Speech recognition and synthesis

Introduction

There is no data like more data

- Speech and Language are extremely complex
- Large amounts of data are necessary to model them
- "The best application is the one with the largest corpus"
- 10-1000 hours of speech recordings needed
- 10^8 - 10^9 word text corpus needed

Introduction: Corpora for Speech and Language Technology

A language corpus is a documented collection of coherent text, speech, video, and transcriptions and annotations of these

Requirements

- Meta data (fixed)
- Normalization (fixed)
- Data (fixed)
- Transcriptions and annotations (cumulative)
- Storage, distribution, access, and software (volatile)

[Wynne(2005)]

Introduction: Corpora for S&L Technology

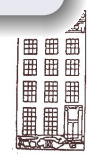
Requirements

- Meta data (fixed): Information on the items
  - Bibliographic/biographic information (author, speaker)
  - Dates
  - Origin, eg, place of publishing, recording
  - Language variant
  - Genre and style
  - Recording trail, post-processing, and formats
  - **Access criteria, Copyrights, Privacy&Ethical guidelines**
  - ...
- Normalization (fixed)
- Data (fixed)
- Transcriptions and annotations (cumulative)
- Storage, distribution, access, and software (volatile)

Introduction: Corpora for S&L Technology

Requirements

- Meta data (fixed)
- Normalization (fixed): All items must adhere to certain guidelines
  - Inclusion/selection criteria
  - Recording and text formats
  - Spelling rules, orthographic normalization
  - Storage formats (sample frequencies, file formats)
  - ...
- Data (fixed)
- Transcriptions and annotations (cumulative)
- Storage, distribution, access, and software (volatile)



Introduction: Corpora for S&L Technology

Requirements

- Meta data (fixed)
- Normalization (fixed)
- Data (fixed): Immutable text or speech records
  - Broadcast recordings
  - Speech recordings
  - Video recordings
  - Original text
  - Transliterations of speech (correctable)
  - ...
- Transcriptions and annotations (cumulative)
- Storage, distribution, access, and software (volatile)

Introduction: Corpora for S&L Technology

Requirements

- Meta data (fixed)
- Normalization (fixed)
- Data (fixed)
- Transcriptions and annotations (cumulative): Added value of interpretations and analysis
  - Orthographic transcription (transliteration) of speech
  - Paragraph and sentence boundaries
  - Phonemic transcription
  - Prosodic transcription (eg, ToBI)
  - Part-of-Speech tagging
  - Lemmatization
  - Syntactic trees (treebank)
  - ...
- Storage, distribution, access, and software (volatile)

Introduction: Corpora for S&L Technology

Requirements

- Meta data (fixed)
- Normalization (fixed)
- Data (fixed)
- Transcriptions and annotations (cumulative)
- Storage, distribution, access, and software (volatile): Practical usage
  - Digital storage, what and where
  - On-line and/or media distribution (DVD)
  - Access policies (pricing, licenses)
  - Exploration software
  - Database tables
  - DBMS
  - Updates and policy
  - ...

Language corpora

Example corpora and their sizes

- IFA Corpus: 50 thousand words ($5\frac{1}{2}$ hours) [Van Son(2003)]
- Spoken Dutch Corpus (CGN): 9 million words (800 hours) [NTU(2004)]
- British National Corpus (BNC): 100 million words [BNC(1997)]
- Twente journal corpus: 300 million words (Dutch) [Ordelman(2002)]
- Tilburg text corpus: 600 million words (Dutch, unpublished?)
- COSMAS corpus archive: 1.8 billion words (German) [IDS(2005)]
- IFA Video Dialog corpus: conversations (5 hours)
  `http://www.fon.hum.uva.nl/IFA-SpokenLanguageCorpora/`

Language corpora: CGN [NTU(2004)]

Contents ($\frac{2}{3}$ Dutch, $\frac{1}{3}$ Flemish)

- 500 hours (5,650,000 words) recorded in The Netherlands
- 300 hours (3,250,000 words) in Flanders
- 4250 speakers
- 15 Styles/genres
- Field recordings with Sony Minidisk
- 16/16 and 8/8 kHz/bit encoding

Language corpora: CGN Styles and Genres

CGN: 9 million words from 800 hours of speech

Hour	kWords	Style
225	2,626	spontaneous conversations ('face-to-face')
51	565	interviews with teachers of Dutch (VNC)
92	1,209	spontaneous telephone dialogues
64	853	spontaneous telephone dialogues
11	136	simulated business negotiations
64	790	interviews/discussions/debates (broadcast)
36	360	discussions/debates/meetings (non-broad.)
44	405	lessons recorded in the classroom
21	208	live (eg sport) commentaries (broadcast)
17	186	newsreports/reportages (broadcast)
36	368	news (broadcast)
15	146	commentaries/columns/reviews (broadcast)
2	18	ceremonious speeches/sermons
16	141	lectures/seminars
104	903	read speech (read books)

Language corpora: CGN Annotations

Annotations and transcriptions

- Orthographic transcription (the full 8,900,000 words)
- Manually verified POS tagging and lemmatization (all)
- Lexicon and identification of multi word units (all)
- Automatic time alignment and phonetic transcription at the word level (all)
- Manually verified broad phonetic transcription (1,000,000 words)
- Manually verified time alignment at the word level (1,000,000 words)
- Syntactic annotation (1,000,000 words)
- Two independent prosodic annotations (250,000 words)

