Lifelong Learning Programme

WITH THE SUPPORT OF THE LIFELONG LEARNING PROGRAMME OF THE EUROPEAN UNION

BRIDGING MATH-GAPS WITH THE LEARNING ENVIRONMENT MUMIE

F. Daalderop, J. Daudt, M. Grudzinski, M. Hanke, N. Kurt,
A. Rassila, R. Seiler, H. Tiitu

What is MUMIE?

Lifelong Learning Programme

- E-learning platform for math-learning & teaching
- combines theory, demos, visualisations, assignments & feedback in one package
- open but not public source ware for institutes of higher education
- MUMIE courses can be offered to students as
  - regular courses (e.g. blended learning, self-study)
  - bridge courses in preparation to a bachelor or master programme
- MUMIE very appropriate for explorative learning

Experience at the TU Delft

Lifelong Learning Programme

- Pilot in 2009: first year course Linear Algebra for students Aero space engineering
- Relevant topics of German course were translated and adapted
- course was offered parallel to regular lectures
- In 2012 an EU LLP proposal was submitted and rewarded to develop bridging courses in the MUMIE environment

value and necessity of bridging courses

Lifelong Learning Programme

- Student mobility for incoming master students from other engineering schools, become more and more important.
- More (international) students with various backgrounds enter master programmes and need bridging courses to (re)master and refresh the necessary knowledge to take advanced master courses.
- Bridging courses are meant to narrow the gap between the knowledge and understanding from students and the demands in the advanced STEM-master courses.
- Using an inclusive e-learning environment makes the bridging course flexible and open to adjustments and extension.
- Teachers can check whether the prerequisite knowledge is present .

Partners in the S3M2 project

(**support successful student mobility with MUMIE**)

Lifelong Learning Programme

For incoming master students

- TU Delft Numerical Analysis
- TU Berlin Probability and Statistics
- KTH Sweden Matlab/Octave intro course (scientific computing)

For incoming bachelor Engineering students

- Aalto Finland bridge material Math

- ILC Berlin: company for support

Partners in the OMB+ project
(**online mathematics bridge course**)

For incoming bachelor students in Germany :
(start: Nov. 3 2014 in German, English version in spring)

- 20+ German Universities under the lead of
- RWTH Aachen and
- Technische Universität Braunschweig

- integral-learning GmbH Berlin: company for support

main activities in S3M2

Lifelong Learning Programme

For every course:
- defining subjects and review
- filling the platform with: theory, visualizations and problems

