# Simulation and Analysis at South Dakota State University REU Site

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#### Overview

- SDSU S&A REU Program focuses on simulation and analysis techniques
- REU students gain a broad perspective of the theory and application of simulations
- Research in CFD (computational fluid dynamics), PV(photovoltaics), statistics, and CS (computational sciences)

# SDSU S&A REU Vision

- Holistic experience for learning how to conduct effective and responsible research
- Student-scholar centered and Communitybased learning
- Provide tools for participants to become effective researchers
- Tangible outcomes at the end of the REU
- Foster desire to continue research in STEM fields



# Recruiting

- I0 Undergraduate Positions
  - Target: 500 mile radius of Brookings, SD
  - Target: Smaller four year colleges
  - Diverse backgrounds of students
    - Engineering (EE, ME, CE)
    - Math, Stat, Physics, CS
    - Economics and others
  - Underrepresented groups

# SDSU S&A REU Team 2012



# Structure of SDSU S&A REU

- Intensive eight week program
- Interdisciplinary
  - Diverse backgrounds and Interests
- Project Based
- Responsible Conduct of Research component
- Extensive Evaluation
- Faculty Mentors + Graduate Assistant Mentors

# SDSU S&A REU Organization



# Computational Sciences (CS)

- Primary Mentors: Dr Kimn (Mathematics)
- Faculty Mentors: Faculty from Engineering and Economics Departments
- Example Projects:
  - Computational Physics
  - Computational Finance
  - Parallel Implementation using MPI & GPU
  - Numerical methods for CFD

# Selected CS Project Results



# **Computational Fluid Dynamics**

- Primary Mentor: Dr. Gent
- Faculty Mentor: Dr. Kimn
- Example Projects:
  - CFD modeling of Photobioreactor (PBR) for Algal Biofuel Production
  - Finite differencing modeling and analysis of grain drying

# Selected CFD Project Results



Temperature profile in Photobioreactor predicted Using CFD



Temperature profiles predicted In grain dryer using MATLAB Code

Contour Plots of Drying Column Conditions



- Primary Mentor: Faculty from Electrical Engineering Department
- Faculty Mentors: Dr. Kimn and Faculty from Mathematics Department
- Example Projects:
- >Modeling of PV
- Simulation of Bulk Heterojunction

# Selected PV Project Results



# Statistics (STAT)

- Primary Mentor: Faculty from Statistics
- Faculty Mentor: Dr. Kimn and Faculty from Mathematics
- Example Projects:
- Bayesian Estimation for Stochastic Volatility
- Inferences for effective doses in toxicological studies

# Selected STAT Project Results

#### Heavy Metal and Fatty Acids Subsample Weights



yrWeightsAcids





Time

# Research Integrity and the Responsible Conduct of Research

- Agenda
  - Week I: Introduction to the Responsible Conduct of Research, lecture and discussion
  - Week 3: Case Studies in the Responsible Conduct of Research, discussion
  - Week 5: Additional case studies, with some emphasis simulation, analysis, statistics and computer modeling
  - Week 7: "Cautionary tales," continued discussion, recap.



#### Social Activities

- Site Visits (POET + EROS)
- Cooked out at Directors' houses
- Informal Activities among Students







# **Selected Outcomes**

- Conference
  Presentations
- Journal Articles
- NSF GRFP Fellowship





# Summary of Advisors (2012-2015)

- Two Universities: SDSU + UM Morris (External Evaluator)
- Six Departments: Math & Stat, Mechanical, Electrical, Civil & Environment, Economics, Education (UM Morris)
- Research Compliance Coordinator, SDSU
- 13 Graduate Assistant Mentors

# Summary of Recruit (2012-2015)

- 34 selected out of 341 national wide applicants.
- I4 Small college students ( > 41 %)
- I I female students (> 32%)
- Two African Americans
- One Veteran
- One Native American Graduate Assistant Mentor

# Summary of Career Choice (2012-2015)

- I6 out of 34 pursuit Graduate School
  - ( > 47 %)
- Majority of other students choose Labs or research jobs

# **Highlights of Results**

- One students awarded NSF Graduate Research Fellowship Program (GRFP)
- Four journal publications
- Six conference proceeding publications
- Mare than ten conference presentations.
- Three students were selected fully supported "Experiencing HPC for Undergraduates" from SC 12-14

### HPC in STEM Disciplines at SDSU

- Renewal for 2016 2018
- IO Week Program
- Reform from the SDSU S&A REU
- + Biological Sciences and Chemistry
- Emphasize on HPC Education and Research
- Professional Development
- Diversity in Recruiting

### Focus Areas of HPC REU





# **HPC** Education

- Sessions led by the HPC
  Specialist at SDSU will be held
  for first 4 weeks of program for
  REU students
- Topics include: Intro to HPC, Linux and the command line, running jobs on cluster, Parallel computing, MPI, R Overview, among others.
- HPC Specialist will also facilitate programming workshops for campus community to participate on Wednesdays
- Additional Session will be held for special need: PETSc and other HPC related software.



# **Professional Development**

- Sessions led by Dr. Gent will be held once a week.
- Topics include: Technical communication, time management, networking, continuous improvement, ergonomics, among others
- Undergraduate Research Symposium in Pierre, SD, July 31-August 1



# HPC Related Results 2016



# **Outcomes of REU Experience**

- Well-defined project with appropriate scope
- Project with tangible and well supported results
- Final reporting
  - Peer-reviewed publication level
- Research presentation (30 minute)
- Opportunity to attend regional/national conference