8. An Integrated Approach: Structure Generator Task Description

The structure generator takes **decriptions of structures with typed fields** as input, and generates an **implementation by a class in C++** for each structure. (see slides GSS 1.8 to 1.10)

1. An input file describes **several structures with its components**.
2. Each **generated class** has an **initializing constructor**, and a **data attribute**, a **set-** and a **get-method for each field.**
3. The **type** of a field may be
   predefined, a **structure** defined in the processed file, or an **imported** type.
4. The generator is intended to **support software development**.
5. **Generated classes have to be sufficiently readable**, s.th. they may be adapted manually.
6. The **generator is to be extensible**, e.g. reading and writing of objects.
7. The description language shall allow, that the **fields of a structure can be accumulated** from several descriptions of one structure.

Lecture Generating Software from Specifications WS 2013/14 / Slide 801

Objectives:

Agree upon the task

In the lecture:

The items are explained.

Example for the Output of the Structure Generator

Import of externally defined strucures:

```
#include "util.h"
```

Forward references:

```
typedef class Customer_Cl *Customer;
typedef class Address_Cl *Address;
```

Class declaration:

Fields:

Initializing constructor:

set- and get-methods for fields:

```
class Customer_Cl {
private:
   Address addr_fld;
   int account_fld;
public:
   Customer_Cl (Address addr, int account)
      {addr_fld=addr; account_fld=account; }
   void set_addr (Address addr)
      {addr_fld=addr;}
   Address get_addr ()
      {return addr_fld;}
   void set_account (int account)
      {account_fld=account;}
   int get_account ()
      {return account_fld;}
};
```

Further class declarations:

```
class Address_Cl {
...
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 802

Objectives:

Describe the generated results

In the lecture:

The items are explained.

Variants of Input Form

closed form:

sequence of struct descriptions,
each consists of a
sequence of field descriptions

```
Customer(  addr:    Address;
           account: int;
         )
Address (  name:  String;
           zip:   int;
           city:  String;
         )
import String from "util.h"
```

several descriptions for the same struct
accumulate the field descriptions

```
Address (  zip:   int;
           phone: int;
         )
```

open form:

sequence of qualified field descriptions

```
Customer.addr:  Address;
Address.name: String;
Address.zip: int;
import String from "util.h"
Customer.account: int;
```

several descriptions for the same struct
accumulate the field descriptions

```
Address.zip: int;
Address.phone: int;
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 803

Objectives:

Discuss alternative input variants early

In the lecture:

The items are explained.