After one year:
- pilot and evaluation with small group of students

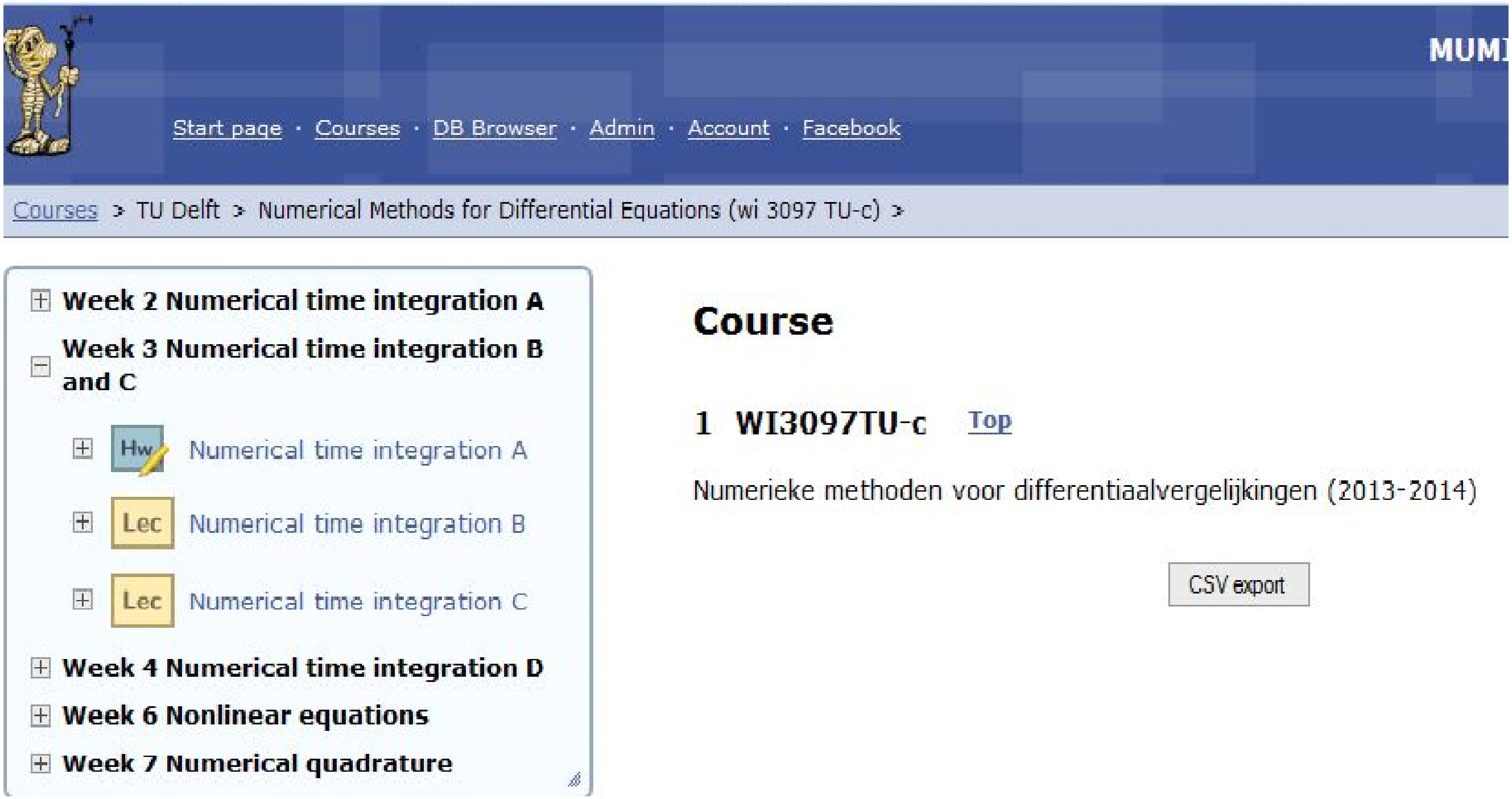
Second year:
- extension of subjects etc.
- development diagnostic test
- pilot and evaluation with larger group

Pilot at the Civil Engineering department

