Computer Aided Translation a User Study

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OUR FOCUS

Goal: Helping Human Translators

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- How can machine translation help human translators?
- First question: What do translators do?

Setup

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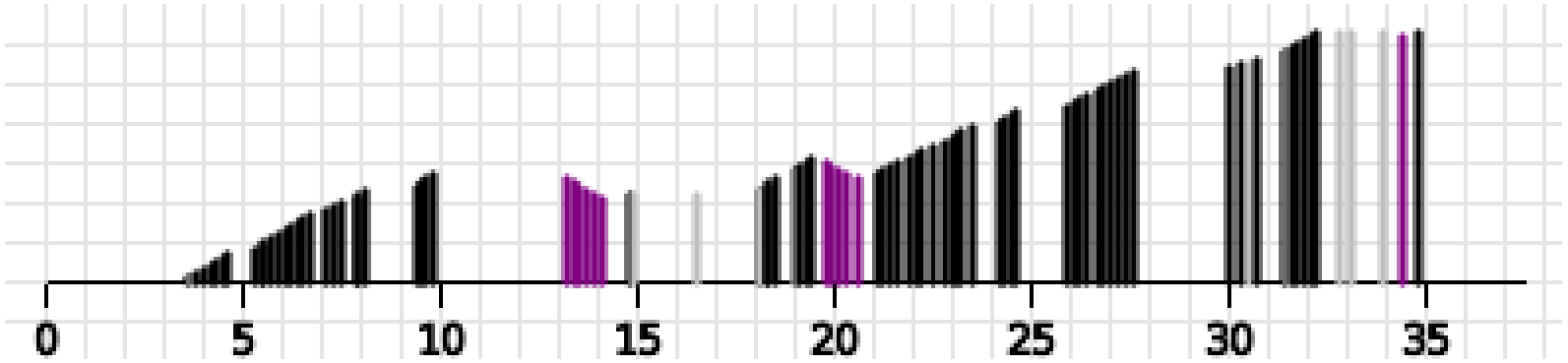
- 10 students at the University of Edinburgh
  - half native French speakers
  - half native English speakers with advanced French
- Each student translated
  - news stories
  - French-English
  - about 40 sentences
  - easy task: familiar content, no specialized terminology
- Keystroke log

Keystroke Log

Input: Au premier semestre, l'avionneur a livr 97 avions.
Output: The manufacturer has delivered 97 planes during the first half.



(37.5 sec, 3.4 sec/word)

black: keystroke, purple: deletion, grey: cursor move
height: length of sentence

Analysis

- We can observe
  - slow typing

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  - beginning pause: reading the input sentence
  - final pause: reviewing the translation
  - short pauses (2-6 seconds): hesitation
  - medium pauses (6-60 seconds): problem solving
  - big pauses (>60 seconds): serious problem

Time Spent on Activities

User	total	Pauses initial	final	short	medium	big	keystroke
L2a	3.3s	0.1s	0.1s	0.2s	1.0s	0.1s	1.8s
L2b	7.7s	1.3s	0.1s	0.3s	1.8s	1.9s	2.3s
L2c	3.9s	0.2s	0.2s	0.3s	0.7s	-	2.5s
L2d	2.8s	0.2s	0.0s	0.2s	0.4s	0.1s	1.8s
L2e	5.2s	0.3s	0.0s	0.3s	1.9s	0.5s	2.2s
L1a	5.7s	0.5s	0.1s	0.3s	1.8s	0.7s	2.2s
L1b	3.2s	0.1s	0.1s	0.2s	0.4s	0.1s	2.2s
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L2 = native French, L1 = native English

average time per input word

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not much time

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		not much time		Pauses	differences		similar
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Pauses Reconsidered

- Our classification of pauses is arbitrary (2-6sec, 6-60sec, >60sec)

- Extreme view: all you see is pauses
  - keystrokes take no observable time
  - all you see is pauses between action points

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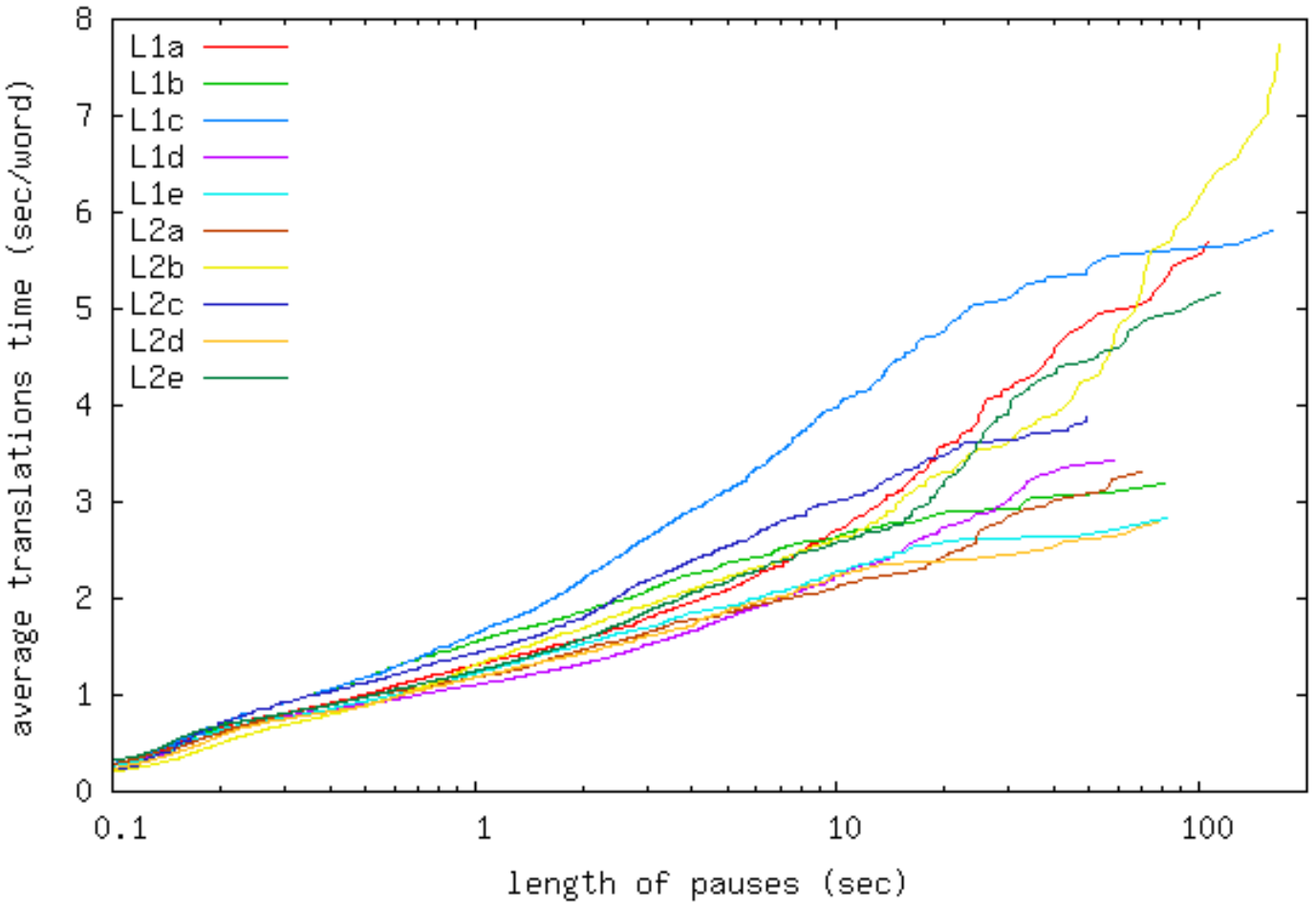
- Visualizing range of pauses:

  time t spent in pauses $p \in P$ up to a certain length l

$$sum(t) = \frac{1}{Z} \sum_{p \in P, l(p) \leq t} l(p)$$

Results


L1a
L1b
L1c
L1d
L1e
L2a
L2b
L2c
L2d
L2e
average translations time (sec/word)
length of pauses (sec)
0
1
2
3
4
5
6
7
8
0.1
1
10
100

Related Work: Tools used by Translators

- Translators often use standard text editors and additional tools
- Bilingual dictionary
- Spell checker, grammar checker
- Monolingual concordancer
- Terminology database
- Web search to establish and verify meaning of terms

Translation Memory

- Source:

  This feature is available for free in the QX 3400.

