WEPS Peer and Automatic Assessment in Online Calculus Course

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Calculus I (spring 2011 course)
Calculus II (spring 2012 course)

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Ordering and the Completeness of Real Numbers

This lecture introduces the properties of the operations of real numbers (addition, subtraction, multiplication, and division). Ordering of numbers and the **Completeness** of the set of real numbers are discussed.

- Operations, Ordering, and the Completeness of Real Numbers
  - Handout
  - Slides
  - Slideshow
- Solved Problems on Operations and Ordering
  - Handout
  - Slides
  - Slideshow
- Expressions
- Equations
- Ordering of Numbers

The following workshops requires students to write a proof, and then to assess other students' submissions

- Ordering x positive implies -x negative
- Ordering 1 > 0

Online Calculus I

Each module contains

- YouTube videos
- Written materials
- **Quizzes (Automatic assessment)**
- **Workshops (Peer assessment)**
- Discussion forum, calendar, gradebook

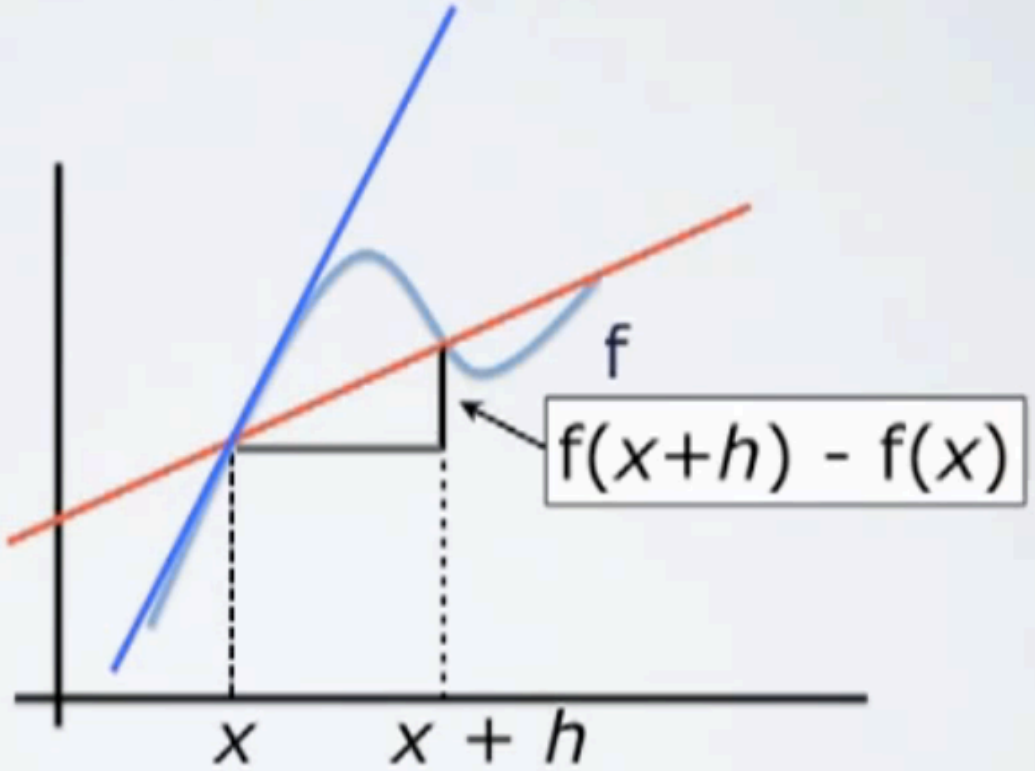
youtube.googleapis.com/v/K-CBJRBtMYQ#Introduction%20to%20Derivatives

youtube.googleapis.com/v/K-CBJRBtMYQ#Introduction%20to%20Derivatives

Introduction to Derivatives
by Mika Seppälä

TANGENTS OF GRAPHS OF FUNCTIONS

Theory and worked out examples explained in YouTube videos
- Viewable also with mobile devices



*Differentiation/Introduction/**Tangents and the Derivative*** by M. Seppälä

Ad

2:47 / 9:26

480p

Automatic Assessment

Students work with problems online, enter answers, get immediate meaningful feedback and monitor their progress

Online practice with computer-generated feedback

Solve for t

$$\frac{t}{2}+\frac{t}{5}=4.$$

Answer: $t =$ 40/7

Your last answer was interpreted as follows:

$$\frac{40}{7}$$

Check

Correct answer, well done.

