Shallow Text Generation

Stephan Busemann
DFKI GmbH
Stuhlsatzenhausweg 3
D-66123 Saarbrücken

Stephan.Busemann@dfki.de
http://www.dfki.de/~busemann

Application Systems for NLG Must be Developed Quickly and in a User-Oriented Way

- **Requirements placed by the application**
  - on the user: recognize and articulate needs
  - on the developer: make herself acquainted with the domain
  - on both: create and adapt a corpus of sample target texts
- **Requirements wrt the software**
  - Adaptability to new tasks and domains
  - Scalability (low costs of the next rule)
  - Modularisation (interpreter, data, knowledge, interfaces)

High efficiency of development is difficult to achieve with traditional approaches to language generation

Source: Stephan Busemann

Non-Trivial Generation Systems are Expensive to Adapt to New Domains and Tasks

- **Examples**
  - KPML (Bateman 1997), systemic grammars, development environment
  - FUF/Surge (Elhadad/Robin 1992), functional unification grammar, interpreter
- **Features**
  - large multi-lingual systems
  - detailed, monolingual semantic representations as input
  - broad coverage of linguistic phenomena (goal: the more, the better)
- **Effort for adaptation**
  - Rich interface to the input language of the system (logical form, SPL)
  - Generation of sentences reflecting the distinctions covered

The excellent scope of services of generic resources can often not easily be utilised in practice

Deep* vs Shallow NLG

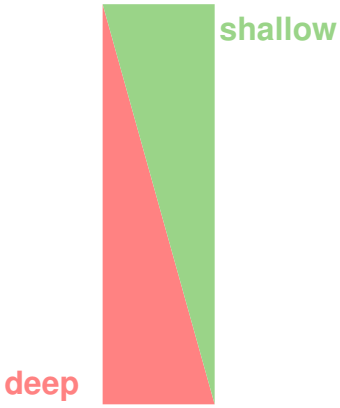
* This differs from the Chomskyan distinction between deep and surface structrure, which is sometimes used to characterize deep and surface generation

- **Deep generation**
  - knowledge-based: models of the domain, of the author and the addressees, of the language(s) involved
  - theoretically motivated: aiming at generic, re-usable technology
  - unresolved issue of general system architecture
- **Shallow generation**
  - opportunistic modelling of relevant aspects of the application
  - diverse depths of modelling, as required by the application
  - some methods can be viewed as „short cuts“ for unsolved questions of deep generation

Shallow generation can be defined in analogy to shallow analysis

There is a Smooth Transition Between Shallow and Deep Methods

- **Prefabricated texts**
- **„Fill in the slots“**
- **with flexible templates**
- **with aggregation**
- **with sentence planning**
- **with document planning**



Source: Stephan Busemann

Shallow Architectures Have a Simple Task Structure

“Deep” model with interaction (cf. Reiter/Dale 2000)

Content Determination
Discourse Planning

Sentence Aggregation
Lexicalisation
Generation of Referring Expressions

Surface Realisation

„Shallow“ Model (Busemann/Horacek 1998)

Content Determination

Text Organisation (Aggregation)

Mapping Onto Linguistic Structures

Source: Stephan Busemann

Overview

- Motivation
- The TG/2 Shallow NLG framework
- Some major applications for shallow NLG
- Assessment and conclusions

Source: Stephan Busemann

Input for Air Quality Report Generation

```
[(COOP threshold-passing)
 (TIME [(PRED season)
        (NAME [(SEASON summer)
               (YEAR 1999)])])
 (POLLUTANT o3)
 (SITE "Völklingen-City")
 (DURATION [(MINUTE 60)])
 (SOURCE [(LAW-NAME bimsch)
          (THRESHOLD-TYPE info-value)])
 (EXCEEDS [(STATUS yes)
           (TIMES 1)])]
```

In summer 1999 at the measuring station of Völklingen-City, the information value for ozone – 180 µg/m³ according to the German decree Bundesimmissions-schutzverordnung – was exceeded once during a period of 60 minutes.

