Is my teaching innovative ... or just a good craftmanship?

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Institute for Analysis and Scientific Computing

Vienna University of Technology, Austria

DIAM, Gdańsk, 24th of June 2024

Charles Church and TU Wien

Content

Tell me, and I'll forget it.
Show me, and I'll remember.
Let me do it, and I'll keep it.

Konfuzius

Content

- University teaching: a challenge!
- University teacher / student – a changing relationship:
  - Lecture/Tutorial: Linear Algebra f. TPH
  - Tutorial: Computernumerics f. TPH
- Summary

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General framework

School/University: What is different?

- Fundamental assumption:

  Voluntary participation and interest in the subject.

- Teaching is not the only task of the university teachers.

- Large number of students in the class.

  Consequences for the students:

- Freedom, not known in the school.

- Great independence required (information).

- Communication is more difficult, psychological barrier.

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Teaching: A challenge!

Consequences for the university teachers:

Is teaching important to me?

Do I have enough time?

- Arouse interest and enthusiasm. Motivation.
- Convey the feeling that students are important to you.
- Facilitate understanding: apply the theory, use the tools that reinforce the insights, visualize wherever possible.
- Enable the smooth running of the course. Provide complete information in time.
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Lecture/Tutorial: Linear Algebra f. TPH

‘Matrix’ is all you need!

Lecture/Tutorial: Linear Algebra f. TPH (2)

Linear Algebra f. TPH

- Introductory mathematical course in the curriculum for TPH, 1. term, for approx. 300 persons.
- Topics: Basic concepts (vector spaces, linear independence, basis, dimension), linear systems of equations (matrix as linear operator acting between vector spaces), Euclidean spaces, eigenvalue problems, ordinary differential equations.
- Length: 2 hours per week.
- Large lecture hall, touchscreen laptop, projecting the printed lecture notes and a document with notes written during the lecture (uploaded).
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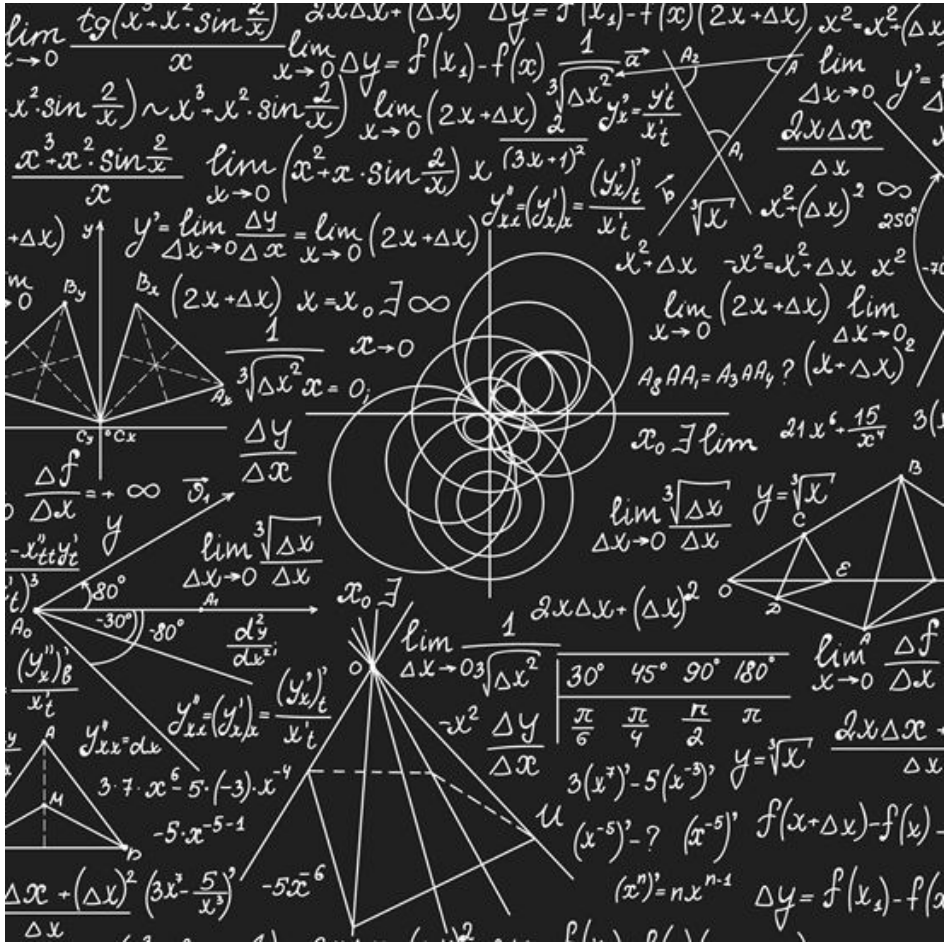
There is no science that has not developed from the knowledge of phenomena, but in order to benefit from this knowledge, one has to be a mathematician.

