CMSC 2016

Creative Mathematical Science Communication

04th October - 06th October, Lübeck

1 Introduction

Welcome to the Hansestadt Lübeck, the "Queen of the Hanseatic League" and to CMSC2016, the conference on Creative Mathematical Science Communication. The conference will take place on the campus of the University of Lübeck located 3 km south of the city center.

This is the third event in a conference series that explores new ways of helping students to achieve 21st Century competencies in mathematics and computer science focusing on algorithmic and computational thinking (computer science unplugged). The previous conferences, held in Darwin, Australia, in 2013 and in Chennai, India, in 2014 saw a unique interaction between computer science / mathematics researchers and educators and artists (theatre, dance, graphic arts). We hope that this meeting will generate new ideas and solutions for our common goal and that you will enjoy your stay in these historic surroundings.

This small booklet contains the schedule of the conference, abstracts of the contributions and maps of the campus and the city center. If you have any further questions, feel free to ask us, the organizing team,

Sebastian Berndt   Claudia Mamat   Rüdiger Reischuk   Martin Schuster

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2 Schedule

Monday

We will meet at the *Brauberger*, which is located in the old city (Alfstraße 36). We have reserved a table for the name *Berndt*. The Brauberger is a traditional micro-brewery that is located within one of the oldest cellar vaults of the city dating back to the year 1225.

Time	Activity	Speaker
19:00	Informal get-together	-

Tuesday

We will meet in the lecture hall (building 70)

Time	Activity	Speaker
09:30 - 10:00	Registration	-
10:00 - 11:00	Apocrypha of CS Unplugged	Mike Fellows
11:15 - 11:45	Coffee Break	-
11:45 - 12:15	Rails Girls 54: Making Rails Girls Even More Fun	Sven Helmer
12:30 - 13:45	Lunch	-
13:45 - 14:15	CS Unplugged and Computational Thinking in schools	Tim Bell
14:30 - 14:45	The ferry cover problem	Valia Mitsou
14:45 - 15:15	Coffee Break	-
15:15 - 16:00	Tools for playing algorithms	Rüdiger Reischuk
16:15 - 16:45	Blockfest	Bill Marsh

Wednesday

We will meet in the lecture hall (building 70)

Time	Activity	Speaker
10:00 - 11:00	Combinatorial mathematics - historical and recreational aspects	Harald Gropp
11:15 - 11:45	Coffee Break	-
11:45 - 12:15	Bring back the median	Vladimir Estivill-Castro
12:30 - 13:30	Lunch	-
13:30 - 15:30	Roles of variables - What happened to a great idea over 10 years?	Olga Timcenko
15:30 - 16:00	Coffee Break	-
16:00 - 17:30	Lady Ada, a play to promote CS Unplugged in primary education	Joek van Montfort, Marijn van der Meer
18:00	Visit of the Old City	-
19:30	Conference Dinner	-

Thursday

We will meet in the lecture hall (building 70)

Time	Activity	Speaker
10:00 - 10:30	Digital Light Art - Boolean Logic with Night Lights	Uwe Geisler
10:45 - 11:15	Bundeswettbewerb Informatik: Germany's National Informatics Competition for Pupils	Till Tantau
11:30 - 11:45	Coffee Break	-
11:45 - 12:15	Playing with the King: Introducing Primary Students to Computational Thinking with a Giant Chess Board	Maria Beatrice Rapaccini
12:30 - 13:30	Lunch	-
13:30 - 13:45	CS Concepts with Dice. New old CS Unlugged-style Activity	Pawel Perekietka
14:00 - 14:15	Interactive objects for algorithmic thinking	Andrea Bonani
14:30 - 15:30	Textile-Math	Sunita Vatuk
15:30 - 15:45	Coffee Break	-
15:45 - 16:15	Kid Krypto based on disjoint directed cycle cover	Frances Rosamond
17:30	Excursion	-

3 Abstracts

Tuesday

Mike Fellows

I propose to focus on the "Apocrypha of CS Unplugged" which is a bunch of stuff I tried out only a few times:

- Kesten's Theorem in percolation theory

- computational biology, and a hands-on activity about sequence alignment (for two sequences, theatrical dynamic programming)

- ... a bunch of stuff that I just tried out in the olden days that didn't make it into the book.

- Prefix codes, that's a good one, as it is very binary (zeros and ones, which is needed for a math-of-CS theme)

Even one time I did zero-knowledge proofs, which can be made quite concrete. I would like to try something about functional analysis, based on jump-ropes linked by bungie cords.

Sven Helmer

Rails Girls, which originated in Finland, is a workshop for young women and girls to learn web application development from scratch, i.e., no prior knowledge in programming is required. When we ran events in Bolzano and Trento, we wanted to go beyond tutorials and offer the participants a chance to develop a small application based on their own ideas, as we felt that this would boost motivation even further. In order to achieve this, we extended the conventional structure of a Rails Girls workshop by a whole day, running it from Friday afternoon until Sunday evening. Here, we want to share our experiences of organizing a successful and exciting new version of Rails Girls.

