BEDROCK's Problem Spaces: Educational Resources for Evolutionary Bioinformatics

Authors

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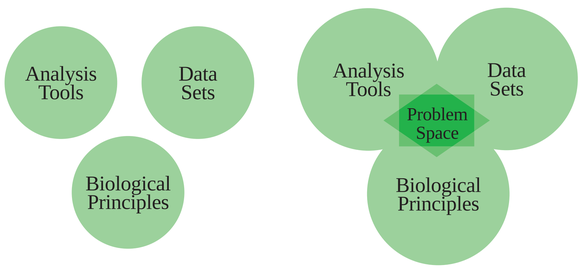
Abstract

This poster introduces a collection of on-line educational resources that are part of the NSF funded BEDROCK Bioinformatics Education Project. We use the idea of a problem space to describe a way of organizing diverse kinds of resources to support collaboration and student inquiry. While individual problem spaces are built around diverse areas such as viral epidemiology, species conservation, protein structure analysis, and invasive species phylogeography they all share several features. Each problem space is designed to engage students and faculty in collaborative research like problem solving. This involves, in part, identifying open research questions, rich data sets and access to a variety of research quality tools. The problem spaces also share an emphasis on the importance of adopting an evolutionary perspective when working with the comparative analysis of molecular data. Additional information can be found online at:

http://bioquest.org/bedrock/problem_spaces/



Introduction to a Problem Space

We have chosen to think about teaching and learning bioinformatics in the confext of problem spaces to reflect some of the exciting possibilities and serious challenges that the flood of molecular data present for biology education.

This approach is built around the use of molecular data to address biological research questions. In contrast to a more traditional lab approach where the students may be asked to follow a highly structured series of procedures to confirm an experimental result, our view of biology education emphasizes the development and exploration of students' questions as they come to understand biological principles, analytical procedures, and the ways that inferences are made from the collection and analysis of data. This approach does not dismiss the importance of learning foundational biological knowledge and skills. In fact, background knowledge and skills are viewed as essential stepping stones to apply one's knowledge to address new problems. So often, in our experience, it is in the application of factual and procedural knowledge to research questions that we come to understand more deeply that background and how scientific claims are developed and justified.

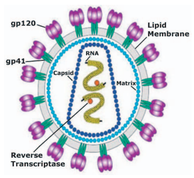
Prion Evolution

Stacey Kiser

This problem space introduces basic skills in protein structure exploration. We will learn to search databases for protein structures, explore the Cn3D software, and propose questions that may be answered with these tools.

How do these conformations differ?

How do small sequence differences affect susceptibility to conformational change?



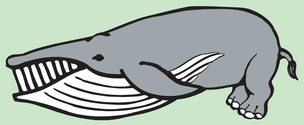
HIV Evolution

Anton E. Weisstein, Sam Donovan, Rebecca Robert

This problem space contains data from a published study on HIV evolution within individual patients. The study involved 15 injection drug users who became infected with HIV between 1989 and 1992. Some of these patients stayed healthy throughout the study, while others progressed rapidly to AIDS. At roughly six-month intervals, the researchers sequenced multiple copies of viral DNA from each patient and measured that patient's CD4 count. The gene region under study affects both the virus's ability to bind to host cells and its ability to evade the host's immune response.

Whale evolution

Sam Donovan and David Hornack



This problem space provides a collection of resources for going beyond the discussions of whale evolution presented in biology textbooks to look at how different types of data can be used to resolve this set of phylogenetic puzzles and to explore other related questions. Trying to make sense of whale evolution is a great place to engage in some evolutionary reasoning and look closely at the way scientists work through difficult historical problems. By the way, the term Whippo is used as a sort of shorthand for the hypothesis that whale and hippos represent sister groups—that is, they are each other's closest living relatives.

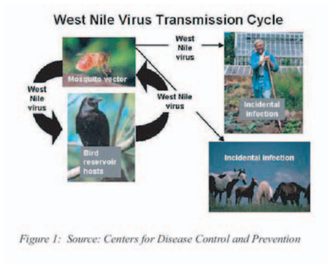


Figure 1: Source: Centers for Disease Control and Prevention

West Nile Virus

Ethel Stanley and Stacey Kiser

This problem space focuses on the West Nile Virus (WNV), an emerging disease in the public eye that continues to generate scientific interest as well. Researchers are exploring questions about its origin, evolution, transmission by multiple vectors and host tissues, replication in multiple hosts, viremic period, viral loads, seroconversion and antibody production, detection, vaccine potential, etc. Central to these investigations are the use of molecular data including nucleic acid sequences and the use of bioinformatics.

Goals for Problem Spaces

- Promote research-like inquiry into biological questions using bioinformatics tools and data resources.
- Support a community of Faculty who are interested in exploring opportunities to incorporate bioinformatics into their undergraduate courses.
- Provide rich data resources and powerful analysis tools, in the context of their use in addressing various biological questions.

Characteristics of Problem Spaces

- Flexibility - by providing a collection of resources and ideas we hope to be that the problem spaces will be useful in diverse settings where students may have different backgrounds in biology, bioinformatics and quantative skills.
- Open Ended - while problem spaces can be used in a variety of ways we hope that they will be used to promote the development and pursuit of students' own questions and support a classroom community of research.
- Dynamic - we hope that problem spaces will develop and change over time as more people use them and add comments, resources, student work, or other materials.

Elements of Problem Spaces

- A brief introduction to an area of research, data set, or applied biological problem.
- A collection of "open research questions" that might be addressed.
- Examples of hand-outs, assignments and other curricular materials used by other faculty.
- Data and other research resources.
- References and links to background materials.
- Examples of student work and other projects that explore the problem space.

For more information visit:

<http://bioquest.org/bedrock/problem_spaces/>

References

BioQUEST Curriculum Consortium. 2004 <http://bioquest.org/bedrock/problem_spaces/>

Supported by

The BioQUEST Curriculum Consortium

National Science Foundation

eotPACI

Howard Hughes Medical Institute