1. Problem Set

Concepts of Programming

WiSe 2024/25

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Due Friday, October 25, 2024, 12:00 PM

Problem 1 Algorithms *10 Pts*

(a) An algorithm is defined as a (1) *finitely described*, (2) *deterministic*, (3) *effectively calculable* procedure that transform an input into an output.

Elaborate on these three properties in the definition. For each property, provide an example where it is *not* fulfilled.

(b) Describe, in as much detail as possible, the steps to make a hard-boiled egg. Is your description an algorithm? Why or why not?

Problem 2 A Game of Guessing Numbers *10 Pts*

Werner and Hannelore play a game called *Guess the Number*. The rules are as follows:

(a) Werner and Hannelore agree on a positive integer $n \geq 1$.

(b) Werner thinks of a secret number $x \in [1, n]$. [1]

(c) Hannelore tries to guess x by proposing numbers.

(d) For each guess y, Werner responds with one of three statements:

- "My number x is greater than y."
- "My number x is less than y."
- "Hit!" (if $y = x$)

(e) The game ends when Hannelore guesses correctly.

Assume Werner plays honestly.

Hannelore uses the following strategy:

- She maintains two variables, a and b, intially set to 1 and n, respectively.
- In each round, Hannelore chooses a number $c \in [a, b]$.
- Based on Werner's response, Hannelore updates a or b:
  - If "Hit!", the game ends.
  - If "Less", she sets $b = c - 1$.
  - If "Greater", she sets $a = c + 1$.

[1] The *brackets* ([]) denote a *closed interval*, i.e. $1 \leq x \leq n$.

(a) Provide a detailed example of this game for $n = 10$, showing Hannelore's strategy in action.

(b) Prove that Hannelore's strategy always succeeds in a finite number of rounds.
Hint: Identify an invariant condition that holds at the beginning of each round.
Your proof should address two key points:

(i) Hannelore makes "progress" in each round;

(ii) Hannelore cannot "miss" Werner's number.

Problem 3 First Steps in Python *10 Pts*

(a) Download and install Python (Version 3) on your computer.

(b) Start the Python REPL and enter the following commands. For each, explain what happens and provide a brief interpretation:

(a)
```
a = 8 + 10
```

(b)
```
help()
quit
```

(c)
```
3 + 5 * 7 == a - 2
```

(d)
```
a = 40
3 + 5 * 7 == a - 2
```

(e)
```
print("KDP", str(a * 50 + 2*10 + 4 - 1) + ".\n")
```

(f)
```
True or (False and True)
```

(g)
```
if a - 4 <= 5:
    print("Ja")
else:
    print("Nein")
```

(h)
```
2 * (4 +

5)
```

(i)
```
for i in range(10):
    print(2 * i +  1)
```

(j)
```
exit()
```

(c) Download the file `mystery.py` from the course website and import it into Python using the command `from mystery import mystery`. What happens when you enter:

```
mystery("anna")
mystery("banane")
mystery("caesar")
```

Conduct further experiments and formulate a hypothesis about what the function "mystery" does.