- Fuzzy match in translation memory:

  This feature is available for free in the QX 3200.
  Diese Funktion ist kostenlos im Modell QX 3200 verfügbar.

- Translator inspects the fuzzy match and uses it in her translation.

Bilingual Concordancer

Examples	Windkraft (noun, feminine) (also: Windenergie)	wind power (noun)	
	Zum Vergleich: **Windkraft** schafft fast sieben Mal mehr. German: www.goethe.de/wis/umw/thm/ntr/de92305.htm	By way of comparison, **wind power** generates almost seven times as much. English: www.goethe.de/wis/umw/thm/ntr/en92305.htm	
	Einführung von Windcube, einer neuen Generation von Wind Lidar für **Windkraft.** German: www.husumwindenergy.com/index.php?L...howUid]=1177	Introducing Windcube, a new generation of **wind** Lidar for **wind power.** English: www.husumwindenergy.com/index.php?L...howUid]=1177	
	Windkraft ist eine etablierte, wettbewerbsfähige Technologie mit hoher Zuverlässigkeit German: www.powergeneration.siemens.de/abou...ns-services/	**Wind power** is an established, competitive technology with high reliability English: www.powergeneration.siemens.com/abo...ns-services/	
Examples	Windkraft (noun, feminine) (also: Windenergie)	wind energy (noun)	
	Je mehr aber klimapolitische Sonntagsreden von der Politik auch in Taten umgesetzt werden, desto höher steigt dieser Preis und desto wettbewerbsfähiger werden saubere Energien wie die **Windkraft.** German: emagazine.credit-suisse.com/app/art...4382 (=DE	But as the focus of the climate change issue shifts increasingly from policy to action, this price will increase and cleaner **energy** sources like **wind** will become more competitive. English: emagazine.credit-suisse.com/app/art...4382 (=en	
	Nur wenige befürchten hingegen, dass dies auch bei erneuerbaren Energieträgern wie Biomasse oder **Windkraft** der Fall sein wird. German: www.eu2006.gv.at/de/News/Press_Rele...1proell.html	However, only a few fear that this will also be the case with renewable **energy** sources such as biomass or **wind energy.** English: www.eu2006.gv.at/en/News/Press_Rele...1proell.html	

show translations in context (www.linguee.com)

Our Types of Assistance

- Sentence completion
  - tool suggests how to complete the translation
  - one phrase at a time

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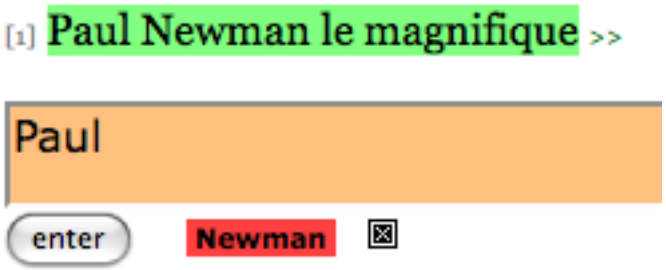
- Postediting machine translation
  - start with machine translation output
  - user edits, tool shows changes

Technical Notes

- Online at `http://www.caitra.org/`
- User uploads source text, translates one sentence at a time
- Implementation
  - AJAX Web 2.0 using Ruby on Rails, mySQL
  - Back end: Moses machine translation system

Predicting Sentence Completion



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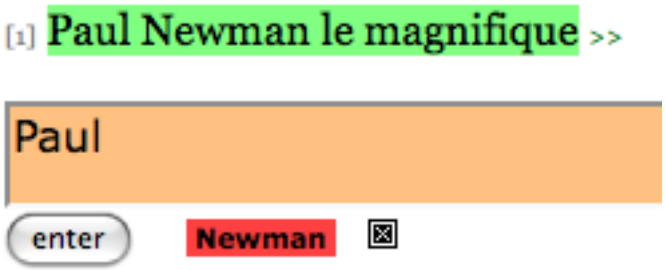

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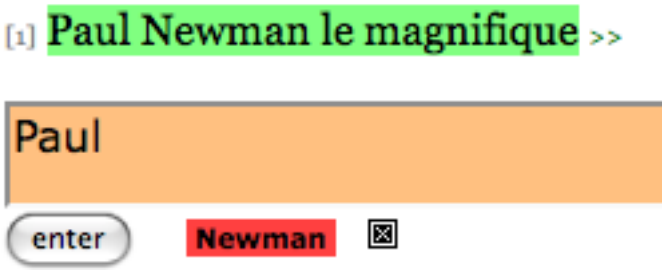

- Tool makes a suggestion how to continue (in red)
- User can accept it (by pressing TAB), or type in her own translation
- Same idea as TransType, with minor modifications
  - show only short text chunks, not full sentence completion
  - show only one suggestion, not alternatives

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- Matches partial user translation against search graph, by optimizing
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- Technical notes
  - search graph is pre-computed and stored in database
  - matching is done server-side, typically takes less than 1 second
  - completion path is returned to client (web brower)

Translation Options

Paul	Newman	le	magnifique
Paul	**Newman**	**the**	**wonderful**
Mr	Newman ,	**the magnificent**	
Mr Paul	Newman here	the wonderful	
as Paul	Committee		beautiful
another	Newman , who speaks		magnificent
with Paul		the splendid	
, Paul		the excellent	
of Paul		the beautiful	
work of Paul			It
the words of Paul			great

- For each word and phrases: suggested translations
- Ranked (and color-highlighted) by probability
- User may click on suggestion → appended to text box