Tim Bell

The CS Unplugged (CSU) project has been running for over two decades, originally being used in the context of outreach and extension in schools, but more recently becoming a popular to deliver new curriculum material. The idea of Computational Thinking (CT) has also been around for decades, but has been popularised in recent years, and is also widely seen as a key driver for changes in school curricula. This talk will explore the development of these two ideas, how they intersect, and how they are being used in schools.

Valia Mitsou

I am planning to present a generalization of the wolf-goat-cabbage puzzle, where a man wants to ferry a set of items across a river, given their incompatibilities and we are looking for the minimum feasible boat size. Along the way, I will explain the relation of this optimization problem with vertex cover (and independent set).

Bill Marsh

BLOCK Fest® is a research-based exhibit that helps raise awareness of early math and science learning by offering hands-on block play experiences to families with young children. Parents, preschool teachers and the community will become more knowledge-able about the importance of early math and science learning as it impacts both school readiness and later math success.

Wednesday

Harald Gropp

Combinatorics is an important part of mathematics, although not well established in some countries of the world. Areas such as graph theory and finite geometry will be discussed from a historical point of view as well as from artistic and recreational Relations.

Vladimir Estivill-Castro

A series of activities illustrate the role of the median as a an indicator of central tendency. These activities start in the playground, and illustrate a certain criterion to be optimized enabling a constructive, concrete physical proof of the role of the median. This is achieved by providing participants a problem of finding the best representative in a one-dimensional setting. Using rope as the cost measure, the challenge of finding the "best" is interpreted as using the least rope. The activity is then extended to 2 dimensions and a grid, and connections are made to facility location (finding the best place for a fire station to attend all potential sites for a fire). We explore variants of the problem (by changing the metric, or the number of centers) and also illustrate analog interpretations of median finding in 2D and point the students to the Fermat-Weber problem. The solutions to random-median problems in 2-D are also used to create collages and decorative patterns for textiles. The learning objective is an investigation of optimization criteria surrounding statistics, as well s facility location and clustering (data analytics), and exposure for an appreciation to computability and algorithmic complexity (comparing with calculating the mean).

Olga Timcenko

Back in 2002, a group of researchers from University of Joensuu, Finland (now University of Eastern Finland) has detected that one of major obstacles for novice learners of programming is grasping a concept of a variable in computer science. Variables in programs could have several well-distinguishable roles, and more than 90% of variables in novice programs belong to less than 10 clearly defied variable roles. The author of this paper made an experiment back in 2005, using that concept to teach children 12-15 years old to program LEGO robots and to go significantly beyond simple LEGO Mindstorms programs children are usually writing. Basically, it was demonstrated that programming a robot can be presented to children like a role-playing narrative activity, where different children play different roles, as helpers of the main character (the robot), by holding values of certain variables (mostly values from sensors and flags whether some event has happened or not). Not much has happened in meanwhile in this direction of research, as can be checked from the website: `http://cs.joensuu.fi/~saja/var_roles/literature.html`, although variables remain a difficult concept to grasp. Revisiting this concept could be a valuable idea for CMSC conference - either as a workshop for children using new generation of LEGO

robots, or organizing a similar experiment in some another graphical programming environment, when children (or novice students of programming) will have to solve some common task.

Joek van Montfort and Marijn van der Meer

Synopsis of the play: A child is exploring in Minecraft and creating some historical world. Lady Ada pops up from this world. The child and Ada then explore the computational underpinnings and realize that they open an much larger world to be explored.This play is work in progress. We don't have sufficient funding yet. However we think it's good enough to be made regardless of funding. Like the New Zealand "CS unplugged the show" we want to lower the floor for schools to start with CS unplugged activities. We also want the play to be valuable as historic play (so viewers get some time to digest the message).

Thursday

Uwe Geisler

The educational artwork explains the very basics of any Computer Technology. It transforms the complexity of the so called Boolean Logic into an appealing and esthetical experience which is even hands-on. The user can interact with the installation at different levels. He can grasp - step by step - how more complex systems work. All this is self explaining and done in a non-verbal and playful manner thus giving it a strong intrinsic motivation for kids and adults alike. All effects are reached by solely using a day to day product (sensor-lights). These are the base for all the displayed digital and binary effects. It is mesmerizing to watch the lights flickering and changing. This is inspiring users to ask further questions and dig deeper into the field. These motivating effects are intended. The artwork is meant as digital Enlightenment. The approach intends to foster creativity, exitement and fascination of computer science.

