Chair of Applied Computer Science III

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Database Systems II
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Exercise Sheet 3

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Exercise 1

Download the `zip` archive for this exercise sheet from the website. The examples can be found in the folder `experiments`.

Exercise 1 a)

Compile `experiment2.cc` with optimization level 0, i.e., `g++ -O0 experiment2.cc -o experiment2.out`.
Analyze the code and try to explain the output for each of the following runs:

- `./experiment2.out -s -l 990 -u 1000`
- `./experiment2.out -l 990 -u 1000`
- `./experiment2.out -s -l 0 -u 10`
- `./experiment2.out -l 0 -u 10`

Exercise 1 b)

Compare the assembler codes of the functions `singleAmp` and `doubleAmp` given in the following:

```
// function with conjunctive predicate connected by single ampersand
bool singleAmp (int a, int b) {
    if ((a == 3) & (b == 5)) {
      return true;
    }
    return false;
}

// function with conjunctive predicate connected by double ampersand
bool doubleAmp(int a, int b) {
    if ((a == 3) && (b == 5)) {
      return true;
    }
    return false;
}
```

Recall that you can halt the compiler at every compilation level. As an alternative, you can use the “Compiler Explorer” (`https://godbolt.org/`).

Exercise 1 c)

Compile `experiment3.cc` with optimization level 0, i.e., `g++ -O0 experiment3.cc -o experiment3.out`.
Analyze the code and try to explain the output for each of the following runs:

- `./experiment3.out -i 100`
- `./experiment3.out -i 100 -s1`

Exercise 2

Exercise 2 a)

What does the term *universal hashing* mean?

Exercise 2 b)

Consider the following four hash functions h_1, h_2, h_3, h_4 that map values from the universe $U := \{0, 1, ..., 5\}$ to the set $D := \{0, 1\}$:

$x \in U$	0	1	2	3	4	5
$h_1(x) \in \{0,1\}$	0	1	0	1	0	1
$h_2(x) \in \{0,1\}$	0	0	0	1	1	1
$h_3(x) \in \{0,1\}$	0	0	1	0	1	1
$h_4(x) \in \{0,1\}$	1	0	0	1	1	0

i. Let $H := \{h_1, h_2\}$. Is H universal?

ii. Let $H' := \{h_1, h_2, h_3\}$. Is H' universal?

iii. Let $H'' := \{h_1, h_2, h_3, h_4\}$. Is H'' universal?

Exercise 3

Implement a hash table that resolves collisions using chaining. Your hash table must be generic: Make the hash function a parameter. Find some data and insert it into your hash table under different hash functions. Output the average length and the maximum length of the buckets/chains in your hash table. What do you observe?

If you cannot find data, use the `words.txt` file provided in the `zip` archive. `words.txt` contains the 1000 most common words in the English language.

The `zip` archive also contains a hash table implementation which you can use as a framework for your own implementation. You can therefore choose which parts you take from the provided code and which parts you would like to implement yourself.