Task Decomposition for the Structure Generator

Structuring	Lexical analysis	Recognize the symbols of the description Store and encode identifiers
	Syntactic analysis	Recognize the structure of the description Represent the structure by a tree
Translation	Semantic analysis	Bind names to structures and fields Store properties and check them
	Transformation	Generate class declarations with constructors and access methods

```
Customer ( addr:      Address;
           account:   int; )

Address (  name:  String;
           zip:   int;
           city:  String; )

import String from "util.h"
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 804

Objectives:

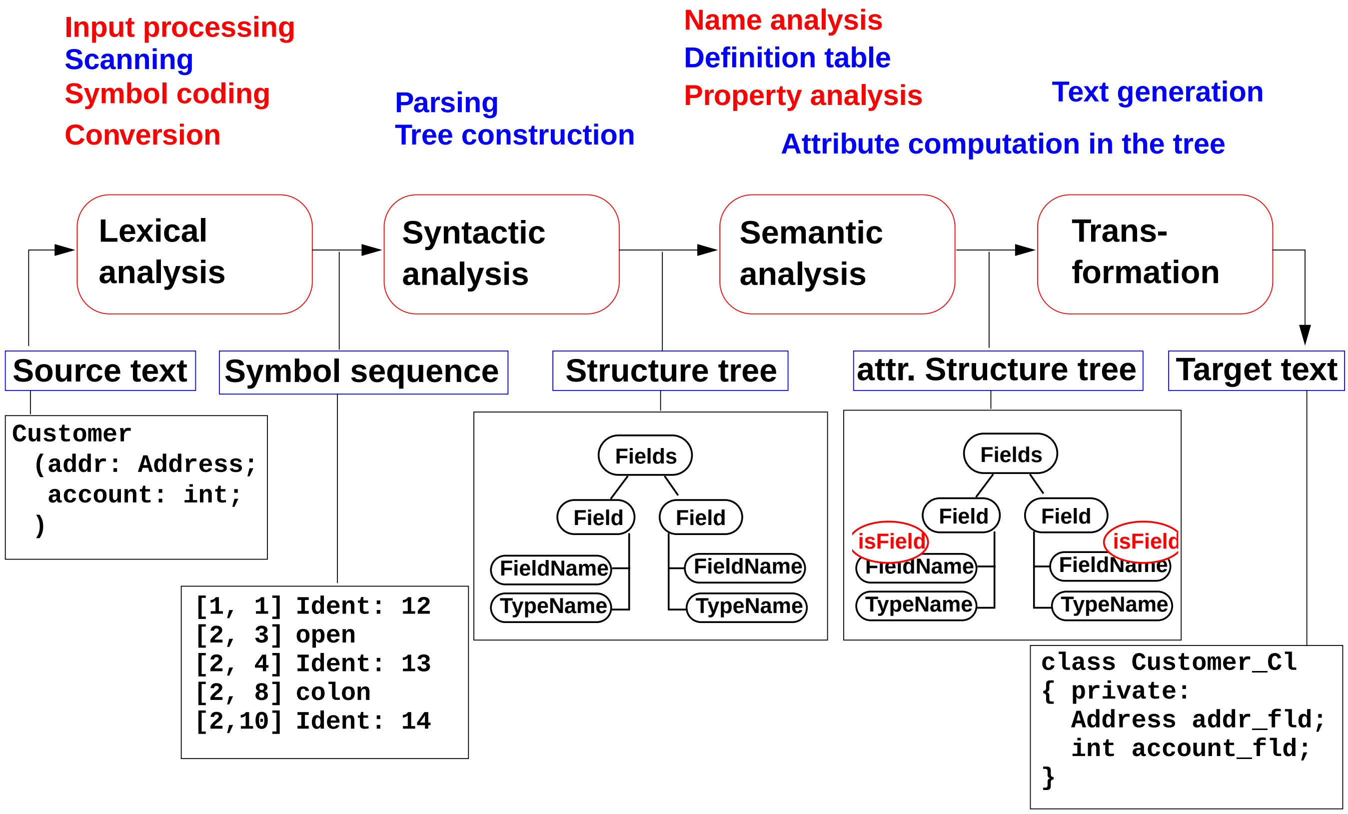
Overview over subtasks

In the lecture:

The items are explained.

Task Decomposition Determines the Architecture of the Generator

Specialized tools solve specific sub-tasks for creating of the product:



Lecture Generating Software from Specifications WS 2013/14 / Slide 805

Objectives:

Structure of the generator

In the lecture:

The items are explained.

Concrete Syntax

Straight-forward natural description of language constructs:

```
Descriptions: (Import / Structure)*.
Import:       'import' ImportNames 'from' FileName.
ImportNames:  ImportName // ','.
Structure:    StructureName '(' Fields ')'.
Fields:       Field*.
Field:        FieldName ':' TypeName ';'.
```

Different nonterminals for identifiers in different roles:,

```
StructureName: Ident.
ImportName:    Ident.
FieldName:     Ident.
TypeName:      Ident.
```

Token specification:

```
Ident:     PASCAL_IDENTIFIER
FileName:  C_STRING_LIT
           C_COMMENT
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 806

Objectives:

Straight-forward specification

In the lecture:

The items are explained.

Abstract Syntax

Concrete syntax rewritten 1:1, EBNF sequences substituted by LIDO LISTOF:

```
RULE: Descriptions  LISTOF Import | Structure          END;
RULE: Import ::= 'import' ImportNames 'from' FileName    END;
RULE: ImportNames   LISTOF ImportName                  END;
RULE: Structure ::= StructureName '(' Fields ')'        END;
RULE: Fields        LISTOF Field                       END;
RULE: Field ::=     FieldName ':' TypeName ';'          END;
RULE: StructureName ::= Ident                          END;
RULE: ImportName ::=    Ident                          END;
RULE: FieldName ::=     Ident                          END;
RULE: TypeName ::=      Ident                          END;
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 807

Objectives:

Concrete syntax rewitten

In the lecture:

The items are explained.

Name Analysis

Described in GSS 5.8 to 5.11

Lecture Generating Software from Specifications WS 2013/14 / Slide 808

Objectives:

Already explained in Ch. 5

In the lecture:

The items are explained.

Property Analysis (1)

It is an error if the **name of a field**, say **addr**, of a structure occurs **as the type of a field** of that structure.

