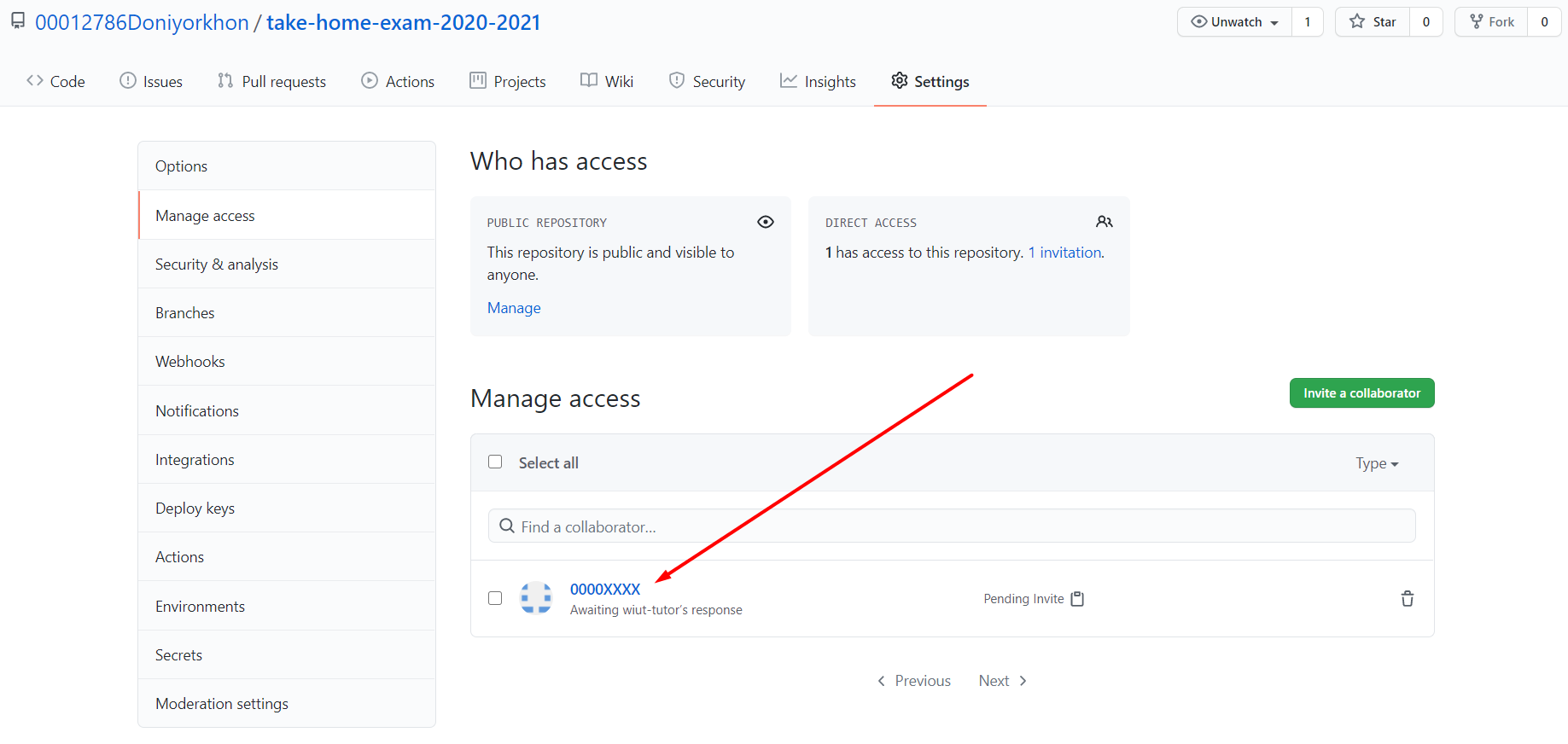
# Task 1

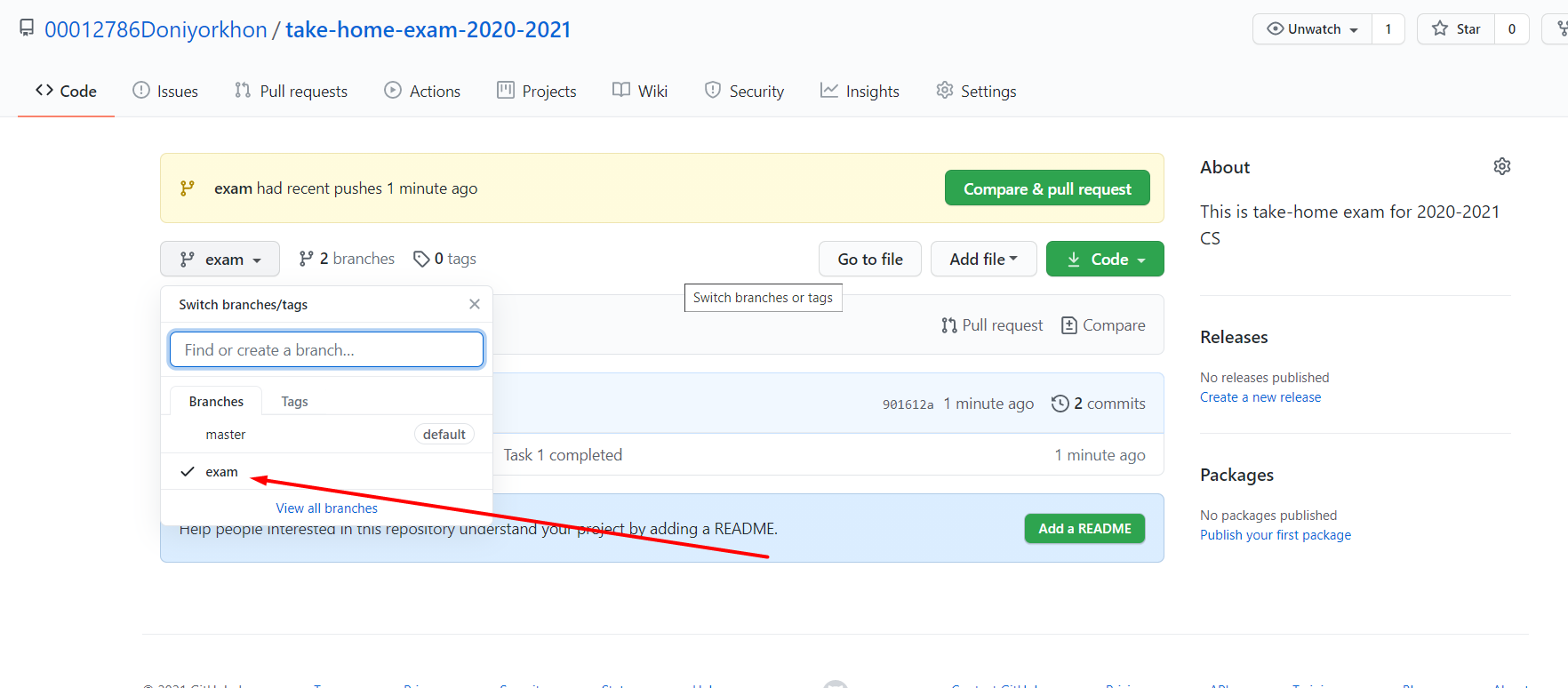
For this part of the assignment, new repository on GitHub platform was created that is accessible by url: <https://github.com/00012786Doniyorkhon/take-home-exam-2020-2021/>

In order to keep versioning the assignment purposes, new branch *exam* was opened.

As this assignment is being done using new repository, one collaboration request has been sent to a GitHub user: *wiut-tutor*:



As soon as Task 1 finishes, new commit is required, so when it was committed to new branch *exam*, such branch started appearing:



# Task 2

ID number: *12786*

|  |  |  |
| --- | --- | --- |
| 2 | 12786 |  |
| 2 | 6393 | 0 |
| 2 | 3196 | 1 |
| 2 | 1598 | 0 |
| 2 | 799 | 0 |
| 2 | 399 | 1 |
| 2 | 199 | 1 |
| 2 | 99 | 1 |
| 2 | 49 | 1 |
| 2 | 24 | 1 |
| 2 | 12 | 0 |
| 2 | 6 | 0 |
| 2 | 3 | 0 |
| 2 | 1 | 1 |
| 2 | 0 | 1 |
| 1278610=110001111100102 | | |

**a)** 1. In order to convert decimal number to binary numeric system the steps below are taken (<https://www.instructables.com/How-to-Convert-From-Decimal-to-Binary/>):

Step 1.

|  |  |  |
| --- | --- | --- |
| 2 | 12786 |  |
|  | 6393 | 0 |

In order to convert a decimal number to binary, the decimal number in our case 12786 is divided by 2 which is on left side and remainder is kept (0) at right side like above.

