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# Evaluating Evaluation

## Lessons from the WMT 2007 Shared Task

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(with a lot of help from Chris Callison-Burch)

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# WMT Evaluation Campaign

- Annual event since 2005
  - shared task of an ACL Workshop on Machine Translation (WMT)
  - now part of EuroMatrix project
  - about 10–15 groups participate each year
  - next year: ACL 2008 (Ohio), Marathon meeting in May 2008 (Berlin)
- Goals
  - promote MT performance for **European languages**
  - **large-scale** (30 million word training), relatively **wide domain** (politics)
  - **low barrier of entry**: baseline system provided (Moses)
  - well-defined set of **homogenous** training data (opposed to NIST eval)
  - allows to focus on **specific** problems (e.g. morphology, unknown words)
  - also an opportunity to **improve evaluation** of MT

## Participants

- Some big players missing...  
(Google, IBM, RWTH Aachen, USC/ISI)
- ... but **wide variety** of systems
  - statistical phrase-based (most)
  - statistical tree-based (CMU)
  - dependency treelet system (Microsoft)
  - rule-based (Systran)
  - rule-based + statistical post-editing (Systran+NRC/Edinburgh)
  - hybrid (system combination) (Saarbrücken)
- Not a toy task: relatively **high translation quality**

# Evaluation of Evaluation

- Organizer's effort mostly focused on questions of evaluation
- **Manual** evaluation: participants volunteer 8 hours worth of work
  - what metric?
  - how many judgments do we need?
  - are judges consistent?
- **Automatic** evaluation
  - evaluation of evaluation campaign
  - what automatic metrics correlate best with human judgment?

## WMT Evaluation 2007

- Tasks
  - English to/from French, German Spanish, and Czech
  - test sets drawn from **Europarl** and **news commentary**
- 88 'primary' system submissions were **manually evaluated**
- Recruited 100+ judges, who contributed 330 hours for **81,000+ judgments**
  - participants in evaluation
  - students of a course on MT
  - paid students at U Edinburgh



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# Evaluation of Evaluation

- We wanted to analyze evaluation measures and establish **best practices**
- Questions to investigate:
  - which **automatic evaluation metrics correlate** most strongly with human judgments of translation quality?
  - how **consistent** are people when they judge translation quality?
  - to what extent do they **agree** with other annotators?
  - can we **improve human evaluation**?

## Fluency and Adequacy

- Traditional metric (used by NIST eval, WMT 2006, IWSLT)
- Two 5-point scales:

How much of the meaning of the reference is preserved?	How do you judge the fluency of the translation?
5 = All	5 = Flawless English
4 = Most	4 = Good English
3 = Much	3 = Non-native English
2 = Little	2 = Disfluent English
1 = None	1 = Incomprehensible

# Web Tool

**Judge Sentence**

You have already judged 14 of 3064 sentences, taking 86.4 seconds per sentence.

**Source:** les deux pays constituent plutôt un laboratoire nécessaire au fonctionnement interne de l'ue .

**Reference:** rather , the two countries form a laboratory needed for the internal working of the eu .

Translation	Adequacy	Fluency
both countries are rather a necessary laboratory the internal operation of the eu .	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> 1 2 3 4 5	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> 1 2 3 4 5
both countries are a necessary laboratory at internal functioning of the eu .	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> 1 2 3 4 5	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> 1 2 3 4 5
the two countries are rather a laboratory necessary for the internal workings of the eu .	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> 1 2 3 4 5	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> 1 2 3 4 5
the two countries are rather a laboratory for the internal workings of the eu .	<input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> <input type="radio"/> 1 2 3 4 5	<input type="radio"/> <input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> 1 2 3 4 5
the two countries are rather a necessary laboratory internal workings of the eu .	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> 1 2 3 4 5	<input type="radio"/> <input type="radio"/> <input checked="" type="radio"/> <input type="radio"/> <input type="radio"/> 1 2 3 4 5
<b>Annotator:</b> Philipp Koehn <b>Task:</b> WMT06 French-English	<input type="button" value="Annotate"/>	
Instructions	5= All Meaning 4= Most Meaning 3= Much Meaning 2= Little Meaning 1= None	5= Flawless English 4= Good English 3= Non-native English 2= Disfluent English 1= Incomprehensible



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## Example

**In** Le deux pays constituent plutôt un laboratoire nécessaire au fonctionnement interne de l'ue.

**Ref** Rather, the two countries form a laboratory needed for the internal working of the EU.

**MT 1** Both countries are rather a necessary laboratory the internal operation of the EU.

**MT 2** Both countries are a necessary laboratory at internal functioning of the EU.

**MT 3** The two countries are rather a laboratory necessary for the internal workings of the EU.

**MT 4** The two countries are rather a laboratory for the internal workings of the EU.

**MT 5** The two countries are rather a necessary laboratory internal workings of the EU.

Judge each sentence in terms of **adequacy** and **fluency** on the scale of 1–5!

