EXPLORING COMPUTER SCIENCE FUNDAMENTALS THROUGH VIRTUAL IDENTITIES

EDUCATOR GUIDEBOOK

MIT Imagination, Computation, and Expression Laboratory

HOW TO USE THIS EDUCATOR GUIDE

Released by the MIT Imagination, Computation, and Expression Laboratory

This guidebook was designed to provide educators with the foundational resources to design and implement learning experiences for students to learn computer science in fun, exciting, relevant ways and to help them develop self-images as computer scientists by seeing their identities as resources from which they can draw upon as learners and doers of computer science.

This guidebook reflects the design and implementation of a weeklong curriculum designed and piloted by MIT researchers to serve Boston-area middle and high school students from underrepresented backgrounds in computer science. However, educators are encouraged to use the guidebook as a starting point for customizing the curriculum to the unique needs of your students and any constraints that may exist within your learning environment. In addition to providing guidance for designing engaging and meaningful learning experiences, this guidebook contains a list of additional free and publicly available resources which can be used to further explore computer science.

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Imagination, Computation, and Expression Laboratory

ABOUT THE MIT ICE LAB

The Imagination, Computation, and Expression Laboratory (ICE Lab) researches and develops computing systems for creative expression, cultural analysis, and social change. Our research and development work includes new forms of gaming, interactive narrative, social media, digital media art, and, most importantly, creative computing forms unanticipated by any of those. To learn more about current projects, visit http://groups.csail.mit.edu/icelab/

EXPLORING COMPUTER SCIENCE (ECS) ALIGNMENT

The learning activities presented in this guidebook include an introduction to computing topics aimed at sparking students' interest and engagement, fostering a student-centric approach in which they are seen as rich holders of prior knowledge which are assets and opportunities for connection to computing. The curriculum allows students to explore their ideas while learning about human-computer interaction, web design, privacy, coding, debugging, and more using an inquiry-based, constructionist approach to teaching and learning.

This guidebook was developed with and endorsed by a team of experienced learning science and curriculum development professionals as well as several Boston-area Advanced Placement (AP) Computer Science teachers. The content in this guidebook is aligned with the first five units of the nationally-recognized Exploring Computer Science (ECS) curriculum, which is an introductory high school course designed to engage students in both computer science content as well as computational thinking and practice. Although the ECS assessments released by the Principled Assessment of Computational Thinking (PACT) team at SRI Education were not administered to students as part of the educational research process, the ECS content and assessment model served as foundational resources during the development of this curriculum and assessment framework.

CONTENT IN THIS GUIDEBOOK

This guidebook has been organized into 6 units and contains detailed examples on how to lead engaging activites and discussions focused on the aforemorentioned goals:

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- **UNIT 3: SOCIAL, ECONOMIC, & CULTURAL ISSUES IN COMPUTING**

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STRATEGIES FOR IMPLEMENTING THIS CURRICULUM

The general run-of-show schedule implemented in the Boston-area program case studies by the MIT ICE Lab is presented below. However, educators are strongly encouraged to customize their curriculum implementation to the unique needs of their students and learning setting, and the below durations should not be considered requirements.

	SUGGESTED DURATION	UNITS / ACTIVITIES
DAY 1	~ 1 HOURS 25 MINUTES	**UNIT 1: INTRODUCTIONS** (25 min) ▪ Icebreakers and Introductions ▪ Sharing Our Characters **UNIT 2: DATA STRUCTURES AS BUILDING BLOCKS** (1 hour) ▪ Introductions to Computing Virtual Identities ▪ Developing Front & Back End Virtual Identities
DAY 2	~ 1 HOUR 25 MINUTES	**UNIT 3: SOCIAL, ECONOMIC, & CULTURAL ISSUES IN COMPUTING** (30 min) ▪ Stylin', Profilin' (How We Express Ourselves Online) ▪ Stereotypes (Representations of Computer Scientists) ▪ Surveillance (Managing Privacy-Related Issues Online) ▪ Mo' Money Mo' Problems (How Companies Profit From Your Data) **UNIT 4: MAP DESIGN & COMPUTING** (55 min) ▪ Exploring Map Games ▪ Maps as Design Tools
DAY 3	~ 5 HOURS	**UNIT 5: MAP DESIGN & COMPUTING** (2 hours) ▪ Introduction to Prototyping ▪ Low-Fidelity Prototyping ▪ High-Fidelity Prototyping **UNIT 6: MAP PATHFINDING & SEARCH** (1 hour) ▪ Map Pathfinding Strategies ▪ Introduction to Search Algorithms **MENTORSHIP ACTIVITIES** (2 hours) ▪ Mentor Networking Lunch ▪ MIT Campus Tour

UNIT 1: INTRODUCTION

Virtual Identities Workshop Introduction

Aligned ECS Units:

The following ECS units are addressed in Unit 1 of this guidebook:

- **ECS UNIT 1: HUMAN COMPUTER INTERACTION**

  In this unit students are introduced to the concepts of computer and computing while investigating the major components of computers and the suitability of these components in the domain of online virtual identities.

Unit Overview

In this unit, students will engage the the following practices:

- Engaging in an introductory discussion on HCI topics
- Engaging in an introductory discussion on the relation of our selves to our virtual identities

Activities in this Unit

1. Icebreaker & Introductions
2. Sharing Our Characters

UNIT 1: ACTIVITY 1
ICEBREAKER & INTRODUCTIONS

Activity Overview

This part of the workshop provides an opportunity for the workshop instructors to present the overview of the workshop structure and agenda, as well as take part in an icebreaker activity between students and educators. This activity can be used prior to any of the subsequent activities throughout the guidebook related to virtual identities.

Key Terms + Concepts

- VIRTUAL IDENTITIES include but are not limited to game avatars, social media profiles, online shopping accounts, general media representations, and are created and maintained for self-expression, surveillance by law enforcement, as well as corporate user data management.

Driving Questions

- When you think of the words "virtual identity," what do you think of?

Materials + Preparation

- Paper & pencils
    - Alternatively: Computers and moderated group discussion forum (e.g.: Slack)

Instructors may look up or create additional icebreaker activities and/or journal prompts to facilitate student/teacher relationship development.

Activity Instructions

Icebreaker and Reflection on Virtual Identities (20 minutes)

- Introduce purpose of workshop, activity agenda, and expectations for students
    - *Rules may include: keeping an open, safe, and supportive atmosphere by respecting when other classmates are speaking, focusing on offering constructive feedback, respecting our selves and others' property.*
- Everyone participates in a verbal icebreaker activity
    - Instructors Begin: Share about where you are from, what you wanted to be when you were their age, how you got interested in computing, what you do for a job and how it involves computing. Instructors should provide an example for students to follow of conveying information efficiently in the allotted time.

        - You may want to use a timer to ensure an inclusive dialogue within the time constraints, particularly for larger groups.
    - **Students Share:** Share about their passions (in general), their interest (if any) in computing, and what they hope to learn from the workshop.
    - **Optional:** Add in a "fun" question such as favorite ice cream flavor, favorite mobile/web app, or favorite TV show to provide a more personal introduction between instructors and students.
- **ASK:** When you think of the words "virtual identity," what do you think of?
- Have students individually reflect on this question by silently writing a response.
- Once students have responded to the prompt, have instructors facilitate small group discussions sharing what students' responses were and probing their responses with additional, more challenging questions.
- As a large group, verbally reflect on major themes and close with overaching definition, broadening virtual identities to any collection of information related to a person's identity.

UNIT 1: ACTIVITY 2
SHARING OUR CHARACTERS

Activity Overview
This activity provides a fun, conversational introduction to the topic of identity representation in relation to our selves by asking students to identify and share 3 fictional characters which represent them.

Key Terms + Concepts
- VIRTUAL IDENTITIES include but are not limited to game avatars, social media profiles, online shopping accounts, general media representations, and are created and maintained for self-expression, surveillance by law enforcement, as well as corporate user data management.

Driving Questions
- When you think of the words "virtual identity," what do you think of? Do you think about fictional characters like the ones you chose to represent yourself, or do you think of something that more directly represents you, like a game avatar that you create and customize?

Materials + Preparation
- (Optional) Computer
- (Optional) Projector

Students may be assigned identifying their 3 fictional characters as a homework assignment prior to the workshop and/or print out or prepare files to display graphical images of their characters to the class as they present.

