

# RUSSIAN VERBAL ASPECT AND MACHINE TRANSLATION

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# Introduction

- Statistical machine translation
  - great progress
  - big corpora necessary
  
- Rule-based machine translation
  - source for theoretical linguistics
  - verification: correct theory → correct translations

# Rules for Aspect?

- Grammatical aspect in Russian
    - polysemous
    - no 1:1 categorical equivalent in other languages
- ⇒ problematic for machine translation

# Interpretation

- some interpretations of ipf:
  - actual-processual
  - conative
  - habitual
  - atemporal
  - general-factual
  - durative
  - ...
- some interpretations of pf:
  - event
  - perfect
  - pluperfect
  - ...

# Systematization of aspect interpretations

- time-relational analysis (Klein 1995)
    - topic time interval I(TT) [time about which an assertion is made]
    - event time interval I(e) [(part of) time of the situation]
    - e.g. *Ivan rabotal, rabotaet i budet rabotat' v Moskve.*  
'Ivan worked, works, and will work in Moscow.'
  - selection-theoretic basis (Bickel 1996)
    - aspect – verbal basis: operator – operandum
    - aspect selects (asserts) specific parts of the verbal basis
  - event structure (Moens & Steedman 1988)
    - dynamic phase ( $\varphi_{\text{dyn}}$ ) – culmination ( $\tau$ ) – consequent state ( $\varphi_{\text{stat}}$ )
    - e.g. *Ivan mne daval knigu a potom ne dal.* (Klein 1995)  
'Ivan me give.PAST.ipf book and then not give.PAST.pf.'
- ⇒ Aspect operators select specific part(s) of the event structure (verb)

# Polysemy and ambiguity

- perfective aspect

- semantic basis:  $I(TT) \supset I(\tau)$  [ $\tau$  is selected]
- specification: boundaries of  $I(TT)$

- (1)
- |   |                           |
|---|---------------------------|
| a. Ja emu <i>dal</i> knigu.                       |                           |
| b. I <i>gave</i> him the book [and then ...]      | $I(TT)$ closed            |
| c. I <i>have given</i> him the book [and now ...] | $I(TT)$ open to the right |
| d. [After] I <i>had given</i> him the book ...    | $I(TT)$ open to the left  |

# Polysemy and ambiguity

- imperfective aspect

- semantic basis:  $I(TT) \circ I(e)$  [overlap]
- specification: selection part  $(\varphi_{\text{dyn}}, e, (\varphi_{\text{stat}}))$ ;  $I(TT)$  boundaries

(2) a.  $I(TT) \subset I(\varphi_{\text{dyn}})$

Kogda on vošel, ona *čitala* knigu.

‘When he came in, she *was reading* a book.’

$[I(\varphi_{\text{dyn}})$ : the time interval of her reading the book, covering only this process excluding beginning or end;

$I(TT)$  is included in the reading-process and specified by the moment when he came in]

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(2) b.  $I(TT) = I(e)$

Ona *rabotala* v universitete.

'She *worked* at the university.' [= She was employed there.]

[ $I(e)$ : the time interval when she was employed at the university;  
 $I(TT)$  runs exactly parallel to the time interval of her working at the university]



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(2) c.  $I(TT) \supset I(e)$

Ona uže *rasskazyvala* emu ètu istoriju.

‘She *has* already *told* him this story.’

[ $I(e)$ : the time interval of her telling the story;

$I(TT)$  includes the complete story-telling event]

# Polysemy and ambiguity

- ambiguity: distinct relations
- polysemy: range of interpretations of these relations

⇒ cross-linguistic justification

# Cross-linguistic evidence

- ambiguity in Russian – morphological differentiation in other languages
  - ambiguity (and polysemy) of **pf aspect**

<b>semantics</b>	<b>interpretation</b>	<b>Russian</b>	<b>English</b>	<b>German</b>
group I <sub>pf</sub> TT closed: [---τ---]	eventive	pf	simple past	imperfect / perfect
group II <sub>pf</sub> TT right open: [---τ---[	perfect (existential, current relevance, extended now, etc.)	pf	perfect	perfect
group III <sub>pf</sub> TT left open: ]--- τ---]	pluperfect	pf	pluperf.	pluperfect

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  - ambiguity (and polysemy) of **ipf aspect**

semantics	interpretation	Russian	English	Turkish
group I <sub>ipf</sub> $TT \subset \varphi_{\text{dyn}}$	processual, conative	ipf	progressive	-iyordu -mekteydi
group II <sub>ipf</sub> $TT = e$	habitual, non-actual, potential, permanent, atemporal	ipf	simple form	-irdi
group III <sub>ipf</sub> $TT \supset e$	general-factive, durative	ipf	simple form	-di

