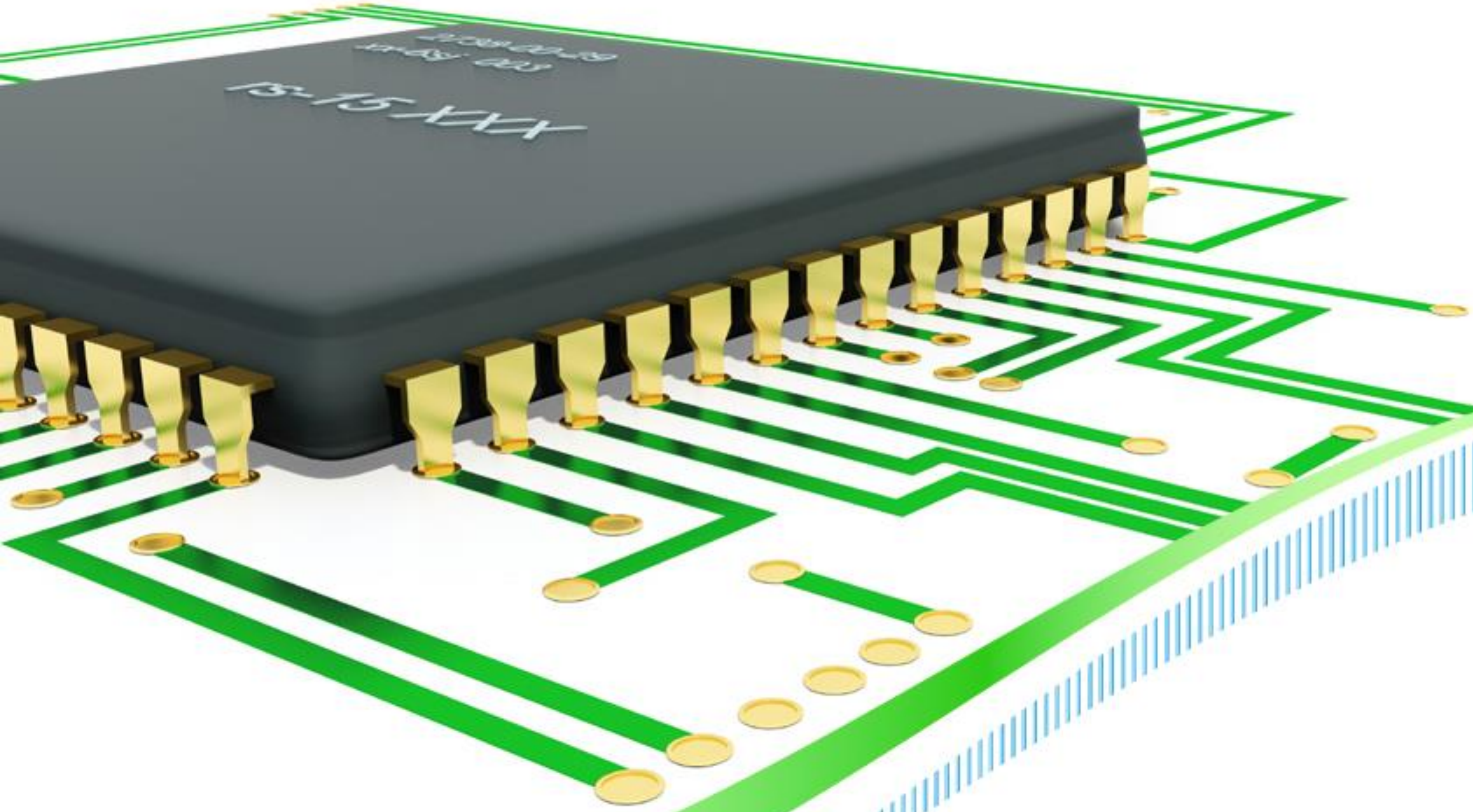
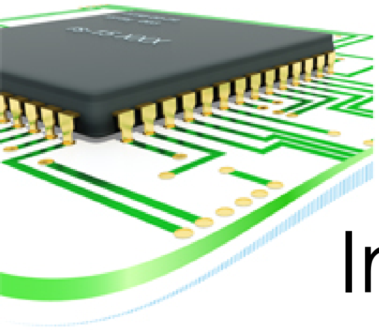


Semantic Analysis

on top of Flex + Bison

Problem

JSON-like translation

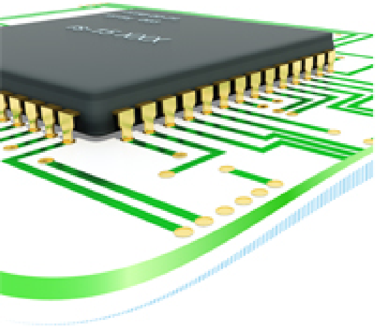


Implement a tool to verify and load the value contained in a text file.

