CMPE 152: Compiler Design

September 26 Class Meeting

Department of Computer Engineering
San Jose State University

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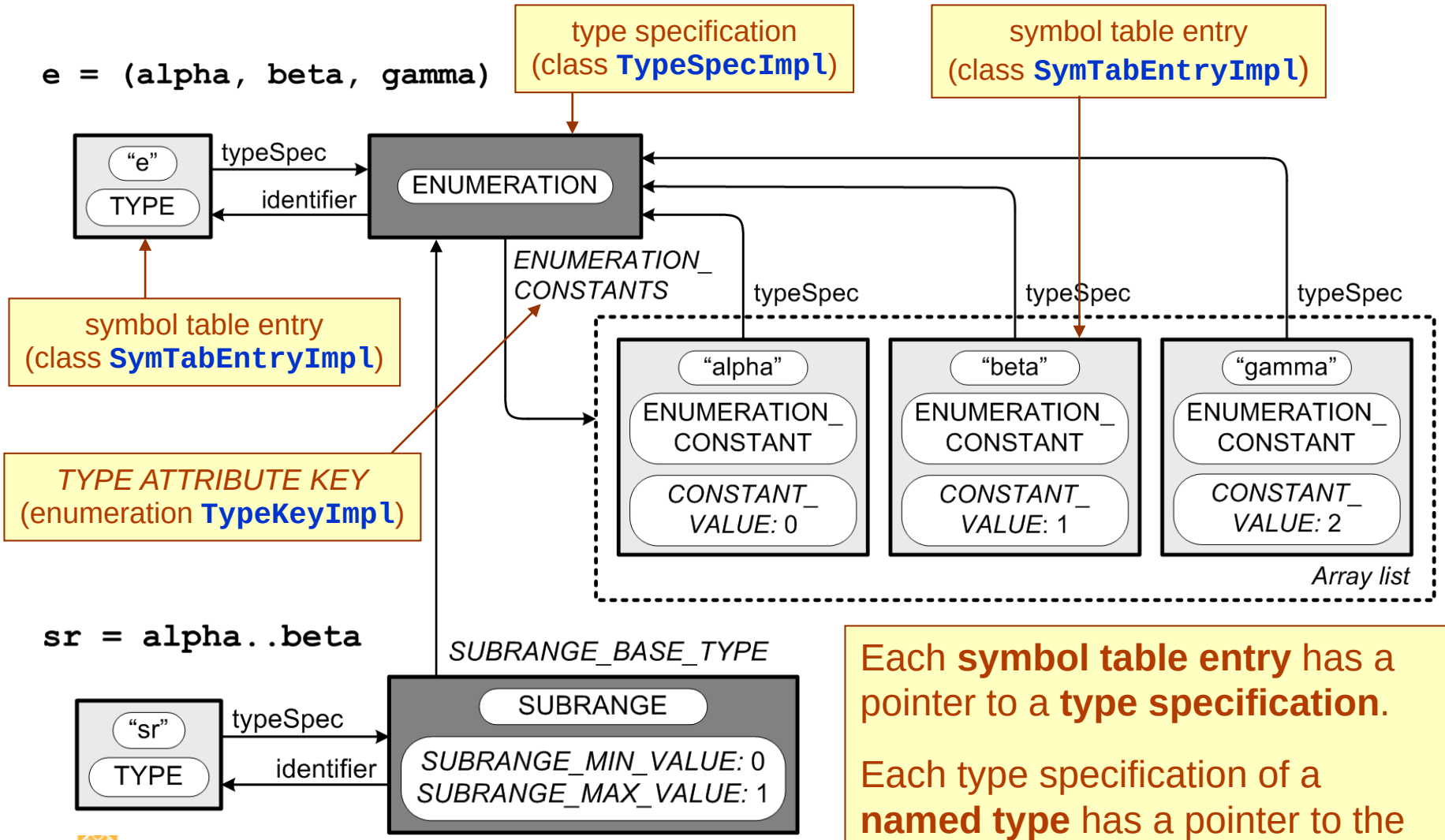
Instructor: Ron Mak

