2008-2009

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The University of Texas at El Paso

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U of Texas El Paso

CREST: Cyber-ShARE-Sharing Resource through Cyber-infrastructure to Advance Research and Education

Participant Individuals

Principal Investigator: Ann Q. Gates
Co-Principal Investigators: Aaron Velasco, Leticia Velazquez; Craig Tweedie; Paulo Pinheiro da Silva
Senior personnel: Miguel Argaez, Vladik Kreinovich, Brian Giza
Others: Rodrigo Romero, Assistant Director
Mary Contreras, Program Coordinator
Leonardo Salayandia, Research Specialist

Detailed Description

Ann Q. Gates: Principal Investigator
Has worked for more than 160 hours : Yes
Contribution to project : Ann Gates (UTEP) coordinates the collective activities and initiatives of Cyber-ShARE, manages the general budget, and contributes to the Subproject #1: Computer Science in Cyber-ShARE Center: Believing and Accepting Cyber-Results. She receives support from CREST.

Paulo Pinheiro da Silva: Co-Principal Investigator
Has worked for more than 160 hours : Yes
Contribution to project : Paulo Pinheiro da Silva leads Subproject #1: Computer Science in Cyber-ShARE Center: Believing and Accepting Cyber-Results. He receives support from CREST.

Aaron Velasco: Co-Principal Investigator
Has worked for more than 160 hours : Yes
Contribution to project : Aaron Velasco leads Subproject #2: Geoscience in Cyber-ShARE Center: Integrated Analysis for Development of 3-D Models of Earth Structure. He receives support from CREST.

Craig Tweedie: Co-Principal Investigator
Has worked for more than 160 hours : Yes
Contribution to project : Craig Tweedie lead Subproject #3: Environmental Science in Cyber-ShARE Center: Advancing the Utility of CI in Environmental Science. He receives support from CREST.

Leticia Velazquez: Co-Principal Investigator
Has worked for more than 160 hours : Yes
Contribution to project : Leticia Velazquez contributes to Subproject #2: Geosciences in Cyber-ShARE Center: Integrated Analysis for Development of 3-D Models of Earth Structure. She receives support from CREST.

Miguel Argaez: Senior personnel
Has worked for more than 160 hours : Yes
Contribution to project : Miguel Argaez contributes to Subproject #2: Geosciences in Cyber-ShARE Center: Integrated Analysis for Development of 3-D Models of Earth Structure. He receives support from CREST.

Vladik Kreinovich: Senior personnel
Has worked for more than 160 hours : Yes
Contribution to project : Vladik Kreinovich contributes to Subproject #1: Computer Science in Cyber-ShARE Center: Believing and Accepting Cyber-Results and to Subproject #2: Geosciences in Cyber-ShARE Center: Integrated Analysis for Development of 3-D Models of Earth Structure. He receives support from CREST.

Brian Giza: Senior Personnel (Education Lead)
Has worked for more than 160 hours : Yes
Contribution to project : Brian Giza is the educational lead. He receives support from the CREST grant.
Rodrigo Romero: Assistant Director of Cyber-ShARE
Has worked for more than 160 hours : Yes
Contribution to project : Dr. Rodrigo Romero is an Assistant Director of the Center. He is supported by the Crest grant.

Leonardo Salayandia: Research Specialist
Has worked for more than 160 hours : Yes
Contribution to project : Mr. Salayandia is a research specialist. He is supported by the CREST grant.

Contreras Mary: Coordinator
Has worked for more than 160 hours : Yes
Contribution to project : Ms. Contreras is the coordinator for the project. She is supported by the CREST grant.

Organizational Partners

The following organizations have partnered with the Cyber-ShARE Center over the past year.

- Aerospace Mission Corporation
- AmeriFlux
- Arctic Observing Network (AON)
- Atair Aerospace Inc.
- Computing Alliance of Hispanic-Serving Institutions (CAHSI)
- Circumarctic Environmental Observatory Network (CEON)
- EcoTrends
- Environmental Systems Research Institute (ESRI)
- Geosciences Network (GEON)
- National Ecological Observatory Network, Inc (NEON)
- Nuna Technologies
- Pan American Center of Earth and Environmental Studies (PACES)
- Sustaining Arctic Observing Networks (SAON)
- USDA Jornado Experimental Range Long-Term Ecological Research Program
- Virtual Solar Terrestrial Observatory (VSTO-NCAR)

Other Collaborators or Contacts

- Elizabeth Anthony, Professor, Department of Geological Sciences, University of Texas at El Paso
- Barry Benedict, Executive Director, Center Environmental Research Management (CERM), University of Texas at El Paso
- Carsten Burstedde, Postdoctoral Student, Director of Center of Computational Geosciences, UT Austin
- Cynthia Chang, Research Scientist, in the Tetherless World Constellation at Rensselaer Polytechnic Institute (RPI)
- Li Ding, Research Scientist, in the Tetherless World Constellation at Rensselaer Polytechnic Institute (RPI)
- Allison Gaylord, Nuna Technolgoies
- Omar N. Ghattas, Director of the Center of Computational Geosciences, University of Texas at Austin
- Phillip Goodell, Professor, Department of Geological Sciences, University of Texas at El Paso
- Kris M. Havstad, Supervisory Research Rangeland Management Scientist, Agricultural Research Service (ARS), United States Department of Agriculture (USDA), Jornada Experimental Range, Las Cruces, NM
- S. Kay Hunt, Manager of Customer Services, Purdue University (Campus Champion program)
- Erik J. Kappus, Department of Geological Sciences, University of Texas at El Paso
- G.R. Keller, Chair, School of Geology and Geophysics, University of Oklahoma
- Bridget Konter, Assistant Professor, Department of Geological Sciences, University of Texas at El Paso
- Jaspar Konter, Assistant Professor, Department of Geological Sciences, University of Texas at El Paso
- Scott Lathrop, Director of Education, Outreach, Training and External Relations, TeraGrid
- Deborah McGuinness, Rensselaer Polytechnic Institute (RPI)
- Kate Miller, Professor, Department of Geological Sciences, University of Texas at El Paso
- Lawrence Murr, Professor, Department of Metallurgical Engineering, University of Texas at El Paso
- Kristine Navarro-McElhaney, Director, Institute of Oral History and Regional Archives Center, University of Texas at El Paso
- Debra Peters, Research Ecologist, Agricultural Research Service (ARS), United States Department of Agriculture (USDA), Jornada Experimental Range, Las Cruces, NM
- Andrzej M. Pownuk, Assistant Professor, Department of Mathematical Sciences, University of Texas at El Paso
- Jay Pulliam, Professor, Department of Geophysics at Baylor University
- Eduardo Quinonez-Rico, Lecturer, Department of Mathematical Sciences, University of Texas at El Paso
- Al Rango, Research Hydrologist, Agricultural Research Service (ARS), United States Department of Agriculture (USDA)
- Steve Roach, Professor, Department of Computer Science, University of Texas at El Paso
- Laura Serpa, Professor, Department of Geological Sciences, University of Texas at El Paso

