Data Structures and Algorithms 2

Coursework

Juan Scerri
1234567A

March 12, 2024

A coursework submitted in fulfilment of study unit ICS2210.

Contents

Chapter 1
Introduction

Noti għal-qabel l-eżmai

`ABCDE... Is this Courier?`

To find Fibonacci sums very quickly, the two results listed below can be used.

https://en.wikipedia.org/wiki/Coffee

Chapter 2

Heading on Level 0 (chapter)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.1 | Heading on Level 1 (section)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.1.1 | Heading on Level 2 (subsection)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you

information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 3 (subsubsection)

Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

Heading on Level 4 (paragraph) Hello, here is some text without a meaning. This text should show what a printed text will look like at this place. If you read this text, you will get no information. Really? Is there no information? Is there a difference between this text and some nonsense like “Huardest gefburn”? Kjift – not at all! A blind text like this gives you information about the selected font, how the letters are written and an impression of the look. This text should contain all letters of the alphabet and it should be written in of the original language. There is no need for special content, but the length of words should match the language.

2.2 | Lists

2.2.1 | Example for list (itemize)

- First item in a list
- Second item in a list
- Third item in a list
- Fourth item in a list
- Fifth item in a list

Example for list (4*itemize)

- First item in a list
  - First item in a list
    - First item in a list
      - First item in a list
      - Second item in a list
    - Second item in a list
  - Second item in a list
- Second item in a list

2.2.2 | Example for list (enumerate)

1. First item in a list
2. Second item in a list
3. Third item in a list
4. Fourth item in a list
5. Fifth item in a list

Example for list (4*enumerate)

1. First item in a list
   a) First item in a list
      i. First item in a list
         A. First item in a list
         B. Second item in a list
      ii. Second item in a list
   b) Second item in a list
2. Second item in a list

2.2.3 | Example for list (description)

First item in a list

Second item in a list

Third item in a list

Fourth item in a list

Fifth item in a list

Example for list (4*description)

First item in a list

First item in a list

First item in a list

First item in a list

Second item in a list

Second item in a list

Second item in a list

Second item in a list

$$F_n = \left\lfloor \frac{\phi^n}{\sqrt{5}} \right\rceil, \quad \phi = \frac{1+\sqrt{5}}{2}. \tag{2.1}$$

$$\sum_{i=1}^{n} F_i = F_{n+2} - 1. \tag{2.2}$$

The original equation for the Fibonacci numbers is a recurrence relation defined as

$$F_n = F_{n-1} + F_{n-2}, \qquad F_1 = F_2 = 1. \tag{2.3}$$

However, there exists a closed-form expression called Binet's Formula which is the following

$$F_n = \frac{\phi^n - (-\phi)^n}{\sqrt{5}}.$$

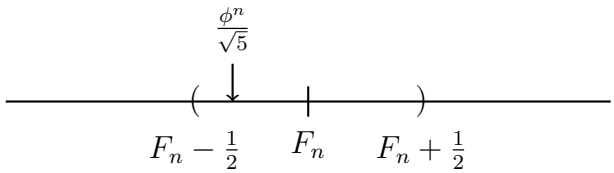
One notices that,

$$\forall\, n \in \mathbb{N} : \left| \frac{(-\phi)^n}{\sqrt{5}} \right| < \frac{1}{2},$$

which implies

$$\forall\, n \in \mathbb{N} : \left| F_n - \frac{\phi^n}{\sqrt{5}} \right| < \frac{1}{2}.$$

Visually, this can be represented as follows.



This allows to conclude that $\frac{\phi^n}{\sqrt{5}}$ is always within rounding error of the actual Fibonacci number. Hence, by rounding $\frac{\phi^n}{\sqrt{5}}$ we get the n-th Fibonacci number.

This completes our derivation for 2.1.

We can prove 2.2 by using an inductive argument.

Argument.

Base case ($n = 1$):

$$LHS = \sum_{i=1}^{1} F_i = F_1 = 1$$
$$RHS = F_{1+2} - 1 = F_3 - 1 = F_2 + F_1 - 1 = 1 + 1 - 1 = 1$$

Hence, the base case holds since $LHS = RHS$.

Inductive case ($n = k$):

Suppose that sum holds for $n = k - 1$.

$$\sum_{i=1}^{k-1} F_i = F_{k-1+2} - 1 = F_{k+1} - 1 \tag{2.4}$$

We are required to show that the sum holds for $n = k$.

$$\begin{aligned}\sum_{i=1}^{k} F_i &= F_k + \sum_{i=1}^{k-1} F_i \\ &= F_{k+1} + F_k - 1 \\ &= F_{k+2} - 1\end{aligned}$$

Therefore, by induction, 2.2 holds for all natural numbers.

Chapter 3
Chapter

This is a chapter

3.1 | Section g

This is a section

3.1.1 | Sub Section

This is a sub section

Sub Sub Section

This is a sub sub section

- this is an item
- this is also an item
  - Subitem A
  - Subitem B
    - Subsubitem A
    - Subsubitem B
      - Subsubsubitem A
      - Subsubsubitem B

```
if (ch == '\\') {
  switch (ch = CSNext()) {
    case '\\':
    case '"':
      // DO NOTHING
      break;
    default:
      fprintf(
          stderr,
          "emitString: Invalid escape sequence\n");
      return -1;
  }
}

if (tok.len >= alc) {
  alc += GROW_SIZE;
  char *tmp = realloc(tok.str, sizeof(char) * alc);

  if (tmp == NULL) {
    perror("emitString");
    return -1;
  } else {
    tok.str = tmp;
  }
}
```

Listing 3.1: The section in `emitString()` which handles escaping.

Proposition 1. *hello*

Theorem 1. *hello*

Conjecture 1. *hello*

Corollary 1. *hello*

Lemma 1. *hello*

Appendix A

Is this part of the appendix?

A.1 | This is in the appendix

Appendix B

Is this also part of the appendix?