Step 2. Division product (6393) is kept divided by 2 (which is on left side) again and the remainder is saved on right side (which is 1).

Step 3. After the last iteration, binary representation of original decimal number is completed on the right column as shown above. Only requirement is to read number sequence from bottom to top.

2. Conversion of decimal number to hexadecimal is logical continuation of decimal-to-binary conversion and it involves the steps below (<https://www.instructables.com/Convert-Decimal-to-Hexadecimal/>):

Step 1. It is required to rewrite product of decimal-to-binary conversion product from right to left every four bits separated by a space character and required to finish by leading extra zeros on the left to complete the last group of four bits:

1278610 = 00 11 0001 1111 00102

Step 2. These four bits are compared to their hexadecimal analogue from this binary-to-hex table (<https://www.wikihow.com/Convert-Binary-to-Hexadecimal>):

|  |  |
| --- | --- |
| **Binary** | **Hexadecimal** |
| **0** | **0** |
| **1** | **1** |
| **10** | **2** |
| **11** | **3** |
| **100** | **4** |
| **101** | **5** |
| **110** | **6** |
| **111** | **7** |
| **1000** | **8** |
| **1001** | **9** |
| **1010** | **A** |
| **1011** | **B** |
| **1100** | **C** |
| **1101** | **D** |
| **1110** | **E** |
| **1111** | **F** |

1278610 = 0011 0001 1111 00102

3 1 F 2

1278610 = 00 11 0001 1111 00102 = 31F216

**b)** According to steps taken for decimal-to-binary conversion of numbers:

9999910 = 0001 1000 0110 1001 11112

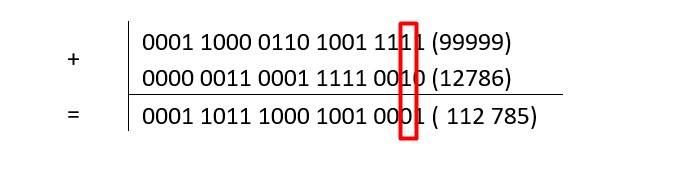
1278610 = 0000 0011 0001 1111 00102

*Addition*. Such operation in binary system is pretty much the same as in decimal system with only one nuance is that binary addition carries 1 addition result equals to 2 (<https://www.calculator.net/binary-calculator.html>):

*0 + 0 = 0, 0 + 1 = 1, 1 + 0 = 1, 1 + 1 = 0, carry over the 1, i.e. 10*

For example, let’s add those two numbers (99999 and 12786) in binary format:

|  |  |
| --- | --- |
| + | 0001 1000 0110 1001 1111 (99999) |
| 0000 0011 0001 1111 0010 (12786) |
| = | 0001 1011 1000 1001 0001 ( 112 785) |

In the picture above it is shown that how carrying over the 1 happens *when 1 + 1* is done.

*Subtraction.* Borrowing happens when the number that is subtracted is larger than the number it is being subtracted from (when 1 is subtracted from 0). When this happens, the 0 in the borrowing column becomes "2" while reducing the 1 in the column being borrowed from by 1. Borrowing will have to occur from each subsequent column until a column with a value of 1 can be reduced to 0 (ibid.):

*0 - 0 = 0*

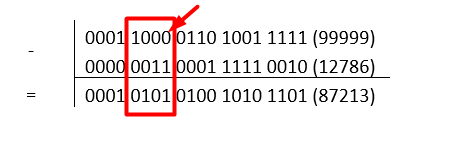
*0 - 1 = 1, borrow 1, resulting in -1 carried over*

*1 - 0 = 1*

*1 - 1 = 0*

For example, let’s subtract those two numbers (99999 and 12786) in binary format:

|  |  |
| --- | --- |
| - | 0001 1000 0110 1001 1111 (99999) |
| 0000 0011 0001 1111 0010 (12786) |
| = | 0001 0101 0100 1010 1101 (87213) |



The picture above clearly shows how borrowing happens from subsequent digits.

**c)** Primary ***use case*** of a hexadecimal number is to simplify binary representation of data by computer scientists. As hex is 2 power of 4, this means there is linear relationship between these two, i.e. hex digit is equivalent to 4 binary digits. Computers use binary system while humans prefer hexadecimal system to shorten binary representation whereby making it legible and easy to read. Another usages of hex are as well below:

\* Hexadecimals can define locations in memory. Two hex digits characterize one byte whereas eight binary digits do the same.