The value is encoded in JSON-like syntax. Make the value available for application specific purposes.

Problem

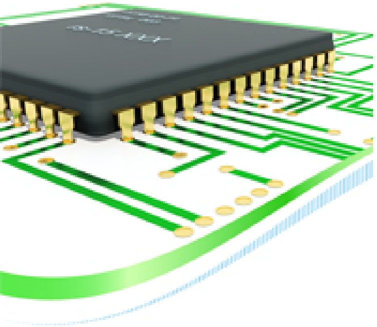
Details and constraints



- A value can be simple or complex
- Simple values are numbers and strings
- Complex values are dictionaries and arrays

- A dictionary is sequence of members enclosed by “{“ and “}”
- A dictionary without member is possible
- Members are separated by commas
- A member can be either
  - in the form of “<member-name>” “:” value
  - or, in the form of <member-name> “:” value

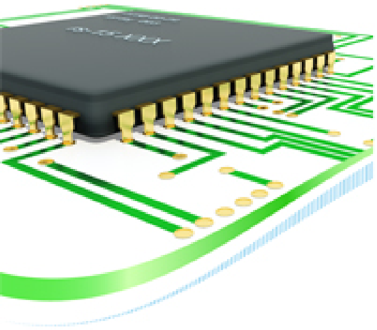
- An array is sequence of values enclosed by “[“ and “]”
- An array without value is possible
- Values are separated by commas



Problem

Sample Input

```
{
   m: "Test\x30\nAbc",
   "field": [1, "Anv", {id:"Test", arr:[]}],
   "anothermember":{},
   val: 0.5E2
}
```



Solution Steps

Analyze the problem statement and the example to

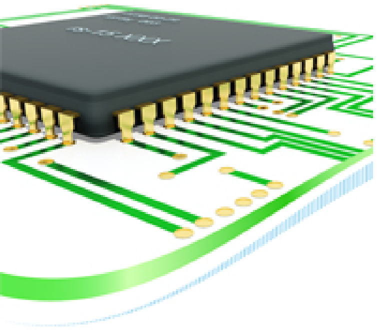
- Identify Tokens
- Develop Grammar
- Design Semantic Representation

The tokens are

“{”, “}”, “[”, “]”, comma, colon, identifier, string, number

Solution Steps

Develop grammar

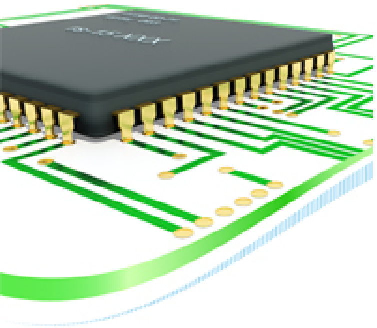


```
dictionary: SOB memberlist EOB;

array: OB valuelist CB;

memberlist: member | member COMMA memberlist | ;

valuelist: jvalue | jvalue COMMA valuelist | ;

member: name COLON jvalue;

name: ID | STR;

jvalue: STR | NUM | dictionary | array;
```

```
%token SOB
%token EOB
%token OB
%token CB
%token ID
%token STR
%token NUM
%token COLON
%token COMMA
```

Solution Steps

Design semantic representation



The representation is hierarchy of values!