Activity Instructions
Sharing Our 3 Fictional Characters (20 minutes)
- Everyone (including instructors) shares 3 fictional characters which represent themselves
- Look them up on Google image search and project images in front of the class
- Explain the specific aspects of each character which relate to your identity
- ASK: When you think of the words "virtual identity," what do you think of? Do you think about fictional characters like the ones you chose to represent yourself, or do you think of something that more directly represents you, like a game avatar that you create and customize?

UNIT 2: DATA STRUCTURES AS BUILDING BLOCKS
Computational Elements of Virtual Identities

Aligned ECS Units:

The following ECS units are addressed in Unit 1 of this guidebook:

- **ECS UNIT 1: HUMAN COMPUTER INTERACTION**

  In this unit will be introduced to fundamental notions of Human Computer Interaction (HCI) and ergonomics. Students will learn that "intelligent" machine behavior is not "magic" but is based on algorithms applied to useful representations of information, including large data sets.

Unit Overview

In this unit, students will engage the the following practices:

- Creating avatars using the AIRvatar system
- Engaging in an introductory discussion on HCI topics
- Running an activity on finding and critically assessing available avatar creators
- Discussing connections among social, economical and cultural contexts

Activities in this Unit

1. Introduction to Computing Virtual Identities
2. Developing Front & Back End Virtual Identities

UNIT 2: ACTIVITY 1
INTRODUCTION TO COMPUTING
VIRTUAL IDENTITIES

Activity Overview

This discussion allows students to learn about the constraints and affordances of virtual identity systems through the perspective of computer science terminology and discuss ethical issues around corporate data collection practices.

Key Terms + Concepts

- VIRTUAL IDENTITIES include but are not limited to game avatars, social media profiles, online shopping accounts, general media representations, and are created and maintained for self-expression, surveillance by law enforcement, as well as corporate user data management.
- AVATARS are media representations of a particular person which can be used in video games, internet forums, and other contexts.
- DATA DOPPELGÄNGERS are profiles created by third-parties which use data collected from people's browsing history, status updates, GPS locations, responses to marketing mail, credit card transactions, public records, and more to personalize their information experience.

Key Takeaways

- When we use social media, certain types of data are being collected, stored, and disseminated about us. It's important to be specific and as knowledgable as possible about this. Because of their business models, these systems are designed to get as much useful information as possible from you.
- "From the moment you check your news feed in the morning to when you purchase lunch with your credit card to Googling your next vacation locale in the evening, the conglomerate of your digital touch points are being harnessed by multiple companies, often without your permission, and then sold to third-party vendors, or data brokers, for the purposes of ad targeting."
  —Tracy Wallace, *"Your Digital Doppelgänger, Or Why Third-Party Data Undermines Personal Agency"*

Driving Questions

- What is the purpose of companies collecting and maintaining data profiles on people?

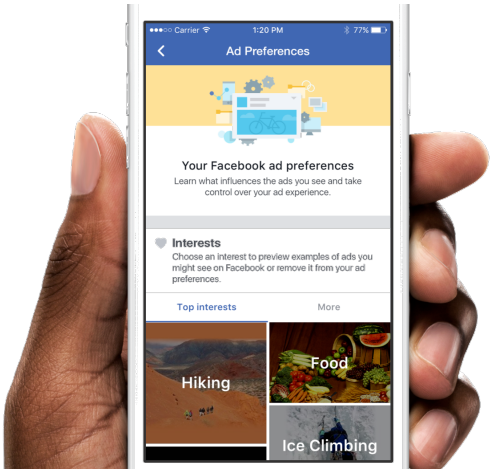
- Should people always have access to this type of information on themselves? Should people have to consent to have this data sold? Is it important for it to be accurate? Why?

Materials + Preparation

- Computer
- Projector
  - **Alternative:** Print handouts of Facebook advertising preferences page

Activity Instructions

- Review discussion on various types of virtual identities (15 minutes)
  - What are the differences in structure and content between virtual identity as avatar, social media profile, and data profile? Who creates each of them?
  - What do you focus on in each of these virtual identies? What are the constraints and limitations of these systems? What aspects of your identity are you not able to represent?
- Facebook Virtual Identity Discussion (35 minutes)
  - Navigate to: https://www.facebook.com/ads/preferences/?entry_product=ad_settings_screen



  - Discuss as a group: What is contained in our Facebook ad profiles? Why do these profiles exist, and how do websites like Facebook make money? How is this information is collected? Is this our *real* self? Do you want it to be accurate or not?
  - When we talk about data on people, this is not typically seen by anyone.
  - Only recently are facebook and google showing their advertising categories, but this is not the complete profile that is stored on you. Anytime you visit a page with a facebook share button, it tells Facebook. Some companies also use "pixels". Incognito browser mode keeps it out of your history but you're still trackable by these websites.
  - **ASK:** What is the purpose of companies collecting and maintaining data profiles on people?
  - **ASK:** Should people always have access to this type of information on themselves? Should people have to consent to have this data sold? Is it important for it to be accurate? Why?

UNIT 2: ACTIVITY 2
DEVELOPING FRONT & BACK END VIRTUAL IDENTITIES

Activity Overview

This activity provides a creative, interactive exercise following students' identification of 3 fictional characters which represent them in which the class collectively creates a game avatar, social media profile, and corporate data profile for the fictional characters identified by the students. The discussion throughout this activity allows students to critically reflect upon the constraints and affordances of virtual identity systems and gain a new awareness of corporate data collection practices.

Key Terms + Concepts

- VIRTUAL IDENTITIES include but are not limited to game avatars, social media profiles, online shopping accounts, general media representations, and are created and maintained for self-expression, surveillance by law enforcement, as well as corporate user data management.
- FRONT END DATA refers to the presentation/client layer on websites or applications that users can see and interact with directly.
- BACK END DATA refers to the data access layer which may include the servers, databases, physical infrastructure and/or hardware used to store website or application information.
- MODULARITY is the degree to which a system's components may be separated and recombined. Modular programming is the process of subdividing a computer program into separate sub-programs.
- AVATARS are media representations of a particular person which can be used in video games, internet forums, and other contexts.
- DATA DOPPELGÄNGERS are profiles created by third-parties which use data collected from people's browsing history, status updates, GPS locations, responses to marketing mail, credit card transactions, public records, and more to personalize their information experience.

Key Takeaways

- Your digital self-representation is not the same as your self. It's another kind of speculative or fictional identity. It's curated to represent a certain kind of self, and we get a very different image of the same person in different digital contexts. The affordances of different avatar and profile creation systems matter, and encourage us to present ourselves in certain ways.

Driving Questions

- What kinds of games do you see avatars and virtual identities being very important to? Why?
- What aren't we able to do or express about your character in particular avatar creation systems?
- What are the most important parts of people's social media profile pages? For example, when you look at someone's Twitter profile, where do you look first?
- Do you find yourself thinking of your social media profiles as your self? What about for other people?
- What kind of information might be useful for an advertiser, or an intelligence agency, for that matter, to know? Would you consider this a virtual identity?

Materials + Preparation

- Computer
- (Optional) Projector

Instructors should identify an avatar design system for students to use as well as to analyze (in terms of the affordances, features, and constraints of the system). Instructors may want to provide instructions in the form of slides or a handout on how to customize and export the avatar as an image file.

Example Avatar Customization & Export Screenshots:


My Avatar Editor
File Menu
Hair Style
Hair Color
Editor: 1.0.5.0
Character: 1.0.5.0
Load
Save
XML
Export
Export your Avatar character to your computer as a bitmap image. You can choose between JPEG or PNG formats.
Hair Part
2/6
Done
Avatar link: http://www.myavatareditor.com/?avatar=00100047007200650061007400 6e0061006d006500004040808


My Avatar Editor
Export
Hair Style
Size:
800 px
Preview
x3.2
Zoom:
15 %
Background: # FFF3C9
Display:
Body
Shadow
Background
Fomat:
JPEG
PNG
Click and drag to reposition
Back
Save
Avatar link: http://www.myavatareditor.com/?avatar=00100047007200650061007400 6e0061006d006500004040808

Activity Instructions

Data Structures & Modularity (20 minutes):

- Our corporate profiles all have **"back end" data:** the image and the code/data structures that implement the **"front end" data:** the information that we see as users.
- Introduce students to the concept of **modularity**, both within the data structure and in the image: all the components are interchangeable. We could replace all the assets and the system would still function the same. You can also swap out functions.
- For example: Show what the Mii data structure looks like. Reflect on various parameters of the system (e.g.: "isGirl" is a Boolean which adds or removes a skirt from the avatar). How is this a good model and how is this a limited model? What are other ways of these avatar attributes being surfaced in the user interface (e.g.: a slider)?
- Show Facebook Interactive graph API interface for data profiles and discuss how the API describes the first four identity fields.

