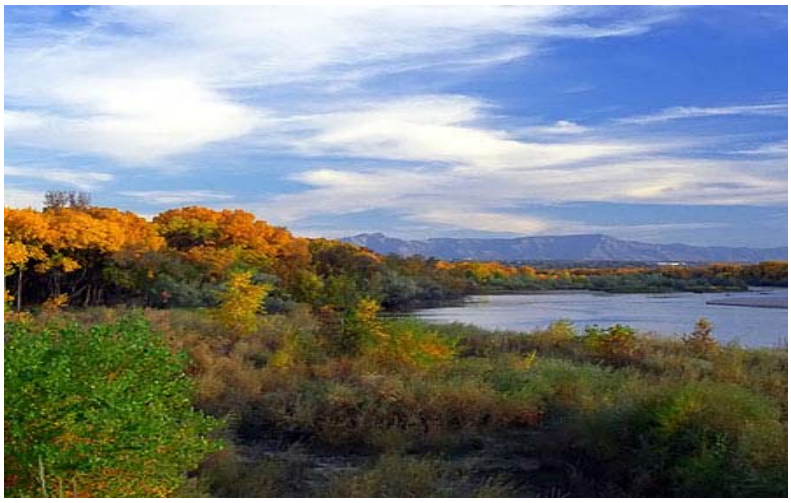
Science Teaching 589
New Mexico Tech
Supercomputing Challenge
2007
Summer Teacher Institute (STI)
Central New Mexico College
South Valley Campus
July 8 - July 20, 2007
Syllabus

Sandia Peak Tramway

Mission Statement
The mission of the Supercomputing Challenge is to improve students' understanding and use of technology by developing their skills in scientific inquiry, modeling, computing, communication, and teamwork.

Summer Teacher Institute Description
The Summer Teacher Institute (STI) is a two-week institute for teachers sponsored in conjunction with CNM, LANL, Sandia and New Mexico Tech. Acquiring skills to support computational science for mid and high school students is the overarching goal of STI. Topics will include problem solving, science, mathematical and agent based modeling, technology, programming, research, working with mentors, project management, time management, team management, presentations, gender equity, computer ethics and technical writing.

Goal of STI
Teachers will learn how to sponsor a Supercomputing Challenge team and how to help students complete an appropriate computational science project in keeping with the Challenge mission statement. The computational project incorporates four components, Project Management, Structured Programming and Design, Mathematical and Agent Based Modeling, and Internet Resources.



Rio Grande Bosque in Autumn

Project Development
Five areas of project-based learning will be a main focus: planning, research, development, refinement and implementation. The creation and maintenance of a yearlong project involves many responsibilities: topic selection, creating a problem definition, topic research, meeting deadlines, providing motivation, obtaining a mentor, ethical behavior, technical reports, oral and computer presentations, team development, time management, online responses, etc. Tips for planning this yearlong commitment will be shared.

Structured Programming and Design
A. Introduction to Computer Programming – JAVA
Computer programming is the process of planning and creating a sequence of steps for a computer to follow. In this class we will utilize the Java programming language on PCs running Windows and on a Linux machine.

Java is a full-featured programming language similar in functionality to C++ and other “high-level” languages. Once heralded as “the next-best thing” for the web, Java is now regarded as an exceptional language for creating stand-alone applications. This is in no small part due to the relative ease with which Java can create a GUI (Graphical User Interface). Many Colleges and Universities now teach Java in “Computer Programming 101”. The High School AP (Advanced Placement) test in computer science uses Java.

B. Introduction to StarLogo
The StarLogo language was designed to enable people to build their own models of complex, dynamic systems. Unlike many other modeling tools, StarLogo supports a tangible process of building, analyzing, and describing models that do not require advanced mathematical or programming skills. Using StarLogo, one can build and explore models and in the process develop a deeper understanding of patterns and processes in the world. In StarLogo, one writes

simple rules for individual behaviors. For instance, one might create rules for a bird, which describe how fast it should fly and when it should fly towards another bird. When one watches many birds simultaneously following those rules, she can observe how patterns in the system, like flocking, arise out of the individual behaviors. Building up models from the individual, or "bird," level develops a better understanding of the system, or "flock," level behaviors.