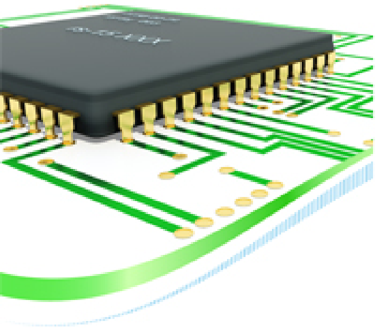
Dictionary and array may have children

```
enum class JValueType
{
   Str = 0,
   Num = 1,
   Dict = 32,
   Arr = 33
};
```

```
class JValue
{
      JValueType type;
   public:
      JValue(JValueType t);
      JValueType getType();
      virtual void
report(ofstream *os)=0;
      virtual ~JValue();
};
```

Solution Steps

Design semantic representation

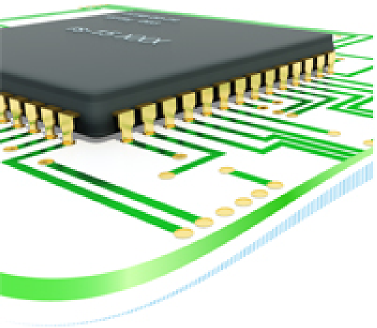


The representation is hierarchy of values!

A simple value without children can be either a double or a string.

```
class JValueDouble : public
JValue
{
   private:
      double   val;
   public:
      JValueDouble(double d);
      virtual void
report(ofstream *os);
};
```

```
class JValueStr : public JValue
{
   private:
      string *str;
   public:
      JValueStr(string *s);
      virtual ~JValueStr();
      virtual void
report(ofstream *os);
};
```



Solution Steps

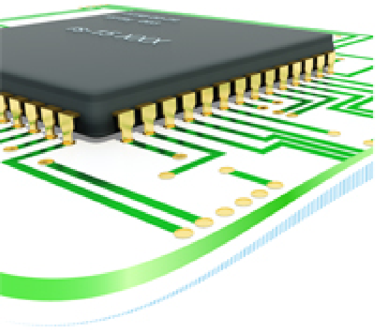
Design semantic representation

The representation is hierarchy of values!

A dictionary is represented by a vector of members.

```
class JMember
{
   private:
      string     *id;
      JValue     *value;
   public:
      JMember(string *pId,
JValue *pValue);
      virtual ~JMember();
      virtual void
report(ofstream *os);
};
```

```
class JDictionary : public JValue
{
   std::vector<JMember *>  *arr;

   public:
      JDictionary();
      ~JDictionary();

      void addMember(JMember *m);
      virtual void report(ofstream
*os);
};
```

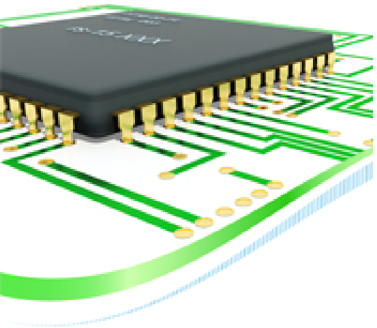


Solution Steps

Design semantic representation

The representation is hierarchy of values!

```
class JArray : public JValue
{
   private:
       std::vector<JValue *>  *arr;
   public:
       JArray();
       ~JArray();

       void addElement(JValue *v);
       virtual void report(ofstream *os);
};
```

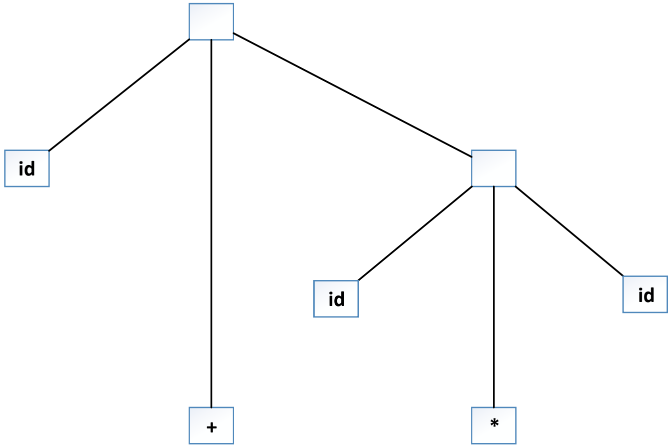


Abstract Syntax Tree (AST)

