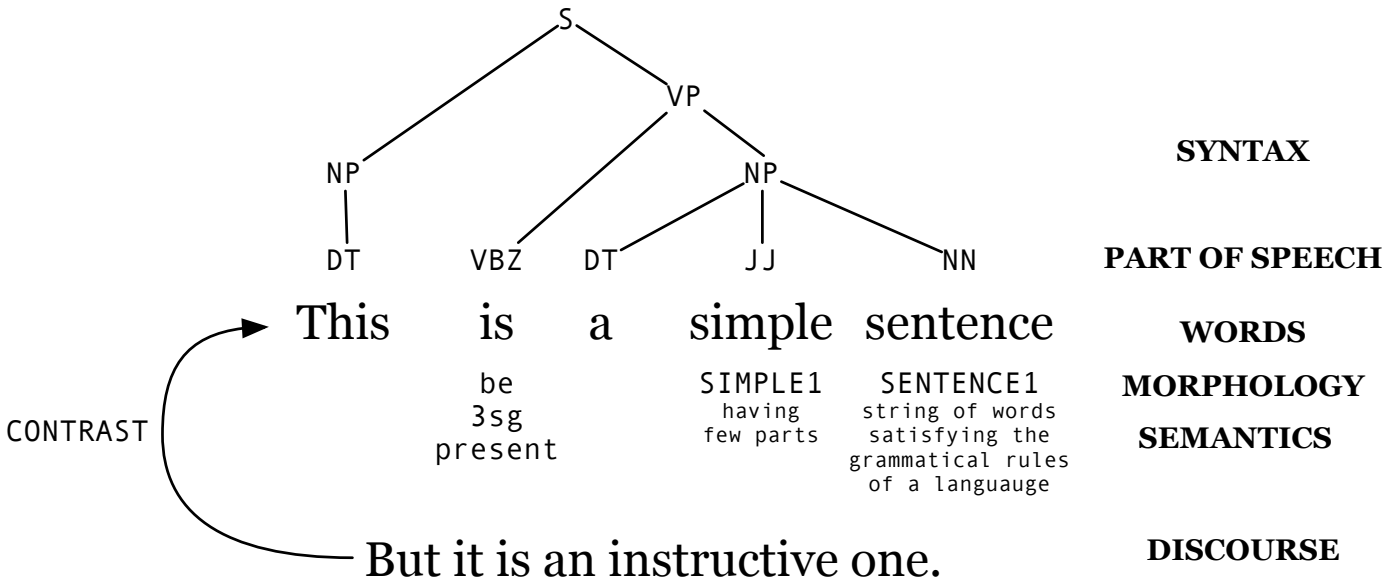
PART OF SPEECH

WORDS

MORPHOLOGY

SEMANTICS

Discourse


S
VP
NP
NP
DT
VBZ
DT
JJ
NN
This
is
a
simple
sentence
be
3sg
present
SIMPLE1
having
few parts
SENTENCE1
string of words
satisfying the
grammatical rules
of a languauge
CONTRAST
But it is an instructive one.
SYNTAX
PART OF SPEECH
WORDS
MORPHOLOGY
SEMANTICS
DISCOURSE

Why is Language Hard?

- Ambiguities on many levels, need context to disambiguate
- Rules, but many exceptions
- Language is infinite, cannot see examples of everything (and lots of what we do see occurs rarely)

Ambiguity

- Ambiguity is sometimes used intentionally for humor:

1. I'm not a fan of the new pound coin, but then again, I hate all change.[1]

2. One morning I shot an elephant in my pajamas. How he got in my pajamas I don't know.[2]

- What makes these jokes funny? Is it the same sort of ambiguity, or something different in each case?

[1] Ken Cheng, 2017. (Winner of Dave's Funniest Joke of the Fringe award.)
[2] Groucho Marx, in the 1930 film Animal Crackers.

Now let's vote

Do the two jokes have the same sort of ambiguity?

1. Yes

2. No

3. I have no idea what you are talking about

Ambiguity

- However, ambiguity is much more common than jokes.

- Exercise for home: where is the ambiguity in these examples? Which is more like Joke 1? Joke 2?