Multiply both sides of the equation

$$\frac{t}{2}+\frac{t}{5}=4$$

by the least common multiple of the denominators, which is $2\cdot 5=10$, to obtain

$$2\cdot 5\cdot\frac{t}{2}+2\cdot 5\cdot\frac{t}{5}=2\cdot 5\cdot 4 \iff 5t+2t=40 \iff 7t=40$$

Divide both sides by 7 to obtain the solution $t=\frac{40}{7}$.

Using the method of integration by substitution, find the following integral:

Run the question tests...

$$\int \frac{\sin(4x)}{\cos(4x)+3}\,dx.$$

-log(cos(4x)+3)/4

Your last answer was interpreted as follows: **-log(cos(4x)+3)/4**

This answer is invalid.

You seem to be missing * characters. Perhaps you meant to type **-log(cos(4*x)+3)/4.**

Using the method of integration by substitution, find the following integral:

$$\int \frac{\sin(4x)}{\cos(4x)+3}\,dx.$$

-log(cos(4*x)+3)/4

Your last answer was interpreted as follows:

$$\frac{-\ln(\cos(4x)+3)}{4}$$

STACK assists with the correct input of formulas

Automatic Assessment

1. Diagnostic test helps students and instructors to know where students stand in the beginning of the course
2. **Continuous** learning by practicing and getting constructive **feedback**

Implemented with STACK, created by Chris Sangwin, Loughborough University, UK

Peer assessment

Students submit homework online, then grade and give feedback to others' work

Peer assessment

Workshop module in Moodle:

1. Students are given homework problems that are to be submitted by Wednesday
2. After the submission deadline, an example solution is provided
3. According to the model solution and assessment criteria, students have to grade and give constructive feedback to five randomly selected students by Sunday
4. Student's own grade from this assignment is the average of the five grades
5. Teacher's role is to monitor and support

Pedagogical goals:

- **Students have to study the model solution and the solutions of five other students that way learning from common mistakes and trying to give corrective feedback**
- **Creating interaction between students in an online course**
- **Scalable to MOOCs**

Problem given in peer assignment

Complex Limit Problem

In this workshop you need to compute the limit

$$\lim_{x\to\infty} \frac{\sin^2\left(\sqrt{x+1}-\sqrt{x}\right)}{1-\cos^2\frac{1}{x}}.$$

Show all the steps of the computation.

A student's solution

The given equation is rather cumbersome, so let's begin by making it a little bit easier to read. Let's name the functions of x in the the numerator as t = (sqrt(x+1)-sqrt(x)) and the functions of x in the denominator as u = 1 / x. Then the original equation looks like this:

$$\lim_{x \to \infty} f(x) = \sin^2(t) / (1 - \cos^2(u)).$$

Since by Pythagorean trigonometric identity $\sin^2(x) + \cos^2(x) = 1$ we may change the denominator to be

$1 - \cos^2(u) = \sin^2(u)$, so the original equation ends up looking like this:

$$\lim_{x \to \infty} f(x) = \sin^2(t) / \sin^2(u).$$

Let's look at the right part of the equation and not worry about limits just yet:

$\sin^2(t) / \sin^2(u) \to (\sin(t) / \sin(u))^2 \to ((\sin(t) * t / t) / (\sin(u) * u / u))^2 \to$

$((\sin(t) / t) * t) / ((\sin(u) / u) * u))^2$.

Another student's feedback

Assessment form

Aspect 1

Has the observation $\lim_{x\to 0} \sqrt{x+1} - \sqrt{x} = 0$ been made and justified by the rewriting

$$\sqrt{x+1} - \sqrt{x} = \frac{\left(\sqrt{x+1}\right)^2 - \left(\sqrt{x}\right)^2}{\sqrt{x+1}+\sqrt{x}} = \frac{1}{\sqrt{x+1}+\sqrt{x}} \to 0 \text{ as } x \to \infty?$$

Grade 12 / 15

Comment The calculations are overwhelmed with extra brackets and there are few excessive steps there (after recieving 1 /(sqrt(x+1)+sqrt(x))) but anyway the observation was made and justified.

