Exercise 1

[Same as in the previous sheet, but with a B+-Tree, instead of a B-Tree.] Calculate the optimal degree $i$ and the number of required levels (also known as the “height” of the tree) for a B+-Tree with the following properties:

- The B+-Tree should store all humans currently living on earth (assume an even 10 billion).
- For each human we store the name, country and a unique identifier (100 Byte per human). The unique identifier will be used as the key and requires 8 Byte to store.
- The degree $i$ of inner and leaf nodes may be different.
- Each node has to fit on a 16KB (16000 Byte) page.
- The page ids in the inner nodes require 8 Byte.
- This time (unlike in the lecture), we want to be precise: an inner node with $n$ tuples requires $n + 1$ page ids to identify its children (in the lecture we simplified this and assumed that a node with $n$ tuples has $n$ page ids).

Exercise 2

Please insert all tuples from the Students relation from the university schema into a hash table of size 5 (as in the figure). Each page can hold up to 2 tuples. As a means of handling collisions, linear chaining should be employed.

```
  p0  p1  p2  p3  p4
  ┌──┬──┬──┬──┬──┐
  │ X │ X │ X │ X │ X │
  └──┴──┴──┴──┴──┘
```

a) Use the following hash function: $\text{hash(key)} = \text{key mod 5}$.

b) Try using a better hash function: $\text{hash(key)} = \text{crc32(key)} \mod 5$ To calculate the CRC32 of a key, you can use a website on the internet, for example: [crc32calc.com?crc=24002&method=crc32&datatype=ascii&outtype=dec](https://crc32calc.com?crc=24002&method=crc32&datatype=ascii&outtype=dec)

Did the better hash function, result in a more evenly balanced hash table?