Lifelong Learning Programme

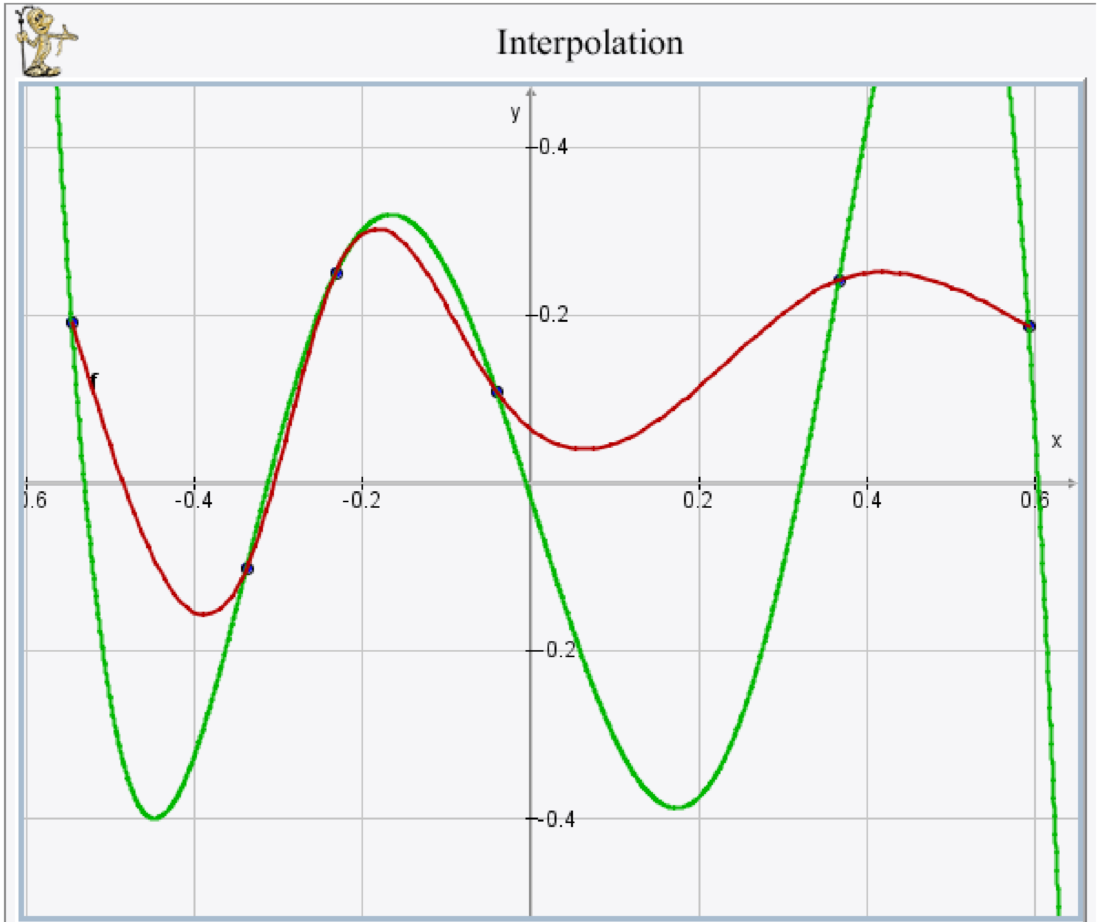
- theory non-linear equations & numerical integration
- two exercises for bisection,
- two exercises for fixed point methods
- one exercise for integral approximation.

