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Automatic assessment and international collaboration in mathematics education

Conference Excellence in Teaching Higher Education Mathematics

Oslo, Norway, 9. – 10.10.2017

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Aalto University

E-Assessment Material Bank Abacus (initial consortium)

Aalto-yliopisto
Aalto-universitetet
Aalto University

LUT
Lappeenranta
University of Technology

OULUN YLIOPISTO
UNIVERSITY of OULU

Åbo Akademi

TAMPERE
UNIVERSITY OF
TECHNOLOGY

Turun yliopisto
University of Turku

Vaasan yliopisto
UNIVERSITY OF VAASA

Other partners (we are looking for more):

RUHR
UNIVERSITÄT
BOCHUM

RUB

VAMK
VAASAN AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES

HELSINGIN YLIOPISTO
HELSINGFORS UNIVERSITET
UNIVERSITY OF HELSINKI

THE UNIVERSITY of EDINBURGH

Metropolia

LAMK
Lahden ammattikorkeakoulu
Lahti University of Applied Sciences

HAMK
HÄMEEN AMMATTIKORKEAKOULU
UNIVERSITY OF APPLIED SCIENCES

UNIVERSITY OF JYVÄSKYLÄ

UNIVERSITY OF
EASTERN FINLAND

TAMK TAMPEREEN AMMATTIKORKEAKOULU

TALLINNA TEHNIKAÜLIKOOL
TALLINN UNIVERSITY OF TECHNOLOGY

IPL
instituto politécnico
de leiria

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STACK ASSIGNMENTS

- Open source software
- Based on Maxima computer algebra system (CAS)
- Developed originally at University of Birmingham by Chris Sangwin
- Allows symbolic manipulation of mathematical content
- Well suited for teaching advanced mathematical topics
- Multipart assignments
- Visualizations

A?

PROJECT AIMS

- Developing a set of standard, ready to use STACK-based problem assignments (initially) for bachelor level mathematics and physics.
- Materials are designed by experts, fully tested and maintained. Teacher does not need to become a software developer.
- Users (teachers and institutions) have full control of the content and underlying software platform. They are allowed to make changes (including translations), and they are not tied to a single supplier.
- Extensive national and international collaboration to further reduce cost and speed up development. Note that the main cost is in programming – doing translations is easy.
- Fostering collaboration between higher education institutions (already a great success in Finland). Note that source codes of assignments can be shared between teachers but should not be seen by students.

WHAT DO WE HAVE (By October 2017)

MATHEMATICS

- Analysis: Single Variable Calculus (FI/EN), Multivariable Calculus (FI), Vector Analysis (FI), Complex Analysis (FI/EN), Differential Equations (SW)
- Applied: Business Mathematics (FI), Approximation and Interpolation (FI)
- Bridge Mathematics (High School – University review assignments) (FI/EN/SW)
- Discrete Mathematics (logic, algebra, number theory, graphs, etc. FI/EN)
- Matrices and Linear Algebra (FI/EN)
- Probability and Statistics (FI/SW)

PHYSICS

- Electromagnetism (FI)
- Mechanics (FI)
- Modern Physics (FI)
- Thermodynamics (FI)

OTHER TOPICS

- Chemistry, various engineering topics, etc. (some assignments, mainly in Finnish)

A?

Applications

Blended Learning

- Weekly assignments
- Exams

MOOCs and Distance Learning

- Massive Open On-line Course
- Get taste of university courses before applying.
- Possibilities for people who cannot or do not want to attend regular courses.
- Public relations?
- A good test case for advanced e-learning technologies and solutions.
- Matrix Algebra 2016, twice in 2017.
- Upcoming Calculus in 2017 (with VHB).

WHY MATRIX ALGEBRA?

