

ingenio

Hybrid Strategies

for
better products and shorter time-to-market



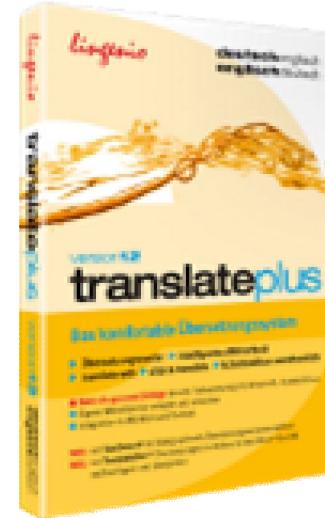
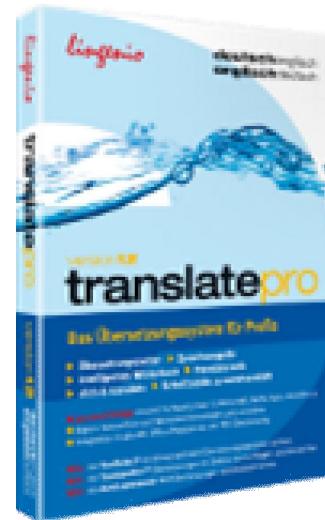
Background

lingenio

- Manufacturer of language technology software & services
 - Spin-off of the research center of  Germany/Heidelberg
 - Founded in 1999, located in Heidelberg, Germany
 - Advancement of IBM-technology *Logic based Machine Translation*
- Core competence:
- Machine translation (RBMT) & electronic dictionaries
 - Linguistic text analysis (morphology, syntax, semantics)

Products

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Products 1

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Client- & client/server-solutions

- *translate*
 - machine translation product (maintained and developed further since 1996)
 - languages: EN ↔ DE, FR ↔ DE, (EN ↔ FR, ES ↔ DE)
 - multi-user versions with user dictionary- & TM-synchronisation
- *translateDictTM*
 - electronic dictionary with innovative search technology
 - IntelliDict® (show reading and translation of a word which are best in the context)
 - FlexiFind ® (find main word in context and display the corresponding dictionary entry)
 - languages: EN↔DE, FR ↔ DE, EN ↔ FR, ES ↔ DE
 - multi-user version with user dictionary-synchronisation

Products 2



Server-based solutions

- *Lingenio Translation Server (LTS)*
 - for a company's intranet or as a service
 - languages: EN ↔ DE, FR ↔ DE, (EN ↔ FR, ES ↔ DE)
 - with user dictionary- & TM-integration, webpage integration
- *Lingenio Dictionary Server (LDS)*
 - for a company's intranet or as a service
 - languages: EN↔DE, FR ↔ DE, EN ↔ FR, ES ↔ DE
 - user dictionary-integration

Public versions (for testing)

- itranslate4eu (EU FP7 project)
- PONS translation portal (partner company PONS GmbH)
(preference over bing DE-EN/FR)

The screenshot shows the ittranslate4eu interface. At the top, there is a navigation bar with tabs for "Text", "Webseite", "Suche", and "Chat". Below the navigation bar, there are language selection buttons for "Deutsch" and "Englisch". To the right of these buttons are links for "Sachgebiet", "Orientierung", "Sprache", "Einstellungen", "Login / Registrieren", "Community", and "Human-Übersetzung". A main text area contains a German sentence: "Die globale Erwärmung hat zahlreiche Folgen - eine davon betrifft Schmetterlinge in Nordamerika. Zehntausende Beobachtungen haben an der US-Ostküste ein klares Bild ergeben: Steigende Temperaturen lassen die Insekten nach Norden wandern." Below this text, a message states: "Ihre Eingabe wird von mehreren Systemen übersetzt. Das soll dazu führen, dass der Text besser verständlich ist. Bitte markieren Sie die beste Übersetzung, indem sie auf den Stern unter ihr klicken. Sie helfen uns dadurch, unser Angebot zu verbessern." To the right of this message are buttons for "Noch: 763", a grid icon, a checkmark icon, and a "übersetzen" button. Below the main text area, the English translation is shown: "The global warming has numerous consequences - one concerns butterflies of this in North America. Ten thousands observations have yielded a clear picture at the U.S. East coast: increasing temperatures let the insects wander to the north." At the bottom of the interface, there are buttons for "lingenio", "vorschlagen", and "fragen".

ittranslate4.eu

Text | Webseite | Suche | Chat

Deutsch Englisch

Sachgebiet Orientierung Sprache Einstellungen Login / Registrieren Community Human-Übersetzung

Die globale Erwärmung hat zahlreiche Folgen - eine davon betrifft Schmetterlinge in Nordamerika. Zehntausende Beobachtungen haben an der US-Ostküste ein klares Bild ergeben: Steigende Temperaturen lassen die Insekten nach Norden wandern.

Ihre Eingabe wird von mehreren Systemen übersetzt. Das soll dazu führen, dass der Text besser verständlich ist. Bitte markieren Sie die beste Übersetzung, indem sie auf den Stern unter ihr klicken. Sie helfen uns dadurch, unser Angebot zu verbessern.

Noch: 763 übersetzen

The global warming has numerous consequences - one concerns butterflies of this in North America. Ten thousands observations have yielded a clear picture at the U.S. East coast: increasing temperatures let the insects wander to the north.

vorschlagen fragen

Partner

Mehr Information

- Hilfe
- Über uns
- Kontakt
- Datenschutzrichtlinie
- Anzeige
- Copyright

Presse-Raum

news and events

Anwendungen

Box, Plugins und Apps

Integration

Webseiten-Add-Ons

Sprachen

was wird unterstützt?

Pons.eu Language Portal

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The screenshot shows the Pons.eu Language Portal interface. At the top, there's a green header bar with the PONS.eu logo, navigation links like 'Wörterbuch', 'Übersetzung', 'Vokabeltrainer', etc., and social media links for Facebook and Twitter. Below the header is a large input field for text translation. The input field contains a German sentence: 'Die Riesenhitze rollt an: Bereits am Samstagvormittag registrierte der Deutsche Wetterdienst (DWD) in Offenbach stellenweise ungewöhnlich hohe Temperaturen Tageszeit. So zeigte das Thermometer im Westen - etwa im Raum Köln/Aachen - bereits 27 Grad an.' Below this, the English translation is displayed: 'The giant heat rolls: The German meteorological service (DWD) in Offenbach registered in places exceptionally high temperatures already on the Saturday morning for the time of day. So the thermometer showed already 27 degrees on the west - approximately on the room Cologne/Aix-la-Chapelle.' At the bottom right of the main content area, there's a small note: 'Ein Service von Lingenio (Hilfe)'.

Lingenio Translation Server



- Integration via Plug-Ins into...
 - Publishing Tools
 - Wordpress, ..
 - CAT-Tools
 - Trados
 - OmegaT,...
- Customization (TMs, user dictionaries)

Products 3

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- *Text analysis*
 - Morphology
 - Syntax (slot grammar analysis)
 - Semantics (shallow semantic structures from slot grammar analyses)
 - Discourse representation (discourse referents, events, referential links)
- *Generation*
 - inflected forms & sentences from morphological/syntactic/semantic structures

Awards

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- 2007: doIT Software Award for *FlexiDict®*
- 2005: doIT Software Award for *IntelliDict®*
- 2000: D2-WAP-Developer Award
by Mannesmann Mobilfunk and Nokia
for *WAP-based Translation Service*
- 1998: European IST-Prize
for *Talk & Translate*
- 1996: European IST-Prize
for *Personal Translator*



Quality evaluation

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Selection...