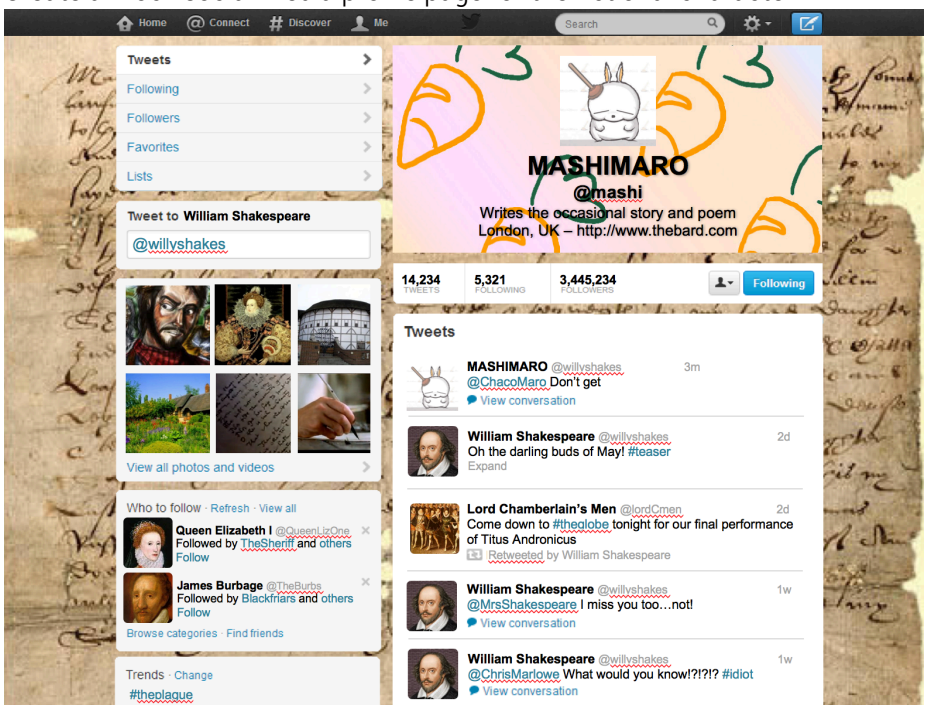
Group Avatar and Profile Creation (40 minutes):

- Have a student volunteer to come up to the front of the room and as a group, create a game avatar, a social media profile, and a corporate data profile for one of the fictional characters that the student chose (if multiple students want to share or a student wants to blend three fictional characters together, that's fine).
    - *Game avatar (10 min)*
        - Create a mock game avatar image of the fictional character.

Video game avatars

        - For example, you can use the Nintendo Mii creator online to create an avatar of the character that might be used in a game.
        - ASK: What kinds of games do you see avatars and virtual identities being very important to? Why?
        - ASK: What aren't we able to do or express about your character in particular avatar creation systems?
    - *Social media profile (15 min)*

- Create a mock social media profile page for the fictional character.



- For example, you can make a fake Twitter account page in Powerpoint or Google Slides and give one of the characters a location, a follower count, their profile picture, often a picture of them, their cover photo, often an abstract image that represents something about them, pinned tweet, other tweets, bio, location, links to other accounts in the bio. Discuss how the profile would differ if you were making it for Snapchat? For Instagram? For Linkedin? For YouTube? For Etsy?
- ASK: What are the most important parts of people's social media profile pages? For example, when you look at someone's Twitter profile, where do you look first?
- ASK: Do you find yourself thinking of your social media profiles as your self? What about for other people?

- *Corporate Data Profile (25 min)*

- Create a mock corporate data profile (*e.g.: to track advertising preferences*) of the fictional character.

Jane Lane corporate data profile

- Sick Sad world fan
- Art
- Art supplies
- Witch House
- Makeup and beauty
- Nonconformity
- Feminism
- Flannel industry
- Doc martens
- Piercings and tattoos
- Dark

- For example, attempt to characterize the character's Facebook ad preferences: https://www.facebook.com/ads/preferences/?entry_product=ad_settings_screen
- When we talk about data on people, this is not typically seen by anyone.
- ASK: What kind of information might be useful for an advertiser, or an intelligence agency, for that matter, to know? Would you consider this a virtual identity?

UNIT 3: SOCIAL, ECONOMIC, & CULTURAL ISSUES IN COMPUTING

Discussions at the Intersection of Culture & Computing

Aligned ECS Units:

The following ECS units are addressed in Unit 3 of this guidebook:

- **ECS UNIT 1: HUMAN COMPUTER INTERACTION**

  In this unit, students will gain an appreciation for the many ways in which computing-enabled innovation have had an impact on society, as well as for the many different fields in which they are used. Connections among social, economical and cultural contexts will be discussed.

Unit Overview

In this unit, students will engage the the following practices:

- Engaging in an introductory discussion on HCI topics
- Discussing connections among social, economical and cultural contexts

Discussions in this Unit

1. Stylin', Profilin' (How We Socialize & Express Ourselves Online)
2. Stereotypes (How People are Perceived and Represented in Computing)
3. Surveillance (How People and Companies Manage Privacies and Related Issues)
4. Mo' Money Mo' Problems (How Companies Make Money Off of Your Data)

UNIT 3: DISCUSSION 1
STYLIN', PROFILIN'
How We Socialize & Express Ourselves Online

Discussion Overview
This discussion allows students to critically reflect on their social media behaviors and how they have been shaped by and affected their culture and social experiences.

Driving Questions
- Do you feel that your life has been improved or harmed by social media? In what ways?
- Do you think your social media profile(s) accurately represent who you are? Why or why not?
- How has social media (or tech/the internet in general) helped your relationships with friends and family?
- Have you ever used social media to make or share art, stories, poetry or other creative work?

Discussion Instructions
- Either assign students homework to read the following articles prior to the workshop, or designate time prior to the discussions to collectively read them together:
    - "The Flight from Conversation" by Sherry Turkle
    - "Internet Connections" in Rookie Mag

      Please note that these are just example media and any related articles/videos may be identified to spark similar discussions on place of the above links.

- Use the driving questions to guide and focus the discussions, either as a large group or in facilitated smaller groups with a large-group recap.

UNIT 3: DISCUSSION 2
STEREOTYPES
How People Are Perceived & Represented in Computing

Discussion Overview
This discussion allows students to critically reflect on the media representations of computer scientists, their relationship to these representations, and their effect on the perception of computing.

Driving Questions
- What stereotypes of programmers do you see shown or challenged in the media? Do you feel like the representations you see of computer scientists are similar to yourself? Why or why not?
- Do you feel like you want or need representation of people who look like you or are similar to you?
- What are the hard skills and soft skills that you think of computer scientists, or programmers as having?
- Do you see programmers as different from hackers or computer scientists or anything else?

Discussion Instructions
- Either assign students homework to watch the following videos prior to the workshop, or designate time prior to the discussions to collectively watch them together:
    - Lyndsey Scott: Model & Programmer
    - Silicon Valley trailer*

      *WARNING: STRONG LANGUAGE, STIGMATIZATION OF AUTISM/MENTAL ILLNESS, SEXUAL CONTENT

      Please note that these are just example media and any related articles/videos may be identified to spark similar discussions on place of the above links.

- Use the driving questions to guide and focus the discussions, either as a large group or in facilitated smaller groups with a large-group recap.

UNIT 3: DISCUSSION 3
MO' MONEY, MO' PROBLEMS
How Companies Make Money Off Your Data

Discussion Overview
This discussion allows students to critically reflect on their computing practices and learn more about how companies make money through sharing user data for advertising.

Driving Questions
- Is any electronic communication truly private?
- What are some of your concerns about social media and privacy?
- How do you determine what's appropriate to share and where?
- What is the purpose of maintaining profiles on people?
- What kind of information might be useful for an advertiser, for that matter, to know?
- Would you consider your data profile a virtual identity?
- Should people always have access to this type of information on themselves? Should people have to consent to have this data sold? Is it important for it to be accurate? Why?

