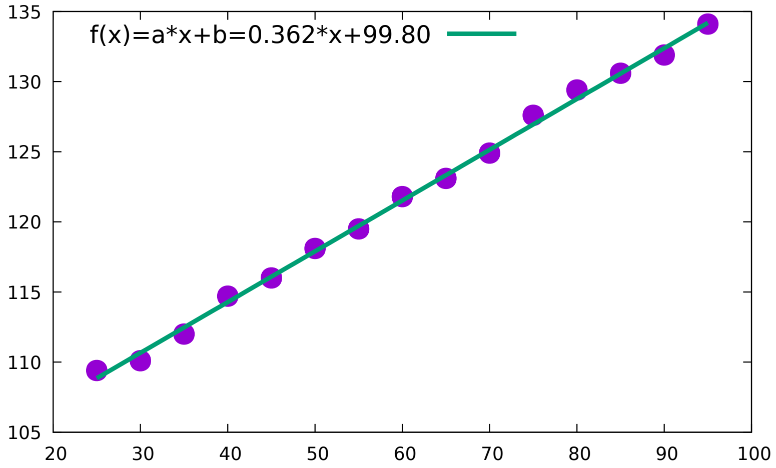
Laboratory 07 – Functions

23.11.2021

Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. A linear regression line has an equation of the form ***Y = a*X+b***, where ***X*** is the explanatory variable and ***Y*** is the dependent variable. The slope of the line is ***a*** and ***b*** is the intercept (the value of ***y*** when ***x*** = 0).



Write a C program that calculates the linear regression coefficients.
Write one C program in which all the following functions will be defined and called.

a) [2points] In the `main` function create two `15`-element arrays of `float`s.

In the first array `x`, the first element is equal to `25`, each subsequent element is 5 larger than the previous one. Write a loop to fill the array `x`.

In the second array `y` we have the following values: `{109.4, 110.1, 112.0, 114.7, 116.0, 118.1, 119.5, 121.8, 123.1, 124.9, 127.6, 129.4, 130.6, 131.9, 134.1}`.

Use the **#define** directive in the program.

Print the arrays in the following form:

```
Point 1 = (25.0, 109.4)
Point 2 = (30.0, 110.1)
Point 3 = (35.0, 112.0)
Point 4 = (40.0, 114.7)
Point 5 = (45.0, 116.0)
Point 6 = (50.0, 118.1)
Point 7 = (55.0, 119.5)
Point 8 = (60.0, 121.8)
Point 9 = (65.0, 123.1)
Point 10 = (70.0, 124.9)
Point 11 = (75.0, 127.6)
Point 12 = (80.0, 129.4)
```

```
Point 13 = (85.0, 130.6)
Point 14 = (90.0, 131.9)
Point 15 = (95.0, 134.1)
```

b)[4points] Write a function that will return the average value of the array passed.
In the main function:
- call the average function for the array `x`.
- call the average function for the array `y`.
Pass to the function: the array and its size.

The most common type of average is the arithmetic mean. If `n` numbers are given, each number denoted by `a[i]` (where `i = 1, 2, ..., n`), the arithmetic mean is the sum of the `a`s divided by `n or` $Avg\,a[\,]=\frac{\sum_{i=0}^{n} a[i]}{n}$.

Print the results.

```
average of x[] = 60.00
average of y[] = 121.55
```

c) [3points] Write a function that calculates `d` according to the formula $d=\sum_{i=0}^{n}(x[i]-avgX)*(x[i]-avgX)$, where `x[i]` are the elements of the array, `avgX` is the average value of the `x` array calculated in the previous step.

In the main function, call the function calculating `d` for the array `x`. Pass to the function: the array, its size, and the average value of the array calculated in the previous step.

Print the result on the screen.

```
d of x[] = 7000.00
```

d) [3points] Write a function that calculates `a` according to the formula $a=\frac{\sum_{i=0}^{n} y[i]*(x[i]-avgX)}{d}$, where `x[i]` and `y[i]` are the elements of the arrays, `avgX` is the average value of the `x` array calculated in the previous steps, and `d` is the value calculated in the previous step.

In the main function, call the function calculating `a`.
Print the result on the screen.

```
a = 0.362
```

e) [2points] Write a function that calculates `b` according to the formul**a** $b=avgY-a*avgX$, where `avgY` is the average value of the `y` array calculated in the previous steps, `avgX` is the average value of the `x` array calculated in the previous steps, `a` is the value calculated in the previous step.

In the main function, call the function calculating `b`.
Print the result on the screen.

```
b = 99.8
```

f) [3points] Write a function that calculates `DeltaY` according to the formula

$$DeltaY=\sqrt{\left(\frac{\sum_{i=0}^{n}\left(y[i]-(a*x[i]+b)\right)^2}{n-2}\right)}$$

, where `x[i]` and `y[i]` are the elements of the arrays, `a,b` are the value calculated in the previous steps, `n` is the size of the array.

In the main function, call the function calculating `DeltaY`.
Print the result on the screen.

```
DeltaY = 0.43
```

In the main function, calculate `DeltaA` and `DeltaB` according to the following formulas:

$$Delta\,A=\frac{Delta\,Y}{\sqrt{d}} \quad , \quad Delta\,B=Delta\,Y*\sqrt{\frac{1}{n}+\frac{avgX^2}{d}} \quad .$$

Print the result on the screen.

```
DeltaA = 0.005, DeltaB = 0.324
```

`DeltaA` and `DeltaB` determine the number of significant digits of `a` and `b`, respectively.

`a` has 3 significant digits and `b` has one significant digit.

```
a = 0.362
b = 99.8
```

Linear regression line has the equation `Y = 0.362 * X + 99.8`

g) [3points] Using the example from lecture 6, split the program into 3 files `(e.g. reg.c, main.c, reg.h)` and create a `makefile.`

```
Next time:
laboratory 08 – Recursive functions
```