Advanced Language Technologies

Information and Communication Technologies
Module "Knowledge Technologies"
Jožef Stefan International Postgraduate School
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Lecture II.
Computer Corpora

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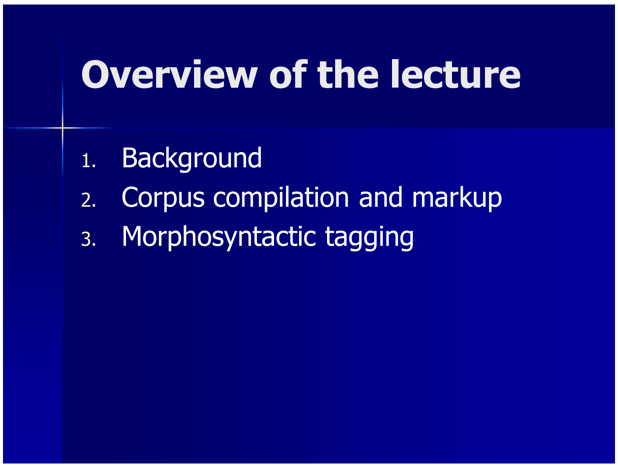
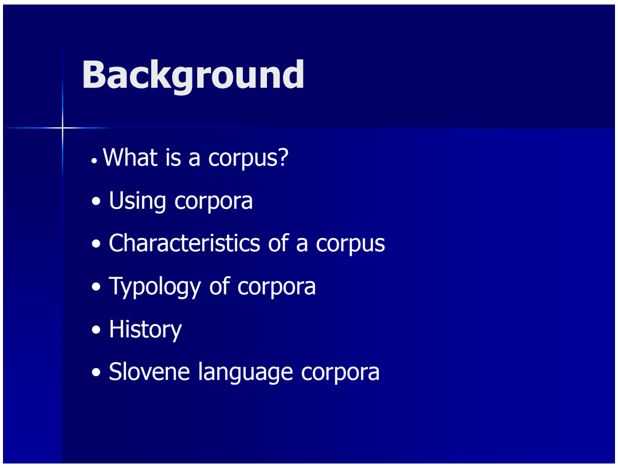


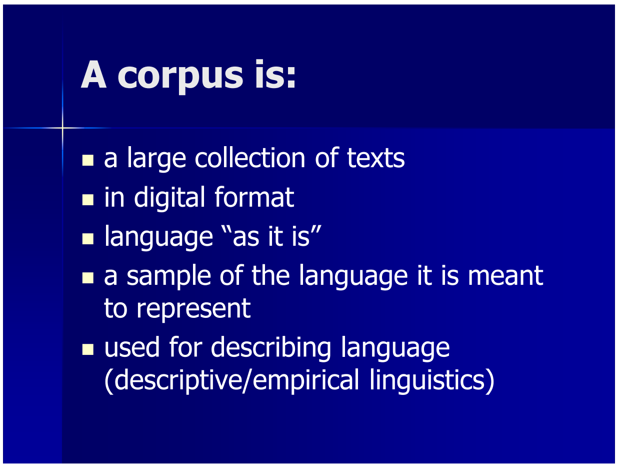
Overview of the lecture

1. Background
2. Corpus compilation and markup
3. Morphosyntactic tagging



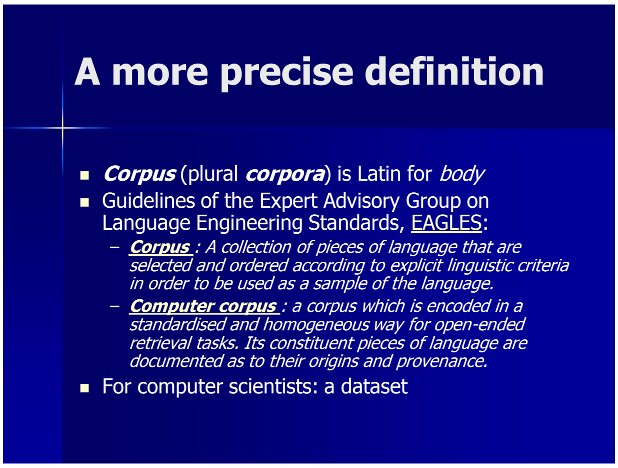
Background

- What is a corpus?
- Using corpora
- Characteristics of a corpus
- Typology of corpora
- History
- Slovene language corpora



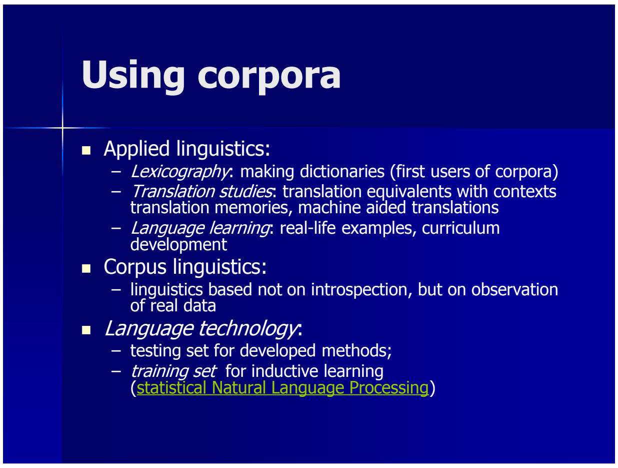
A corpus is:

- a large collection of texts
- in digital format
- language "as it is"
- a sample of the language it is meant to represent
- used for describing language (descriptive/empirical linguistics)



A more precise definition

- ***Corpus*** (plural ***corpora***) is Latin for *body*
- Guidelines of the Expert Advisory Group on Language Engineering Standards, EAGLES:
  - ***Corpus*** *: A collection of pieces of language that are selected and ordered according to explicit linguistic criteria in order to be used as a sample of the language.*
  - ***Computer corpus*** *: a corpus which is encoded in a standardised and homogeneous way for open-ended retrieval tasks. Its constituent pieces of language are documented as to their origins and provenance.*
- For computer scientists: a dataset



Using corpora

- Applied linguistics:
  - *Lexicography*: making dictionaries (first users of corpora)
  - *Translation studies*: translation equivalents with contexts translation memories, machine aided translations
  - *Language learning*: real-life examples, curriculum development
- Corpus linguistics:
  - linguistics based not on introspection, but on observation of real data
- *Language technology*:
  - testing set for developed methods;
  - *training set* for inductive learning (statistical Natural Language Processing)

Characteristics of a (good) corpus

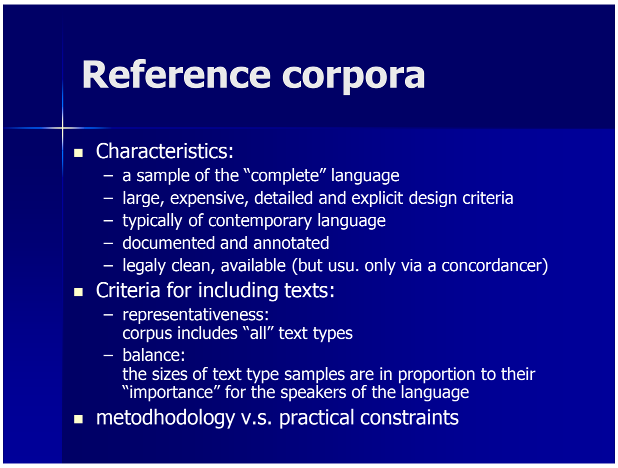
- *Quantity*:
  the bigger, the better
- *Quality* :
  the texts are authentic; the mark-up is validated
- *Simplicity*:
  the computer representation is understandable, with the markup easily separated from the text
- *Documented*:
  the corpus contains bibliographic and other meta-data

Typology of corpora I.

