Universität Duisburg-Essen
Computational Mechanics
Campus Essen

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# Introduction to Numerical Methods
# Tutorial 14

**All computations should be carried out using rational numbers or decimal numbers with 3 digits.**

**Exercise 1:**
Let

$$A := \begin{pmatrix} 2 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \in \mathbb{R}^{4\times 4}$$

be a given matrix.

**(i)** Compute manually the eigenvalues of $A$.

**(ii)** Compute the eigenvectors for the maximum and the minimum eigenvalue. Normalize the vectors using the $\infty$-, 1-, and 2-norm, i.e., for $\|\cdot\|_\infty$, $\|\cdot\|_1$, and $\|\cdot\|_2$.

**Exercise 2:**
Let $A$ as in Exercise 1 be given and let $q^{(0)} = (0,0,1,0)^T \in \mathbb{R}^4$ be the given initial vector

**(i)** Compute 4 steps of the power iteration using $\|\cdot\|_\infty$ and $\|\cdot\|_1$ for the normalization.

**(ii)** Compute 3 steps of the inverse iteration to determine the smallest eigenvalue using $\|\cdot\|_\infty$ and $\|\cdot\|_1$ for the normalization.

**(iii)** What do you discover when you consider $\nu^{(k)}$?

**(*)-Exercise 3:** ( 8 + 6 + 1 = 15 points)
Let $A$ as in Exercise 1 be given and let $q^{(0)} = (0,0,1,0)^T \in \mathbb{R}^4$ be the given initial vector

**(i)** Compute 4 steps of the power iteration using $\|\cdot\|_2$ for the normalization.

**(ii)** Compute 3 steps of the inverse iteration to determine the smallest eigenvalue using $\|\cdot\|_2$ for the normalization.

**(iii)** What is different to Exercise 2?

**Programming Exercise 5:** (delivery date: 7.02.2011, 8 points)
Program the power iteration for the example discussed in Exercise 3. Use the Euclidean-norm. Stop if the iterates for $q$ or $\nu$ do not differ more than $10^{-7}$, i.e., $\|q^{(k)} - q^{(k-1)}\|_2 < 10^{-7}$ or $\|\nu^{(k)} - \nu^{(k-1)}\|_2 < 10^{-7}$.

**Delivery: 3. February 2011**
The corrected exercises and programming exercises will be handed back after the written exam on the 14th of february.

I wish you all the best for your coming exams.
Have a nice semester break.