Discussion Instructions
- Either assign students homework to read the following articles prior to the workshop, or designate time prior to the discussions to collectively read them together:
    - First 3 sections of Social Media Surveillance and Law Enforcement
    - All 4 episodes on Propublica: Breaking the Black Box
    - Cybertwee artists are overriding the patriarchy with cuteness

      Please note that these are just example media and any related articles/videos may be identified to spark similar discussions on place of the above links.

- Use the driving questions to guide and focus the discussions, either as a large group or in facilitated smaller groups with a large-group recap.

UNIT 3: DISCUSSION 4
SURVEILLANCE
How People Manage Privacy-Related Issues

Discussion Overview
This discussion allows students to critically reflect on their computing practices, how they are represented online, and the surveillance practiced by corporations and law enforcement.

Driving Questions
- How is social media used as a way to represent people? Which of these examples from the readings do you feel are relevant to you? Which do you feel are irrelevant or don't affect you?
- What are the different levels of surveillance and ways to protect against each of the following:
    - Friends, Parents, Schools & Employers, Hackers, NSA, and Police/Law Enforcement
- Of the above groups, who are you most worried about? Are you worried at all?
- What practices do you currently use to protect yourself and your data from surveillance?

Discussion Instructions
- Either assign students homework to watch the following videos prior to the workshop, or designate time prior to the discussions to collectively watch them together:
    - First 3 sections of Social Media Surveillance and Law Enforcement
    - All 4 episodes on Propublica: Breaking the Black Box
    - Cybertwee artists are overriding the patriarchy with cuteness

      Please note that these are just example media and any related articles/videos may be identified to spark similar discussions on place of the above links.

- Introduce concept of **sousveillance**: watching from below, rather from above (e.g.: video recordings of police misconduct).

- Use the driving questions to guide and focus the discussions, either as a large group or in facilitated smaller groups with a large-group recap.

UNIT 4: MAP DESIGN & COMPUTING

Designing and Computing Maps

Aligned ECS Units:

The following ECS units are addressed in Unit 1 of this guidebook:

- **ECS UNIT 2: PROBLEM SOLVING**

  In this unit students will apply a variety of problem-solving techniques to provide opportunities for computational thinking in the context of map games, map design, and map implementation.

Unit Overview

In this unit, students will engage the the following practices:

- Playing Mazzy and/or other map-related computing games
- Discussing maps as a design tool for representing ideas
- Discussing how to document functional specifications and requirements
- Representing students' own communities (eliciting generative themes)

Activities in this Unit

- Exploring Map Games
- Maps as Design Tools

UNIT 4: ACTIVITY 1
EXPLORING MAP GAMES

Activity Overview
In this activity, students will learn to identify foundational computing concepts in map-related video games.

Key Terms + Concepts
- DESIGN CONSTRAINTS refers to a limitations or "guide rails" on the requirements and/or operation conditions under which a design must be built and cannot violate.
- AFFORDANCES are clues about how an object should be used, typically provided by the object itself or its context. They provide information about the possible effect of an action on an object or environment.
- LOOPS are constructs which repeat the same actions a certain number of. times, or until a certain condition is true.
- CONDITIONALS are constructs which perform different computations or actions depending on whether a programmer-specified boolean condition evaluates to true or false.

Key Takeaways
- We can think about map games through the lens of computer science concepts.
- The ability for the user to come up with creative ways of solving problems is a main aspect of what makes map games fun.

Driving Questions
- What are the visual elements and actions one can take when playing map games? What parts of the game interface do we pay attention to?
- How are these elements in the game actually built using computer science?
- What makes map games fun and/or challenging to play?

Materials + Preparation
- (Optional) Projector
- Computers for each student
    - Alternative: Students can play in pairs, or students could volunteer to play game and project image for entire class to see/discuss/play.

Instructors should identify a map-related game for students to play during this workshop. Examples include but are not limited to: Minecraft, PacMan, Legend of Zelda, map games on Scratch, or Mazzy. If you plan to use the Mazzy game, it is recommended that you set up the computers and fully load the game 30 minutes prior to the workshop session.

Example Map Game Screenshots:

IMAGE CREDIT: NINTENDO ® / SUPER MARIO BROS. ®

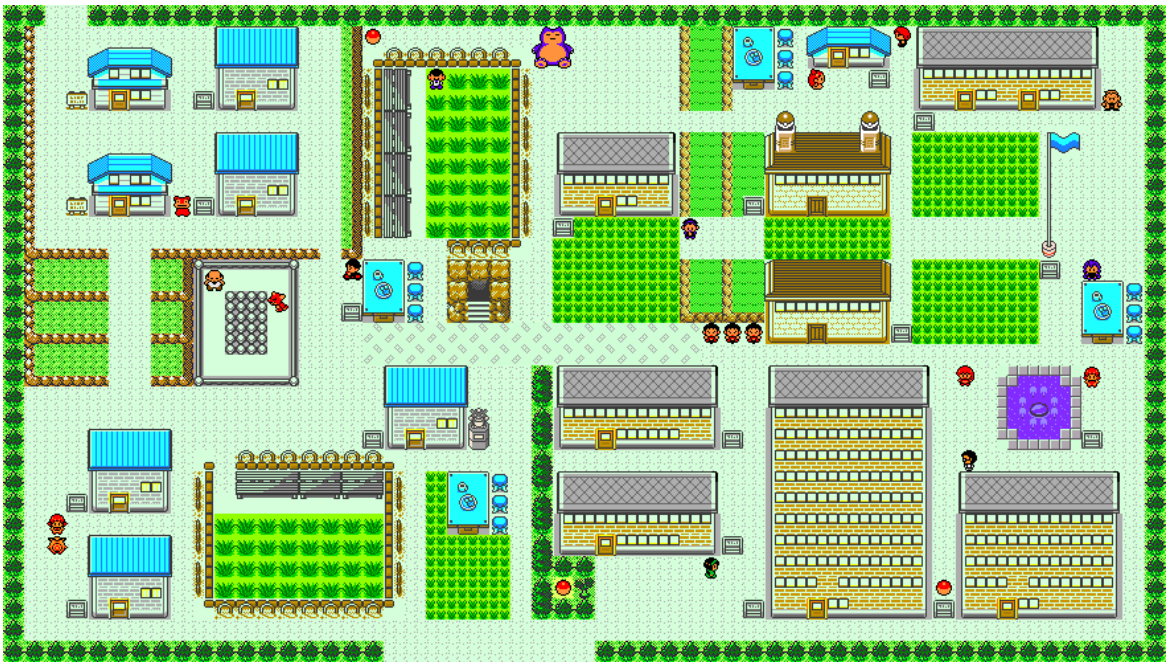


IMAGE CREDIT: POSTED ON PHOLDER.COM/R/UCLA/

IMAGE CREDIT: POKÉMON COMPANY INTERNATIONAL, INC.

Activity Instructions

- Introduce & Demo Map Game (5 minutes):
  - Instructors should introduce workshop agenda, and demo and/or explain the basic instructions for how to play the map game (e.g.: how to start game, basic controls, what options can be entered, etc.).
- Students Play Map Games (25 minutes):
  - Have students navigate to and play map games.
  - Instruct students to focus on the following aspects of the game while they play:
    - *Actions they are / are not able to do in the game*
    - *Visuals, fonts, music, animations, transitions*
    - *What makes the game fun, easy, hard, challenging, etc.*
- Discuss How Map Game Was Built (20 minutes):
  - Have students shut down games, consoles, and computers
  - Lead a large-group discussion
    - Have students share their observations from the game play experience
    - Discuss computer science key terms using the map game as example
      - *In map games, the main "affordances" and "design constraints" users pay attention to are "walkable" surfaces, obstacles, and paths to goals.*

        - *These "design constraints" and "affordances" are what guide engineers and programmers to implement the map game system.*
        - *It's important in game design to focus on making your themes/ideas clear through structured visuals and design choices and to make games challenging enough that it's interesting, but not too challenging so that users will not enjoy playing the game.*
        - *In Mazzy, we can use loops to get past challenging levels which limit the number of moves you can enter.*
    - Begin to encourage students to reflect on how different themes and ideas could be represented in map form, and what requirements that design might have.