In this problem, assessment is broken down into three aspects, each with maximum points and instruction to grade

Lessons learned from workshops

- Give very clear instructions, e.g. students should write down what they are doing for others to see what is going on
- Problems should be easy enough for all to get started
- Encourage everybody to submit even if thinking that the solution is not complete
- Assessment criteria to be designed carefully and explained to students
- Make clear that student's role is not to act as a grader, rather to help others to learn

WEPS

- Grants from NSF SAVI-program (Science Across Virtual Institutes) and Academy of Finland
- Develop learning analytics and motivational methods in MOOCs
- **myweps.com** offers these materials freely for teaching and learning under creative commons license

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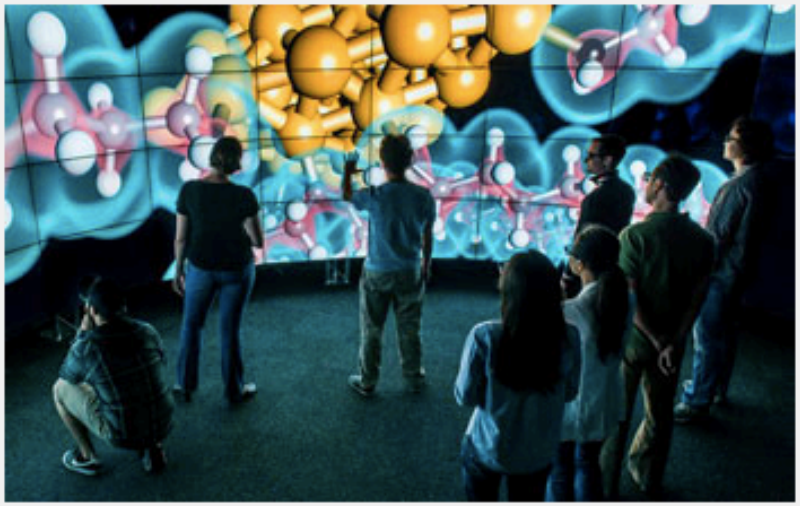
Press Release 13-031

International Team Targets Innovations in STEM Learning

U.S-Finnish collaboration through Science Across Virtual Institutes (SAVI) brings the strengths of each country to bear on improving science, technology, engineering and mathematics education in K-16 classrooms



International partners meet at an opening meeting at Stanford University in January, 2013.
Credit and Larger Version

Life-like avatars serve as cognitive tutors in a game to help students comprehend science texts.
Credit and Larger

Advancing an Online Project in the Assessment and Effective Teaching of Calculus

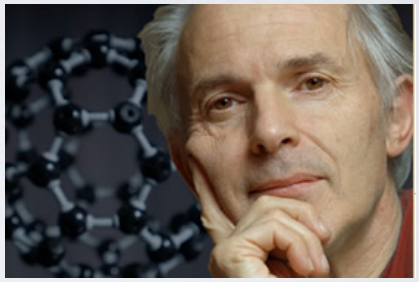
George Mason University, University of Helsinki, Florida State University, Texas A&M University

Researchers from the U.S. and Finland are conducting ground-breaking analyses on a massive open online course (MOOC) on calculus that is based at the University of Helsinki: the World Education Portals (WEPS). MOOCs represent a potentially revolutionary development in the design of teaching and learning environments. This project involves several universities in the US and Finland; it is convening a variety of experts on learning, assessment, cognitive diagnostic modeling, and research methodology to: (1) advance the learning of calculus, and (2) recommend best practices on the design, deployment and analysis of this, and other, MOOCs.