  1. This morning I walked to the bank.
  2. I met the woman in the cafe.
  3. I like the other chair better.
  4. I saw the man with glasses.

- We will explain in much more detail later in the course.

Data: Words

Possible definition: strings of letters separated by spaces

- But how about:
  - punctuation: commas, periods, etc are normally not part of words, but others less clear: high-risk, Joe's, @sloppyjoe
  - compounds: website, Computerlinguistikvorlesung

- And what if there are no spaces:
  伦敦每日快报指出,两台记载黛安娜王妃一九九七年巴黎
  死亡车祸调查资料的手提电脑,被从前大都会警察总长的
  办公室里偷走.

Processing text to decide/extract words is called **tokenization**.

Word Counts

Out of 24m total word tokens (instances) in the English Europarl corpus, the most frequent are:

any word

Frequency	Token
1,698,599	the
849,256	of
793,731	to
640,257	and
508,560	in
407,638	that
400,467	is
394,778	a
263,040	I

nouns

Frequency	Token
124,598	European
104,325	Mr
92,195	Commission
66,781	President
62,867	Parliament
57,804	Union
53,683	report
53,547	Council
45,842	States

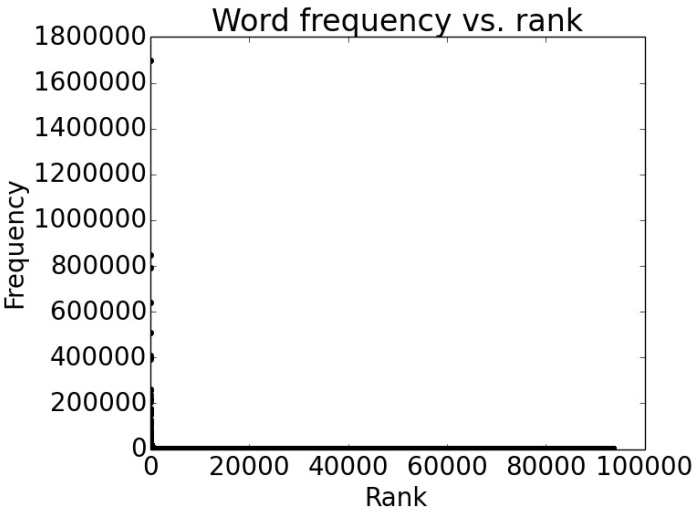
Word Counts

But there are 93638 distinct words (**types**) altogether, and 36231 occur only once! Examples:

- cornflakes, mathematicians, fuzziness, jumbling
- pseudo-rapporteur, lobby-ridden, perfunctorily,
- Lycketoft, UNCITRAL, H-0695
- policyfor, Commissioneris, 145.95, 27a

Plotting word frequencies

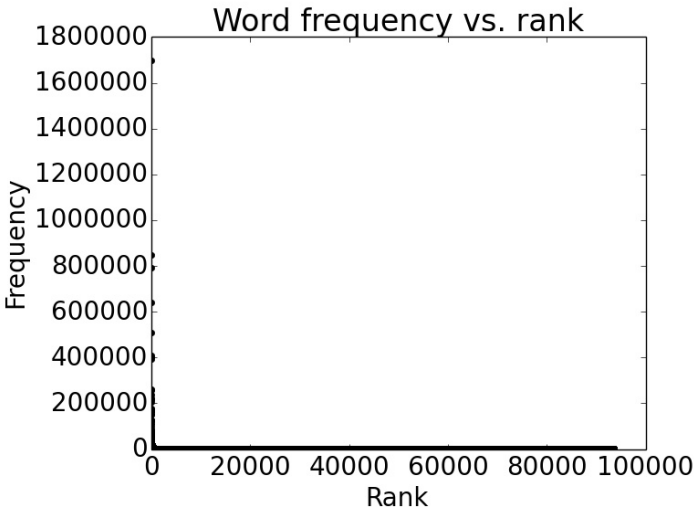
Order words by frequency. What is the freq of nth ranked word?