UNIT 4: ACTIVITY 2
MAPS AS DESIGN TOOLS

Activity Overview
In this activity, students will learn to use maps as design tools to constrain their thinking for authoring design requirements, which can eventually be implemented using programming.

Key Terms + Concepts
- DESIGN CONSTRAINTS refers to a limitations or "guide rails" on the requirements and/or operation conditions under which a design must be built and cannot violate.
- DATA VISUALIZATION is a general term that describes any effort to help people understand the significance of data by placing it in a visual context. Patterns, trends and correlations that might go undetected in text-based data can be exposed and recognized easier with data visualization.

Key Takeaways
- We can use maps as a way to visualize and represent various kinds of data (not just paths and geographic information) and structure system requirements and possible actions in an organized way.

Driving Questions
- What kinds of data do regular maps help to visualize and represent?
- What are other creative ways that maps can be used to visualize other data?
- How do we need to organize information for it to presented in map form?

Materials + Preparation
- Computer and Projector
    - Alternative: Instructors can prepare printed-out example maps and hand them out to students

Instructors should identify several map design examples which visualize or present non-path/location information in a creative way to demonstrate how maps can be used as tools for computational thinking.

Example Map Design Screenshots:

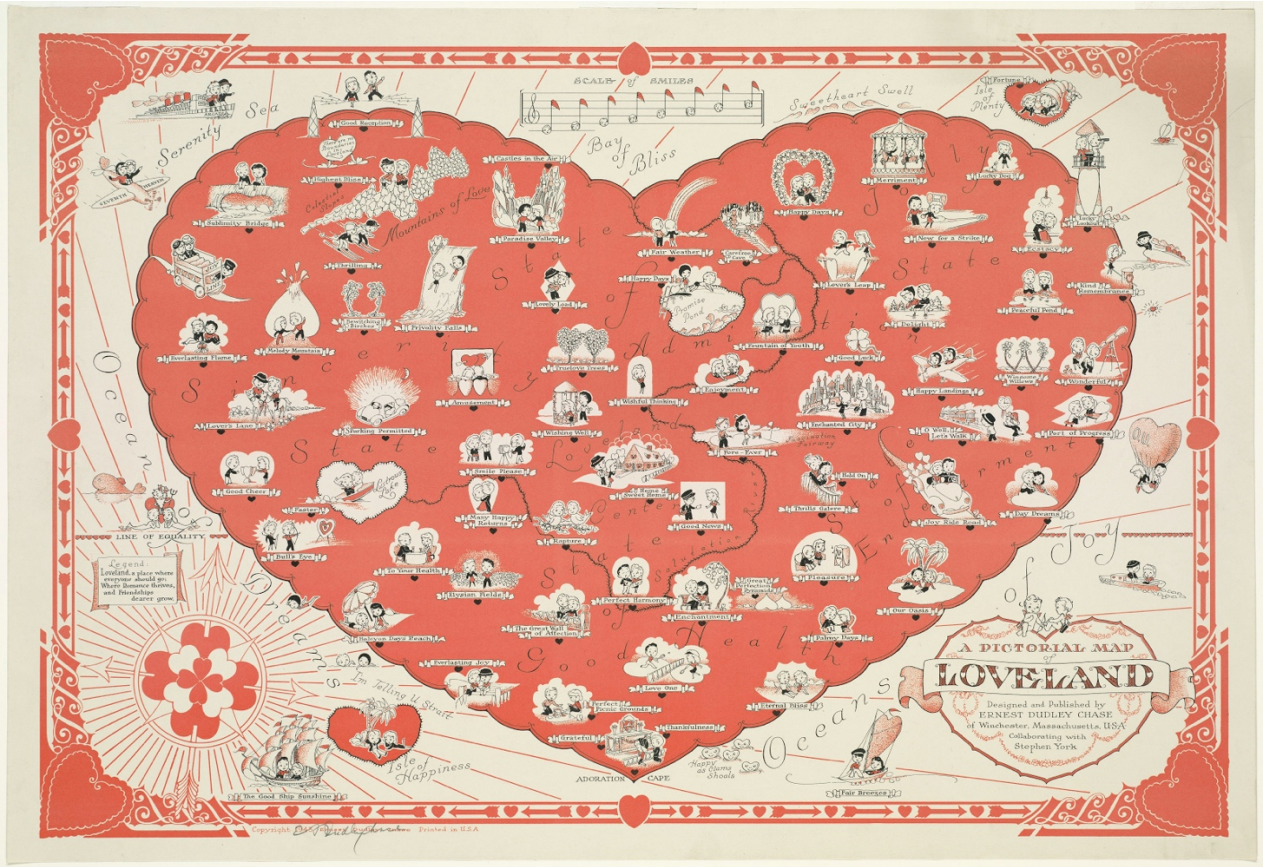


IMAGE CREDIT: POSTED ON STREETSOFSALEM.COM/2012/02/14/MAPS-OF-THE-HUMAN-HEART

IMAGE CREDIT: © KATHERINE SAXON

IMAGE CREDIT: © EDISON YAN

IMAGE CREDIT: © SENSORY MAPS / © KATE MCLEAN

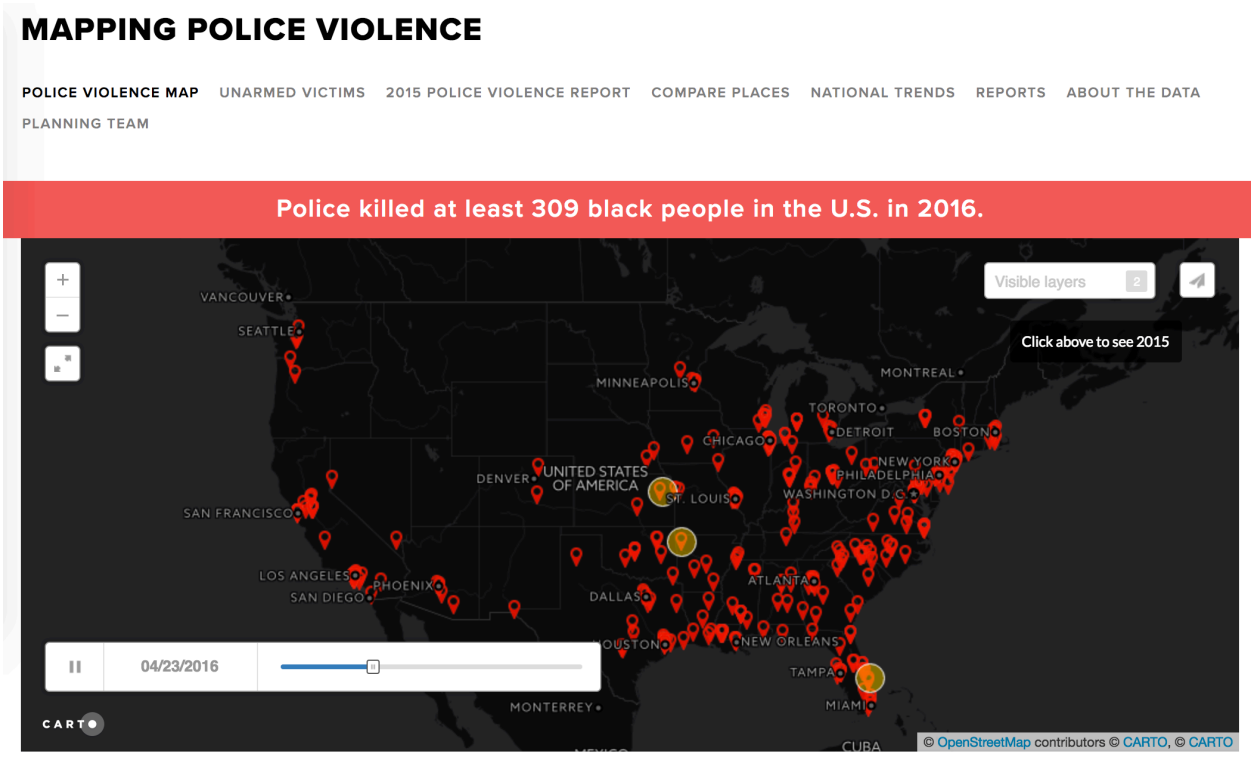


IMAGE CREDIT: MAPPINGPOLICEVIOLENCE.ORG

Activity Instructions

- Maps as Design tools (15 minutes):
  - Present Mazzy/map game example visuals as starting point
  - Next, continue to other map visuals which present other themes/data in creative ways
    - Identify and label the themes and ideas in the map
    - Discuss **what** information is being presented and **how** it's being presented
    - Critique how the map is effective (or not) at conveying themes
  - After going through examples, discuss common "requirements" that all the map designs needed to address to be created.
    - How did the designers go from the information/idea to the visual map?
- Students Brainstorm Map Themes (20 minutes):
  - Based on the previous discussion, students will use the sticky note method to elicit themes for their own, new map designs:
    - *Distribute sticky notes and markers to students*
    - *Have students silently write ideas and post their notes on the wall*
  - Instructors may either go over the notes aloud as a group or review/organize the notes after class, coming up with labels to cluster similar ideas into "themes."
  - These themes will be used in the next unit to design and prototype map games.