# Judgments

	Adequacy					Fluency				
	1	2	3	4	5	1	2	3	4	5
System 1										
System 2										
System 3										
System 4										
System 5										



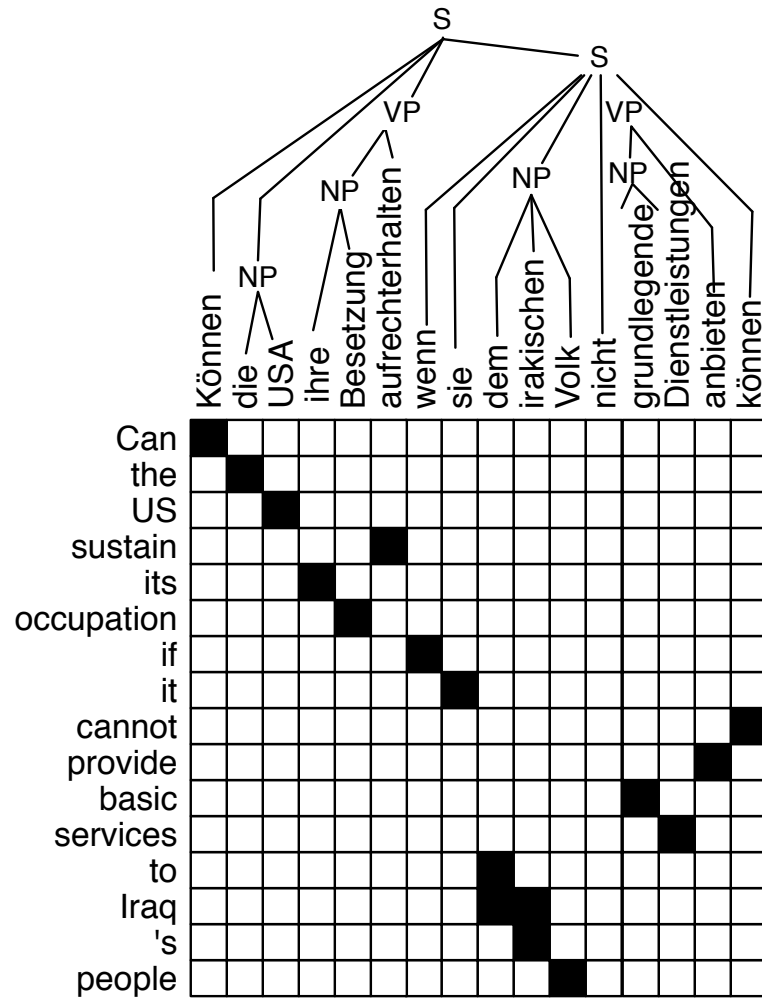
# Manual Evaluation

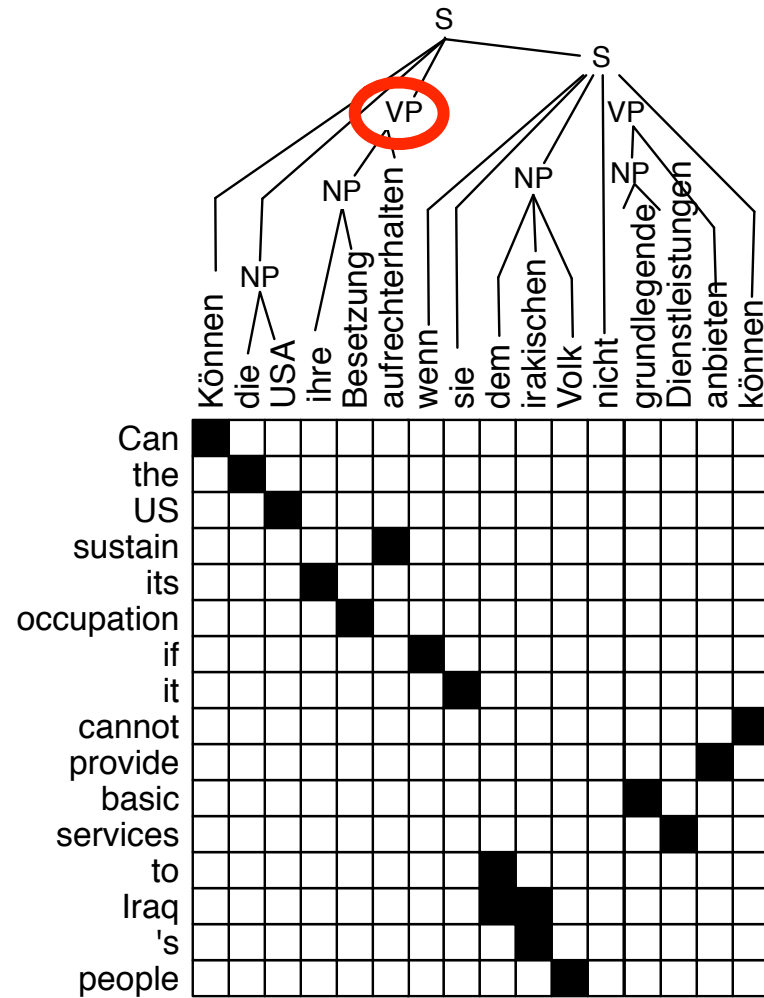
- Three different **types of evaluation**:
  - score each translation along *fluency* and *adequacy* scales
  - rank translations of sentences relative to each other
  - rank translations of sub-sentential units
- Metrics evaluated by
  - inter-annotator **agreement** (agreement with others)
  - intra-annotator agreement (self consistency)
  - average **time** to make one judgement

