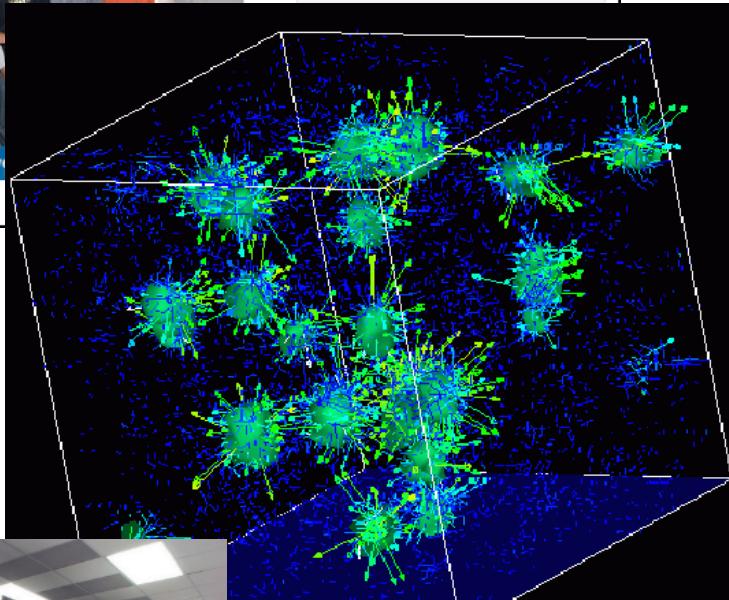


The screenshot shows the Brookhaven National Laboratory's Educational Programs page. The header features the laboratory's logo and the text "Educational Programs". Below the header is a navigation bar with links for Home, About, Teachers, Students, College Faculty, Postdocs, Mentors, and News. To the right of the navigation bar are social media icons for Facebook, Twitter, Google+, and YouTube. A "Now Featuring" section highlights the "4th Annual SCI-ED Day" held on November 4, 2014. Below this, there are two images: one showing a group of people at a science fair booth and another showing a person in a lab coat. A blue banner at the bottom left reads "Upcoming Events".

# Survey of Scientific Computing (SciComp)



```
1  using System;
2  using System.Collections.Generic;
3  using System.ComponentModel;
4  using System.Data;
5  using System.Drawing;
6  using System.Linq;
7  using System.Text;
8  using System.Windows.Forms;
9
10 namespace SimpleEvents
11 {
12     public partial class Form1 : Form
13     {
14         Person person = new Person();
15
16         public Form1()
17         {
18             InitializeComponent();
19             person.FirstName = "Christian";
20             person.LastName = "Rene";
21         }
22
23         private void button1_Click(object sender, EventArgs e)
24         {
25             person.HairColor = textBox1.Text;
26         }
27     }
28 }
```

## Unit 1 Course Overview, Hello Problems

## About Brookhaven National Laboratory



### Who We Are

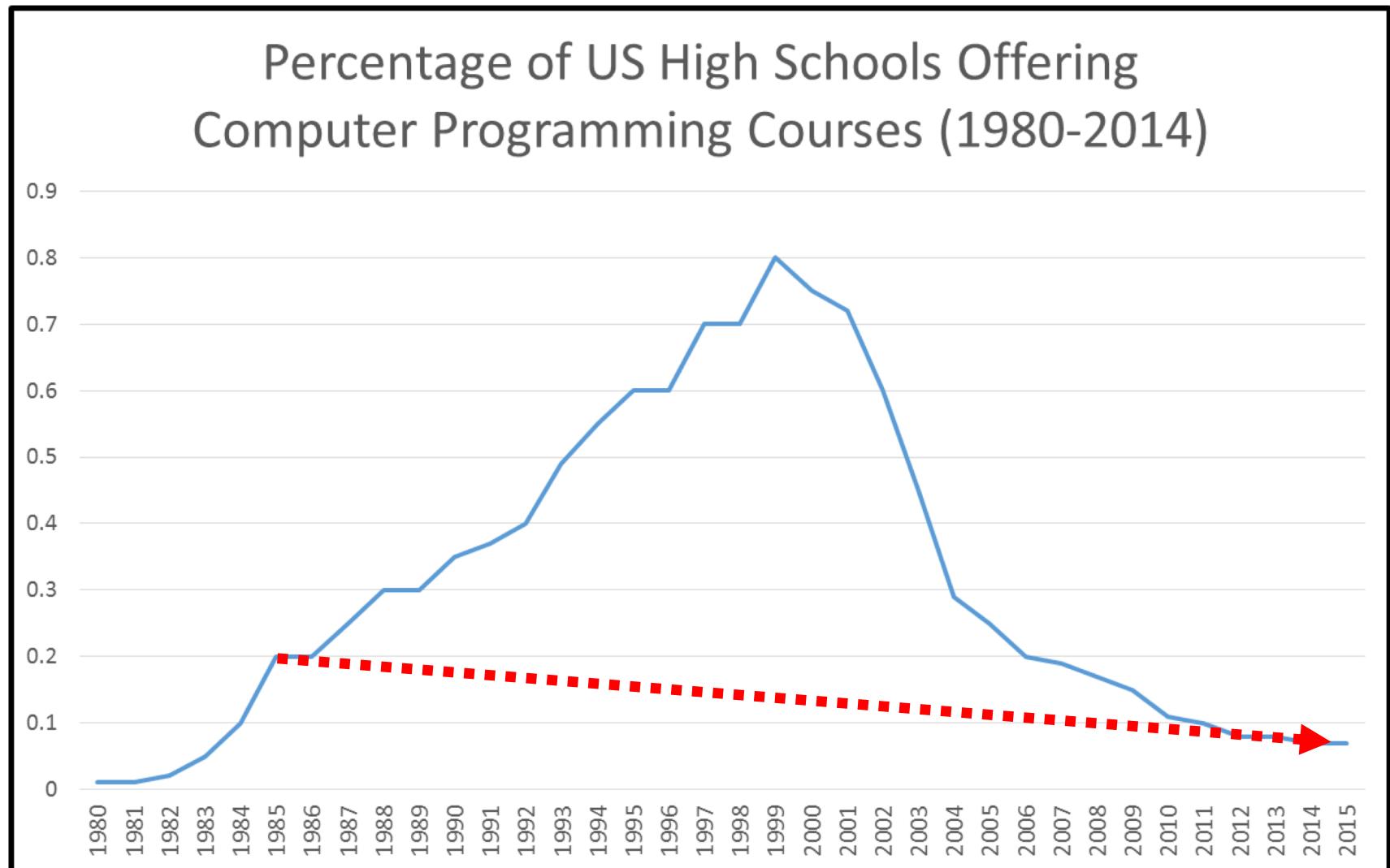
Brookhaven National Laboratory is a multipurpose research institution funded primarily by the U.S. Department of Energy's Office of Science. Located on the center of Long Island, New York, Brookhaven Lab brings world-class facilities and expertise to the most exciting and important questions in basic and applied science—from the birth of our universe to the sustainable energy technology of tomorrow.

We operate cutting-edge large-scale facilities for studies in physics, chemistry, biology, medicine, applied science, and a wide range of advanced technologies. The Laboratory's almost 3,000 scientists, engineers, and support staff are joined each year by more than 4,000 visiting researchers from around the world. Our award-winning history stretches back to 1947, and we continue to unravel mysteries from the nanoscale to the cosmic scale, and everything in between.