- Medium:
  - *written language*
  - *spoken language* (spoken, but in writing / transcription)
  - *speech corpora* (actual speech signal)
- Content:
  - *reference* corpora (representative), e.g. BNC
  - *sub-language corpora* (specialised), e.g. COLT
- Structure:
  - corpora with *integral* texts
  - corpora or of text *samples* (historical and legal reasons) e.g. Brown

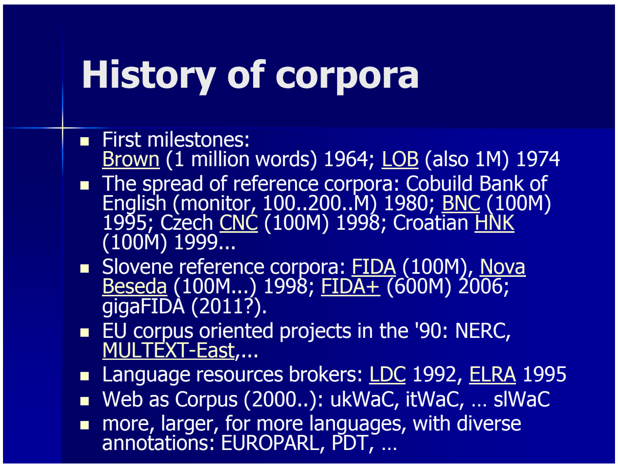
Typology of corpora II

- Time:
  - *static* corpora
  - *monitor* corpora (language change)
- Languages:
  - *monolingual* corpora
  - multilingual *parallel* corpora (e.g. Hansard, Europarl, JRC Acquis)
  - multilingual *comparable* corpora
- Annotation:
  - *plain text* corpora
  - *annotated* corpora



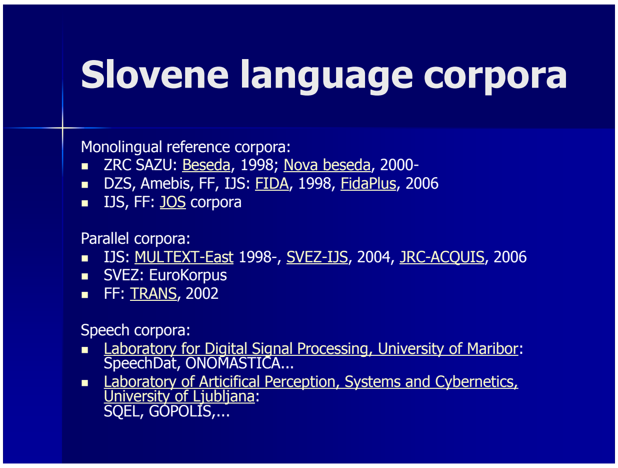
Reference corpora

- Characteristics:
  - a sample of the "complete" language
  - large, expensive, detailed and explicit design criteria
  - typically of contemporary language
  - documented and annotated
  - legaly clean, available (but usu. only via a concordancer)
- Criteria for including texts:
  - representativeness:
    corpus includes "all" text types
  - balance:
    the sizes of text type samples are in proportion to their "importance" for the speakers of the language
- metodhodology v.s. practical constraints



History of corpora

- First milestones:
  Brown (1 million words) 1964; LOB (also 1M) 1974
- The spread of reference corpora: Cobuild Bank of English (monitor, 100..200..M) 1980; BNC (100M) 1995; Czech CNC (100M) 1998; Croatian HNK (100M) 1999...
- Slovene reference corpora: FIDA (100M), Nova Beseda (100M...) 1998; FIDA+ (600M) 2006; gigaFIDA (2011?).
- EU corpus oriented projects in the '90: NERC, MULTEXT-East,...
- Language resources brokers: LDC 1992, ELRA 1995
- Web as Corpus (2000..): ukWaC, itWaC, … slWaC
- more, larger, for more languages, with diverse annotations: EUROPARL, PDT, …



Slovene language corpora

Monolingual reference corpora:

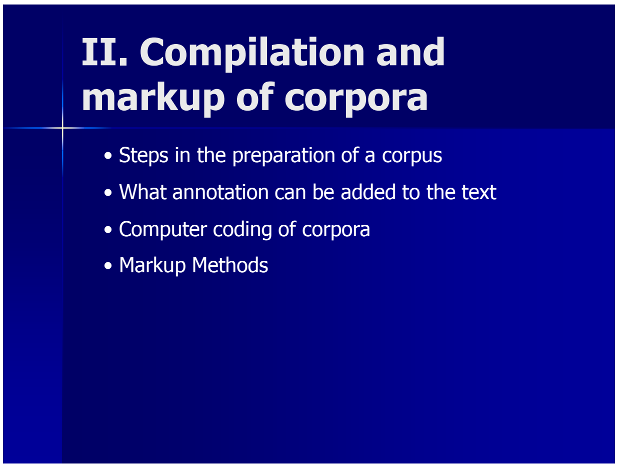
- ZRC SAZU: Beseda, 1998; Nova beseda, 2000-
- DZS, Amebis, FF, IJS: FIDA, 1998, FidaPlus, 2006
- IJS, FF: JOS corpora

Parallel corpora:

- IJS: MULTEXT-East 1998-, SVEZ-IJS, 2004, JRC-ACQUIS, 2006
- SVEZ: EuroKorpus
- FF: TRANS, 2002

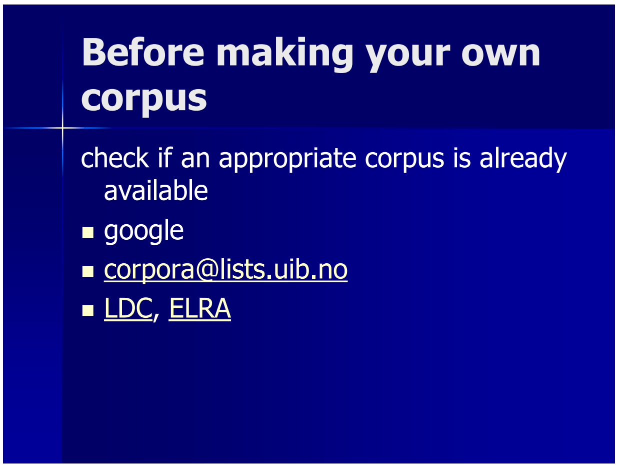
Speech corpora:

- Laboratory for Digital Signal Processing, University of Maribor:
  SpeechDat, ONOMASTICA...
- Laboratory of Articifical Perception, Systems and Cybernetics, University of Ljubljana:
  SQEL, GOPOLIS,...