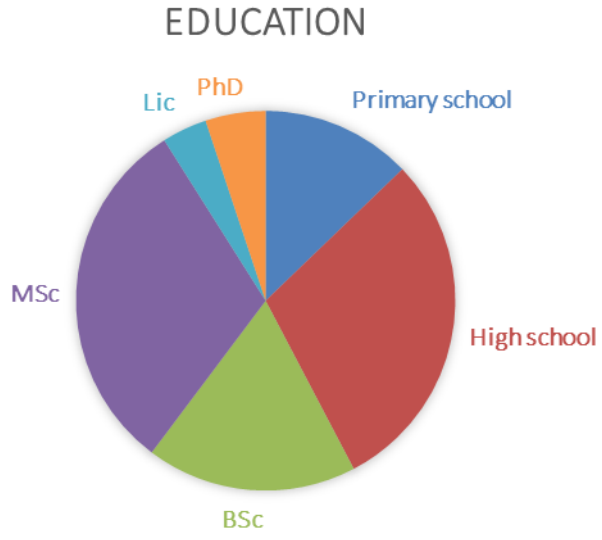
- First year topic for the engineering students
- Easily accessible
- Differs from high school mathematics
- General usefulness in various subjects and disciplines
- Automated assessment tools function well with the topics

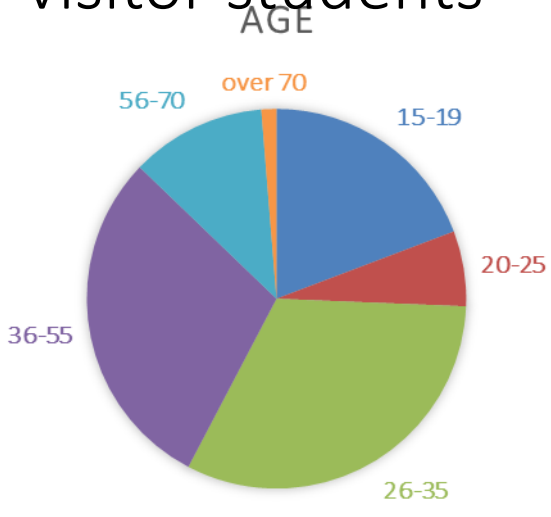
COURSE MATERIALS

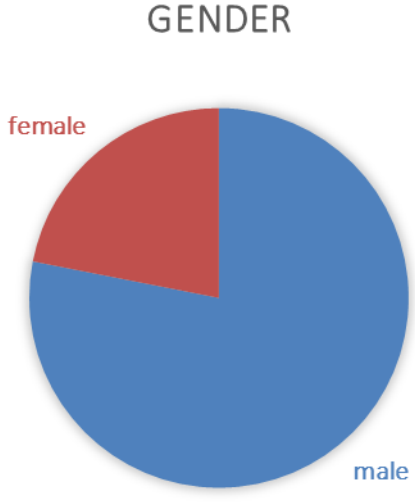
- Lectures
- Lecture videos
- Interactive GeoGebra materials
- Written homework assignments
- Automatically assessed STACK exercises
- Discussion forum at Piazza

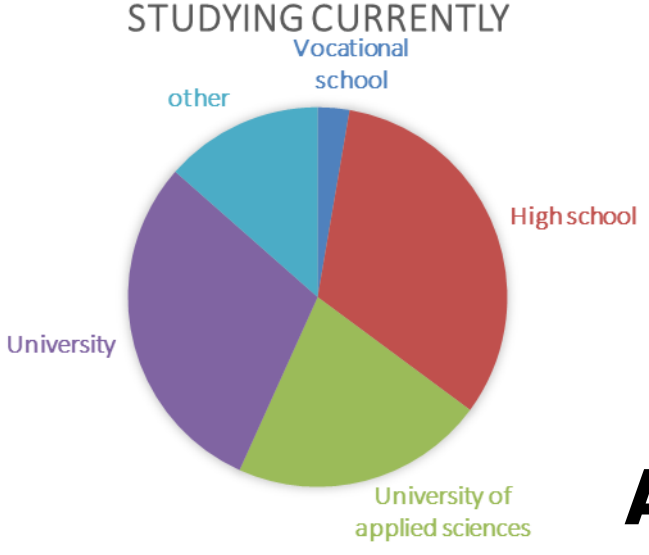
Pilot Course (2016)
79 visitor students
192 students from Aalto