\* Hexadecimals represent colors. Each of RGBs is characterized by two hex digits: #RRGGBB.

\* Hexadecimals represent MAC addresses, data contract of standards like Modbus. MAC address consists of 12-digit hex number with formats of MMMM-MMSS-SSSS or MM:MM:MM:SS:SS:SS (first six hex digits represent Adapter manufacturer ID and another six hex digits show Adapter serial number). RS-232 interface applying Modbus protocol transfers ASCII or Hex-represented values, for example, Slave can send function codes represented in hex format to a Master in order to perform some operation (<https://www.picotech.com/library/oscilloscopes/modbus-serial-protocol-decoding>).

Hexadecimal systems are well known for their some advantages:

* Signifying a number using a base of 16 means comes up with less number of digits compared to binary or decimal. Hex system allows to store more info using less space. Hence, large binary numbers are written using hex system.
* As hex system is human-legible, it is used to group binary numbers for easier understanding like in Task 1.
* Moreover, such concise representation of binary numbers using hex format lowers error occurring possibility of binary numbers sequence.

# Task 3

Father’s and Mother’s names combination: *Botir&Aziza*

Tree:

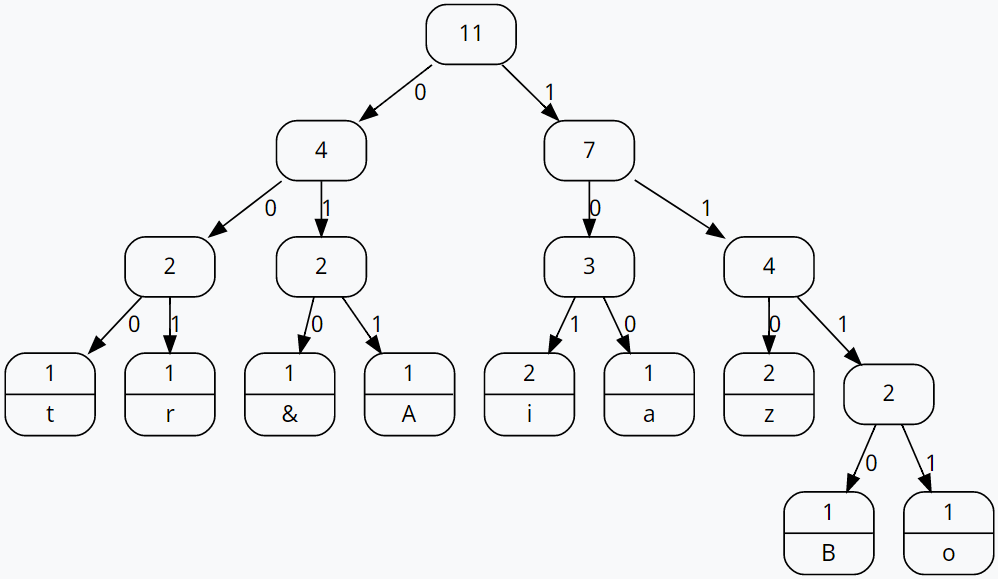


Table:

|  |  |  |  |
| --- | --- | --- | --- |
| **Character** | **Frequency** | **Code** | **Code length** |
| B | 1 | 1110 | 4 |
| o | 1 | 1111 | 4 |
| t | 1 | 000 | 3 |
| i | 2 | 101 | 3 |
| r | 1 | 001 | 3 |
| A | 1 | 011 | 3 |
| z | 2 | 110 | 3 |
| A | 1 | 100 | 3 |
| & | 1 | 010 | 3 |

Total number of bits of resulting encoded message using frequency of characters:

Freq(B)\*codeLength(B) + Freq(o)\*codeLength(o) + … Freq(&)\*codeLength(&) = 1\*4+1\*4+1\*3+…+1\*3+1.3 = 35

In order to find number of bits representing those characters, these should be calculated:

Sum of frequencies = 9

Total number of bits = 8 \* 9 = 72 bits

According to Huffman encoding, total number of bits is calculated as:

1\*4 (B) +1\*4 (o) + 2\*3 (z) + 1\*3 (a) + 2\*3 (i) + 1\*3 (A) + 1\*3 (&) + 1\*3 (r) + 1\*3 (t) = 35

Bits saved = 72 - 35 = 37

# Task 4

# Task 5

# Task 6

# Task 7

# Task 8

# Task 9

# Reference list