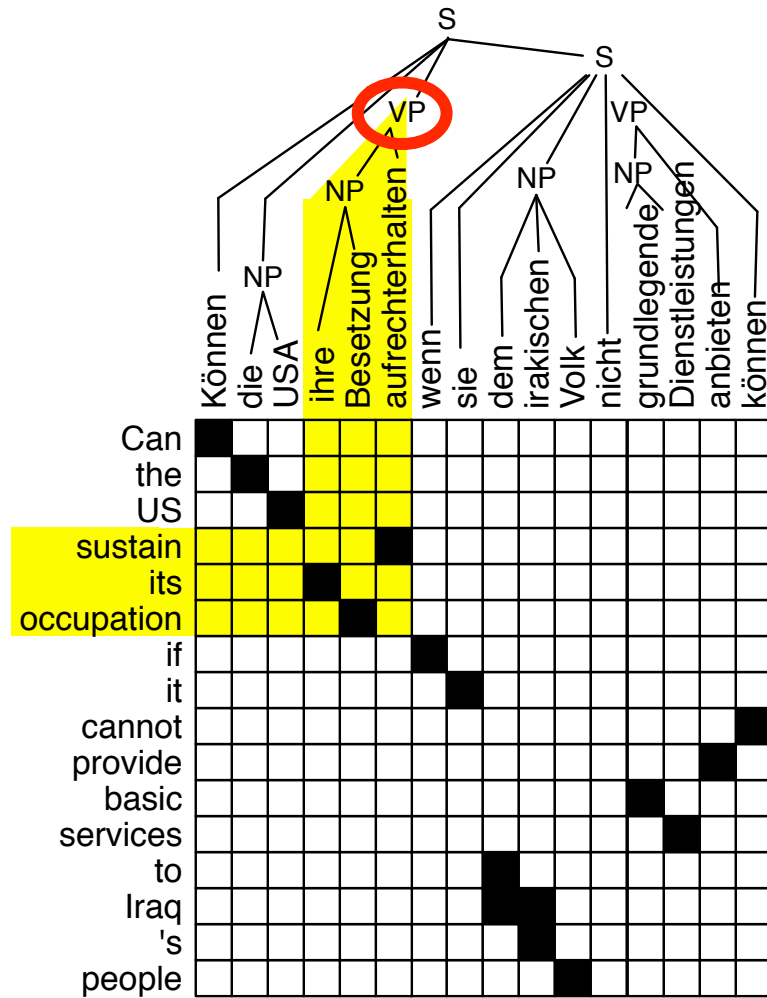
# Ranking Translations of Constituents

- Intuition: Ranking translations of **long sentences** is **difficult**, because systems produces errors in different parts of them
- Goal: focus attention on particular **parts of the translation** to make the task **easier**
- Method:
  1. automatically word-align source with reference and system translations
  2. **parse source** sentence
  3. select **constituents** to be judged
  4. highlight source phrase and corresponding target phrases
  5. rank those

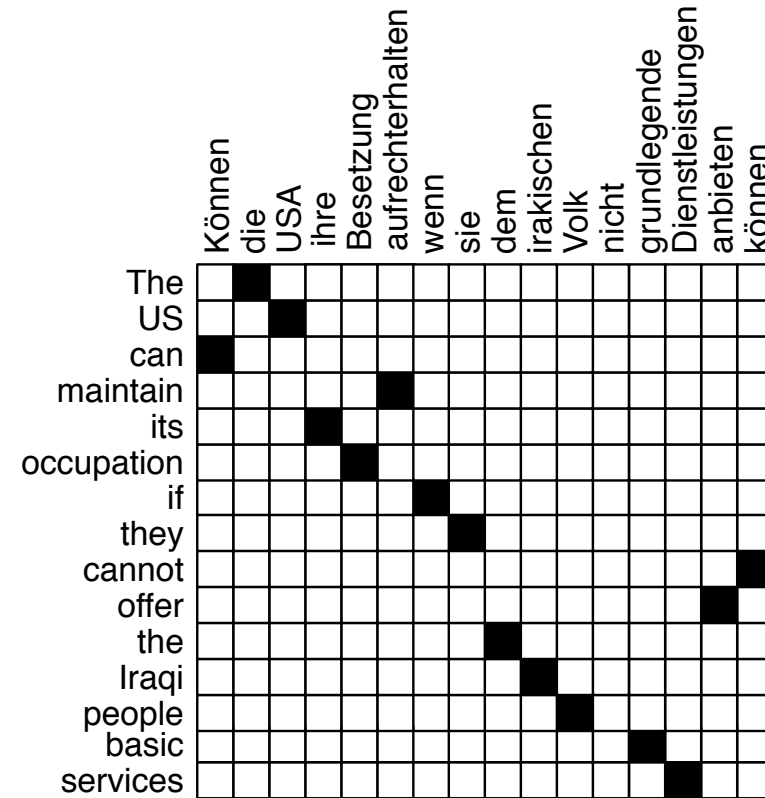
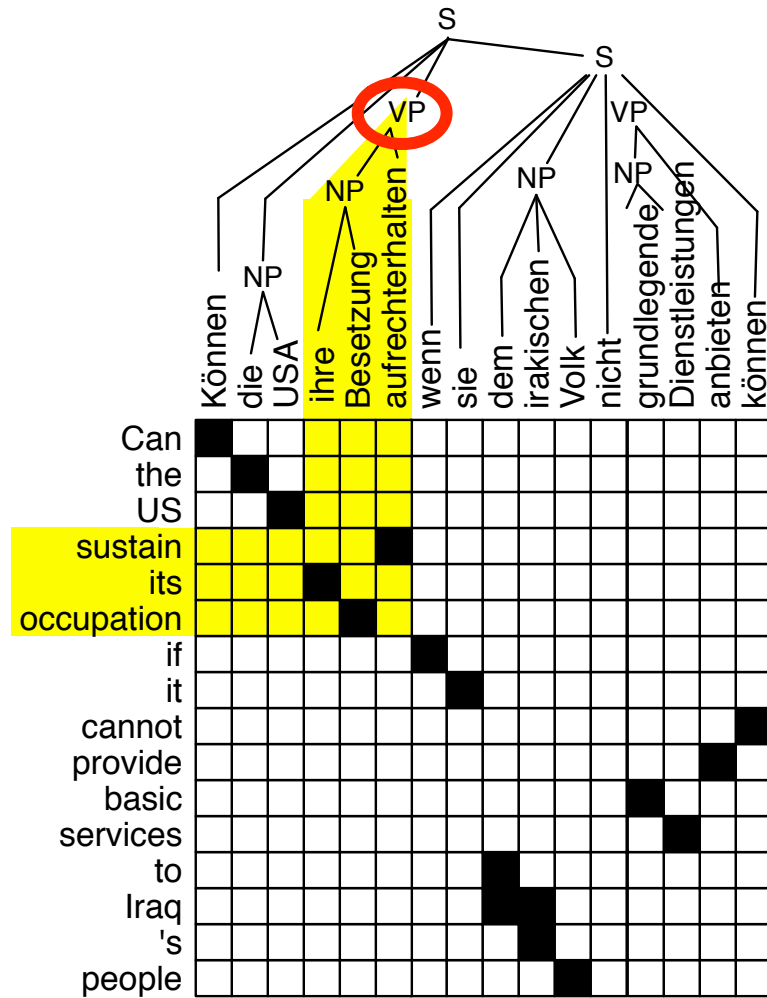
	Können	die	USA	ihre	Besetzung	aufrechterhalten	wenn	sie	dem	irakischen	Volk	nicht	grundlegende	Dienstleistungen	anbieten	können
Can	■															
the		■														
US			■													
sustain					■											
its				■												
occupation					■											
if						■										
it							■									
cannot																■
provide															■	
basic													■			
services														■		
to									■							
Iraq										■						
's											■					
people												■				