www.cs.sjsu.edu/~mak

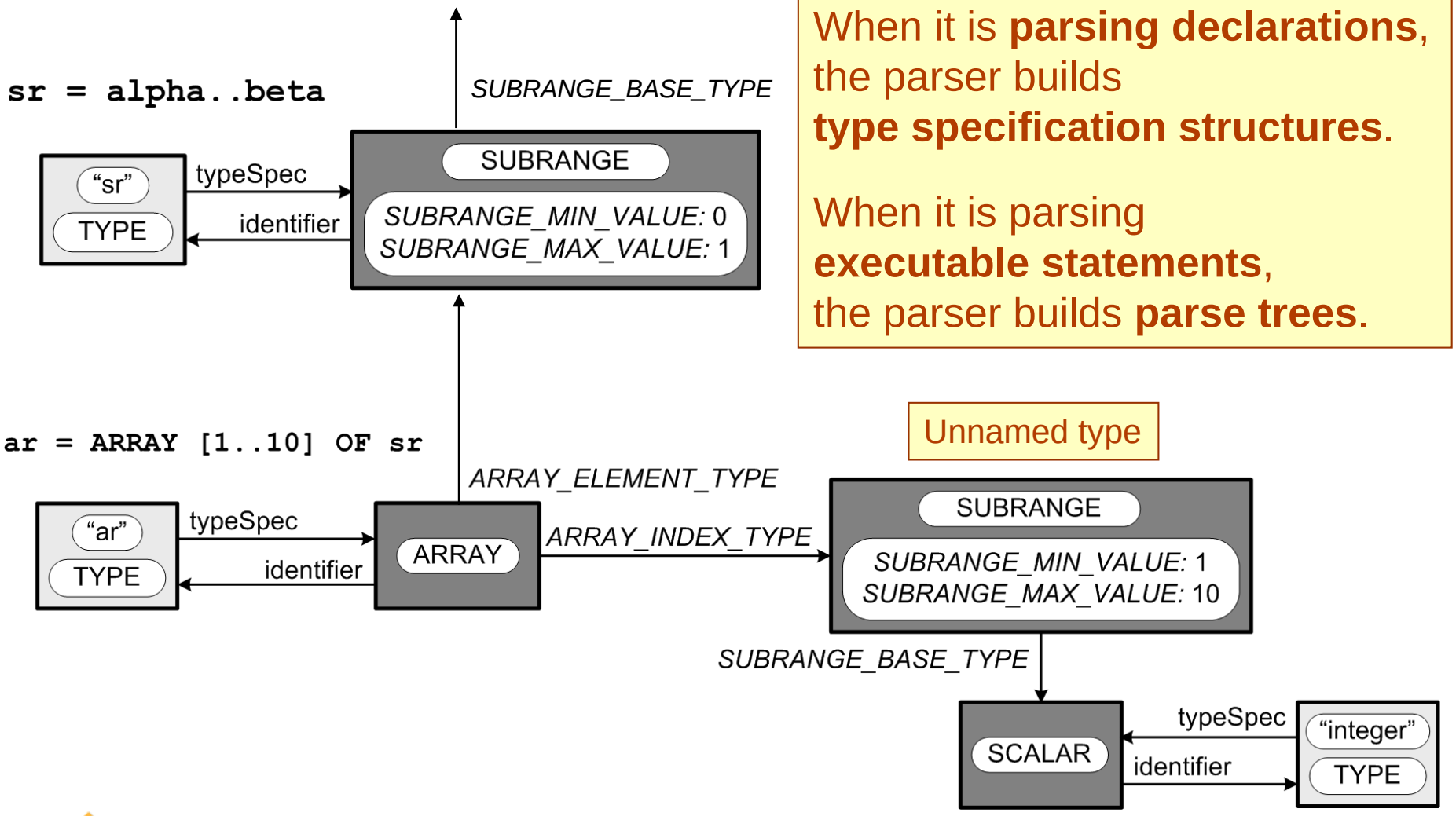
Type Definition Structures



Each **symbol table entry** has a pointer to a **type specification**.

Each type specification of a **named type** has a pointer to the type identifier's symbol table entry.

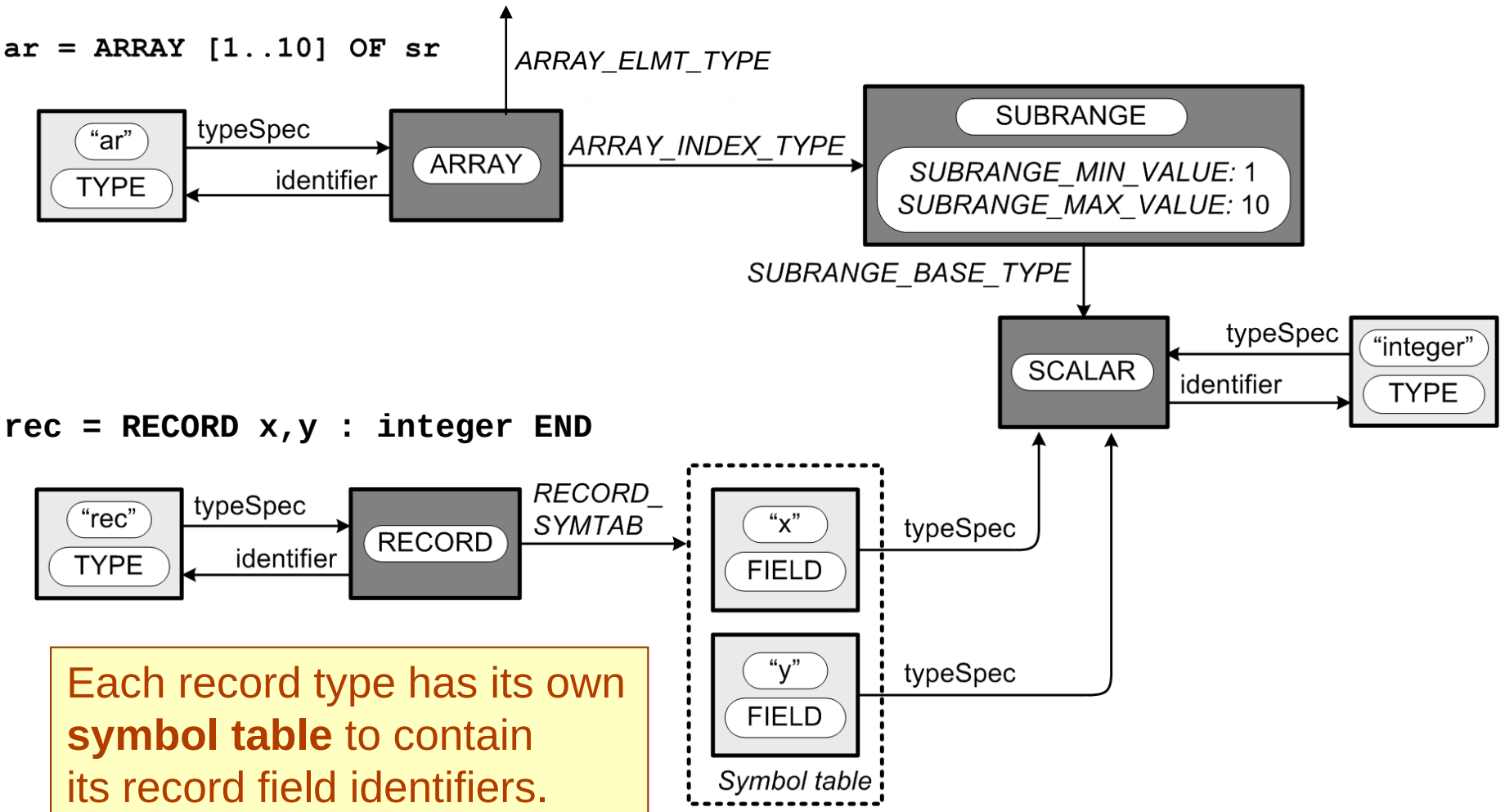
Type Definition Structures, *cont'd*



When it is **parsing declarations**, the parser builds **type specification structures**.

When it is parsing **executable statements**, the parser builds **parse trees**.

Type Definition Structures, *cont'd*



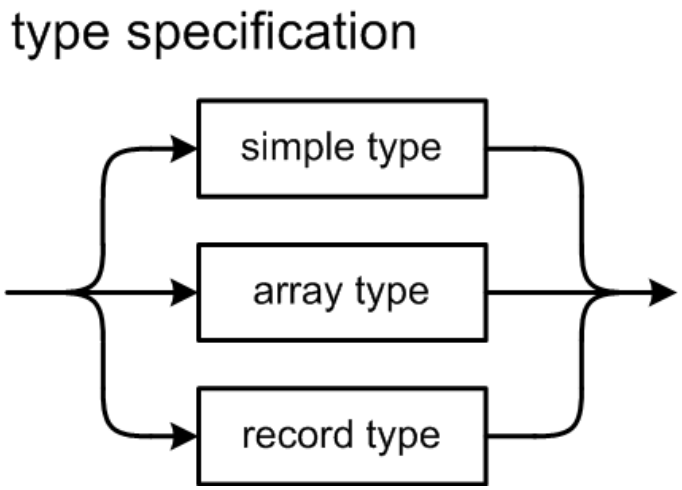
Each record type has its own **symbol table** to contain its record field identifiers.