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  - conditional probabilities $\phi(\bar{e}|\bar{f})$, $\phi(\bar{f}|\bar{e})$
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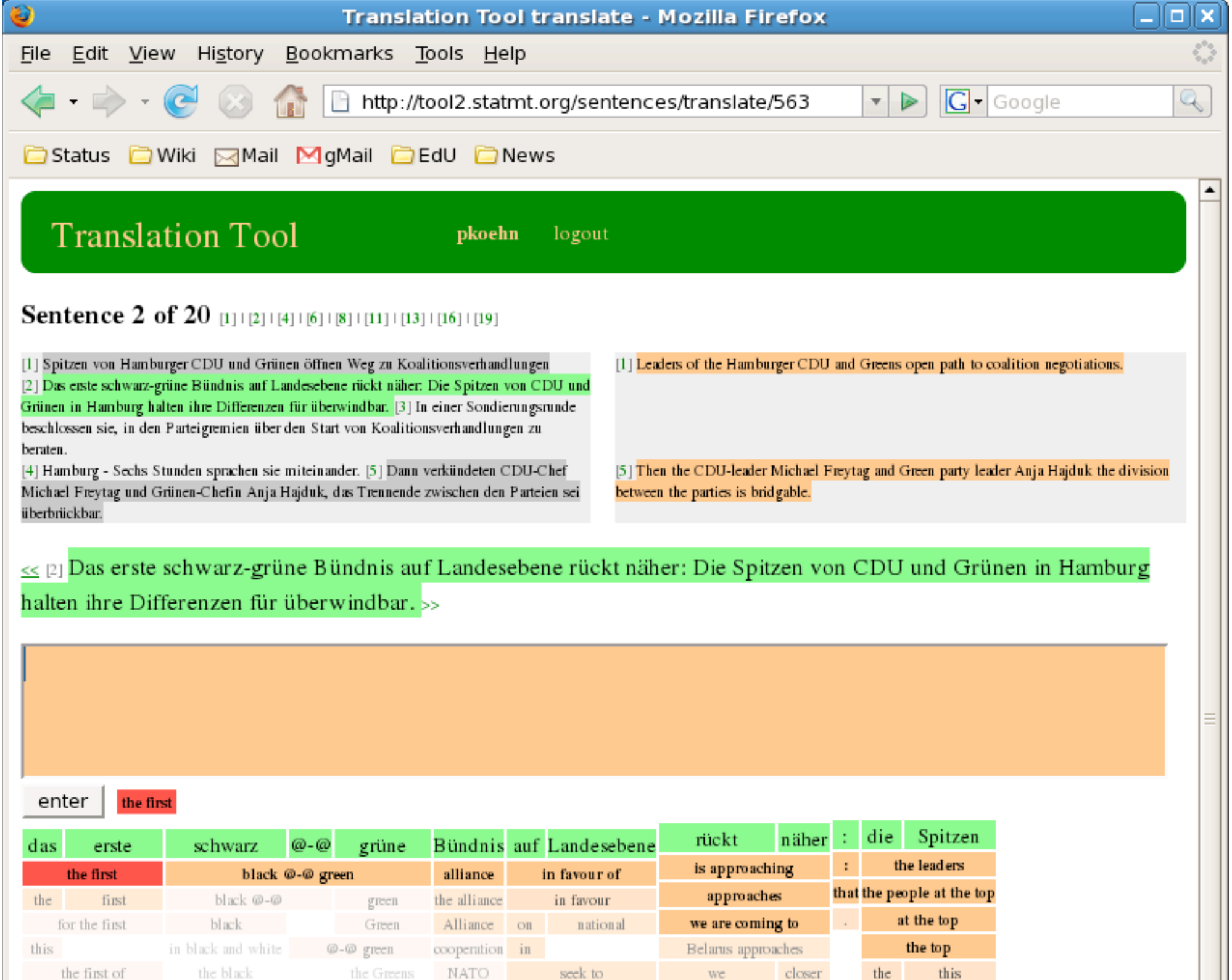
- Ranking of shorter vs. longer phrases by including outside future cost estimate


Translation Tool translate - Mozilla Firefox
File Edit View History Bookmarks Tools Help
http://tool2.statmt.org/sentences/translate/563
Google
Status Wiki Mail gMail EdU News
Translation Tool
pkoehn logout
Sentence 2 of 20 [1] | [2] | [4] | [6] | [8] | [11] | [13] | [16] | [19]
[1] Spitzen von Hamburger CDU und Grünen öffnen Weg zu Koalitionsverhandlungen
[2] Das erste schwarz-grüne Bündnis auf Landesebene rückt näher: Die Spitzen von CDU und Grünen in Hamburg halten ihre Differenzen für überwindbar. [3] In einer Sondierungsrunde beschlossen sie, in den Parteigremien über den Start von Koalitionsverhandlungen zu beraten.
[4] Hamburg - Sechs Stunden sprachen sie miteinander. [5] Dann verkündeten CDU-Chef Michael Freytag und Grünen-Chefin Anja Hajduk, das Trennende zwischen den Parteien sei überbrückbar.
[1] Leaders of the Hamburger CDU and Greens open path to coalition negotiations.
[5] Then the CDU-leader Michael Freytag and Green party leader Anja Hajduk the division between the parties is bridgable.
<< [2] Das erste schwarz-grüne Bündnis auf Landesebene rückt näher: Die Spitzen von CDU und Grünen in Hamburg halten ihre Differenzen für überwindbar. >>
enter
the first
das erste schwarz @-@ grüne Bündnis auf Landesebene rückt näher : die Spitzen
the first black @-@ green alliance in favour of is approaching : the leaders
the first black @-@ green the alliance in favour approaches that the people at the top
for the first black Green Alliance on national we are coming to . at the top
this in black and white @-@ green cooperation in Belarus approaches the top
the first of the black the Greens NATO seek to we closer the this

Postediting Machine Translation

<< [2] L'inoubliable interprète de "Butch Cassidy et le Kid" est mort des suites d'un cancer, à l'âge de 83 ans, dans sa maison du Connecticut. >>
The unforgettable ~~interpreter~~ actor of " Butch Cassidy and the Sundance Kid " died as a result of cancer ~~,~~ at the age of 83 ~~years~~ ~~,~~ in his house in Connecticut . (9 edits)

The unforgettable actor of "Butch Cassidy and the Sundance Kid" died as a result of cancer at the age of 83 in his house in Connecticut.

- Textbox is initially filled with machine translation
- User edits translation
- String edit distance to machine translation is shown (blue background)

Evaluation

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- Five different conditions
  - unassisted
  - prediction (sentence completion)
  - options
  - predictions and options
  - post-editing

Quality

- We want faster translators, but not worse

- Assessment of translation quality
  - show translations to bilingual judges, with source
  - judgment: fully correct? yes/no

> Indicate whether each user's input represents a fully fluent and meaning-equivalent translation of the source. The source is shown with context, the actual sentence is bold.

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- Average score: 50% correct — lower than expected
  - judges seemed to be too harsh
  - when given several translations, tendency to judge half as bad

Example of Quality Judgments

Src.	Sans se démonter, il s'est montré concis et précis.	
MT	Without dismantle, it has been concise and accurate.	
1/3	Without fail, he has been concise and accurate.	*(Prediction+Options, L1a)*
4/0	Without getting flustered, he showed himself to be concise and precise.	*(Unassisted, L1b)*
4/0	Without falling apart, he has shown himself to be concise and accurate.	*(Postedit, L1c)*
1/3	Unswayable, he has shown himself to be concise and to the point.	*(Options, L1d)*
0/4	Without showing off, he showed himself to be concise and precise.	*(Prediction, L1e)*
1/3	Without dismantling himself, he presented himself consistent and precise.	*(Prediction+Options, L2a)*
2/2	He showed himself concise and precise.	*(Unassisted, L2b)*
3/1	Nothing daunted, he has been concise and accurate.	*(Postedit, L2c)*
3/1	Without losing face, he remained focused and specific.	*(Options, L2d)*
3/1	Without becoming flustered, he showed himself concise and precise.	*(Prediction, L2e)*

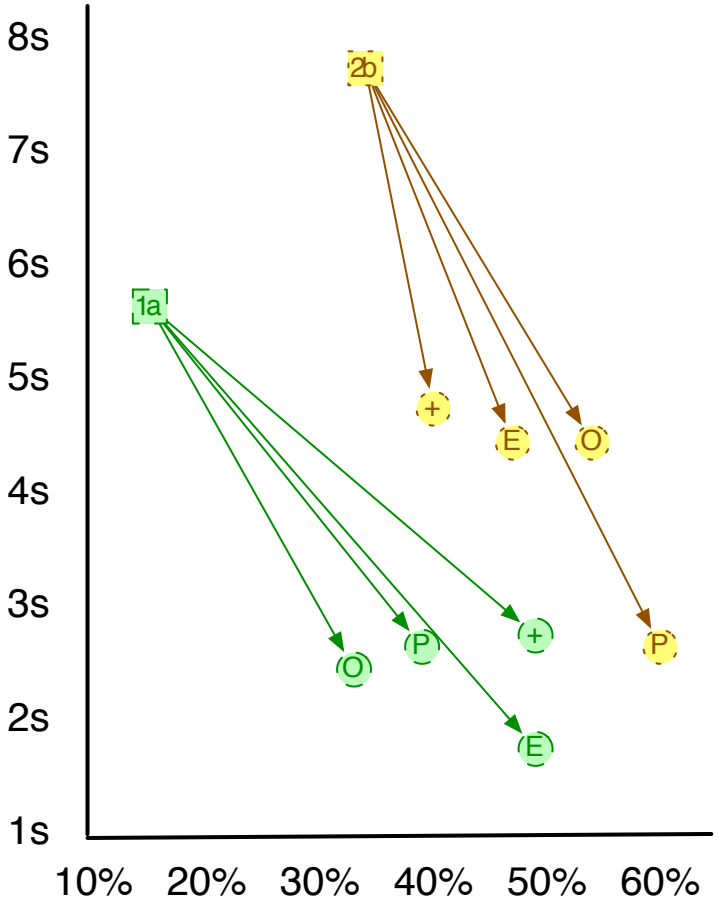
Faster and Better

Assistance	**Speed**	**Quality**
Unassisted	4.4s/word	47% correct
Postedit	2.7s (-1.7s)	55% (+8%)
Options	3.7s (-0.7s)	51% (+4%)
Prediction	3.2s (-1.2s)	54% (+7%)
Prediction+Options	3.3s (-1.1s)	53% (+6%)

