

EteRNA: Crowdsourcing New RNA Designs

Case Study Overview

Ribonucleic acid — or RNA — is key to life, playing a role in regulating the functions of cells. Scientists have been exploring RNA structures to better understand their biological roles.

To that end, researchers at Carnegie Mellon University and Stanford University have harnessed the power of crowdsourcing to create new RNA designs through an online game.

Funded through seed grants from by the National Institutes of Health, the National Science Foundation, Stanford University, and others, *EteRNA* is a browser-based “game with a purpose” that lets players solve puzzles related to the folding of RNA molecules. The goal is to help find RNA molecules that are biologically active.



Project Description

EteRNA is a two-dimensional puzzle-solving exercise using the four bases — adenine, guanine, uracil and cytosine — that make up RNA molecules. Players can design elaborate structures, including knots, lattices and switches.

EteRNA takes advantage of human problem-solving capabilities to solve puzzles that are too difficult for computers, given their lack of human intuition. As one project developer put it, “Computers don’t have flashes of insight.” The researchers are capitalizing on the collective intelligence of *EteRNA* players to answer fundamental questions about RNA folding mechanics.

Each week, the gaming community chooses the best designs created by players. Scientists at Stanford then synthesize the selected RNA molecules to see how their folding patterns compare with computer predictions, thereby improving computer models.

Challenges

The game is based on Foldit, so the developers did not face the challenges of starting from scratch. See [Foldit](#) for challenges related to this kind of crowdsourcing project.

Benefits and Outcomes

EteRNA's creators have been pleasantly surprised by the solutions of *EteRNA* players: Because not all of the players are experts in the field of RNA research, their creativity isn't constrained by what they think a correct answer should look like. Tens of thousands of players have contributed RNA sequence designs, with hundreds of designs synthesized for testing so far.

Ultimately, *EteRNA* researchers hope to identify a complete and repeatable set of rules for synthesizing RNA molecules that consistently fold in expected shapes. Such basic principles would facilitate the design of RNA-based nanomachines and switches. As one researcher put it, the dream is to create a functional RNA that can be transcribed into cells to sense light or even deactivate a virus.

By operating as a Massive Open Laboratory, the *EteRNA* researchers have engaged approximately 37,000 non-experts interested in science to participate in scientific research in a creative, meaningful, and productive way, and have led to not only the identification of RNA design rules but also the development and improvement of automated algorithms being used to predict RNA structures. Additionally, their results show that lay participants in a Massive Open Laboratory are capable of generating hypotheses and conducting experiments. This project is on-going; lab results are shared publicly on the *EteRNA* website on a regular basis.

Tips

- **Scope Out Your Problem — Know Your Tools; Know Where Your Project Fits**
Several *EteRNA* researchers had worked on previous incarnations of the game (Foldit and Rosetta@home), so they already had an understanding of the power, intuition and creativity of the crowd, particularly of those without scientific expertise (who lack the biases and expectations that come with familiarity with a topic). Having seen how successful the previous games were, they knew what this kind of crowdsourcing game could accomplish. Rather than developing something completely new, they altered the existing game to accomplish a specific task that would take much longer if performed by a handful of researchers.
- **Build a Community — Engage Your Community**
EteRNA allows its players to be creative with their formations (to a point) and communicate with each other through online forums. It also keeps them up to date on research progress they've helped to make. All of these aspects make for a more inclusive and congenial atmosphere, which aids in engaging players new and old. Players' feedback is also encouraged (for example, through a forum, comments, surveys, Wiki, and groups), and the researchers maintain constant communication with their players through the website's main page, blog, and press sections covering lay and scientific pieces.
- **Sustain and Improve Communicate Effectively**
EteRNA's researchers keep their players up to date with all the news concerning the

game, including new research milestones they helped to reach, on the homepage and in a blog on the *EteRNA* website. As with Foldit, they go one step further and give their players authorship credit for their papers. This level of communication and inclusion is a very important component of the research. Keeping the players so involved and giving them the credit they deserve not only helps to motivate them but also highlights their importance in the research.

Learn More

- Website: [EteRNA](#)
- [Automated Band Annotation for RNA Structure Probing Experiments With Numerous Capillary Electrophoresis Profiles \(Journal Article, 2015\)](#)
- [EteRNA News](#)
- [List of Publications From the Das Lab](#)
- [New Videogame Lets Amateur Researchers Mess With RNA](#)
- [RNA Design Rules from a Massive Open Laboratory \(Journal Article, 2013\)](#)

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