Combinatorial Interaction Testing with CTWEDGE

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CTWEDGE in brief

https://github.com/fmselab/ctwedge

Language for CIT problems

1. with a precise formal semantics and a grammar by Xtext
2. A textual editor integrated in the eclipse IDE

Set of tools

3. for importing/exporting CIT problems
4. for generating test suites (by using external tools)

Framework

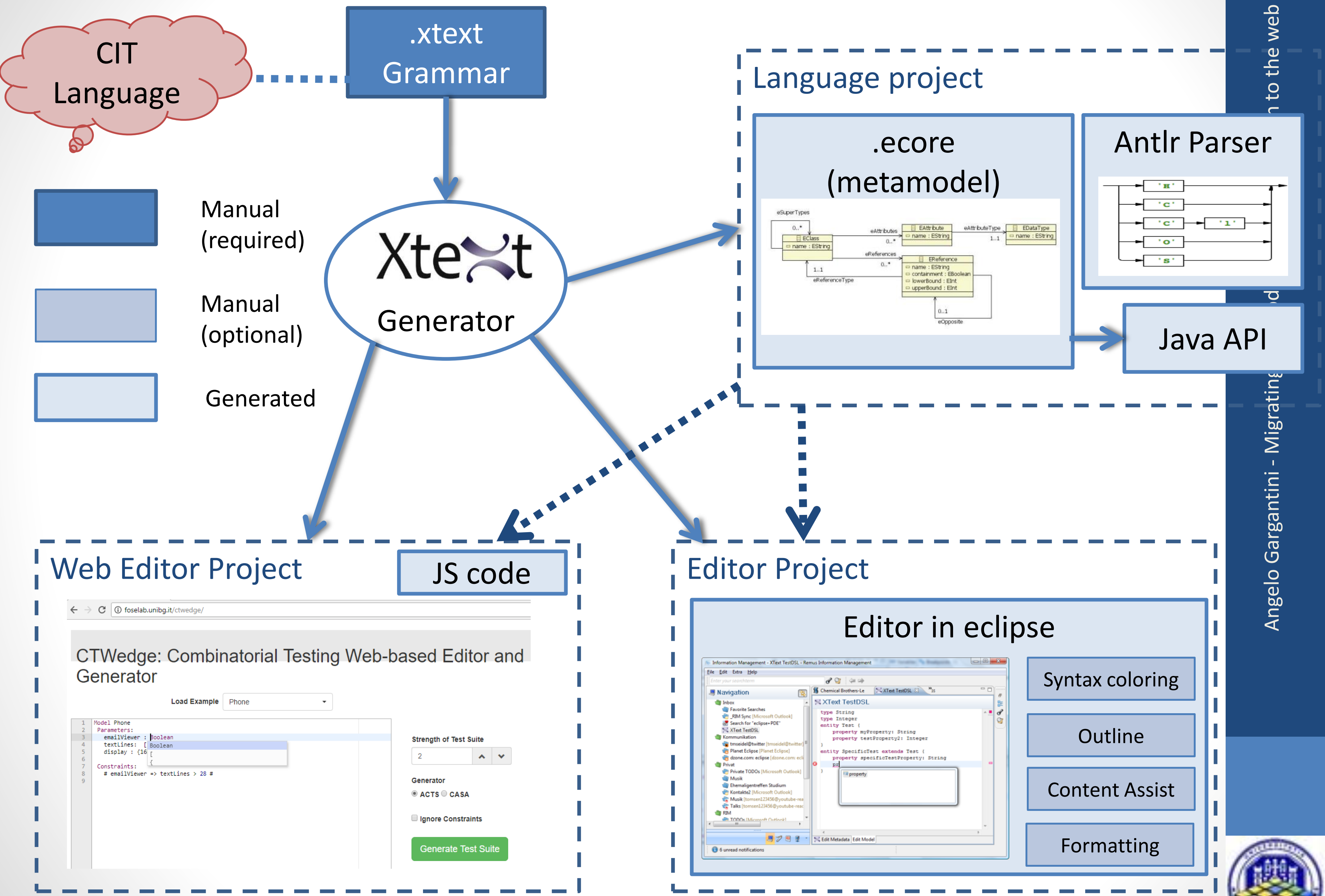
5. based on the Eclipse Modeling Framework (EMF), library to manipulate combinatorial problems in Java
6. A rich collection of Java utility classes and methods
7. A rich collection of benchmarks

INSTALLING CTWEDGE

As eclipse plugin
https://fmselab.github.io/ctwedge/ctwedge_update/

CTWEDGE EDITOR

DEMO

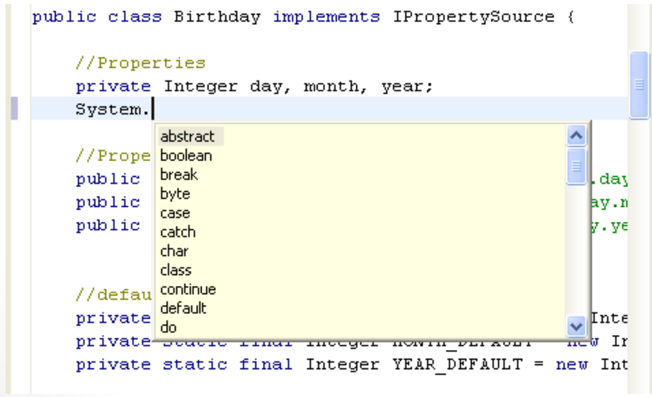


```
Model Phone
 Parameters:
   emailViewer : Boolean
   textLines:  [
   display : {16

 Constraints:
   # emailViewer => textLines > 28 #
```

```
type String
type Integer
entity Test {
    property myProperty: String
    property testProperty2: Integer
}
entity SpecificTest extends Test {
    property specificTestProperty: String
    pr
}
```