- 2013: Good network solution (*translate pro version12*)
- 2011: Good quality (*translate pro version 12*)
- 2009: Good quality (*translate pro version 11*)
- 2007: Very good quality (*translate pro version 11*)
- 2007: Test winner (*translate plus version 10*)
- 2005: Good quality (*Office dictionary*)
- 2000: Test winner (*Personal Translator Office plus*)



Motivation

- shorter time-to-market with more and better systems

Constraints

- high quality
- compatibility with rule-based components/systems

Hybrid Strategies

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RB-systems

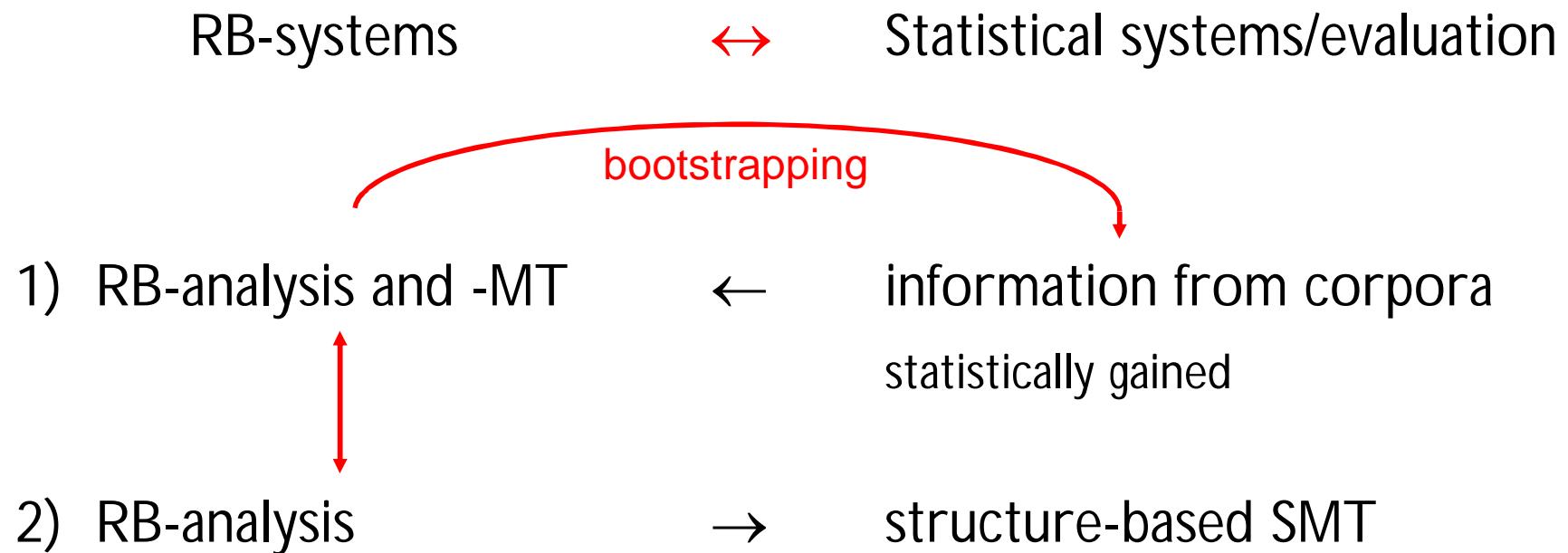
Statistical systems/evaluation

- 1) RB-analysis and -MT ← information from corpora
statistically gained

- 2) RB-analysis → structure-based SMT

Hybrid Strategies

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Hybrid Strategies

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bootstrapping

1) New content for RB-analysis, -MT ← information from corpora

- Monolingual
 - learn morphological classification and forms from corpus data
 - learn syntactic information from corpus data
 - learn semantic information from corpus data
- Multilingual
 - learn dictionary entries from bilingual corpus data

Monolingual content (for rule-based analysis and MT)

- learn morphological classification and forms from corpus data
Example
Deriving de/het gender classification for Dutch nouns for RBMT generation tasks
(poster session)
- learn semantic information from corpus data: semantic typing
(using subcategorization & collocation information,...)
- learn syntactic information from corpus data

Monolingual Data

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- learn syntactic information from corpus data

Strategies:

- learn grammar rules / parsing
 - MALT-parser (invited talk Joakim Nivre, Nivre et al 2006, Bohnet, ..)
- learn rule selection preferences

Hybrid Strategies

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learn grammar rule selection preferences from corpus data

- use sentence annotations/analyses (stored in database)
- use alignment and RB-transfer information between analysis nodes

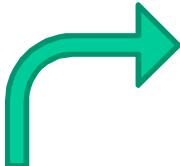
(background: 'slot grammar' analyses (dependency grammar) (McCord 1989),..

Hybrid Strategies

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Aumenta la demanda de energía eléctrica por la ola de calor

(the demand for electricity **increases** because of the heat-wave – **Increase the demand ... !**)



| | | |
|----------------------|------------------------|-----------------------------------|
| ndet | aument5001423<1,3,u> | verb<fin<[[pers3,sg,pres!ind]],X |
| subj(n) | la4253663<2> | det<def,[f sgl],X7> |
| ncomp(p<[nach!dat]>) | demandaa4236031<3,5> | noun<cn,[f sgl],def> |
| objprep(dat) | de4235161<4,5> | prep(de,X8,5> |
| top | energia4241313<5> | noun<cn,[f sgl],aj> |
| vprep | electrico4240217<6> | adj(X13,[f sgl],X14> |
| ndet | por4264971<7,9> | prep<por,X9,9> |
| objprep(gen) | la4253663<8> | det<def,[f sgl],X10> |
| d(1) | ola4260661<9> | noun<cn,[f sgl],def> |
| nachfrage | de4235161<10,11> | prep<de,X11,11> |
| nachtemp(< | calor4229297<11> | noun<cn,[m sgl],X12> |
| strom68061 | | |
| steig66781 | | |
| wegen78049 | | |
| d(7) | | |
| hitzewelle | | |
| top | aument4226689<1,u,3,5> | verb<fin<[[pers3,sg,pres!ind],[pe |
| ndet | la4253663<2> | det<def,[f sgl],X13> |
| obj(n) | demandaa4236031<3,u> | noun<cn,[f sgl],def> |
| comp(p<de>) | de4235161<4,5> | prep(de,X4,5> |
| objprep(n) | energia4241313<5> | noun<cn,[f sgl],aj> |
| nadj | electrico4240217<6> | adj(X9,[f sgl],X10> |
| nprep | por4264971<7,9> | prep<por,X5,9> |
| ndet | la4253663<8> | det<def,[f sgl],X6> |
| objprep(n) | ola4260661<9> | noun<cn,[f sgl],def> |
| nprep | de4235161<10,11> | prep<de,X7,11> |
| objprep(n) | calor4229297<11> | noun<cn,[m sgl],X8> |

Hybrid Strategies

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Example:

- DE ↔ ES
- improve grammar ES

ES: *Aumenta la demanda de energía eléctrica por la ola de calor*
(*the demand* for electricity *increases* because of the heat-wave – *Increase the demand ... !*)

