Summer School of Science S3++ 2010

Summer School of Science S3/S3++ is a summer camp held at Science and Education Center Višnjan, Croatia, for high school students interested in the natural sciences: biology, chemistry, physics as well as computer science and engineering. Work is organized around projects whose aim is to provide students with hands-on experience with science and scientific method in an informal atmosphere. Projects are lead by young scientists, mostly PhD students and young doctors of sciences from Croatia and abroad. Beside work on projects, all participants attend lectures covering topics of general interest and from all fields of natural sciences and beyond. Work in small groups (three to four students per one project leader) and lectures in different fields of science provide a unique, high quality learning program for gifted students from Croatia and abroad.

This year we celebrate the 10^{th} anniversary of our School (the first camp was organized in 2001). As we tried to move our program forward, this year both camps (S^3, for 1^{st} and 2^{nd} year of high school and S^3++, for 3^{rd} and 4^{th} year) were international with participants as well as project leaders from abroad. S^3++ 2010 project leaders from Croatia, Slovenia, UK and USA have prepared five projects for sixteen participants from Bosnia and Herzegovina, Croatia, Germany, Serbia, Spain, Romania and USA. Beside projects, participants were actively involved in two workshops and four evening lectures. Everything was condensed in nine working days and one 'field trip day'. During that period twelve young scientists took part in our program as the project/workshop leaders or lecturers.

Evolution in the Core – a Journey Through the Basics of Artificial Life

Evolution has inspired computer scientists by giving them new and powerful tools to use in improving programs that they make. Evolution basically optimizes the performance of organisms in the environment in the same way that living organisms become more adapted to the world they live in. In CoreWar, programs- also called warriors, compete against each other in a simulated environment referred to as the *core*. In order to simulate evolution of warriors in the *core*, Blanca (Spain), Ivan Matej (Bosnia and Herzegovina) and Toni (Croatia) with their project leader Nenad Tomašev (Jožef Stefan Institute, Slovenia) created a genetic algorithm in java programming language. The program mimics the basic mechanisms of evolution: mutation, recombination, and selection, in order to create better warriors from existing ones. During the runs of the genetic algorithm, several types of warriors emerged, successively replacing each other as the population evolved and complexity increased. Mutation resistant forms were the most frequent ones, since they were not as likely to die from small random changes to their executing code.

Nuclear Magnetic Resonance – Construction and Application

From its invention in 1946, nuclear magnetic resonance (NMR) has remained one of the most important experimental techniques in physics, chemistry, biochemistry and medicine. Gabrijela Klara (Croatia), Markus (Germany) and Valentino (Croatia) together with their creative project leader Damjan Pelc (Faculty of Science, Zagreb) tried to construct a home-made NMR machine, suitable for simple physical and chemical experiments. Accompanied by many technical problems they bravely wriggled through the project and at the end created functional NMR device. They learned a lot about electronics, technical engineering and scientific background of NMR.

Finding Antibiotic Resistance Genes Using Phyletic Profiling

A well-known problem of antibiotic usage is that people misuse antibiotics for viral infections, which helps bacteria in their evolution and gaining resistance to antibiotics. Some bacteria are already resistant to multiple antibiotics, for example *Staphylococcus aureus*. In this project Mina (Serbia), Leti (USA), Alan (Croatia) and Ivan (Croatia) with their project leaders Fran Supek and Jelena Repar (Ruđer Bošković Institute, Croatia) tried to identify an antibiotic resistance gene from pool of ten "mystery" proteins. Using computer programming they created a hypothesis about the function of the ten "mystery" proteins and tested that hypothesis in the lab. Proteins with similar amino acid sequences often have similar function, so they compared the sequences on the computer using algorithm that they implemented. After validation of data using different data mining techniques they identify one of "mystery" proteins with antibiotic activity. Laboratory tests on *E. coli* mutant bacteria using different antibiotics confirmed hypothesis that *tolC* protin in *E. coli* acts as the specific drug efflux pump for tetracycline antibiotic.

Holography: Trapping the Light Fantastic

Holograms are a way of storing all the information about an object contained in the light it reflects or transmits. Because of this, they can be used to reproduce exact image of that object, including third dimension (depth). To make holograms light waves coming from the object are recorded onto a film in such way that the film responds not only changes in the intensity of light (like normal photographic film), but also changes in wave phases. There are several methods to make holograms, and during this project Barbara (Croatia), Hrvoje (Croatia), Ante (Croatia) together with Nicholas Harrigan (Imperial College London, UK) tried two of them. First they created transmission holograms to introduce the theory of holograms and their creation, followed by construction of reflection hologram. First step was to build anti-vibration table because holograms are really sensitive on vibrations, as well as to prepare dark room for making holograms and developing plates. The geometry and other details of the experimental arrangement were varied in order to try and ascertain the optimal conditions for producing holograms of each type.

Biomolecular Interactions - The Nuclear Pore Complex

Proteins function in many capacities: they form essential physical structures within the cell, including gateways between internal compartments and between the cell and the environment; they sense stimuli and signal responses; they catalyze the essential chemistry of life. Tamara (Croatia), Andrea (Romania) and Marina (Croatia) leaded by John LaCava (Rockefeller University, New York, USA) learned and implemented some current methods in the preparation of protein extracts from yeast cells, capturing the target proteins from the complex mixture of cell extract, and then detecting and visualizing them. Project included lot of practical biological work –buffer preparations, protein extraction and crosslinking, affinity chromatography, SDS-PAGE, different gel staining methods and Western blotting. Using computer software Cytoscape they schematically represented protein interaction networks from data available in public repositories.

Workshops

Two workshops have been organized during the Camp.

Science and Society workshop lead by Branimir Lukić attempted to stimulate a decision-making process by examining a project of Družba-Adria. Using combined debate and theater approach this issue was examined from several viewpoints, those of citizens, environmentalists, politicians and oil industry. “Government” at the end made a final decision.

Multidisciplinary Scientific Temptation (MST) is a workshop which consists of a short introductory part, practical group work and a final discussion. Students were placed into one of three teams: computer science, biology or chemistry team headed by Nino Antulov-Fantulin, Anamarija Štafa and Marko Košiček. The goal of MST was to simulate forensic (CSI) problem and methods which are often used for different forensic analysis. After 4 hours of practical work, each team presented their findings to the others at the discussion meeting and the “crime”.

Lectures

During the Camp four lectures have been organized from different field of science (medicine, chemistry, astronomy and scientific publishing). These lectures were followed by interesting discussions that fulfill the mail goal of lectures – developing the culture of science communication and critical thought.

Free time

During the camp we had one free day for a field trip to explore Croatian cultural and natural heritage. First we went to Monkodonja, ancient city near Rovinj and then we spent some time at the beach near Rovinj. After refreshing swim we visited Rovinj and Tićan before we came back in Višnjan.

For more information about Summer School of Science please visit our new web site open for 10th anniversary http://s3.sci.hr

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