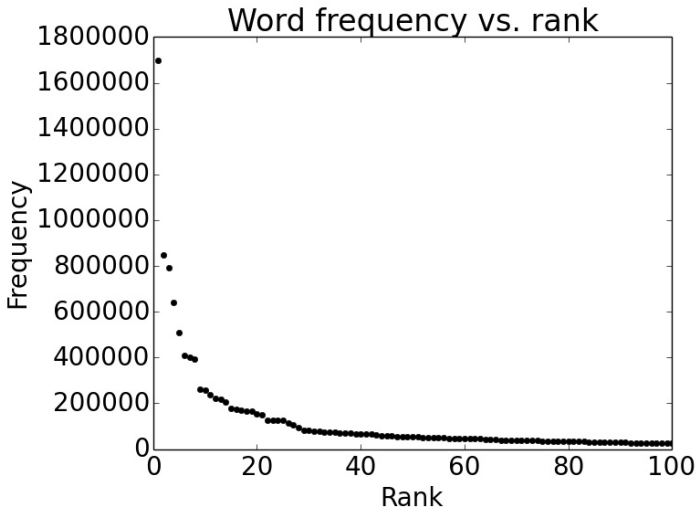


Frequency	Token	Rank
1,698,599	the	1
849,256	of	2
793,731	to	3
640,257	and	4
508,560	in	5
407,638	that	6
400,467	is	7
394,778	a	8
263,040	I	9

Plotting word frequencies

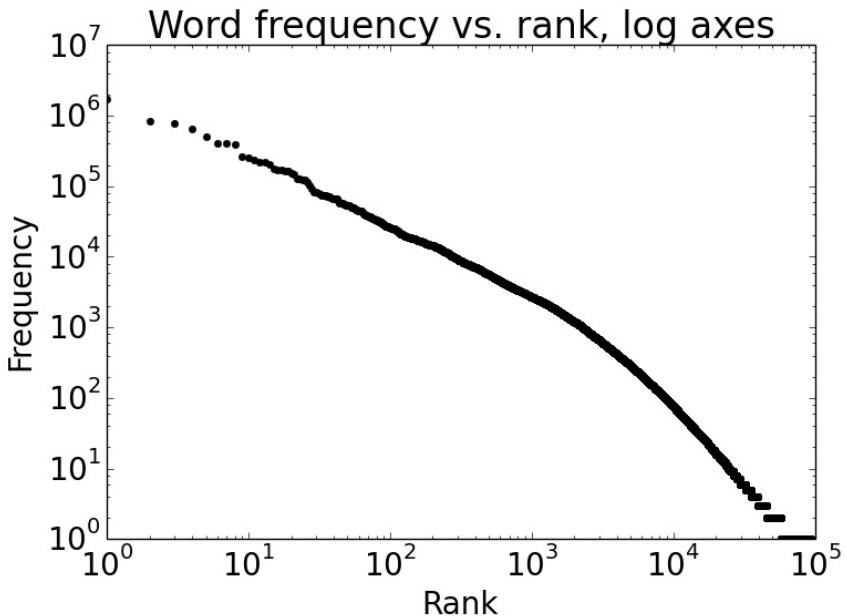
Order words by frequency. What is the freq of nth ranked word?