UNIT 5: PROTOTYPING MAPS
Bringing Ideas to Life with Protoypes

Aligned ECS Units:

The following ECS units are addressed in Unit 5 of this guidebook:

- **ECS UNIT 3: WEB DESIGN**

  In this unit, students' knowledge of abstraction and website design will expand by enabling them to take the roles of developers by creating paper and digital prototypes, writing documentation for users, and exploring issues of social responsibility in web use.

Unit Overview

In this unit, students will engage the the following practices:

- Discussing issues important in their communities
- Re-skinning and customizing their own map game website
- Discussing how to document functional specifications and technical requirements
- Playing peers' game prototypes and providing constructive feedback
- Iterating upon their game designs based on peer feedback
- Discussing online social responsibility and website access control

Activities in this Unit

- Introduction to Prototyping
- Low-Fidelity Prototyping
- High-Fidelity Protoyping

UNIT 5: ACTIVITY 1
INTRODUCTION TO PROTOTYPING

Activity Overview

This activity introduces the concept of prototypes to students, exploring the difference between low and high fidelity prototypes, and understand how prototypes are used in the real world.

Key Terms + Concepts

- PROTOTYPES are interactive drafts or models of a product built to test a concept or process, and are generally used to evaluate and gain feedback on a new design. Prototyping serves to provide specifications for a real, working system rather than a theoretical one.
- USER TESTING is the process of evaluating a product by collecting data from people actually using the system.
- LOW-FIDELITY PROTOTYPES are prototypes which are sketchy and incomplete, sharing some characteristics of the target product but generally simple, usually in order to quickly produce the prototype and test broad concepts.
- HIGH-FIDELITY PROTOTYPES are prototypes which may be quite close to the final product, with lots of detail and functionality. From a user testing point of view, a high-fidelity prototype is close enough to a final product to be able to examine usability questions in detail and make strong conclusions about how behavior will relate to use of the final product.
- WIZARD OF OZ PROTOYPES are prototypes that only work by having someone behind-the-scenes who is "pulling the levers" and "flipping the switches," which allows testing of more complex design concepts before a system is fully working.

Key Takeaways

- Prototyping is very important in the development process and provides a way of evaluating and testing design ideas, clarifying design requirements, and resolving issues throughout the development process.

Driving Questions

- What is a protoype?
- What are low fidelity vs. high fidelity protoypes?
- How are protoypes used in the real world?
- What is the use of doing prototypes on paper?

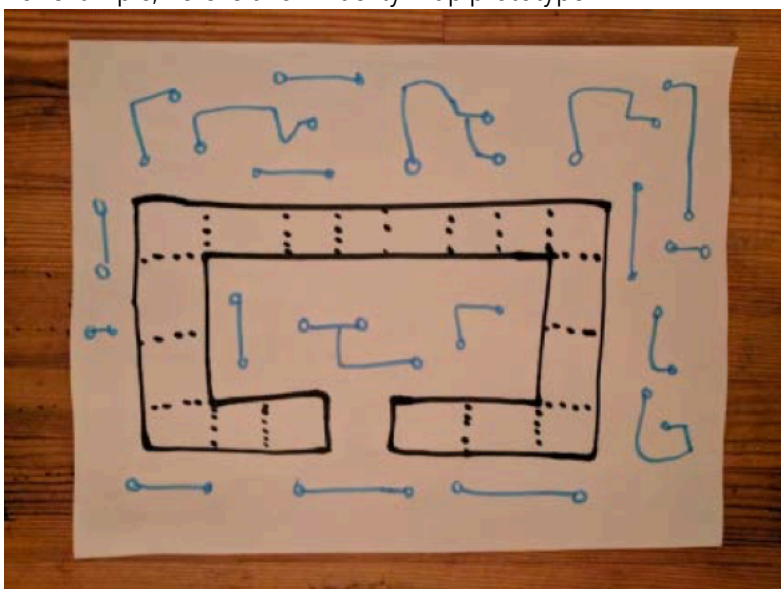
Materials + Preparation

- Computer
- (Optional) Projector

Activity Instructions

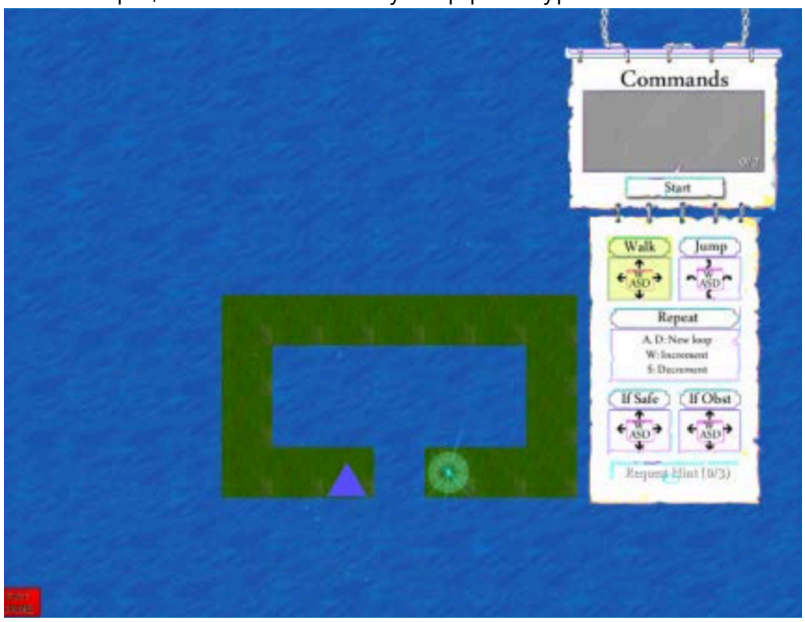
Defining Prototypes (15 minutes):

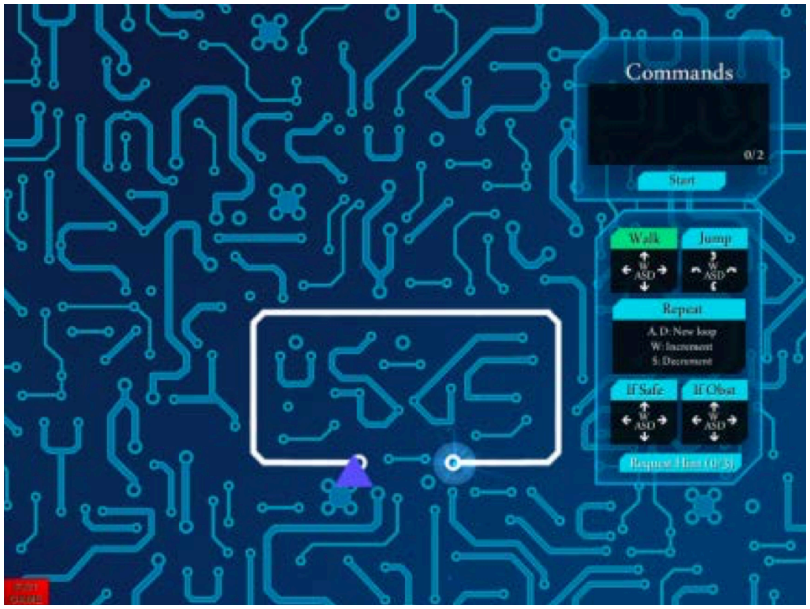
- Introduce the activity by framing it as a discussion of the process of how we bring ideas to life.
- Ask students to share a few of their favorite apps and products are.
- Ask students to consider how these products were created, and what the first step of building that product might have looked like.
- ASK: What is a protype?
    - Explain that a **"protoype"** is:
        - An early version of a design
        - A tool of testing an interactive game or technology with users
- ASK: What are low fidelity vs. high fidelity protoypes?
    - Explain that **"low-fidelity prototypes"** are:
        - sketchy and incomplete
        - generally simple
        - used to quickly test broad concepts
    - For example, here is a low-fidelity map prototype:



    - Explain that **"high-fidelity prototypes"** are:
        - more refined, with lots of detail and functionality
        - closer to the final product
        - used to examine usability questions in detail
        - used to make strong conclusions about system requirements

- For example, here is a low-fidelity map prototype:

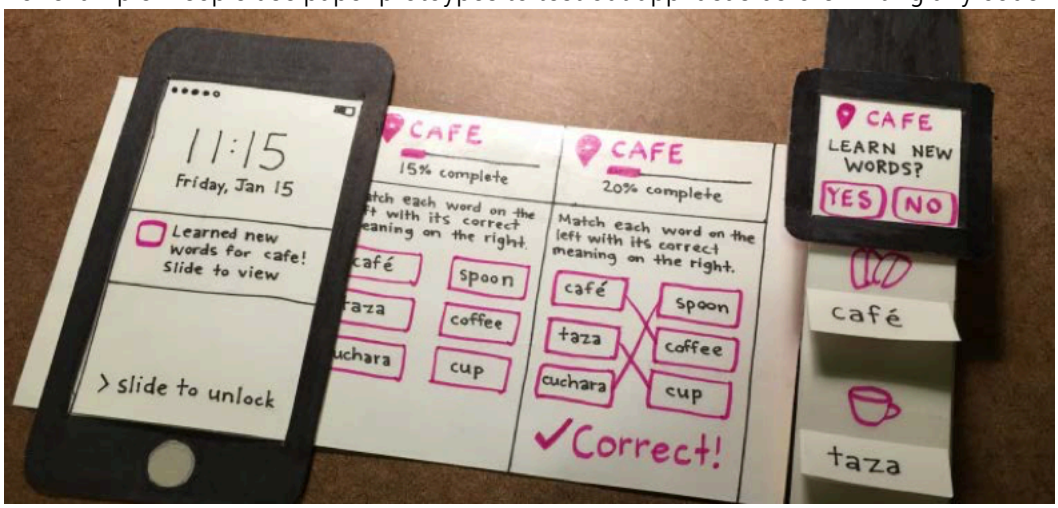




Protoypes in Practice (15 minutes):

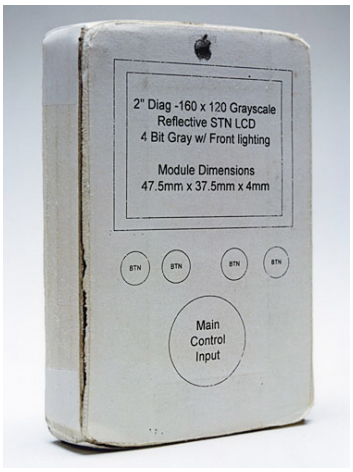
- ASK: How are protoypes used in the real world?
  - Explain that prototypes enable companies to save money and time by quickly testing out ideas and soliciting feedback through a process called **"user testing,"** in which people actually use and provide insight into how a product will be used in the real world before it has been finalized.

- For example: People use paper protoypes to test out app ideas before writing any code:



- For example: Extensive protoyping is performed for famous products we know and love:

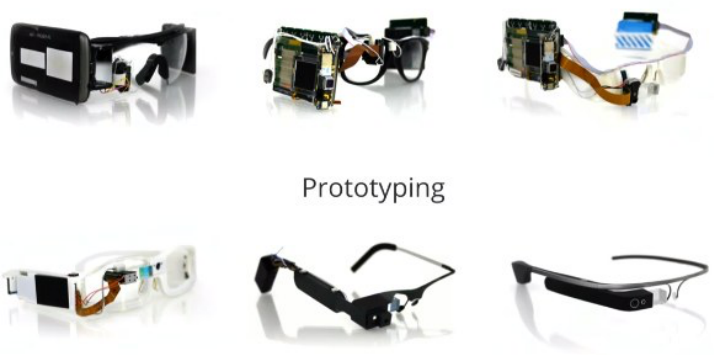
  - Apple iPod



  - Apple iPad

- Apple Watch

- Google Glass



- Explain to students that simple protoypes made of paper and plastic can be used for user testing before they're fully finished and polished. These **"wizard of oz prototypes"**:
    - only work by having someone behind-the-scenes who is "pulling the levers" and "flipping the switches"
    - allows testing of more complex design concepts before a system is fully working
- ASK: What is the use of doing prototypes on paper?
    - Explain that paper protoypes are:
        - quick and easier to make than higher-fidelity protoypes
        - do not distract users with small details which aren't as important as the broad concepts of the design
        - easy to throw away and restart if the ideas are not working out
- Wrap up the discussion by challenging students to think about how they might begin protoyping some of the maze game designs they explored in the previous unit.

UNIT 5: ACTIVITY 2
LOW-FIDELITY PROTOTYPING

Activity Overview

In this activity, students will begin the process of designing and developing their own map games by creating paper prototypes with their peers. This unit may be presented following Unit 4: Activity 2, in which students generate themes for their maps using the sticky note method.

Key Terms + Concepts

- LOW-FIDELITY PROTOTYPES are prototypes which are sketchy and incomplete, sharing some characteristics of the target product but generally simple, usually in order to quickly produce the prototype and test broad concepts.
- AFFORDANCES are the sensory characteristics of a product which intuitively suggest its functionality and use, helping users to naturally take the correct steps and accomplish their goals.

Key Takeaways

- Paper prototyping is a useful technique that consists of creating hand drawings of user interfaces in order to enable them to be rapidly designed, simulated and tested to make the resulting product or idea better.

Driving Questions

- What are issues or themes which we feel are important to address our communities?
- How does playing the map game actually work?
- How can we deploy information about this theme on our game map?
- What game mechanics and problem solving techniques will users need to win your game?

Materials + Preparation

- Art Supplies (Pens, Pencils, Markers, Colored Pencils, etc.)
- Lined Grid Paper (Link To Example Grid Paper)
- Extra Scratch Paper
- (Optional) Computer and projector

Activity Instructions

Students Play Map Games & Brainstorm Map Themes (30 minutes):

- If students have not already completed Unit 4: Activities 1 and 2, students should play and explore digital map games and reflect upon the guiding questions presented in these activities, then complete the sticky-note brainstorming activity to generate themes they can visualize using maps as a design tool.
- ASK: What are issues or themes which we feel are important to address our communities?
- Organize students into small teams, each assigned one of the elicited theme "labels" which they will use to design and prototype their map games.
- For example, students may have brainstormed themes which can be clustered into the label "school dress codes" or "police brutality."

Discussing Game Mechanics (20 minutes):

- Introduce the activity, in which students will be using the labels they came up with to paper protoype a map game which represents the themes they brainstormed.
- Review with students that **"low-fidelity prototypes"** are:
    - sketchy and incomplete
    - generally simple
    - used to quickly test broad concepts
- ASK: How can we deploy information about this theme on our game map?
- Discuss that in this case, we can deploy information through the following elements:
    - player starting square
    - obstacles (non-walkable squares)
    - walkable squares
    - goal square
    - (optional) bonuses (*e.g. visual elements users can navigate through*)
- Explain to students that **"affordances"** are the characteristics of a product which help users know how to use it correctly, and they will need to think critically about their protoype visual design to provide good affordances. Some examples of affordances include:
    - A button, by being slightly raised above an otherwise flat surface, suggests the idea of pushing it.
    - A lever, by being an appropriate size for grasping, suggests pulling it. A blinking red light and buzzer suggests a problem and demands attention.
    - A chair, by its size, its curvature, its balance, and its position, suggests sitting on it.
- ASK: How does playing the map game actually work?
- Discuss that the map game happen on a square grid, and the player gives instructions to the computer, which the computer has to follow exactly. There are 4 types of game instructions:
    - **Walk:**
        - The most basic moves: up, down, left, right
        - Move one space in direction of arrow

        - Can be represented as the following:

    - Jump:
        - Move two spaces in the direction of the arrow
        - If there is an obstacle, you can jump over it
        - Want to avoid jumping into obstacles
        - Can be represented as the following:

    - Loop:
        - Do whatever is inside the parentheses the number of times the player says
        - Counts as a single move
        - Can be represented as the following:

    - Conditional:
        - Do whatever is inside the parentheses *only* if the next tile is safe, or if the next time is an obstacle (depending on if the tile says ifSafe or ifObst)
        - Counts as a single move
        - Can be represented as the following:

- ASK: What game mechanics and problem solving techniques will users need to win your game?
- Have students discuss the optimal path that they imagine players taking. Remind them:
    - This can be thought of as an answer key
    - If you want this to be more compex, consider requiring players to use jumps, loops, etc.