DE: *Die Nachfrage ... steigt*

- *prefer subj-application to imperative in context ...*

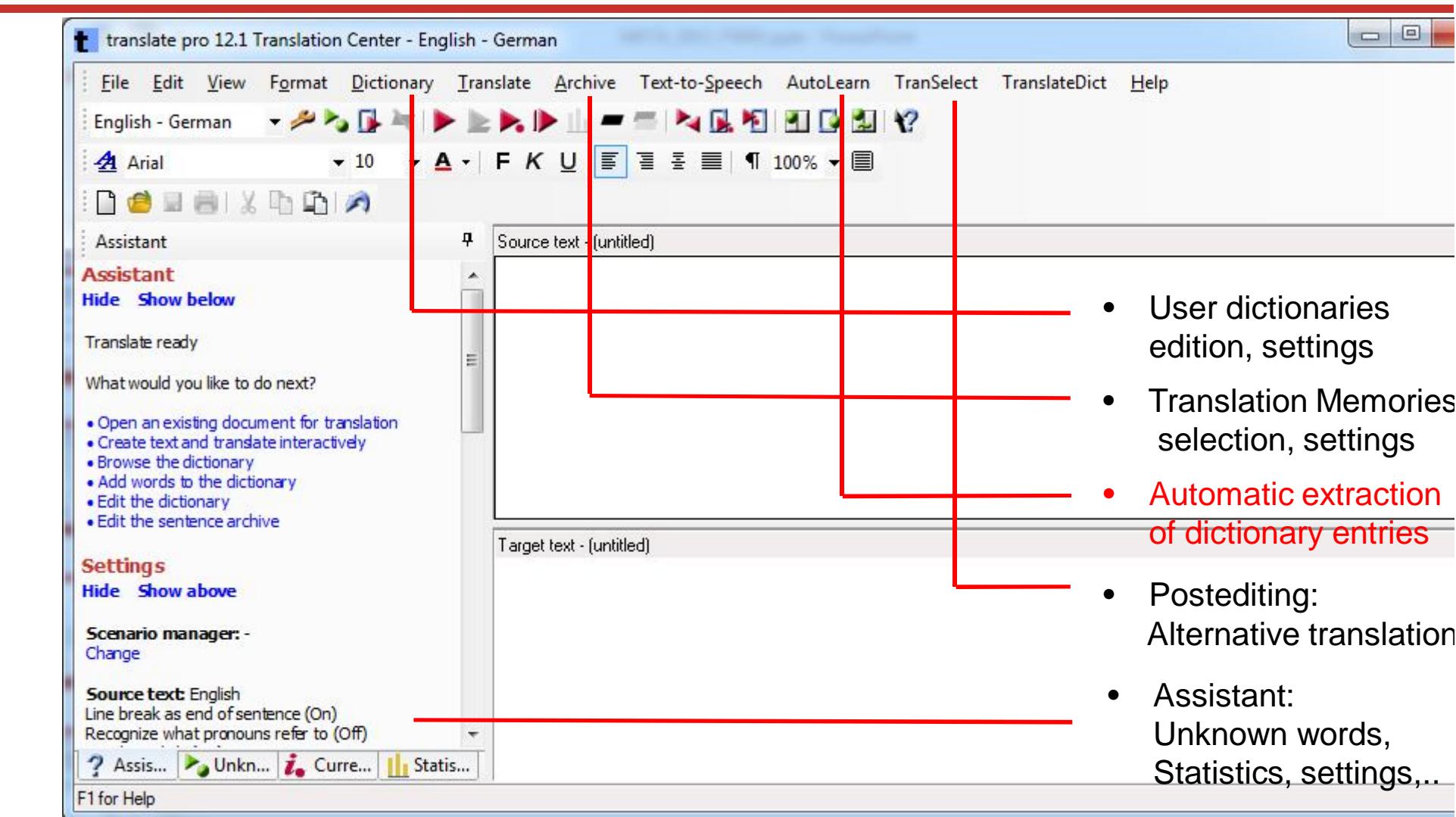
(Babych et al 2012)

1.b) Multilingual content for RBMT from corpora

- learn dictionary entries from bilingual corpus data
- Autolearn<word>

Translation Center

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extracts suggestions for dictionary entries from ...

- postedited MT
- translation memories
 - from single sentence pairs
 - complete TMs
- from bilingual text
 - via Lingenio sentence aligner

bilingual texts ...

European insurance regulation

Solvency Consulting Knowledge Series



Solvency II für Schaden-Umfall-Versicherer

(III) Gesamtbilanzansatz und Auswirkungen auf die Versicherungswirtschaft

Dieser Artikel stellt die grundlegenden Prinzipien des Gesamtbilanzansatzes und die Auswirkungen auf die Versicherungswirtschaft unter Solvency II für einen Schaden- Umfall-Versicherer dar. Sie bauen auf dem Vorschlag zur Rahmenrichtlinie vom Februar 2008 der EU-Kommission und der Durchführung der Richtlinie innerhalb der vierten quantitativen Auswirkungsstudie QIS4 auf, an denen 1.412 Versicherungsunternehmen bis Juli dieses Jahres teilgenommen haben. Die europäische Versicherungsaufsicht soll sich an zeitgemäßen Vorgaben orientieren. Im Gegensatz zu den bisherigen Solvabilitätsvorschriften soll Solvency II eine prospektive und risikoorientierte ökonomische Sichtweise widerspiegeln. Die künftigen Vorschriften beruhen auf einem Gesamtbilanzansatz. Dabei sollen die Solvabilitätsvorschriften mit den Rechnungslegungsvorschriften harmonisiert werden. Vermögensgegenstände und Verbindlichkeiten sind konsistent zu Marktwerten zu bewerten. Zur Bewertung der Vermögensgegenstände können grundsätzlich die IFRS-Bestimmungen zugrunde gelegt werden. Sind keine Marktwerte vorhanden, sind die Bilanzposten neu zu bewerten. Die Abbildung stellt die Komponenten einer ökonomischen Bilanz dar. Die vierte quantitative Auswirkungsstudie zeigt, dass in den Unternehmen kaum Unterschiede zwischen den Bilanzsummen der derzeitigen Solvency-I-Bilanz und der neuen Solvency-II-Bilanz bestehen. Der Aufbau der Bilanzen unterscheidet sich jedoch grundsätzlich. Der Unterschied ist umso größer, je weniger die lokalen Rechnungslegungsanforderungen marktvalorientierte Annahmen zugrunde legen. Dabei war die Neubewertung der Kapitalanlagen auf der Aktivseite zu Marktwerten der Solvency-II-Bilanz von den meisten Unternehmen problemlos durchzuführen. Schwierigkeiten traten lediglich bei der Bewertung von latenten Steuern, Beteiligungen, Rückversicherungs-forderungen und kondemintären Geschäften auf. Die stärksten Veränderungen sind auf der Passivseite der künftigen Solvenzbilanz zu erwarten: Versicherungstechnische Rückstellungen konnten noch nicht von allen Unternehmen vollständig neu bewertet werden.