TypeDefinitionsParser.parse()

```
TYPE
    e = (alpha, beta, gamma);      TypeDefinitionParser::parse()
    sr = alpha..beta;              TypeSpecificationParser::parse()
    ar = ARRAY [1..10] OF sr;
    rec = RECORD
              x, y : integer
          END;
```

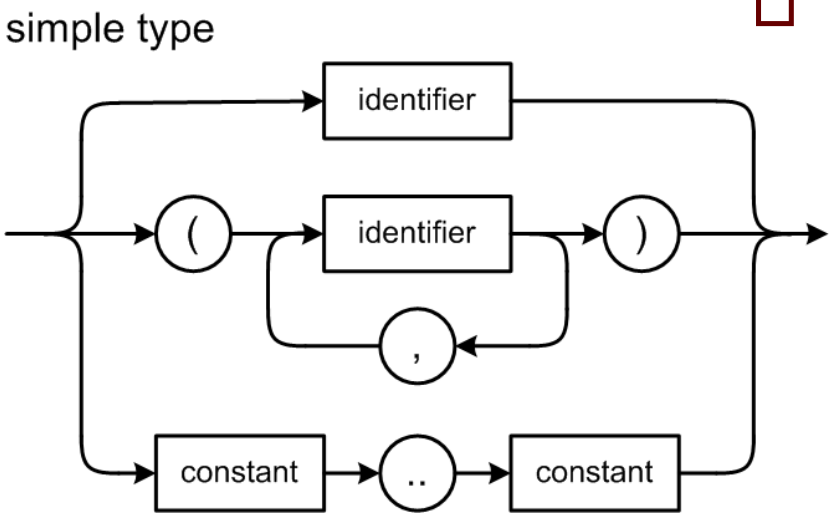
- Loop to parse each type definition.
  - Parse the type identifier and the **=** sign.
  - Call the **parse()** method of **TypeSpecificationParser**.
    - Parse the type specification and return a **TypeSpec** object.
    - Cross-link the **SymTabEntry** object of the type identifier with the **TypeSpec** object.

TypeSpecificationParser.parse()



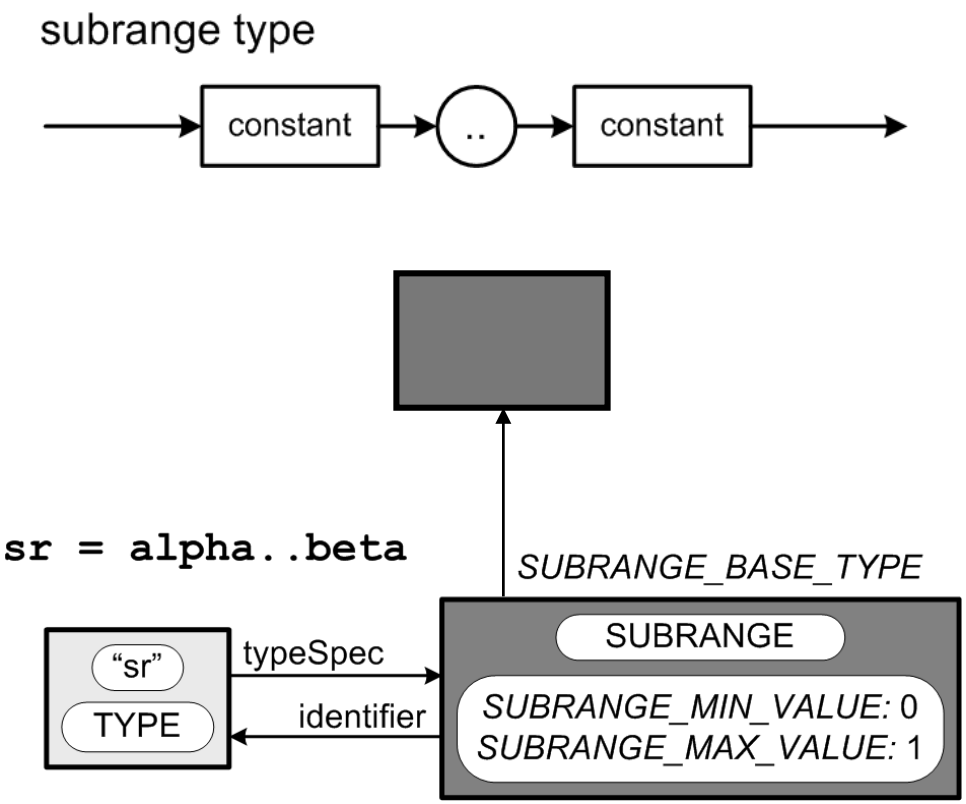
- Parse an array type.
  - If there is an **ARRAY** reserved word.
  - Call the **parse()** method of **ArrayTypeParser**
- Parse a record type.
  - If there is a **RECORD** reserved word.
  - Call the **parse()** method of **RecordTypeParser**
- Parse a simple type.
  - In all other cases.
  - Call the **parse()** method of **SimpleTypeParser**

SimpleTypeParser.parse()



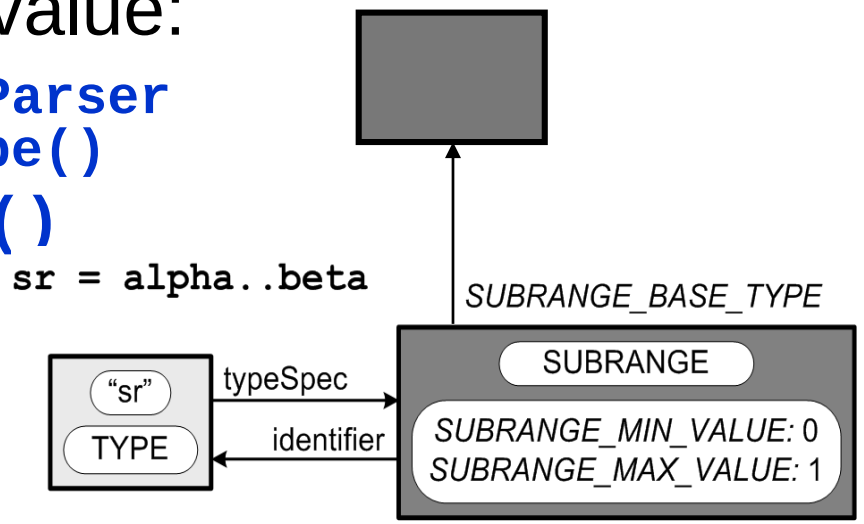
- Method **parse()** parses:
  - A previously-defined type identifier.
    - Including **integer**, **real**, etc.
  - An enumeration type specification.
    - Call the **parse()** method of **EnumerationTypeParser**.
  - A subrange type specification.
    - Call the **parse()** method of **SubrangeTypeParser**.