Some examples in MUMIE



Example 2

To add a point left click while holding the 'c' key.



Two points are atleast required to perform the interpolation function(s).

☑ Lagrange interpolation ☑ Spline interpolation

Example 3

Initial Value Problem

Consider the numerical method:

$$\begin{cases} k_1 = hf(t_n, w_n) \\ k_2 = hf(t_n + \frac{1}{2}h, w_n + \frac{1}{2}k_1) \\ w_{n+1} = w_n + k_2 \end{cases}$$

a) Is this method implicit or explicit?

- ○ Implicit
- ○ Explicit

b) Determine the amplification factor.

$Q(\lambda h) =$ [?] + [?] $h\lambda +$ [?] $(h\lambda)^2$

c) Consider the differential equation

$y' = -y + \cos(t)$.

Determine the maximum step size.

$h \leq$ [?]

Save

Demo | Training | Problem

Help | Reset

Correction | New data | View data

Results on grades

Lifelong Learning Programme

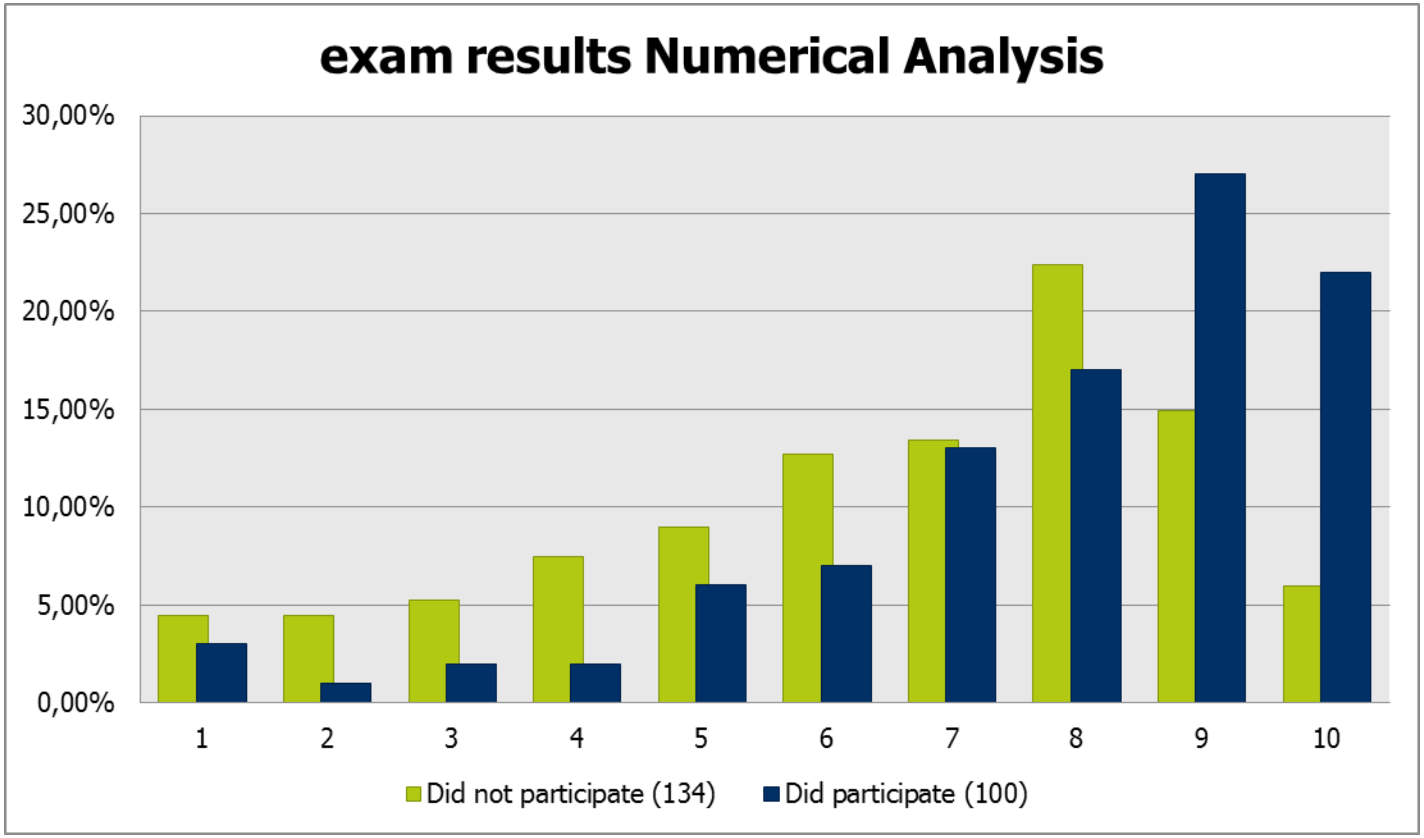


table results on grades 2

Lifelong Learning Programme

	No MUMIE	Excl. Bonus	Incl. bonus
Percentage passed	67%	86%	90%
Average exam grade	6.25	7.58	8.02

Highlights student survey (n=100) Civil Engineering students

Lifelong Learning Programme

results	N=100
Home work assignments were too easy in MUMIE	70%
applets in MUMIE helped them understand the course material and motivated them to learn the course	70%
I recommend other students to use MUMIE for the Numerical Analysis course	68%
Problems with JAVA	15%

Conclusions student results

Lifelong Learning Programme

- MUMIE benefits the student in getting a higher grade for the exam.
- Students participating in MUMIE are stimulated to frequently spend time studying the material and not wait until last moment.
- Students using MUMIE might have gained extra insight in the mathematical concept from using the interactive visualizations in MUMIE.
- Students who participate in MUMIE are willing to put extra effort in the course in order to pass the exam.

Conclusions developers/teachers

Lifelong Learning Programme

- Use of LaTex files in MUMIE
- Open/not public software; support has to be paid
- Advantage to have money from LLP to experiment and test this e-learning environment
- To develop visualisations in JAVA is not easy (generic frame work makes visualizations accessible to non programmers)
- Summer course for students to make visualisations very useful
- Especially for bridging courses MUMIE is an interesting e-learning platform where incoming (master) students can refresh and master missing theory and practice

Lifelong Learning Programme

Pilot Scientific Computing with Matlab/Octave

how to

– simulate problems and
– solve numerical problems with Matlab/Octave

– octave is integrated into MUMIE
– homework problems : Matlab code is automatically corrected

Pilot Scientific Computing

w

Octave output

Your aswer is wrong.

