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NetLogo Mobile*: Introduction to A New Incarnation of NetLogo with embedded tools for Designing Interactive Scaffolds

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Abstract: We propose a demo session for NetLogo Mobile (1), the new incarnation of NetLogo for informal and formal learning contexts, and its embedded tools for researchers and educators to design interactive scaffolds. Based on constructionist and situated learning theories, we aim to empower learners to be full participants in agent-based forms of computational media to foster computational thinking. We then walk through the design of the software and describe two sections of the session.

Introduction

NetLogo (Wilensky, 1999), the most widely used agent-based modeling platform, is a powerful tool to foster computational thinking with complex systems (Wilensky, 2001; Wilensky & Rand, 2015). While NetLogo is in widespread use, we see great potential to significantly further scale the NetLogo community. Therefore, we propose a demo session to introduce the new incarnation of NetLogo: NetLogo Mobile (Chen & Wilensky, 2020) and embedded tools for designing interactive agent-based scaffolds on-the-fly. Running on almost every major computational platform, NetLogo Mobile comes with a more intuitive, scaffolded, and modern interface for a wide spectrum of informal and formal learning contexts. It aims to substantially increase young learners' (from elementary school students to high school students) access to powerful and expressive agent-based modeling tools to support computational thinking and modeling. Our latest project benefits greatly from the recent development in ubiquitous computing, research in individual and collaborative scaffolding, and lessons from our successful online learning communities.

The proposed demo session will be comprised of two interactive sections in an online setting. Depending on the available time slots, we are hoping for a 30-60 minutes session. First, we will invite the audience to play with a NetLogo model, adapted to NetLogo Mobile and scaffolded by interactive guidance. Second, we will provide a backstage tour to introduce the tools that produce the scaffolds, and invite the audience to create a scaffolded model of their own. Following the official sections, we will continue to engage with the participants, as we sincerely welcome feedback and questions from them. After the session, we will release all the materials as an appendix of the final summary to serve the readers of the conference proceeding.

As of March 2021, we are near the end of the first development iteration. Pre-release versions are currently distributed at https://turtlesim.com/products/turtle-universe/. Based on hundreds of thousands of NetLogo users, and millions of installations of our other constructionist learning app Physics Lab, we expect an emerging global online learning community by the time of the ISLS 2021 conference.

Theoretical Stance

Computational thinking (CT) is a critical form of literacy that increasingly supports a widening array of social and productive activities. While its importance has been increasingly recognized in academic and classroom contexts, there are still substantial challenges in implementing CT vision in and out of the classroom. In particular, the CT outreach for young learners is limited and has great potential to improve (Lee, et, al. 2011).

Meanwhile, computational media offer especially rich opportunities to increase the engagement of the learner (Turkle, 1984). Agent-based modeling (ABM) is a perfect candidate for computational media: it is increasingly used in studying complex systems by real scientists (Railsback & Grimm, 2011; Wilensky & Rand, 2015), but also easy to read, write, and visualize. The advantages of ABM for understanding complex systems are magnified in educational contexts (Wilensky & Papert, 2010). Using Wilensky & Papert's theory of restructuration, it is now possible for students without extensive knowledge in algebra and calculus to master the agent-based representation with a much-lowered threshold.

Based on constructionist learning theory (Papert & Harel, 1991), we see learning as most effective when the learner is constructing meaningful products. Embracing situated learning theory (Lave & Wenger, 1991), we

also see learning as a process of participation in communities of practice. Hence, the core idea of NetLogo Mobile is to empower, scaffold, and encourage more learners to be full participants in agent-based forms of computational media, to be consumers, creators, curators, and moderators in a massive online learning community that grows out of participation in these software tools.

A Walk-Through of the Design

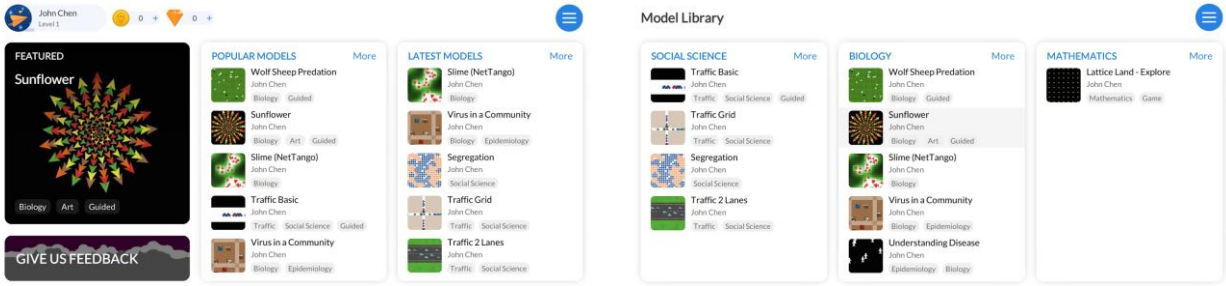

Figure 1&2. Homepage and Models Library.