```
Customer (addr: Address; account: addr;)
```

Introduce a PDL property

```
IsField: int;
```

and check it:

```
SYMBOL Descriptions COMPUTE
  SYNT.GotIsField = CONSTITUENTS FieldName.GotIsField;
END;

SYMBOL FieldName COMPUTE
  SYNT.GotIsField = ResetIsField (THIS.Key, 1);
END;

SYMBOL TypeName COMPUTE
  IF (GetIsField (THIS.Key, 0),
    message (ERROR,
            CatStrInd ("Field identifier not allowed here: ",
                    THIS.Sym),
            0, COORDREF))
  <- INCLUDING Descriptions.GotIsField;
END;
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 809

Objectives:

A property introduced for checking

In the lecture:

The items are explained.

Property Analysis (2)

It is an error if the **same field** of a structure occurs **with different types specified**.

```
Customer (addr: Address;) Customer (addr: int;)
```

We introduce **predefined types** `int` and `float` as **keywords**. For that purpose we have to change both, concrete and abstract syntax correspondingly:

```
RULE: Field ::=  FieldName ':' TypeName ';' END;
```

is replaced by

```
RULE: Field ::= FieldName ':' Type ';' END;
RULE: Type ::=  TypeName                END;
RULE: Type ::=  'int'                   END;
RULE: Type ::=  'float'                   END;
```

```
SYMBOL Type, FieldName: Type: DefTableKey;
RULE: Field ::= FieldName ':' Type ';' COMPUTE
   FieldName.Type = Type.Type;
END;
RULE: Type ::= TypeName COMPUTE
   Type.Type = TypeName.Key;
END;
RULE: Type ::= 'int' COMPUTE
   Type.Type = intType;
END;
... correspondingly for floatType
```

Type information is propagated to the `FieldName`

`intType` and `floatType` and `errType` are introduced as PDL known keys.

Lecture Generating Software from Specifications WS 2013/14 / Slide 810

Objectives:

A simple type analysis

In the lecture:

The items are explained:

- Predefined types: keywords are easier than identifiers!
- Late syntax modifications may occur.
- Use of known keys.

Property Analysis (3)

It is an error if the **same field** of a structure occurs **with different types specified**.

```
Customer (addr: Address;) Customer (addr: int;)
```

Request from PDL a property **Type** that has an operation **IsType (k, v, e)**.

```
Type: DefTableKey [Is]
```

It sets the **Type** property of key k to **v** if it is unset; it sets it to **e** if the property has a value different from **v**.

```
SYMBOL FieldName COMPUTE
  SYNT.GotType =
    IsType (THIS.Key, THIS.Type, ErrorType);

  IF (EQ (ErrorType, GetType (THIS.Key, NoKey)),
    message
    (ERROR, "different types specified for this field",
    0, COORDREF))
  <- INCLUDING Descriptions.GotType;
END;

SYMBOL Descriptions COMPUTE
  SYNT.GotType = CONSTITUENTS FieldName.GotType;
END;
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 811

Objectives:

PDL property functions are used

In the lecture:

The items are explained:

- There are more useful PDL property functions.
- Apply typical PDL usage pattern!

Structured Target Text

Methods and techniques are applied as described in Chapter 6.

For one structure there may be **several occurrences of structure descriptions** in the tree. At only one of them the complete class declaration for that structure is to be output. that is achived by using the **DoItOnce** technique (see GSS-4.5):

```
ATTR TypeDefCode: PTGNode;

SYMBOL Descriptions COMPUTE
   SYNT.TypeDefCode =
      CONSTITUENTS StructureName.TypeDefCode
      WITH (PTGNode, PTGSeq, IDENTICAL, PTGNull);
END;

SYMBOL StructureName INHERITS DoItOnce COMPUTE
   SYNT.TypeDefCode =
      IF ( THIS.DoIt,
           PTGTypeDef (StringTable (THIS.Sym)), PTGNULL);
END;
```


Lecture Generating Software from Specifications WS 2013/14 / Slide 812

Objectives:

Apply PTG techniques

In the lecture:

The items are explained:

- Recall the DoItOnce technique.
- Recall Chapter 6.