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Im Sommer 1999 wurde der Informationswert für Ozon an der Messstation Völklingen-City während einer 60-minütigen Einwirkungsdauer (180 µg/m³ nach Bundesimmissionsschutzverordnung) einmal überschritten.

Input for Air Quality Report Generation

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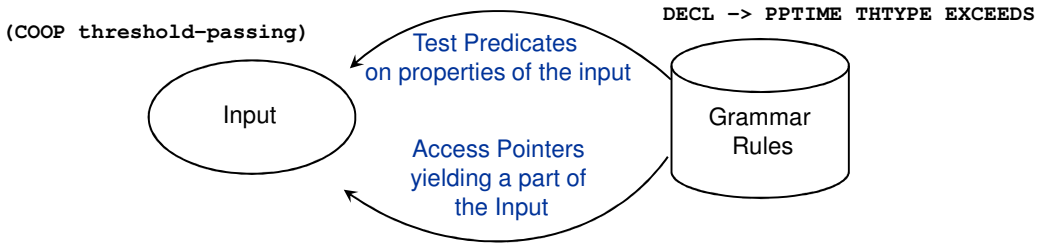
TG/2 Offers a Flexible Framework for NLG

- **TG/2 is a transparent production system**
- **TG/2 interprets a separately defined set of condition-action rules**
- **TG/2 maps pieces of input onto surface strings**

TG/2 keeps grammars largely independent from input representations



TG/2 Grammars Integrate Canned Texts, Templates and Context-free Rules

```
My category is DECL.
IF the slot COOP is 'threshold-passing
   AND the slot LAW-NAME is specified
THEN apply PPtime from slot TIME
     apply THTYPE from CURRENT-INPUT
     utter "("
     apply LAW from slot LAW-NAME
     utter ") "
     apply EXCEEDS from slot EXCEEDS
     utter "."
WHERE THTYPE AND EXCEEDS agree in GENDER
```

(Busemann 1996)