Your answer:

```
function out = count_char(a, txt)
  out == sum(a == txt);
end
```

Sample solution:

```
function out = count_char(a, txt)
  out = sum(a == txt);
end
```

Octave output

```
error: `out' undefined near line 2 column 3
error: called from:
error:   /srv/webapps/s3m2/WEB-INF/correction/1410714682316-5/count_char.m at line 2, column 7
```

Explanation:

Your code caused a runtime error

Lifelong Learning Programme

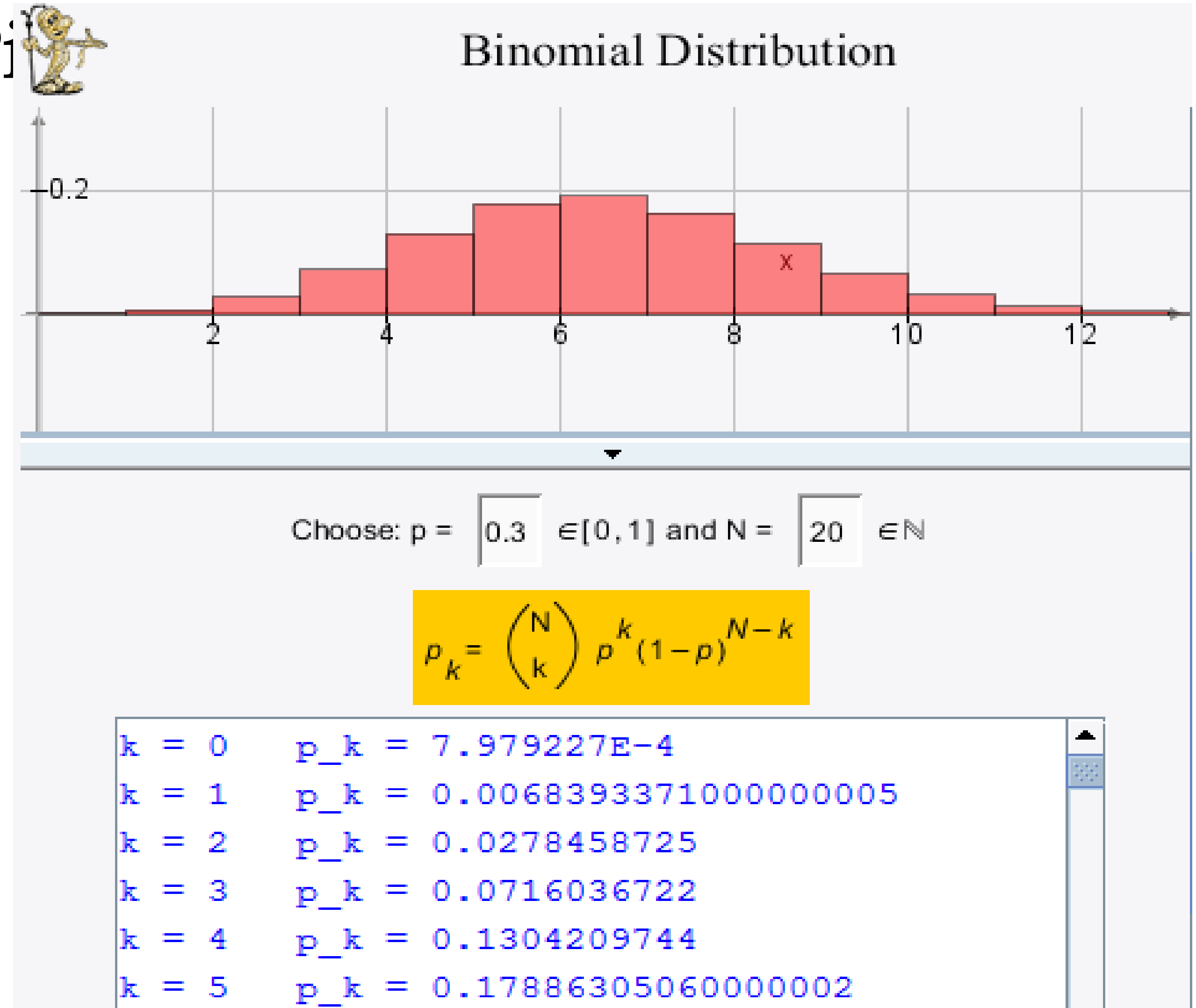
Pilot Statistics and Probability

– 9 lectures about the fundamentals of statistics and probability

– many exercises with full solutions (incremental visibility)

