CIBRED- Educating Cyberinfrastructure Concept and Teragrid Resources to the 21st Century's Allied Health Professionals

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Overview

The NSF funded project, Cyberinfrastructure (CI) for Biological Researchers, Educators, and Developers (CIBRED), is a virtual organization consisting of participants from several institutions engaged in CI research as well as education and outreach (Fig. 1).

Cyberinfrastructure for Biological Researchers, Educators, and Developers (CIBRED)

http://www.cieducation.net

Figure 1. CIBRED project overview

The mission of the project is:

to empower current researchers and the future workforce with specific CI tools and a transdisciplinary work environment that will allow them to generate new knowledge with a focus on the problem that transcends the boundaries of different disciplines and technologies needed to achieve their scientific objectives.

The specific goal of the CI-TEAM implementation project is:

Application of current research in a project-centric and transdisciplinary environment for development of a sustainable CI education program aimed at the future CI Workforce and which will be deployed by their educators

In this regard, National University, in collaboration with Virginia Bioinformatics Institute, is developing a course termed 'Cyberinfrastructure for Healthcare Management', which is designed to train 21st Century's allied health professionals at K13/14 levels (Fig. 2).

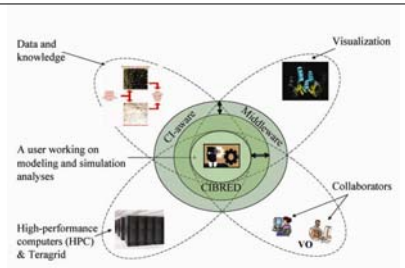

Figure 2 Relationships between the knowledge worker at the center of the CI with high-performance computers and Teragrid, middleware, VO (virtual organizations), data management and knowledge discovery, and visualization services. The objective of CIBRED is to educate and bring awareness of CI (*Courtesy of S. Wang12; courtesy of Stan Watowich13*).

Problem Description

The integration of knowledge from various fields such as computer science, mathematics, chemistry, and biology has resulted in a vast opportunity for creating new research environments. In part, this is accomplished by providing effective and efficient CI platforms. However, design, development, deployment and dissemination of course curriculum in schools and colleges that provides information on CI components is essential for preparation of the next generation workforce.

Approach

The CIBRED develops CI educational program within a project-centric, research-focused, and interdisciplinary learning environment (Fig. 3).

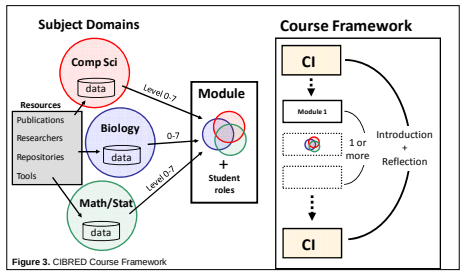

Figure 3. CIBRED Course Framework

Modules

Modular design for developing the course materials

Module 1: Overview of Cyberinfrastructure for Health Informatics

Module 2: Informatics for Disease Management

Module 3: Dengue and Swine Flu outbreaks as models for Public Health response

Module 4: Disease control - Drug discovery and vaccine research

Health informatics (HIT) is a transdisciplinary science that requires domain knowledge of various disciplines, such as, medical science (anatomy, physiology, etc.), molecular biology and bioinformatics, computer technology, among other fields. Data types from various sources will be incorporated into the modules (Fig. 4).

Figure 4 Examples of various data types generated different medical devices that will be incorporated into the modules.

For personalized medicine, advanced computational technologies will certainly play an important role in managing and analyzing massive quantities of medical data. However, lack of interoperability of the medical devices brings a new challenge for such data analysis. To train this new generation of medical professionals, this course integrates CI in the existing course curriculum. This course uses the basic information on CI and provides case studies to show the example of its implementation

Case Studies:

1. H1N1 influenza that killed more than 130 people across the Globe and has recently caused WHO to declare level 6 alert.

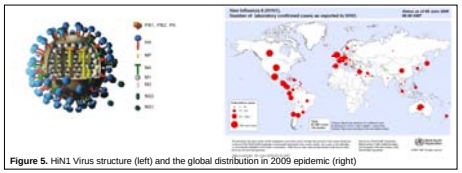

Figure 5. HiN1 Virus structure (left) and the global distribution in 2009 epidemic (right)

In a team environment, students will collect the information from various sources including CDC, NCBI and WHO.

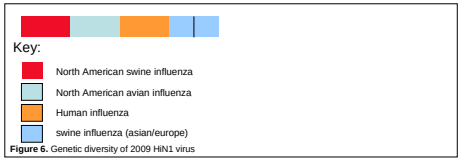

Figure 6. Genetic diversity of 2009 HiN1 virus

Moreover, report from a panel discussion at SC09 on this topic by an CDC informatics expert will also be available. Students will be able to learn how informatics is used to globally monitor HiN1 cases (Fig 5 & 6).

Figure 7. vector of dengue virus

2. Dengue

NIAID experts now see dengue as potential threat to U.S. health (Fauci & Morens, JAMA 2008). Dengue is transmitted to humans by the Aedes aegypti (rarely Aedes albopictus) mosquito, which feeds during the day (Fig 7). This infectious disease affecting almost 50 million people annually is caused by four closely related virus serotypes of the genus Flavivirus, family Flaviviridae. Each serotype is sufficiently different that there is no cross-protection and epidemics caused by multiple serotypes (hyperendemicity) can occur (Fig. 8)

Flaviviridae family

enveloped RNA viruses

major diseases

- Hepatitis C
- Dengue
- Yellow fever
- West Nile fever

No effective drugs

No effective Vaccine

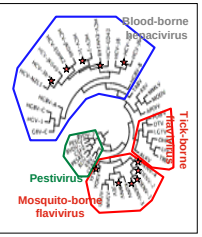

Figure 8. Phylogenetic analysis of the Flaviviridae family

Discovery Research

Varieties of resources with bioinformatics tools for drug discovery research, available from Biology Workbench, NCBI, European Bioinformatics Institute, etc.

Small molecule drug discovery

UTMB group using World Community Grid for computational screening of potential drugs followed by wet lab experiments

Vaccine development

UC-Berkeley group running clinical study in Managua, Nicaragua supported by HIT (Fig. 9, Avilés, et. al.(2007)).

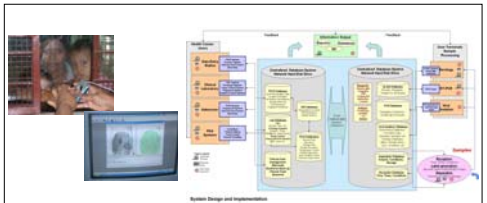

Figure 9. HIT Infrastructure (Avilés, et. al.(2007))

Multi disciplinary work involved in disease management

- Drug Discovery Research
- Vaccine development
- Clinical study
- Epidemiology
- Environmental issues
- Health Informatics –tools and technologies
  Predictive tools
- Public health – education and training
- Cyberinfrastructure – petascale level
  high performance computing

Project-centric hands-on experience

Number of Students per group: 6-8

Roles of subgroups:

Paramedical supportive

Clinicians, Specialists

Informaticians (EHR, GIS, DSS, etc.)

Molecular biologists

Pharma-researchers (Vaccine, drug developers)

Project outcome: Research Reports (with new findings?)

Course Deployment

National University, in Fall,2009. After assessment, to be the course is publicly available for dissemination nationally and internationally.

Acknowledgements

References:

1. Avilés, et. al.(2007). PLoS Med. 4(10):1578-83.

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