En été 1999
la valeur limite autorisée
(
selon le decret ...
)
a été dépassée une fois
.

```
My category is THTYPE.
IF there is no slot THRESHOLD-TYPE specified
THEN utter "la valeur limite autoris&e2e "
WHERE THTYPE has value 'fem for GENDER
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```
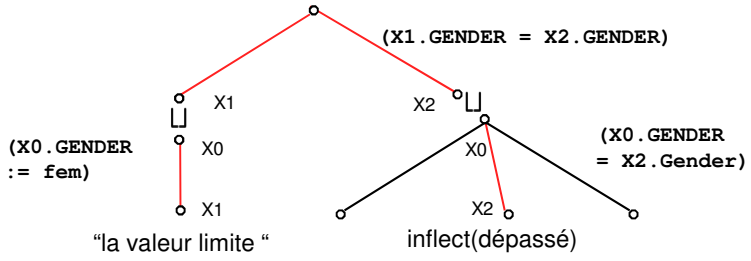


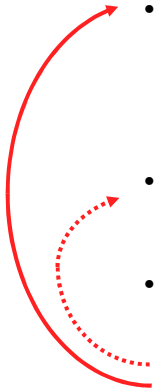
Constraints are Percolated Across the Derivation Tree

- Feature unification (⊔) at tree nodes
- Every tree of depth 1 is licensed by a grammar rule
- A feature can be assigned a value (:=)
- Two features can be constrained to have identical values (=)



The Interpreter is Based on the Context-Free Backbone of the Grammars

THREE-STEP EVALUATION CYCLE



- **Matching**
  - Identify all rules with the **current category**
  - For each of them perform its tests on the **input structure** (“IF” part)
  - Add those passing the tests to the conflict set
- **Conflict resolution**
  - Select an element of the conflict set (possibly by some preference mechanism)
- **Firing**
  - Evaluate the rule‘s constraints (if available, “WHERE” part)
  - For each element of the “THEN” part, read the new category and determine the new input structure by evaluating the associated access pointer

Source: Stephan Busemann

Overview

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- **The TG/2 Shallow NLG framework**
- **Some major applications for shallow NLG**
- **Assessment and conclusions**

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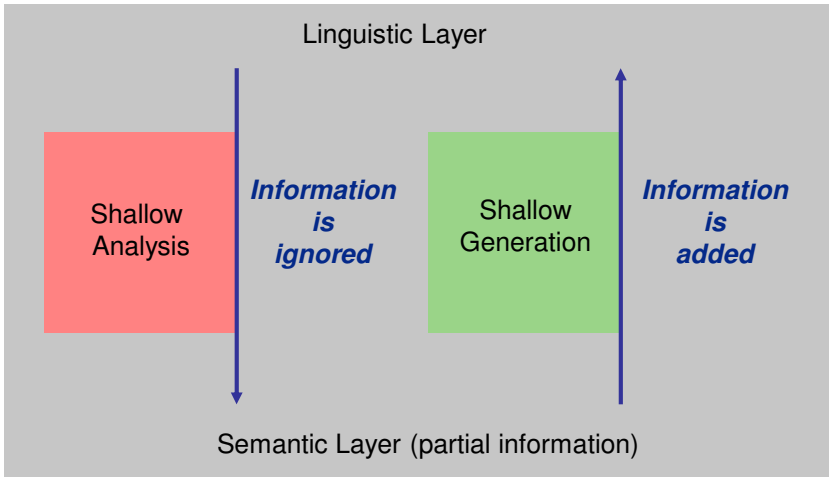
Shallow Processing Deals With Partial Information



Source: Stephan Busemann

Some Major Applications with TG/2

Shallowness / Domain dependence of grammar

much

some

little info added

TEMSIS – multilingual air quality reports (Busemann/Horacek 1998)
ImmoML – real estate announcements (German Telekom in 2007)
COMRIS – personalized recommendations in a conference scenario (Geldof 1999)

COSMA – appointment scheduling dialogue contributions (Busemann et al. 1994)

MUSI – syntactic realizer for medical scientific sentences (Lenci et al. 2002)

Depth / reusability of grammar

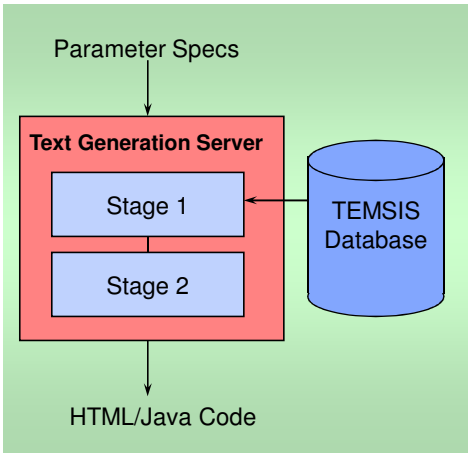
(Busemann 2005)

Source: Stephan Busemann

Text Generation in TEMSIS Occurs in Two Steps

GENERATION SYSTEM OVERVIEW

- **Parameter selection by the user**
  - language (D, E, F, P, C, J)
  - pollutant and measurement station
  - relevant period of time
- **Stage 1: Text schema construction**
  - querying the database
  - composition of report structure
  - elision of contextual redundancies
- **Stage 2: Linguistic realisation by TG/2**
  - selection of sentence patterns
  - wording, phrasing, grammar
- **HTML postprocessing**



Source: Stephan Busemann

The Texts Vary According to the User's Preferences

EXAMPLE

- **Parameters selected within the TEMSIS Navigator menus:**
  - French text about a German situation
  - ozone data, exceeding thresholds according to decree
  - measurements at Völklingen-City in summer 1997 (to be confirmed)

Vous avez choisi la station de mesure de Völklingen-City afin de consulter la pollution atmosphérique relevée en été 1997.

A la station de mesure de Völklingen-City, la valeur d'information pour l'ozone pour une exposition de 60 minutes (180 µg/m³ selon le decret allemand (Bundesimmissionsschutzverordnung)) a été dépassée une fois.

La valeur d'interdiction du trafic (240 µg/m³) a aussi été dépassée une fois.