II. Compilation and markup of corpora

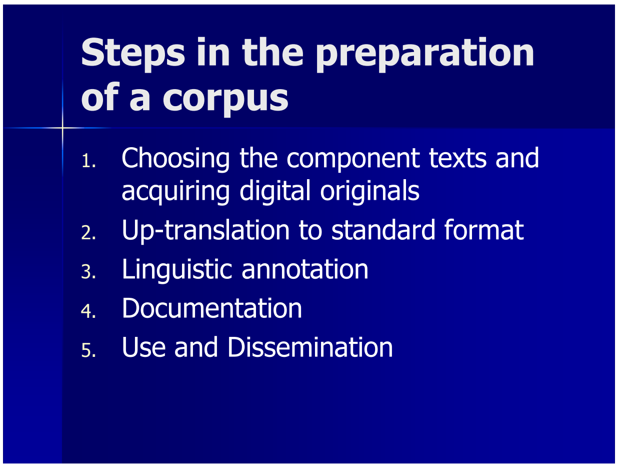
- Steps in the preparation of a corpus
- What annotation can be added to the text
- Computer coding of corpora
- Markup Methods



Before making your own corpus

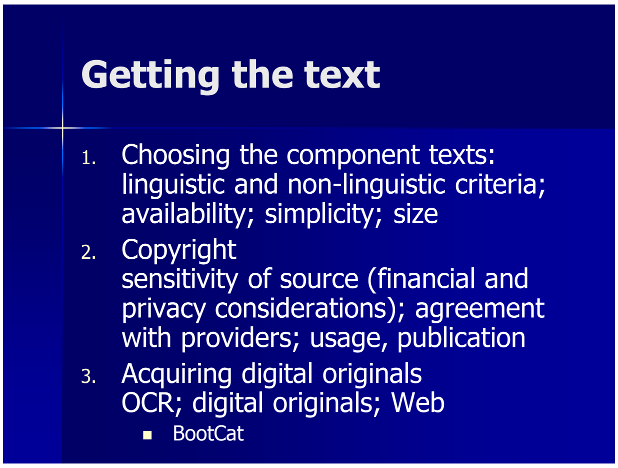
check if an appropriate corpus is already available

- google
- corpora@lists.uib.no
- LDC, ELRA



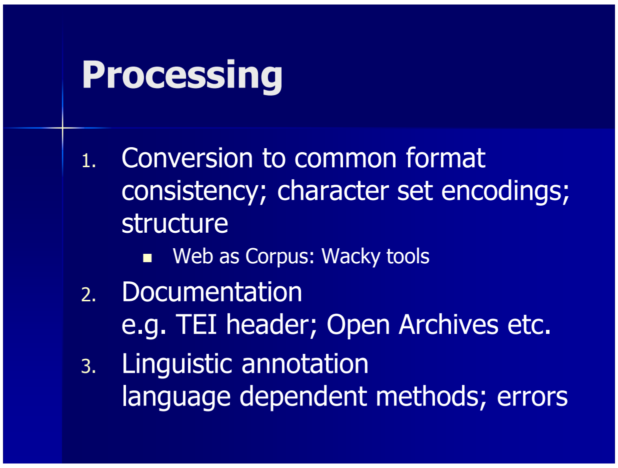
Steps in the preparation of a corpus

1. Choosing the component texts and acquiring digital originals
2. Up-translation to standard format
3. Linguistic annotation
4. Documentation
5. Use and Dissemination



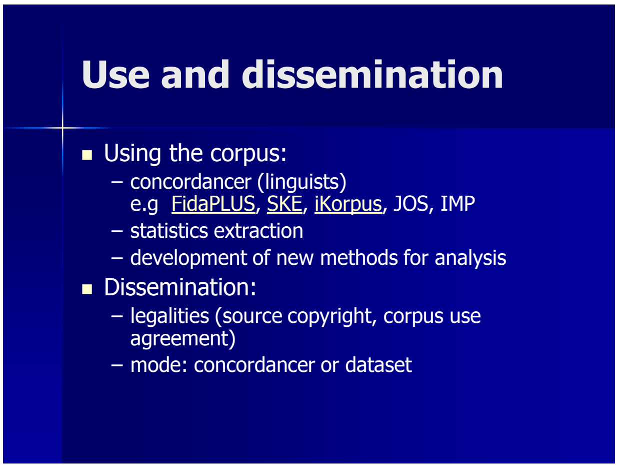
Getting the text

1. Choosing the component texts:
   linguistic and non-linguistic criteria; availability; simplicity; size
2. Copyright
   sensitivity of source (financial and privacy considerations); agreement with providers; usage, publication
3. Acquiring digital originals
   OCR; digital originals; Web
   - BootCat



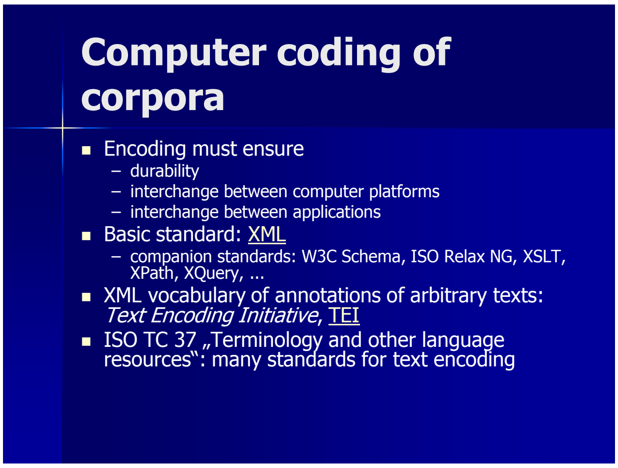
Processing

1. Conversion to common format
   consistency; character set encodings; structure
   - Web as Corpus: Wacky tools
2. Documentation
   e.g. TEI header; Open Archives etc.
3. Linguistic annotation
   language dependent methods; errors



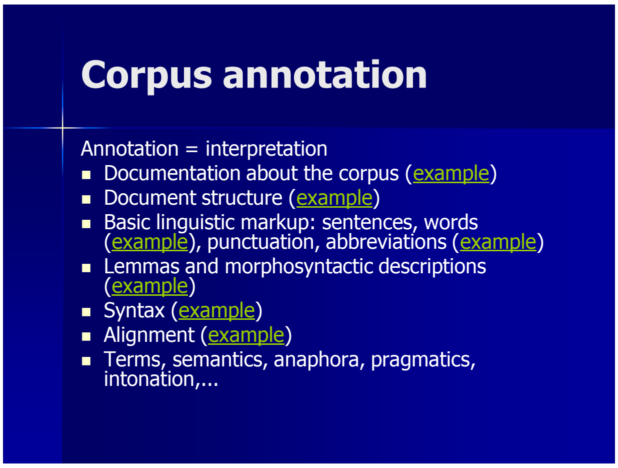
Use and dissemination

- Using the corpus:
  - concordancer (linguists)
    e.g FidaPLUS, SKE, iKorpus, JOS, IMP
  - statistics extraction
  - development of new methods for analysis
- Dissemination:
  - legalities (source copyright, corpus use agreement)
  - mode: concordancer or dataset