Solvency Consulting Knowledge Series

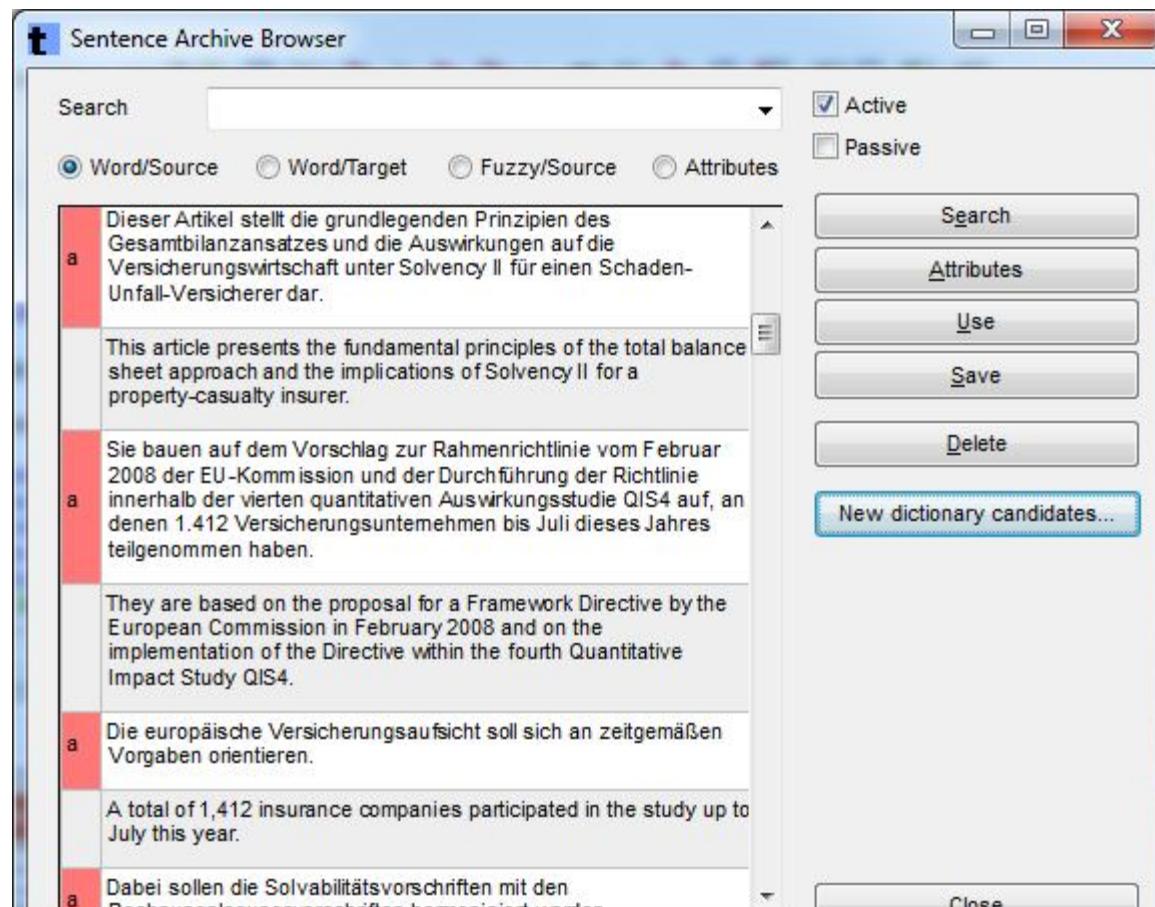


Solvency II for property-casualty insurers

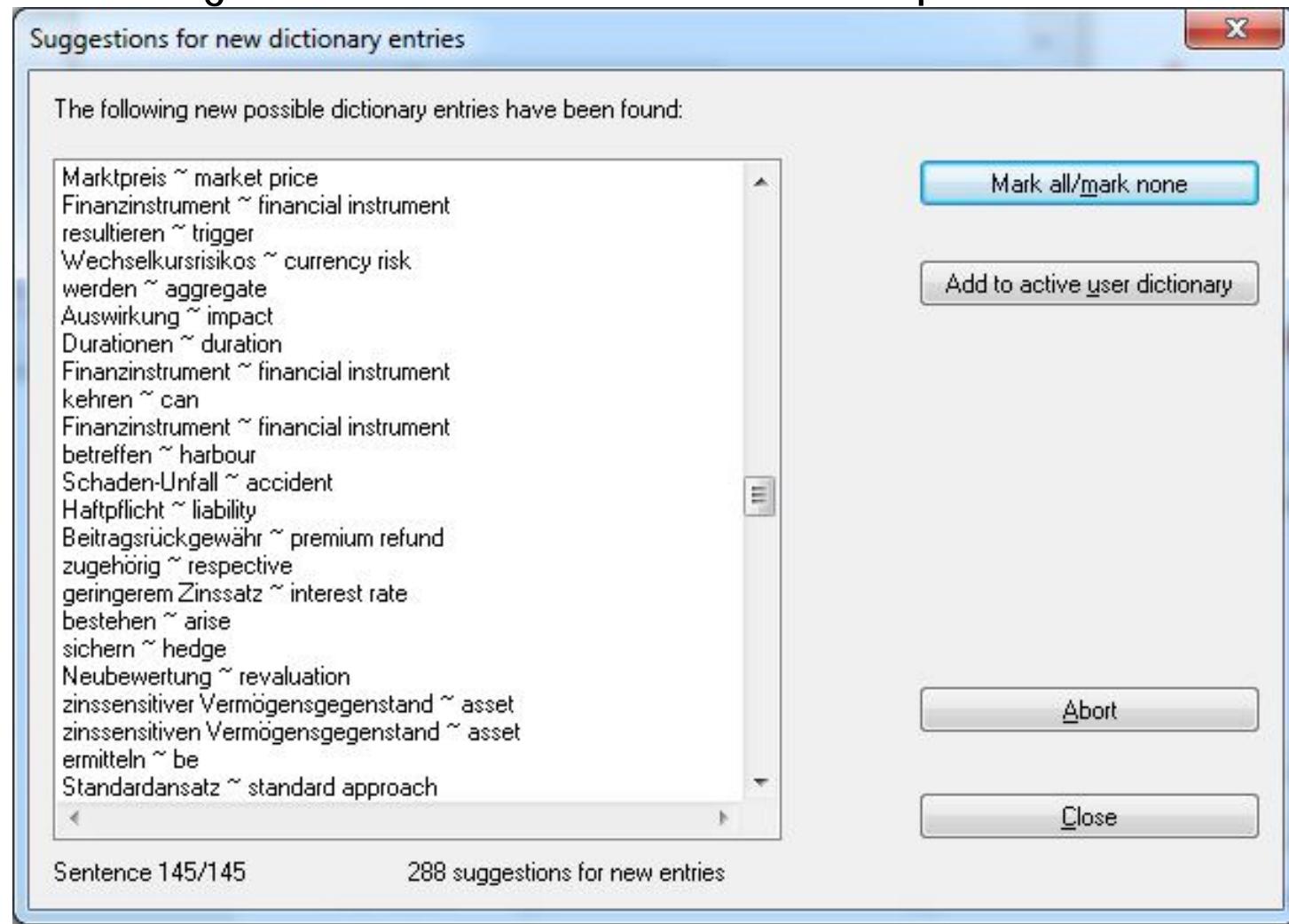
(II) Total balance sheet approach and impact on the insurance industry

This article presents the fundamental principles of the total balance sheet approach and the implications of Solvency II for a property-casualty insurer. They are based on the proposal for a Framework Directive by the European Commission in February 2008 and on the implementation of the Directive within the fourth Quantitative Impact Study QIS4. A total of 1.412 insurance companies participated in the study up to July this year. European insurance supervision is to be geared to modern requirements. Unlike the present solvency regime, Solvency II is designed to reflect a prospective and risk-oriented economic view. It will be based on a total balance sheet approach and harmonized with accounting rules and regulations. Assets and liabilities will consistently be recognized at market values. In principle, IFRS provisions can be used as a basis for valuing the assets. If market values are unavailable, the balance sheet items must be revalued. Figure 1 shows the components of an economic balance sheet. The fourth quantitative impact study shows that the QIS4 balance sheet does not considerably deviate from the current Solvency I balance sheet. The balance sheet composition, however, differs fundamentally. The less the local accounting regulations are based on market value assumptions, the greater the difference. In the case of most companies, the investments on the assets side were revalued without difficulty at the market values of the Solvency I balance sheet. Difficulties were only encountered with the valuation of deferred taxes, participations, reinsurance receivables and intragroup transactions. The greatest changes to be expected will involve the liabilities side of the future solvency balance sheet. Not all companies have been able to fully revalue their technical provisions yet. These provisions are especially important for determining the eligible capital components for covering the solvency capital requirement, since they have a direct impact here. In addition, these provisions are used to calculate the solvency capital requirement. On average, the value of the provisions is lower than under Solvency I, mainly because the valuation system is different. The coverage ratio, i.e. the ratio between available eligible capital and the solvency capital requirement SCR considered necessary in view of the insurance company's risk situation, is an

align & import into translation memory...



extract from single TM sentences or from complete TMs...



suggestions ...

- relate (potentially) to all parts of speech
(nouns, verbs, adjectives,...)
 - include multiword expressions
-
- can be selected for integration into active user dictionary....

AutoLearn<word> - Extraction method *lingenio*

Use..

1. Translation relations from system dictionaries
2. Structures as assigned to source and target sentence by the analysis components of the MT system

Example

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DE:

Die Lithofazien-Analyse der Pliozän-Schicht hat eine gewisse Anzahl von Umweltablagerungen ergeben.

EN:

Lithofacies analysis of the Pliocene succession unravelled a number of depositional environments.

Dependency grammar structures

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Dependence tree.

```
0---- top      s<ergeb,209287>    mtv(ind:dcl:nwh,tf(pres,1,0),a):[[ergeb]]  
|---- subj(n)  s<analyse,26886>   noun(cn,nom,-<-<pers3,sg>,f),[],[]:=[[activity,analyse]]  
|---- ndet     s<die,d>          det(nom,-<-<pers3,sg>,f),[def]:[[d,die]]  
|---- ncompound Lithofazien       noun(prop,cmp,-<-<pers3,sg>,X1),[],[]:=[[Lithofazien,unknown]]  
|---- nobj(u)  s<schicht,602138> noun(cn,gen,-<-<pers3,sg>,f),[],[]:=[[conv,measure,nonliv,nonself,part,,:  
|---- ndet     s<der,d>          det(gen,-<-<pers3,sg>,f),[def]:[[d,der]]  
|---- ncompound s<pliozän,1179941> noun(cn,cmp,-<-<pers3,sg>,nt),[],[]:=[[pliozän]]  
|---- obj(n)   s<anzahl,39999>   noun(cn,acc,-<-<pers3,sg>,f),[],[]:=[[anobj,anzahl,quant,plagr<nnoun>]]  
|---- ndet     s<ein,182125>     det(acc,-<-<pers3,sg>,f),[indef]:[[ein]]  
|---- nadj    s<gewiss,gewiss>  adj(p,acc,-<-<pers3,sg>,f),[],[]:=[[gewiss,modall]]  
|---- nobj(u)  s<ablagerung,5035> noun(cn,gen,-<-<pers3,pl>,f),[],[]:=[[ablagerung,phys]]  
|---- ncompound s<umwelt,720122> noun(cn,cmp,-<-<pers3,sg>,f),[],[]:=[[coll,liv,umwelt]]
```