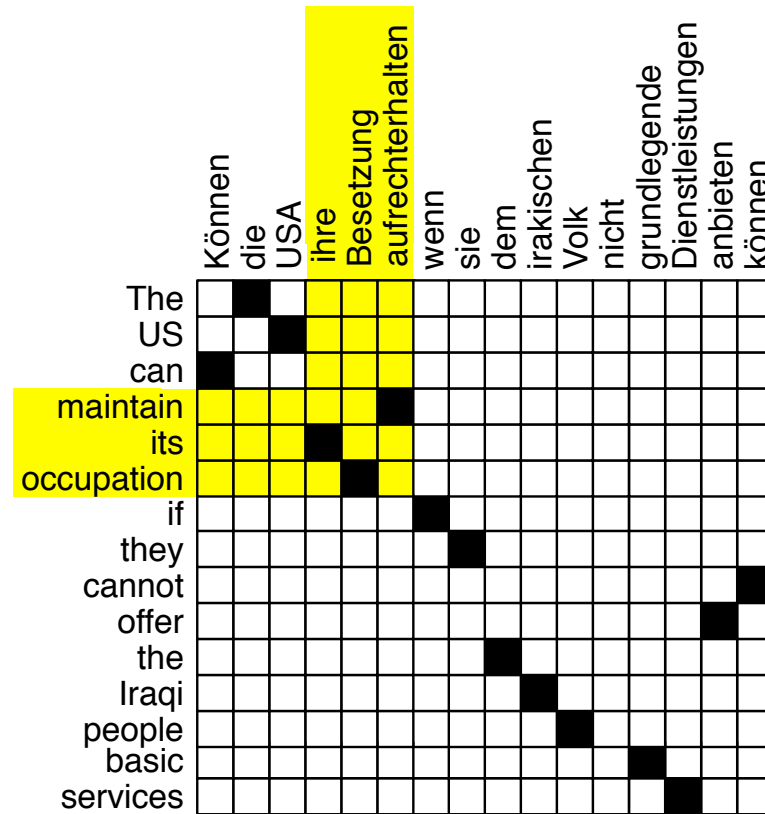
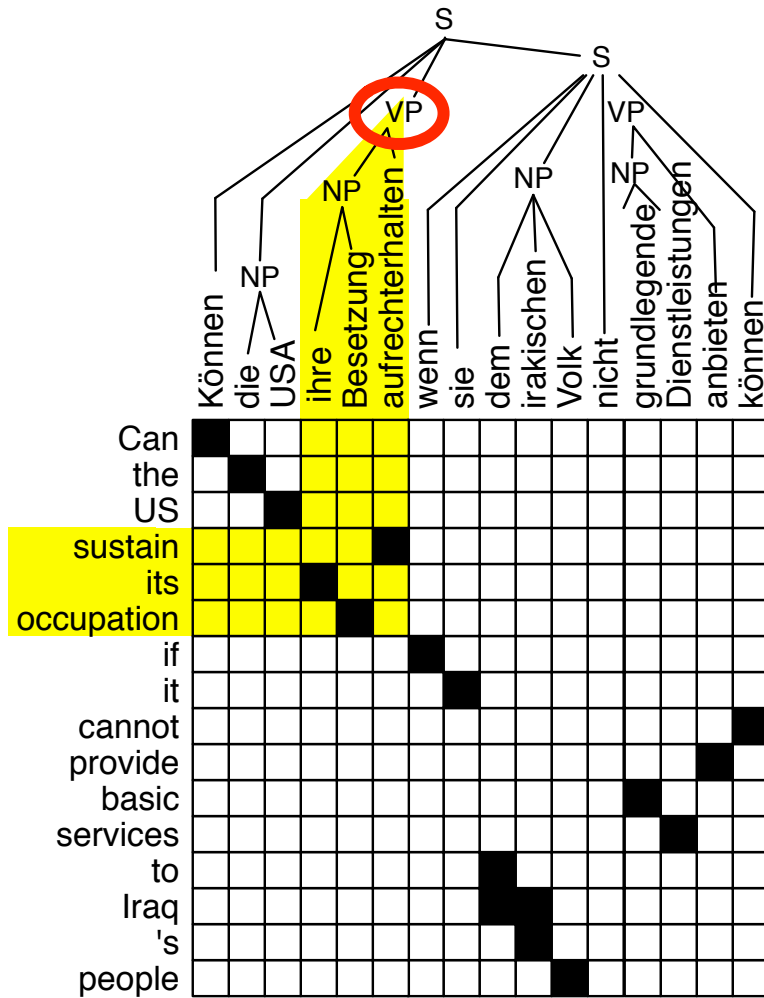