Pascal Subrange Type



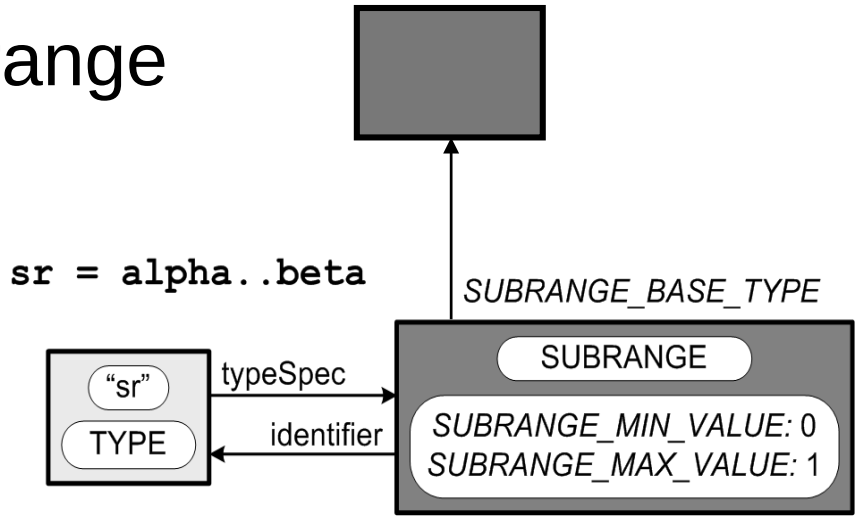
SubrangeTypeParser.parse()

- Call **TypeFactory::create_type(SUBRANGE)** to create a new subrange type specification.
- Parse the minimum constant value.
  - Call **ConstantDefinitionsParser::parse_constant()**
- Get and check the data type of the minimum constant value:
  - Call **ConstantDefinitionsParser ::get_constant_type()**
  - Call **check_value_type()**
    - The type must be integer, character, or an enumeration.
- Consume the **..** token.



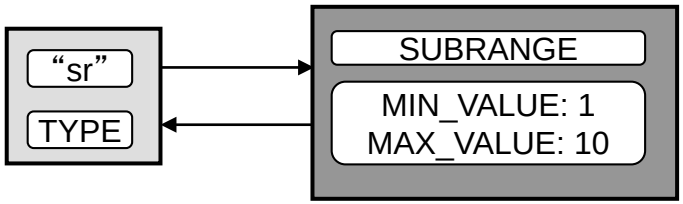
SubrangeTypeParser.parse()

- Parse the maximum constant value.
- Check that both minimum and maximum values have the same data type.
- Check that the minimum value <= maximum value.
- Set attributes of the subrange type specification.
  - **SUBRANGE_BASE_TYPE**
  - **SUBRANGE_MIN_VALUE**
  - **SUBRANGE_MAX_VALUE**



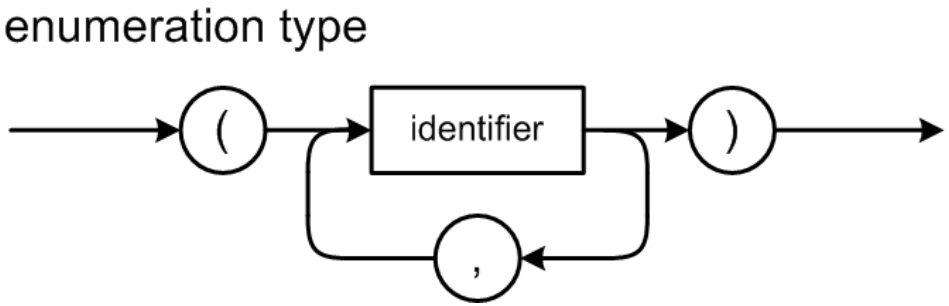
Parsing a Subrange Type

```
TYPE
    sr = 1..10;
    enum = (alpha, beta, gamma);
    ar = ARRAY [sr, enum] OF integer;
    rec = RECORD
              x, y : real
          END;
```

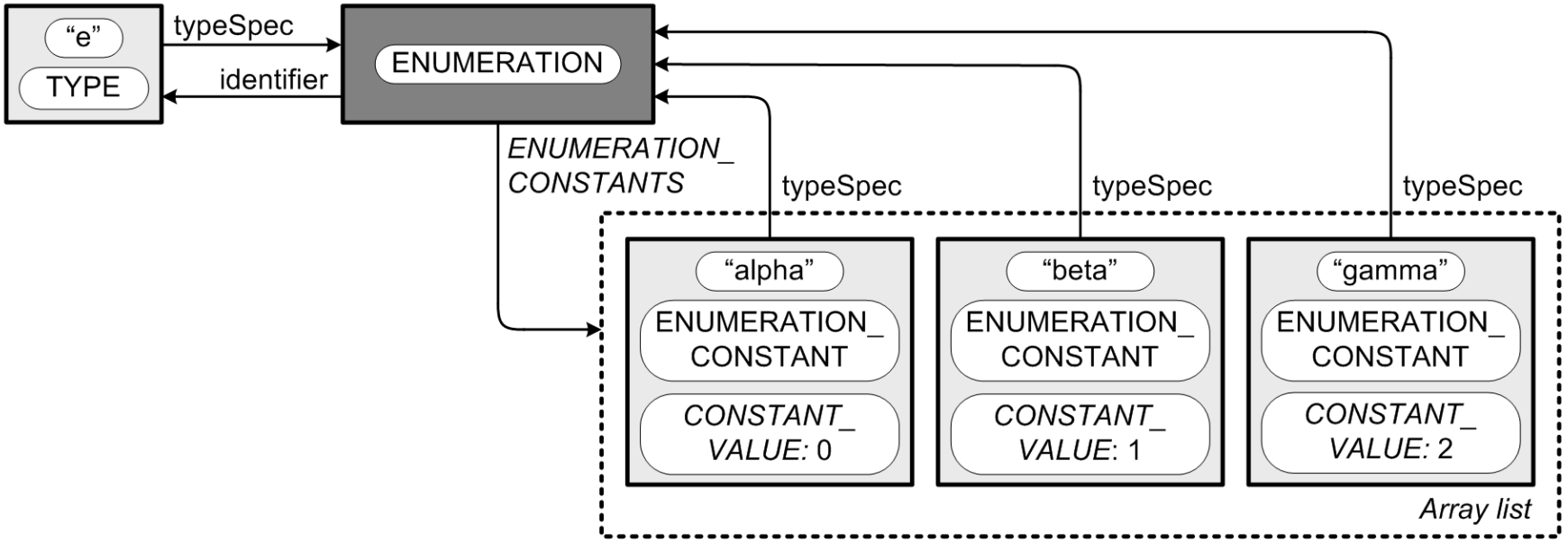


- **Pascal**
  - ➔ **PascalParserTD::parse()**
  - ➔ **BlockParser::parse()**
  - ➔ **DeclarationsParser::parse()**
  - ➔ **TypeDefinitionsParser::parse()**
    - ➔ **TypeSpecificationParser::parse()**
    - ➔ **SimpleTypeParser::parse()**
    - ➔ **SubrangeTypeParser::parse()**