Computer coding of corpora

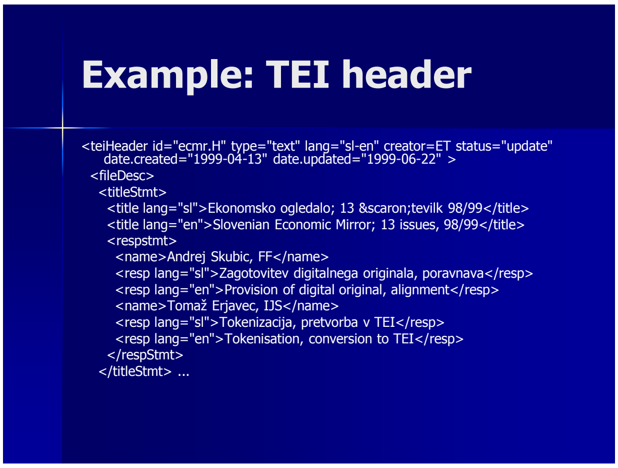
- Encoding must ensure
  - durability
  - interchange between computer platforms
  - interchange between applications
- Basic standard: XML
  - companion standards: W3C Schema, ISO Relax NG, XSLT, XPath, XQuery, ...
- XML vocabulary of annotations of arbitrary texts: *Text Encoding Initiative*, TEI
- ISO TC 37 „Terminology and other language resources“: many standards for text encoding



Corpus annotation

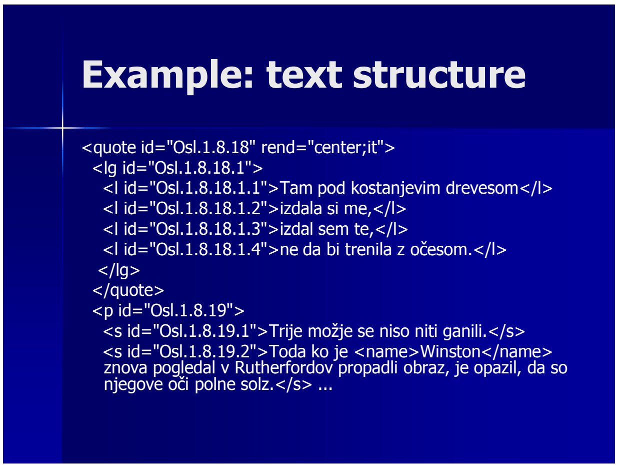
Annotation = interpretation

- Documentation about the corpus (example)
- Document structure (example)
- Basic linguistic markup: sentences, words (example), punctuation, abbreviations (example)
- Lemmas and morphosyntactic descriptions (example)
- Syntax (example)
- Alignment (example)
- Terms, semantics, anaphora, pragmatics, intonation,...



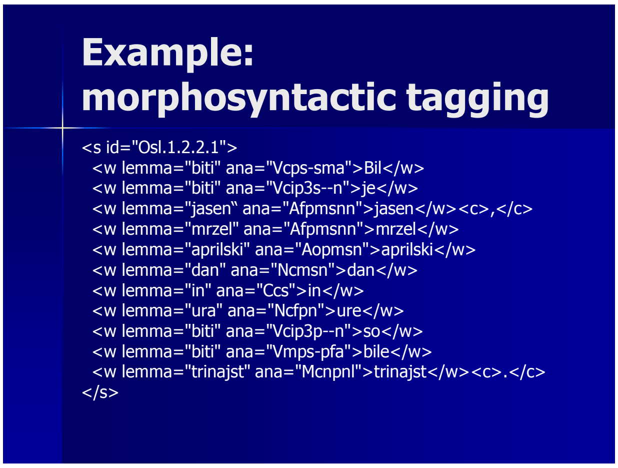
Example: TEI header

```
<teiHeader id="ecmr.H" type="text" lang="sl-en" creator=ET status="update"
    date.created="1999-04-13" date.updated="1999-06-22" >
  <fileDesc>
    <titleStmt>
      <title lang="sl">Ekonomsko ogledalo; 13 &scaron;tevilk 98/99</title>
      <title lang="en">Slovenian Economic Mirror; 13 issues, 98/99</title>
      <respstmt>
        <name>Andrej Skubic, FF</name>
        <resp lang="sl">Zagotovitev digitalnega originala, poravnava</resp>
        <resp lang="en">Provision of digital original, alignment</resp>
        <name>Tomaž Erjavec, IJS</name>
        <resp lang="sl">Tokenizacija, pretvorba v TEI</resp>
        <resp lang="en">Tokenisation, conversion to TEI</resp>
      </respStmt>
    </titleStmt> ...
```



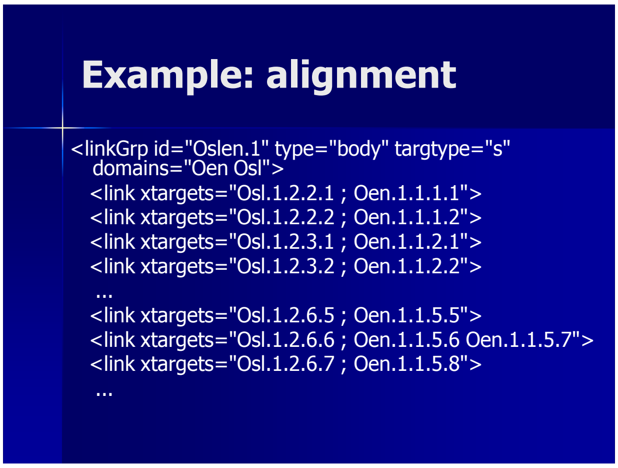
Example: text structure

```
<quote id="Osl.1.8.18" rend="center;it">
  <lg id="Osl.1.8.18.1">
    <l id="Osl.1.8.18.1.1">Tam pod kostanjevim drevesom</l>
    <l id="Osl.1.8.18.1.2">izdala si me,</l>
    <l id="Osl.1.8.18.1.3">izdal sem te,</l>
    <l id="Osl.1.8.18.1.4">ne da bi trenila z očesom.</l>
   </lg>
  </quote>
  <p id="Osl.1.8.19">
    <s id="Osl.1.8.19.1">Trije možje se niso niti ganili.</s>
    <s id="Osl.1.8.19.2">Toda ko je <name>Winston</name>
    znova pogledal v Rutherfordov propadli obraz, je opazil, da so
    njegove oči polne solz.</s> ...
```



