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Sommersemester 2018
27.06.2018

Übungen zur Vorlesung
Computermathematik

Serie 12

Aufgabe 12.1. Which journal hides behind the abbreviation *Math. Mod. Meth. Appl. S.*? What is the complete title? What is the correct abbreviation? Write a bibliography which contains two articles of the last edition of this journal. Which journal has the abbreviation *Math. Comput.*? What is the complete title? What is the current abbreviation? Extend your bibliography with two articles of the current edition of this journal. Further extend it with an English book from Stefan Sauter as well as his dissertation. To find the dissertation, you can use the *Mathematics Genealogy Project*, see `http://www.genealogy.ams.org`.

Aufgabe 12.2. Plot in MATLAB the potential $f(x, y) = x \cdot \exp(-x^2 - y^2)$ as a graph in $\mathbb{R}^2 \times \mathbb{R}$ as well as colored projection onto the plane, where we consider $[-5, 5]^2 \subset \mathbb{R}^2$ as the domain. Add a horizontal `colorbar` under the plots. Export the plots as `eps`-files from MATLAB via `print` (cf. MATLAB-slide 106). Include the graphics in a LaTeX-document. To this end, use the `figure`-environment with legend, where the pictures should be (via `minipage`) displayed one beside the other.

Aufgabe 12.3. Write a sort algorithm of your choice in MATLAB (you must not use the command `sort`). Copy your code in a suitable LaTeX-environment. Compare your algorithm with the MATLAB-command `sort`. Therefore, generate 5 random vectors of length 10^j, $j = 4, \ldots, 8$, and consider the required computational times. Write your results in a LaTeX-tabular of the following form.

N	10^4	10^5	10^6	10^7	10^8
`sort`					
`mysort`					

Aufgabe 12.4. Use `\newtheorem`, to generate a new *theorem*-environment. Write as well a *proof*-environment. The proof should start (as part of the environment) with bold-italic ***Proof.*** The end of the proof (as part of the environment) should be indicated with a right-aligned `\blacksquare` $\blacksquare$, i.e., there is a right-aligned $\blacksquare$ at the end of the proof. Formulate and prove the following theorem in LaTeX. All appearing references should be realised via `\label` and `\ref` etc. Write a suitable macro for norms and $\mathrm{dist}(\cdot, \cdot)$.
Let $A, B \subset \mathbb{R}$ open intervals with compact closure $\overline{A}, \overline{B}$ and $A \cap B = \emptyset$. We define the boundary of the sets as $\partial A := \overline{A} \setminus A$ and $\partial B := \overline{B} \setminus B$ (the symbol ∂ is generated by `\partial`). Then, there holds for the distances of the two sets that $\mathrm{dist}(A, B) = \mathrm{dist}(\partial A, \partial B)$, where we define for arbitrary sets $C, D \subset \mathbb{R}$

$$\mathrm{dist}(C, D) := \inf\{\|x - y\|_2 : x \in C, y \in D\} \tag{1}$$

Hint. Show that $\mathrm{dist}(A, B) = \mathrm{dist}(\overline{A}, \overline{B})$. Next, note that the infimum in (1) is a minimum for compact sets C, D.
Remark. The theorem also holds for open subsets $A, B \subset \mathbb{R}^n$ with $n \in \mathbb{N}$.

Aufgabe 12.5. Write a MATLAB-function `pythagoras` which calculates for given $n \in \mathbb{N}$ and given file name `name` n different Pythagorean triples. The result should be written as a LaTeX table in the file `name.tex`. Further, write a LaTeX-document which includes such a table via `\input{name.tex}`.

Aufgabe 12.6. Select a scientific article of Winfried Auzinger, Dirk Praetorius and Joachim Schöberl resp. from `http://www.ams.org/mathscinet`. Add a book of Jens Markus Melenk. Save the bibliographic data in a BibTeX-file `article.bib`. You can take the entries via copy and paste from MathSciNet.

Aufgabe 12.7. Write short LaTeX-documents, in which you include `article.bib` from Aufgabe 12.6 and cite every entry of the bib-file. The documents should illustrate the differences between the styles `plain`, `unsrt`, and `alpha`.

Aufgabe 12.8. Write a LaTeX- file with the algorithm of the Gauss-elimination.

> **Input:** Matrix $A \in \mathbb{K}^{n\times n}$ with LU-decomposition, right-hand side $b \in \mathbb{K}^n$
>
> `for` $k = 1, \dots, n-1$
>   `for` $i = k+1, \dots, n$
> $\ell_{ik} = a_{ik}^{(k)}/a_{kk}^{(k)}$
> $b_i^{(k+1)} = b_i^{(k)} - \ell_{ik} b_k^{(k)}$
>   `for` $j = k+1, \dots, n$
> $a_{ij}^{(k+1)} = a_{ij}^{(k)} - \ell_{ik} a_{kj}^{(k)}$
>   `end`
>   `end`
> `end`
>
> **Output:** non-trivial entries of the matrices $L, U \in \mathbb{K}^{n\times n}$ with $u_{ij} := a_{ij}^{(i)}$
> as well as the modified right-hand side $y \in \mathbb{K}^n$ with $y_i := b_i^{(i)}$.

Write a C-fuction `void gauss(double** A, double* b, int n)` which realizes this procedure and which overwrites A and b appropriately. Include your C-code with the help of the `listing`-package in the same document.