Bridging Syntax to Semantic Representation

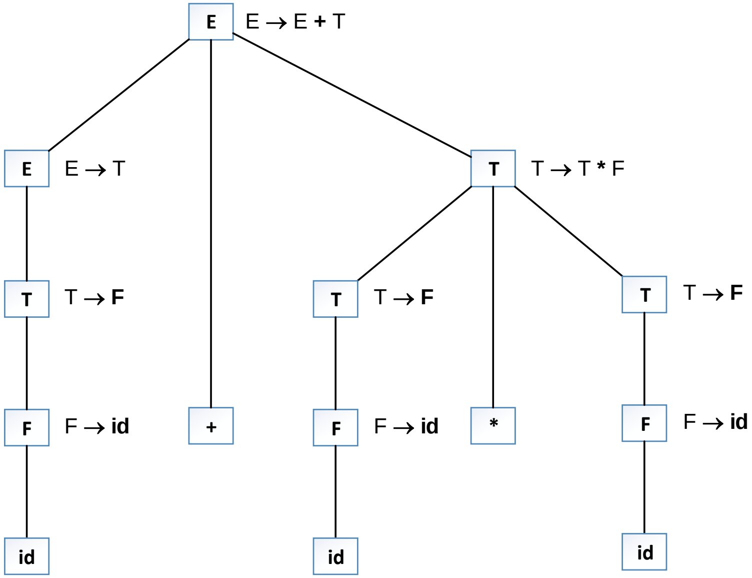
Parse tree reflects derivations.
AST reflects logical structure.