Faster and Better, Mostly

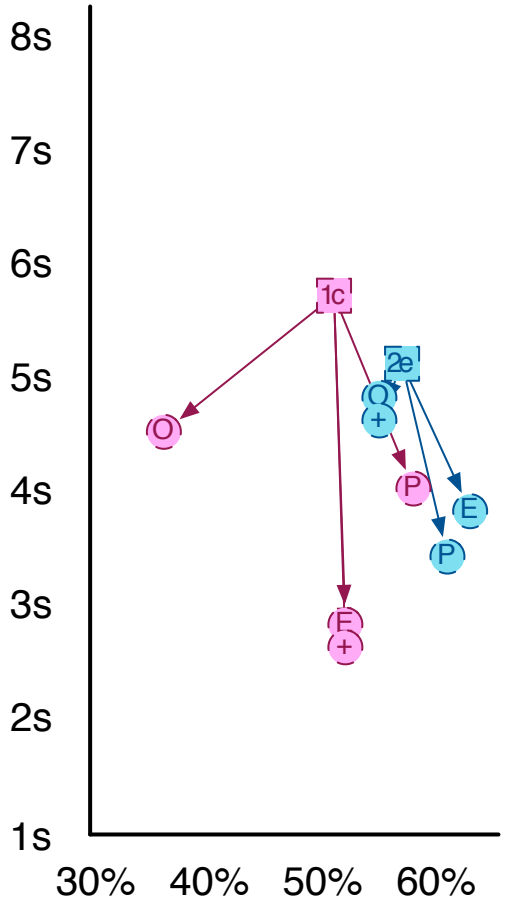
User	Unassisted	Postedit		Options		Prediction		Prediction+Options	
L2a	3.3sec/word 23% correct	**1.2s** **39%**	**-2.2s** **+16%)**	**2.3s** **45%**	**-1.0s** **+22%**	**1.1s** **30%**	**-2.2s** **+7%)**	**2.4s** **44%**	**-0.9s** **+21%**
L2b	7.7sec/word 35% correct	**4.5s** **48%**	**-3.2s)** **+13%**	**4.5s** **55%**	**-3.3s** **+20%**	**2.7s** **61%**	**-5.1s** **+26%**	**4.8s** **41%**	**-3.0s** **+6%**
L2c	3.9sec/word 50% correct	**1.9s** **61%**	**-2.0s** **+11%**	**3.8s** **54%**	**-0.1s** **+4%**	**3.1s** **64%**	**-0.8s** **+14%**	**2.5s** **61%**	**-1.4s** **+11%**
L2d	2.8sec/word 38% correct	**2.0s** **46%**	**-0.7s** **+8%**	2.9s 59%	(+0.1s) (+21%)	2.4s 37%	(-0.4s) (-1%)	**1.8s** **45%**	**-1.0s** **+7%**
L2e	5.2sec/word 58% correct	**3.9s** **64%**	**-1.3s** **+6%**	4.9s 56%	(-0.2s) (-2%)	**3.5s** **62%**	**-1.7s** **+4%**	4.6s 56%	(-0.5s) (-2%)
L1a	5.7sec/word 16% correct	**1.8s** **50%**	**-3.9s** **+34%**	**2.5s** **34%**	**-3.2s** **+18%**	**2.7s** **40%**	**-3.0s** **+24%**	**2.8s** **50%**	**-2.9s** **+34%**
L1b	3.2sec/word 64% correct	2.8s 56%	(-0.4s) (-8%)	*3.5s* *60%*	*+0.3s* *-4%*	*6.0s* *61%*	*+2.8s* *-3%*	*4.6s* *57%*	*+1.4s* *-7%*
L1c	5.8sec/word 52% correct	**2.9s** **53%**	**-3.0s** **+1%**	4.6s 37%	(-1.2s) (-15%)	**4.1s** **59%**	**-1.7s** **+7%**	**2.7s** **53%**	**-3.1s** **+1%**
L1d	3.4sec/word 49% correct	3.1s 49%	(-0.3s) (+0%)	4.3s 51%	(+0.9s) (+2%)	3.8s 53%	(+0.4s) (+4%)	3.7s 58%	(+0.3s) (+9%)
L1e	2.8sec/word 68% correct	**2.6s** **79%**	**-0.2s** **+11%**	*3.5s* *59%*	*+0.7s* *-9%*	2.8s 64%	(-0.0s) (-4%)	*3.0s* *66%*	*+0.2s* *-2%*
avg.	4.4sec/word 47% correct	**2.7s** **55%**	**-1.7s** **+8%**	**3.7s** **51%**	**-0.7s** **+4%**	**3.2s** **54%**	**-1.2s** **+7%**	**3.3s** **53%**	**-1.1s** **+6%**

Slow Users 1: Faster and Better



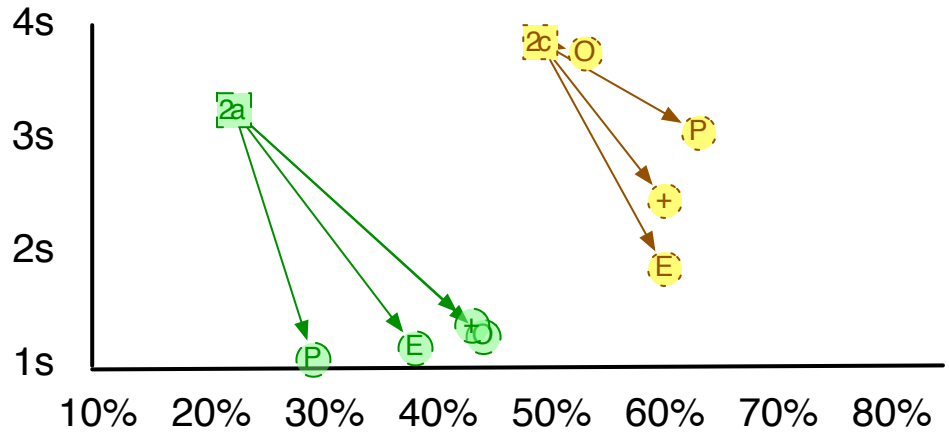
- Unassisted
  - more than 5 seconds per input word
  - very bad (35%, 16%)
- With assistance
  - much faster and better
  - reaching roughly average performance

Slow Users 2: Only Faster



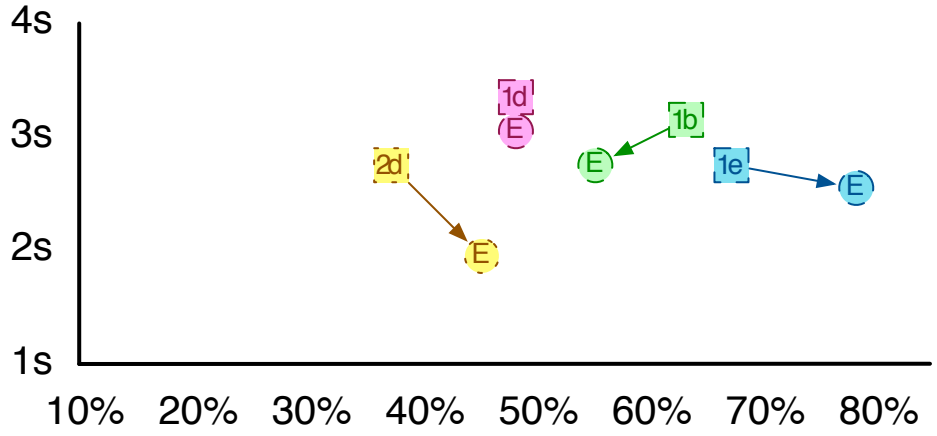
- Unassisted
  - more than 5 seconds per input word
  - average quality
- With assistance
  - faster and but not better