Dependence tree.

```
0---- top      s<unravel,205272>  mtv(ind:dcl:nwh,tf(past,0,X1),a):[[unravel]]  
|---- subj(n)  s<analysis,865631> noun(cn,nom,-<-<pers3,sg>,nt),[],[]:=[[analysis]]  
|---- npren    Lithofacies        noun(prop,[nom,acc],-<-<pers3,X2>,nt),[],[]:=[[Lithofacies,unknown]]  
|---- nobj(n)  s<succession,51567> noun(cn,gen,-<-<pers3,sg>,nt),[],[]:=[[succession]]  
|---- ndet     s<the,1301140>    det(gen,-<-<pers3,sg>,nt),[def]:[[the]]  
|---- nadj    s<pliocene,1179944> adj(p,gen,-<-<pers3,sg>,nt),[nwh]:[[pliocene]]  
|---- obj(n)   s<number,1146254> noun(cn,acc,-<-<pers3,sg>,nt),[],[]:=[[number,quant,perco<nobj(n)>]]  
|---- ndet     s<a,851651>      det(acc,-<-<pers3,sg>,nt),[indef]:[[all]]  
|---- nobj(n)  s<environment,1001184> noun(cn,gen,-<-<pers3,pl>,nt),[],[]:=[[environment]]  
|---- npren    depositional      noun(prop,[nom,acc],-<-<pers3,X3>,nt),[],[]:=[[depositional,unknown]]
```

Dependency grammar structures + transfer knowledge

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Dependence tree.

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Dependence tree.

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`---- nobj(n)   s<environment,1001184> noun(cn,gen,-<-<pers3,pl>,nt),[],[]:=[[environment]]  
`---- npren     depositional   noun(prop,[nom,acc],-<-<pers3,X3>,nt),[],[]:=[[depositional,unknown]]
```

Dependency grammar structures + transfer knowledge (+ statistics)

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Dependence tree.

```
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`---- ndet      s<the,1301140>   det(gen,-<-<pers3,sg>,nt),[def]:[[the]]  
`---- nadj      s<pliocene,1179944> adj(p,gen,-<-<pers3,sg>,nt),[nwh]:[[pliocene]]  
`---- obj(n)    s<number,1146254> noun(cn,acc,-<-<pers3,sg>,nt),[],[]:=[[number,quant,perco<nobj(n)>]]  
`---- ndet      s<a,851651>     det(acc,-<-<pers3,sg>,nt),[indef]:[[all]]  
`---- nobj(n)   s<environment,1001184> noun(cn,gen,-<-<pers3,pl>,nt),[],[]:=[[environment]]  
`---- npren     depositional    noun(prop,[nom,acc],-<-<pers3,X3>,nt),[],[]:=[[depositional,unknown]]
```

Dependency grammar structures + transfer knowledge (+ statistics)

lingenio

Derive new relations

Dependence tree.

```
o----- top      s<ergeb,209287>  ->v<ind:dcl:nwh,tf<pres,1,0>,a>:[[ergeb]]  
`---- subj(n)   s<analyse,26886>  noun<cn,nom,-<-(pers3,sg),f>,[]>:[[activity,analyse]]  
`---- ndet      s<die,d>        det<nom,-<-(pers3,sg),f>, [def]>:[[d,die]]  
`---- ncompound Lithofazien     noun<prop,cmp,-<-(pers3,sg),X1>,[]>:[[Lithofazien,unknown]]  
`---- nobj(u)   s<schicht,602138> noun<cn,gen,-<-(pers3,sg),f>,[]>:[[conv,measure,nonliv,nonself,part,<  
`---- ndet      s<der,d>        det<gen,-<-(pers3,sg),f>, [def]>:[[d,der]]  
`---- ncompound s<pliozän,1179941> noun<cn,cmp,-<-(pers3,sg),nt>,[]>:[[pliozän]]  
`---- obj(n)    s<anzahl,39999>  noun<cn,acc,-<-(pers3,sg),f>,[]>:[[anobj,anzahl,quant,plagr<nnoun>]]  
`---- ndet      s<ein,182125>    det<acc,-<-(pers3,sg),f>, [indef]>:[[ein]]  
`---- nadj      s<gewiss,gewiss> adj<p,acc,-<-(pers3,sg),f>,[]>:[[gewiss,modall]]  
`---- nobj(u)   s<ablagerung,5035> noun<cn,gen,-<-(pers3,pl),f>,[]>:[[ablagerung,phys]]  
`---- ncompound s<umwelt,720122> noun<cn,cmp,-<-(pers3,sg),f>,[]>:[[coll,liv,umwelt]]
```

Dependence tree.

```
o----- top      s<unravel,205272>  ->v<ind:dcl:nwh,tf<past,0,X1>,a>:[[unravel]]  
`---- subj(n)   s<analysis,865631> noun<cn,nom,-<-(pers3,sg),nt>,[]>:[[analysis]]  
`---- npren     Lithofacies     noun<prop,[nom,acc],-<-(pers3,X2),nt>,[]>:[[Lithofacies,unknown]]  
`---- nobj(n)   s<succession,51567> noun<cn,gen,-<-(pers3,sg),nt>,[]>:[[succession]]  
`---- ndet      s<the,1301140>   det<gen,-<-(pers3,sg),nt>, [def]>:[[the]]  
`---- nadj      s<pliocene,1179944> adj<p,gen,-<-(pers3,sg),nt>, [nwh]>:[[pliocene]]  
`---- obj(n)    s<number,1146254> noun<cn,acc,-<-(pers3,sg),nt>,[]>:[[number,quant,perco<nobj(n)>]]  
`---- ndet      s<a,851651>    det<acc,-<-(pers3,sg),nt>, [indef]>:[[all]]  
`---- nobj(n)   s<environment,1001184> noun<cn,gen,-<-(pers3,pl),nt>,[]>:[[environment]]  
`---- npren     depositional  noun<prop,[nom,acc],-<-(pers3,X3),nt>,[]>:[[depositional,unknown]]
```

Dependency grammar structures + transfer knowledge (+ statistics)

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Derive new relations → AutoLearn<word>

Dependence tree.

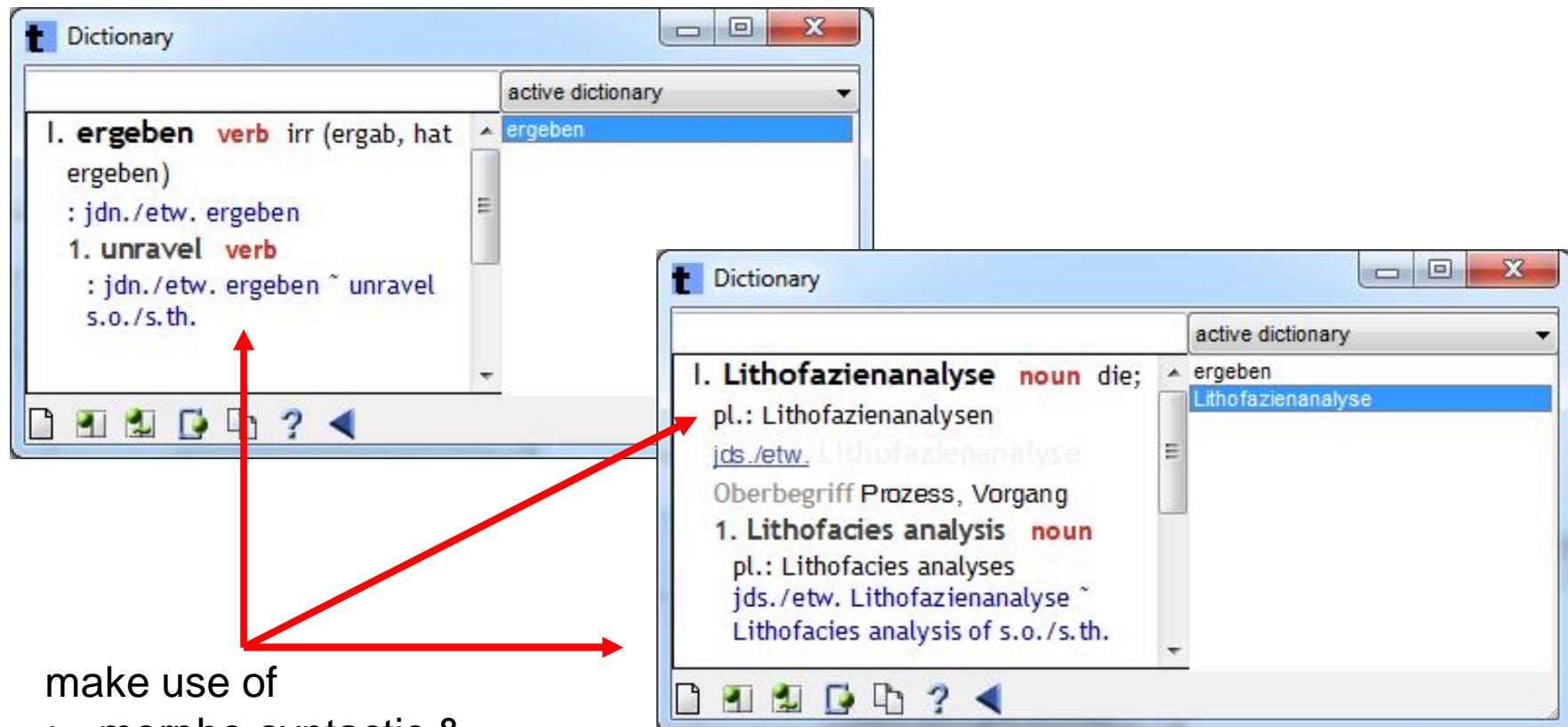
```
o----- top      s<ergeb,209287>  ->w<ind:dcl:nwh,tf<pres,1,0>,a>:[[ergeb]]  
`---- subj(n)   s<analyse,26886>  noun<cn,nom,-<-(pers3,sg),f>,[]>:[[activity,analyse]]  
`---- ndet      s<die,d>        det<nom,-<-(pers3,sg),f>, [def]>:[[d,die]]  
`---- ncompound Lithofazien     noun<prop,cmp,-<-(pers3,sg),X1>,[]>:[[Lithofazien,unknown]]  
`---- nobj(u)   s<schicht,602138> noun<cn,gen,-<-(pers3,sg),f>,[]>:[[conv,measure,nonliv,nonself,part,<  
`---- ndet      s<der,d>        det<gen,-<-(pers3,sg),f>, [def]>:[[d,der]]  
`---- ncompound s<pliozän,1179941> noun<cn,cmp,-<-(pers3,sg),nt>,[]>:[[pliozän]]  
`---- obj(n)    s<anzahl,39999>  noun<cn,acc,-<-(pers3,sg),f>,[]>:[[anobj,anzahl,quant,plagr<nnoun>]]  
`---- ndet      s<ein,182125>    det<acc,-<-(pers3,sg),f>, [indef]>:[[ein]]  
`---- nadj      s<gewiss,gewiss>  adj<p,acc,-<-(pers3,sg),f>,[]>:[[gewiss,modall]]  
`---- nobj(u)   s<ablagerung,5035> noun<cn,gen,-<-(pers3,pl),f>,[]>:[[ablagerung,phys]]  
`---- ncompound s<umwelt,720122> noun<cn,cmp,-<-(pers3,sg),f>,[]>:[[coll,liv,umwelt]]
```

Dependence tree.