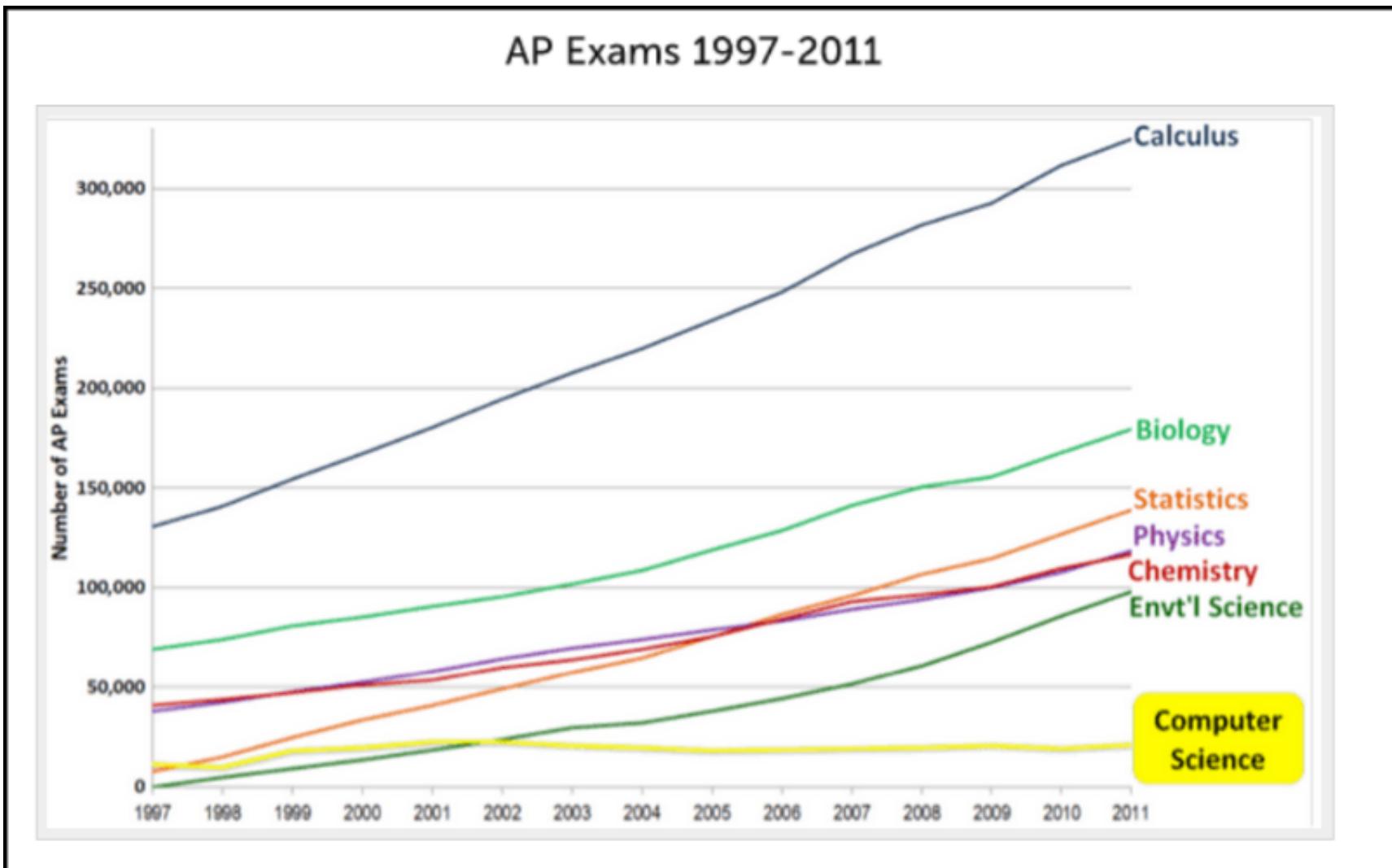
# Agenda

- The Growing Need for Scientific Computing
- Differentiating CompSci vs. **SciComp**
- Scientific Computing is *the* Pathway for STEM
- SciComp as a **Translational** Science
- Detailed Course Syllabus
- Motivation for learning C++
- Reasonable Course Expectations
- Getting a Degree in Scientific Computing

# A National Challenge



# A National Challenge



# The Challenge to DOE

- Scientists across DOE have noted a dramatic rise in the **startup latency** of interns who do not possess foundational programming skills
- This latency means that for the ***initial 6-8 weeks of their assignment***, the interns are essentially unproductive as they must first acquire basic knowledge of how to write software
- Instead of learning key scientific principles from their mentor, the interns are spending their precious lab time **often working alone**, figuring out how to instruct the computer to perform rudimentary data processing tasks
- From the perspective of DOE scientists, **the need to adeptly wield software tools has never been as urgent as it is today**

# The Hype

## Kevin's Story

Modern-day scientists and engineers are spending more and more of their work days in front of the computer. As an example, consider my friend Kevin, who works in oceanography and mechanical engineering. Whoa, sounds like he's probably spending all day out on high-tech boats rigging together mechanical devices like MacGyver and collecting data from underwater sensors, right? This must be his typical work day -- hard hats and heavy-duty work gloves.



# The Reality

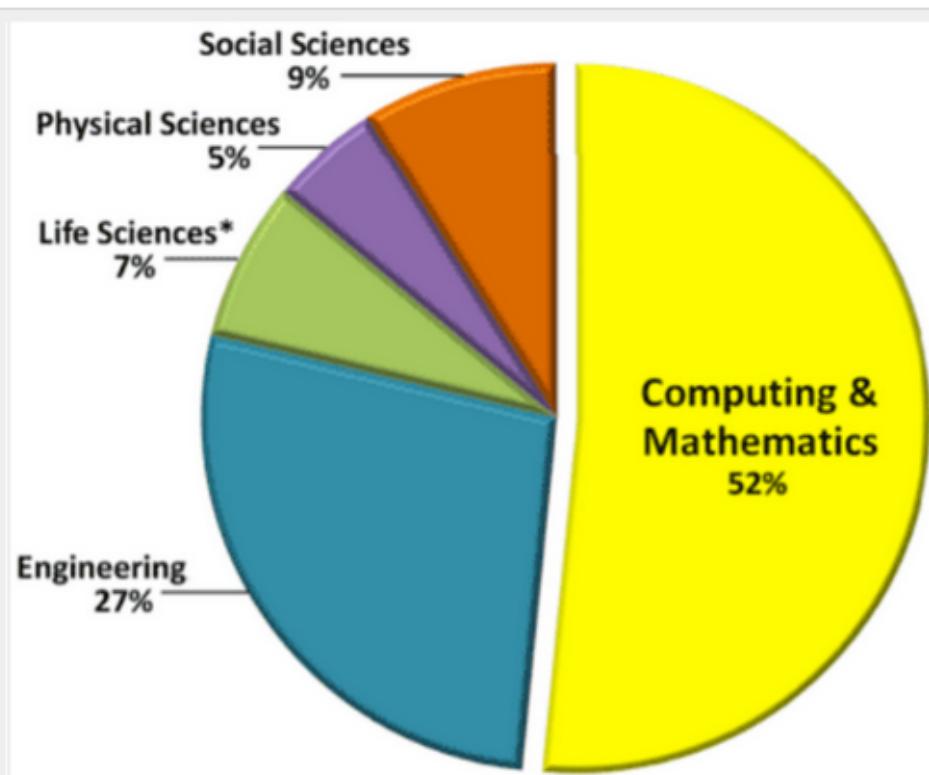
Actually, Kevin spends less than 5% of his time out on the ocean; the other 95% of the time, he's sitting in front of the computer writing programs to clean up, transform, process, and extract insights from data collected out in the field. This is what Kevin looks like at work on most days:



The same story plays out for scientists and engineers in all sorts of fields: astronomers, biologists, physicists, aerospace engineers, economists, geneticists, ecologists, environmental engineers, neuroscientists ... the list goes on and on. Modern-day science and engineering is all about processing, analyzing, and extracting insights from data.

# The Irony

Projected Annual Growth of STEM Job Openings 2010-2020



Source: Jobs data are calculated from the Bureau of Labor Statistics (BLS), Employment Projections 2010-2020