Backgrounds of the visitor students

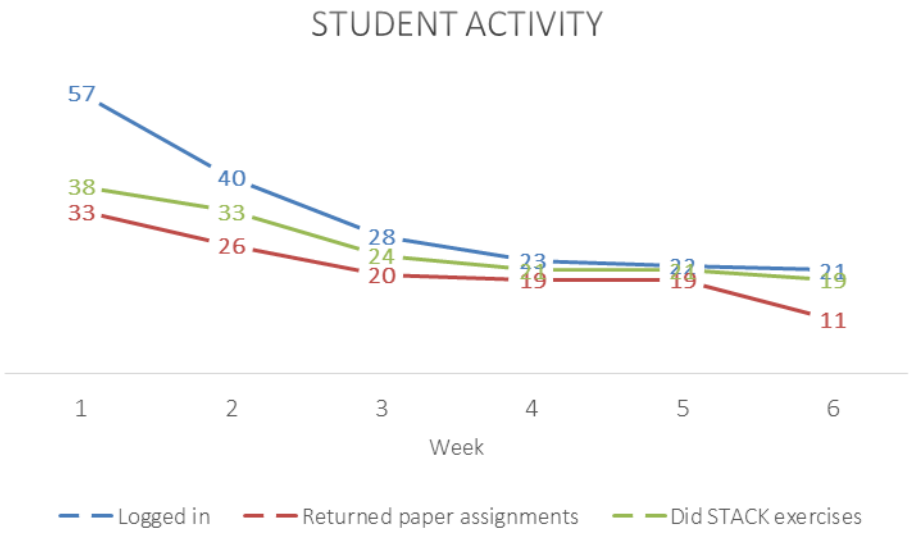


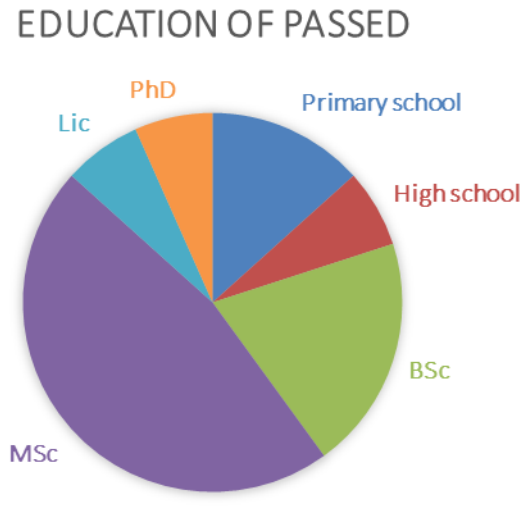






16 visitor students finished the course with ”Passed”





Aalto OpenLearning | Kurssit | Tietoa palvelusta | Suomi (fi) | Muokkaustila päälle

Aalto MOOC Matriisilaskenta

KATSAUS KURSSEISTANI / OMAT KURSSINI / COURSES / MATRIISI

Tervetuloa!

Matriisilaskennan MOOC-kurssi

MOOCin väki toivottaa sinut tervetulleeksi tälle matriisilaskennan kurssille! Kurssin opetus seuraa Aalto-yliopiston insinöörikoulutuksen ensimmäisen vuoden matriisilaskennan kurssia. Kurssilla opitaan esittämään ja ratkaisemaan lineaarisia yhtälöryhmiä matriisimuotoisina, suorittamaan matriisien peruslaskutoimituksia, erilaisia matriisihajotelmia ja niiden merkitys ja käyttö erilaisissa sovelluksissa.

Kurssin opettaja
Antti Rasila
matriisimooc@aalto.fi

Every pair of equations can be geometrically interpreted as a graph of two straight lines. Here we have four pairs of equations and four graphs. Connect each pair of equations to the correct graph.

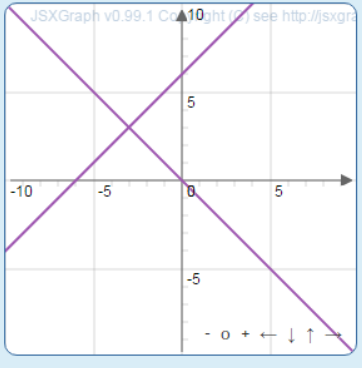
a) $\begin{cases} 8 \cdot y - 8 \cdot x = 48 \\ 2 \cdot x - 2 \cdot y = -20 \end{cases}$

b) $\begin{cases} -5 \cdot y - x = 6 \\ x - 5 \cdot y = 14 \end{cases}$

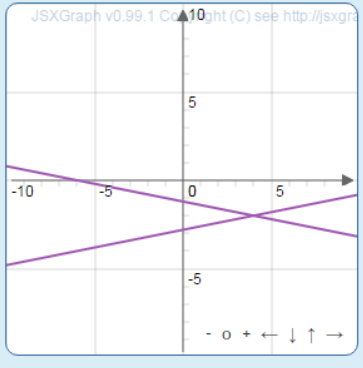
c) $\begin{cases} 2 \cdot x - 2 \cdot y = -12 \\ -2 \cdot y - 2 \cdot x = 0 \end{cases}$

d) $\begin{cases} -2 \cdot y - 2 \cdot x = 0 \\ -10 \cdot y - 10 \cdot x = 0 \end{cases}$

