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High-throughput access to biological knowledge and reasoning through online games

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I. INTRODUCTION

Games are emerging as a powerful organizational and motivational tactic throughout many areas of society. Wherever people have a goal that they are having trouble reaching, be it getting their chores done [1], learning all the functions of Microsoft Visual studio [2], or finishing a 10K [3], many are finding success by posing the required tasks as elements of games. Games can turn small units of work, that alone might seem boring, into fun steps taken towards a meaningful success. In doing so, they can sometimes dramatically increase individuals' chances of reaching their objectives. The process of translating elements of non-game contexts (e.g. science, most traditional work, learning, exercise, etc.) into aspects of games is now known as 'gamification'.

Gamification is being used to meet a variety of scientific goals by serving as an effective way to organize and incentivize large-scale volunteer labor. The protein-folding game Foldit was the first of a growing wave of applications of games in the context of biological research. From this well-publicized [4] beginning in protein structure, we now have a variety of biological games about, for example, RNA structure design [5], multiple sequence alignment [6], and neural connectivity mapping [7]. In these games, players help advance scientific objectives by performing tasks that cannot be completed successfully by computers alone.

II. GENEGAMES.ORG

At genegames.org we are exploring the use of games to access the knowledge and reasoning abilities of *biologist* players. Previous attempts to apply the gaming paradigm in biology have focused on problems that can be mapped easily to visual reasoning and pattern recognition tasks, thus enabling people with little or no prior knowledge of biology to play and to make real contributions. While this is ideal from the perspective of accessing the largest possible number of players, not all problems can be translated easily to games oriented around visual reasoning. Furthermore, there are literally hundreds of thousands of people with biological training in the world and more with the ability and the desire

to learn. The games emerging at genegames.org are experiments in rapidly eliciting structured knowledge from this large, global community.

In the game 'GenESP' (based on the original 'ESP Game' [8]), players contribute their knowledge of gene function and disease relevance. In 'The Cure', players help to identify biomarker gene sets that can be used to improve predictions of breast cancer prognosis. These games are still in development but initial tests are promising in terms of both recruiting knowledgeable players and capturing useful structured knowledge as a product of their play.

We will present details about the design of the games as well as preliminary results from ongoing experiments. In addition, the game prototypes will run live during the conference allowing attendees to play and provide the developers with important feedback.

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