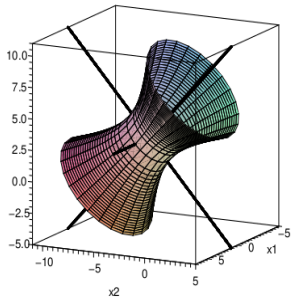
Daniel Bernoulli



Lecture notes

LINEARE ALGEBRA für TPH

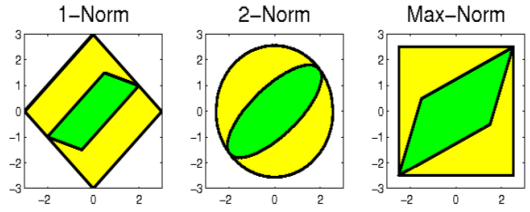
Winfried Auzinger
Gabriela Schranz-Kirlinger
Peter Szmolyan
Ewa Weinmüller



Wien, 2020

ÜBUNGSSKRIPTUM zur
LINEAREN ALGEBRA für TPH

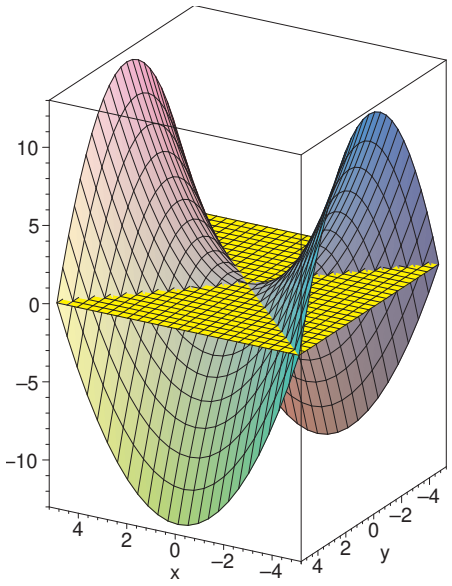
Gabriela Schranz-Kirlinger Peter Szmolyan Ewa Weinmüller

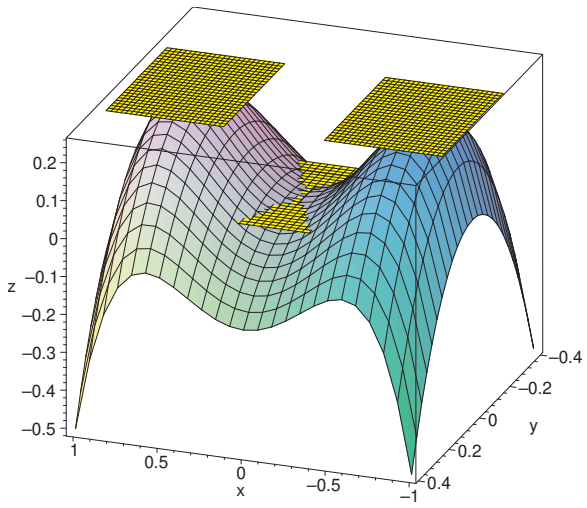


Wien 2019

During the course

- Graphical illustration whenever possible.