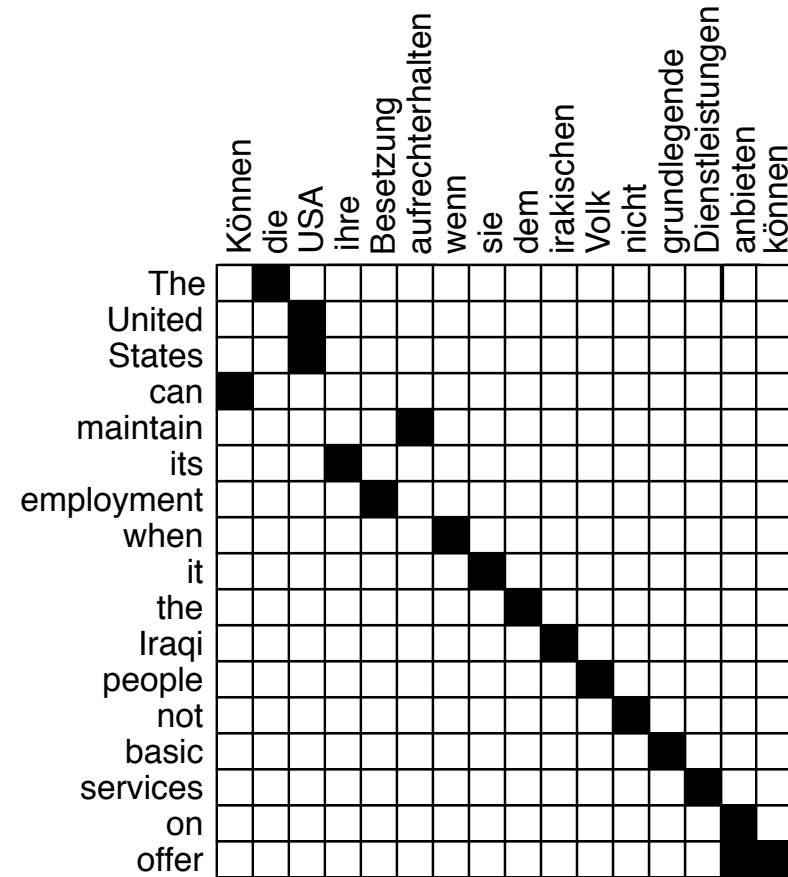
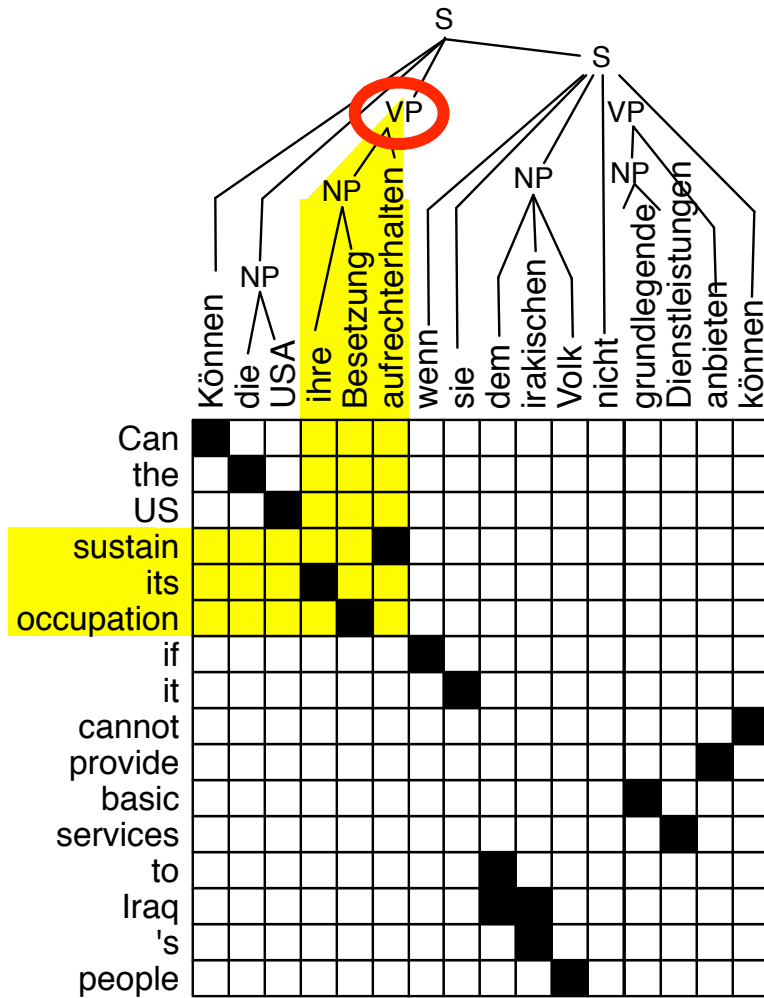