– interactive visualizations

Pi


Binomial Distribution
0.2
2
4
6
8
10
12
Choose: p = 0.3 ∈[0,1] and N = 20 ∈ℕ
$p_k = \binom{N}{k} p^k (1-p)^{N-k}$
k = 0 p_k = 7.979227E-4
k = 1 p_k = 0.006839337100000005
k = 2 p_k = 0.0278458725
k = 3 p_k = 0.0716036722
k = 4 p_k = 0.1304209744
k = 5 p_k = 0.1788630506000002

OMB+

(**online mathematics bridge course**)

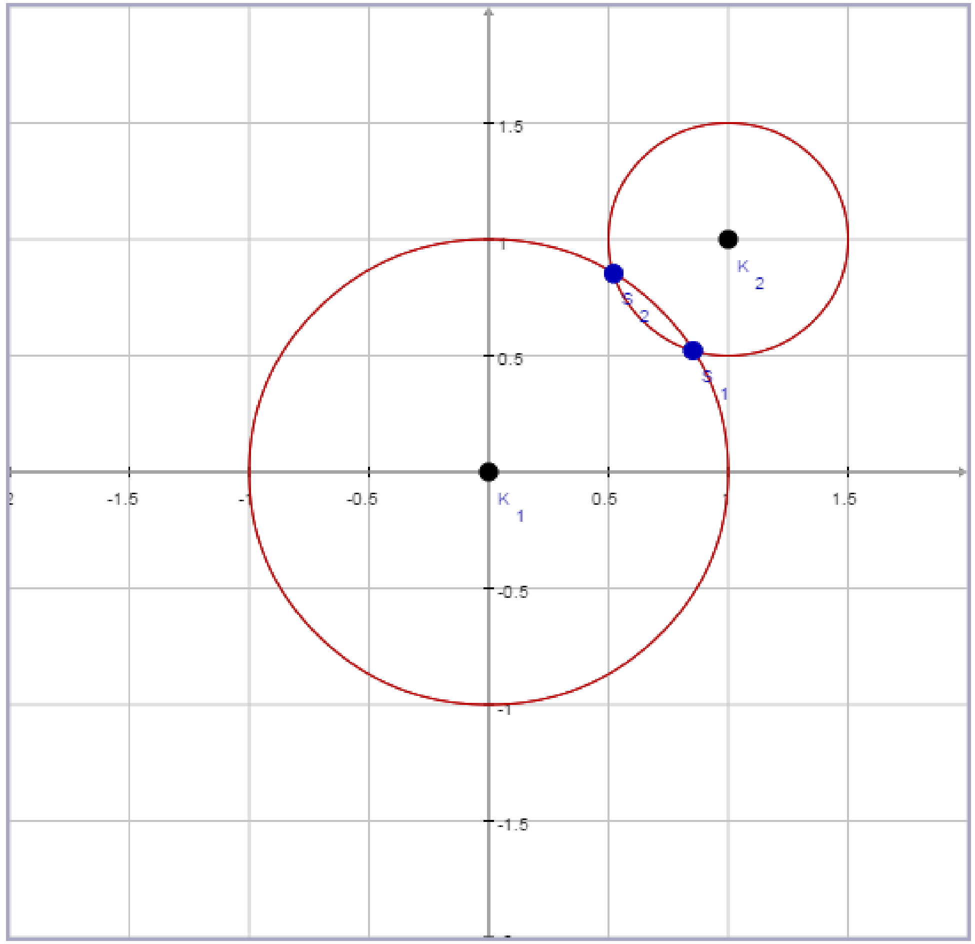
- For incoming bachelor students in Germany

- syllabus follows Cosh standard (widely accepted in Germany)
  - numbers & fractions
  - linear and quadratic equations
  - elementary functions
  - differential and integral calculus

- pedagogical concept follows to a large extent the highly successful Swedish online mathematical bridge course by a group of Swedish universities under the lead of KTH.
  - virtual tutorium
  - call center

