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

Exercise sheet 02

Deadline: May 06, 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 **ex02_xyz.dfy**, where you please replace xyz by your ilias user name.

Mark the beginning of each new problem by //Problem 1, ... , //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 2.3.2, page 53) 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. (3 point)
Do Exercise 1.8 from the book: For part (a), give example values for s and m so that there is no appropriate reconstruction of x and y possible.

Problem 3. (3 points)
Do Exercise 2.6 from the book. Notice that the book uses notation $\{\{P\}\}\,C\,\{\{Q\}\}$ rather than just $\{P\}\,C\,\{Q\}$. This is probably to distinguish it from Dafny-Code which uses braces "{" and "}" in the syntax of commands.

Exercise 2.6.

For each of the following triples, come up with some predicate to replace the question mark to make it a Hoare triple that holds. Make your conditions as precise as possible.

```
a) {{ -128 <= x < 0 }} x := 1 - x {{ ? }}
b) {{ 0 <= x <= y < 100 }} y := y - x {{ ? }}
c) {{ x is even && y < 100 }} x, y := y, x {{
   ? }}
```

Problem 4. (3 points)
Do Exercise 2.8 from the book.

Exercise 2.8.

For each of the following triples, come up with some predicate to replace the question mark to make it a Hoare triple that holds. Make your conditions as general as possible.

```
a) {{ ? }} b := y < 10 {{ b ==> x < y }}
b) {{ ? }} x, y := 2*x, x+y {{ 0 <= x <= 100 && y <=
   x }}
c) {{ ? }} x := 2*y {{ 10 <= x <= y }}
```