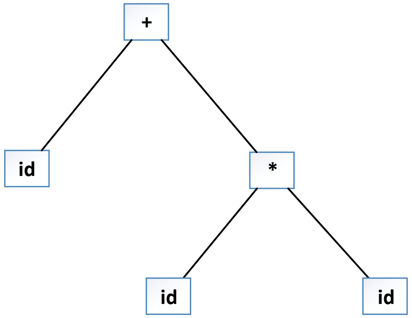
Input: id + id * id

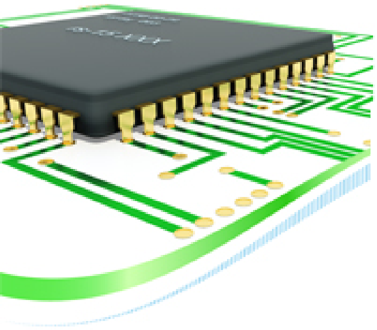


G:
E → E **+** T | T
T → T ***** F | F
F → **-** E | **(** E **)** | **id**

E → E **+** T
E → T
T → T ***** F
T → F
F → **-** E
F → **(** E **)**
F → **id**

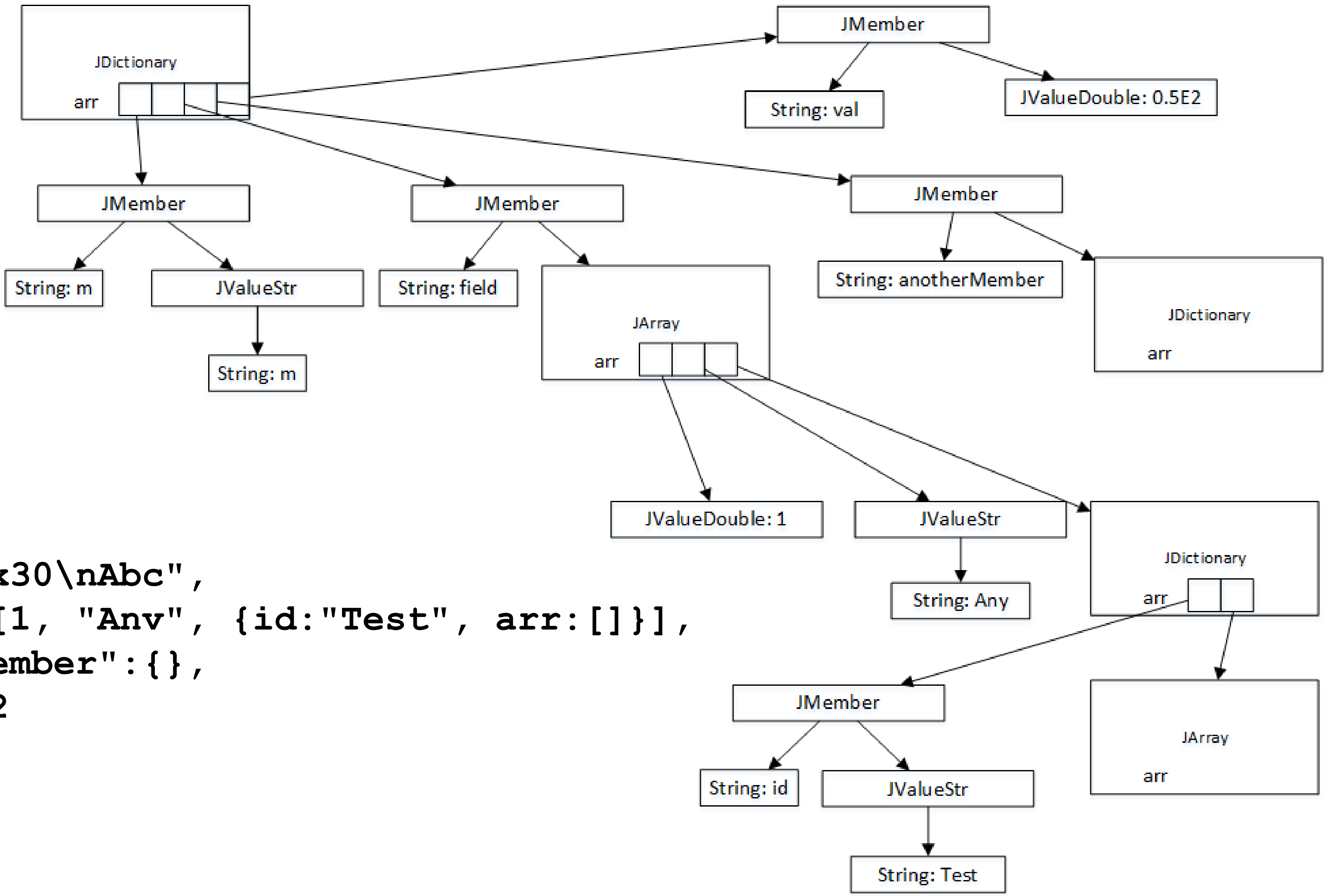






Abstract Syntax Tree (AST)

Bridging Syntax to Semantic Representation

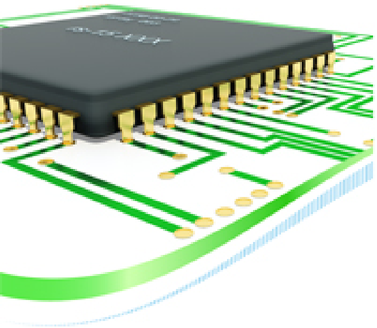


Input:

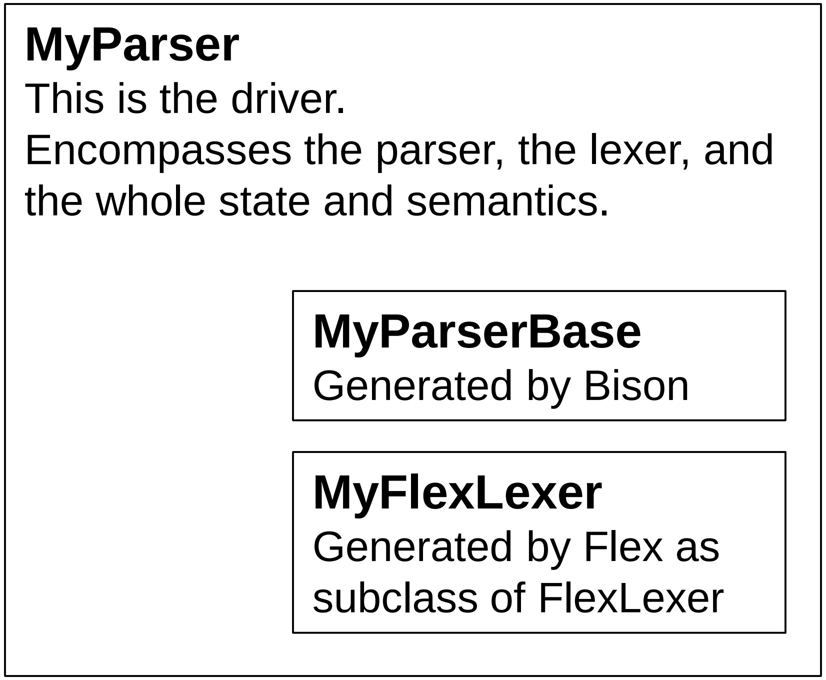
```
{
   m: "Test\x30\nAbc",
   "field": [1, "Anv", {id:"Test", arr:[]}],
   "anothermember":{},
   val: 0.5E2
}
```

Flex + Bison

Objects for Parsing



It is a fine wiring!