The learners' journey with NetLogo Mobile starts with a models library (Figure 1&2), where we display popular and recent models together with learners' remixes of them. The library provides a more organized view of models. Then, all information of a model is integrated into the same page, where the learner could switch to a comment area for discussion, or browse the remixes created by other learners.

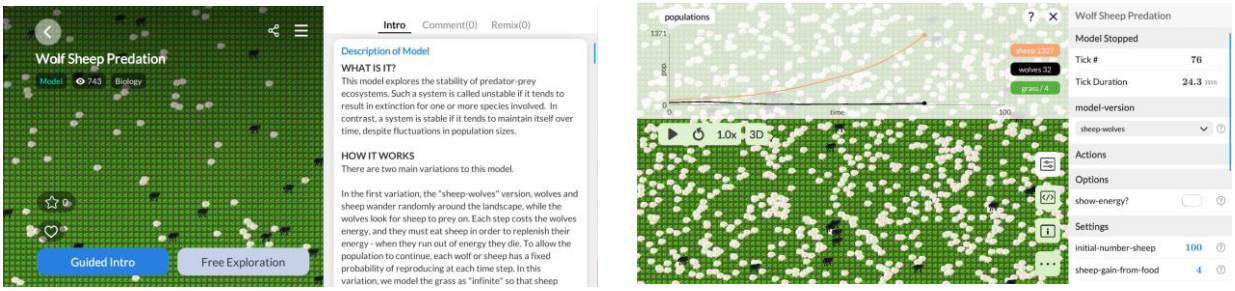

Figure 3&4. Information and Interface of a model.

The modeling interface (Figure 3&4) has been overhauled with a compact design aimed at smaller screens. On the right-hand side, the learner can switch between widgets, text-based, and block-based programming (based on NetTango, see Horn, et, al. 2014. & Horn, et, al. 2020) to play with the model. The panel with little "i" allows the learner to get help from the description or from other members of the community.

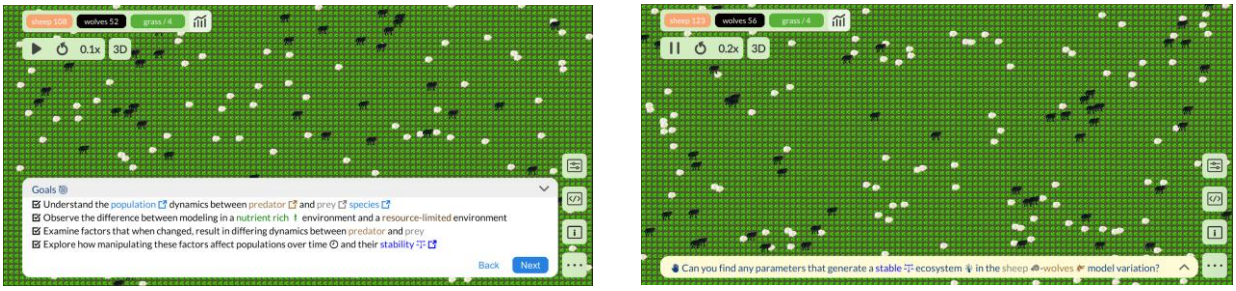

Figure 5&6. Guided Intro to a model.

When the learner enters the "Guided Intro" (Figure 5&6), an additional layer of scaffolds will be provided on top of the interface. We aim to strike a balance between the constructionist elements, where the learners play with the model to construct meaningful outcomes, and instructionist elements, where we scaffold the learner through guidance, prompts, and goals. Specifically, we provide contextual scaffolds to help understand the meaning of different parts of the model. All these interactive elements are fully configurable by researchers, educators, and learners, through our visual scaffold authoring tool that will be demonstrated in our demo session.