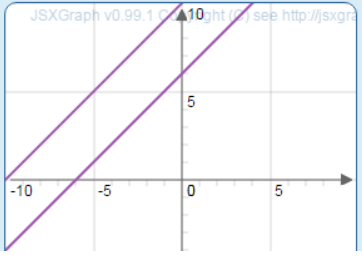
Graph 1:



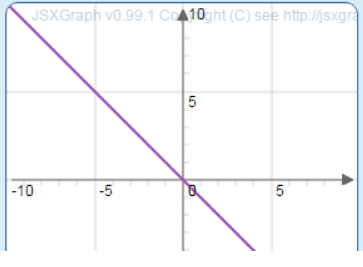
Graph 2:



Graph 3:



Graph 4:



Let's solve the system of linear equations

$$\begin{cases} -6 \cdot x_1 - 5 \cdot x_2 = -2 \\ 12 \cdot x_1 + 10 \cdot x_2 = -4 \end{cases}$$

using Gaussian elimination. First transform the system into matrix form $\mathbf{Ax} = \mathbf{b}$ where $\mathbf{A}$ is the coefficient matrix, $\mathbf{x} = \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$ and $\mathbf{b}$ contains the constant terms on the right side of the equations.

Input the augmented matrix $[\mathbf{A}|\mathbf{b}]$ as the first intermediate step:

$$\begin{bmatrix} & & \\ & & \end{bmatrix}$$

Next compute the reduced row echelon form of the augmented matrix using row operations. Input the resulting matrix $\mathbf{rref}\,[\mathbf{A}|\mathbf{b}]$:

$$\begin{bmatrix} & & \\ & & \end{bmatrix}$$

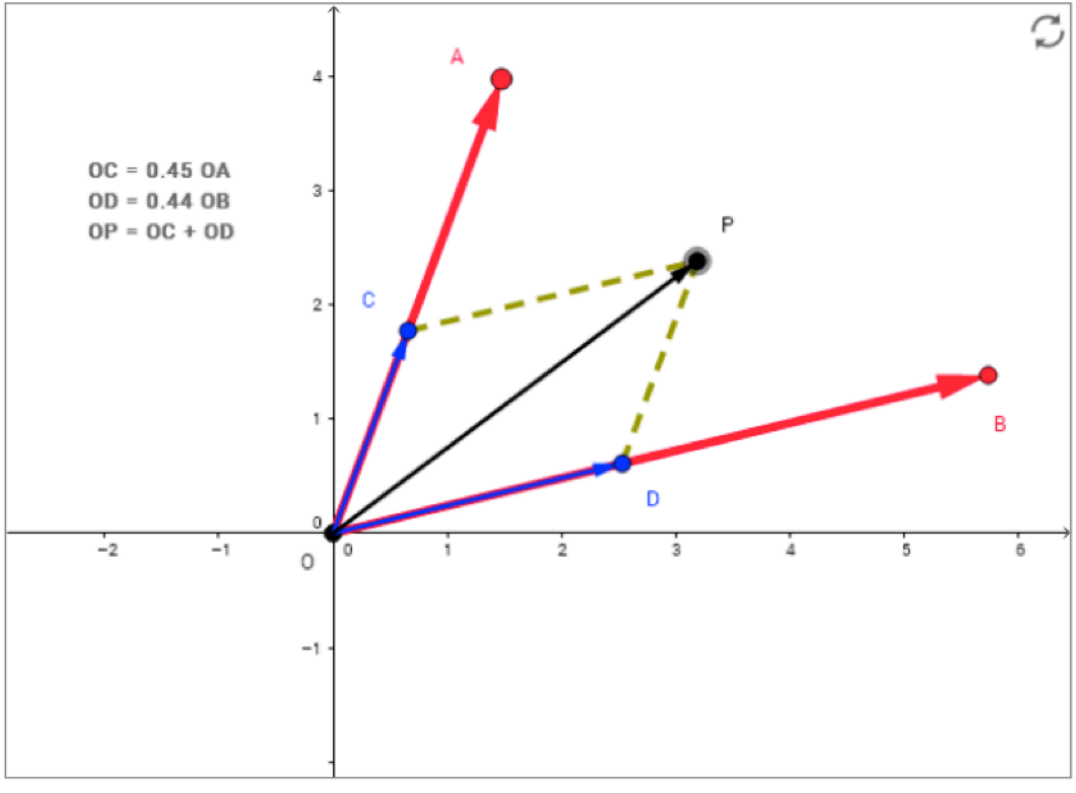
From this matrix we can deduce the amount the solutions to the system and the solutions themselves. Input the number of solutions to the system. If there are an infinite number of solutions, input **inf**.