- Relate mathematical notions to their physical applications.
  Work $\Leftrightarrow$ line integral of a vector field.
- Touchscreen laptop, projecting the printed lecture notes and a document with notes written during the lecture (uploaded).
- Illustration videos on YouTube:3Blue1Brown Essence of linear algebra
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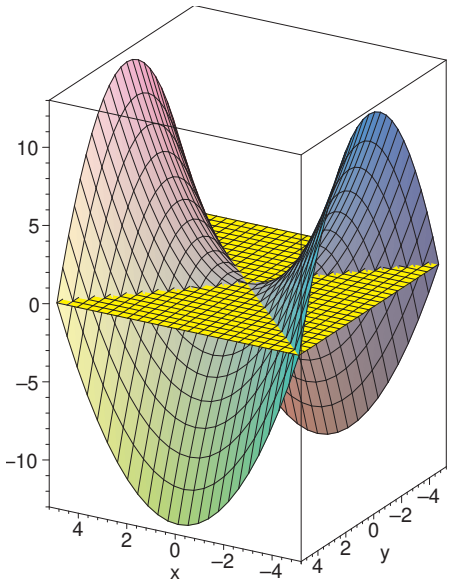

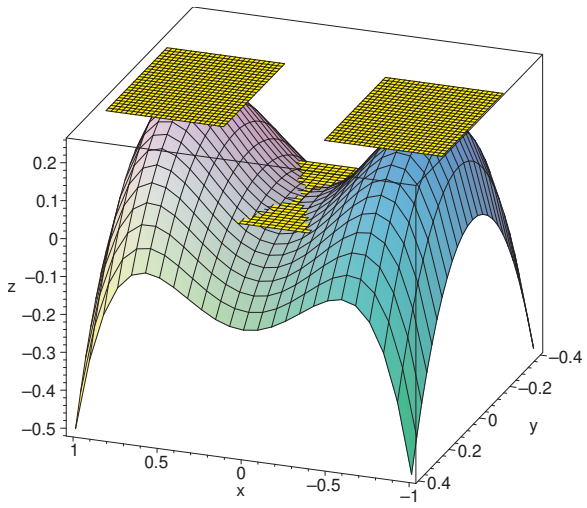

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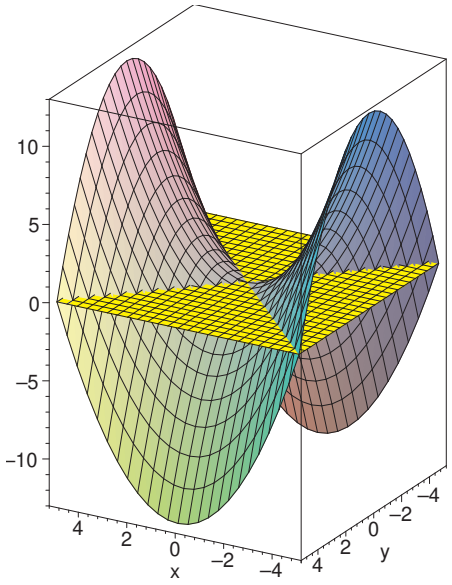

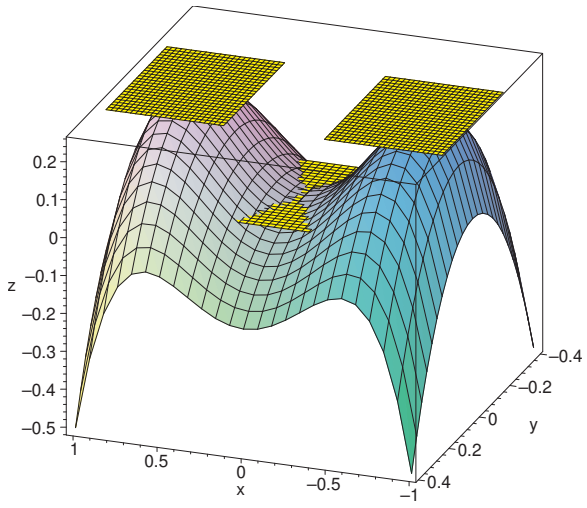

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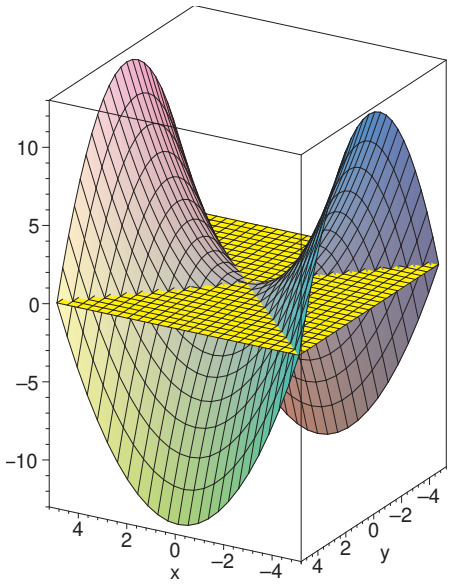