Demo Session: Technological Setup

At this moment, NetLogo Mobile works on a wide variety of hardware that can be found in everyday learning environments in and out of the classroom. However, both the calculation and rendering of agent-based modeling are inherently computational heavy. Hence, we recommend that the audience have one or more of the following:

- iPhones: newer than iPhone 6s, running iOS 11 or later;
- iPads: produced later than 2015 (iPad Mini 4/iPad Air 2), running iOS 11 or later;
- Android Phones/Tablets: produced later than 2015, running Android 6.0 or later;
- Macs: running macOS 10.12 (Sierra) or higher;
- Windows Desktops/Laptops: running Windows 7, DX10+ compatible.

We recommend that every participant downloads, installs, and explores NetLogo Mobile before the session starts. One of our major design goals is to scaffold inexperienced learners on the Internet to explore the world of ABM, and we are looking forward to feedback from the audience. For participants who want to create interactive scaffolds during the session, an available Mac or PC with a modern browser is also needed.

Demo Session: Section 1

We plan to spend half of the session offering an overview of NetLogo Mobile, its learning and interface design, and its scaffolds created by us. We expect the session to be a live Zoom meeting or equivalent with screen sharing capability. First, we will choose a scaffolded agent-based model from the models library and encourage the audience to go through it with the software installed on their devices. A live, informal, and voluntary survey will be taken in-app from the participants to describe their reactions and feelings. We will share the anonymized result of the quick survey, as well as the real-time usage statistics of the software collected and anonymized over the Internet. We would then explain the potential for researchers to capture the learning data from tens, hundreds, or thousands of learners remotely with the platform. Some possible questions to answer during the session:

- What kinds of interactions can we observe from the live data feed?
- Which contextual scaffold did the participants trigger most frequently?

Demo Session: Section 2

The second section of the demo session will be in the back of the stage, where the interactive scaffolds are created with a visualized editor with forms and simple NetLogo code snippets. We plan to use the model from Section 1 to demonstrate how the scaffold was created, and how the researchers, teachers, and even students can leverage the editor to create their own interactive scaffolds in a nutshell. To provide a concrete example, we would ask for some quick ideas from the audience to improve or randomly change the scaffold, implement them on-the-fly, and then share it in the software. We will then suggest the audience try the new scaffolded version of the model shared by the speakers in the online community, and explain how the community works as a shared venue of computational media.

Then, in the spirit of constructionist learning, we will encourage the participants to create a tiny artifact of their own. To make the task less intimidating, we will provide a simple agent-based model with a semi-complete scaffold for the participants to start with. We will also share slides to explain the model and list some potential learning issues that might need to be addressed as a starting point. Several breakout rooms will be set up to facilitate cooperative learning, and the speakers will wander around to take questions. While we hope that each group can share their work during the session, due to time constraints, we will encourage each group to share their work in the online community and explore other groups' artifacts after the session. Finally, the speakers will remain in the virtual conference room to take more feedback, answer questions, and discuss opportunities with the audience.

Future Work and Implications

While we only plan to demonstrate a few key features of NetLogo Mobile, there are many more for researchers, educators, and learners to explore. We believe that this new incarnation of NetLogo has great potential for a

spectrum of learning settings. NetLogo Mobile has been designed for use in informal learning environments, where we expect the learners to discover and download the software on App Stores. Yet in the future, we expect that NetLogo Mobile will be adapted for use in classrooms, where the curriculum designers can integrate lots of scaffolds within the model and ease the burden of instructors. It may also be adapted to museum settings, where the modernized design works much better than the desktop or Web implementations of NetLogo on touch-based devices and supports many more forms of visitor scaffolding. Exploring the very wide range of possibilities is beyond the scope of the session, but we look forward to more discussions and interactions with the community and the interactive learning platform.

NetLogo Mobile opens a new set of research opportunities, as we have encountered literature gaps when investigating the first iteration of development. For example, when we try to implement a more modern graphical representation for some agent-based models, we do not know where to strike the balance between abstraction and concreteness. A vivid 3D graphical representation that is similar to the video games surrounding today's children may capture learners' attention better, at the cost of potentially distracting them from the learning content. How can we measure the effect in a non-uniform and ever-changing population of learners, with other digital artifacts around them also evolving rapidly? The modest forms of graphic representation today were unimaginable decades ago. And this is only one of the numerous questions we encountered during the development process.

As Wilensky and Papert (2010) stated, computation-based representations, or in their term, "restructurations" of science contents are poised to make a significant impact on knowledge domains. For NetLogo Mobile, our question for future work is: how can we restructurate the representation and scaffolding of the models to have an impact on learners' interaction and internalization of the restructurated knowledge domains?

Endnotes

(1) Since the initial submission of this proposal, we have renamed NetLogo Mobile to Turtle Universe.

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