**Theoretical Computer Science – CTS**  
 **All Lecture Notes  
Winter Semester 2024   
Aqeel, Muazzam Bin**

**01\_Lessons\_TCTS\_WS24\_Intro.pdf**

The summary of this document is that why is theoretical computer science is important

Using the figure below we see how theoretical computer science concepts, such as automata theory and formal languages are used in compiler construction  
  
A diagram of a code generation

Description automatically generated  
The first phases, the so-called "front end", check whether a program is syntactically correct and prepare for further processing. The so-called "back end" is then responsible for the actual translation, i.e. the code generation. The front-end phases are mainly based on concepts from automata theory and formal languages.

**02\_Lessons\_TCTS\_WS24\_MathBasics**

1. **Sets**
   1. **A set is a collection of elements, Elements can be anything**
      1. Numbers
      2. Characters
      3. Symbol
      4. People
      5. Objects
   2. **Properties**
      1. Order is not important in the collection of elements
      2. An element can be only contained at most once in a set
         1. If you insert the same element again, nothing would be added additionally
   3. **Sets of Numbers**

|  |  |  |
| --- | --- | --- |
| **Types** | **Symbol** | **Example** |
| Natural Numbers | N |  |
| Integer numbers | Z |  |
| Rational numbers | Q |  |
| Real Numbers | R |  |

* 1. **Set Operations**

|  |  |  |
| --- | --- | --- |
| **Types** | **Symbol** | **Example** |
| * Empty set | ∅ |  |
| * Element x is contained in set A | x∈A |  |
| * **Cardinality of set A**   Number of elements | |A| |  |
| * Set A is strict subset of set B | A⊂B |  |
| * **A is subset of B**  A and B might be identical sets | A⊆B |  |
| * **Union of A and B**   All elements that are contained in A or in B | A∪B={x ∣ x∈A∨x∈B} |  |
| * **Intersection of A and B**   All elements that are contained in A and in B | A∩B={x ∣ x∈A∧x∈B} |  |
| * **Set difference** All elements that are contained in A but not in B | A∖ B={x ∣x∈A∧x∉B} |  |
| * **Cartesian product of A and B** Set of all pairs (a, b) that can be built with first component a from set A and second component b from set B | A×B={(a,b)∣a∈A∧b∈B} |  |
| * **Power set of A** Set of all subsets of A The empty set ∅ and the complete set A itself are always included | p(A)={X ∣X⊆A} |  |