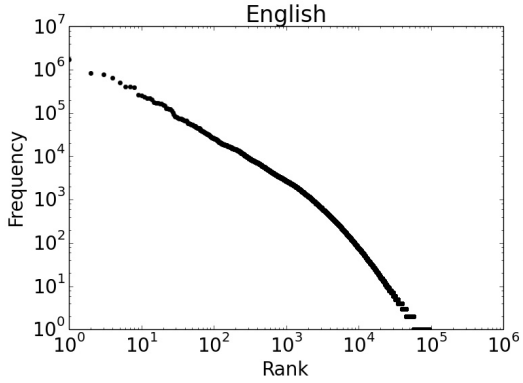


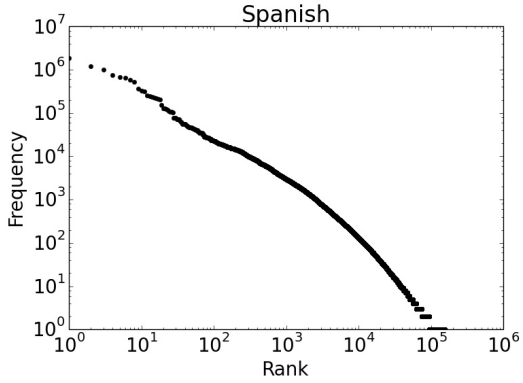


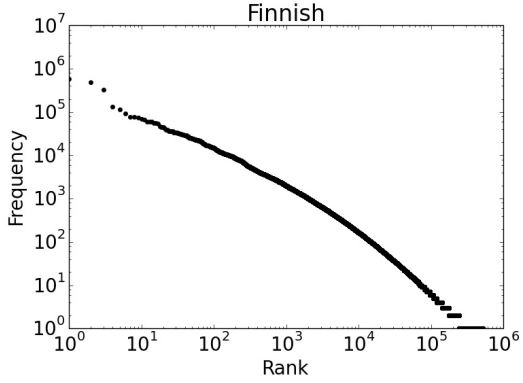
Rescaling the axes

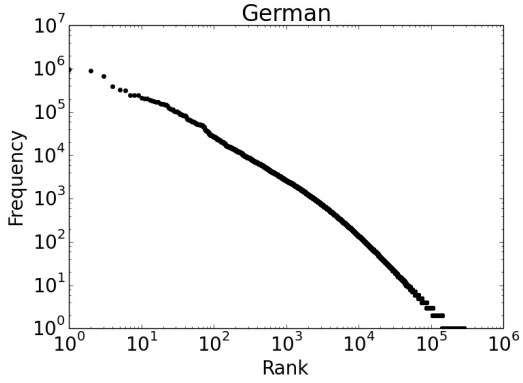
To really see what's going on, use logarithmic axes:




English
Frequency
Rank


Spanish
Frequency
Rank


Finnish
Frequency
Rank


German
Frequency
Rank

Zipf's law

Summarizes the behaviour we just saw:

$$f \times r \approx k$$

- $f =$ frequency of a word
- $r =$ rank of a word (if sorted by frequency)
- $k =$ a constant

Zipf's law

Summarizes the behaviour we just saw:

$$f \times r \approx k$$

- $f =$ frequency of a word
- $r =$ rank of a word (if sorted by frequency)
- $k =$ a constant

Why a line in log-scales?

$$fr = k \quad \Rightarrow \quad f = \frac{k}{r} \quad \Rightarrow \quad \begin{aligned} \log f &= \log k - \log r \\ y &= c - x \end{aligned}$$

Linguistics and Data

- Data
  - looking at real use of language in text
  - can learn a lot from empirical evidence
  - but: Zipf's law means there will always be rare instances
- Linguistics
  - build a better understanding of language structure
  - linguistic analysis points to what is important
  - but: many ambiguities cannot be explained easily

Course organization

- Lecturers: Sharon Goldwater, Shay Cohen; plus lots of help!
- 3 lectures per week (Mon/Tue/Fri)
- Weekly, in alternate weeks (1st lab is **this week**):
  - 1.5 hr lab for exploring data and developing practical skills
  - 1 hr tutorial for working through maths and algorithms
- Labs will be done in **pairs**; tutorial work can be done with whomever you choose.

Course materials and communication

- Available on Learn page, even if you are not yet registered (see link on `http://course.inf.ed.ac.uk`)
- Main textbook: "Speech and Language Processing", Jurafsky and Martin. We use **both** 2nd Ed (2008) and 3rd Ed (draft chapters).
- Labs, assignments, code, optional readings: all on web page.
- We use the **Piazza** discussion forum. Sign up now using link on Learn!

Assessment

- Two assessed assignments, worth 25% altogether.
  - require some programming, but assessed on explanations and "lab-report" style write-ups.
  - You may (and are encouraged to) work in pairs.
- Exam in December, worth 75% of final mark.
  - short factual answers, longer open-ended answers, problem-solving (maths, linguistics, alogithms).