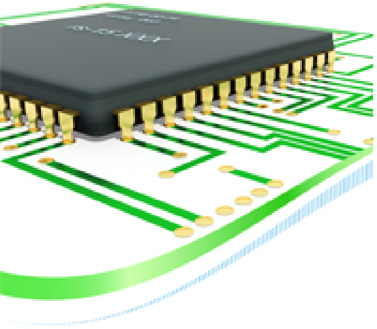
MyParser
This is the driver.
Encompasses the parser, the lexer, and the whole state and semantics.

MyParserBase
Generated by Bison

MyFlexLexer
Generated by Flex as subclass of FlexLexer

Flex + Bison

Scraping semantics from lexemes



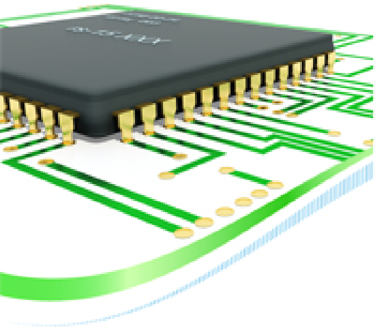
- Application requests parse using driver
  - The driver sets up configuration and uses auto-generated parser’s parse method
    - The parse method runs SR method and requests lexer to report a lexeme
      - The lexeme is reported back to the action code!
        - The action code calculates and sets the semantics for the lexeme.
        - The action code returns the relevant token identifier.

The driver has actions for both lexer and the parser.

The driver is made accessible from both the lexer and the parser.

Flex + Bison

Synthesizing semantics

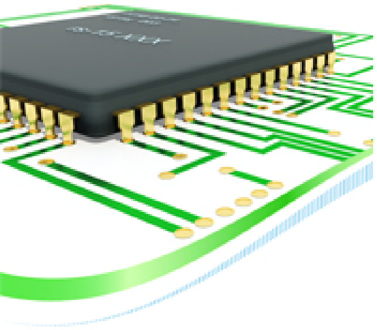


The art(!) of returning semantics using fine-wiring.

- **The parser calls driver's lex method because it was instructed to do so in .y (see line 19 and its effects). The generated parser passes a pointer where the semantics can be saved! This is the opportunity to save the pointer (lval).**
  - **The driver's lex method calls MyFlexLexer's lex method, which is not in MyFlexLexer.cpp module! It is hijacked by the YY_DECL macro through the definition in the .l file (see the lines in .l and its effects).**
    - **When the driver's action method is called by the lexer, the saved pointer (lval) can be used thread-safely to store semantics! From this point on, the extracted semantics is in the game field of bison parser.**

Types for Semantics

Bison's semantic_type



Use of the union semantic type.

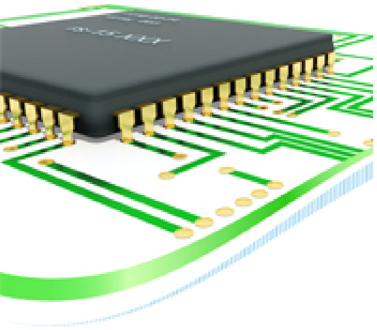
Define data types to represent semantics for both tokens and non-terminals!

```
%define api.value.type union

%nterm <JValue *> jvalue
%nterm <JDictionary *> dictionary
%nterm <JDictionary *> memberlist
%nterm <JArray *> array
%nterm <JArray *> valuelist
%nterm <string *> name
%nterm <JMember *> member
```

```
%token SOB
%token EOB
%token OB
%token CB
%token <string *>ID
%token <string *>STR
%token <double> NUM
%token COLON
%token COMMA
```

Actions for Semantics

Bison’s semantics game!



- See use of semantics in combination with actions and the methods called.
- No globals in solution!
- Download, compile, and observe by using debugger!
- See the output sample03output.txt as a means of verification.
- This is also the Intermediate Representation and the Target for this problem.
- What is missing to serve potential application needs!

QUESTIONS!