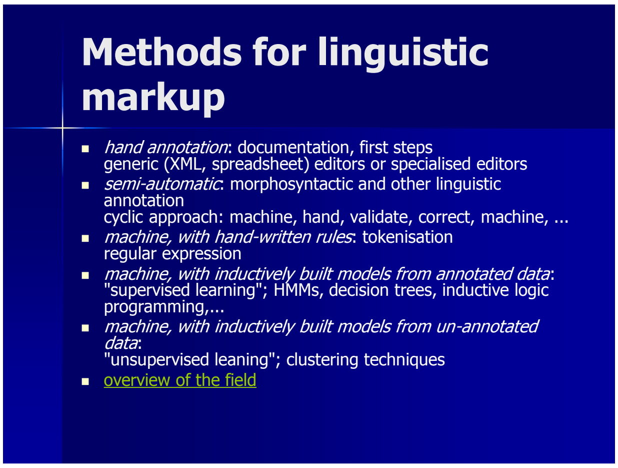
Example: morphosyntactic tagging

```
<s id="Osl.1.2.2.1">
  <w lemma="biti" ana="Vcps-sma">Bil</w>
  <w lemma="biti" ana="Vcip3s--n">je</w>
  <w lemma="jasen“ ana="Afpmsnn">jasen</w><c>,</c>
  <w lemma="mrzel" ana="Afpmsnn">mrzel</w>
  <w lemma="aprilski" ana="Aopmsn">aprilski</w>
  <w lemma="dan" ana="Ncmsn">dan</w>
  <w lemma="in" ana="Ccs">in</w>
  <w lemma="ura" ana="Ncfpn">ure</w>
  <w lemma="biti" ana="Vcip3p--n">so</w>
  <w lemma="biti" ana="Vmps-pfa">bile</w>
  <w lemma="trinajst" ana="Mcnpnl">trinajst</w><c>.</c>
</s>
```



Example: alignment

```
<linkGrp id="Oslen.1" type="body" targtype="s"
  domains="Oen Osl">
  <link xtargets="Osl.1.2.2.1 ; Oen.1.1.1.1">
  <link xtargets="Osl.1.2.2.2 ; Oen.1.1.1.2">
  <link xtargets="Osl.1.2.3.1 ; Oen.1.1.2.1">
  <link xtargets="Osl.1.2.3.2 ; Oen.1.1.2.2">
   ...
  <link xtargets="Osl.1.2.6.5 ; Oen.1.1.5.5">
  <link xtargets="Osl.1.2.6.6 ; Oen.1.1.5.6 Oen.1.1.5.7">
  <link xtargets="Osl.1.2.6.7 ; Oen.1.1.5.8">
   ...
```

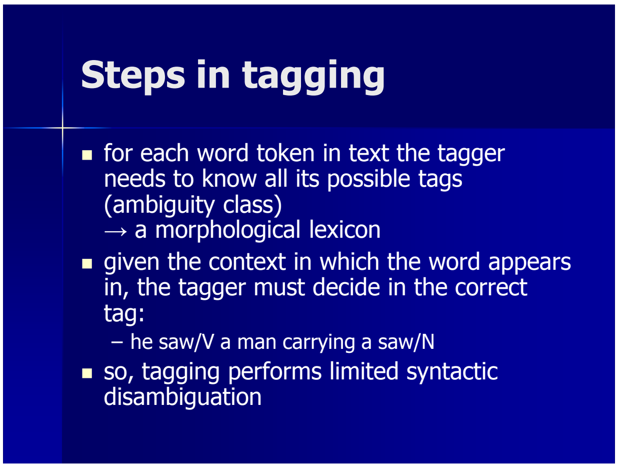


Methods for linguistic markup

- *hand annotation*: documentation, first steps
  generic (XML, spreadsheet) editors or specialised editors
- *semi-automatic*: morphosyntactic and other linguistic annotation
  cyclic approach: machine, hand, validate, correct, machine, ...
- *machine, with hand-written rules*: tokenisation
  regular expression
- *machine, with inductively built models from annotated data*:
  "supervised learning"; HMMs, decision trees, inductive logic programming,...
- *machine, with inductively built models from un-annotated data*:
  "unsupervised leaning"; clustering techniques
- overview of the field

III. Morphosyntactic tagging

- Better known as part-of-speech (PoS) tagging
- Tagging is the task of labeling each word in a sequence of words with its appropriate part-of-speech
- Words are often ambiguous with respect to their POS:
  - *saw* → singular noun „I brought a saw"
  - *saw* → past tense of verb „I saw a tree"
- Purposes and applications (examples):
  - pre-processing step for further analyses:
    - lemmatisation
    - syntactic structure, etc.
  - text indexing, e.g. nouns are more useful than verbs
  - pronunciation in speech processing



Steps in tagging

- for each word token in text the tagger needs to know all its possible tags (ambiguity class)
  → a morphological lexicon
- given the context in which the word appears in, the tagger must decide in the correct tag:
  - he saw/V a man carrying a saw/N
- so, tagging performs limited syntactic disambiguation

Example: Penn Treebank

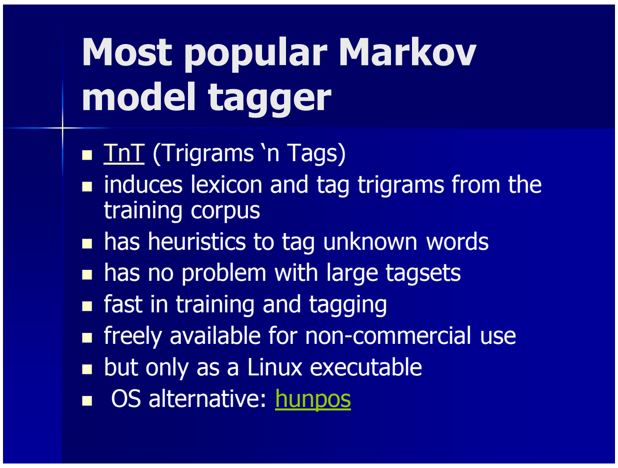
Under/IN the/DT proposal/NN ,/, Delmed/NNP would/MD issue/VB about/IN 123.5/CD million/CD additional/JJ Delmed/NNP common/JJ shares/NNS to/TO Fresenius/NNP at/IN an/DT average/JJ price/NN of/IN about/IN 65/CD cents/NNS a/DT share/NN ,/, though/IN under/IN no/DT circumstances/NNS more/JJR than/IN 75/CD cents/NNS a/DT share/NN ./.