Till Tantau

In the 1980's, the Gesellschaft für Informatik started a national competition in informatics, which has become the annual Bundeswettbewerb Informatik with about 1500 pupils participating in the first round. Its objective is, firstly, to promote interest in computer science in secondary school and, secondly, to identify and support top future computer scientists. In the talk I will give an overview of the competition's organization and present a number of the problem sets used.

Maria Beatrice Rapaccini

This study describes how computing, mathematics and playing chess are strictly related. They affect other school disciplines and domains: Science, Technology, Engineering, Mathematics, Art, Design (STEAM), and more (STEMx). Math, science, social studies, and literacy have been the pillars of modern education for over a century. But in the face of a uber-connected and technological-driven world, new perspectives naturally emerge. Computing and coding are new subjects. It draws together the strands of computer science, information technology and digital literacy, and seeks to equip children with computational thinking skills and the creativity they need to understand and change the world. On the other side chess is an excellent tool to demonstrate the theme of critical thinking and problem solving. Teaching chess to children involves more than just playing the game and it can be used as teaching method. A modified Pycomotricty Giant Chessboard (PSG) methodology applied to computational thinking education is shown. The aim of this approach is not teaching children how to play chess and coding, but to let them approach the world of chess with the same curiosity they have when listening to a fairy tale, trying to enter it gradually, until they become part of it, dancing as a Rock and playing rhymes with the King. From last studies on neurosciences, it has been confirmed how psychomotor activity favours learning, speech development and abstract thinking, thus enhancing creativity and social abilities in children. In a nutshell, computing and

chess, are remarkable universal languages, they bridge the gaps of language, gender, economics, age and education, anyone can learn the foundations and the basics from an elementary level, both are used as educational tools to aid learning and they are part or in the core curriculum in some countries in the world.

Pawel Perekietka

Computers are, of course, very complicated devices. But the main problems concerning computers can easily be illustrated by means of a simple models. The activity presents ideas of popularizing the concepts of a computer and of a computer program (memory, instructions and a programming language), using a common die as a teaching aid. The model can be also used to state some of the problems involving a computer and its memory, e.g. halting problem or equivalence of programming languages The idea was invented in 1970s by Prof. Zdzisław Pawlak (1926 – 2006), a Polish mathematician and computer scientist who was known for his fundamental works on the rough set theory.

Andrea Bonani

The focus of my work is to introduce the algorithmic thinking in school through the use of interactive objects exploiting the potential offered by a new technology that has developed around the world and is called the internet of things (IoT). IoT refers to the expansion of Internet technologies to include wireless sensor networks and smart objects by extensive interfacing of exclusively identifiable, distributed communication devices. With an increase in the deployment of smart objects, IoT is expected to have a significant impact on human life in the near future. It can also be used to create more significant learning spaces. In particular, my study is orientated to graph algorithms because there is relatively little material available and a lot of practical applications suitable to explain algorithmic thinking to pupils. My current focus is to introduce activities to learn algorithms for finding a minimum spanning tree, as an example of a graph algorithm. The activity with these objects that I plan to do should be done at school in a regular classroom, during the lessons of mathematics or sciences. My aim is actually to devise a series of such activities, ranging from the simplest to the most complex ones, so to address learning skills of pupils from age of 8-9 years up to 15 years, with progressive difficulty of experiences. The physical objects I am designing compose a physical network, where each object is modeling the node of a graph (while graph edges are just wires). The network is monitored by a server, that is, software placed on the teachers' computer. The server continuously gathers data from the objects, tracking actions by pupils while building a minimum spanning tree. In this way the teacher can monitor the process of learning and can (1) be alerted about which pupils are stuck, so to possibly help them, (2) get help for an objective evaluation of pupils via detailed logs on their activity, and (3) review his teaching activity and plan new activities, again based on past activity logs. The interactive objects, which will be used in the activity, are being created in a makerspace using cheap material, so to replicate them in relative large numbers (say 10-20 per class). Each object contains an Arduino board to provide

intelligence and communication capabilities to and from the server. The outside of the object is very simple, just providing one key and a led, respectively for getting input and giving feedback to pupils. Pilot experiences with this network of objects are planned for Fall 2016 in a middle school (pupils aged 11-13).