# US Department of Labor - 2019

## Robotics Engineering Careers

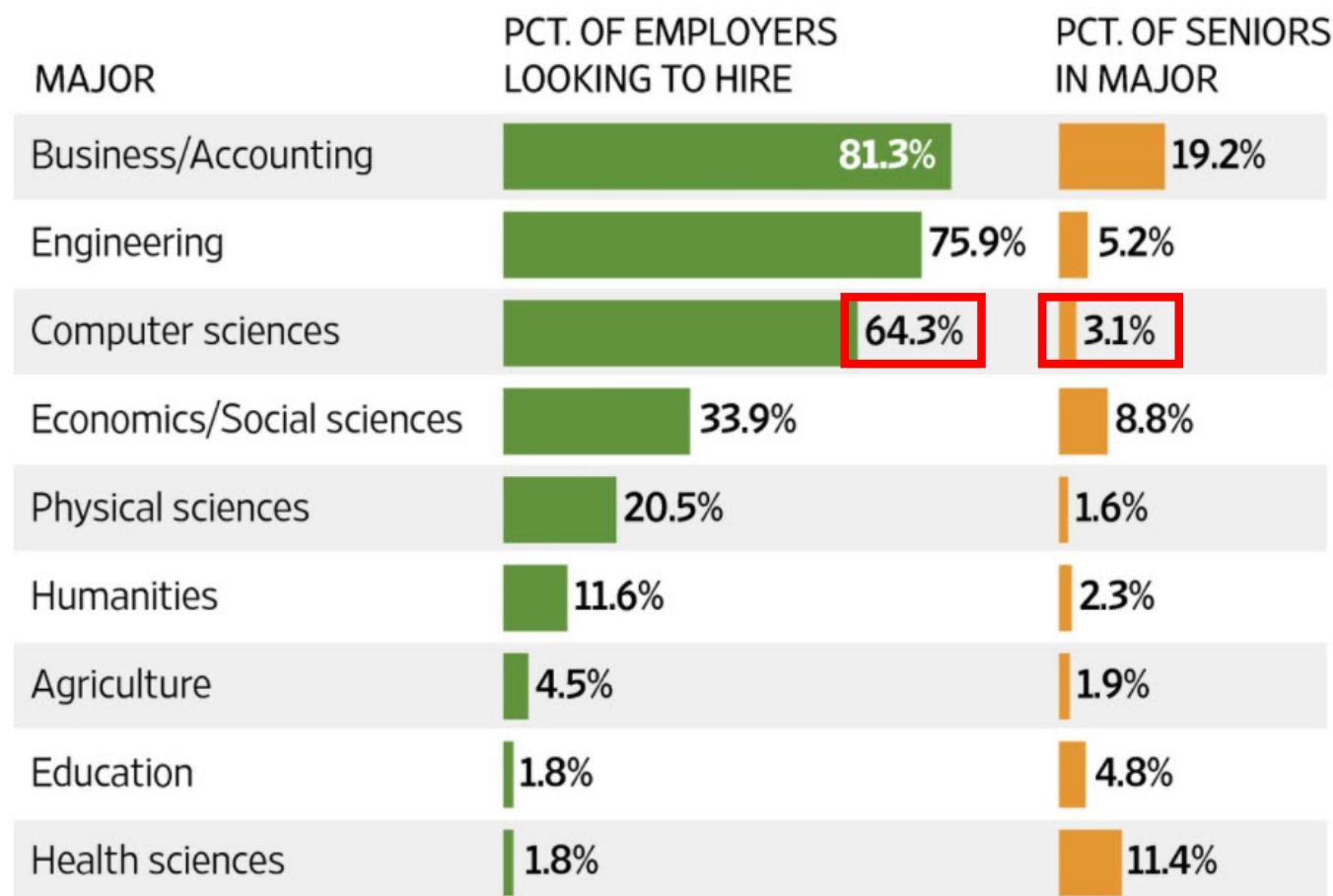
Quick Facts: Electro-mechanical Technicians	
2018 Median Pay ?	\$57,790 per year \$27.78 per hour
Typical Entry-Level Education ?	Associate's degree
Work Experience in a Related Occupation ?	None
On-the-job Training ?	None
Number of Jobs, 2016 ?	13,800
Job Outlook, 2016-26 ?	4% (Slower than average)
Employment Change, 2016-26 ?	500

## Scientific Computing Careers

Quick Facts: Computer and Information Research Scientists	
2018 Median Pay ?	\$118,370 per year \$56.91 per hour
Typical Entry-Level Education ?	Master's degree
Work Experience in a Related Occupation ?	None
On-the-job Training ?	None
Number of Jobs, 2016 ?	27,900
Job Outlook, 2016-26 ?	19% (Much faster than average)
Employment Change, 2016-26 ?	5,400

# The College Majors Employers Want

Employers are on the hunt for engineering, business and computer-science graduates; here's how popular those majors are among college seniors.



Note: Current hiring plans compared with degrees conferred in 2015

Sources: National Association of Colleges and Employers;  
National Center for Education Statistics

THE WALL STREET JOURNAL.



Current Students  
Calendar  
Jobs  
Contact

# Stanford High School Summer College



ABOUT ▾ ACADEMICS ▲ STUDENT LIFE ▾ TAKE THE TOUR ADMISSIONS ▾ APPLY ▾

2016 Courses Registration Instructors Intensives Credit & Course Load Academic Support

## Introduction to Scientific Computing (CME 108)

### DESCRIPTION

Introduction to Scientific Computing Numerical computation for mathematical, computational, physical sciences and engineering: error analysis, floating-point arithmetic, nonlinear equations, numerical solution of systems of algebraic equations, banded matrices, least squares, unconstrained optimization, polynomial interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations, truncation error, numerical stability for time dependent problems and stiffness. Implementation of numerical methods in MATLAB programming assignments. Prerequisites: MATH 51, 52, 53; prior programming experience (MATLAB or other language at level of CS 106A or higher).nGraduate students should take it for 3 units and undergraduate students should take it for 4 units.

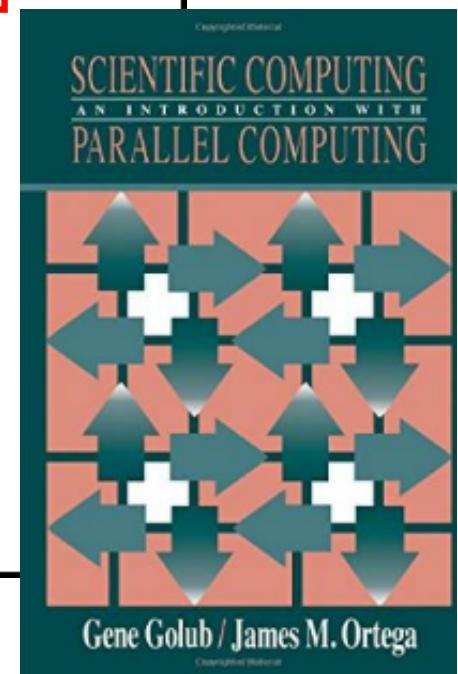
# What is Scientific Computing?

Golub and Ortega: “*Scientific computing is the collection of tools, techniques and theories required to solve on a computer mathematical models of problems in science and engineering.*”

Or a more narrow definition: “*Development and use of numerical methods and mathematical models to solve real-world problems efficiently on computers.*”

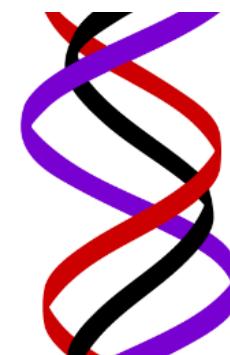
Interdisciplinary field requiring:

- knowledge about the underlying (physical) problem,
- ability to formulate a mathematical model,
- stable & accurate numerical schemes,
- efficient implementation on high performance computers.



# What is Scientific Computing?

- Scientific computing problems **cannot be solved** using a graphing calculator or with Microsoft Excel
  - The computer should not been seen as just another closed form tool like an scientific instrument
  - SciComp does not require writing thousands of lines of code to answer problems – complete code usually fits on **one** slide!
- SciComp is **applied** computer science
  - The first name of CompSci is *computer*
  - The first name of SciComp is science
  - A **triple helix** of math, science, and computing



# SciComp vs CompSci

## Scientific Computing

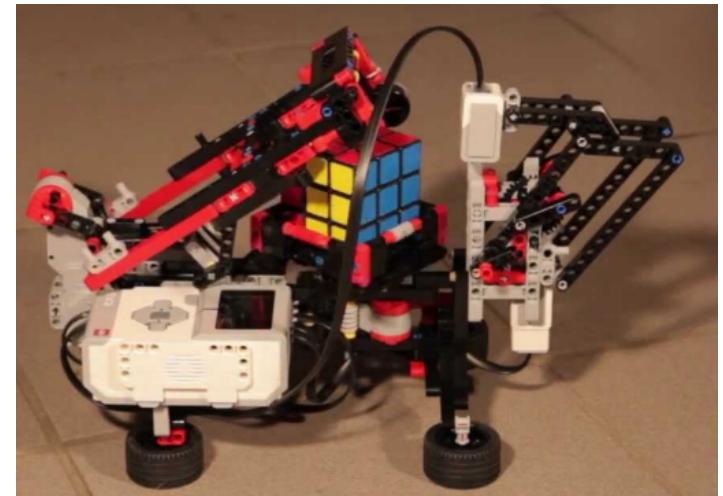
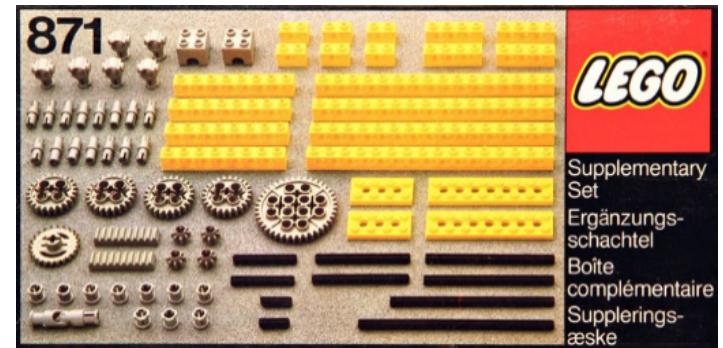
- Probability and Statistics
- Simulation and Modelling
- Data Visualization
- Storing and Analyzing Very Large Datasets
- Parallel & Distributed Algorithms
- Speed and Accuracy Paramount
- Functional Languages
- Open-Ended Problems with Unknown Solutions