PoS taggers

- Most taggers induce the language model from a hand-annotated corpus
- Typically, two resources are induced:
  - lexicon, giving the ambiguity class of a word and their frequencies in the training corpus
  - tag n-grams

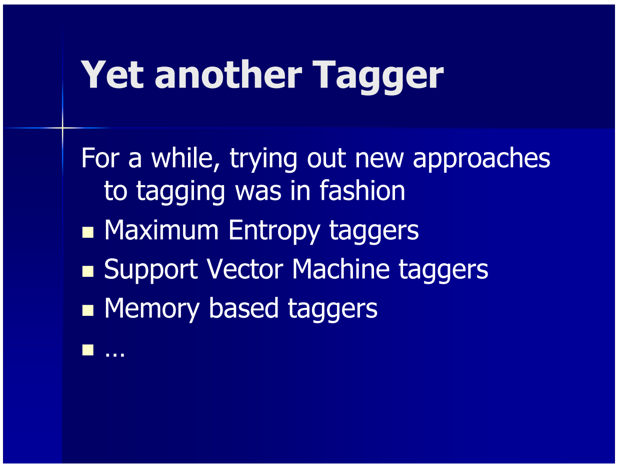
Tagging with Markov Models

- Sequence of tags in a text is regarded a Markov chain
- Limited horizon: A word’s tag only depends on the previous tag: $p(x_{i+1} = t^j \mid x_1, \ldots, x_i) = p\ (x_{i+1} = t^j \mid x_i)$
- Time invariant: This dependency does not change over time: $p(x_{i+1} = t^j \mid x_i) = p(x_2 = t^j \mid x_1)$
- Task: Find the most probable tag sequence for a sequence of words
- Maximum likelihood estimate of tag t^k following t^j: $p(t^k \mid t^j) = f(t^j,t^k) / f(t^j)$
- Optimal tags for a sentence: $t'_{1,n} = arg\ max\ p(t_{1,n} \mid w_{1,n}) = \Pi\ p(w_i \mid t_i)\ p(t_i \mid ti_{-1})$



Most popular Markov model tagger

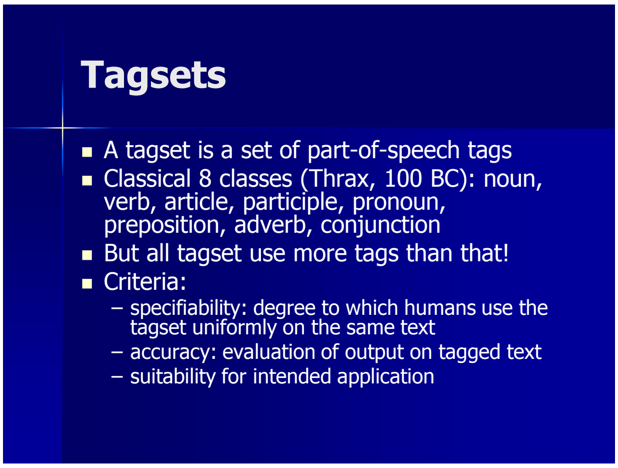
- TnT (Trigrams 'n Tags)
- induces lexicon and tag trigrams from the training corpus
- has heuristics to tag unknown words
- has no problem with large tagsets
- fast in training and tagging
- freely available for non-commercial use
- but only as a Linux executable
- OS alternative: hunpos



Yet another Tagger

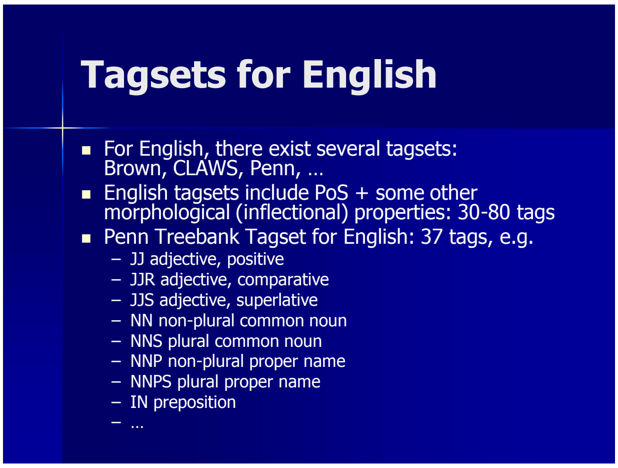
For a while, trying out new approaches to tagging was in fashion

- Maximum Entropy taggers
- Support Vector Machine taggers
- Memory based taggers
- …



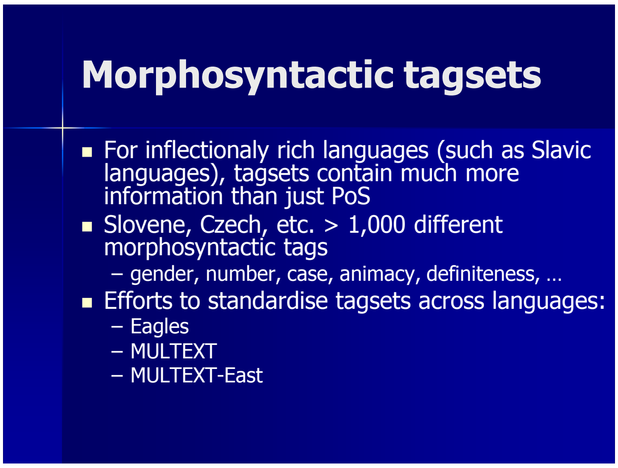
Tagsets

- A tagset is a set of part-of-speech tags
- Classical 8 classes (Thrax, 100 BC): noun, verb, article, participle, pronoun, preposition, adverb, conjunction
- But all tagset use more tags than that!
- Criteria:
  - specifiability: degree to which humans use the tagset uniformly on the same text
  - accuracy: evaluation of output on tagged text
  - suitability for intended application



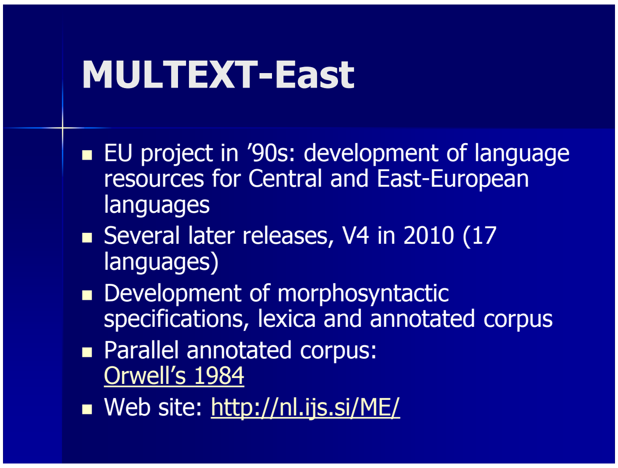
Tagsets for English

- For English, there exist several tagsets: Brown, CLAWS, Penn, …
- English tagsets include PoS + some other morphological (inflectional) properties: 30-80 tags
- Penn Treebank Tagset for English: 37 tags, e.g.
  - JJ adjective, positive
  - JJR adjective, comparative
  - JJS adjective, superlative
  - NN non-plural common noun
  - NNS plural common noun
  - NNP non-plural proper name
  - NNPS plural proper name
  - IN preposition
  - …



Morphosyntactic tagsets

- For inflectionaly rich languages (such as Slavic languages), tagsets contain much more information than just PoS
- Slovene, Czech, etc. > 1,000 different morphosyntactic tags
  - gender, number, case, animacy, definiteness, …
- Efforts to standardise tagsets across languages:
  - Eagles
  - MULTEXT
  - MULTEXT-East