Fast Users



- Unassisted
  - fast: 3-4 seconds per input word
  - L2a is very bad (23%), L2c is average (50%)
- With assistance
  - faster and better
  - L2a closer to average (30-45%), L2c becomes very good (54-61%)

Refuseniks

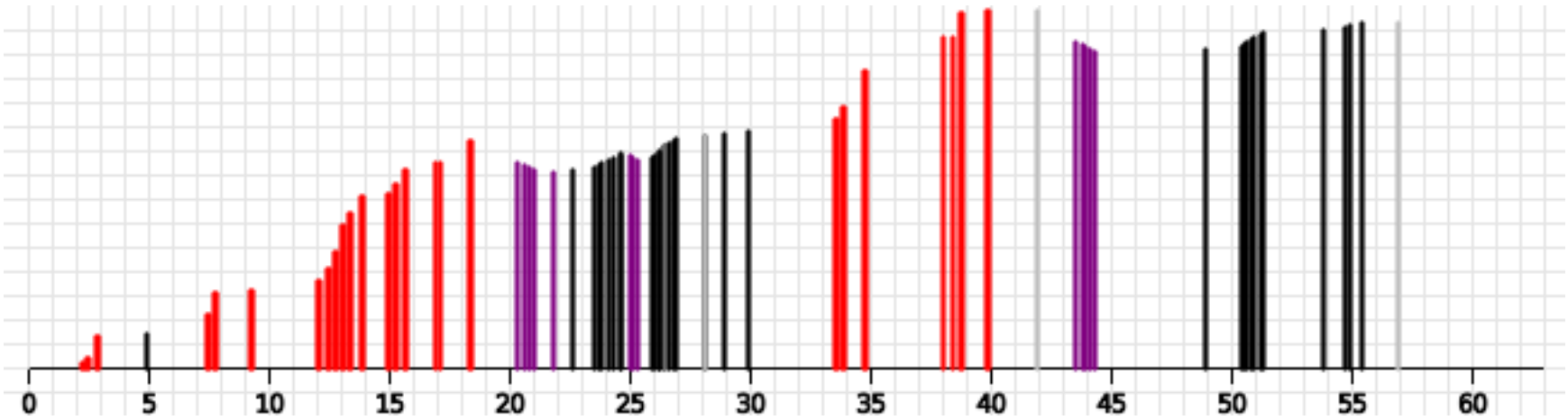


- Use the assistance sparingly or not at all, and see generally no gains
- The two best translators are in this group
- Postediting
  - mixed on quality (2 better, 1 worse, 1 same), but all faster
  - best translator (L1e, 68%) becomes much better (record 79%)

Further Analysis

- How does the assistance change translator behaviour?
- How do translators utilize assistance?
- How is the translation produced?

Keystroke Log



black: keystroke, purple: deletion, grey: cursor move

red: sentence completion accept

orange: click on translation option

Analysis: Segment into periods of activity: typing, tabbing, clicking, pauses

one second before and after a keystroke is part of typing interval

Activities: Native French User L2b

User: L2b	total	init-p	end-p	short-p	mid-p	big-p	key	click	tab
Unassisted	7.7s	1.3s	0.1s	0.3s	1.8s	1.9s	2.3s	-	-
Postedit	4.5s	1.5s	0.4s	0.1s	1.0s	0.4s	1.1s	-	-
Options	4.5s	0.6s	0.1s	0.4s	0.9s	0.7s	1.5s	0.4s	-
Prediction	2.7s	0.3s	0.3s	0.2s	0.7s	0.1s	0.6s	-	0.4s
Prediction+Options	4.8s	0.6s	0.4s	0.4s	1.3s	0.5s	0.9s	0.5s	0.2s

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Slighly less time spent on typing

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Options	4.5s	0.6s	0.1s	0.4s	0.9s	0.7s	1.5s	0.4s	-
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Postedit	4.5s	1.5s	0.4s	0.1s	1.0s	0.4s	1.1s	-	-
Options	4.5s	0.6s	0.1s	0.4s	0.9s	0.7s	1.5s	0.4s	-
Prediction	2.7s	0.3s	0.3s	0.2s	0.7s	0.1s	0.6s	-	0.4s
Prediction+Options	4.8s	0.6s	0.4s	0.4s	1.3s	0.5s	0.9s	0.5s	0.2s

Less pausing

Especially less time in big pauses

Slighly less time spent on typing

Activities: Native English User L1e

User: L1e	total	init-p	end-p	short-p	mid-p	big-p	key	click	tab
Unassisted	2.8s	0.3s	0.2s	0.2s	0.3s	0.1s	1.9s	-	-
Postedit	2.6s	0.4s	0.3s	0.2s	1.0s	0.1s	0.7s	-	-
Options	3.5s	0.1s	0.3s	0.4s	0.6s	0.2s	1.7s	0.1s	-
Prediction	2.8s	0.1s	0.3s	0.3s	0.3s	-	1.4s	-	0.3s
Prediction+Options	3.0s	0.1s	0.3s	0.2s	0.5s	-	1.9s	-	-

Activities: Native English User L1e

User: L1e	total	init-p	end-p	short-p	mid-p	big-p	key	click	tab
Unassisted	2.8s	0.3s	0.2s	0.2s	0.3s	0.1s	1.9s	-	-
Postedit	2.6s	0.4s	0.3s	0.2s	1.0s	0.1s	0.7s	-	-
Options	3.5s	0.1s	0.3s	0.4s	0.6s	0.2s	1.7s	0.1s	-
Prediction	2.8s	0.1s	0.3s	0.3s	0.3s	-	1.4s	-	0.3s
Prediction+Options	3.0s	0.1s	0.3s	0.2s	0.5s	-	1.9s	-	-

Little time spent on assistance

Activities: Native English User L1e

User: L1e	total	init-p	end-p	short-p	mid-p	big-p	key	click	tab
Unassisted	2.8s	0.3s	0.2s	0.2s	0.3s	0.1s	1.9s	-	-
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Does not use both assistances, little overall change

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Options	3.5s	0.1s	0.3s	0.4s	0.6s	0.2s	1.7s	0.1s	-
Prediction	2.8s	0.1s	0.3s	0.3s	0.3s	-	1.4s	-	0.3s
Prediction+Options	3.0s	0.1s	0.3s	0.2s	0.5s	-	1.9s	-	-

Does not use both assistances, little overall change

Postediting: less typing (-1.2s) more medium pauses (+0.7s)

Little time spent on assistance

Origin of Characters: Native French L2b

User: L2b	key	click	tab	mt
Postedit	18%	-	-	81%
Options	59%	40%	-	-
Prediction	14%	-	85%	-
Prediction+Options	21%	44%	33%	-

Origin of Characters: Native French L2b

User: L2b	key	click	tab	mt
Postedit	18%	-	-	81%
Options	59%	40%	-	-
Prediction	14%	-	85%	-
Prediction+Options	21%	44%	33%	-

Translation comes to large degree from assistance

Origin of Characters: Native English L1e

User: L1e	key	click	tab	mt
Postedit	20%	-	-	79%
Options	77%	22%	-	-
Prediction	61%	-	38%	-
Prediction+Options	100%	-	-	-