## Computer Science

- General Data Structures
- Design Methodologies
- Procedural Languages
- Stand-Alone Programs
- Emphasis on Object-Orientation
- Simple Data Models
- Sequential Algorithms
- Less Graphics Intensive
- Directed Closed-Form Problems with Known Solutions

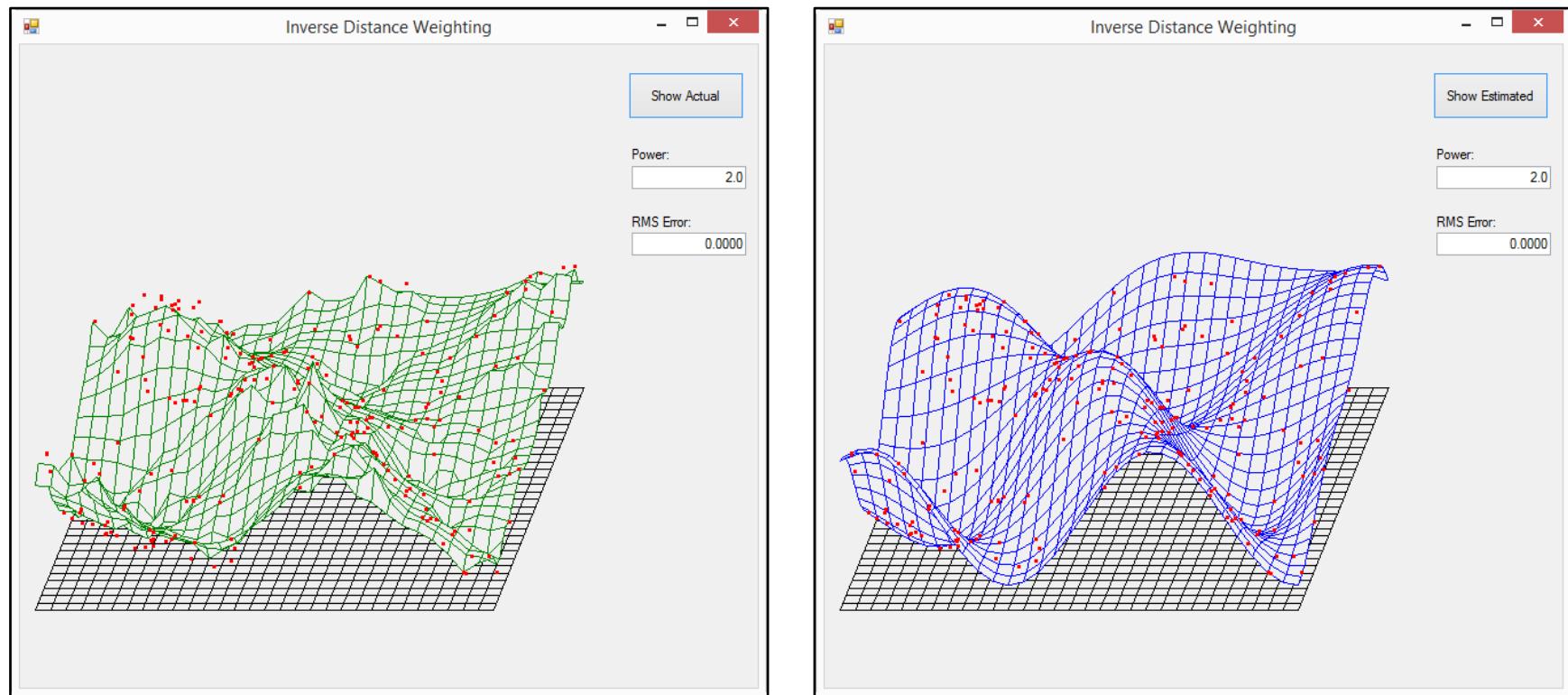
# SciComp = Just Enough CompSci

- Data **types**: **int, double, bool, string**
- Data **structures**: pointers, vectors, streams, classes
- **Statements**: **for(), while(), if(), return**
- **Patterns**: brute force, recursion, divide & conquer, map-reduce
- **Algorithms**: GCD, mean/variance, sorting, searching
- **Helpers**: **Random**, mod %, Stopwatch, **Allegro**, **ROOT**



# Example SciComp Topic

## Multidimensional Interpolation



A first order approximation having only 24%  
of the world sampled (220 of 900 actual points)

# SciComp As Translational Science

$$u(\mathbf{x}) = \begin{cases} \frac{\sum_{i=1}^N w_i(\mathbf{x}) u_i}{\sum_{i=1}^N w_i(\mathbf{x})}, & \text{if } d(\mathbf{x}, \mathbf{x}_i) \neq 0 \text{ for all } i \\ u_i, & \text{if } d(\mathbf{x}, \mathbf{x}_i) = 0 \text{ for some } i \end{cases}$$

where

$$w_i(\mathbf{x}) = \frac{1}{d(\mathbf{x}, \mathbf{x}_i)^p}$$

```
double GetEstHeight(double x, double z)
{
    double sumWeight = 0;
    double sumHeightWeight = 0;

    for (size_t n{}; n < numSamples; ++n) {
        double distance = sqrt(pow(x - samples[n].x, 2)
                               + pow(z - samples[n].z, 2));

        if (distance == 0) return samples[n].y;

        double weight = 1 / pow(distance, p);
        sumWeight += weight;
        sumHeightWeight += samples[n].y * weight;
    }

    double height = sumHeightWeight / sumWeight;
    return height;
}
```

# SciComp = The Pathway to Internships

indeed®

what: **Scientific Computing** where: **Find Jobs**

job title, keywords or company

Upload your resume - Let employers find you

Jobs 1 to 10 of 2,103

Scientific Computing jobs

Sort by: relevance - date

Salary Estimate

- \$65,000+ (1780)
- \$80,000+ (1496)
- \$95,000+ (1059)
- \$105,000+ (762)
- \$120,000+ (363)

Job Type

- Full-time (1965)
- Contract (129)
- Temporary (42)
- Internship (35)
- Part-time (34)
- Commission (6)

Company

- Xilinx (88)
- Sandia National Laboratories (44)**
- Lawrence Berkeley National Laboratory (42)**
- BAE Systems (34)
- General Dynamics Advanced Information Syste
- General Dynamics Mission Systems (34)
- Amazon Corporate LLC (34)
- Member Technology (33)
- Oak Ridge National Laboratory (31)**
- Medical Science & Computing, Inc. (30)**
- The Johns Hopkins Applied Physics Laborator**
- xentity corporation (24)
- Lawrence Livermore National Laboratory (19)**
- Sentient (17)
- Howard Hughes Medical Institute (17)

**Software Developer - 963**  
HX5 - Huntsville, AL  
The ITL conducts research and development in Informatics and Computational Science and Engineering with particular emphasis on providing high-performance...  
12 days ago - email  
Sponsored

