ENHANCING REMOTE SENSING EDUCATION WITH GEOBRAIN CYBERINFRASTRUCTURE

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1. INTRODUCTION

Dramatic advances in remote sensing (RS) capabilities and related data and information technology have enabled increasingly comprehensive observations and understanding of the Earth system (ES). Modern ES study heavily relies on computer based processing and analysis of digital remote sensing data. Therefore, modern ES researchers have to master skills and knowledge essential for handling RS data, such as data formats and projections, computational approaches, software tools, and remote sensing algorithms and processing methods. In order to produce such a workforce, ES education needs to keep pace with advance in remote sensing technologies by integrating the state-of-the-art geospatial information technology in the classroom teaching and exploring innovative educational approaches, such as:

1) involving students in an inquiry process [1, 14],
2) using extensive remote sensing data in classroom teaching [9, 10],
3) cultivating technical competence and intellectual self-confidence in research [12],
4) addressing computational thinking and quantitative skills [11, 12], and
5) engaging student interest and creating understanding through exciting, real-world applications [12].

Despite the different approaches, it is essential to let students understand the diverse, massive, and multi-disciplinary nature of the remote sensing data and equip students with skills and knowledge to handle these data. In the post-secondary remote sensing education curriculum, emphasis has been placed on how to digitally process large amount of multi-source remote sensing data to solve real world problems, a data-intensive approach.

2. *ISSUES IN DATA-INTENSIVE RS EDUCATION*

Obviously, data-intensive RS education relies on availability, accessibility, and usability of remote sensing data and computing facilities for the higher education communities. Both technological and educational communities have worked actively in bringing real scientific data and associated computing facility into teaching and learning [5, 6, 16]. However, due to the diversity and complexity of ES data (e.g. multiple sources, heterogeneous data structure and types, different formats and projections, incompatible spatial resolutions, variable spatial and temporal coverage and scales) and the shortcomings of current data and processing infrastructure, data accessibility and usability still remain a big problem. Educators still face obstacles when trying to access and use RS data and analysis tools in ES education [7, 9, 12]. The major obstacles include: 1) difficulties in finding, accessing, integrating and using massive RS data, and 2) inadequate data processing and analytic functions and computing facilities.

3. GEOBRAIN SOLUTION

Data-intensive RS education, in order to be successful, needs great support from broadest science, education and technology societies. Many efforts have been and are being put on removing obstacles to data-intensive RS education through innovative information technologies. The GeoBrain project is one of the efforts. Funded by NASA, the project aims to build a comprehensive remote sensing data cyberinfrastructure to facilitate data-intensive ES education.

In meeting the essential needs of current and future data-intensive ES education, a unique "by the community and for the community" strategy, which attempts to encourage broadest participation, collaboration and sharing, is adopted in the development of GeoBrain. The strategy ensures the GeoBrain system to be built with greater flexibility, effectiveness and responsiveness into the demands of data-intensive ES education.

The GeoBrain functionalities are developed with a focus on removing the two major categories of obstacles to data-intensive RS education by taking advantages of recent advances in cyberinfrastructure (CI) [15]. By adopting and developing state-of-the-art Web services, geospatial interoperability and knowledge management technologies, GeoBrain addresses the solutions for data-intensive RS education comprehensively, including:

1) making distributed data and computing resources easily accessible online from a single point of entry,
2) customizing data at user request,
3) enabling automated or semi-automated multi-source geospatial data integration,
4) providing online on-demand data discovery, access, mining, visualization, and analysis, and
5) promoting geospatial processing modeling, knowledge building and sharing

All functions available in GRASS Open Source GIS [13] have been implemented as Web services in GeoBrain. Petabytes of remote sensing data in NASA EOSDIS data centers, the USGS Landsat data archive, and NOAA CLASS are accessible transparently and processable through GeoBrain. The GeoBrain system is operated on a high performance cluster server with large disk storage and fast Internet connection. All GeoBrain capabilities can be accessed by any Internet-connected Web browser through GeoBrain Portals. Details about these solutions and the approaches to the solutions can be found in [2, 3, 4], and at http://geobrain.laits.gmu.edu.

4. EHANCING REMOTE SENSING EDUCATION

Dozens of universities have used GeoBrain as an ideal platform to support data-intensive RS education. Through GeoBrain, students are easier trained for scientific concepts, spatial and temporal scales, real-world problem solving, and necessary technical skills. A specific example of using GeoBrain in RS education is the course Geog 588, Digital Remote Sensing taught in the Department of Geography and Geoinformation Science at George Mason University by the authors. The course uses the textbook "Introductory Digital Image Processing, A Remote Sensing Perspective" [8]. The textbook is widely adopted in the geography departments around the world for training students on digital processing of remote sensing data. The course allows students to learn the different type of remote sensing data and their formats, and algorithms for processing the data to solve real world problems. In the traditional teaching situation for the course, the professor prepared a set of sample remote sensing data and commercial desktop remote sensing software, such as ERDAS, was used for students to do the lab exercises. The students had to do the excurses in the lab and only could use those simple data. For this specific course at GMU, we have developed GeoBrain-based lab excurses for the course. With the GeoBrain cyberinfrastructure, students of the course now can explore petabytes of remote sensing data in the NASA, NOAA, and USGS data archives instead of dealing only with the very limited sample data. Students have much more powerful computing facility of GeoBrain cluster server available for their excurses instead of low capable desktop computers. And students can explore the data and do the excurses any time at any place they want as long as they can access the Internet through the Web Browse. The feedback from students are all very positive about the learning experience with the GeoBrain cyber-infrastructure.