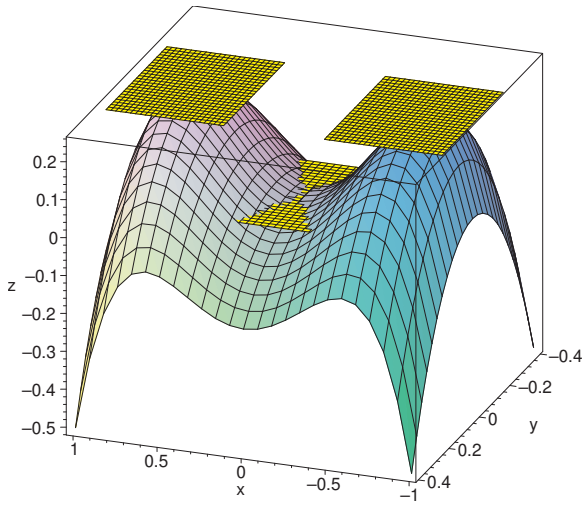

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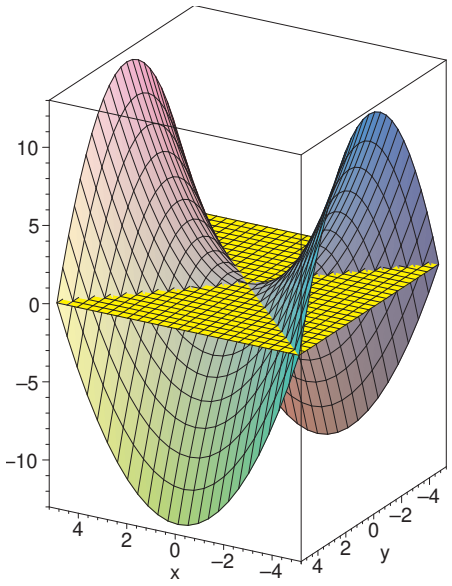

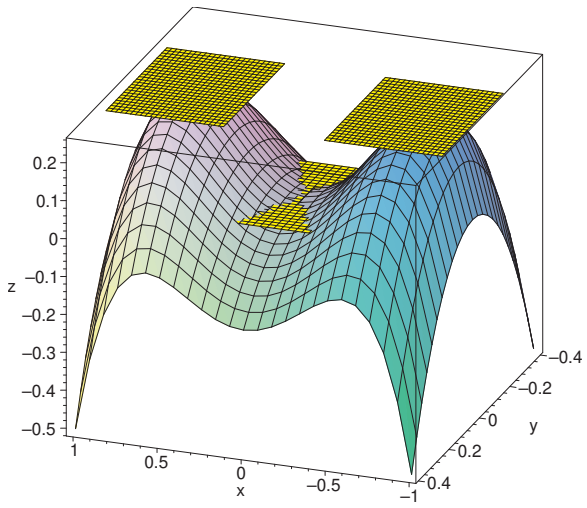

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- TUWEL TU Wien `https://tuwel.tuwien.ac.at/course/view.php?id=58907`
- Open Books Exam/Tests `https://tuwel.tuwien.ac.at/course/view.php?id=59234`

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Closing lecture

Part 1: Highlights: Principles, concepts, results, solution methods... trying to give a weighting.

Part 2: My research area: Numerical Analysis, Scientific Computing ... steam generator.

Part 3: Still something missing?