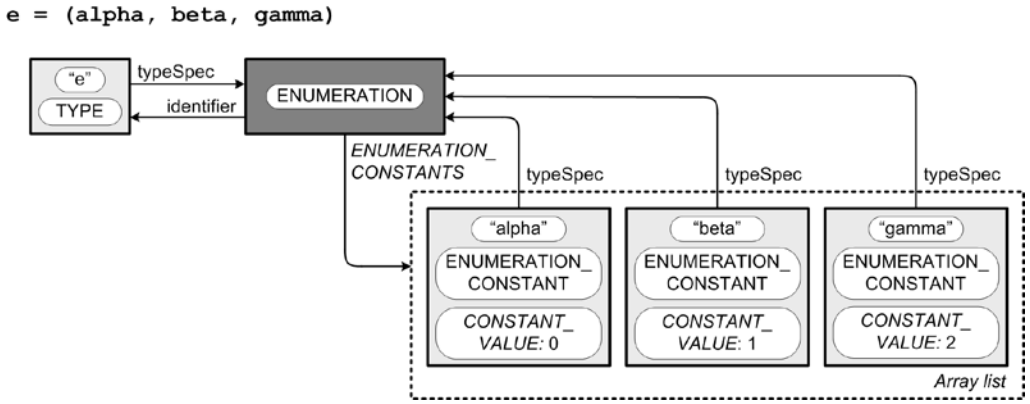
Pascal Enumeration Type




```
e = (alpha, beta, gamma)
```

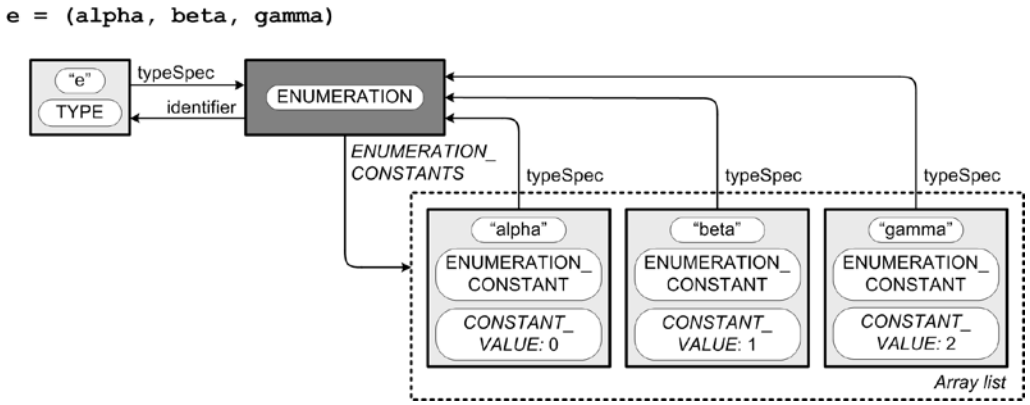


EnumerationTypeParser.parse()



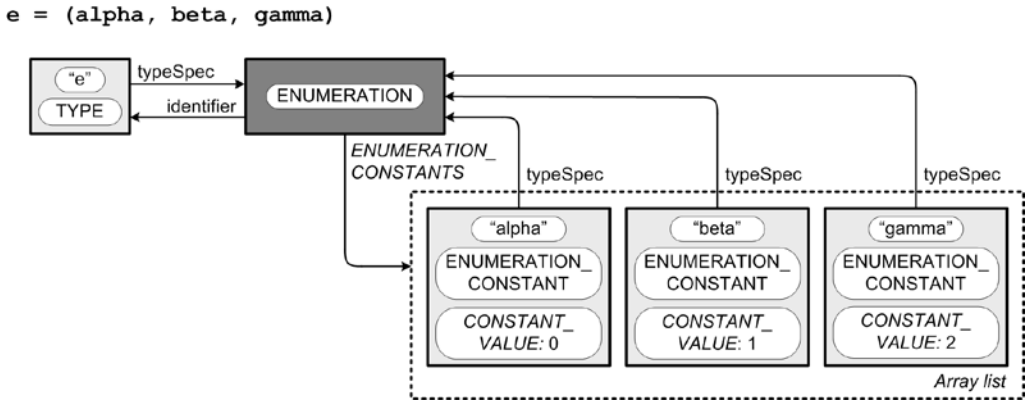
- Call **`TypeFactory::create_type(ENUMERATION)`** to create a new enumeration type specification.

`EnumerationTypeParser.parse()` *cont'd*



- Loop to parse each enumeration identifier.
  - Call **`parse_enumeration_identifier()`**
    - Set the definition of the identifier to **`ENUMERATION_CONSTANT`**.
    - Set the **`typeSpec`** field of the identifier to the enumeration type specification.
    - Set the **`CONSTANT_VALUE`** of the identifier to the next integer value (starting with 0).
  - Build a **`vector<SymTabEntry *>`** of symbol table entries for the enumeration identifiers.

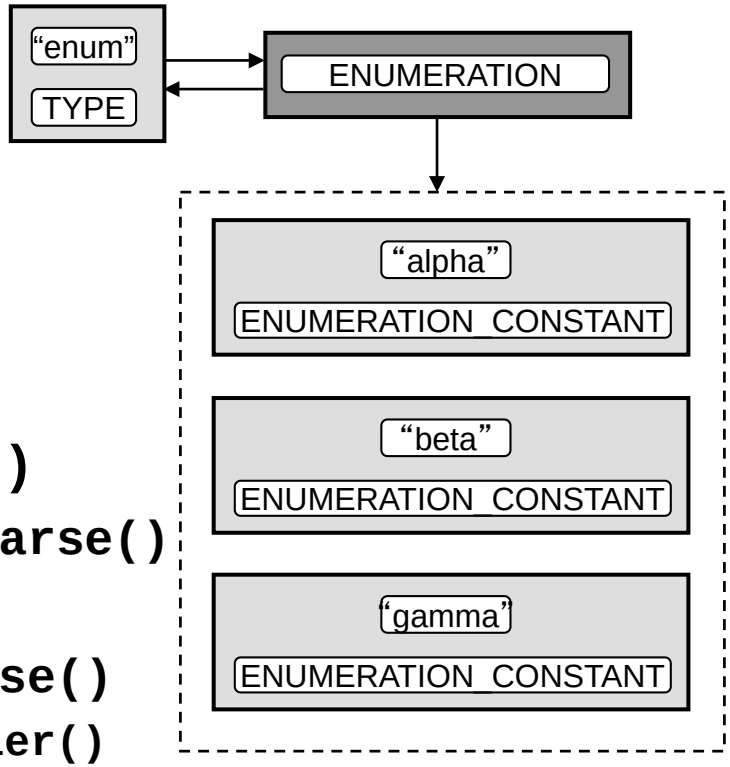
`EnumerationTypeParser.parse()` *cont'd*



- Set the **`ENUMERATION_CONSTANTS`** attribute of the enumeration type specification to the array list.