- Ricardo von Borries, Assistant Professor, Department of Electrical and Computer Engineering, University of Texas at El Paso
- Stephan Zednik, Research Associate, in the Tetherless World Constellation at Rensselaer Polytechnic Institute (RPI)
- Ann Zimmerman, Research Assistant Professor, School of Informatics Information Collaboratory for Research on Electronic Work, University of Michigan
- Taisser Y. Zumlot, 2006, Department of Geological Sciences, University of Texas at El Paso

Students Involved in Cyber-ShARE Activities

Table 1: Students working on Cyber-ShARE projects

Student	Classification	Project or activity

1. Salayandia, Leonardo - Hispanic Non–Citizen – PHD - Center
2. Gallegos, Irbis Josue - Hispanic Resident – PHD - Center
3. Ochoa Jr, Omar - Hispanic US Citizen – PHD – Center
4. Olaya, Julio Cesar - Hispanic Non–Citizen – PHD – Center
5. Reyes Estevez, Jose M - Hispanic Non-Citizen – GRAD - Center
6. Archer, David A. - Hispanic US Citizen – Undergrad – Project # 2
7. Avila, Daniel - Hispanic US Citizen – Undergrad - Center
8. Avila, Natalia - Hispanic US Citizen – Undergrad - Center
9. Berumen, Gloria - Hispanic US Citizen – Undergrad - Center
10. Lopez, Andrew P. - Hispanic US Citizen – Undergrad – Project #2
11. Licea, Francisco - Hispanic US Citizen – GRAD – Center
12. Mendez, Arely - Hispanic US Citizen – Undergrad - Center
13. Nevarez, Jesus R - Hispanic non Citizen – Undergrad - Center
14. Ordonez, Maria - Hispanic US Citizen – GRAD - Center
15. Vazquez, Enrique Hispanic US Citizen – GRAD – Center`
16. Vela Garcia, Yoliet - Hispanic US Citizen – Undergrad - Center
17. Jaimes Hernandez, Aline- Hispanic Non-Citizen – PHD - Project #3
18. Brady, Jerald J - White US Citizen – GRAD - Project #3
19. Escapita, Irving j - Hispanic non Citizen – Undergrad - Project #3
20. Gates, David Quiroz - Hispanic US Citizen – Undergrad - Project #3
21. Ramirez Garcia, Gesuri - Hispanic non Citizen – GRAD - Project #3
22. Gomez, Javier I – Hispanic US Citizen – GRAD – Project #2
23. Sosa, Uram I- Hispanic Non-Citizen – PHD - Project #2
24. Thompson, Lennox E – African American US Citizen – GRAD - Project #2
25. Del Rio, Nicholas R - Hispanic U.S. Citizen – PHD – Project #1
26. Gandara, Aida G - Hispanic US Citizen – PHD – Project #1
27. Garza, Antonio - Hispanic US Citizen – Undergrad – Project #1
28. Ortiz Perez, Julian J - Hispanic US Citizen – GRAD – Project #1
29. Porras, Hugo D - Hispanic US Citizen – Undergrad – Project #1
30. Reyes, Patricia - Hispanic Non-Citizen – GRAD – Project #1

31. Patlan, Ezer - Hispanic US Citizen – GRAD – Project #2

Other students:
1. Goswami, Santonu – Asian Non-Citizen – PhD in Environmental Science
2. Johnson, David R. – White U.S. Citizen – Postdoc in Environmental Science
3. Cody, Ryan P. – White U.S. Citizen – Technician in Environmental Science
4. Franco, Juan Carlos – Hispanic U.S. Citizen – Technician in Environmental Science
5. Andresen, Christian G - Hispanic U.S. Citizen – Technician in Environmental Science
6. Mensik, Juri – White Non-Citizen – Undergraduate in Environmental Science

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Project Activities

This section is divided as follows:
A. Center activities
B. Subproject 1 Activities
C. Subproject 2 Activities
D. Subproject 3 Activities

A. Center Activities

The Cyber-ShARE Center provides meeting space, presents workshops and training opportunities, conducts educational and K-12 outreach activities, sponsors a Distinguished Lecture Series, and provides general computing services and resources for UTEP and the community. These are described in this section. In addition, the section describes the courses that have been offered to support Cyber-ShARE projects.

Meeting Venue

The Center serves as a meeting venue for two of the CREST subprojects: "Believing and Accepting Cyber-Results" led by co-PI Dr. Pinheiro and "Integrated Analysis for Development of 3-D Models of Earth Structure" led by co-PI Dr. Velasco. In addition, the Center has provided a meeting space for the following UTEP groups:

- CargoTrust project- a project led by co-PI Dr. Pinheiro and funded by the Department of Homeland Security to focus on providing visual explanations of international cargo shipment threat assessment proofs;
- INNOVA Gameworks and Animation- an organization created by undergraduate students majoring in CS, English, Music, and Graphic Design to develop computer entertainment games.
- Computational Science Course CPS 5401 (Introduction to Computational Science)- the Center provided space for the lecture and allowed students to work in the computer laboratory for the 2008 fall and 2009 spring semesters. The course was comprised of Master and Ph.D. students of the newly created Computational Science Program. The students were invited to attend the workshops organized by the Center and related to computational science. Such workshops helped students deepen their knowledge in computer science and taught them how to use the supercomputing equipment at UTEP.

Workshops and Training

The workshops offered by Cyber-ShARE are listed in a separate section. In addition to the workshops presented through the Center, Cyber-ShARE Research Scholars and staff received training in high-performance computing as described below:

- In September 2008, Leonardo Salayandia attended a three-day workshop for new users of TeraGrid systems offered by the National Center for Supercomputing Applications at the University of Illinois at Urbana-Champaign.
- On October 31, 2008, Dr. Romero, Leonardo Salayandia, and Julio Olaya participated in a Web-based TeraGrid New User workshop that covered fundamental aspects on how to use TeraGrid's CI to run and monitor high-performance computing applications.
- On January 30, 2009, Dr. Romero, Julio Olaya, and Francisco Licea participated in a Web-based TeraGrid New User workshop that presented the basic tools and steps for using TeraGrid to execute high-performance computations. In addition, the session provided advice to new participants in the TeraGrid Campus Champion program.