NetLogo is particularly well suited for modeling complex systems developing over time. Modelers can give instructions to hundreds or thousands of independent "agents" all operating concurrently. This makes it possible to explore the connection between the micro-level behavior of individuals and the macro-level patterns that emerge from the interaction of many individuals.
NetLogo lets students open simulations and "play" with them, exploring their behavior under various conditions. It is also an authoring environment which enables students, teachers and curriculum developers to create their own models. NetLogo is simple enough that students and teachers can easily run simulations or even build their own. And, it is advanced enough to serve as a powerful tool for researchers in many fields.

TNG, The Next Generation, is modeling and simulation software. While this version holds true to the premise of StarLogo as a tool to create and understand simulations of complex systems, it also brings with it several advances. Through TNG we hope to

1. Lower the barrier to entry for programming by making programming easier. Entice more young people into programming through tools that facilitate making games.
2. Create compelling 3D worlds that encompass rich games and simulations

La Luz Trail, North East Albuquerque

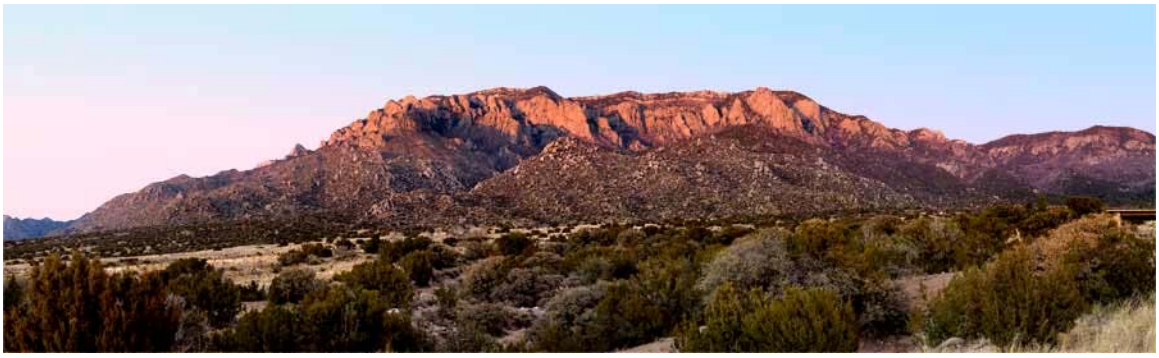
C. Introduction to Python
Python is a powerful and clear language for introducing programming. Python is becoming more popular for teaching computer programming. Its strengths for teaching include its syntactic simplicity, flexible typing, and interactive interpreter.

The interactive interpreter is an extremely valuable aid to learning and experimentation. Learning-by-doing is about trying things out and seeing what happens. The faster you can get results from your experiment, the faster that learning produces results. Using the interactive interpreter in place of a compiler can be helpful with initially learning the language or even quickly learning a new library. Python uses fewer symbols than languages like Java and C.

D. Mathematicia
From simple calculator operations to large-scale programming and interactive-document preparation, *Mathematica* is a tool at the frontiers of scientific research, in engineering analysis and modeling, in technical education from high school to graduate school, and wherever quantitative methods are used.

E. Prediction with Spreadsheets
Spreadsheets offer the function of predicting a trend from some existing data. One you are happy with the reliability of the data you have sourced, you can find out what would be the outcome for a dependent variable in the event of the independent variable (usually time) moving in steps. Linear regression is a statistical technique that is often used in business. We are going to look at a kangaroo farm and how we can predict the numbers from the farm.

Math Modeling
Mathematical modeling is the process of creating a mathematical representation of some phenomenon in order to gain a better understanding of it; mathematical modeling is an integral component of the computational science project. During the process of building a mathematical model, the modeler must decide what factors are relevant to the problem and what factors can be de-emphasized. Once a model has been developed and used to answer questions, it should be critically examined and often modified to obtain a more accurate reflection of the phenomenon. In this way, mathematical modeling is an evolving process; as new insight is gained, the process begins again as additional factors are considered. Generally the success of a model depends on how easily it can be used and how accurately it predicts.