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Use of corpora in Speech Technology: Research

Phonetic, prosodic and syntactic research

- Phoneme durations
- Stress and Accent placement
- Intonation and expressive speech (emotions)
- Part-of-Speech tagging
- Prosodic and syntactic boundaries
- Phoneme assimilation (eg, word boundaries)
- Pronunciation variation
- Morphological decomposition
- Visual speech

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Use of corpora in Speech Technology: TTS Modeling

Text to Speech synthesis

- Produce accentuation and boundaries from text
- Produce phoneme durations from text
- Grapheme-to-phoneme conversion (lexicon)
- Chunk words into groups (punctuation)
- Decompose words into components (compound words)

Use of corpora in Speech Technology: ASR Modeling

Automatic Speech Recognition

- Hidden Markov Model training
- Speech templates for template based recognition
- Language model (smoothed N-grams)
- Pronunciation variation
- Treebank training (syntactic probabilities)

Annotation, Segmentation, and labeling: Orthography

Manual Orthographic transcription (transliteration) is used to automatically generate

- Tokens (words) $\Rightarrow$ Word alignment
- Phonemic transcription $\Rightarrow$ Phone alignment
- POS tags

All annotations and segmentation can be manually verified (at great cost)

Annotation, Segmentation, and labeling: POS tagging

POS tags are used to automatically generate

- Lexical stress
- Syntactic structure
- Lemmas
- Prosodic structure (ToBI) $\Rightarrow$ **currently only by hand**

All annotations and segmentation can be manually verified (at great cost)

Phonetic symbols

Speech corpora needed an unambiguous digital encoding of IPA symbols (now there is UNICODE)

- Language specific encodings
  - 1 character ASCII encodings + diacritics (SAMPA)
  - 2 character ASCII encodings (SWITCHBOARD)
- Complete IPA encodings
  - 2 character ASCII encoding (eg, Worldbet [Hieronymus(1994)])
  - Control encodings (LaTeX Tipa, Praat)
- Currently, control encodings are impractical for manual labeling
- Note that mapping sounds to the IPA is *not* trivial

Phonetic symbols: CGN's SAMPA vs Worldbet encoding

Vowels IPA	CGN	Wbet	Example	Word
ɪ	I	'I '	lIp	lip
ɛ	E	'E '	lEx	leg
ɑ	A	'A '	lAt	lat
ɔ	O	'> '	bOm	bom
ʏ	Y	'ux'	pYt	put
i	i	'i '	lip	liep
y	y	'y '	byr	buur
e	e	'e '	lex	leeg
ø	2	'7 '	d2k	deuk
a	a	'a '	lat	laat
o	o	'o '	bom	boom
u	u	'u '	buk	boek
ə	@	'& '	x@-lE+k	gelijk
ɛi	E+	'Ei'	wE+s	wijs
øy	9+	'8y'	h9+s	huis
ɔu	O+	'Ou'	kO+t	koud

Assignment: Week 3 Manipulating prosody

Change intonation and duration

- Open sentence in praat (eg, assignment 1/2)
- Create a Word tier (Help → Praat Intro → Intro 7. Annotation)
- Add the (aligned) words to the tier
- Copy to a Phoneme tier
- Then add (split into) the phonemes
- Create a manipulation (Help → Praat Intro → Intro 8. Manipulation)
- Move the stress(-es) to a different word(s)
- What are the contributions of intonation, duration, or intensity?
- Hand in your report as a PDF

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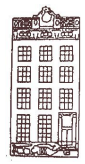

Appendix A

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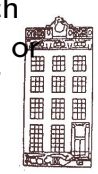

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End of Terms and Conditions

The GNU General Public License VIII

Appendix: How to Apply These Terms to Your New Programs

If you develop a new program, and you want it to be of the greatest possible use to the public, the best way to achieve this is to make it free software which everyone can redistribute and change under these terms.
To do so, attach the following notices to the program. It is safest to attach them to the start of each source file to most effectively convey the exclusion of warranty; and each file should have at least the "copyright" line and a pointer to where the full notice is found.

> *one line to give the program's name and a brief idea of what it does.*
> *Copyright (C) yyyy name of author*
> *This program is free software; you can redistribute it and/or modify it under the terms of the GNU General Public License as published by the Free Software Foundation; either version 2 of the License, or (at your option) any later version.*
>
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Also add information on how to contact you by electronic and paper mail.
If the program is interactive, make it output a short notice like this when it starts in an interactive mode:

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> *Gnomovision comes with ABSOLUTELY NO WARRANTY; for details type 'show w'.*
> *This is free software, and you are welcome to redistribute it under certain conditions; type 'show c' for details.*

The GNU General Public License IX

The hypothetical commands `show w` and `show c` should show the appropriate parts of the General Public License. Of course, the commands you use may be called something other than `show w` and `show c`; they could even be mouse-clicks or menu items—whatever suits your program.
You should also get your employer (if you work as a programmer) or your school, if any, to sign a "copyright disclaimer" for the program, if necessary. Here is a sample; alter the names:

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