Program Verification   Prof. Dr. H. Peter Gumm
Summer 2023

Exercise sheet 01

Deadline: April 29, 8:00 p.m.

Register in the lab group in Ilias and submit your answer file from there. Your file should be a syntactically correct Dafny-file named **ex01_xyz.dfy**, where you please replace xyz by your ilias user name.

Mark the beginning of each new problem by //Problem 2, //Problem 3, //Problem 4. Answers to questions that do not consist of Dafny code should be enclosed in comments. Dafny has line comments preceded by „//“ and region comments enclosed in „/*“ and „*/“.

Problem 1.   (3 points)
Read the first chapters (until and including chapter 1.4, page 35) of „*Program Proofs*“ and do all examples in Dafny. (There is nothing to hand in for this exercise. I'll give you the 3 points on good faith.)

Problem 2.   (1 point)
Do Exercise 1.6 from the book.

Problem 3.   (2 points)
Do Exercise 1.7, parts (a) and (b) from the book. You are not required to implement *MaxSum*, only its specification.

Problem 4.   (6 points)
Here we take a first look at Hoare triples. We consider the following program excerpt :
    { P } x := 2*x+1; { Q } y := x + y; { R }
which combines the Hoare triples { P } x := 2*x+1; { Q } and { Q } y := x + y; { R }. Try to answer the following questions as good as possible:

(a) If we know $P \equiv x \leq y$ what can be said about Q and what can be said about R?

(b) If we know $R \equiv x \leq y$ what can we know about Q and what about P?

(c) If we know $R \equiv x + y == 8$ what can be said about P?

You can test your answers using Dafny as in the following program example,

```
// Problem 4a
method Ex_01_4a()
{   var x:int,y:int := *,*;

    assume P;
      x := 2*x+1;
    assert Q;
      y := x+y;
    assert R;
}
```

where you should replace P, Q, R by the conditions you want to check, e.g. replace P by `x <= y` for the first question, etc..