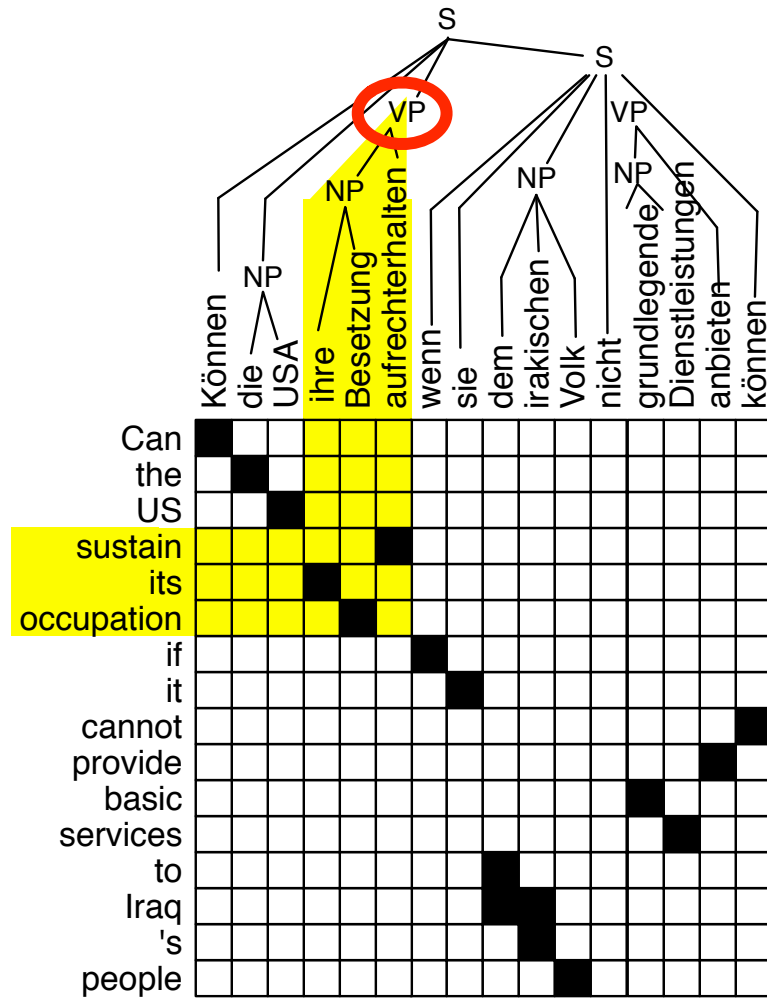
System translation 1



System translation 1



System translation 2



	Können	die	USA	ihre	Besetzung	aufrechterhalten	wenn	sie	dem	irakischen	Volk	nicht	grundlegende	Dienstleistungen	anbieten	können
The																
United																
States																
can																
maintain																
its																
employment																
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the																
Iraqi																
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System translation 2

## Results of the Meta-Evaluation

- We measured agreement among annotators using the **kappa coefficient**:

$$K = \frac{P(A) - P(E)}{1 - P(E)}$$

where

- $P(A)$  is the proportion of times that the annotators agree
  - $P(E)$  is the proportion of time that they would agree by chance.
- **Interpretation** of  $K$  scores varies, but:
    - .6 – .8 is **good** agreement
    - .4 – .6 is **moderate** agreement
    - $< .4$  and we should start to **worry**

## Inter-Annotator Agreement

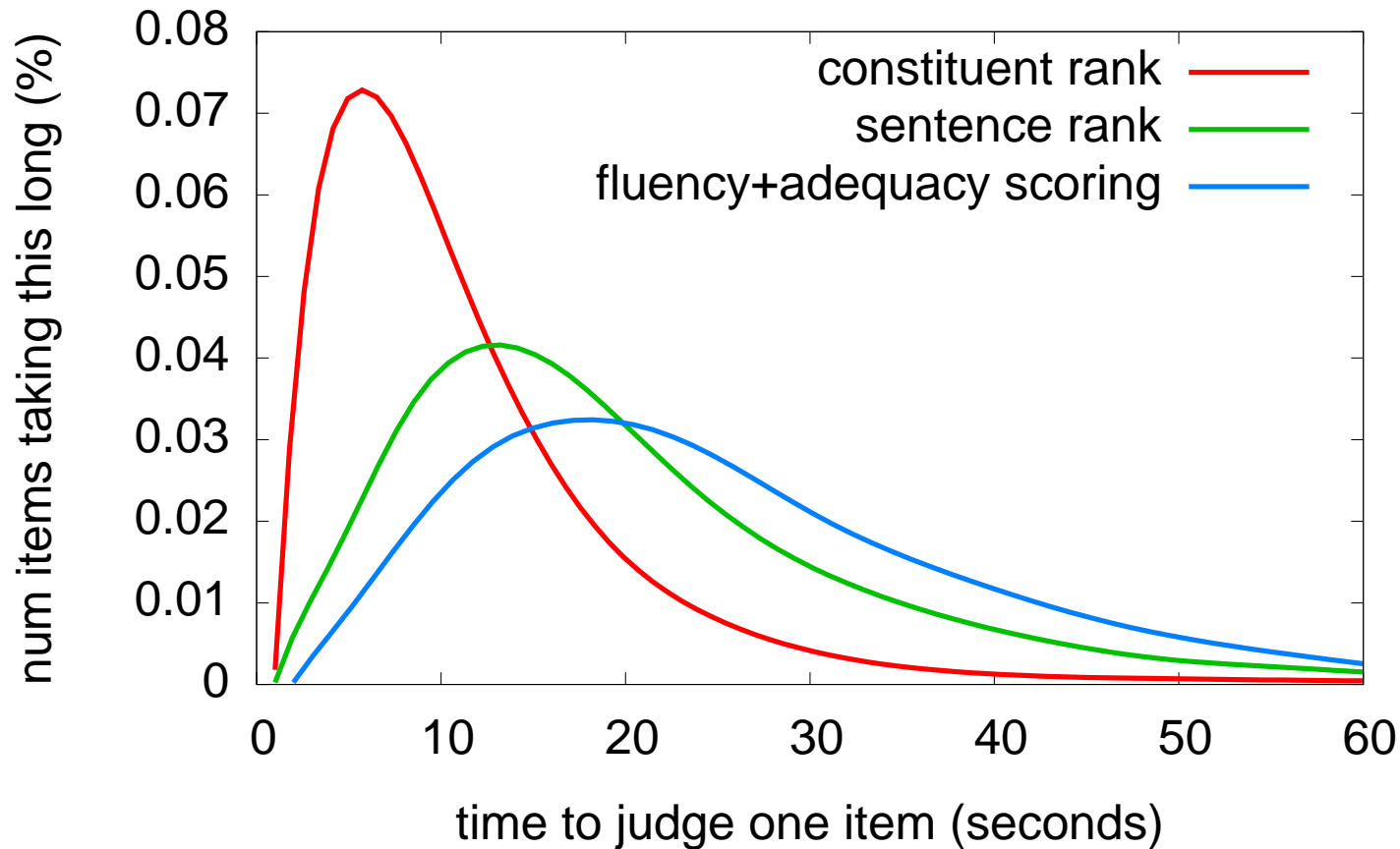
Evaluation type	$P(A)$	$P(E)$	$K$
Fluency (absolute)	.400	.2	.250
Adequacy (absolute)	.380	.2	.226
Fluency (relative)	.520	.333	.281
Adequacy (relative)	.538	.333	.307
Sentence ranking	.582	.333	.373
Constituent ranking	.712	.333	.566