Editor features

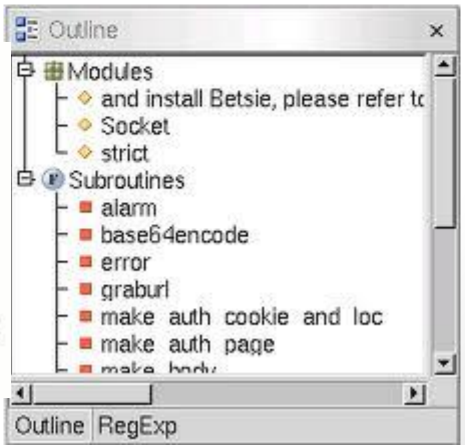
- Syntax Coloring
- Content Assist
- Template Proposals
- Rich Hover
- Rename Refactoring
- Quick Fixes
- Outline
- Folding
- Hyperlinks for all Cross References
- Find References
- Toggle Comment
- Mark Occurrences
- Formatting



```
public class Birthday implements IPropertySource {

    //Properties
    private Integer day, month, year;
    System.

    //Prope
    public                                          .day
    public                                          ay.m
    public                                          y.ye


    //defau
    private                                         Inte
    private                                         new Ir
    private static final Integer YEAR_DEFAULT = new Int
```

abstract
boolean
break
byte
case
catch
char
class
continue
default
do

```
r    path to the feature's project directory
 current version, for example '0.4.2'

sion

 = shift;

ead_file("$feature_dir/feature.xml");


 m/version\s*=\s*"(\d+\.\d+\.\d+)"/s)

$1;

ersion))

e version missing in $feature_dir/feature.xml";

;
```

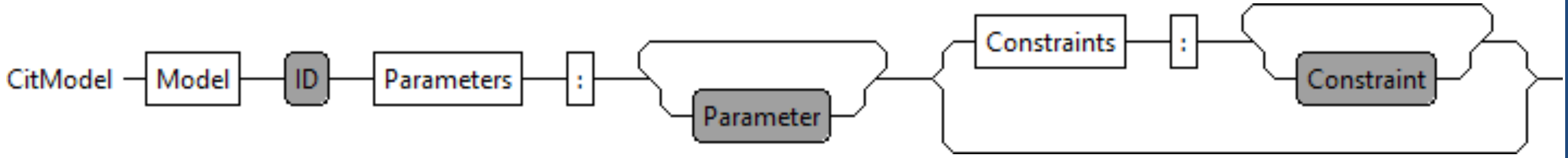


MODELLING COMBINATORIAL PROBLEMS

Grammar

- Very similar to EBNF:

```
CitModel:
  'Model' name=ID
  //list of parameters
  'Parameters' ':' (parameters+=Parameter)+
  // constraints
  ('Constraints' ':' (constraints+=Constraint)+)?;
```



- Translated to ANTLR

CTWEDGE Language in a glance

```
Model Model
Parameters:
...
~~end~~
Constraints:
# ... #
~~end~~
```

Parameters

Constraints

Example:
A family of phones, that can have several types of cameras, display,…

Example

```
/*
 * This is an example model
 */
Model Phone
 Parameters:
   emailViewer : Boolean
   textLines:  [ 25 .. 30 ]
   display : {16MC, 8MC, BW}

Constraints:
  # emailViewer => textLines > 28 #
```

Parameters and their types

- To describe a combinatorial problem would be sufficient to specify the number of variables and their cardinality.
- ctwedge language forces the designer to name parameters and to specify their types by listing all the values in their domain.
- **Choice:** explicit parameter names to facilitate the modeling of real systems and to ease the specification of constraints and seeds

Enumerative for parameters that can take a value in a set of symbolic constants.

the display of the cell phone can be colored (with 16 or 8 millions colors) or black and white,

```
display: { 16MC 8MC BW };
```

Parameters (2)

Boolean for parameters that can be either true or false.

the phone can have an email viewer

```
emailViewer: boolean;
```

Numerical values in a **range** for parameters that take any value in an integer range.

Phones have a number of lines between 10 and 30, but only every 5 is valid

```
textLines: [ 10 .. 30 ] step 5;
```

A list of **Numbers** for parameters that take any value ina set of integers.

The phone has been produced in 2012 and 2013

```
Year: {2012 2013};
```

Constraints

- In ctwedge, we adopt the language of propositional logic with equality and arithmetic to express constraints
- General Form (GF) constraints
  - propositional calculus and Boolean operators

    ```
    a or b => c and d
    ```

  - equality and inequality

    If the phone has an email viewer then

    ```
    # emailViewer==true  => textLines>=threshold #
    ```

  - arithmetic over the integers
  - relational and arithmetic operators for numeric terms

    ```
    # textLines >= threshold + 10 #
    ```

- A valid test must satisfy all the constraints

TEST GENERATION

Test generation

- CTWEDGE does not include in itself generators. Currently supports the following test generators, each defined as generator plugin:
  - AETG is a plugin developed by students following the pseudo code for the greedy algorithm of AETG.
  - IPO is a plugin developed by us following the pseudo code for IPO.
  - Random is a simple random algorithm that adds new randomly built tests until all the n-wise combinations are covered.
  - ACTS is an external test generator tool developed by the NIST.
  - CASA is an external tool for test generation based on simulated annealing by Myra Cohen and colleagues.
  - ATGT_SMT is an external tool combining heuristics and SMT solving.

- Some support constraints, seeds, …