MULTEXT-East

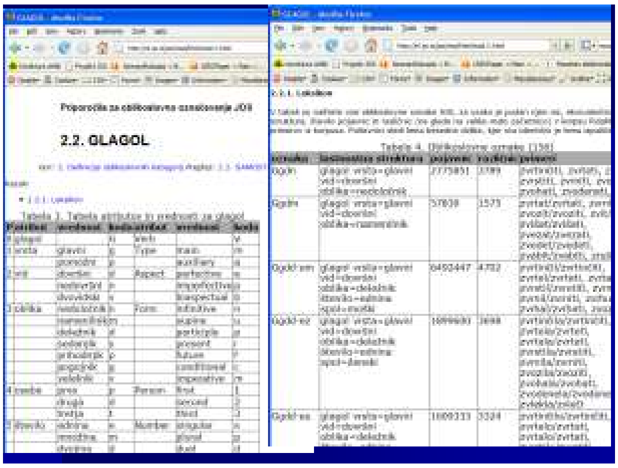
- EU project in '90s: development of language resources for Central and East-European languages
- Several later releases, V4 in 2010 (17 languages)
- Development of morphosyntactic specifications, lexica and annotated corpus
- Parallel annotated corpus: Orwell's 1984
- Web site: http://nl.ijs.si/ME/

MULTEXT-East morphosyntactic specifications

- Specify
  - what morphosyntactic features particular languages distinguish,
  - what their names and values are,
  - how they can be mapped to tags (morphosyntactic descriptions, MSDs)
- e.g. that *Ncms* is:
  - a valid for Slovene
  - is equivalent to *PoS:Noun, Type:common, Gender:masculine, Number:singular*
- http://nl.ijs.si/ME/V4/msd/html/

JOS project

- JOS language resources are meant to facilitate developments of human language technologies and corpus linguistics for the Slovene language
- Morphosyntactic specifications
- Two annotated corpora (morphosyntactic descriptions and lemmas)
  - jos100k (hand validated)
  - jos1M (partially hand validated)
- Sampled from FidaPLUS corpus
- jos100k: syntactic and semantic levels of linguistic description
- Two web services
  - concordancer
  - text annotation tool
- Encoded in TEI P5
- Freely available (CC): http://nl.ijs.si/jos/



Priporočila za oblikoskladenjsko označevanje JOS

2.2. GLAGOL

- 2.2.1. Lastnosti

Tabela 1. Tabela atributov in vrednosti za glagol

Položaj	vrednost	koda	atribut	vrednost	koda
0 glagol		G	Verb		V
1 vrsta	glavni	g	Type	main	m
	pomožni	p		auxiliary	a
2 vid	dovršni	d	Aspect	perfective	e
	nedovršni	n		imperfective	p
	dvovidski	v		biaspectual	b
3 oblika	nedoločnik	n	Form	infinitive	n
	namenilnik	m		supine	u
	deležnik	d		participle	p
	sedanjik	s		present	r
	prihodnjik	p		future	f
	pogojnik	g		conditional	c
	velelnik	v		imperative	m
4 oseba	prva	p	Person	first	1
	druga	d		second	2
	tretja	t		third	3
5 število	ednina	e	Number	singular	s
	množina	m		plural	p
	dvojina	d		dual	d

2.2.1. Leksikon

[illegible]

Tabela 4. Oblikoslovne oznake [138]

oznaka	lastnostna struktura	pojavnic	različnic	primeri

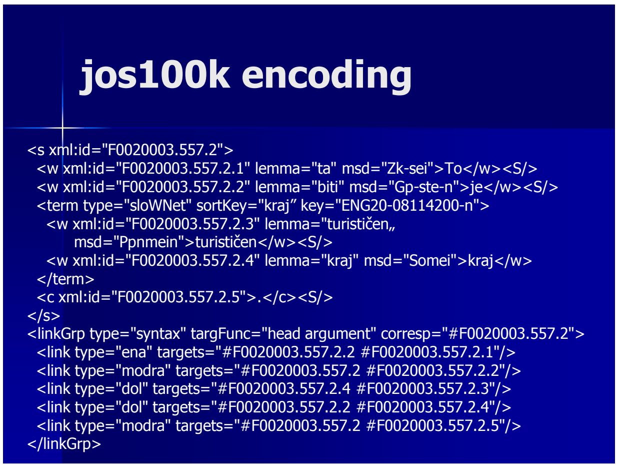
Ggdn	glagol vrsta=glavni
	vid=dovršni
	oblika=nedoločnik
		2775851	2789	zvrtinčiti, zvrtati, z
				zvestiti, zvoziti, zv
				zvohati, zvoderati,

Ggdm	glagol vrsta=glavni
	vid=dovršni
	oblika=namenilnik
		57838	1575	zvrtat/zvrtati, zvrt
				zvozit/zvoziti, zvit
				zvibat/zvibati,
				zvezat/zvezati,
				zvedet/zvedeti,
				zvabit/zvabiti, zrsl

Ggdd-em	glagol vrsta=glavni
	vid=dovršni
	oblika=deležnik
	število=ednina
	spol=moški
		6450447	4702	zvrtinčil/zvrtinčiti,
				zvrtal/zvrtati, zvrta
				zvrstil/zvrstiti, zvr
				zvrtil/zvrtiti, zvoha
				zvihal/zvihati, zvoz

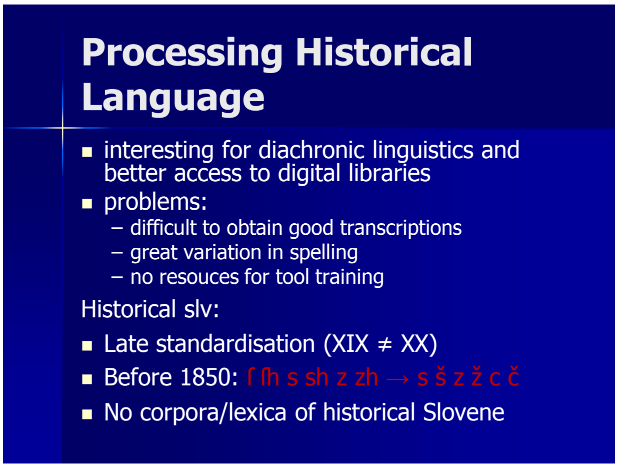
Ggdd-ez	glagol vrsta=glavni
	vid=dovršni
	oblika=deležnik
	število=ednina
	spol=ženski
		1899681	3698	zvrtinčila/zvrtinčiti,
				zvrtela/zvrteti,
				zvrtala/zvrtati,
				zvrstila/zvrstiti,
				zvrnila/zvrniti,
				zvozila/zvoziti,
				zvohala/zvohati,
				zvoderala/zvoderati,
				zvlekla/zvleči

