Unplugged Assignments for K-12 AI Education

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Introduction

In this column, we introduce our two "unplugged" (i.e. no technology needed) Model AI Assignments: Introducing AI and Semantic Networks and Knowledge Representations. We also reflect on the potential benefits of unplugged activities for broadening access to AI-related learning experiences.

Why "Unplugged" Activities to Learn about AI?

Resources for computer science (CS) education that do not require technology have become valuable in computing education for a variety of reasons, including their low cost, ease of implementation, incorporation of physical/embodied interaction, and often playful nature (Nishida et al., 2009). Inspired by these "CS Unplugged" materials (Bell, Rosamond, & Casey, 2012), there have been a few existing online resources for AI education developed in the past year or two that do not require technology. Ali et al. have developed an unplugged middle-school curriculum for AI ethics (Ali, Payne, Williams, Park, & Breazeal, 2019) and Lindner et al. have developed a six-lesson unplugged curriculum for teaching about concepts like decision trees and reinforcement learning (Lindner, Seegerer, & Romeike, 2019). A few other resources for unplugged AI resources that have not been formally published have been recently made available as lesson plans online (Microsoft, n.d.; Group, n.d.; Krueger, n.d.; Seegerer & Lindner, n.d.).

There remains a lot of space in the field for the development of additional "unplugged" AI activities. These activities have the potential to broaden access to AI-related learning experiences at a low cost to educators. They also

have the potential to be more engaging for novice audiences, since they involve hands-on paper-based activities that typically do not require prerequisite coding knowledge.

The Model AI Assignments

In this column, we present two unplugged assignments that aim to teach introductory AI concepts to young learners with no prior experience in AI or computer science.

Introducing AI

The first assignment, Introducing AI, is intended as a high-level introduction to AI and can be used to kick off an AI-related class, unit, or workshop. Students engage in an interactive worksheet activity and explore questions such as: *What is artificial intelligence?*; *Where have you used it before?*; *How do you feel about it?*; *How does it work?*. This assignment can be completed as a worksheet activity or the worksheet can be used as a guide to lead an in-class activity.

The activity requires the use of a printable deck containing cards with *examples of AI technologies* and possible *inputs*, *algorithms*, and *outputs* for AI devices. The worksheet activity begins by prompting students to consider where they have seen AI before and how they feel about AI. Then, they are asked to look at the examples of AI in the card deck and select cards with technologies they have interacted with previously. Finally, students are walked through a high-level explanation of how AI works and are guided by the worksheet to create an imaginary AI using the *input*, *algorithm*, and *output* cards. Our assignment also includes additional questions for learners to reflect on after the activity, such as prompting learners to reflect on the strengths and weaknesses of their imaginary AI device or

asking learners to discuss whether they think their feelings about AI might change in the future.

In our experience, this activity has been engaging for family groups with children ages 6 and up. Younger children (6-9) needed support from adults or older siblings to read the worksheet instructions/card descriptions but were able to actively engage in identifying AI examples they had previously interacted with, discussing their feelings about AI, and finding sensor/dataset/algorithm cards to create an imaginary AI (mostly using the pictures on the front as a guide).

This activity aims to equip learners to be able to a) identify AI technologies that they have used before; b) distinguish between technology that uses AI and technology that does not use AI; c) identify their preconceptions and discuss their feelings about AI; d) define the terms sensor, dataset, and algorithm and recognize several examples of each; and e) explain that AI takes an input, processes that input using an algorithm, and produces an output.

Semantic Networks and Knowledge Representations

The second assignment, Semantic Networks and Knowledge Representations, is focused on communicating concepts related to knowledge representations and reasoning. AI agents store and organize information in their memory using structures known as *knowledge representations*. One type of knowledge representation is a *semantic network*. Semantic networks are a way of representing relationships between objects and ideas. For example, a network might tell a computer the relationship between different animals (e.g. a cat IS-A mammal; a cat HAS whiskers). In this assignment, learners can create their own semantic networks (Figure 1) by gluing down printable cards containing concepts (e.g. cat, mom, friend) and arrows containing relationships (is, has, likes, dislikes). Provided card decks contain concepts related to animals, family, and musical instruments. Blank cards are also provided to allow learners to make networks on custom topics.

Students can simulate an AI-user interaction using their semantic networks. Two students
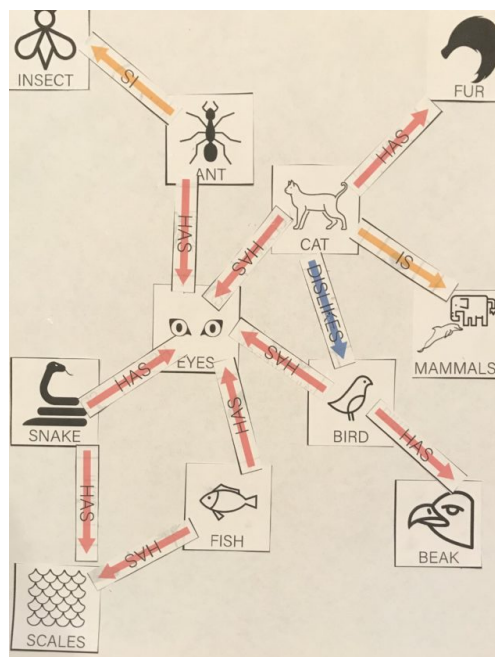

Figure 1: Example of a completed semantic network activity

can trade completed semantic networks and ask their partner questions about the network they created (e.g. "What is a cat?"). The student's partner should answer the questions using the semantic network as their only guide (simulating an AI agent whose only knowledge is based on the semantic network). Learners are then encouraged to reflect on the networks they create and consider the strengths and limitations of the knowledge representation using a provided list of questions that can be used to foster discussion or as a written activity.

In our experience, this activity has been engaging for learners ages 6 and up, although younger learners many need some adult support during the latter half of the activity when they are asked to simulate an AI agent using their network. We have also observed that the activity is engaging and fosters learning for learners with little to no prior knowledge about AI. This assignment could be adapted as either a take-home written activity or an in-class group project, and cards/arrows could be customized to foster interdisciplinary connections.

This activity aims to help learners a) understand that one way computers store common-sense knowledge is using networks of con-

nected concepts and relationships; b) explain at a high-level how a computer would use the network they built to answer questions (e.g. follow the HAS arrows connected to "cat" to answer "What does a cat have?"); and c) reflect on the strengths and limitations of semantic networks as a way of representing knowledge.

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