Watermelon Aspect of the Mountains at Sunset

The mathematical modeling/computational science module will include an overview of the role of mathematical modeling in the computational science project, modeling sites and resources, some examples of models (compartmental models, population models, epidemic models, one- and two-dimensional heat flow models, etc.), and an introduction to some pitfalls in numerical computation. Examples will be implemented in Excel, but can be programmed in JAVA or any other procedural computer language.

Internet Resources – The Challenge website, http://challenge.nm.org, will link to all important resources: Technical Guide, teacher resources on gender equity, ethics, computational science, mentors, research, presentations, technical writing, grants, programming, data resources, etc. Links to science, math, technology and computational science standards and ways to integrate technology into the curriculum will be utilized. These sites will be shared throughout the two weeks.

Course Requirements
Students will attend two full weeks of classes, 90 hours, covering core components of computational science: project development, programming, math modeling, and Internet resources.

Students will

- participate in creating a team supercomputing computational project.
- present the project to a team of judges.
- learn about the 2007-08 Challenge timetable, milestones and expectations
- learn programming skills: an introduction to JAVA programming, Star Logo, Math and Excel programming
- learn math and agent based modeling, computational techniques, project management tips, and research aides.

Sandia Mountains from Downtown Albuquerque

Credit
Interested attendees will receive three units of graduate credit from New Mexico Tech, course name and number Science Teaching 589.

Grading
Grading will be based on creating a teamed computational science project. Students will complete a collaborative digital portfolio by posting a web page on the Mode computer at Los Alamos.

Readings and Online Resources and Software
Readings are in the STI library or online. Technical manuals will be accessed from online sources. The library will have books from the instructors' collections of texts and references that relate to computational science, modeling, complex systems and personal favorites.

Resources
Bonnie Averbach and Orin Chein, *Problem Solving Through Recreational Mathematics*, Dover, 2000.

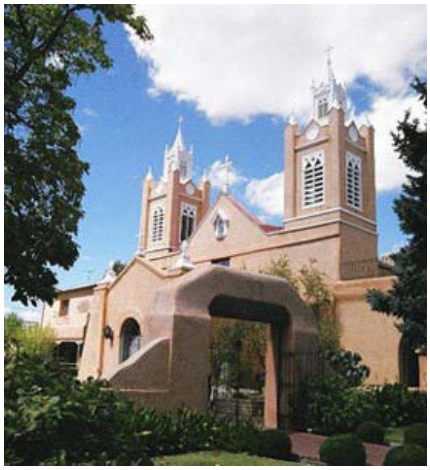
Allen Downey, Jeff Elkner and Chris Meyers, *How to Think Like a Computer Scientist: Learning with Python* **http://www.greenteapress.com/thinkpython/**

Dmitri Fomin, Sergey Genkin, Ilia Itenberg, *Mathematical Circles (Russian Experience),* American Mathematical Society, 1996.

Patrick Lenicioni, *The Five Dysfunctions of a Team,* Jossey-Bass,1965.

Thom Markham, John Mergendoller, John Larmer, and Jason Ravitz, *Project Based Learning Handbook*, Buck Institute for Education, 2003

Polya, *How to Solve It: A New Aspect of Mathematical Method*
First Princeton Paperback Printing, 1973



Old Town Church

Kathy Sierra, Bert Bates, *Head First Java, Second Edition*, O'Reilly, February 2005

Paul Zeitz, *The Art and Craft of Problem Solving*, John Wiley & Sons, Inc., 1999

Math Circles http://www.geometer.org/sjcircle/

Towards 2020 Science — A Reader's Guide, March 2006, Microsoft
Schools Fail to Teach and 2020 Science Report Summary

Teaming: Forming Storming Norming Performing
http://www.businessballs.com/tuckmanformingstormingnormingperforming.htm

Use of Complexity Science
http://complexsys.org/pdf/ComplexityScienceSurvey.pdf

Supercomputing Challenge web page resources
http://challenge.nm.org/resources

Guiding Student Research: Making Research Happen in Your School: The National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology

StarLogo Download from http://education.mit.edu/starlogo

NetLogo Download from http://ccl.northwestern.edu/netlogo

Teacher Forum – Creating Communities
http://drupal.org/

Mathematica
Student Resources
http://www.wolfram.com/products/student/mathforstudents/resources.html

NetBeans - NetBeans is an integrated development environment (IDE), developed and made available at no cost by Sun. It is principally for use in Java development, but can also be used for writing code in other languages.
www.netbeans.org