Sunita Vatuk

I propose to discuss a collaboration of the past 18 months with Varuni Prabakhar, a mathematician/post-doc at IMSc, the weaving and blockprinting shops at Kalakshetra, and Cross Town Shuttlers, a group of weavers in New York City. We have developed and tested integrating curriculum at the Kalakshetra school and The School KFI in Chennai, and will be adding several schools in New York City as well as the math education program at City College in 2016-17. The project builds on other art and math integration I have developed over the past decade: paper-folding, kolams, print-making and photography, to name a few.
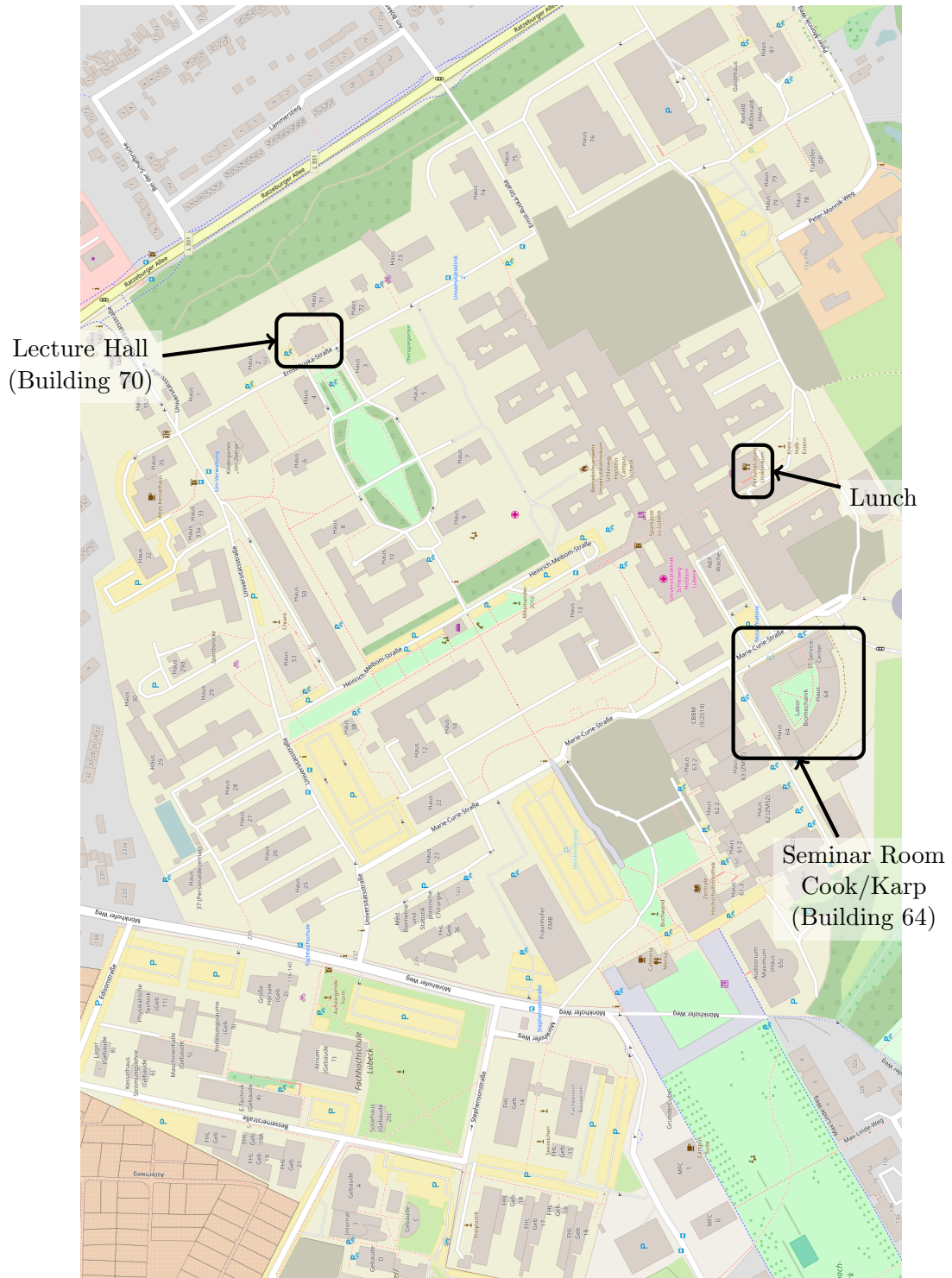
The analysis and making of textiles provides an incredibly rich arena in which to hone observation and design skills, create a culture of inquiry and respectful discussion, and ask authentic questions that range from the purely combinatorial to the algebraic (group theory), from the purely mathematical to the aesthetic, from the theoretical to the practical. Because of the availability of handloom cloth in India and the fashion industry in New York City, there is the added advantage of opening children's and teachers' eyes to the magic in the everyday.

My motivation for wanting to present this work at CMSC is to find additional connections between weaving and computer science that I, as a mathematician, am not as likely to find. By presenting this work to this group, I hope to push the project in new directions.

Frances Rosamond

This activity will engage the audience with the original Kid Krypto based on Perfect Code, and a new crypto for even younger children based on disjoint directed cycles.

4 Map of the Campus

Lecture Hall
(Building 70)

Lunch

Seminar Room
Cook/Karp
(Building 64)

5 Map of the Old City

Brauberger
(Monday)

Excursion
(Thursday)

Restaurant San Marco
(Wednesday)