Educational Activities

Dr. Brian Giza collaborated and integrated educational outreach and workshops with Project ACE and the Mother-Daughter/Father-Son middle school (MS) STEM programs and prepared outreach components that were presented for outreach activities in UTEP's Engineering Excites program that targets middle and high school students. In addition, the Center under the direction of Dr. Giza is building standards-aligned educational activities that use content or concepts from Cyber-ShARE sub-projects and are web-ready. Other activities include the following:

- In spring 2009, Giza met with Leonardo Salayandia to plan a web-form-based procedure for teachers to create lessons that would involve the Cyber-ShARE server and create a repository of lessons there that are automatically tagged with Semantic Web metadata.
- In spring 2009 , Giza met with Craig Tweedie and his research group to explore ways to adapt the approaches used by an Arctic Ice module to take advantage of the web-services and data from Barrow Area Information Database (BAID, at http://www.baidims.org). The result was an outreach component.
- In spring 2009 Giza began discussions with Science-approach.com (formerly the Center for image-Processing in Education, an NSF educational project). The goal was to ascertain the intellectual property status of the STEM education materials released by the project in the 1990s and whether they could be adapted and updated with modern open-source software and used or disseminated as part of the Cyber-ShARE education outreach activities. Discussions are still ongoing with Director Steven Moore (steven@science-approach.com).

The list of outreach activities is presented in a later section.

Distinguished Lecture Series

- On September 11, 2008, Dr. Juan Meza, the head of the HPC Research Department of Lawrence Berkeley National Laboratory, presented the Cyber-ShARE Distinguished Lecture entitled "A Direct Constrained Optimization Method for Solving the Kohn-Sham Equations." This optimization is used in materials simulations for nanostructure research. The lecture was cosponsored with the Computational Science Program.
- On April 27, 2009, Dr. Ann Zimmerman, an assistant professor in the School of Information of the University of Michigan, presented the Cyber-ShARE Distinguished Lecture entitled "Data Sharing and Reuse in the Age of Cyber-Enabled Research and Discovery." This lecture discussed the challenges faced by researchers attempting to share and reuse data within and across disciplines and how solutions to such challenges affect education and training, multidisciplinary collaboration, and policy and decision-making for cyber-enabled discovery.

Resources

The Cyber-ShARE Center serves as resource for the university and community. The Center joined the TeraGrid Campus Champion Program in order to enhance support of interdisciplinary projects that develop and use cyber-infrastructure (CI) to advance research, education, and training of the next-generation scientist and engineer. This partnership with TeraGrid enabled to Center to launch a series of workshops to train UTEP faculty and students to use high-performance computing and scientific visualization resources. Other examples of resources and support provided by Cyber-ShARE are described below:

- Dr. Romero collaborated with Dr. Phillip Goodell of UTEP's Department of Geological Sciences and Dr. Taisser Zumlot to develop a website tht will provide geochemistry data of New Mexico targeting use by both researchers and the college graduate community. In addition, this collaboration is developing an educational game to help users to obtain diverse information about geochemistry of twenty one elements found in the state of New Mexico.
- The Center developed two new implementations of Bouguer Anomaly computation: an online calculator available at http://www.Cyber-ShARE.utep.edu/resources/tools/bouguer-anomaly/BouguerAnomalyForm and a web service. Bouguer Anomaly software is used in the Geosciences to remove terrain attraction from a free air anomaly through the Bouguer reduction method.
- The Center obtained administrative control of a Cray XD1 machine with 36 dual-core AMD 2.2 GHz Opteron processors, 144 GB of RAM, 1.5 TB of disk space, and a 317 GFlops rating. This new cluster enhances the processing capacity of the two previously existing computational clusters of the Center.
- By request of Dr. Amitava Biswas, a new Cyber-ShARE user from the Department of Rehabilitation Sciences, the Center installed Matematica and Matlab software packages in the Center's GEON cluster, an eleven-node ROCKS computational cluster.
- Center storage was allocated to store Shuttle Radar Topography Mission (SRTM) data collected by NASA, which represents the most up-to-date, globally collected topography data set of the

Earth. SRTM makes up the first globally continuous (60 degrees north to 60 degrees south) 90m resolution data set, with 30m resolution within the Unites States and its territories. In addition to providing a continuous data set, it also provides a global reference frame for the location and topography of islands, some of which have been substantially mislocated in existing databases. The SRTM data set is used by the students in UTEP's Volcanology class (taught by J. Konter) as the basis for a visualization of each student's volcano, as part of their final project. These visualizations support their final project and were part of an educational presentation on visualization tools at the annual American Geophysical Union (AGU) fall meeting (Konter and Smith-Konter, 2008). Other classes in the Geological Sciences department such as the GIS class also make use of this type of data. Beyond the use in a classroom setting, a number of students and faculty use these data to create maps of their research areas.

- The Center provided HPC support for physics and metallurgy.
- The Cyber-ShARE Center supported Dr. Eduardo Quinonez from the Math Department to carry out research on optimization in operations research.
- Dr. Tweedie and the Environmental Science research subproject provided technical assistance to the following groups:
    - AmeriFlux – provided advice on the establishment of field based instrumentation and ancillary cyber-infrastructure challenges for the bio-geosciences
    - Arctic Observing Network (AON) and Circumarctic Environmental Observatory Network (CEON) – provided use-case scenarios for the development of the network.
    - National Ecological Observatory Network, Inc (NEON) – provided advice on the establishment of field based instrumentation and ancillary cyber-infrastructure challenges for the Ecological Sciences
    - Sustaining Arctic Observing Networks (SAON) – provided use-case scenarios for the development of AON
    - Al Rango, Debra Peters, Kris Havsted (USDA), and the USDA Jornado Experimental Range Long-Term Ecological Research Program – provided technical and other assistance for the establishment of field instrumentation, advice on the use and application of unmanned aerial vehicles in the environmental sciences, and linkages to EcoTrends and NEON.
    - Allison Gaylord (Nuna Technolgoies) – provided technical and other assistance for the establishment of web based mapping and information systems

Cyber-ShARE provided opportunities for high-school and college students to work as interns in Center projects.

- On April 6 through 10, 2009, Ryan Hoffer, a high-school student from El Paso Country Day School, worked as an intern at the Cyber-ShARE Center. During his internship week, Mr. Hoffer studied how to represent knowledge and work flows through ontologies by reading an introductory technical paper and following a presentation prepared by Leonardo Salayandia on the use of ontologies for data interoperability. Then he learned to use WDO-It!, a tool for creating work-flow driven ontologies developed by L. Salayandia, to create an ontology for a 1D-Refraction model.