Example for an interactive visualization with adaptive explanation

2 Circles intersect in 2 points



Betrachten Sie den Kreis K_1 mit Mittelpunkt (0,0) und Radius $r_1 = \boxed{1} > 0$

$$K_1 := \left\{(x,y)\in\mathbb{R}^2 \,\middle|\, x^2 + y^2 = (\ 1\ )^2\right\}$$

und einen zweiten Kreis K_2 mit Mittelpunkt ($\boxed{1}$, $\boxed{1}$) und Radius $r_2 = \boxed{\tfrac{1}{2}} > 0$

$$K_2 := \left\{(x,y)\in\mathbb{R}^2 \,\middle|\, (x-(\ 1\ ))^2 + (y-(\ 1\ ))^2 = (\ \tfrac{1}{2}\ )^2\right\}.$$

Bestimmen Sie ihre Schnittpunkte (falls es solche gibt).

Eine Möglichkeit besteht darin, $x^2 + y^2 = (\ 1\ )^2$ von

$$(x-(1))^2 + ((\text{-}1)+y)^2 = (\ \tfrac{1}{2}\ )^2$$

zu subtrahieren. Sie erhalten dann

$$(x-(1))^2 + ((\text{-}1)+y)^2 - x^2 - y^2 = (\ \tfrac{1}{2}\ )^2 - (\ 1\ )^2$$

und durch Ausmultiplizieren sowie Vereinfachen die lineare Gleichung

$$(1*x)+(1*y)= \frac{11}{8}\ .$$

Auflösen nach x ergibt

$$x = \frac{\left((\text{-}1*y)+\left(\frac{11}{8}\right)\right)}{1} = \left(\text{-}1*y\right) + \frac{11}{8}.$$

Einsetzen von x in $x^2 + y^2 = (\ 1\ )^2$ führt zu der quadratischen Gleichung

$$\left(\left(\text{-}1*y\right)+\left(\frac{11}{8}\right)\right)^2 + y^2 = (\ 1\ )^2.$$

Sie hat die beiden Lösungen

$$y_1 = 0.52$$
$$y_2 = 0.85\ .$$

Somit erhalten Sie durch Einsetzen von y_1 bzw y_2 in $(1*x)+(1*y)= \frac{11}{8}$

$$x_1 = 0.85$$
$$x_2 = 0.52\ .$$

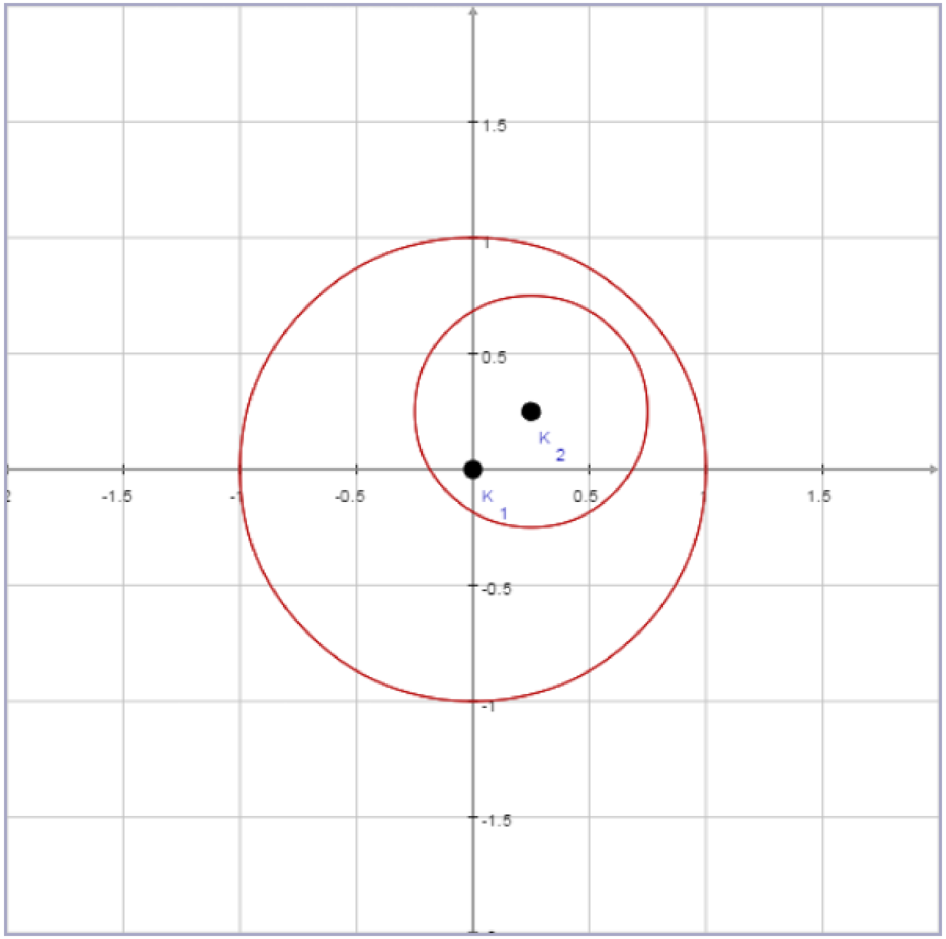
Daraus ergeben sich die beiden Schnittpunkte

