IFIPS Institut de Formation d'Ingénieurs
UNIVERSITÉ PARIS-SUD 11

Verification and Validation

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PROGRAM VERIFICATION

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The course website is `www.lri.fr/~wolff/teach-material/2008-09/IFIPS-VnV/`.

Generally speaking, exercises will be posted online Monday afternoon. They can be (but need not be) handed in at the start of the exercises sessions, or in any other way that the assistants allows for.

Exercise 1 (Hoare Logic)
Derive the following Hoare triples using inference rules introduced during the course:

1. $\{x \geq 0\}$ `x:==x+1` $\{x \geq 1\}$
2. $\{x \geq 0\}$ WHILE `x` $\geq$ `0` DO `x:==x-1` $\{x = -1\}$
3. {true} WHILE true DO `x:==x+1` $\{x = 72\}$
4. {false} `x:==3` $\{x = 0\}$

Exercise 2 (Square root derivation)
We prove the loop of the "square-root":

```
WHILE  sum <= a DO
( i :==  i + 1;
  tm :== tm + 2;
  sum :==  tm + sum)
```

Exercise 3 (Binary Search in an Array)
The following program implements a binary search of a value v in a sorted array t between 0 and $N-1$. If the value is found at index k then the result is k otherwise it is -1.

```
int binary(int t[], int N, int v) {
  int res = -1;
  int l = 0;
  int u = N-1;
  while (res==-1 && l <= u) {
```

```
    int m = (l + u) / 2;
    if (t[m] < v) l = m + 1;
    else if (t[m] > v) u = m - 1;
    else res=m;
  }
  return res;
}
```

1. Write pre and post-condition for this function (do not forget the condition for avoiding access in `t` outside the bounds)
2. Find an invariant for the loop
3. Find a variant for justifying termination of the loop