- On June 12 through 18, 2009, Daniela Field, a freshman from Southern Methodist University, volunteered to work at the Center. She developed content for GeoScavenger, a serious game to help users to learn geochemistry concepts based on data for 21 elements found in the state of New Mexico. She also helped to test and deliver a CI workshop to four groups of participants in the College of Engineering ExcITES 2009 program. She also wrote the story about Cyber-ShARE's participation in ExcITES that is posted at www.Cyber-ShARE.utep.edu.
- Starting May 1, 2009, Raul Reyes, a UTEP ECE freshman, starting volunteering ten hours a week at the Cyber-ShARE Center. He is working with Arely Mendez, a Cyber-ShARE Research Scholar, on a project to display and post to an Internet repository near real-time seismic data from UTEP's Kidd Observatory.

New courses that were developed and presented in support of Cyber-ShARE included:

- Computational Science (CPS 5401): A graduate-level course that presents an introduction to basic computational science skills including UNIX, scientific programming using high level languages, message passing interface, and parallel computer architectures.
- Geological Science (xx): Introduction to Seismology; Technology in Ecology and Environmental Science (cross listed with Biology and Environmental Science Master's program and open to Cyber-ShARE Students)
- Mathematics (MATH 5345): Numerical Optimization -A study of numerical algorithms for solving systems of nonlinear equations, unconstrained optimization, and nonlinear least squares problems. Derivation of necessary and sufficient conditions for constrained optimization, and an introduction to interior-point methodology.
- Computational Science (CPS 5310): Mathematical and Computer Modeling – Computer simulation of selected practical problems from physics, engineering, geology, biology, or chemistry. Students learn to create mathematical models, formulate modeling assumptions, select appropriate numerical methods, implement them in the form of a computer program, and visualize the numerical results. Emphasis is given to verification and validation procedures, and team-oriented training activities.
- Biology (BIO 5327): A graduate level course that focuses on the range of technological innovations that are used in ecology range to solve complex real world problems, including sensors, automated data collection systems, GIS, and relational databases.

Other Activities

On December 4, 2008, the Cyber-ShARE subproject team leaders engaged in a four-hour facilitated workshop to identify the projected outcomes of the project at 18 months (spring of 2010), and at five years. Dr. Catherine Oleksiw, Director of K-16+ research, facilitated the workshop.

On April 27, 2009, Dr. Ann Zimmerman met with the project teams, and she has begun to conduct a data practices study with the Cyber-ShARE scientists to understand what activities, actions, and artifacts characterize data practices of scientists; what technologies are being used; and what problems are addressed by data practices.

A Cyber-ShARE student is being funded to work with an "Oral History" project that is documenting successful entrepreneurial endeavors in the El Paso region. The project is capturing important knowledge that would be lost otherwise, and Cyber-ShARE's work is focused on digitizing and annotating the interviews with appropriate metadata.

Dr. Craig Tweedie worked with Dr. Steve Roach's 2008-09 senior software engineering class on a project that developed an interactive web based portal for the storage, analysis and downloading of automatic weather station data.

B. Subproject 1: Computer Science – Believing and Accepting Cyber-Results

The goal of subproject 1 is to gain users' confidence in workflow execution results by enhancing results with provenance information, trust recommendations, and levels of uncertainty. This subproject addresses provenance, trust, and uncertainty about the results of cyber-infrastructure-based applications. Drs. Pinheiro da Silva (lead), Gates, Kreinovich contributes to the goals. The activities of this subproject are summarized below.

In the second year, the CS subproject team started implementing systematic semantic enhancements to geo-science and environment science processes with the goal of improving the problem-solving capabilities of these processes. The enhancements are part of the subproject goal of working closely and collaboratively with geoscientists and environment scientists to simultaneously accomplish the following objectives:

1. To understand how scientists tackle scientific problems, and in particular, how they develop, execute and improve complex processes to solve those problems;
2. To expose scientists to semantic and cyber-infrastructure technologies that have the potential of overcoming known limitations of the current scientific processes;
3. To indentify key enhancements that can better support solving the problems identified in (1);
4. To develop tools that can be used to create and maintain artifacts in support of enhancements identified in (2); and
5. Using the proposed enhancements in (3) and the tools in (4), to collaboratively work with scientists to enhance their complex processes.

These objectives have driven the activities within the group and have led to documenting selected scientific processes. A goal is to establish a new Cyber-ShARE-way of enhancing these scientific processes with semantic information, the CI-Miner approach, and to develop human resources in other scientific fields capable of replicating and disseminating the use of semantic technology.

The processes that were documented with semantic enhancement are as follows:

- Hole's Code – Earth science/seismology
- Reflectance Data Gathering – Environmental science
- 2 ½ D crustal structure of the Earth – Earth science
- National Center for Atmospheric Research (NCAR) CHIP Quick Look Process – Solar physics

Another direction focused on developing new (and faster) algorithms for processing uncertainty related to cyber-infrastructure, where different data points come with different information about their uncertainty (e.g., probabilistic, interval, and fuzzy). More efficient algorithms have been developed for processing uncertainty, especially uncertainty related to cyber-infrastructure, where different data points come with different information about their uncertainty.

C. Subproject 2: Geosciences – Integrated Analysis for Development of 3-D of Earth Structure

The goal of subproject 2 is to determine the physical properties of the Earth by advancing data fusion of distinct information sources and by studying and developing techniques and approaches for integrating data with varying accuracy and sensitivity. Drs. Velasco (lead), Velazquez, Argaez, and Kreinovich contribute to the goals. The faculty and students involved in the project represent a wide range of disciplines: geosciences, computational mathematics, and computer science.

The Geosciences team has initiated weekly meetings to discuss research progress and direction. Out of these weekly discussions, the team has initiated activities, such as working groups for data sharing across disciplines and projects, the development of ontologies in geophysics, the development of workflow driven ontologies in geophysics, and the production of documents to explain processes and research topic that will be understandable to students and scientists in all three disciplines in the project. The weekly review is the foundation for the collaboration, and the team has gained insights that have led to innovations in the research.

The Geosciences team have made presentations and attended national and international meetings, including: SIAM, 13th GAMM-IMACS International Symposium on Scientific Computing, National Mathematical Congress in Columbia, the Annual Fall Meeting of the American Geophysical Union, 2009 Annual Conference of the Computing Alliance of Hispanic-Serving, and the Society for the Advancement of Chicanos and Native Americans in Science.

D. Subproject 3 (Environmental Sciences) Activities

The goal of subproject 3 is to address the challenge of optimizing data streams and sensor arrays in ecological and environmental networks through case studies targeting improved characterization of environmental phenomena and processes.

Collectively, this effort includes faculty and students who represent the following disciplines: biology, environmental science, geosciences, computational science, electrical and computer engineering, and mathematics. Members of this subproject meet weekly and include approximately equal numbers of student and technician attendees funded on non-CREST projects. Meetings focus on the presentation of student and faculty research and discussion focuses on interdisciplinary problem solving that facilitates further development of the research. Subproject research collaborators meet separately to the weekly group meetings. These opportunities for cross-disciplinary communication and exchange of ideas have facilitated this subproject tremendously and a range of novel research activities have been developed as a result.