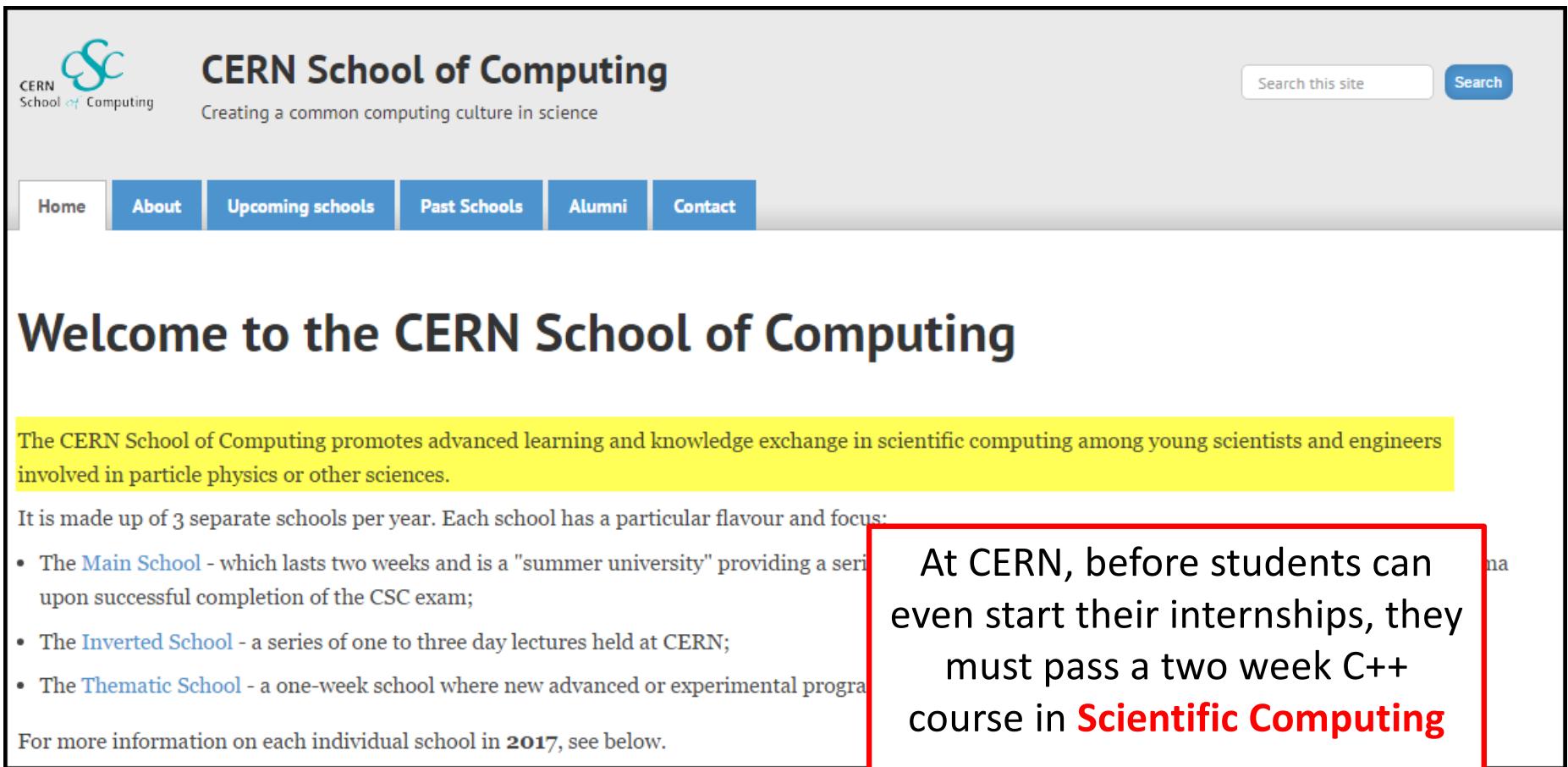
**Senior Computational Biologist**  
Medical Science & Computing - Bethesda, MD  
Medical Science & Computing (MSC) is an exciting growth oriented company, dedicated to providing mission critical scientific and technical services to the...  
Easily apply  
14 hours ago - email  
30+ days ago - email  
Sponsored

**Computational Scientist**  
Texas A&M Engineering - College Station, TX  
Experience in scientific computing and in-depth understanding of the following:. The HPRC is in process to purchase a new supercomputer, and its current...  
6 days ago - save job - email - more...

**Computational Scientist**  
Engility Corporation - ★★★★☆ 228 reviews - Virginia  
Experience in Scientific Computing environment with Scientific background preferably in chemistry, toxicology, biology (10+ years)...  
15 days ago - save job - email - more...



# SciComp = The Pathway to Internships



The screenshot shows the CERN School of Computing website. The header features the logo 'CERN School of Computing' with a stylized 'SC' icon. Below the logo is the tagline 'Creating a common computing culture in science'. A search bar with 'Search this site' and 'Search' buttons is on the right. A navigation menu at the top includes 'Home' (highlighted), 'About', 'Upcoming schools', 'Past Schools', 'Alumni', and 'Contact'. The main section has a large title 'Welcome to the CERN School of Computing'. Below it is a yellow box containing text about the school's purpose. A list of three types of schools is provided, followed by a note about individual school information. A red box highlights a statement about a C++ course in Scientific Computing, and another red box highlights the importance of these skills.

The CERN School of Computing promotes advanced learning and knowledge exchange in scientific computing among young scientists and engineers involved in particle physics or other sciences.

It is made up of 3 separate schools per year. Each school has a particular flavour and focus:

- The [Main School](#) - which lasts two weeks and is a "summer university" providing a series of lectures and projects upon successful completion of the CSC exam;
- The [Inverted School](#) - a series of one to three day lectures held at CERN;
- The [Thematic School](#) - a one-week school where new advanced or experimental programs are introduced.

For more information on each individual school in [2017](#), see below.

At CERN, before students can even start their internships, they must pass a two week C++ course in **Scientific Computing**

That is how important CERN views these skills!

## (HSRP - Research) High School Research Program

The High School Research Program (HSRP) is a highly competitive six week educational program for students interested in pursuing science, technology, engineering and mathematics (STEM) studies. Selected students, together with Brookhaven National Laboratory (BNL) scientific staff collaborate on projects that support BNL and the Department of Energy mission.

**HSRP is a commuter program. BNL does not provide housing or transportation to and from the Laboratory.**

### Audience for This Program

Recommended for students that have completed 11th grade. Due to BNL safety regulations students under the age of 18 may not be allowed to perform certain tasks.

### Rules & Eligibility Criteria

1. Must be available for the entire duration of the program, Monday to Friday 8:30 a.m. to 5:00 p.m.
2. Transportation and housing is not provided.
3. Must be a United States Citizen or Permanent Resident Alien (PRA) at the time of applying. PRA must hold an active United States Permanent Resident Card.
4. Recommended for students that have completed the 11th grade and not be younger than 15 years of age at the start of the program.



The High School Research Program (HSRP) is an advanced high school program in which students are paired with a BNL scientist.

### Important Dates

**Registration Opens:**  
Wednesday, December 19, 2018, at 9:00 a.m.

**Registration Closes:**  
Friday, March 22, 2019, at 5:00 p.m.

**Program Starts:**  
Monday, July 8, 2019, at 9:00 a.m.

**Program Ends:**  
Friday, August 16, 2019, at 5:00 p.m.

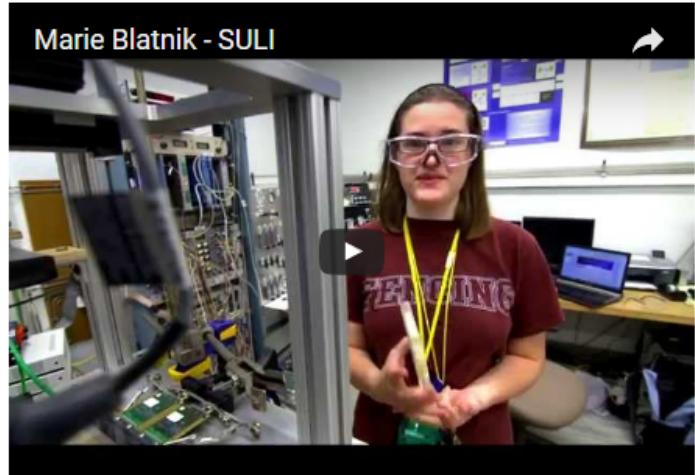
**Application Deadline:**  
Friday, March 22, 2019, at 5:00 p.m.

**All notifications send by:**  
Friday, May 17, 2019, at 5:00 p.m.

### Contact Information

For more information about this program

## (Internship - SULI) Science Undergraduate Laboratory Internship



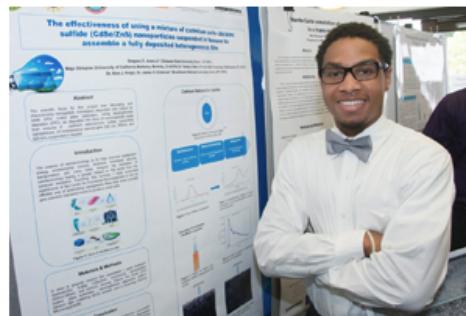
**SULI Intern Interview:** Studies in calorimetry using silicon photomultipliers and tracking using gas electron multipliers for the super-PHENIX upgrade Experiment

The U.S. Department of Energy (DOE) has established a national program to give research experience in areas of chemistry, physics, engineering, biology, nuclear medicine, applied mathematics, high- and low-energy.

Brookhaven National Laboratory (BNL) offers student appointments through a national program titled the Science Undergraduate Laboratory Internship (SULI) developed through DOE. Participants will be placed with members of the scientific and professional staff in an educational program developed to give research experience in areas such as chemistry, high- and low-energy physics, engineering, biology, nuclear medicine, applied mathematics.

At BNL, a SULI appointment will include features which have been the mainstay of our undergraduate Student Program since 1952:

- You will participate in a cutting-edge scientific research program, directed by a BNL staff member. The nature of your research assignment will be determined after a review of your background and interests by our staff, relative to their current research activities.



The United States Department of Energy (DOE) has established undergraduate research internships at national laboratories across the country. These internships are run for 10 weeks during the summer and for 16 weeks during the fall and spring semesters. Internships are offered in areas such as physics, biology, chemistry, environmental and atmospheric sciences, engineering, computers applied mathematics and nuclear science.