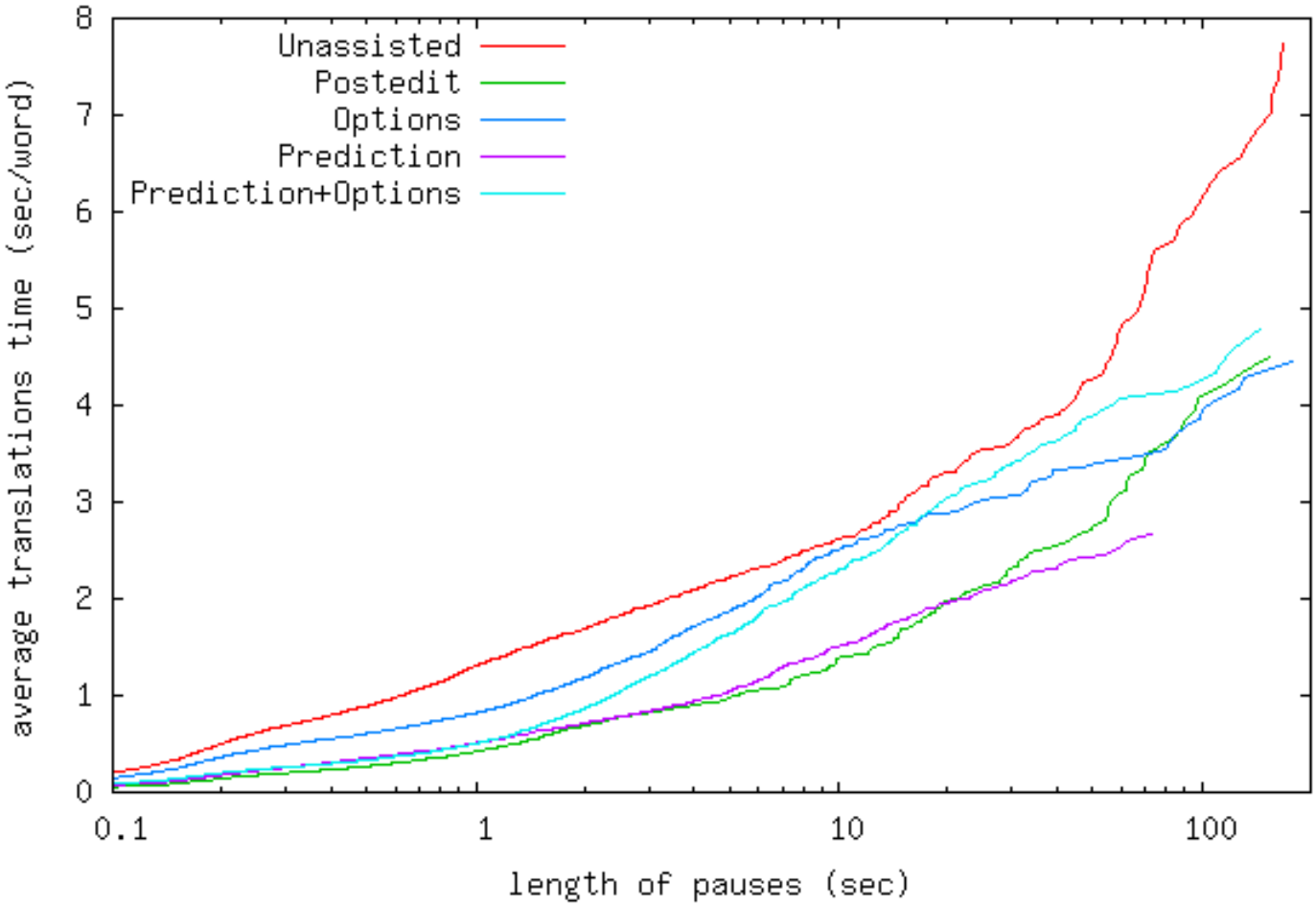
Origin of Characters: Native English L1e

User: L1e	key	click	tab	mt
Postedit	20%	-	-	79%
Options	77%	22%	-	-
Prediction	61%	-	38%	-
Prediction+Options	100%	-	-	-

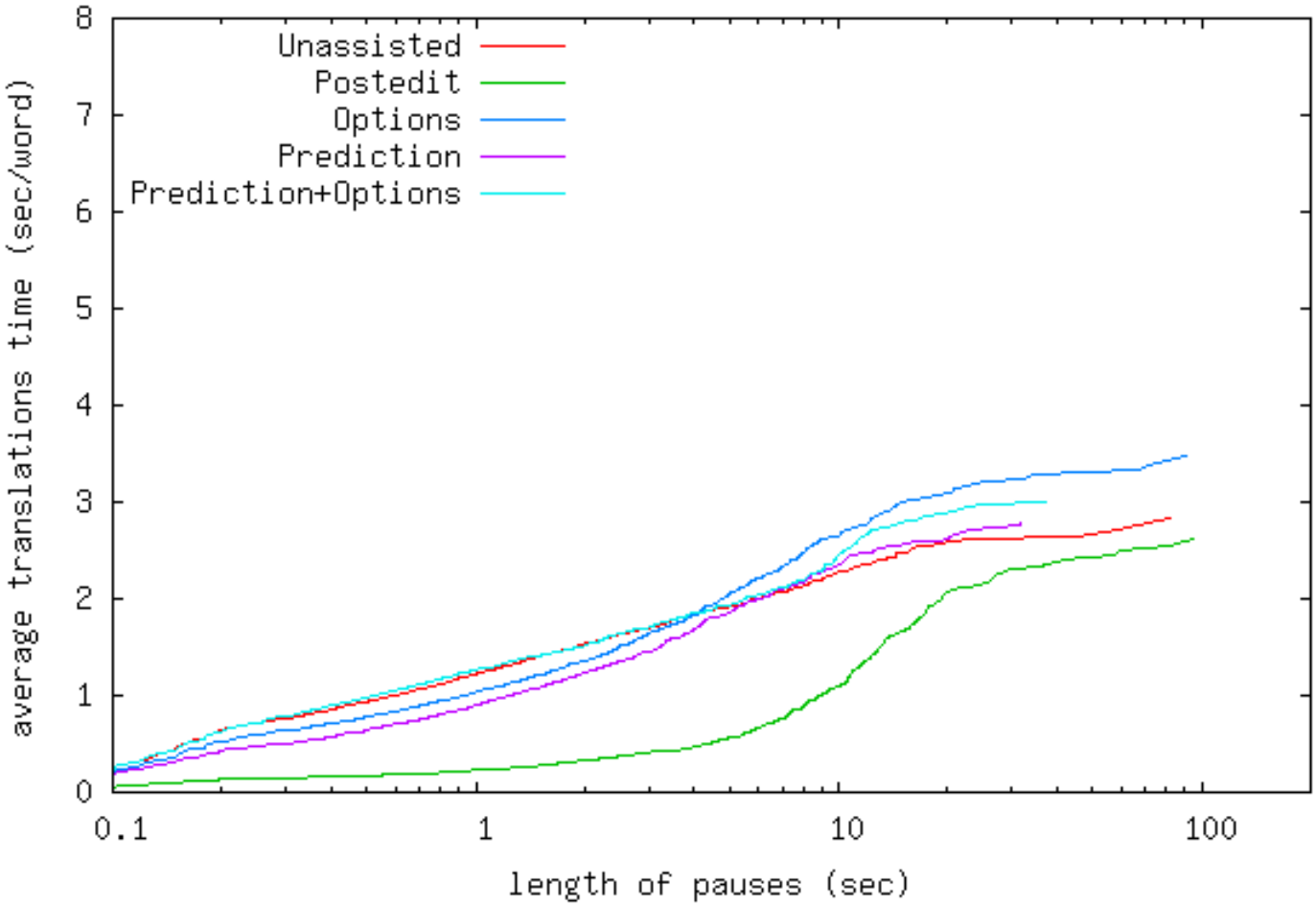
Although hardly any time spent on assistance,