Research results have been presented at multiple national and international meetings; several software applications and web services have been launched and or are undergoing prototype testing; external collaborations with several government and industry partners have been established; a major field installation of environmental sensors has been completed; and the roof of the biology building at UTEP has been renovated as a green roof space suitable as a sensor testing platform.

Findings

Center:

The Cyber-ShARE Center members have established an effective model for collaborating across disciplines. The Center has become a resource for numerous projects on campus that need assistance with managing data. The list of collaborators has been provided in another section of this report.

- In 2008-2009 Giza designed, pilot-tested and trained students in two new web-ready project-based CD-based activities designed for middle school STEM outreach: The *Earthquake sounds* module and the *Arctic Ice* module. Both modules are online at Giza websites and are being adapted for archiving/access via the Cyber-ShARE server.
    - Earthquake sounds is at http://www.educationtechnologies.com/modules/equake/
    - Arctic Ice is at http://www.educationtechnologies.com/modules/ice1/
- In fall 2008 Giza utilized the template developed for the Cyber-ShARE education outreach lessons in his graduate science education course SIED 5325 "Inquiry Science Education in Bilingual Settings" (22 students). In this first iteration of the Cyber-ShARE Curriculum Cadre, students built lessons using WIKIs and other technology tools that would be appropriate for use in K-12 STEM-education classrooms.

Subproject 1: Computer Science – Believing and Accepting Cyber-Results

A more comprehensive understanding of how scientific processes can be semantically enhanced is one of the contributions of the second year of Cyber-ShARE. The steps for semantic enhancement of scientific processes are enumerated below:

Step 1: Develop an ontology describing classes of methods, data, and data sources needed to describe the processes of interest (this is a workflow-driven ontology - WDO).
Step 2: Using the WDO of Step 1, develop semantic abstract workflows (SAWs) representing the process to be enhanced.
Step 3: Using the SAWs of Step 2, create wrappers to capture provenance information about future process executions.
Step 4: Identify use cases for things such as data discovery and product debugging.
Step 5: (optional) Identify ontologies describing concepts of the field of interest.
This step may include the development of ontologies if none are available.
This step may include the harvesting of concepts from ontologies in Step 1 into methods, data and data sources.
Step 6: Using the provenance information collected in Step 3, create a triple-store database of provenance information.
Step 7: Develop database queries to answer the use cases identified in Step 4.

The sequence of steps above logically start with Step 4 – what are the goals in terms of products and results that scientists in Cyber-ShARE want to achieve once they have better ways of sharing and reusing their resources? It is important to note that Cyber-ShARE aims for new scientific discoveries through the use of enhanced processes based on new capabilities for sharing and reusing resources. The CS team understands how semantic technologies may facilitate the sharing and reuse of resources; however, CS

also understands that effective collaboration between the CS team and other teams of domain experts is the only way of effectively enhancing their processes with semantic technology. With that in mind, we highlight that the steps above are a more focused way of supporting this collaboration because it takes into consideration the process of educating scientists in semantic technologies at the same time that it gives computer scientists more time to get involved in the development of scientific processes.

Several scientific processes have been documented. Each is described below.

- The Hole's code algorithm has been documented in a WDO. The goal of Holes code is to produce a seismic 3D velocity model that defines the large-scale tectonic features associated with the crustal structure of a region. This particular algorithm uses both travel time values picked from refraction data, as well as shot survey and derived stacking velocities obtained by processing seismic reflection data. The initial data set, 1D velocity model, is data that was obtained from previous seismic studies. Data is produced to parametrically modify the initial model and create an intermediate model that is fed into the process again, creating a more accurate model within about 7 iterations.
- The geosciences project team has created an abstract workflow to capture the processes for creating a 2 ½ D crustal structure of the Earth. The abstract workflows are at three different levels of detail. At the highest level of abstraction, the workflow documents the sources used to create the Earth model: processed gravity and magnetic datasets from a community-driven repository. With these datasets, the profile line is determined by the geophysicist, and this process is described in more detail as a subworkflow, documenting the next level of abstraction. The profile line, along with a Receiver Function dataset obtained from EarthScope.org, is used to determine the depth to Moho. The profile line and the depth to Moho information, along with the gravity and magnetic datasets are used to create the crustal model by employing a technique called forward modeling, in which the calculated values of the Earth's crust density is calculated from the gravity and magnetic datasets. The geophysicist matches these values as closely as possible by means of educated guesses and other collected evidence about the crustal region under study.
- The Reflectance Data Gathering workflow (as an abstract workflow) captures the running of a robotic tram line that collects reflectance measurements and analyzes the raw data to determine if the collected data is correct. The process uses a program developed at Purdue University that analyzes multispectral and hyperspectral data. The data annotator is used to reference the intermediate and final products of the process. This requires identifying the antecedents and the conclusion for each node set of PML and to configure correctly the working environment.

The following are the observations gained from encoding of these processes as abstract workflows:

- We were able to demonstrate to scientists the benefits of using conceptual workflow tools for viewing and discussing processes, as well as a means for communication and knowledge dissemination
- The CS team was able to compare executable workflow environments to conceptual workflow environments, i.e., Kepler Workflow System vs. WDO-It! implementation of Hole's code because we could work at a conceptual level. It was relatively easy for the CS team to rapidly build a diagram or workflow representing the Hole's process. The CS team was able to modify the workflow easily based on comments or suggestions made about the workflow by seismologists.
- There are still questions about how to handle data sets and iteration in a tool like WDO-It!, and there are still a few cases of iteration that are not handled in the workflow due to these issues.

For example, in a single iteration, we chose not to model the fact that the initial model is merged or added to the filtered model to create the new model. The issue had more to do with creating a convoluted diagram than not being able to do it. Adding such a feature started creating too many directions for the *3DVelocityModel* data set.