## Intra-Annotator Agreement

Evaluation type	$P(A)$	$P(E)$	$K$
Fluency (absolute)	.630	.2	.537
Adequacy (absolute)	.574	.2	.468
Fluency (relative)	.690	.333	.535
Adequacy (relative)	.696	.333	.544
Sentence ranking	.749	.333	.623
Constituent ranking	.842	.333	.762

## Time to judge one item





## Automatic evaluation metrics

- Ranked system outputs using 11 different automatic metrics
  - N-gram matching:  
*Bleu, GTM, Translation Error Rate*
  - Flexible matching:  
*Meteor, ParaEval precision, ParaEval recall*
  - Linguistic info:  
*Dependency overlap, Semantic role overlap, WER over verbs*
  - Correlation-centric:  
*Maximum correlation training on adequacy, and on fluency*
- Meta-evaluation: Spearman's rank correlation with human judgments

## Proportion of time entries were top-ranked in manual evaluation

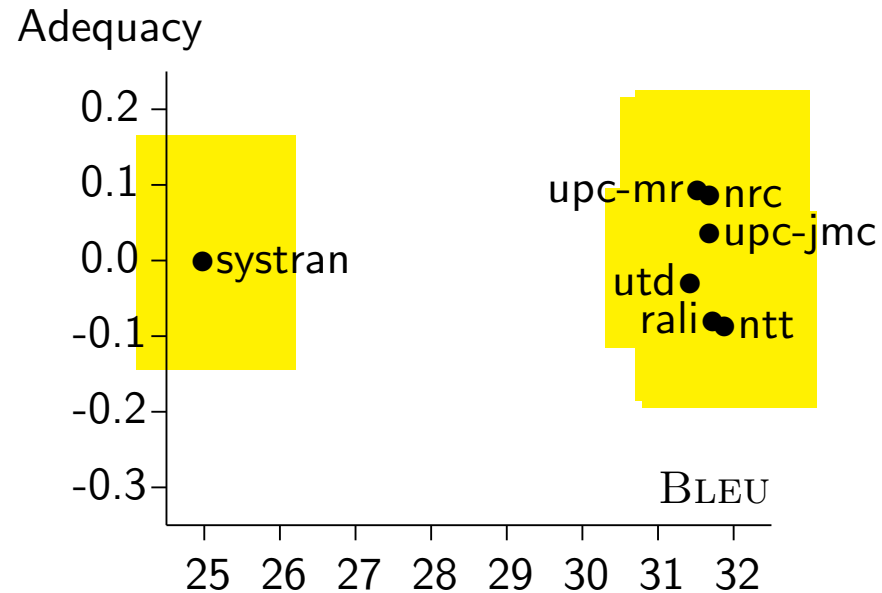
<b>SYSTRAN</b>	<b>32%</b>
<b>University of Edinburgh</b>	<b>20%</b>
University of Catalonia	15%
LIMSI-CNRS	13%
University of Maryland	5%
National Research Council + SYSTRAN	5%
Commercial Czech-English system	5%
University of Valencia	2%
Charles University	2%