```
o----- top      s<unravel,205272>  ->w<ind:dcl:nwh,tf<past,0,X1>,a>:[[unravel]]  
`---- subj(n)   s<analysis,865631>  noun<cn,nom,-<-(pers3,sg),nt>,[]>:[[analysis]]  
`---- npren     Lithofacies       noun<prop,[nom,acc],-<-(pers3,X2),nt>,[]>:[[Lithofacies,unknown]]  
`---- nobj(n)   s<succession,51567> noun<cn,gen,-<-(pers3,sg),nt>,[]>:[[succession]]  
`---- ndet      s<the,1301140>    det<gen,-<-(pers3,sg),nt>, [def]>:[[the]]  
`---- nadj      s<pliocene,1179944> adj<p,gen,-<-(pers3,sg),nt>, [nwh]>:[[pliocene]]  
`---- obj(n)    s<number,1146254>  noun<cn,acc,-<-(pers3,sg),nt>,[]>:[[number,quant,perco<nobj(n)>]]  
`---- ndet      s<a,851651>      det<acc,-<-(pers3,sg),nt>, [indef]>:[[all]]  
`---- nobj(n)   s<environment,1001184> noun<cn,gen,-<-(pers3,pl),nt>,[]>:[[environment]]  
`---- npren     depositional     noun<prop,[nom,acc],-<-(pers3,X3),nt>,[]>:[[depositional,unknown]]
```

Dictionary entries assigned to suggestions

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make use of

- morpho-syntactic &
- semantic information & defaults of the MT system (bootstrapping)

Entries can be edited

Do more !

lingenio

Use analysis constraints !

Dependence tree.

```
o---- top      s<ergeb,209287>  ->v<ind:dcl:nwh,tf<pres,1,0>,a>:[[ergeb]]  
`--- subj(n)   s<analyse,26886>  noun<cn,nom,-<-<pers3,sg>,f>,[ ]>:[[activity,analyse]]  
`--- ndet      s<die,d>        det<nom,-<-<pers3,sg>,f>,[def]>:[[d,die]]  
`--- ncompound Lithofazien     noun<prop,cmp,-<-<pers3,sg>,X1>,[ ]>:[[Lithofazien,unknown]]  
`--- nobj(u)   s<schicht,602138> noun<cn,gen,-<-<pers3,sg>,f>,[ ]>:[[conv,measure,nonliv,nonself,part,<u>]]  
`--- ndet      s<der,d>        det<gen,-<-<pers3,sg>,f>,[def]>:[[d,der]]  
`--- ncompound s<pliozän,1179941> noun<cn,cmp,-<-<pers3,sg>,nt>,[ ]>:[[pliozän]]  
`--- obj(n)    s<anzahl,39999>  noun<cn,acc,-<-<pers3,sg>,f>,[ ]>:[[anobj,anzahl,quant,plagr<nnoun>]]  
`--- ndet      s<ein,182125>    det<acc,-<-<pers3,sg>,f>,[indef]>:[[ein]]  
`--- nadj     s<gewiss,gewiss>  adj<p,acc,-<-<pers3,sg>,f>,[ ]>:[[gewiss,modall]]  
`--- nobj(u)   s<ablagerung,5035> noun<cn,gen,-<-<pers3,pl>,f>,[ ]>:[[ablagerung,phys]]  
`--- ncompound s<umwelt,720122> noun<cn,cmp,-<-<pers3,sg>,f>,[ ]>:[[coll,liv,umwelt]]
```

Dependence tree.

```
o---- top      s<unravel,205272>  ->v<ind:dcl:nwh,tf<past,0,X1>,a>:[[unravel]]  
`--- subj(n)   s<analysis,865631> noun<cn,nom,-<-<pers3,sg>,nt>,[ ]>:[[analysis]]  
`--- npren     Lithofacies     noun<prop,[nom,acc],-<-<pers3,X2>,nt>,[ ]>:[[Lithofacies,unknown]]  
`--- nobj(n)   s<succession,51567> noun<cn,gen,-<-<pers3,sg>,nt>,[ ]>:[[succession]]  
`--- ndet      s<the,1301140>   det<gen,-<-<pers3,sg>,nt>,[def]>:[[the]]  
`--- nadj     s<pliocene,1179944> adj<p,gen,-<-<pers3,sg>,nt>,[nwh]>:[[pliocene]]  
`--- obj(n)    s<number,1146254> noun<cn,acc,-<-<pers3,sg>,nt>,[ ]>:[[number,quant,perco<nobj(n)>]]  
`--- ndet      s<a,851651>    det<acc,-<-<pers3,sg>,nt>,[indef]>:[[all]]  
`--- nobj(n)   s<environment,1001184> noun<cn,gen,-<-<pers3,pl>,nt>,[ ]>:[[environment]]  
`--- npren     depositional   noun<prop,[nom,acc],-<-<pers3,X3>,nt>,[ ]>:[[depositional,unknown]]
```

syntactic constraints

morphological constraints

semantic constraints

Extended AutoLearn with selection restrictions

lingenio