Cmap, free concept mapping software

Instructors

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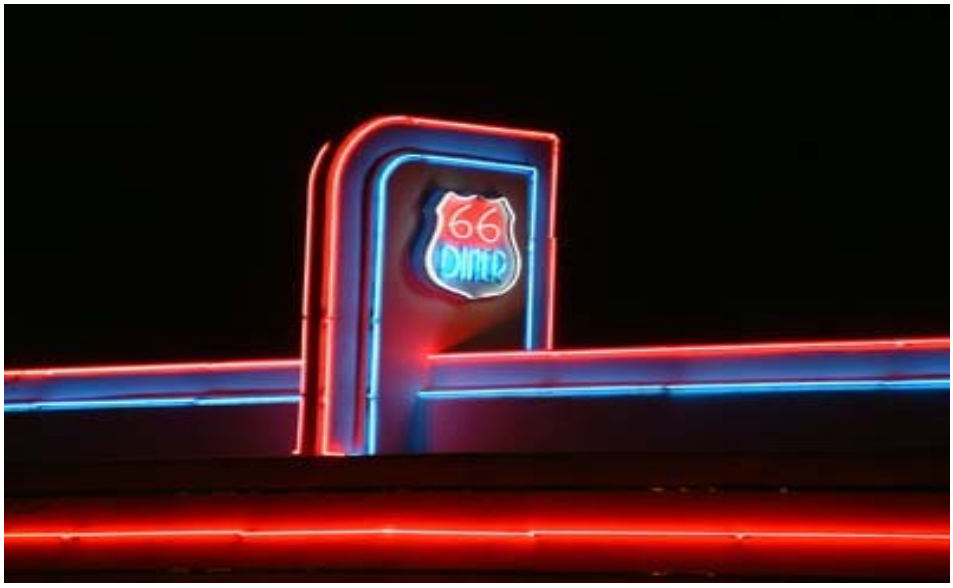
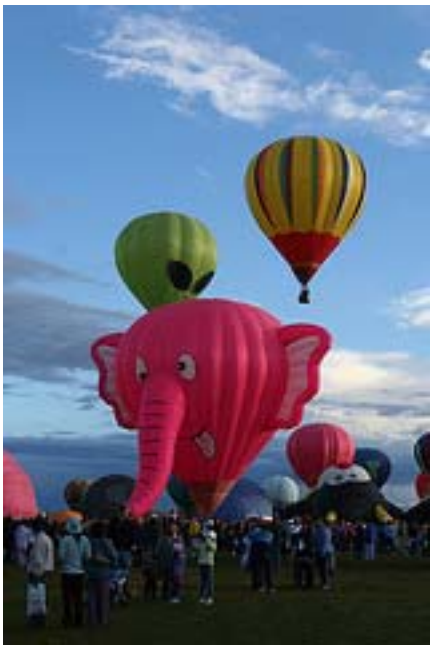


Get Your Kicks on Route 66 (and check out the neon!)

Web Resources (Partial)

Bad Science
http://www.ems.psu.edu/~fraser/BadScience.html
Challenge Acceptable Use Policy
http://www.challenge.nm.org/Glorieta/aup.shtml
Gender Equity - http://www.holtsoft.com/chris/CASCONEquity.pdf
Women in Science
http://www.womeninscience.org/
Girls are Closing the Gap
http://online.wsj.com/article_email/0,,SB111213497906192393lJjg4NjlaJ4o56nZHSJaKWJm4,00.html
Mathematical Models
http://www.krellinst.org/AiS/textbook/unit2/projdev2.3.5.html
Modeling for Understanding in Science Education

http://www.wcer.wisc.edu/ncisla/muse/
NASA Math Models and Data - http://geo.arc.nasa.gov/sge/landsat/l7.html
Non-software Teacher Resources to Support Modeling
http://www.ecsu.k12.mn.us/envision/gradrule/additional.html
Supercomputing Challenge
http://www.challenge.nm.org/
Research –
http://www.challenge.nm.org/archive/0102/STI/Research_for_STI.html
Other SC related links –
Siemens Westinghouse Competition
http://www.siemens-foundation.org
Technical Guide – StarLogo, JAVA, Unix, etc.
http://www.challenge.nm.org/ctg



