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Übungen zur Vorlesung
Einführung in das Programmieren für TM

Serie 4

Aufgabe 4.1. Write a function `radian`, which, given the magnitude of an angle $\theta \in \mathbb{R}^+$ measured in degrees, computes the measure in radians. The computed value ψ must be in reduced form, i.e., $\psi \in [0, 2\pi)$. Save your source code as `radian.c` into the directory `serie04`.

Aufgabe 4.2. Write a function `rounding`, which, given $x \in \mathbb{R}^+$, computes the number $n \in \mathbb{N}$ which is closest to x. If x is exactly in the middle between two integers n and $n+1$, the function chooses the biggest one, i.e., $n+1$. Then, write a main program which reads the number x from the keyboard, calls the function and displays the rounded value. Save your source code as `rounding.c` into the directory `serie04`.

Aufgabe 4.3. Write a function `minabs` that, given two numbers $x, y \in \mathbb{R}$, returns the one whose absolute value is smaller. Then, write a main program, which reads x and y from the keyboard and calls the function. Save your source code as `minabs.c` into the directory `serie04`.

Aufgabe 4.4. Write a `void`-function `vectorproduct`, which, given two vectors $\mathbf{u} = (a, b, c)^T$ and $\mathbf{v} = (x, y, z)^T$, computes the vector product $\mathbf{w} = \mathbf{u} \times \mathbf{v}$ defined by

$$\begin{aligned} w_1 &= bz - cy \\ w_2 &= cx - az \\ w_3 &= ay - bx. \end{aligned}$$

Then, write a main program which reads the vectors $\mathbf{u}, \mathbf{v}$ from the keyboard, calls the function and displays the vector product. Save your source code as `vectorproduct.c` into the directory `serie04`.

Aufgabe 4.5. Write a recursive function `binomial` that computes the binomial coefficient $\binom{n}{k}$ for $k \le n$. Use the addition formula

$$\binom{n}{k} = \binom{n-1}{k} + \binom{n-1}{k-1} \quad \text{for } 1 \le k < n$$

with $\binom{n}{0} = 1 = \binom{n}{n}$ for $n \in \mathbb{N}_0$. Write a main program which reads in $k, n \in \mathbb{N}_0$ with $k \le n$ and computes $\binom{n}{k}$.

Aufgabe 4.6. For $x > 0$, the recursively defined sequence

$$x_1 := \frac{1}{2}(1 + x), \quad x_{n+1} := \frac{1}{2}\Big(x_n + \frac{x}{x_n}\Big) \quad \text{for } n \ge 1$$

converges towards $\sqrt{x}$. Write a recursive function `sqrt_` which computes for given $x > 0$ and $\tau > 0$ the *first* element x_n of the sequence that satisfies

$$\frac{|x_n - x_{n+1}|}{|x_n|} \le \tau \quad \text{or} \quad |x_n| \le \tau.$$

Moreover, write a main program which reads in x and τ, computes the approximation x_n of $\sqrt{x}$ and compares it to the exact value, i.e. prints out the absolute error $|x_n - \sqrt{x}|$.
Hint: You can use the function `sqrt` from the math library to compute the exact value $\sqrt{x}$. For the computation of the absolute value $|x|$ of a real number x, you can use the function `fabs` from the math library.

Aufgabe 4.7. Write a function `sum(n)` which, given $n \in \mathbb{N}$, computes the sum $\sum_{j=1}^{n}(j/2)$. To obtain the sum, do not use the expression $\frac{1}{2}\sum_{j=1}^{n} j$. What do you observe? Then, write a main program which reads n from the keyboard, calls the function and displays the result. Save your source code as `sum.c` into the directory `serie04`.

Aufgabe 4.8. Write a `void`-function `multiple(k,nmax)`, which computes and displays all the integer multiples of $k \in \mathbb{N}$ which are $\leq n_{\max} \in \mathbb{N}$. For instance, for $k = 5$ and $n_{\max} = 19$, the function yields the output

```
1 x 5 = 5
2 x 5 = 10
3 x 5 = 15.
```

Then, write a main program, which reads the values k and n from the keyboard and calls `multiple(k,nmax)`. Save your source code as `multiple.c` into the directory `serie04`.