### Important Dates

**Program Starts:**  
Monday, January 9, 2017, at 8:00 a.m.

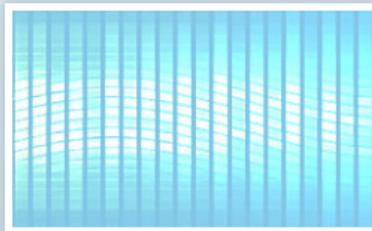
**Program Ends:**  
Friday, April 28, 2017, at 5:00 p.m.

**Spring Application Due:**  
Friday, October 7, 2016, at 5:00 p.m.

### Contact Information

For more information about this program, contact:

**Dr. Mel Morris**  
Brookhaven National Laboratory  
Bldg.438 – P.O. Box 5000  
Upton, NY 11973-5000  
631-344-5963 (phone)  
631-344-5832 (fax)  
[mmorris@bnl.gov](mailto:mmorris@bnl.gov)



Computer Science &amp; Mathematics



Scientific Data &amp; Computing Center



Center for Data-Driven Discovery



Computational Science Lab

## About Us

Building on its capabilities in data-intensive computing and computational science, Brookhaven National Laboratory is embarking upon a major new Computational Science Initiative.

Advances in computational science, data management and analysis have been a key factor in the success of Brookhaven Lab's scientific programs at the Relativistic Heavy Ion Collider (RHIC), the National Synchrotron Light Source (NSLS), the Center for Functional Nanomaterials (CFN), and in biological, atmospheric, and energy systems science, as well as our collaborative participation in international research endeavors, such as the ATLAS experiment at Europe's Large Hadron Collider.

The Computational Science Initiative (CSI) brings together under one umbrella the expertise that has driven this success to foster cross-disciplinary collaborations to address the next generation of scientific challenges posed by facilities such as the new National Synchrotron Light Source II (NSLS II). A particular focus of CSI's work will be the research, development and deployment of novel methods and algorithms for the timely analysis and interpretation of high volume, high velocity, heterogeneous scientific data created by experimental, observational and computational facilities to accelerate and advance scientific discovery. CSI is hereby taking an integrated approach, providing capabilities from leading edge research to multi-disciplinary teams that deliver operational data analysis capabilities to the scientific user communities.

### Job Opportunities

- ▶ [Director of the Center for Data Driven Discovery \(C3D\)](#)
- ▶ [Software Engineers](#)

### Contacts

**Kerstin Kleese van Dam**

Director, Computational Sciences Initiative and  
Chair of the Center for Data-Driven Discovery  
631.344.6019

**Robert Harrison**

Chief Scientist

**Lauri Peragine**

Administrative Specialist, 631.344.7090

### Events

## Brookhaven Lab Advances its Computational Science and Data Analysis Capabilities

Using leading-edge computer systems and participating in computing standardization groups, Brookhaven will enhance its ability to support data-driven scientific discoveries

November 18, 2016



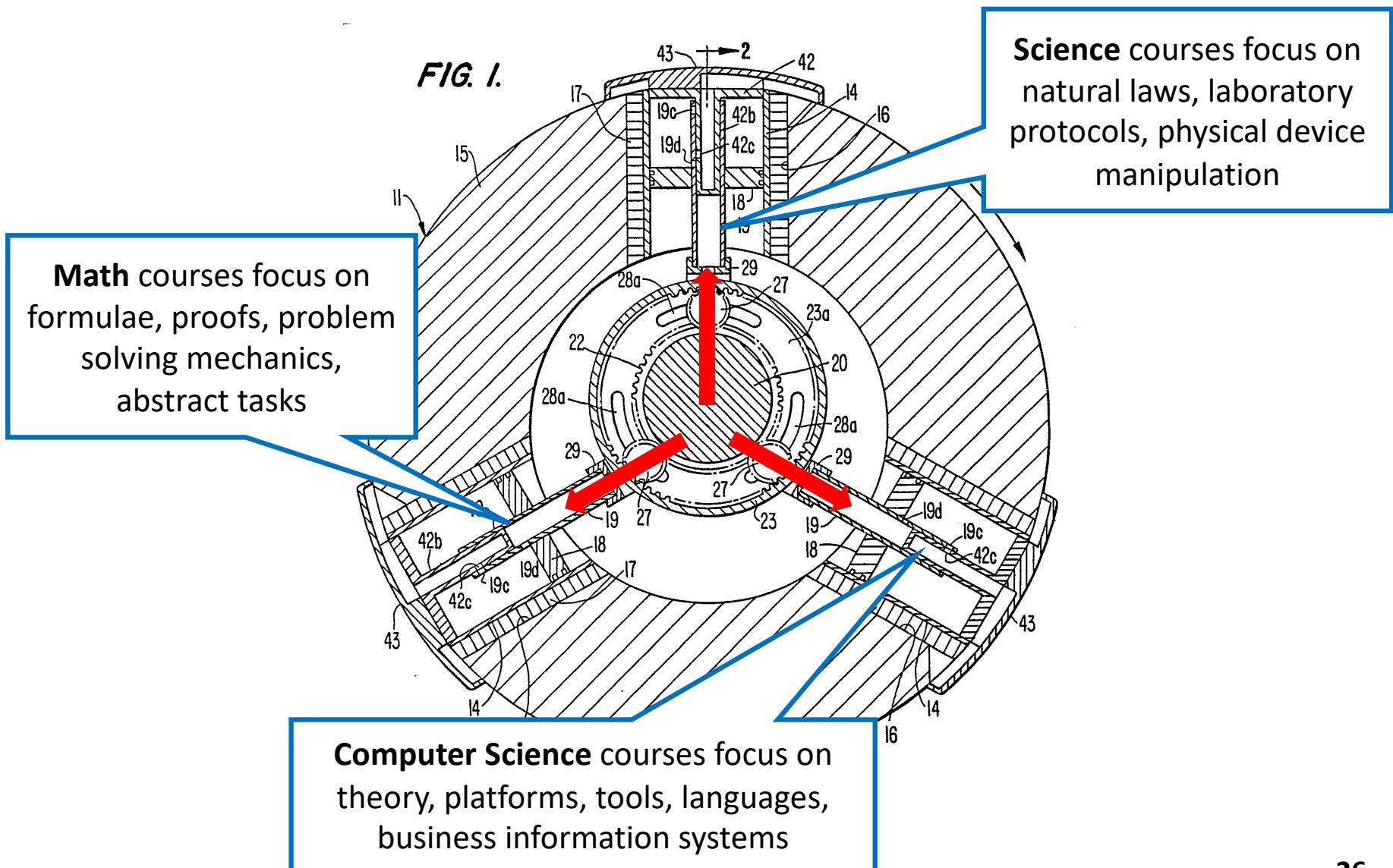
Members of the commissioning team—(from left to right) Imran Latif, David Free, Mark Lukasczyk, Shigeki Misawa, Tejas Rao, Frank Burstein, and Costin Caramarcu—in front of the newly installed institutional computing cluster at Brookhaven Lab's Scientific Data and Computing Center. [+ENLARGE](#)

At the U.S. Department of Energy's (DOE) Brookhaven National Laboratory, scientists are producing vast amounts of scientific data. To rapidly process and interpret these data, scientists require advanced computing capabilities—programming tools, numerical models, data-mining algorithms—as well as a state-of-the-art data, computing, and networking infrastructure.