Ggdd-es	glagol vrsta=glavni
	vid=dovršni
	oblika=deležnik
		1809233	3324	zvrtinčilo/zvrtinčiti,
				zvrtelo/zvrteti,
				zvrtalo/zvrtati,



jos100k encoding

```
<s xml:id="F0020003.557.2">
  <w xml:id="F0020003.557.2.1" lemma="ta" msd="Zk-sei">To</w><S/>
  <w xml:id="F0020003.557.2.2" lemma="biti" msd="Gp-ste-n">je</w><S/>
  <term type="sloWNet" sortKey="kraj” key="ENG20-08114200-n">
    <w xml:id="F0020003.557.2.3" lemma="turističen„
          msd="Ppnmein">turističen</w><S/>
    <w xml:id="F0020003.557.2.4" lemma="kraj" msd="Somei">kraj</w>
  </term>
  <c xml:id="F0020003.557.2.5">.</c><S/>
</s>
<linkGrp type="syntax" targFunc="head argument" corresp="#F0020003.557.2">
  <link type="ena" targets="#F0020003.557.2.2 #F0020003.557.2.1"/>
  <link type="modra" targets="#F0020003.557.2 #F0020003.557.2.2"/>
  <link type="dol" targets="#F0020003.557.2.4 #F0020003.557.2.3"/>
  <link type="dol" targets="#F0020003.557.2.2 #F0020003.557.2.4"/>
  <link type="modra" targets="#F0020003.557.2 #F0020003.557.2.5"/>
</linkGrp>
```

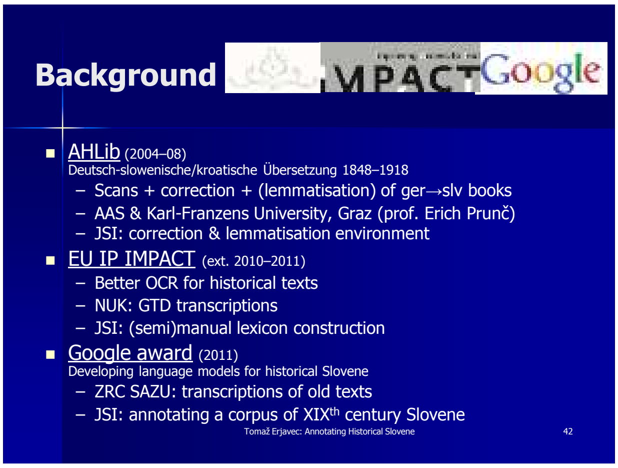


Processing Historical Language

- interesting for diachronic linguistics and better access to digital libraries
- problems:
  - difficult to obtain good transcriptions
  - great variation in spelling
  - no resouces for tool training

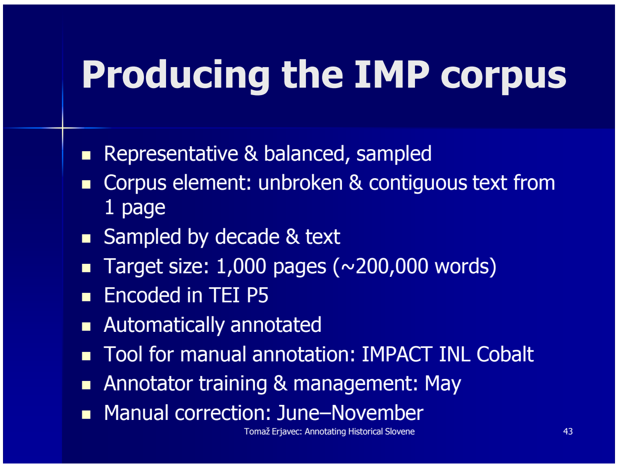
Historical slv:

- Late standardisation (XIX ≠ XX)
- Before 1850: ſ ſh s sh z zh → s š z ž c č
- No corpora/lexica of historical Slovene



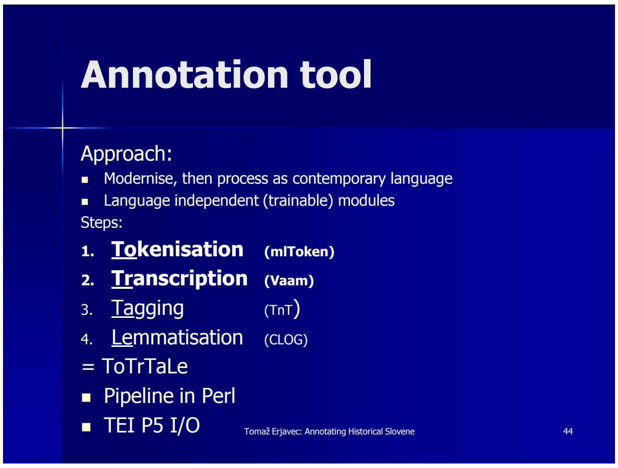
Background

- AHLib (2004–08)
  Deutsch-slowenische/kroatische Übersetzung 1848–1918
  - Scans + correction + (lemmatisation) of ger→slv books
  - AAS & Karl-Franzens University, Graz (prof. Erich Prunč)
  - JSI: correction & lemmatisation environment
- EU IP IMPACT (ext. 2010–2011)
  - Better OCR for historical texts
  - NUK: GTD transcriptions
  - JSI: (semi)manual lexicon construction
- Google award (2011)
  Developing language models for historical Slovene
  - ZRC SAZU: transcriptions of old texts
  - JSI: annotating a corpus of XIXth century Slovene



Producing the IMP corpus

- Representative & balanced, sampled
- Corpus element: unbroken & contiguous text from 1 page
- Sampled by decade & text
- Target size: 1,000 pages (~200,000 words)
- Encoded in TEI P5
- Automatically annotated
- Tool for manual annotation: IMPACT INL Cobalt
- Annotator training & management: May
- Manual correction: June–November



Annotation tool

Approach:

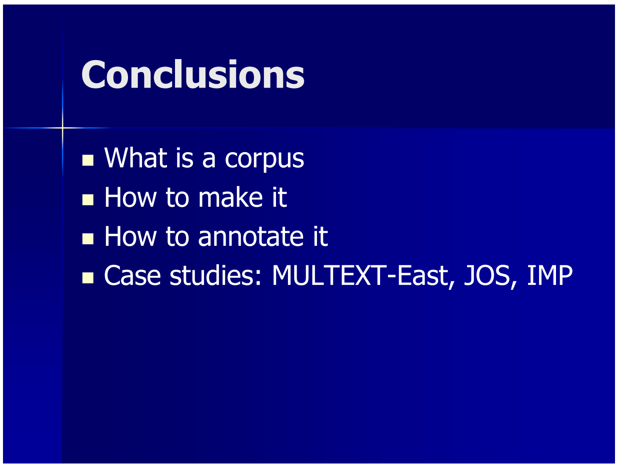
- Modernise, then process as contemporary language
- Language independent (trainable) modules

Steps:

1. **Tokenisation (mlToken)**
2. **Transcription (Vaam)**
3. Tagging (TnT)
4. Lemmatisation (CLOG)

= ToTrTaLe

- Pipeline in Perl
- TEI P5 I/O



Conclusions

- What is a corpus
- How to make it
- How to annotate it
- Case studies: MULTEXT-East, JOS, IMP