## Proportion of time entries were top-ranked by automatic metrics

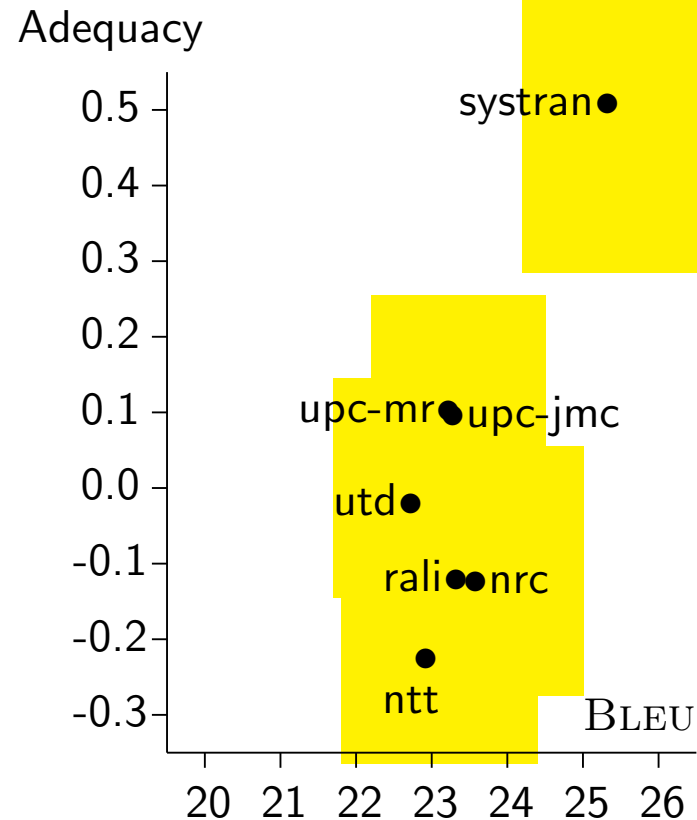
<b>University of Edinburgh</b>	<b>41%</b>
University of Catalonia	12%
LIMSI-CNRS	12%
University of Maryland	9%
Carnegie Mellon University	8%
Charles University	4%
University of California at Berkeley	3%
National Research Council + SYSTRAN	2%
<b>SYSTRAN</b>	<b>2%</b>
Saarland University	0.8%

## Systran puzzle (WMT 2006)



- *English–French, adequacy vs. BLEU, in-domain*
- see also Callison-Burch et al.'s **critique of BLEU** [EACL 2006]

## Mystery resolved?



- *English–French, adequacy vs. BLEU*
  - **out-of-domain**
  - Systran: **best** BLEU, **best** *manual*
- lack of correlation only due to the **overly literalness** of BLEU?

## Correlation

	Adequacy	Fluency	Rank	Constituent	Overall
Semantic role	<b>.77</b>	<b>.84</b>	<b>.80</b>	.74	<b>.79</b>
ParaEval-Recall	.71	.74	.77	<b>.80</b>	.76
Meteor	.71	.72	.75	.67	.71
<i>Bleu</i>	<i>.69</i>	<i>.72</i>	<i>.67</i>	<i>.60</i>	<i>.67</i>
Max adeq corr	.65	.66	.66	.53	.63
Max flu corr	.64	.65	.66	.51	.61
GTM	.66	.67	.62	.50	.61
Dependency overlap	.64	.64	.60	.51	.60
ParaEval-Precision	.64	.65	.61	.49	.60
1-TER	.61	.54	.52	.51	.54
1-WER of verbs	.38	.42	.43	.30	.38



## Semantic Role Overlap

- Proposed by Giménez and Màrquez2007 [WMT 2007]
- Solves the Linear-B [NIST 2005] and Systran [WMT 2006] puzzle
  - NIST 2005: correlation of 0.6–0.7 vs. 0.06 for BLEU
  - WMT 2006: correlation of 0.9–0.95 vs. 0.6–0.85 for BLEU
- Checks if arguments/adjuncts to verbs overlap
- Tunable?

## Lessons for Automatic Metrics

- Still an **essential tool** when building SMT systems
- Research papers should also **report manual** evaluation
- Consistent **bias** in automatic metrics when comparing different type of systems
- Improving automatic evaluation is a **well-defined task**
  - goal: better correlation with human judgments
  - impossible to *game* the metric
  - fast to compute to be usable in tuning



## Lessons for Manual Metrics

- Agreement was low for fluency and adequacy scores
- We should research ways of **improving manual evaluation** so that it is
  - more consistent
  - faster / cheaper
  - easier to perform
  - re-usable
- Are we asking the right question?
  - we do **not** care, how **good** machine translation is
  - we do care, how **useful** machine translation is



## Future Evaluations

- Euromatrix project starts an **ongoing online evaluation** later this year
- Goals:
  - provide common test sets and training data,
  - provide means for asynchronous evaluation
  - collect translations, show off best of best
- Expanded in scope to translation between **all 23 official European languages**
  - that's 253 language pairs, and 506 directions!
  - *you* could have the best Latvian-Maltese translation system in the world!
- **Continue annual evaluation**, which will focus on a subset of languages and do extensive manual evaluation
  - next year will include Hungarian
  - **ideas for manual evaluation welcome!**

## Best German-English Systems

- German → English Europarl:  
**SYSTRAN** > liu > uedin = upc > cmu-uka > nrc > saar
- German → English News Corpus:  
**SYSTRAN** > uedin > upc > nrc > saar
- English → German Europarl:  
**UEDIN** > systran = upc > cmu-uka > nrc > saar
- English → German News Corpus:  
**SYSTRAN** > upc > uedin > nrc > ucb > saar

## Best Spanish-English Systems

- Spanish → English Europarl:  
**UPC = UEDIN** > upv > cmu-syntax > cmu-uka = systran > nrc > saar
- Spanish → English News Corpus:  
**UPC** > uedin > systran > cmu-uka > nrc > upv > saar
- English → Spanish Europarl:  
**UEDIN** > upc = upv > cmu-uka > nrc = systran
- English → Spanish News Corpus:  
**SYSTRAN** > upc > cmu-uka > ucb > uedin > nrc = upv

## Best French-English Systems

- French → English Europarl:  
**LIMSI = UEDIN** > systran-nrc = upc > nrc > systran > saar
- French → English News Corpus:  
**LIMSI** > upc = uedin > systran > systran-nrc > nrc > saar
- English → French Europarl:  
**LIMSI** > systran-nrc = uedin > upc > nrc = systran > saar
- English → French News Corpus:  
**SYSTRAN-NRC=SYSTRAN** > limsi > nrc = ucb = uedin > ucb > saar



## Best Czech-English Systems

- Czech → English News Corpus:  
**UMD** > cu > uedin > pct
- English → Czech News Corpus:  
**PCT** > umd > uedin