The CS team also had the following results for the tools being developed:

- Improved usability of the WDO-It! editor: Based on feedback from users of our own team that are working as liaisons across different projects (from the Earth Sciences, Environmental Sciences, and Astronomy), our proof-of-concept WDO-It! tool has been improved to include several features that make the tool easier to use. Some of the features include improved handling of files for opening and saving, improved navigation through the graphical user interface of the tool, and a graphical representation of the dependencies between ontology files and workflow files. With these improvements, the WDO-It! tool is getting closer to an initial release that can be used by the greater community
- Made updates to the WDO meta-model to include provenance: The meta-model used in the WDO approach to create Semantic Abstract Workflows has been updated to reuse concepts from the provenance component of the Proof Markup Language (PML-P); furthermore, a graphical notation has been created to represent these PML-P concepts as part of a workflow graph. The update to the meta-model extends the usefulness of workflows not only to understand and formally document scientific processes, but also to construct applications that can capture provenance about the artifacts produced by such scientific processes. Furthermore, the inclusion of provenance research into the WDO approach has created a symbiotic working relationship between members of our team that are doing research related to workflows and provenance. The result has been an increased community of users and research
- Improved Probe-It! - Scientific provenance visualization framework.
    - Contributed to the development of an API that supports generation of code capable of capturing provenance information about scientific processes
    - Feedback to Probe-It! developers led to the addition of new methods for specifying sources

Probe-It! provides scientists the ability to better understand how scientific artifacts were generated, and thus the ability to discern between high and low quality artifacts used in their respective field of study. Within Cyber-ShARE, Probe-It has been improved to support specific visualization capabilities for the scientific artifacts that we are in the process of capturing provenance information.

Another one of the directions in subproject 1 was developing new (and faster) algorithms for processing uncertainty related to cyber-infrastructure, where different data points come with different information about their uncertainty (e.g., probabilistic, interval, fuzzy). More efficient algorithms have been developed for processing uncertainty, especially uncertainty related to cyber-infrastructure, where different data points come with different information about their uncertainty, and different algorithmic and mathematical aspects of this problem have also been described. The following were also developed:

- new efficient algorithms for dynamic data processing under uncertainty
- new algorithms for hypothesis testing under interval uncertainty
- new algorithms for producing the Pareto sets of possible non-dominated solutions for multi-criteria optimization

Subproject 2: Geosciences – Integrated Analysis for Development of 3-D of Earth Structure

The Geosciences subproject team has made progress on various projects that have allowed for fruitful collaborations and innovative technical breakthroughs. Through a strong collaboration between scientists and computer scientists, we have developed ontologies and work-flow driven ontologies for seismic and mathematical components of the project. We have also begun the development of "modular" documents that are meant to describe fundamental processes and science issues for the project in a language that is understandable across disciplines. The first such document, 1-D Velocity Model Development, demonstrates the key concepts behind modeling and was written by a computational science student.

The subproject team has taken two different approaches for attaining its objective of developing 3-D velocity models of the Earth derived from multiple data sets. The first approach focuses on merging the output of modeling individual data sets. This approach, which we call model fusion, takes into account the resolution of the model and the errors associated the analysis. The second approach is to develop a theoretical framework for inverting multiple data sets. This approach will take longer to develop and implement. Both approaches are working at different ends of the problem. Model fusion focuses on the outputs, and the inverting multiple data sets focuses on the input.

The results of the computational scientists, who are working in collaboration with scientists, include the following:

- Proved that a related notion called the quasi-central path, while being a less restrictive notion, is sufficiently strong to guide the iterates towards a solution of the problem.
- Developed an optimization code for John Hole's Algorithm for solving a 3-D seismic travel time tomography problem and produce a more accurate model of the Earth. The expected code will offer the use of restrictions in material properties and parameters by applying Interior-Point Methods.
- Investigated two global optimization strategies combined with three parameterization schemes that can be applied for solving large scale parameter estimation problems.
- Modified a reconstruction method based on Reweighted Normal Equations (RNEs); observed that the modified RNEs had reduced computational complexity, both in terms of number of iterations and computation time.
- Showed an algorithm that is capable of working efficiently to recover the reflection coefficients from seismic data in the area of seismic reflection and separating two speakers in a single channel recording in the audio separation problem.
- Implemented a primal-dual interior-point method to solve an inverse seismic wave problem. We compare the numerical behavior of the logarithmic barrier, primal-dual interior-point (IPM), projected conjugate gradient, and primal-dual active sets methods for solving one-dimensional partial differential equations constrained optimization problems arising on earthquake applications.

Subproject 3: Environmental Science – Advancing the Utility of CI in Environmental Science

Weekly meetings and group discussion have facilitated a range of research and other activities in the environmental sciences. The team has developed use-case scenarios that have been used to develop work flows, software, and web services for interacting with a range of environmental sensors, analyzing collected data and visualizing these in a web based environment. Filed instrumentation focused on improving knowledge of land-atmosphere carbon, developing a water and energy budget, and developing a backend CI.

In addition, the team has designed, engineered, and flight tested an unmanned aerial vehicle. An instrument package for this has been developed and is undergoing field testing.

The Cyber-ShARE Center has facilitated the development of work flows, software and web services, engineering faculty have facilitated the development of research infrastructure and instrumentation; domain focused researchers have proved use case scenarios and all of these have been fully documented. These research products will form key platforms for future research foci.

Training and Development

The following workshops and training opportunities were offered by the Cyber-ShARE Center to the UTEP community.

- "Using TeraGrid and Cyber-ShARE HPC Resources," presented on November 7, 2008. Dr. Rodrigo Romero, Leo Salayandia, and Julio Olaya prepared and delivered this workshop to introduce new users to application parallelization, basic MPI programming, and CI resources available through TeraGrid and Cyber-ShARE. Programming drills were tested by Cyber-ShARE Research Scholars Arely Mendez, Gloria Berumen, Natalia Avila, Javier Gomez, and Uram Anibal Sosa. The workshop was attended by 13 people including faculty, staff, and undergraduate and graduate students.

- "Parallel Programming Using the Message Passing Interface," presented on February 6, 2009. Dr. Romero, Leo Salayandia, and Julio Olaya prepared this workshop to teach attendees how to program parallel applications in a distributed computational environment using MPI. Programming drills were tested by L. Salayandia and Francisco Licea. The workshop was attended by 17 people including faculty, staff, and undergraduate and graduate students.

- "Data Interoperability through Ontologies," presented on February 20, 2009. Leonardo Salayandia and Aida Gandara developed and delivered this workshop to introduce attendees to create and use ontologies to represent knowledge for data dissemination efforts. The workshop was attended by 25 people including faculty and undergraduate and graduate students.

- In collaboration with the Computing Alliance of Hispanic-Serving Institutions (CAHSI), IBM, and Dr. Steve Roach from the Computer Science Department, the Center coordinated and cosponsored the IBM Tech Briefing "Change and release management for software development." The goal of the briefing was to show software developers, integrators, build managers, project managers, and software engineering students and faculty how to manage a project release to handle unexpected changes which occur in the software development lifecycle.

- "Poster Critique," presented on March 6, 2009. Dr. Ann Gates and Elsa Villa prepared and delivered this Affinity Research Group (ARG) workshop to develop Cyber-ShARE student researchers. The 3-hour workshop focused on preparing a critique, the role of devil's advocate to expand point of view, and providing constructive feedback. Approximately 30 students attended the workshop.