Writing the Final Report
http://www.challenge.nm.org/FinalReports/writing.shtml
Fractal Foundation
www.fractalfoundation.org

Schedule for 8 July – 20 July

Sunday, 8 July. 5:00 – 8:00
Hotel Check In
Reception, Introductions
Icebreakers

Monday-Friday, 9 July – 20 July, 8:30 – 4:30

The first week of Summer 2007 STI is devoted to learning what a successful computational project is. We will use a transportation example and develop models in Java, NetLogo, and Python. We will introduce TNG and Mathematica. All participants will be introduced to each of the software tools. By Wednesday, they will have selected one to use to develop a well-defined example that will be presented on Friday in an proposal, mimicking the Challenge year for students.

Participants will use a Drupal based blog as a routine part of reporting, discussion, research and assessment. We hope that students can learn to blog to journal their Challenge year.

We are embarking upon a new middle school strategy based on the success of the NSF grant, GUTS, Growing Up Thinking Scientifically.

On Monday the 9th, there will be a Keynote Presentation. Other special events including visits by Jonathan Wolfe, from the Fractal Foundation, field trip to Eclipse Aviation, solar cooker building and usage, and guest lecturers about the Challenge, computational science and transportation networks.

Monday – Friday, 16 July – 20 July

During the second week, students will draw on the experiences with the transportation models and plan and execute their own projects in team format. The effort will incorporate the essential practices that their students will need to complete a successful Challenge project: problem definition, abstracts, research, mentors, good teamwork strategies, milestone planning, programming, multiple examples, and oral, visual, and written presentations. Lecture/online tutorials will address each of these aspects. The projects will be shown to a panel of Challenge judges on Friday afternoon.

The second week will include a detailed look at the Challenge year schedule with an emphasis on deadlines and special events. Additionally, students will continue to explore and utilize the resources available at http://challenge.nm.org. Visiting scientists, Challenge teams and teachers from previous years, video presentations, and Internet resources will continue to supplement the project work. Additionally, there will be continued use of the bulletin boards, blogs. eMail, and video/audio tools for discussion, reflection and assessment.

Suggested Evening and Weekend Educational Field Trips

Albuquerque Isotopes Baseball Club
1601 Avenida Cesar Chavez SE
Albuquerque, NM 87106
Phone: (505) 924-BALL
www.albuquerquebaseball.com

Museums

Albuquerque Museum (The)
American International Rattlesnake Museum
Explora Science Center and Children's Museum of Albuquerque
Indian Pueblo Cultural Center
Maxwell Museum of Anthropology
National Atomic Museum
Natural History Museum
LodeStar Astronomy Center
Startup: Albuquerque and the Personal Computer Revolution

Outside Venues

Duck Pond at UNM
La Luz Trail
Old Town
Petroglyph National Monument
Rio Grande Nature Center
Rio Grande Bio Park
Concert series. Thursdays, Bio Park Botanic Gardens. Fridays, Rio Grande Zoo. Albuquerque. 764-6200.
Route 66
Sandia Tram

Shopping

Albuquerque Uptown
Coronado Mall
Cottonwood Mall
Old Town
Weekend Flea Market

Weekend Fun
Indian Dances every weekend. Indian Pueblo Cultural Center

Albuquerque Summerfest is an outdoor summer festival featuring both local and national music and dance entertainment. Saturday evenings from 5 - 10:30 pm at the Harry E. Kinney Civic Plaza *(corner of 3rd St. and Marquette NW)* in downtown Albuquerque and are free to the public. In addition to music and dance entertainment there are food vendors, a beer garden, an arts and crafts market, and plenty of children's activities such as face painting, magic, juggling, interactive drumming, fun jumps and more. Parking is available under the Harry E. Kinney Civic Plaza for a fee. Access parking lot from 3rd St. and Marquette.

Catch the Bird to Summer Fun!

Beginning Memorial Day weekend and running through Labor Day weekend, the New Mexico Rail Runner Express is offering special Friday and Saturday service for the summer.

Summer Schedule (PDF)

Note: On Friday, the regular Rail Runner fares apply. On Saturday, a flat $2 fee of will be charged for unlimited Rail Runner travel for the day.*