NSF and Academy of Finland funded SAVI Project

Anthony E. Kelly
George Mason U

Eric Hamilton
Pepperdine U



Harry Kroto
Nobel Laureate (Chemistry) FSU

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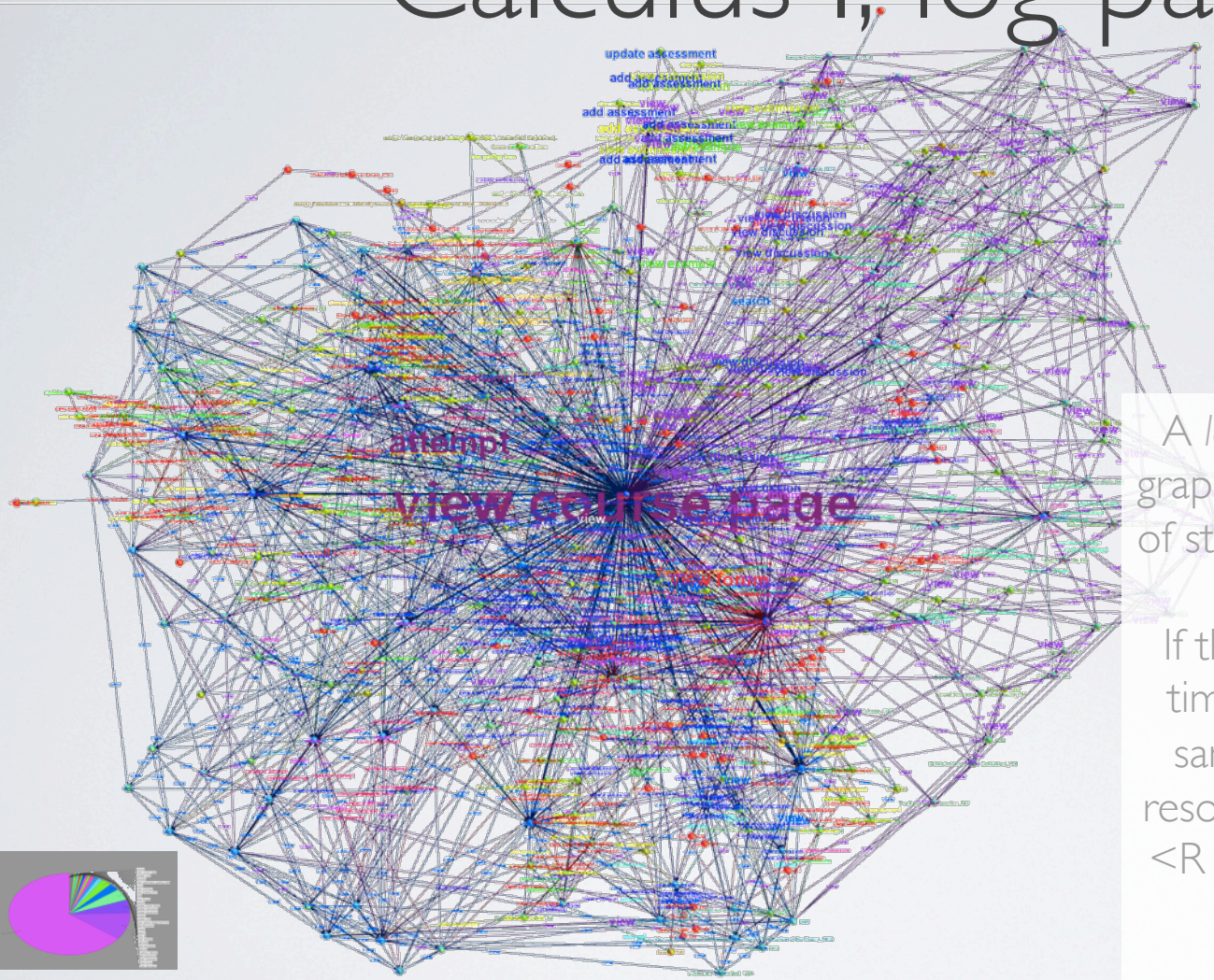
Mika Seppälä U of
Helsinki and FSU