fair amount of characters produced by it

Pauses: French-Native User L2b

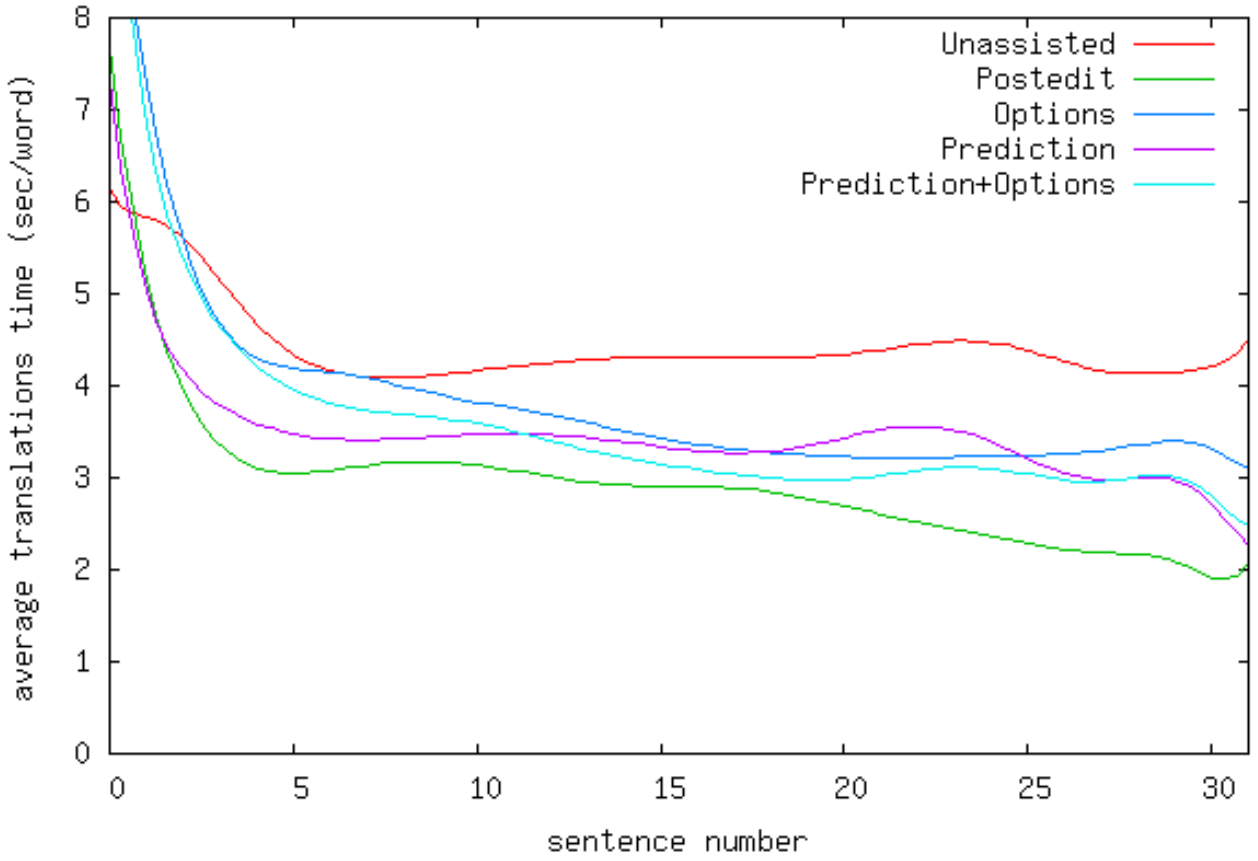


Pauses: English-Native User L1e



Learning Curve

users become better over time with assistance



User Feedback

- Q: In which of the five conditions did you think you were most accurate?
  - predictions+options: 5 users
  - options: 2 users
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  - prediction+options: 4.6
  - prediction: 3.9
  - options: 3.7
  - postediting: 2.9

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  - prediction: 3.9
  - options: 3.7
  - postediting: 2.9
- **Note:** does not match empirical results

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- Some good translators ignored the assistance
- Fastest and (barely) best with postediting, but did not like it

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- Better prediction model
  - different metrics to find best matching prefix
    - BLEU, TER, ...
    - word substitution scored by letter string edit distance
  - prediction as a machine learning multi-class classification problem
  - prediction based on parse forest from tree-based models

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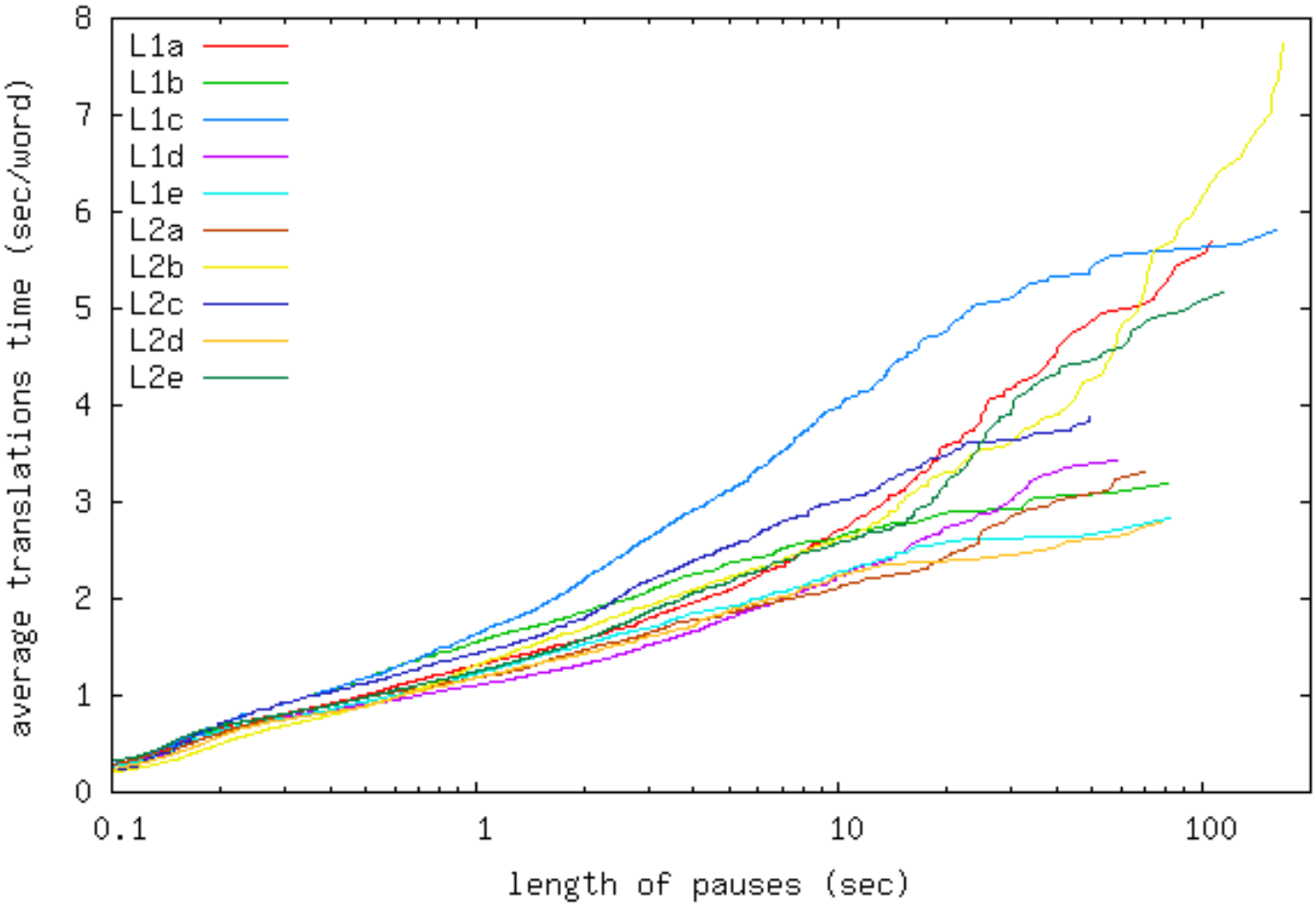
  - show which expressions are more or less common
  - language model to highlight unusual transitions in output
- Translation memory
  - finding most similar sentence in parallel corpus
  - show translation, highlight difference, fill in difference with MT

Try it at home!