En été 1996 la valeur d'information (180 µg/m³) n'a pas été dépassée .

Source: Stephan Busemann

The Reports Consist of Several Statements

SAMPLE SCHEMA FOR SUMMER OBSERVATION, THRESHOLD PASSING

- **Confirm pollutant, measurement station, and time interval**
- **Number the values exceeding the lowest threshold**
- **Number the values exceeding the next threshold**
- **Compare with values of preceeding year**
- **Repeat the core statement („Summary“)**

A schema is instantiated on the basis of the input parameters and the retrieved data

Source: Stephan Busemann

Instantiating a Schema Leads to a Report Structure

TEXT ORGANISATION

- **Achieves text coherence by**
  - removing redundant information
  - inserting particles („also“)
  - simple techniques of aggregating information
- **Yields canned texts or intermediate content representations**
- **Intermediate representations are independent of particular languages**
  - TG/2 generates German, French, English, Portuguese, Chinese and Japanese text from them

Shallow generation can do without explicit knowledge representation and text planning

Source: Stephan Busemann

Non-Linguistic Input for Air Quality Report Generation in TEMSIS

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 (TIME [(PRED season)
        (NAME [(SEASON summer)
               (YEAR 1999)])])
 (POLLUTANT o3)
 (SITE "Völklingen-City")
 (DURATION [(MINUTE 60)])
 (SOURCE [(LAW-NAME bimsch)
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Multilingual Generation in TEMSIS

- **Grammar size about 100-120 rules**
- **Written with standard text editors (emacs)**
- **Six languages: German, French, English, Chinese, Japanese, Portuguese**
- **Grammar is the only language-specific part** (except for canned texts about pollutants etc. and error messages)
- **Adding a new language required little effort: 2-4 weeks, depending on skills** (incl. getting familiar with the system)

Generated Texts Are Not Invented

CORPUS-BASED GRAMMAR DEVELOPMENT (Ehud Reiter)

- **User provide examples for target texts - the more, the better**
  - Texts produced manually by domain experts
- **Initial analysis of user-generated corpus**
  - Identify the knowledge used by the authors
  - Clarify with users any underlying semantic and rhetoric relationships
  - Discuss with users how the texts can be improved
- **Analysis of the revised corpus**
  - Definition of linguistic coverage
  - Correlate surface chains and underlying relations
  - Test of revised corpus (Wizard of Oz) and iterate the whole process, if necessary
- **Generalisation from Corpus Samples to Prototypical Examples (Templates)**
  - Basis for shallow grammar development

Input and Grammars

- **Most NLG systems expect a specific, fixed kind of input**
  - Linguistic vs non-linguistic
  - Course-grained vs fine-grained semantic specifications
  - The TG/2 framework does not constrain input
- **TG/2 grammars usually are domain-dependent**
  - The TEMSIS input needs domain-dependent interpretation
  - Grammar development in TEMSIS was cheap (~120 rules, ~20 lexemes)
- **Deeper applications require a more generic approach**
  - MUSI input is language-specific
  - MUSI grammar to cover German sentence structures (DUDEN grammar)
  - Coverage requirements are considerably higher than with shallow NLG (> 900 rules, several thousand lexemes)
  - TG/2 grammar editor eGram to improve maintainability

MUSI: Language-Specific Input to TG/2