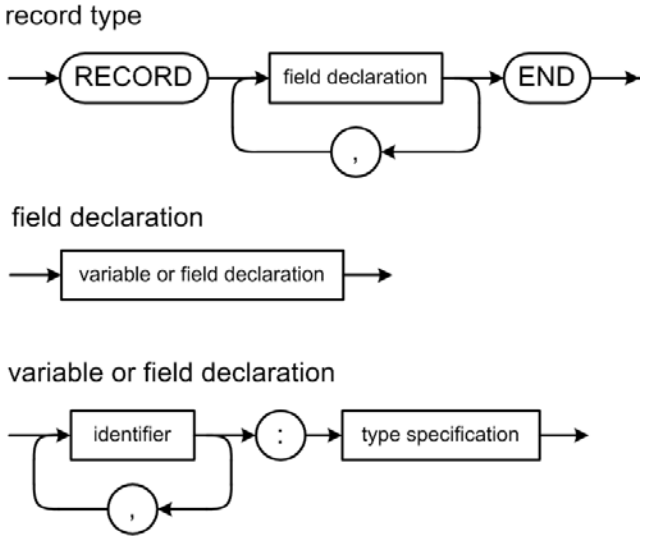
Parsing an Enumeration Type

```
TYPE
    sr = 1..10;
    enum = (alpha, beta, gamma);
    ar = ARRAY [sr, enum] OF integer;
    rec = RECORD
              x, y : real
          END;
```

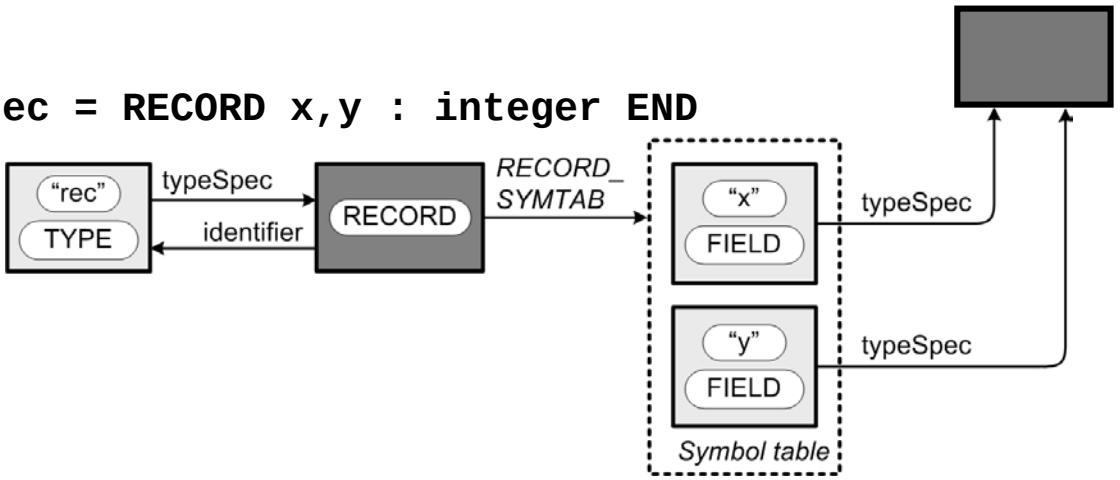


- **TypeDefinitionsParser::parse()**
  - ➔ **TypeSpecificationParser::parse()**
  - ➔ **SimpleTypeParser::parse()**
  - ➔ **EnumerationTypeParser::parse()**
    - ➔ **parse_enumeration_identifier()**

Pascal Record Type

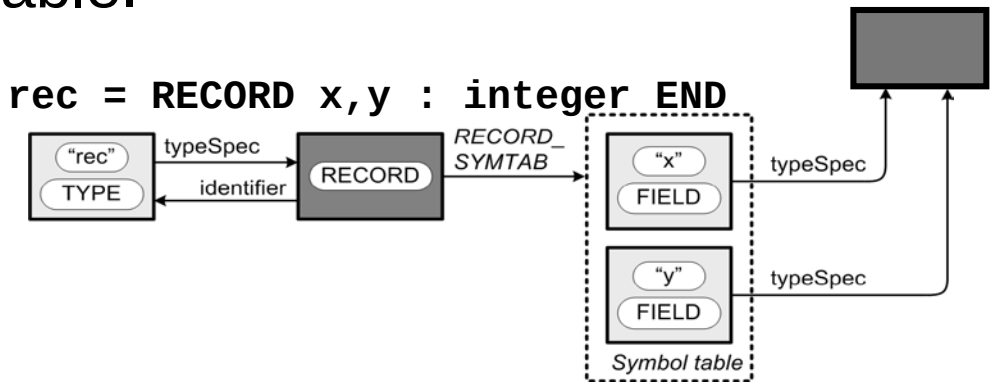



```
rec = RECORD x,y : integer END
```



RecordTypeParser.parse()

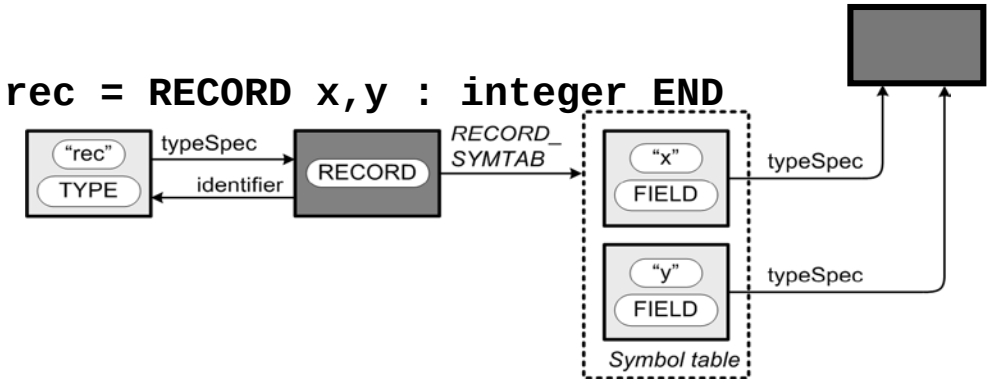
- Call **TypeFactory::create_type(RECORD)** to create a new record type specification.
- Create and push a new symbol table onto the symbol table stack.
  - Set the **RECORD_SYMTAB** attribute of the record type specification to the new symbol table.