```
source entry
lemma:      ergeben
identifier:  209287
part of speech:1
stem:        ergeb
sem. types:  true
slots:       [subj(n):!obj1(n)]


target entry
lemma:      unravel
identifier:  205272
translation: unravel
conditions: [subj(n):[analyse,det(_138969,_138970)],obj1(n):[anzahl,det(_139157,_139158)]]
restructuring: xf(ts([tau(subj(n),[analysis,det(_140725,_140726)])],tau(obj(n)),[number,det(_141255,_141256]))


source entry
lemma:      Lithofazienanalyse
identifier:  26886
part of speech:3
stem:        lithofazienanalyse
sem. types:  activity
slots:       nobj1(u)


target entry
lemma:      Lithofacies analysis
identifier:  865631
translation: ['Lithofacies analysis'!'Lithofacies analyses']
conditions: [nobj1(u):[schicht,det(_146196,_146197)]]
restructuring: xf(ts([x]))
```

Extended AutoLearn with selection restrictions

lingenio

```
source entry
lemma:      ergeben
identifier:  209287
part of speech:1
stem:        ergeb
sem. types:  true
slots:       [subj<n>|obj1<n>]

target entry
lemma:      unravel
identifier:  205272
translation: unravel
conditions: [subj<n>:[analyse,det<_138969,_138970>],obj1<n>:[anzahl,det<_139157,_139158>]]
restructuring: xf<(ts<[tau<subj<n>],[analysis,det<_140725,_140726>])>tau<obj<n>,[number,det<_141255,_141256
```

```
source entry
lemma:      Lithofazienanalyse
identifier:  26886
part of speech:3
stem:        lithofazienanalyse
sem. types:  activity
slots:       nobj1<u>

target entry
lemma:      Lithofacies analysis
identifier:  865631
translation: ['Lithofacies analysis' | 'Lithofacies analyses']
conditions: [nobj1<u>:[schicht,det<_146196,_146197>]]
restructuring: xf<(ts<[x]>)
```

subject constraint

direct object constraint

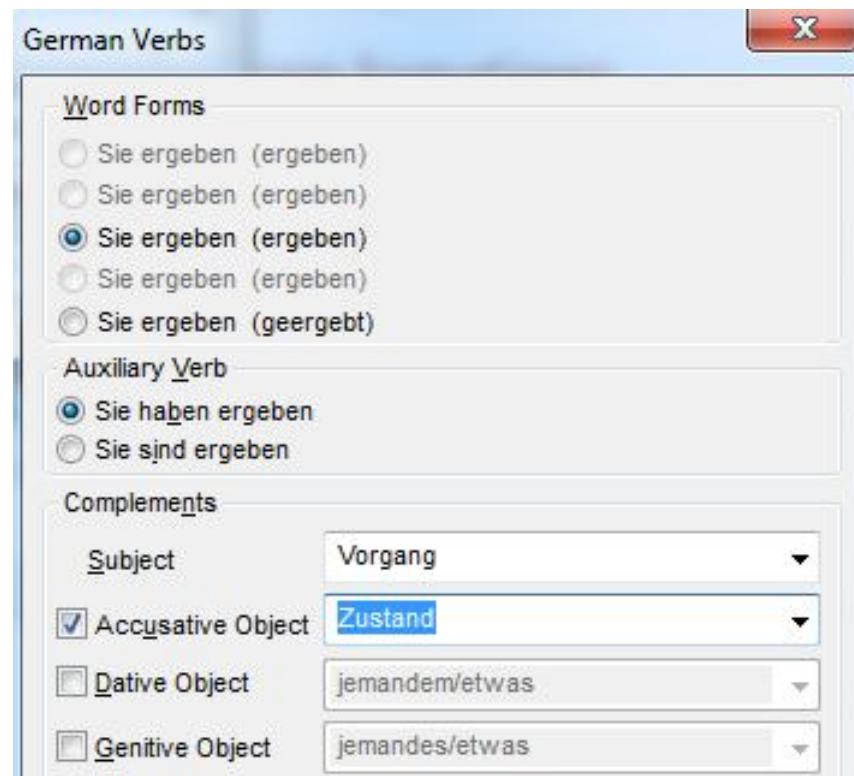
genitive object constraint

Extended AutoLearn with selection restrictions

lingenio

- extract restrictions
Lithofazien-Analyse ergibt Anzahl Umweltablagerungen ~ unravel
 - weaken conditions (Lithofazien-Analyse -> Analyse -> ,Process')
Analyse ergibt Ablagerung (frame with less specific words)
,Process' ergibt ,Result' (frame with semantic types)
 - Select conditions by evaluating occurrences in corpora
Analyse/'Process' ergibt Ablagerung/'Result' ~ unravel, yield ?
- Determine appropriate context items & context type probabilities !

- soon: **translatepro** version 13 with selection restrictions



2) RB-analysis → structure-based SMT

Basis:

- slot grammar analysis (McCord 1989),..
 - ‚abstract‘ dependency structures (shallow semantic representations)
 - database infrastructure
 - a relational database with:
 - Multilingual corpora (Europarl, customer TMs,..)
 - Alignment information
 - Morpho-syntactic, semantic analyses (abstract dependency structures & disambiguation)
- (Cooperation with University of Stuttgart, SFB 732 (Eckart, Eberle, Heid et al 2010))
- Compute translation models on the basis of pairs of such structures

RB-analysis → structure-based SMT *lingenio*

Example: European solvency law

EN: The adoption of the Framework Directive at EU level is awaited with anticipation.

DE: Mit Spannung wird die Verabschiedung der Rahmenrichtlinie auf EU-Ebene erwartet.

The screenshot shows a database interface with a table titled 'textsentences'. The table has columns: objdescr, objid, segnr, lang, sentid, and sent. The data consists of six rows, each corresponding to an object 'mrück3' with ID 704566. The rows show translations in English (en) and German (de) for different segments (segnr 1-3) of the sentence. The English text is the target language, while the German text is the source language. The last row contains a partial sentence from the English side.

| | objdescr character varying(100) | objid bigint | segnr bigint | lang character varying(10) | sentid bigint | sent character varying(2500) |
|---|------------------------------------|-----------------|-----------------|-------------------------------|------------------|--|
| 1 | mrück3 | 704566 | 1 | en | 704567 | CEIOPS plans first implementing measures for Solvency II |
| 2 | mrück3 | 704566 | 1 | de | 704568 | CEIOPS plant erste Durchführungsmaßnahmen für Solvency II |
| 3 | mrück3 | 704566 | 2 | en | 704569 | The adoption of the Framework Directive at EU level is awaited with anticipation. |
| 4 | mrück3 | 704566 | 2 | de | 704570 | Mit Spannung wird die Verabschiedung der Rahmenrichtlinie auf EU-Ebene erwartet. |
| 5 | mrück3 | 704566 | 3 | de | 704571 | In der Richtlinie werden die wichtigsten Grundsätze festgelegt. |
| 6 | mrück3 | 704566 | 3 | en | 704572 | For as soon as it has been adopted, implementing measures will need to be established. |

RB-analysis → structure-based SMT *lingenio*

EN: The adoption of the Framework Directive at EU level is awaited with anticipation.
DE: Mit Spannung wird die Verabschiedung der Rahmenrichtlinie auf EU-Ebene erwartet.

Representation of analyses of different type, computed by different systems using different processing parameters, at different times

```
select * from tlex.textanalyses where objdescr='mrück3' and segnr=2 and type='dep'
```

The screenshot shows a database interface with a toolbar at the top and a table below. The table has columns for objdescr, objid, segnr, lang, sentid, anaid, type, sarea, option, sys, ananr, content, and lastana. There are two rows of data, both corresponding to 'mrück3' and 'segnr=2'. The first row is in English ('en') and the second in German ('de'). The 'content' column contains complex JSON-like strings representing the analysis results.

| | objdescr character bigint | objid bigint | segnr bigint | lang char | sentid bigint | anaid bigint | type char | sarea char | option charac | sys charact | ananr integer | content character varying(90000) | lastana timestamp without time zone |
|---|---------------------------------|-----------------|-----------------|--------------|------------------|-----------------|--------------|---------------|------------------|----------------|------------------|---|--|
| 1 | mrück3 | 70451 | 2 | en | 70456 | 75065 | dep | | | anapqa | 1 | [tnode(11,s(await,879048),mtv(ind:dcl:nwh,tf(p:2014-04-24 22:54:27.45 | |
| 2 | mrück3 | 70451 | 2 | de | 70457 | 73528 | dep | | | anapqa | 1 | [tnode(12,s(erwart,214343),mtv(ind:dcl:nwh,tf(p:2012-07-26 17:23:32.078 | |

RB-analysis → structure-based SMT *lingenio*

DB-analyses can be displayed as trees (pretty-print facility)