5. CONCLUSIONS

RS education faces opportunities and challenges in an increasingly data-intensive world. Easy access, integration and analysis of distributed RS data play essential roles in RS education. The GeoBrain cyberinfrastructure provides effective computing infrastructure and dynamic online mechanism in meeting a wide range of needs of current and future data-intensive RS education. By tracking the feedbacks from the educational partners and our teaching experience on Geog 588, we conclude that GeoBrain has provided many benefits to data-intensive remote sensing education, including:

- enhancing classroom teaching and lab exercises
- improving teaching and learning effectiveness,
- supporting inquiry-based, problem-based and authentic learning activities,
- providing free and open computational cyber-laboratory experiments.

Practices of GeoBrain in data-intensive RS classroom teaching, learning and discovery activities demonstrate that GeoBrain can bring significant impacts on how RS education, research, and applications can be conducted since any person who has an Internet-connected desktop/laptop computer can access/utilize vast amount of geospatial data, analytic functions, and computing resources used to be only available to a few privileged researchers.

6. REFERENCES

[1] Barstow, D. and E. Geary, 2001, Blueprint for Change: Report from the National Conference on the Revolution in Earth and Space Science Education, Snowmass, Colorado, TERC, 100 p, http://www.earthscienceedrevolution.org/acknowledge/acknowledge01.cfm.

[2] Deng, M. and Di L., 2009, “Building an Online Learning and Research Environment to Enhance Use of Geospatial Data”, *International Journal of Spatial Data Infrastructures Research*, 2009, Vol. 4, 77-95.

[3] Di, L., 2005. “The Implementation of Geospatial Web Services at GeoBrain.” Proceedings of 2005 NASA Earth Science Technology Conference. June 28-30, 2005. College Park, MD. 7p. (CD-ROM).

[4] Di, L., 2004. GeoBrain-A Web Services based Geospatial Knowledge Building System. Proceedings of NASA Earth Science Technology Conference 2004. June 22-24, 2004. Palo Alto, CA, USA. (8 pages. CD-ROM)

[5] DLESE, 2001, December 12, 2001, DLESE Strategic Plan, Version 12.0.

[6] Domenico, B., J. Caron, E. Davis, R. Kambic and S. Nativi, 2002. “Thematic Real-time Environmental Distributed Data Services (THREDDS): Incorporating Interactive Analysis Tools into NSDL,” *Journal of Digital Information*, Volume 2, Issue 4, Article No 114, 2002-05-29.

[7] Hanson, K., and B. Carlson, 2005, Effective Access: Teachers’ Use of Digital Resources in STEM teaching, edited, p.97, Education Development Center, Inc., http://www.edu.org.gdi/publications_SR/EffectiveAccessReport.pdf.

[8] Jensen, J. R., 2005, ***Introductory Digital Image Processing: A Remote Sensing Perspective,*** 3rd Edition, Prentice-Hall, 525 p.

[9] Ledley, T.S., A. Prakash, C. Manduca, and S. Fox, 2008. “Recommendations for Making Geoscience Data Accessible and Usable in Education”, *EOS*, Vol. 89, No. 32.

[10] Manduca, C.A. and D. Mogk, 2002, Using Data in Undergraduate Science Classroom: Report from an Interdisciplinary Workshop, Carleton College, http://dlesecommunity.carleton.edu/research_education/usingdata/

[11] Manduca, C.A., E. Baer, G. Hancock, R.H. Macdonald, S. Patterson, M. Savina, and J. Wenner, 2008, “Making Undergraduate Geoscience Quantitative.”, *EOS*, 89 (16), 149-150. http://serc.carleton.edu/serc/EOS-89-16-2008.html

[12] Marlino, M., Sumner, T., and Wright, M., 2004. “Geoscience Education and Cyberinfrastructure”, Report from a workshop held in Boulder, Colorado, April 19-20, 2004. http://www.dlese.org/documents/reports/GeoEd-CI.pdf

[13] Mitasova, H., M. Neteler, 2002. Open Source GIS: A GRASS GIS Approach, 460 pages, Kluwer Academic Pres

[14] National Research Council, 1996, National Science Education Standards, 262 p., National Academy Press, Washington D.C., http://www.nap.edu/books/0309053269/html.

[15] NSF CIC, 2007. “Cyberinfrastructure Vision for 21st Century Discovery”, National Science Foundation Cyberinfrastructure Council, March 2007. http://www.nsf.gov/pubs/2007/nsf0728/index.jsp

[16] Wright, M.J. and T.R. Sumner, 2003, DLESE Developers Workshop, 2003: Report on Workshop Outcomes, University Corporation of Atmospheric Research, p. 78.