Check

A?

Kokeile ja tutki

Kun tason kantavektorit ovat lineaarisesti riippumattomia, niiden lineaariyhdistelynä voidaan saada mikä tahansa tason piste. Liikuta tason kantavektoreita (punaiset vektorit $\mathbf{OA}$ ja $\mathbf{OB}$ ja pistettä $\mathbf{P}$ ja huomaa, missä tilanteessa pistettä ei voi ilmaista kantavektoreiden avulla. Tässä tilanteessa punaiset vektorit ovat lineaarisesti riippuvia, eivätkä siis muodosta tason kantaa.



In this question we want you to apply integration by parts to this integral:

$$\int 9x^3 e^{3x}\,\mathrm{d}x$$

As a reminder by integration by parts we mean this:

$$\int u(x)v'(x)\,\mathrm{d}x = u(x)v(x) - \int v(x)u'(x)\,\mathrm{d}x$$

Your selection placed to the formula leads to this:

$$u(x) = e^{3x} \quad v'(x) = \frac{27x^4}{4}$$
$$u'(x) = 3e^{3x} \quad v(x) = \frac{27x^5}{20}$$

$$\int \frac{27x^4 e^{3x}}{4}\,\mathrm{d}x = \frac{27x^5 e^{3x}}{20} - \int \frac{81x^5 e^{3x}}{20}\,\mathrm{d}x$$

Which basically means that you will have to integrate this:

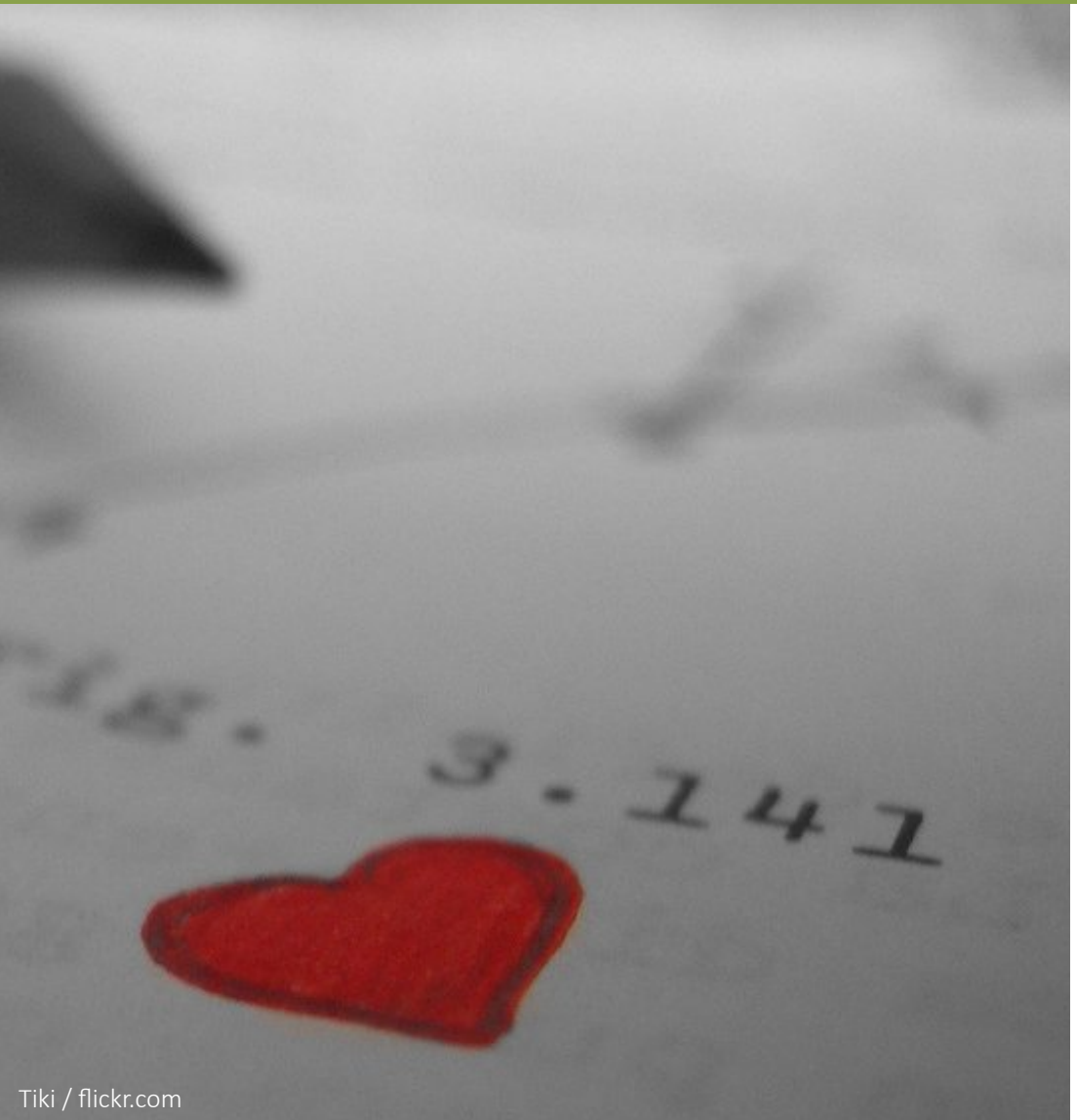
$$\int \frac{81x^5 e^{3x}}{20}\,\mathrm{d}x$$