`RecordTypeParser.parse()` *cont'd*

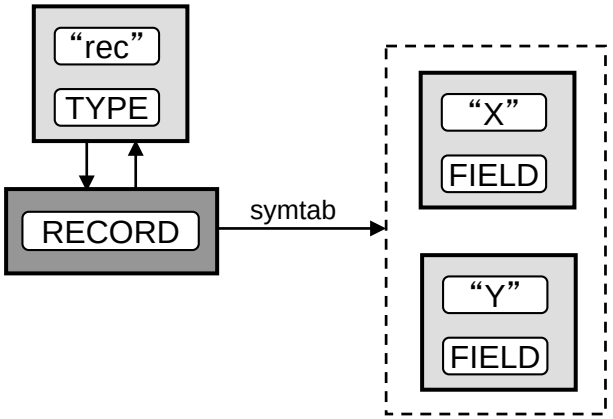
- Call **`VariableDeclarationsParser::parse()`** to parse the field declarations.
  - Set each field's definition to **`FIELD`**.
  - Enter each field into the current symbol table (the one just pushed onto the top of the stack).
- Pop the record type's symbol table off the symbol table stack.

After the record type's symbol table has been popped off the symbol table stack, it's still referenced by the **`RECORD_SYMTAB`** attribute.



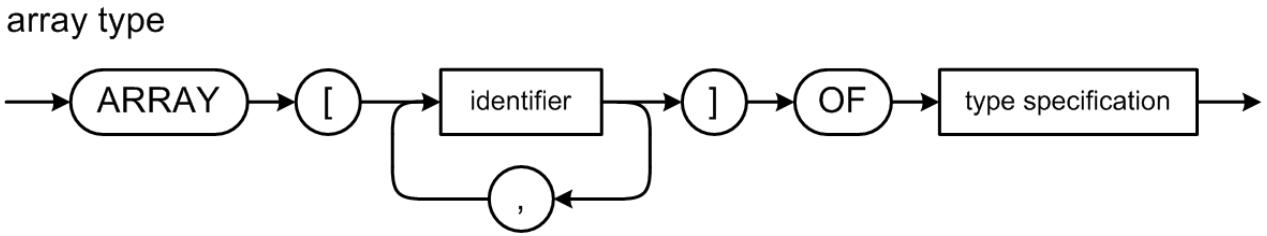
Parsing a Record Type

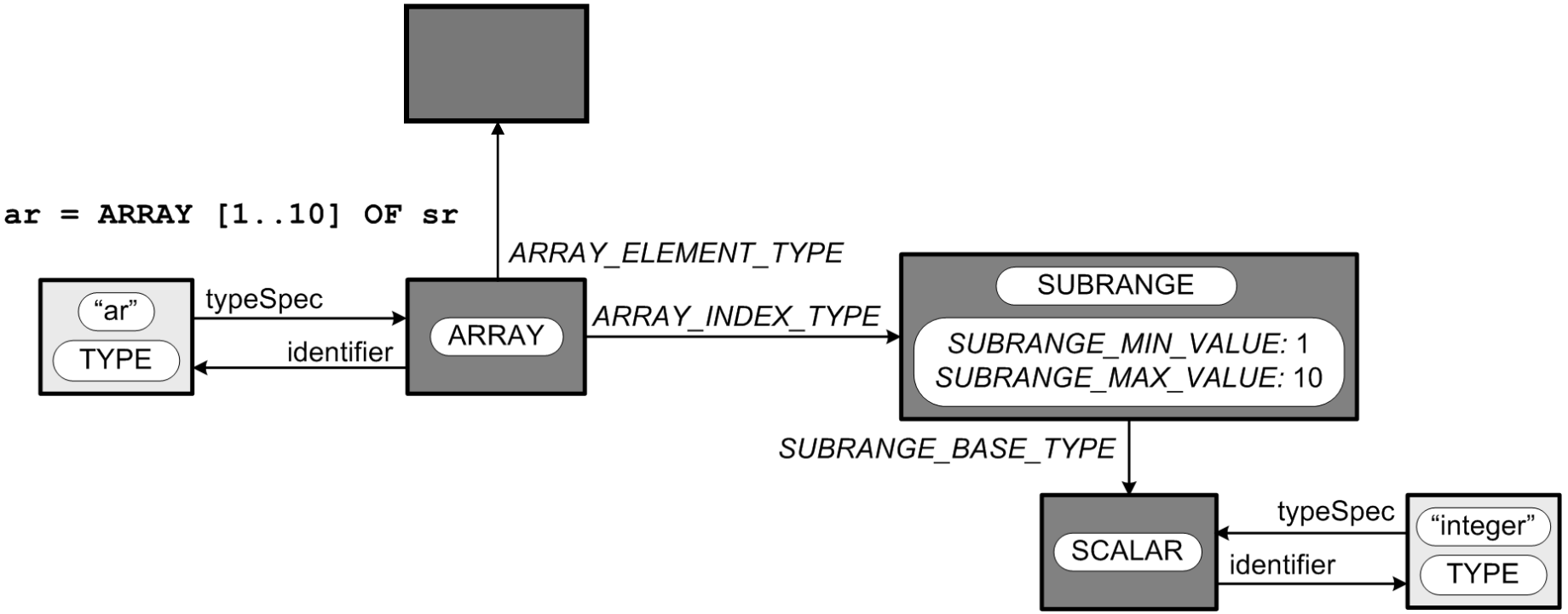
```
TYPE
    sr = 1..10;
    enum = (alpha, beta, gamma);
    ar = ARRAY [sr, enum] OF integer;
    rec = RECORD
              x, y : real
          END;
```



- **TypeDefinitionsParser::parse()**
  - ➔ **TypeSpecificationParser::parse()**
  - ➔ **RecordTypeParser::parse()**
    - ➔ **VariableDeclarationsParser::parse()**

Pascal Array Type





Pascal Multidimensional Array

- These definitions are all equivalent:

```
dim3 = ARRAY [1..3, 'a'..'z', boolean] OF real;

dim3 = ARRAY [1..3] OF ARRAY ['a'..'z']
                            OF ARRAY [boolean] OF real;

dim3 = ARRAY [1..3, 'a'..'z'] OF ARRAY [boolean] OF real;

dim3 = ARRAY [1..3] OF ARRAY ['a'..'z, boolean] OF real;
```