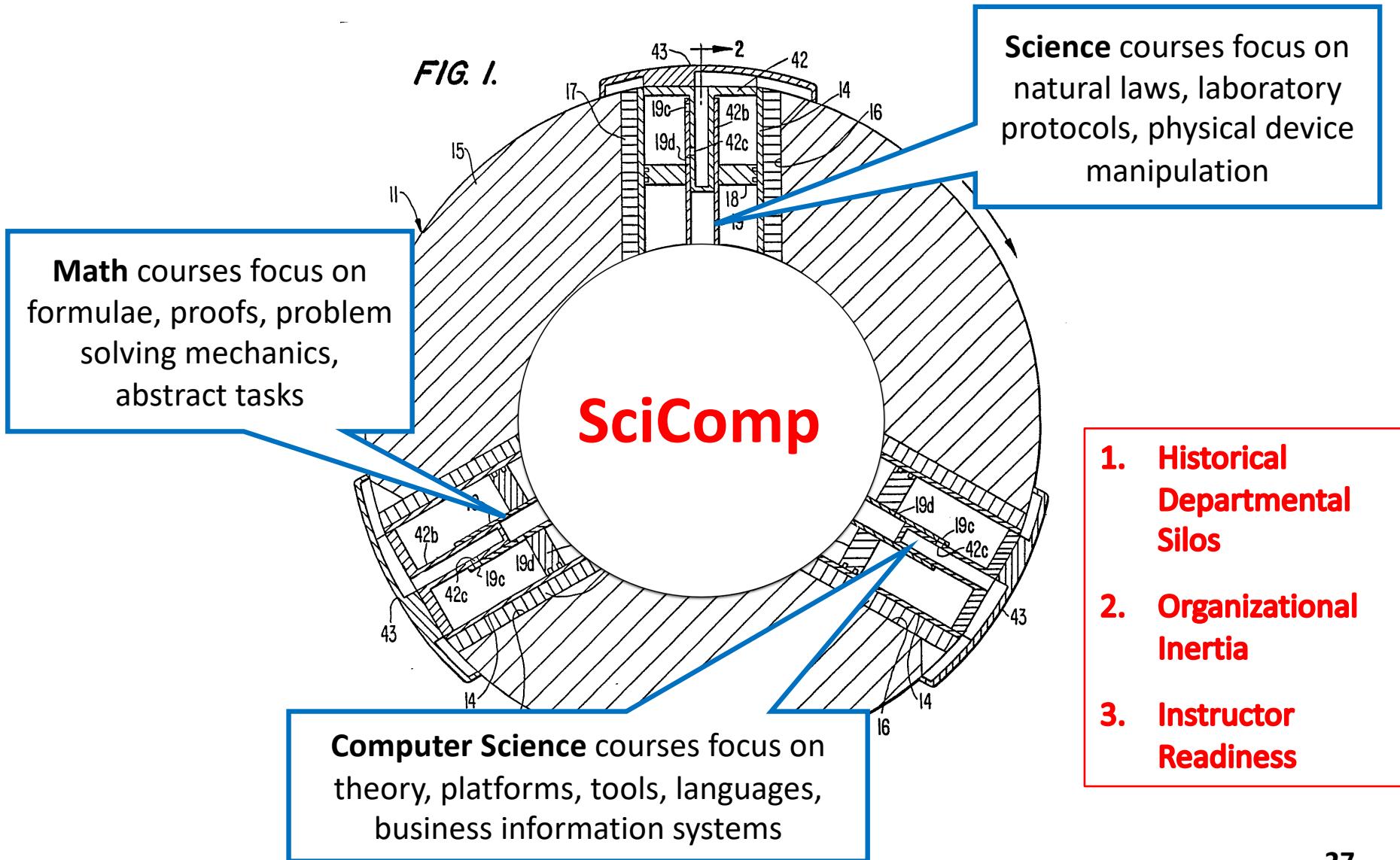
# The Challenge Facing Educators

- How to introduce SciComp into a tightly controlled preexisting **science** curriculum?
- How to control compute resources normally owned by the Math, Engineering, or Business departments?
- How to demonstrate solving **science problems** using code **before** students complete their first CompSci course?
- How to address worries that writing code impairs scientific intuition or reduces the time for hands-on experiences?
- How to raise the comfort level of science educators who have not written computer code **in years**?

# SciComp Is Getting Lost in the Middle



# SciComp Is Getting Lost in the Middle



# The Challenge Facing Educators

A search for “computing”...

Within the Next Generation Science Standards (NGSS), there are three distinct and equally important dimensions to learning science. These dimensions are combined to form each standard—or performance expectation—and each dimension works with the other two to help students build a cohesive understanding of science over time.

THE THREE DIMENSIONS OF SCIENCE LEARNING

CROSSCUTTING CONCEPTS

<https://www.nextgenscience.org>

GLOSSARY | CONTACT | NEWS | FAQ | SEARCH

SUBSCRIBE FOR THE LATEST NGSS NEWS >

GET TO KNOW THE STANDARDS • FIND TOOLS AND RESOURCES • SEARCH THE STANDARDS •

178

# The Challenge Facing Educators

The screenshot shows the Next Generation Science Standards website. At the top left is the logo "NEXT GENERATION SCIENCE STANDARDS For States, By States". At the top right is a blue "SEARCH" button. Below the logo, there are three navigation links: "THE STANDARDS", "INSTRUCTION AND ASSESSMENT", and "PLANNING AND COMMUNICATION". The main content area has a grey header "Search". Below it, a search bar shows the term "computing" with a red box around it. A red callout box points from this term to the text "A search for ‘computing’". Below the search bar, the heading "Search results" is followed by a list. The first item is "1. Maine", which includes a snippet of text about computing devices. A red callout box points from this snippet to the text "Returns only one article about rolling out computing ‘devices’". To the right of the search results is a large black-bordered box containing the text "Searches for" followed by a bulleted list: "• computers...", "• programming...", "• coding...". Below this list is the text "also return nearly zero documents". At the bottom right of the page is a "Basic page" link and a list of other search categories: "Commonly Searched Terms", "DCI Arrangements", "Evidence Statements", "Exemplar", "News", "Performance Expectation", "Resource", and "Topic Arrangements". At the very bottom right is a blue "ADVANCED SEARCH" button. The page number "29" is located at the bottom right corner.

SEARCH

THE STANDARDS ▾ INSTRUCTION AND ASSESSMENT ▾ PLANNING AND COMMUNICATION ▾

Search

Search / Content / Content

computing

A search for “computing”

Search results

1. Maine

... (MLTI). This program currently sustains 74,000 computing devices throughout the state. This program provides 60,000 students and 11,000 teachers with one-to-one computing and access to software and to computer-based especially ...

Returns only one article about rolling out computing “devices”

Searches for

- computers...
- programming...
- coding...

also return nearly zero documents

Basic page

Commonly Searched Terms

DCI Arrangements

Evidence Statements

Exemplar

News

Performance Expectation

Resource

Topic Arrangements

ADVANCED SEARCH

29

# Yet you are Leading the World!

A screenshot of a Google search results page. The search query "high school scientific computing" is highlighted in a red box. The results show three top hits:

- New Brookhaven Summer Course Introduces High School Students to**  
<https://www.bnl.gov/newsroom/news.php?a=25855>  
Aug 6, 2015 - Dave Biersach, a senior technology engineer at Brookhaven, taught 19 local **high school** students the foundations of **scientific computing**.
- Students Complete Scientific Computing Course - Longwood Central ...**  
[longwood.k12.ny.us/district\\_news/students\\_complete\\_scientific\\_computing\\_course](http://longwood.k12.ny.us/district_news/students_complete_scientific_computing_course)  
May 9, 2019 - LHS Students Complete BNL **Scientific Computing** Course Twelve Longwood **High School** students recently completed a 20-week scientific ...
- bni scientific computing seminar - Sayville Public Schools**  
<https://www.sayvilleschools.org/Page/5142>  
Up to Thirty (30) Sayville students from grades 9-12 can be selected to learn the core **scientific computing** skills. The Program will take place at the **High School** ...
- Brookhaven Lab, Adelphi launch scientific computing minor – Long ...**  
<https://libn.com/News/Education>  
May 14, 2019 - Biersach helped to address this challenge by launching a series of after-school **scientific computing** clubs at **high schools** on Long Island, from ...

A blue speech bubble on the right side of the screen contains the text: "We're the top 10 hits in Google!"

# Riverhead computing students visit

## Coding Enrichment Program For Budding Scientists

By RiverheadLOCAL



Riverhead mi  
Elementary S  
Program visit  
see how comp

SMITHI  
second c  
research  
National  
intereste

Smithtown High School East is offering an enrichment program open to all interested 10th – 12th grade students.

[Longwood Central School District » District News » Students Complete Scientific Computing Course](#)

## STUDENTS COMPLETE SCIENTIFIC COMPUTING COURSE

### LHS Students Complete BNL Scientific Computing Course

Posted on 05/09/2019



Twelve Longwood High School students recently completed a 20-week scientific computing course designed to spark an interest in computer-literate researchers of tomorrow.

Sponsored by Brookhaven National Laboratory and developed by instructor and technology architect David Biersach, the course introduced the students to modern coding techniques to address

data analysis challenges in sciences. Additionally, students had access to Wolfram Mathematica software as well as cloud computing to complete lab exercises designed to introduce 11 fundamental techniques of analysis and presentation of scientific data.

"The Scientific Computing Course gave me the knowledge to work through difficult problems in my future career," said sophomore Jack Mendes.

The students met once a week at the high school and completed 45 hands-on programming labs. The course also provided an introduction of internship and research opportunities offered by Brookhaven National Laboratory.

## Developing Scientific Computing Capabilities for the Workforce of Tomorrow

This summer's Scientific Computing 102 internship prepared college students for the big data challenges facing researchers in science, technology, engineering, and mathematics (STEM)



[+ ENLARGE](#) The 2016 Scientific Computing 102 students with their instructor, David Biersach (first from the right, front row) and the Office of Educational Programming team.

For young scientists joining a research project for a summer, every minute of the experience is precious. In addition to reading previous publications and learning the scientific vernacular, many of the students coming to the U.S. Department of Energy's (DOE) Brookhaven National Laboratory for summer research internships must scramble to teach themselves how to code so they can work with their data.