$$S_1 = <\ 0.85\ ,\ 0.52\ >\quad \text{und}\quad S_2 = <\ 0.52\ ,\ 0.85\ >\ .$$

(Lösungen mit mehr als zwei Nachkommastellen werden auf zwei Stellen gerundet.)

Example of interactive visualization with adaptive explanation

2 Circles do not intersect



Betrachten Sie den Kreis K_1 mit Mittelpunkt (0,0) und Radius $r_1 = \boxed{1} > 0$

$$K_1 := \left\{(x,y)\in\mathbb{R}^2 \,\middle|\, x^2+y^2 = (\ 1\ )^2\right\}$$

und einen zweiten Kreis K_2 mit Mittelpunkt ($\boxed{\frac{1}{4}}$, $\boxed{\frac{1}{4}}$) und Radius $r_2 = \boxed{\frac{1}{2}} > 0$

$$K_2 := \left\{(x,y)\in\mathbb{R}^2 \,\middle|\, (x-(\ \tfrac{1}{4}\ ))^2 + (y-(\ \tfrac{1}{4}\ ))^2 = (\ \tfrac{1}{2}\ )^2\right\}.$$

Bestimmen Sie ihre Schnittpunkte (falls es solche gibt).

Eine Möglichkeit besteht darin, $x^2 + y^2 = (\ 1\ )^2$ von

$$(x - \left(\tfrac{1}{4}\right))^2 + (\left(\tfrac{-1}{4}\right) + y)^2 = (\ \tfrac{1}{2}\ )^2$$

zu subtrahieren. Sie erhalten dann

$$(x - \left(\tfrac{1}{4}\right))^2 + ((-14)+y)^2 - x^2 - y^2 = (\ \tfrac{1}{2}\ )^2 - (\ 1\ )^2$$

und durch Ausmultiplizieren sowie Vereinfachen die lineare Gleichung

$$(14*x)+(14*y)= \tfrac{7}{16}\ .$$

Auflösen nach x ergibt

$$x = \frac{\left(\left(\frac{-1*y}{4}\right)+\left(\frac{7}{16}\right)\right)}{\frac{1}{4}} = \left(-1*y\right) + \frac{7}{4}$$

Einsetzen von x in $x^2 + y^2 = (\ 1\ )^2$ führt auf die quadratische Gleichung

$$\left(\left(-1*y\right) + \left(\tfrac{7}{4}\right)\right)^2 + y^2 = (\ 1\ )^2.$$

Diese Gleichung hat keine reelle Lösung, d.h. es gibt keine Schnittspunkte.

Geometrisch: der Abstand der Mittelpunkte ist kleiner als der Unterschied der Radien:

$$\text{Abstand}\ \sqrt{\left(\tfrac{1}{4}\right)^2 + \left(\tfrac{1}{4}\right)^2} < |\ 1\ -\ \tfrac{1}{2}\ |.$$

Wish to try the bridging courses?

Lifelong Learning Programme

WITH THE SUPPORT OF THE LIFELONG LEARNING PROGRAMME OF THE EUROPEAN UNION

Interested in S3M2 courses? Go to:
http://www.s3m2.eu/

Interested in OMB+ ? Go to:
http://www.ombplus.de (starting Nov. 3 2014)

Really interested contact:
http://www.integral-learning.de/ to discuss the possibilities

THANK YOU!