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- Approximation for $\pi = 3.141592....$
- Archimedes: Consider a unit circle, its circumference is $C_{\text{circle}} = 2\pi$. Consider the inscribed and the sircumscribed hexagon:

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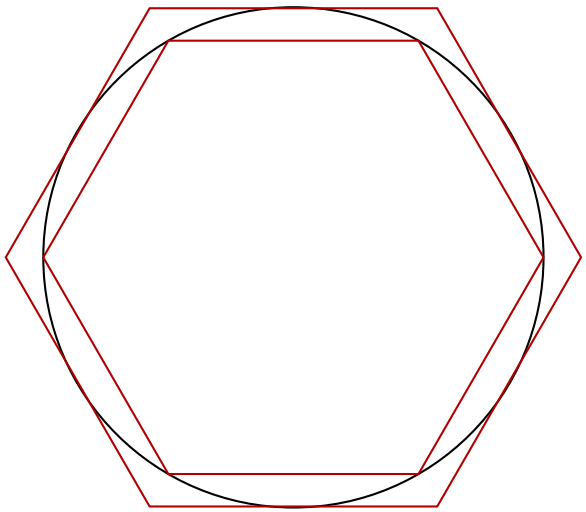

$$c_k < C_{\text{circle}} < C_k$$

$$\frac{c_k}{2} < \pi = \frac{C_{\text{circle}}}{2} < \frac{C_k}{2}$$

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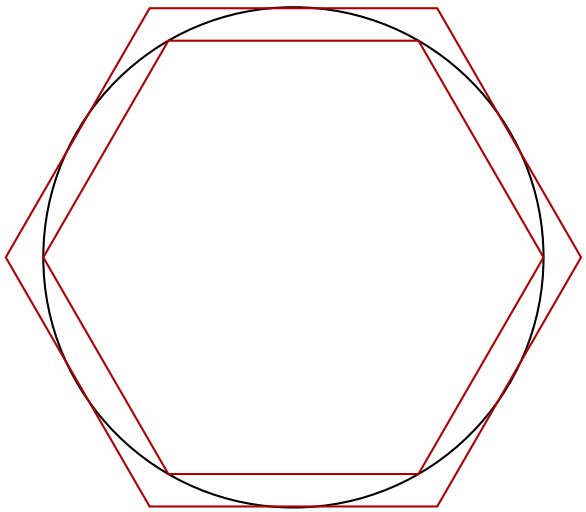

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$$3\frac{10}{71} < \pi < 3\frac{1}{7} \quad \Rightarrow \quad \pi \approx 3.141831107$$

Closing lecture: Part 3

$$u_1 := 2, \quad u_{k+1} := 2^{k+1} \sqrt{2\left(1 - \sqrt{1 - (2^{-k}\, u_k)^2}\right)}, \qquad k = 1, 2, \ldots$$

```
 2    2.828427124746190
 4    3.1 21445152258053
 6    3.14 0331156954739
 8    3.1415 13801144146
10    3.1415 87725279961
12    3.141592 345611077
14    3.1415926 33463248
16    3.1415926 45321215
18    3.141592 910939673
20    3.14159 6553704820
22    3.141 674265021758
24    3.14 2451272494134
26    3.1 6227760168380
30     0.000000000000000 !!!
```

Closing lecture: Part 3

$$u_1 := 2, \quad u_{k+1} := u_k \sqrt{\frac{2}{1+\sqrt{1-(2^{-k}\,u_k)^2}}}, \qquad k = 1, 2, \ldots$$

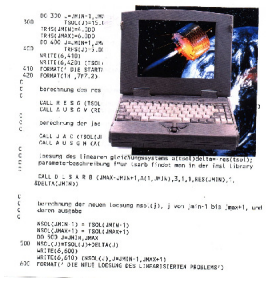
```
 2   2.828427124746190
 4   3.1 21445152258053
 6   3.14 0331156954753
 8   3.141 513801144301
10   3.1415 87725277160
12   3.14159 2345570118
14   3.1415926 34338563
16   3.14159265 2386591
18   3.1415926535 14593
20   3.14159265358 5094
22   3.141592653589 501
24   3.1415926535897 76
26   3.14159265358979 4
28   3.14159265358979 5
30   3.14159265358979 5
```