```
select * from tlex.textanalyses where objdescr='mrück3' and segnr=2 and type='dep'
```

| III | | | | | | | | | | | | |
|---|----------------------|-----------------|-----------------|--------------|------------------|-----------------|--------------|---------------|------------------|----------------|------------------|---|
| gabefeld | | | | | | | | | | | | |
| benanzeige Zerlegung Meldungen Historie | | | | | | | | | | | | |
| | objdescr characte | objid bigint | segnr bigint | lang char | sentid bigint | anaid bigint | type char | sarea char | option charac | sys charact | anarr integer | content character varying(90000) |
| 1 | mrück3 | 704512 | en | 70456 | 75065 | dep | | | | anapgspl | 1 | [tnode(11,s(await,879048),mtv(ind:dcl:nwh,tf(p:2014-04-24 22:54:27.45 |
| 2 | mrück3 | 704512 | de | 70457 | 73528 | dep | | | | anapgspl | 1 | [tnode(12,s(erwart,214343),mtv(ind:dcl:nwh,tf(p:2012-07-26 17:23:32.078 |

```
| ?- dbshow(sent(mrück3,2),de,dep,anapgspl,'','','').
```

Mit Spannung wird die Verabschiedung der Rahmenrichtlinie auf EU-Ebene erwartet.

Dependence tree.

```

----- top      s(erwart,214343)      mtv(ind:dcl:nwh,tf(pres,0,x1),p):[erwart]
+-- vprep     s(mit,477132)      prep([mit|dat],[nwh]):[[mit]]
+-- objprep(dat) s(spannung,648871)  noun(cn,dat,-(<-<(pers3,sg),f),[]):[[emot,mass,sp
+-- obj(n)    s(verabschiedung,738371) noun(cn,acc,-(<-<(pers3,sg),f),[]):[[event,verabs
+-- ndet      s(die,d)      det(acc,-(<-<(pers3,sg),f),[def]):[[d,die]]
+-- nobj(u)   s(rahmenrichtlinie,558906) noun(cn,gen,-(<-<(pers3,sg),f),[]):[[anordnung0,r
+-- ndet      s(der,d)      det(gen,-(<-<(pers3,sg),f),[def]):[[d,der]]
+-- vprep     s(auf,51163)      prep([auf|acc],[nwh]):[[auf]]
+-- objprep(acc) s(ebene,176855) noun(cn,acc,-(<-<(pers3,sg),f),[]):[[ebene,stall
+-- ncompound  s(EU,216608)      noun(prop,cmp,-(<-<(pers3,sg),f),[]):[[EU,inst]]
```

time: 140 msec

RB-analysis → structure-based SMT *lingenio*

dep = abstract dependency structure (shallow semantic structure)

| sys | ai | content |
|----------|----|--|
| charact | in | character varying(90000) |
| anapgspl | 1 | tnode(11,s(await,879048),mtv(ind:dcl:nwh,tf(pres,0,0),p):([[await]],top,[head,obj(n):2,vprep:12, |
| anapgspl | 1 | tnode(12,s(erwart,214343),mtv(ind:dcl:nwh,tf(pres,0,1),p):[[erwart]],top,[head,vprep:1,obj(n):5, |

```
?- dbshow(sent(mriick3,2),de,dep,anapgspl,'','').
```

Mit Spannung wird die Verabschiedung der Rahmenrichtlinie auf EU-Ebene erwartet.

different auxiliary structures

Dependence tree.

```

----- top          s(erwart,214343)           mtv(ind:dcl:nwh,tf(pres,0,X1),p):[[erwart]]
+--- vprep        s(mit,477132)           prep<mit,dat>,town>:[[mit]]                                one event node
+--- objprep(dat) s(spannung,648871)       noun(cn,dat,-<-<pers3,sg>,f),[]:=[[emot,mass,sp
+--- obj(n)       s(verabschiedung,738371) noun(cn,acc,-<-<pers3,sg>,f),[]:=[[event,verabs
+--- ndet         s(die,d)               det(acc,-<-<pers3,sg>,f),[def]:[[d,diell
+--- nobj(u)      s(rahmenrichtlinie,558906) noun(cn,gen,-<-<pers3,sg>,f),[]:=[[anordnung0,r
+--- ndet         s(der,d)               det(gen,-<-<pers3,sg>,f),[def]:[[d,der]]
+--- vprep        s(auf,51163)            prep(lauf|acc],[nwh]):[[auf]]
+--- objprep(acc) s(ebene,176855)       noun(cn,acc,-<-<pers3,sg>,f),[]:=[[ebene,stall
+--- ncompound    s(EU,216608)           noun(prop,cmp,-<-<pers3,sg>,f),[]:=[[EU,inst]]
```

time: 140 msec :: The adoption of the Framework Directive at EU level is awaited with anticipation.

Dependence tree.

```

----- top          s(await,879048)           mtv(ind:dcl:nwh,tf(pres,0,0),p):[[await]]
+--- obj(n)       s(adopt,857828)           noun(cn,acc,-<-<pers3,sg>,nt),[]:=[[adoption]]                                one event node
+--- ndet         s(the,1301140)           det(acc,-<-<pers3,sg>,nt),[def]:[[the]]
+--- nobj(n)      s(directive,159298)       noun(cn,gen,-<-<pers3,sg>,nt),[]:=[[directive]]
+--- ndet         s(the,1301140)           det(gen,-<-<pers3,sg>,nt),[def]:[[the]]
+--- nnoun        s(framework,1029028)       noun(cn,[nom,acc],-<-<pers3,sg>,nt),[]:=[[artefact0,fr
+--- nprep        s(at,876180)             prep(at,[nwh]):[[at,pprefv,staticp]]
+--- objprep(acc) s(level,1097188)          noun(cn,acc,-<-<pers3,sg>,nt),[]:=[[level,tonoun]]
+--- nnoun        s(EU,216612)             noun(cn,[nom,acc],-<-<pers3,sg>,nt),[]:=[[EU,humcoll]]
+--- vprep        s(with,1347183)           prep(with,[nwh]):[[nonloclp,pprefv,with]]
+--- objprep(acc) s(anticipation,214388)       noun(cn,acc,-<-<pers3,sg>,nt),[]:=[[anticipation]]
```

RB-analysis → structure-based SMT *lingenio*

dep = abstract dependency structure (shallow semantic structure)

| sys | ai | content |
|---------|----|---|
| charact | in | character varying(90000) |
| anapqs | 1 | [tnode (11,s(await,879048),mtv(ind:dcl:nwh,tf(pres,0,0),p):([[await]]),top,[head,obj(n):2,vprep:12, |
| anapqs | 1 | [tnode (12,s(erwart,214343),mtv(ind:dcl:nwh,tf(pres,0, 1),p):[[erwart]],top,[head,vprep:1,obj(n):5, |

- Source and target structures are more similar
- 'structure-based' SMT on the basis of abstract dependency analyses
- better SMT

Current hybrid developments

lingenio

- Lingenio background:
,Rule-based' analysis & translation (DE, EN, ES, FR,...)
- Investigation of corpora and annotation of corpus segments
- Different hybrid methods
 - extract mono- and multilingual rules from corpora on the basis of frequency information and annotations
 - determine probabilities for structural and lexical disambiguation decision schemes
 - Compute translation models for structure-based SMT
- Faster go-to-market, better systems

Research

lingenio

- Improving accuracy and coverage of analysis & translation

- EU Marie Curie project

Hy^{gh}
HyTra



UNIVERSITY OF LEEDS

(Hybrid high quality machine translation)

- BMWi project *FlexNeuroTrans*



(Flexible MT for medium-sized businesses using neural nets)

- Hybrid methods, information from the internet for MT,...



Thank you for your attention!

Questions ?

Contact: info@ingenio.de, 0049 6221 9146751, www.ingenio.de