- "Scientific Visualization," presented on March 27, 2009. Dr. Romero prepared and delivered this workshop to introduce attendees to the principles of visualization for scientific research and engineering. This workshop was attended by 13 people including faculty and undergraduate and graduate students.

- "Setting Goals and Objectives," presented on May 1, 2009. Dr. Ann Gates and Elsa Villa prepared and delivered this workshop to develop Cyber-ShARE student researchers. The 2-hour workshop focused on evaluating and writing goals and objectives. Approximately 18 students attended the workshop.

- "Linux New User Training," presented on June 5, 2009. Julio Olaya and Francisco Licea prepared and delivered this workshop to teach attendees basic command line, file system structure, and software development commands and tasks in a Linux operating system distribution. This workshop was attended by 26 people including undergraduate and graduate students.

- "C Programming Intro," presented on June 19, 2009. Julio Olaya and Francisco Licea prepared and delivered this workshop to introduce attendees to the C language syntax, program structure, and programming tools in a Linux environment. This workshop was attended by 18 people including staff and undergraduate and graduate students.

- "Advanced C Programming," presented on July 3, 2009. Francisco Licea prepared and delivered this workshop to teach attendees how to use advanced C language constructs and debugging techniques in a Linux programming environment. This workshop was attended by 24 undergraduate and graduate students.

Teacher Training workshops:

Dr. Brian Giza participated in the following training:

- He presented the "Integrated Earthquake Sounds" module in BED-ECED 4311 Undergraduate Science Education methods course in fall 2008, reaching 21 preservice teachers.

- He presented the "Integrated Earthquake Sounds" and "Arctic Ice" modules in MSED 4311 Undergraduate Science Education methods course in spring 2009, reaching 21 preservice teachers, and in SIED 5325 Graduate Science Education methods course in spring 2009, reaching 22 inservice teachers.

Outreach Activities

The Cyber-ShARE Center's staff and student Research Scholars participated in a series of outreach activities both inside and outside of UTEP campus. The following is a list of such activities:

- On August 12, 2008, Dr. Romero and student Research Scholars gave a presentation to 51 engineering freshmen of the University of Texas at El Paso who were attending new student orientation. Attendees were introduced to basic concepts related to CI and its application in research and education. The presentations also described the impact of the Cyber-ShARE Center and its three initial subprojects on UTEP and the research community in general.

- On Saturday November 8, 2008, Dr. Giza presented two workshops for participants in the UTEP Mother Daughter-Father Son program. The workshops were based on the integration of satellite imagery with animation using open-source cross-platform tools. Material used for the workshops is posted that the following web link: http://www.educationtechnologies.com/modules/satanim1.

- In November 2008 Giza presented the Earthquake sounds module to approximately 60 middle school students and their parents as part of the Mother-Daughter/Father-Son Open house.

- In March 2009 Giza presented the Arctic Ice module to approximately 60 middle school students and their parents as part of the Mother-Daughter/Father-Son Career Day.

- The Environmental Science sub-project prepared several environmental CI information panels for display in a fall 2008 – spring 2009 museum exhibit at UTEP's Centennial Museum. This exhibit was visited by more than 5000 school children and more than 2000 other members of the general public.

- Dr. Giza presented two summer workshops for K-12 students in summer 2008, both presenting the Earthquake sounds module. One for 20-25 Middle School Students, one for 20-25 High School Students.

- On February 24, 2009, Dr. Romero and student Research Scholars Natalia Avila, Maria Ordonez, and Ivan Gris visited Chapin High School to participate in that school engineering week. Four presentations were given to 58 students enrolled in the course "Principles of Engineering" and 15 students enrolled in "AP Computer Science." The presentations introduced basic CI topics and its application to research. In addition, the presentations also described the impact of the Cyber-ShARE Center and its three initial subprojects on UTEP and the research community in general.

- On March 9, 2009, Dr. Romero, Natalia Avila, and Maria Ordonez supported the Department of Computer Science by participating in UTEP's third annual Mining for Majors/Picking Careers Fair that was organized by the Academic Advising Center, the University Counseling Center, and University Career Center. The event is designed to inform UTEP students about educational and occupational choices so they can make informed decisions about future opportunities. Participants provide students with information about their degree programs and related career options.

- On February 16, 17, and 20, Dr. Romero and student Research Scholars Natalia Avila, Arely Mendez, Gloria Berumen, Ivan Gris, and Daniel Davila gave seven presentations to a total of sixty eight high school students participating in the College of Engineering's Engineering Week. The presentations introduced attendees to basic CI concepts and applications of CI to research. Furthermore, the presentations described the impact of the Cyber-ShARE Center and its three initial subprojects on UTEP and the research community in general.

- On June 15, 16, and 18, 2009, Dr. Romero, Maria Ordonez, Natalia Avila, Arely Mendez, Gloria Berumen, Ivan Gris, and Daniela Field participated in the College of Engineering ExcITES 2009 program by preparing and delivering presentations and hands-on activities to 74 attendees from

a local middle school. Basic CI concepts and applications of CI to research were introduced. Presentations also described the impact of the Cyber-ShARE Center and its subprojects on research and education. Hands-on activities covered the use of ontologies for knowledge representation, graphical computation of impact of climate change on arctic ice, and the use of web sites to disseminate information.

- On June 30, 2009, Aldo Garcia and Violeta Juarez, and CS and EE freshmen students from Cañada Community College in Redwood City, California started working on a remote honors project with Cyber-ShARE staff. Both students were sponsored to participate in the project by MESA, a program to help underrepresented students to succeed in STEM careers. Leonardo Salayandia led the project which consisted in designing and developing automatic testing code for WDO-It! An end-of-summer release is expected.

- Cyber-ShARE contributed to the Pathways program within the Department of Geological Sciences at UTEP, an NSF supported project that includes a two-week summer high school camp and a Research Experience for Undergraduate (REU) component that occurs during the school year. The two-week camp brings in 15 students and 3 teachers from the El Paso, TX region and exposes them to the broad field of the geosciences. There are two sessions of the camp run each year.