Computernumerics

```
      DO 300 J=JMIN-1,JM
  300         TSOL(J)=15.
      TRHS(JMIN)=4.0D0
      TRHS(JMAX)=6.0D0
      DO 400 J=JMIN+1,JM
  400         TRHS(J)=5.0
      WRITE(6,410)
      WRITE(6,420) (TSOL
  410 FORMAT(' DIE STARTI
  420 FORMAT(1H ,7F7.2)
C
C     berechnung des res
C
      CALL R E S G (TSOL
      CALL A U S G V (RE
C
C     berechnung der jac
C
      CALL J A C (TSOL(JI
      CALL A U S G M (A(
C
C     loesung des linearen gleichungssystems a(tsol)delta=-res(tsol);
C     parameterbeschreibung f"ur lsarb findet man in der imsl library
C
      CALL D L S A R B (JMAX-JMIN+1,A(1,JMIN),3,1,1,RES(JMIN),1,
     &DELTA(JMIN))

C
C     berechnung der neuen loesung nsol(j), j von jmin-1 bis jmax+1, und
C     deren ausgabe
C
      NSOL(JMIN-1) = TSOL(JMIN-1)
      NSOL(JMAX+1) = TSOL(JMAX+1)
      DO 500 J=JMIN,JMAX
  500 NSOL(J)=TSOL(J)+DELTA(J)
      WRITE(6,600)
      WRITE(6,610) (NSOL(J),J=JMIN-1,JMAX+1)
  600 FORMAT(' DIE NEUE LOESUNG DES LINEARISIERTEN PROBLEMS')
```

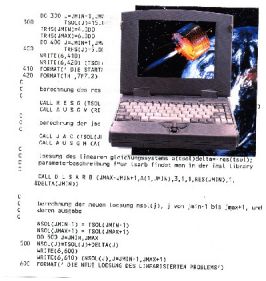
Tutorial for Computernumerics



Tutorial for Computernumerics

- 4th term, 72 participants
- 2 projects pro term, one topic for a small group of 6, three subtopics for 3 pairs $\Rightarrow$ 36 pairs
- one meeting per week, 30-45 minutes per group $\Rightarrow$ 6 to 9 hours per week
- written documentation in Latex

Tutorial for Computernumerics



Tutorial for Computernumerics

- 4th term, 72 participants
- 2 projects pro term, one topic for a small group of 6, three subtopics for 3 pairs $\Rightarrow$ 36 pairs
- one meeting per week, 30-45 minutes per group $\Rightarrow$ 6 to 9 hours per week
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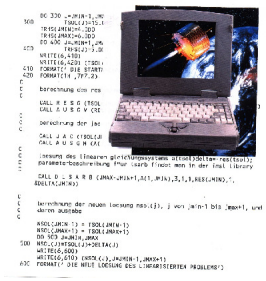

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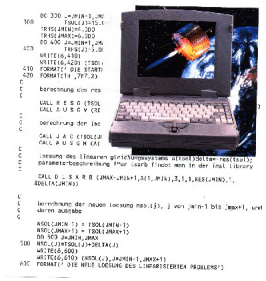

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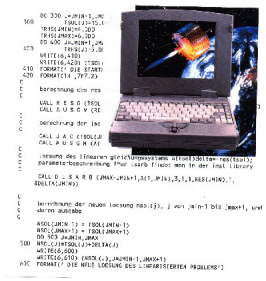

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BEST DISTANCE LEARNING
An der TU Wien wird die Lehrveranstaltung
103.058 VU Praktische Mathematik II für TPH
unter Mitwirkung von
Ao.Univ.-Prof^in.i.R. Dipl.-Ing^in. Dr^in.techn.
Ewa Weinmüller
mit dem Best Distance Learning Award 2020 ausgezeichnet.
2020
Best Distance Learning
VU Praktische Mathematik II für TPH
BEST TEACHER
An der Fakultät für Mathematik und Geoinformation wird
Ao.Univ.-Prof.i.R. Univ.Doz.
Ewa Weinmüller
mit dem Best Teacher Award 2017 ausgezeichnet.
2017
Best Teacher
Ewa Weinmüller
BEST TEACHER
FINALIST
FINALIST
EWA
WEINMÜLLER