

Testwell CTC++ User Testimonial

Paris-Sud University is a place dedicated to high-level research, focused on understanding the world, backing student success and responding to the needs of society. Its high level of research is evidenced by numerous awards and its position in international rankings. But Paris-Sud University can also be proud of its leading position among French universities, in terms of integration of students and doctoral students.



Paris-Sud University trains more than 31 000 students each year and provides a high quality education at Bachelor, Master, Engineer and Doctorate levels, in a wide range of fields, from Basic Sciences (Mathematics, Physics, Computer Science...), Health Science and Sport Science to Law, Economics and Management.



There are several Computer Science education programs delivering different degrees, at the Faculty of Science, the Orsay University Institute of Technology and the Polytech Paris-Sud School of Engineering.

Nowadays, software development processes focus more on modelling and verification steps. Future software engineers should be acquainted with methods and tools for designing, implementing and validating their code. This is why we introduced Testwell CTC++ in several software engineering courses, from undergraduate to master and engineering degrees.

In these courses, students are introduced to various testing methods like functional unit, integration or system testing and structural testing. In particular, formal aspects of testing are emphasized, to make students aware of the fundamental notions on which the practice relies.

Structural testing is presented as a formal test generation method, that allows one to produce tests satisfying code coverage criteria defined on the control flow graph like "all statements", "all branches", "all conditions" or MC/DC. It can be viewed as a complementary approach to functional unit testing, and code coverage as a measure of testing efficiency.

In order to show how structural testing can naturally and efficiently be integrated in a software development process, we train students to use Testwell CTC++ under Eclipse to measure the coverage of Java code achieved by functional unit tests written in JUnit. Students first write JUnit tests from a given specification, and run them on several implementations of this specification (faulty or not), whose code is hidden. Then they open the code they tested before as a black box and run Testwell CTC++ with their tests to know the reached rate for the different coverage criteria provided by Testwell CTC++. Finally, their aim is to improve their coverage by analysing the uncovered parts of the program and enhancing their test set accordingly.

```

62 // si on a trouve elt, on retire 1 a sa multiplicite si elle est > 1
63 if(tab[i].occ > 1) {
64     tab[i].occ--;
65     return true;
66 }
67
68 // si elt est present avec une multiplicite 1, on supprime sa case
69 // on decale tous les elements suivants vers la gauche
70 for(int j = i; j < size - 1; j++) {
71     tab[j] = tab[j+1];
72 }
73
74 tab[size - 1] = null; // on efface la derniere case avec null
75 size = size - 1; // on decremente la taille
76 return true;
77 }
78 }
79
80 // on renvoie l'ensemble de tous les elements compris entre inf et sup
81 public Ensemble subset(Integer inf, Integer sup) {
82     Ensemble s = new Ensemble(); // on cree un Ensemble vide
83
84     if(inf == null || sup == null) { // si inf ou sup est null, on renvoie l'ensemble vide
85         1: T | | _
85         2: F | | T
85         3: F | | F
86         return s;
87     }
88
89     // sinon, on parcourt le tableau
90     for(int i = 0; i < size; i++) {
91         if(tab[i].val >= inf && tab[i].val <= sup && tab[i].occ == 1) {
91             1: T && T && T
91             2: T && T && F
91             3: T && F && _
91             4: F && _ && _
92             s.add(tab[i].val); // on ajoute tous les elements entre inf et sup de multiplicite 1
93         }
94     }

```

The HTML report is easy to read by students and shows in a user-friendly way the uncovered code or conditions, which allows them to focus on missing tests.

The use of Testwell CTC++ shows students that even the most complete functional test set does not cover subtle details of the implementation. Designing tests according to the real final implementation is necessary to hope finding faults that stay hidden from functional tests.



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