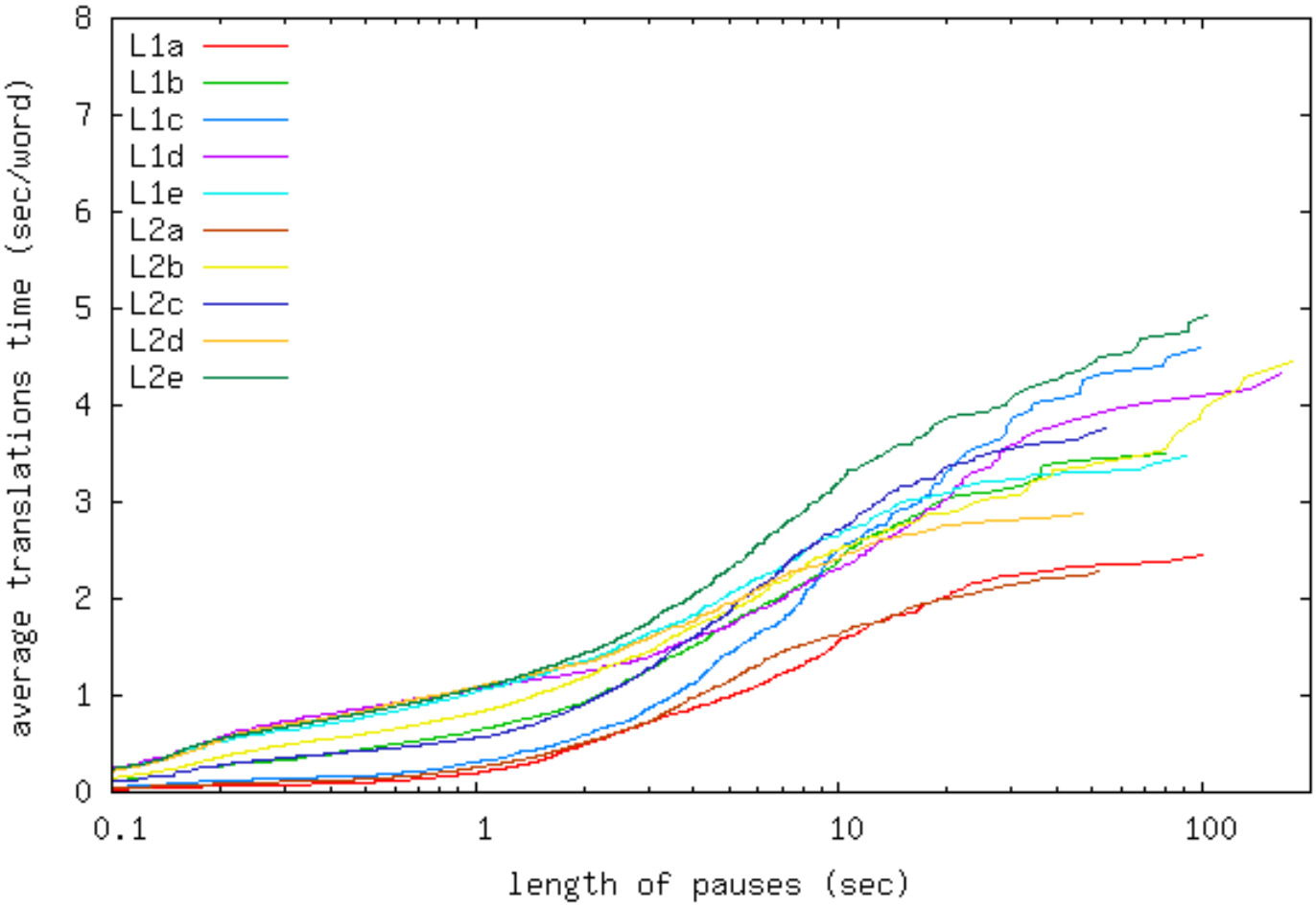
http://www.caitra.org/

questions?

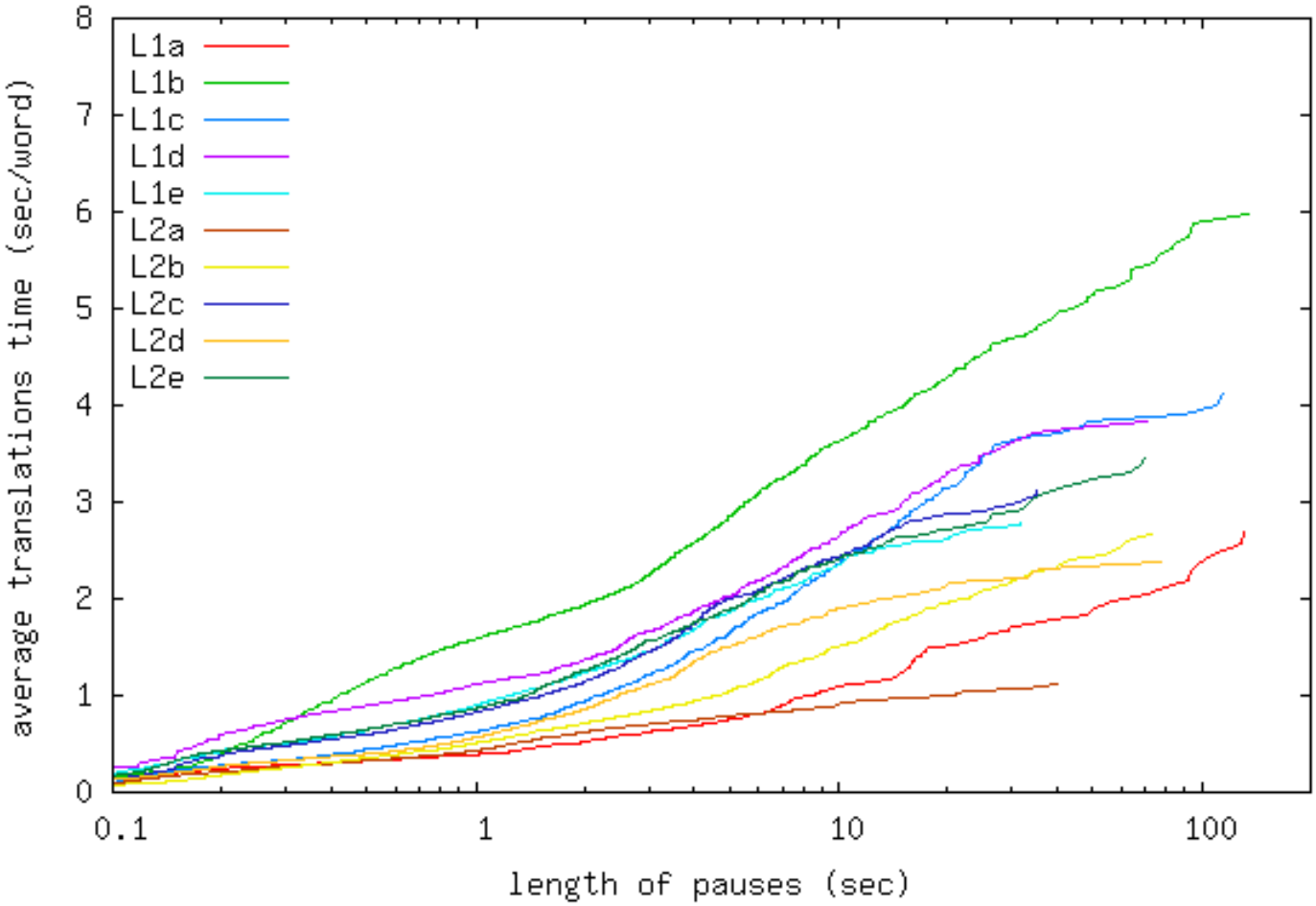
Pauses: Unassisted



Pauses: Options



Pauses: Prediction of sentence completion



Pauses: Postediting