Programming Session I

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Computer Science and Mathematics
Preparatory Course

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Brief Excursion on Number Systems

Number Systems

- **Natural Numbers:** $\mathbb{N} = \{0, 1, 2, 3, 4, \dots\}$
- **Integer Numbers:** $\mathbb{Z} =$
- **Rational Numbers:** $\mathbb{Q}$
- **Real Numbers:** $\mathbb{R}$

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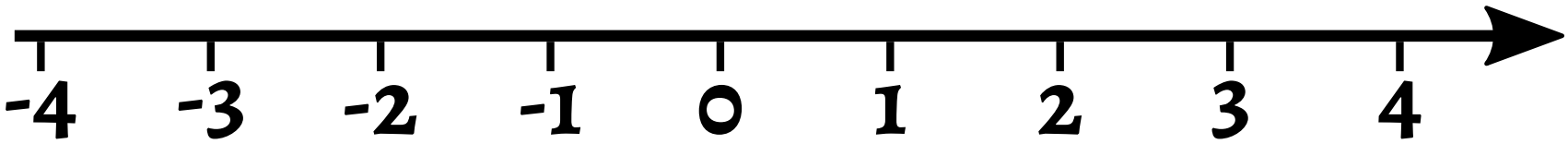

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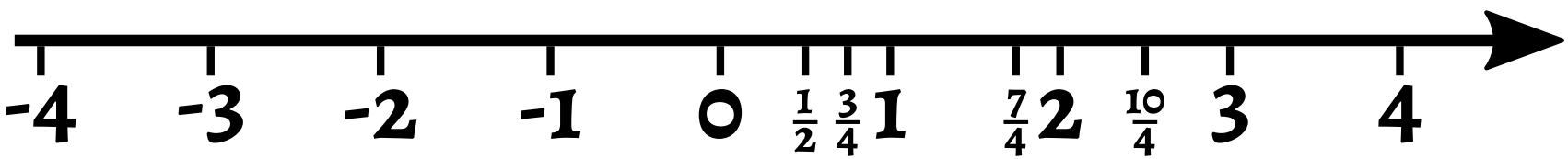

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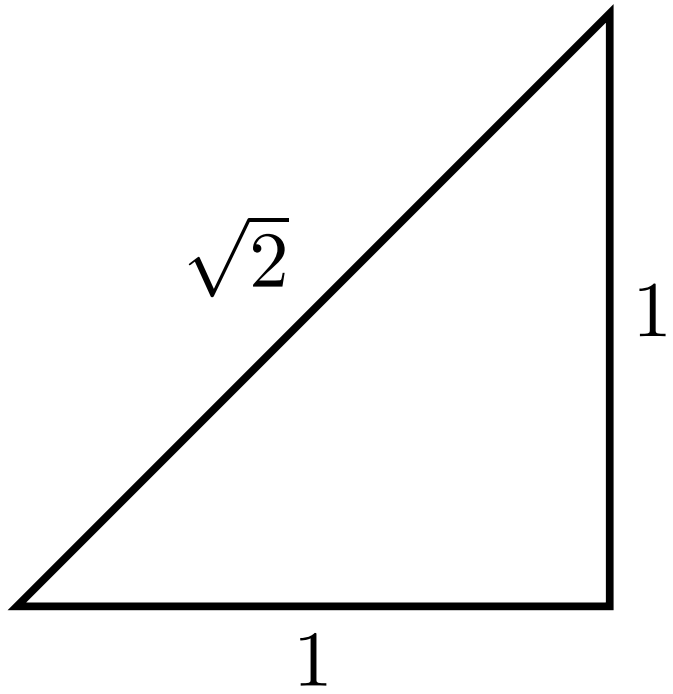
- However: $\sqrt{2}$ is not a rational number
- The irrational number $\sqrt{2} = 1.4142135\ldots$ is part of the real world:



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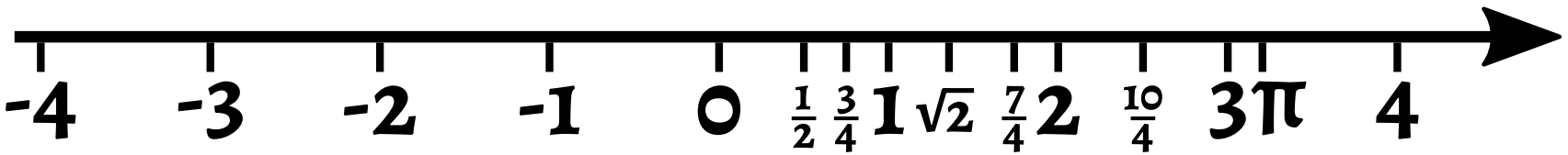

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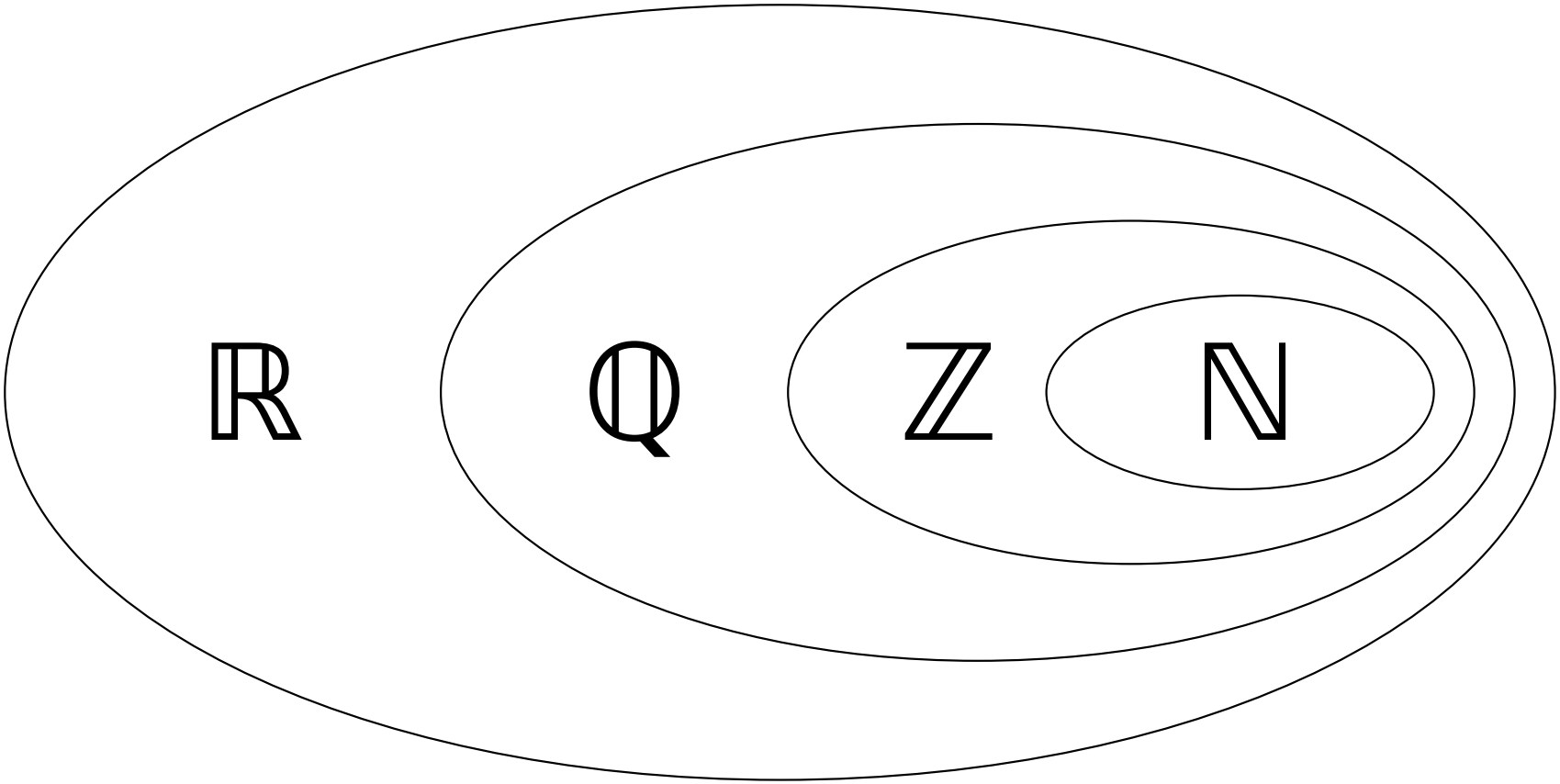
Honorable Mention