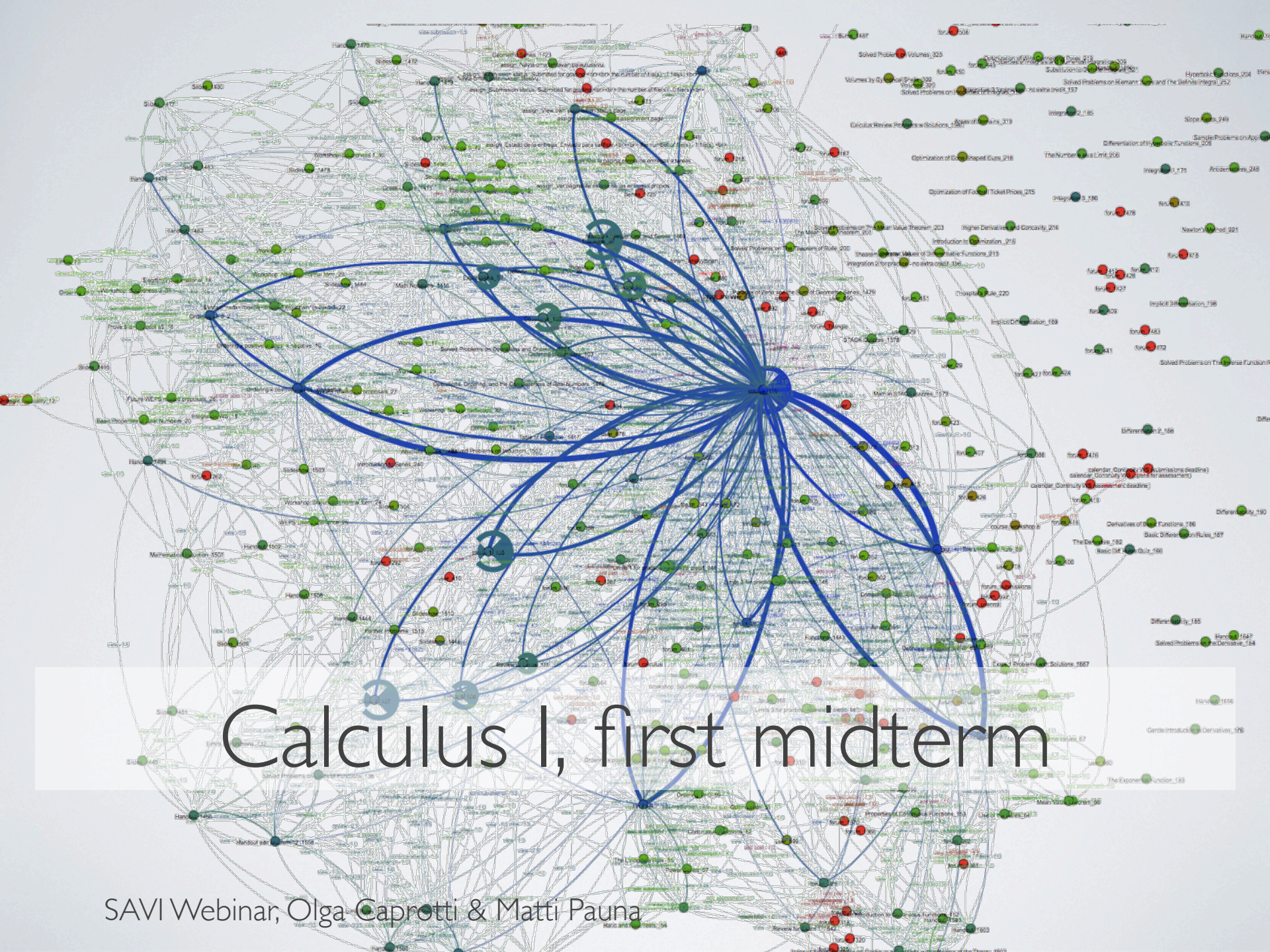
Calculus I, log paths



A *log path* is a subgraph in the graph of activities of the network of students recorded by the logs.

If the log contains consecutive time-stamped records for the same userid, accessing online resources R1 then R2, the edge <R1,R1> appears in the activity network.

It is labeled by the activity name.



Calculus I, first midterm

SAVI Webinar, Olga Caprotti & Matti Pauna