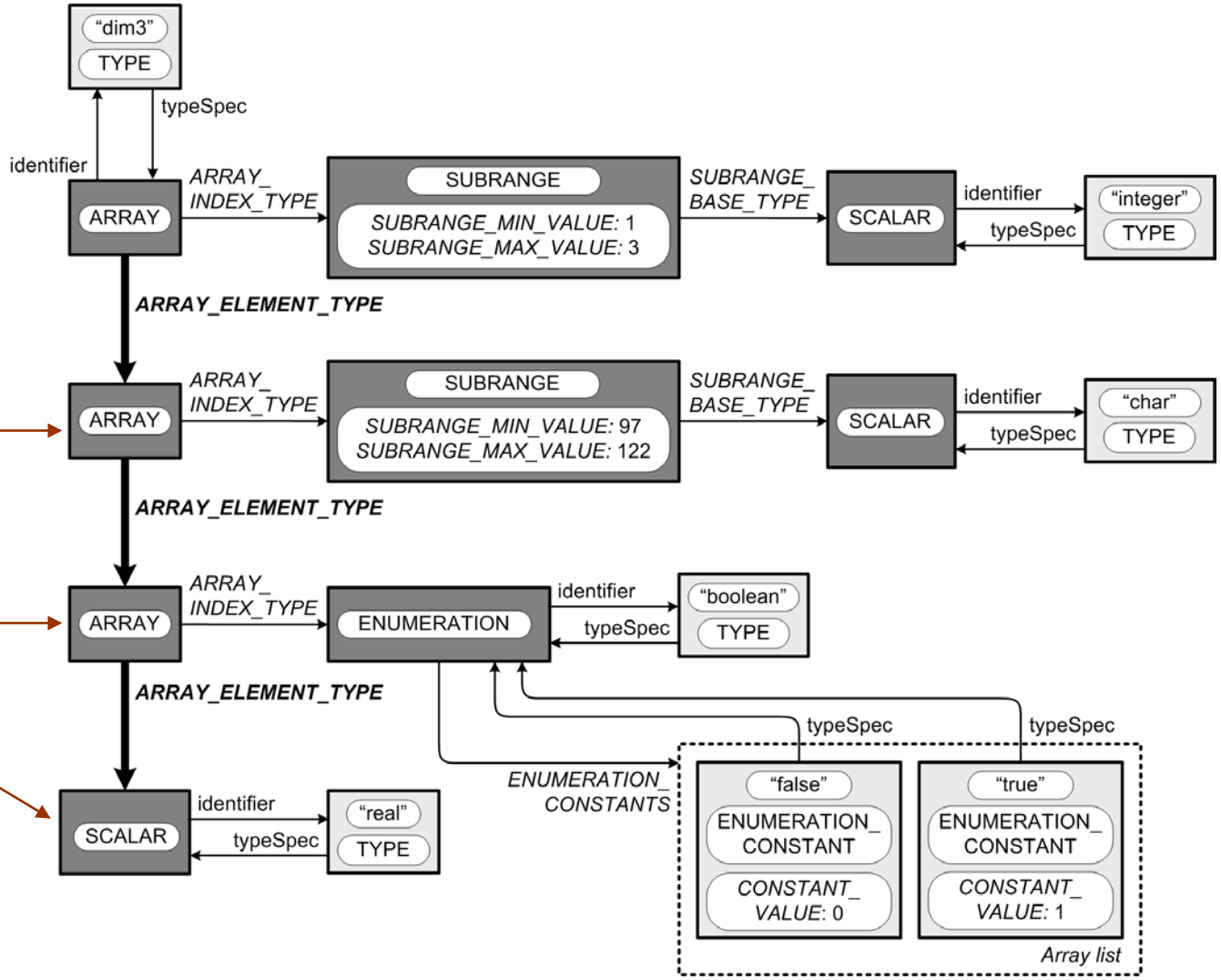
- Therefore, they must all generate the same type specification structure.

Pascal Multidimensional Array

```
dim3 = ARRAY [1..3, 'a'..'z', boolean] OF real;
dim3 = ARRAY [1..3] OF ARRAY ['a'..'z'] OF ARRAY [boolean] OF real;
```

The ***ARRAY_ELEMENT_TYPE*** references form the **backbone** of this structure (a linked list).

The first two element types are **arrays**, and the third element type is **real** scalar.



`ArrayTypeParser.parse()`

- Call **`TypeFactory::create_type(ARRAY)`** to create a new array type specification.

ArrayTypeParser.parse()

- Call **parse_index_type_list()** to parse the list of index types.
  - Set local variable **element_type** to the new array type specification.
  - Loop to call **parse_index_type()** to parse each index type.
    - Call **simpleTypeParser::parse()** to parse the index type.
    - Set the attributes for a subrange or enumeration index type specification.
    - Set the **ARRAY_ELEMENT_COUNT** attribute for the current array type spec.

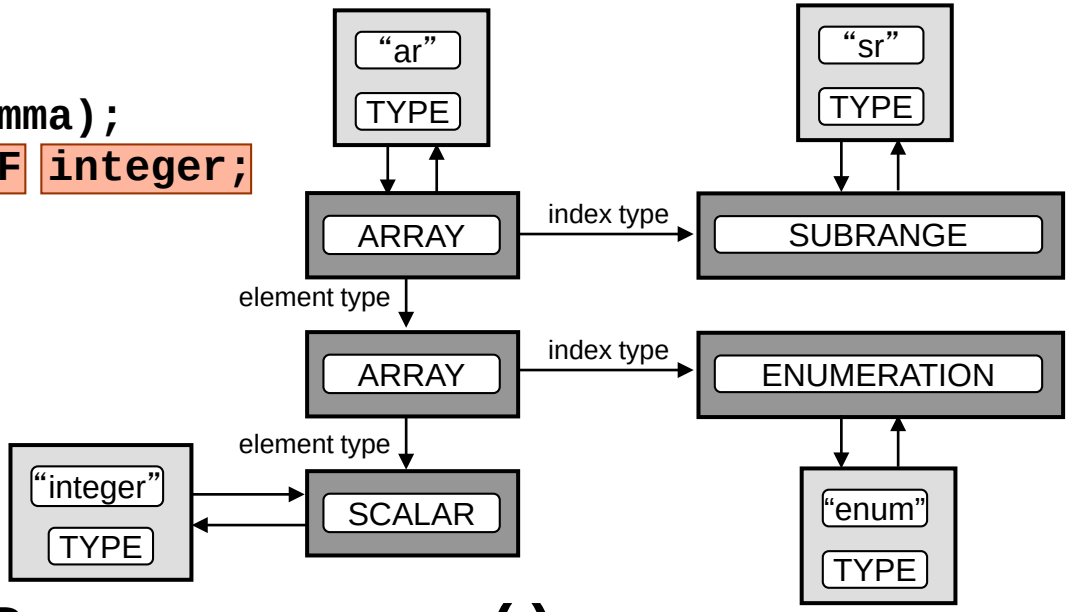
ArrayTypeParser.parse()

- Call **parse_index_type_list()** to parse the list of index types *(cont'd)*.
  - For each index type in the list *after the first*:
    - Call **TypeFactory::create_type(ARRAY)** to create the next **element_type** value.
    - Set the **ARRAY_ELEMENT_TYPE** attribute of the previous **element_type** value to link to the new **element_type** value.
- Call **parse_element_type()** to parse the final element type.
  - Link the previous element type to the final element type.

These **element_type** references create the **backbone**.

Parsing an Array Type

```
TYPE
    sr = 1..10;
    enum = (alpha, beta, gamma);
    ar = ARRAY [sr, enum] OF integer;
    rec = RECORD
              x, y : real
          END;
```



- **TypeDefinitionsParser::parse()**
  - ➔ **TypeSpecificationParser::parse()**
  - ➔ **ArrayTypeParser::parse()**
    - ➔ **parse_index_type_list()**
    - ➔ **parse_index_type()**
    - ➔ **parse_element_type()**