"If six out of their ten weeks here are spent just learning the basics of computer programming, those undergraduates will have a reduced opportunity to acquire true expertise in their field," noted David Biersach, a technology architect at Brookhaven Lab. "I work with the Information Technology Division [ITD], so I get to see what scientists across the lab are doing with custom coding solutions and where a lot of the interns are struggling."

## Writing Code for a More Skilled and Diverse STEM Workforce

Twenty science, technology, engineering, and math majors, mostly undergraduates funded by the National Science Foundation, will participate in the Alliances for Minority Participation program this summer for a new three-week workshop designed to develop skills.

September 6, 2018



## Working with Brookhaven Lab, Adelphi Offers First Scientific Computing Minor in New York State



An introductory scientific computing course that started out in 2015 as a weekly high-school after-school program developed by Brookhaven Lab is now part of the curriculum for a new scientific computing minor offered at Adelphi University.

# SciComp

## Survey of Scientific Computing

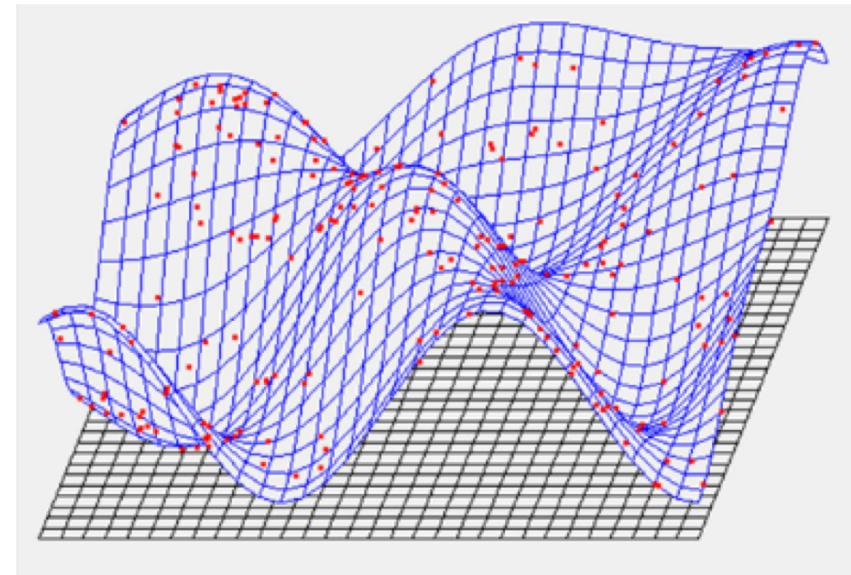
- Objectives
  - Provide patterns for solving real-world **science problems** by writing custom software
  - Demonstrate how **scientific computing impacts all science disciplines**
  - Enable students to **translate scientific formulas into correct and efficient code**
  - Review techniques for the **effective visualization** of complex data
  - Show optimal methods to store and analyze very large data sets
  - **Prepare students to conduct interdisciplinary research at world-class institutions**

# Mathematical Concepts

- Systems of Equations
- Probability Distributions
- Combinatorics
- Simulation & Modeling
- Monte Carlo Integration
- Polar & Spherical Coordinates
- Dynamical Systems
- Mesh Interpolation
- 2D Affine Transformations
- Vector & Complex Algebra
- Signals Analysis

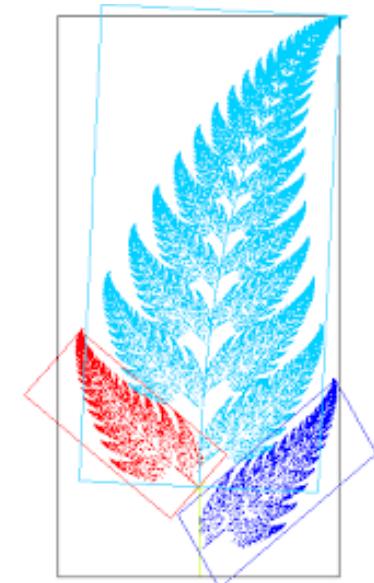
$$\varphi = [1; \{1\}]$$

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = 1 + \frac{1}{4} + \frac{1}{9} + \frac{1}{16} + \frac{1}{25} + \dots = \frac{\pi^2}{6}$$



# Computer Science Concepts

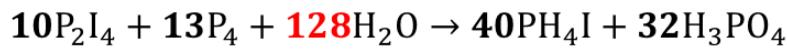
- Representations and Encodings
- Random Number Generation
- Strings, Arrays, Operators
- Loops, Functions, Recursion
- Searching & Sorting
- 2D and 2.5D Graphics (Oblique Projection)
- Boolean Algebra, Digital Logic Circuits
- Runtime Complexity
- File I/O (CSV)
- CERN ROOT



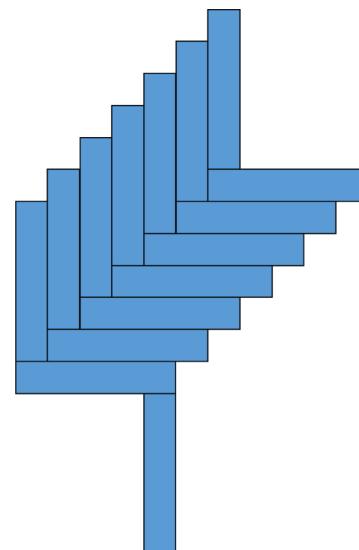
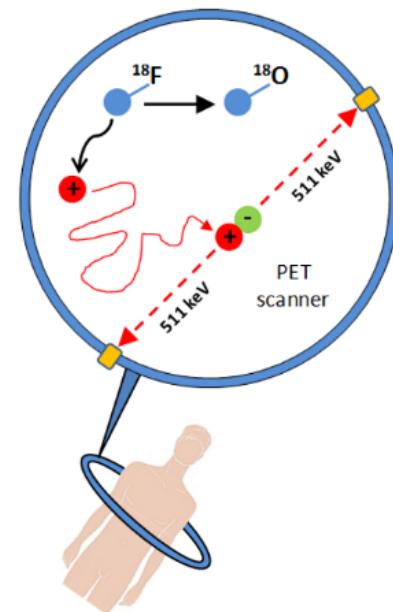
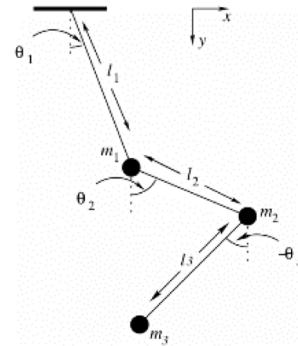
<b>NOT</b>	$A \rightarrow B$	<table border="1"><tr><td>A</td><td>B</td></tr><tr><td>1</td><td>0</td></tr><tr><td>0</td><td>1</td></tr></table>	A	B	1	0	0	1									
A	B																
1	0																
0	1																
<b>AND</b>	$A \wedge B \rightarrow C$	<table border="1"><tr><td>A</td><td>B</td><td>C</td></tr><tr><td>1</td><td>1</td><td>1</td></tr><tr><td>1</td><td>0</td><td>0</td></tr><tr><td>0</td><td>1</td><td>0</td></tr><tr><td>0</td><td>0</td><td>0</td></tr></table>	A	B	C	1	1	1	1	0	0	0	1	0	0	0	0
A	B	C															
1	1	1															
1	0	0															
0	1	0															
0	0	0															
<b>NAND</b>	$\overline{A \wedge B} \rightarrow C$	<table border="1"><tr><td>A</td><td>B</td><td>C</td></tr><tr><td>1</td><td>1</td><td>0</td></tr><tr><td>1</td><td>0</td><td>1</td></tr><tr><td>0</td><td>1</td><td>1</td></tr><tr><td>0</td><td>0</td><td>1</td></tr></table>	A	B	C	1	1	0	1	0	1	0	1	1	0	0	1
A	B	C															
1	1	0															
1	0	1															
0	1	1															
0	0	1															

# Science Concepts

- Mechanics and Kinematics
- Waves (Fourier Analysis)
- Unit Conversion
- Genetic Sequence Analysis
- Balancing Ionic Equations
- Projectile Motion
- Equilibrium & Thermodynamics
- Radioactive Decay



Phosphonium iodide



sorted suffixes
0 a a c a a g t t t a c a a g c
11 a a g c
3 a a g t t t a c a a g c
9 a c a a g c
1 a c a a g t t t a c a a g c
12 a g c
4 a g t t t a c a a g c
14 c
10 c a a g c
2 c a a g t t t a c a a g c
13 g c
5 g t t t a c a a g c
8 t a c a a g c
7 t t a c a a g c
6 t t t a c a a g c