- **Complex Numbers:** $\mathbb{C} = a + ib$, where $a, b \in \mathbb{R}$ and $i = \sqrt{-1}$

Number Systems



Writing Files

- Opening a file

```
#This creates the file if it does not exist
fileObject = open("fileOutput.txt", "w")
#Option 'w' will overwrite existing files
#Use the option 'a' to append to a file instead
```

- Writing to the file

```
#Add \n to end a line and \t to create a tab
fileObject.write("Hello you!\n")
```

- Close the file after usage:

```
fileObject.close()
```

If-Else

- If and else are organized by indentation and colons

```
x = 3.5
is_x_4 = False
if x == 4 : #if <condition> :
    is_x_4 = True #indented block is called only
    print("x is 4") #if <condition> applies
else : #else is on the same level as if
    print("x is not 4")
#Regular program continues here
```

While Loops

- Print the numbers from 1 to 10

```
goal = 5 #define two variables for the exit condition
test = 0
while test != goal:
    test = test +1 # Increase test by 1
    print(test) # prints 1,2,3,4,5 a number per loop
```

The List Datatype

- Lists allow to manage a collection of variables

```
names = ["Alice","Bob","Carl","Dora"]
numbers = [1,2,3,5,8]
```

- Accessing and modifying elements in a lists

```
print(names) #['Alice','Bob','Carl','Dora']
single_name = names[2] #single_name = 'Carl'
first_element = numbers[0] #first_element = 1
last_name = names[len(names)-1]#last_name = 'Dora'

names[1] = "Bert" #names ['Alice','Bert','Carl','Dora']
```

Operations on Lists

- Example Operations

```
numbers = [1,2,3,5,8]
names = ["Alice","Bob","Carl"]
count = len(names) #count=3
names.append("Daisy") #['Alice','Bob','Carl','Daisy']
numbers2 = [13,21,34]
numbers3 = numbers + numbers2 #[1,2,3,5,8,13,21,34]
subset = numbers3[2:5] #[3,5,8]
#characters from position 2 (included) to 5 (excluded)
```

Helpful Functions

- The random module

```
import random #import the module similar to import math
#assigns dice_roll a number between 1 and 6
dice_roll = random.randint(1,6)
#assigns coin_flip either a 0 or 1
coin_flip = random.randint(0,1)
```

- Deleting list elements

```
names = ["alf","donald","charly brown","bud spencer"]
del names[1] #deletes the second element
print(names) # ["alf","charly brown","bud spencer"]
```

Tasks: Control Statements

1. Write a Guessing Game, where the script chooses a random integer between 0 and 20 and the user has to guess it. With each guess the user gets told if his guess was higher or lower than the desired number.
   - Start by assigning a random integer to a variable using random.randint(0,20)
   - Create a while-loop in which the user is asked for a number
   - Depending on the number input tell the user whether his guess was smaller,higher or equal to the desired value
   - Think about how to end the while-loop

Tasks: Lists

2. Write a script that returns the biggest element in a list
   - Create a list with arbitrary numbers of your choice
   - Loop through the list with a for loop
   - In each loop compare the current list element with your current estimate of the highest number
3. Write a script that looks for a specific element in the list and deletes it
   - Loop through the list with a for-loop and store the elements position in a variable
   - After the for loop remove the element at that position with the *del* command

4*. Write a script that takes a list and transfers its elements to a second list in sorted order.
   - Look for the smallest element in the first list. Write it to the second list. Delete it in the first list. Repeat.

Tasks: Writing to a File

5*. Write a script that writes down the list from yesterday's task 3 to a file:

- Start by opening the file
- First write "Coefficients:\n" to the file to create the first line
- Write your coefficients in the second line separated by commas
- Write "Values:" to the next line
- Run a loop through your list and in each loop write down x and the function value g(x) stored in the list

File Content Sketch:

Coefficients:
a_3, a_2, a_1, a_0
Values:
0, $g(0)$
1, $g(1)$
⋮
19, $g(19)$
20, $g(20)$