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Web/Internet Site

Cyber-ShARE website: http://Cyber-ShARE.utep.edu

- Prototype semantic wiki installation
  - http://rio.cs.utep.edu
- Personal websites:
  - trust.cs.utep.edu/members/aida
  - http://Cyber-ShARE.utep.edu/research/es/people/graduate-students/msc-students/juan-carlos-gonzalez
  - http://Cyber-ShARE.utep.edu/research/es/people/graduate-students/msc-students/juan-carlos-gonzalez
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Other Specific Products

- Knowledge sharing:
    - SAWServer, workflow content management server: Tool for publishing Workflow-Driven Ontologies (WDOs), Semantic Abstract Workflows (SAWs) and other workflow-related documents on the web. Tool initially designed to work via services and now migrating to Drupal to take advantage of an established open-source tool that provides collaborative features like user management and blogs
- Abstract workflow editor for workflow-driven ontologies:
    - WDOIt! workflow editor development: Tool for creating work-related ontologies including terminology and workflows. Development, help with design of general features and fixes and specifically implemented concept renaming, bookmarking, some drag-n-drop features and workspace support. We are in the process of preparing for first release including development of testcases and software web deployment.
- Tool deployment through Java Webstart
    - Probe-It! provenance visualization at http://trust.cs.utep.edu/probeit/
    - WDO-It! editor at http://trust.utep.edu section on
- Uploaded artifacts, PML-P and PML-J documents to make them web-accessible:
    - Earth science:
        - http://iw.cs.utep.edu/earthscience
    - Environmental science:
        - http://iw.cs.utep.edu/environmentalscience
    - Solar physics:
        - http://iw.cs.utep.edu/astronomy

Contributions within the Discipline

How have your findings, techniques you developed or extended, or other products from your project contributed to the principal disciplinary field(s) of the project? Please enter or update as appropriate.

The contributions are as follows:

- The definition of conceptual workflows that are enhanced with semantic information to document scientific processes and facilitate understanding, discussions, and dissemination of knowledge.
- The Web-based mapping and information systems from the Environmental Science group gives domain researchers new search and analytical capabilities,
- The field instrumentation at the Jornada LTER fills a critical research gap in the AMeriFlix, SpecNet networks
- The UAV that has been developed is one of only a few focused on measuring environmental processes and phenomenon in the U.S.
- The model fusion approach that the Geosciences team is working may allow for fundamental shifts in how geoscientists work with data in developing Earth models. Furthermore, this approach may be used in other areas of geophysics where multiple data sets are collected, such a earthquake rupture imaging.

Contributions to Other Disciplines

How have your findings, techniques you developed or extended, or other products from your project contributed to disciplines other than your own (or disciplines of colleagues and associates not covered under "Contributions within Discipline")? Please enter or update as appropriate.

The environmental subproject has been invited to beta test several new software packages from ESRI. They have shared code and web services with the CH2 M Hill Polar Services, the National Snow and Ice Data Center and the Global Change Master Directory. The National Weather Service and NOAA use our real-time climate tool to improve weather forecasting in the El Paso area.

The work that is being done on the CS subproject is being transferred to National Center for Atmospheric Research (NCAR) CHIP Quick Look process. In particular, knowledge gained from working on the Hole's Code workflow was transferred to the CHIP Quick Look workflow. A difference was that the NCAR scientific team desired to use the workflow to facilitate the discussions of their existing Quick Look processes in order to implement new ones. For them, such ability would make it easier to propagate the design to new implementations. Thus, the expectations and discussions in this project were focused more on how to use the workflow once it was created, as well as the capture of provenance. To address this, workflow orchestration was enhanced to generate a corresponding PML document that captures provenance information about the data produced during module execution. In addition, the Probe-It! Tool has been used in solar astronomy to visualize provenance associated with images of the corona, exposing all the details that went into generating these images including process traces and information about the data sources. If some anomaly was apparent in the coronal pictures, then scientists could use Probe-It! to trace through the provenance and identify where in the process an error might have been introduced.

Techniques for processing uncertainty that have been developed as part of this project have been successfully applied to the following areas:

- to control where new algorithms have been developed to take into account monotonicity in intelligent control under uncertainty;
- to electrical engineering, where we came up with new techniques for arc detection under uncertainty;
- to decision making and financial engineering, where new methods of handling uncertainty and estimating risk have been developed, in particular, methods that avoid restrictions imposed by Arrow's impossibility theorem; in some cases, these methods lead to a new justification of the existing heuristic techniques;
- to physics, where uncertainty comes from the partial character of our knowledge; we came up with new ideas of solving inverse problems under uncertainty;
- to signal processing, where efficient methods of data processing and Fourier transform under uncertainty have been developed;
- to social sciences, where we gave a new explanation that diversity improves the problem-solving ability of a group;
- to transportation engineering, where we justified the current semi-heuristic techniques of handling uncertainty of the drivers' behavior [K4], and developed new efficient algorithms;

The research on hybrid optimization algorithm has applications to other disciplines. A challenging problem in some real world applications is finding a global minimum (an optimal solution) for highly nonlinear problems. These problems usually appear in PDE-constraint optimization which results from applications in earthquake, recuperative of reservoirs, find oil, and medicine, among others. The procedure consists in three fundamental phases. In the first phase, a stochastic algorithm is implemented to find a region(s) where we conjecture the optimal solution can be. In the second phase, each region is modeled by a smooth quadratic function and some equality and inequality constraints are associated which represent some characteristic of the region and also some physical properties of the problem. Finally, our primal-dual algorithm is implemented to obtain a local solution in each region. The optimal solution is determined by the point that produces the minimum value of the objective function.

Contributions to Human Resources

How have results from your project contributed to human resource development in science, engineering, and technology?

The active collaboration between members of the three Cyber-ShARE projects that integrates knowledge from geosciences, computer science, mathematics, environmental science, and engineering is probably one of the most important contributions to the development of human resources. Through involvement in these projects, the Cyber-ShARE Center is preparing the next-generation scientist and engineer who can work on multi-disciplinary teams and who has an understanding of CI. The professional development workshops that provide training in CI middleware and high performance computing, the outreach components that involves students in activities that include technology and science, and the courses that reach future teachers are critical to human resource development. In addition, students are exposed to cutting-edge technologies and concepts that are not typically introduced in the curriculum, and students are able to practice and hone their skills in a real application.

Cyber-ShARE promotes the involvement of students in development workshops, preparation for graduate studies, scientific symposia, and mentoring. Students have these experiences at the university and through conferences, e.g., AGU, Computing Alliance of Hispanic-Serving Institutions, and SACNAS.

Contributions to Resources for Research and Education

How have results from your project contributed to physical, institutional, and information resources for research and education (beyond producing specific products reported elsewhere)? Please enter or update as appropriate.

Through the Cyber-ShARE portal, researchers have access to tools, data, and educational modules.

Contributions Beyond Science and Engineering

How have results from your project contributed to the public welfare beyond science and engineering (e.g., by inspiring commercialized technology or informing regulatory policy)? Please enter or update as appropriate.

Ph.D. student Aida Gandara organized a panel and discussion groups at the 3rd Annual Computing Alliance of Hispanic-Serving Institutions (CAHSI) conference regarding promotional messages that could attract students, in particular middle-school girls, to computing. The report and video can be found on (http://cahsi.org) and both were forwarded to WGBH's New Image of Computing initiative.