# Disambiguation

- machine translation
  - relevant: cross-linguistic perspective  $\Rightarrow$  solve basic ambiguities
  - [language-internal perspective: interpretational range (polysemy)]

# Disambiguation

- machine translation
    - relevant: cross-linguistic perspective  $\Rightarrow$  solve basic ambiguities
    - [language-internal perspective: interpretational range (polysemy)]
  - automatic disambiguation
    - specification of
      - boundaries of I(TT)
      - selected part of verbal basis, i.e. internal structure of I(TT)
    - specification by
      - lexical means (verb semantics, adverbials, etc.)
      - syntactic means (connectors, syntagmatic restrictions, etc.)
- $\Rightarrow$  basis: syntactic and semantic features provided by ETAP-3

# Aspectually relevant semantic / syntactic features in dictionaries of ETAP

- used mainly for syntactic analysis
- semantic features, e.g.:
  - 'VREMJA' ('time'): temporal lexemes
  - 'DEJSTVIE' ('action'): action which develops in time and which is initiated by an active subject
  - 'PROCESS': process which develops in time and which is initiated by a passive subject
  - etc.
- syntactic features, e.g.:
  - 'DLIT' ('duration'): period of time
  - 'NEOPR' ('indetermination'): indefinite pronouns
  - etc.

# Classification of predicates (Apresjan 2006)

- 17 classes, e.g.:
- ‘dejatel'nosti’ (‘activities’): actual-processual and general-factual readings are ruled out, whereas durative interpretation is most likely → ‘group II<sub>ipf</sub>’ can be assigned in lexical entries
- ‘dejstvija’ (‘actions’): less explicit, allows for all possible ipf interpretations → further information provided by aspectually relevant components has to be taken into account (adverbials, particles, conjunctions)
- etc.



# Towards a solution: an example

- (3)      *Ran'she ja po večeram prodelyval èti gimnastičeskie upražnenja po pjat' raz.*  
*lit.* ‘formerly I in evenings do.PAST.ipf these gymnastic exercises each five times’

Lexemes and phrases that are important for aspectual interpretation:

- *ran'she* ‘formerly’
- *po večeram* ‘in the evenings’
- *prodelyvat'* ‘[to] do’
- *upražnenie* ‘exercise’
- *po pjat' raz* ‘five times each’

# Aspectually relevant information

- *ran'she* ‘formerly’: semantic features: ‘temporally indefinite’, ‘referentially indefinite’ (excludes group I<sub>ipf</sub> interpretations)
- *po [večeram]* ‘in [the evenings]’: semantic feature (*po16*): ‘regularity’ (excludes group I<sub>ipf</sub> and group III<sub>ipf</sub> interpretations)
- *prodelyvat'* ‘[to] do’: aspectual information: ipf
- *upražnenie* ‘exercise’: ‘zanjatie’ (‘occupation’, cf. Ju.D. Apresjan 2006: action whose immediate object is just to accomplish this action); (in combination with ipf: allows for group I<sub>ipf</sub>, II<sub>ipf</sub> and III<sub>ipf</sub> interpretations)
- *po [pjat' raz]* ‘[five times] each’: semantic feature (*po20*): ‘distributive’ (allows for group I<sub>ipf</sub>, II<sub>ipf</sub>, III<sub>ipf</sub> interpretations)

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# Interpretation

- language internal:
  - IF predicate has feature 'occupation'
  - AND IF aspect = ipf
  - AND IF tense = past
  - AND IF adverb 'group II<sub>ipf</sub>'
  - THEN 'group II<sub>ipf</sub>' interpretation
- translation:
  - IF 'group II<sub>ipf</sub>' interpretation
  - THEN 'simple form' in English

# Conclusion

- selection-theoretic and time-relational account
- groups specifying boundaries of I(TT) and the relation between I(TT) and I(e)
- annotation of lexemes with specific, aspectually relevant information
- system of semantic and syntactic features (ETAP)
- classification of predicates (Apresjan 2006)
- “calculation” of aspect interpretation (formalized as conditional instructions)
- problem: interaction with previous/following sentence ...

# Future work

- classification of verbal and nominal predicates (first step: restricted set of predicates as test basis)
- refined system of semantic features for verbs, predicative nouns, adverbials, particles and conjunctions (first step: restricted set)
- development and implementation of rules for aspect disambiguation and translation
- verification of the linguistic theory in practice
- improvement of the theory.

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