```
[(SENTENCE DECL)
 (VC [(VOICE PASSIV) (MOOD IND) (TENSE PRAESENS) (SBP S2)
      (STEM "verursach")])
 (DEEP-SUBJ [(TY GENERIC-NP)
             (NUMBER SG) (DET INDEF) (NR V2) (GENDER MAS)
             (STEM "antagonismus")
             (PP-ATR [(PREP MIT) (DET WITHOUT) (NUMBER SG) (GENDER NTR)
                      (STEM "Acetylcholin")
                      (LOCATIVE ...)])
             (ADJ [(STEM "kompetitiv")
                   (POS ADJECTIVE) (DEG POS)])])
 (DEEP-AKK-OBJ [(TY GENERIC-NP)
                (NUMBER PLUR) (DET DEF) (GENDER FEM)
                (STEM "wirkung")])]
```

Die Wirkungen werden durch einen kompetitiven Antagonismus mit Acetylcholin ... verursacht.

Source: Stephan Busemann

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Realization of German Sentences in MUSI

- **Size of hand-written grammar: about 950 rules**
- **Written with standard text editors (emacs), then dedicated editor eGram**
- **CFGs do not support encoding of word order variation etc.**
- **Metarule formalism within eGram (Rinck 2003)**
- **Size of derived grammar about 2.500 rules**
- **Processing slows down with huge conflict sets**
- **Take decisions on sentence structure and lexical choice outside of TG/2**

Performance loss on backtracking is low

Size of grammars and conflict sets can slow processing down

Overview

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TG/2 is a Single Pass Mapper

- **TG/2 is often combined with other NLG components**
  - TEMSIS: Text structuring depending on database content; TG/2 generating at paragraph level
  - MUSI: Lexicalization and syntactic choice, avoiding huge conflict sets in TG/2; TG/2 as a sentence realizer
- **Limited usability for large NLG tasks**
  - MUSI generation times at about 1 second per sentence, with 50-word sentences at 2-4 seconds
  - Stark contrast to small grammars such as for TEMSIS that are interpreted in 0,3-0,5 seconds per sentence
  - Large grammars are difficult to maintain

Source: Stephan Busemann

Shallow Generation Has Pros and Cons

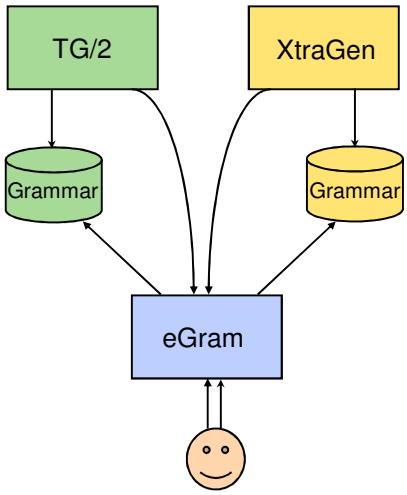
ASSESSMENT

Possible advantages	Possible drawbacks
• Low development effort • Reusable interpreter and subgrammars • Very fast processing • Easy introduction of additional languages • Easy extension with alternative formulations (through a preference mechanism in TG/2)	• Knowledge representation depends on application • Implicit dependencies • Scalability is inherently lower than with deep generators • Maintaining transparency of grammars can become a cost factor

Source: Stephan Busemann

Conclusions

- TG/2 is a framework that can implement shallow NLG tasks as well as deep realization
- Grammar writing for TG/2 and XtraGen is supported by eGram
- TG/2 has been licensed to more than 30 sites for commercial, educational and research purposes



Source: Stephan Busemann

References

Note: a rather comprehensive bibliography of the field is available from http://www.fb10.uni-bremen.de/anglistik/langpro/bibliographies/

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Source: Stephan Busemann

Questions Answered by Slideset

- **How does shallow generation differ in principle from (standard) deep generation?**
- **Give advantages and disadvantages of shallow generation.**
- **How are sample corpora used to ensure the required coverage is available and the correct wordings are generated?**
- **Should an NLG problem be addressed by using as a resource clause-length pieces of prefabricated text with gaps to be filled during generation? Justify your decision considering both the complexity of the problem and the complexity of the generation process.**

Design an NLG System Based on TG/2

- **Task/domain: stock values in comparison to previous three days**
- **Data: 100 stock, each with values on four subsequent days**
- **Input: name of a stock**
- **Output: tendency, changes not covered by the tendency**
- **Suggestion for work:**
  - Choose the grainsize, with which you will inform the user.
  - What useful pre-calculations would you make on the data?
  - How would you represent the TG/2 input?
  - How would you define TG/2 rules to generate the output?
  - Demonstrate your results (inputs, rules, outputs)
- **As always in NLG there is no single or best solution**
- **Try to cover all imaginable developments of the data.**