You now have a few options on how to continue, you can either just give the value of that integral and if it is correct this whole process ends or you can repeat the same integration by parts process on that integral and hopefully generate an easier integral through it. You could also undo your selection and try again with another $u(x)$ and $v'(x)$.

Have you noticed how the order of that term in the integral grows? Surely, the integral would be simpler to solve if that order went down instead?

$\int \frac{81x^5 e^{3x}}{20}\,\mathrm{d}x =$ [ ] Repeat integration by parts | Undo this selection

Check



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POSITIVE FEEDBACK

Students really liked the freedom provided by

- STACK assignments
- Lecture videos
- Interactive materials

Students' belief in the usefulness of the materials was high

FUTURE

We are planning additional MOOCs on Single Variable Calculus (2017) and also Multivariable Calculus (TBD) in collaboration with Bavarian Virtual University VHB (Germany).

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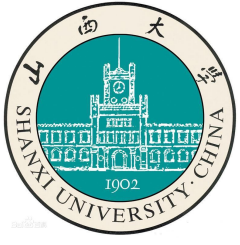
China-Finland Collaboration in Mathematical Modeling



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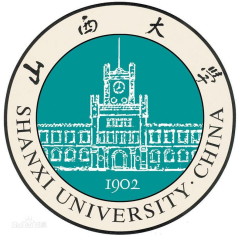
TECHNOLOGY

- **Background:** Long history of teaching of modeling as a collaborative effort in Finnish universities.
- The national network has been coordinated by Tampere University of Technology since 2002.
- Consists of six partner universities (Tampere University of Technology, Aalto University, Lappeenranta University of Technology, University of Eastern Finland, University of Jyväskylä, and University of Oulu)
- The main purpose of the network is to develop online learning and web-based teaching methods for mathematical modeling.

CIMO Project: 2016-2018



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- Two year CIMO project for Finland-China collaboration in mathematical modeling
- Finland: Aalto University (A.R.) , Tampere University of Technology (Prof. Lassi Paunonen, coordinator) China: Hunan First Normal University (Prof. Xuxin Yang), Shanxi University (Prof. Bao-Zhu Guo)
- The main goal is to develop a joint e-learning course in mathematical modeling, initially focusing on models involving differential equations.
- Includes other related activities such as student and faculty exchanges.
- Pilot course is ongoing.

THANK YOU FOR YOUR ATTENTION!

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