British higher education system

- Main principle: self-study guided by non-assessed work (some of it used for formative feedback), final assessed exam.
- Do **not** expect to learn everything just by sitting in lectures and tutorials! **Most** of your time should be in self-study:
  - Labs: intended to be done during scheduled lab times, but you may wish to look over them in advance (or revise after).
  - Tutorial sessions: do exercises **in advance**, bring questions. Discussion to help answer, learn more, and provide feedback.
  - Assessed assignments.
  - Other: reading textbook, working through examples and review questions, seeking out online materials, group study sessions.

Background needed for this course?

- Know or currently learning Python.
- Background in Linguistics and prepared to learn maths (mainly probability) and algorithms
- Background in CS and prepared to learn linguistics (and maybe maths)

Advice/warnings

- Students with little programming/maths: you can do it, but it will be very intensive.
  - Find study partners, start work early.
  - Pair up with a computer scientist.
- Students with programming but little maths or weak English: you can do it, but it will be very intensive.
  - Find study partners, start work early.
  - Pair up with a linguist or someone with stronger English.
- Students with strong programming/maths/machine learning: still fairly intense, plenty of scope for challenge. Don't underestimate the need to develop critical thinking and writing skills.

Quotes from course feedback forms

"What would you say to students interested in taking this course?"

Do everything that you are told to do/read, do not underestimate anything, devote a lot of time.

It is a good course. Although it is very intensive, I did learn a lot of stuff than I expected. As long as you take advantage of all the learning resources provided and work hard on every assignment, you will definitely benefit a lot from it.

It's a great course, but it's not a walk in the park, so be prepared to work hard.

You'll learn a lot, but it is challenging.

What this course is, and isn't

This course is a fast-paced introduction/survey course. We **will**

- introduce many of the basic tasks in NLP and discuss why they are challenging
- present linguistic concepts and standard methods (maths/algorithms) often used to solve these tasks
- give you enough background to be able to read (some) current NLP research papers and take follow-on courses in sem 2

But we **will not**

- say too much about cutting edge methods or heavy-duty machine learning (see ML courses and NLU+)

Relationship to other NLP courses

- ANLP is **required** if you want to take NLU+ in sem 2.
  - Recent advances, including lots about deep learning approaches.
  - This course covers the linguistic, mathematical, and computational background needed first.

- Alternative text processing course: TTDS (20 pts, MSc, full year)
  - Focuses more on web search and shallow text processing
  - Less about the subtleties of language structure and meaning
  - More weight on practicals, including team project
  - Assumes more maths and programming background

Preparing for next week

- We will be starting with probabilistic models next week.
- If you haven't taken a course on probability theory (or related), start working through the tutorial **now** (link on week 2 of lecture schedule).
- Probabilistic material starts early to give you longer to absorb before the exam.
- In general, material is front-loaded: you'll have more assignments from other courses later on.

Labs start this week!

- Four available times on Wed/Thu/Fri afternoons this week.
- To see which to attend, check Learn Announcements tomorrow morning.
  - Learn page is linked from `http://course.inf.ed.ac.uk`.
  - While on Learn, sign up for Piazza!

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- To see which to attend, check Learn Announcements tomorrow morning.
  - Learn page is linked from `http://course.inf.ed.ac.uk`.
  - While on Learn, sign up for Piazza!
- **Before your lab**: do the Preliminaries section of Lab 1. That is,
  - Get your DICE account and make sure you can log in to the lab machines in AT (or find a partner who can).
  - Read/work through the Introduction to DICE (linked from the lab) while at a DICE machine.

Tomorrow's lecture

- Lecture theatre only holds 120, compared to 190 today.
- This is almost certainly too small, and I'm trying to find a solution.
- In the meantime:
  - **If you are auditing, please do not come tomorrow.**
  - If you can't get a seat tomorrow, please watch the lecture video on Learn (it should become available about an hour after class).

Questions and exercises:

- What does ambiguity refer to? Does it always involve a word with two different meanings?
- Do the exercise on slide 15.
- What is a word token? A word type? How many tokens and how many types are there in the following sentence?
  the new chair chaired the meeting
- What does Zipf's law describe, and what are its implications? (We will see more about implications in the next few lectures.)