Creating Paper Prototypes (25 minutes):

- Review the summary of the steps for paper protoyping with students:
    1. Label your theme
    2. Decide how to deploy information on game map (start, goal, obstacles, etc.)
    3. Decide game mechanics (here an optimal path that you imagine players taking)
- Have students work in their teams to create paper protoypes of game maps using the grid paper and art materials, centered on their theme. Ensure students address the following questions as they work on their design:
    - What are the main ideas your map design conveys?
    - What are the goals?

    - What are the obstacles?
    - What are the paths?
- Optionally, allow students to orally present and share their paper protoype designs in front of the class, provide feedback, and share open questions/issues with their design.

UNIT 5: ACTIVITY 3
HIGH-FIDELITY PROTOTYPING

Activity Overview

In this activity, students will continue the process of designing and developing their own map games by creating digital prototypes and testing them with their peers. This unit may be presented following Unit 4: Activity 1, in which students create paper protoypes of their game maps as a first step to creating digital protoypes.

Key Terms + Concepts

- USER TESTING is the process of evaluating a product by collecting data from people actually using the system.
- HIGH-FIDELITY PROTOTYPES are prototypes which may be quite close to the final product, with lots of detail and functionality. From a user testing point of view, a high-fidelity prototype is close enough to a final product to be able to examine usability questions in detail and make strong conclusions about how behavior will relate to use of the final product.
- DOCUMENTATION includes manuals, help systems, and other materials used to introduce and explain a system to users and make it easier to accomplish tasks and resolve issues.
- PRIVACY in software and web development is the principle of protecting private information about people, especially in shared or collaborative systems, and of helping to keep people free of distractions.

Key Takeaways

- In user testing, high-fidelity prototypes enable developers to examine usability questions in detail and make strong conclusions about how behavior will relate to use of the final product.

Driving Questions

- What do we want to learn about our game's design in user testing?
- What is important information to document for new users of our map games?
- How can we improve our map design based on user testing?
- What are important concepts to consider when publishing websites and information online?

Materials + Preparation

- Extra Scratch Paper and/or Index Cards
- Computers for students (must be compatible with the MazeStar platform)

- (Optional) Projector

Instructors should have prepared paper protoypes with students of their game maps prior to this activity. should plan to set up and test computers with MazeStar and Mazzy platforms in advance of workshop. Students will need to create user accounts to use editor, so instructors may also want to provide instructions for the registration process, as well as basic information on how to use the platform.

Activity Instructions

Creating Digital Prototypes (30 minutes):

- Review the key ideas presented while learning about paper prototyping as a class
- Have students divide into their map game design teams and review the following questions regarding their paper map creations:
    - What are the main ideas your map design conveys?
    - What are the goals?
    - What are the obstacles?
    - What are the paths?
- Have each team use one computer to sign into the MazeStar editor: http://people.csail.mit.edu/dkao/MazzyBeta/PortalGLS/
- Have students work on implementing their digital map game protoype using the MazeStar editor using their paper protoypes.

User Testing (40 minutes):

Prepare for User Testing (15 minutes):

- Explain to students that now that they have drafted the first version of their protoypes, they will be conducting **"user testing"** with their classmates. Explain that user testing:
    - involves collecting data from people actually playing and testing their game
    - helps improve upon the initial design by identifying issues with the user experience
- ASK: What do we want to learn about our game's design in user testing?
- Have students work in their teams to brainstorm a list of questions they want to answer or specific aspects they want to address about their map game design.
- ASK: What is important information to document for new users of our map games?
- Have students work in their teams to write a few sentences with simple instructions for new game players (written on scratch paper or an index card) to be left at the computer monitor with their games during user testing.
- Explain that we will be conducting user testing on our map game prototypes, and that our goal is to collect constructive feedback from our peers. Remind everyone constructive feedback is:
    - information-specific
    - issue-focused
    - based on observations

- empowers recipients to focus on problem-solving and brainstorming creative solutions

Prepare for User Testing (25 minutes):

- Once each map game has been set up with its corresponding instruction set, students can begin testing out each others' games.
- Have students will test the games they did not help develop for 3-5 minutes at a time, testing the game and writing constructive feedback on what was enjoyable, difficult, confusing, etc. on index cards, scratch paper, or using comments on an online communication channel.

Design Iteration & Privacy Discussion (30 minutes):

Design Iteration Based on User Testing Feedback (15 minutes):

- Have teams review the feedback that was left by users on their digital map game prototypes.
- ASK: How can we improve our map design based on user testing?
- Have teams first brainstorm and write down some ideas on how to act upon the feedback
- Next, have teams work on actually implementing some of these improvements using MazeStar
- Wrap up activity by having students reflect on how this process is used in professional industry user research to improve products before publicly releasing them, as well as throughout the development process (e.g.: have students think about product changes they've seen in their favorite apps and websites and how those changes may have been sparked by user feedback).

Privacy Discussion (15 minutes):

- Transition to the next topic by introducting the concept of preparation and readiness for the public release of a large-scale website or app, and mention privacy as a key component of this.
- ASK: What are important concepts to consider when publishing websites and information online?
- Explain that **"privacy"** is the principle of protecting private information about people, especially in shared or collaborative systems, and of helping to keep people free of distractions and:
  - may be provided for security reasons
  - may keep people from being deluged with unsolicited people contacting them
  - may allow people to protect personal information from being shared with others
  - may be in tension with a legitimate desire to share information to help people coordinate (as in 'awareness' systems).
- As a group, discuss potential ethical concerns which may guide how we decide what information to make available and how.
- For example, *reciprocity* says that people can not find information about you without making the same information about themselves available to you. Another concern is that people sometimes need to share certain information about themselves for reasons of security or accountability.
- Discuss the tradeoffs between having more lenient vs. more restricted privacy restrictions.
- Discuss examples of privacy and security implications in the real world.
- For example, Target had a huge security issue which resulted in one of the biggest data breaches to hit a U.S. retailer. Target had reported that hackers stole data from up to 40 million credit and debit cards of shoppers who had visited its stores during the 2013 holiday season.

UNIT 6: MAP PATHFINDING & SEARCH

Strategies for Finding Paths To Our Goals

Aligned ECS Units:

The following ECS units are addressed in Unit 6 of this guidebook:

- **ECS UNIT 3: PROGRAMMING**

  In this unit, students will explore the process of designing algorithms and creating programming solutions, iterative development, and learn about the availability of online and community platforms for continued creative computational learning.

Unit Overview

In this unit, students will engage the the following practices:

- Discussing map games in the context of computational concepts
- Discussing algorithms, programming, and design in computing systems
- Discussing iterative development, future work on avatars, mazes, and websites
- Exploring free and low-cost, publicly available novice development platforms

Activities in this Unit

- Map Pathfinding Strategies
- Introduction to Search Algorithms

UNIT 6: ACTIVITY 1
MAP PATHFINDING STRATEGIES

Activity Overview
This activity frames map games within the concept of computational pathfinding, exploring the concepts of graphs and how they are used in the programming and design of computing systems.

Key Terms + Concepts
- PATHFINDING is the plotting, by a computer application, of the shortest route between two points. It is a more practical variant on solving mazes.
- GRAPHS are sets of vertices connected by edges, where the edges may have a direction associated with them.

Key Takeaways
- Players can think strategically about how to go from start to goal state while playing map games. Programmers commonly use graphs to represent simply-connected data.

Driving Questions
- What are the elements of the game map that we focus on when trying to get to the goal?
- What is the simplest way to get from the start tile to the goal tile in the map game?
- Are there more strategic ways to get from the start tile to the goal tile in the map game?
- How can we represent map games in graph form?

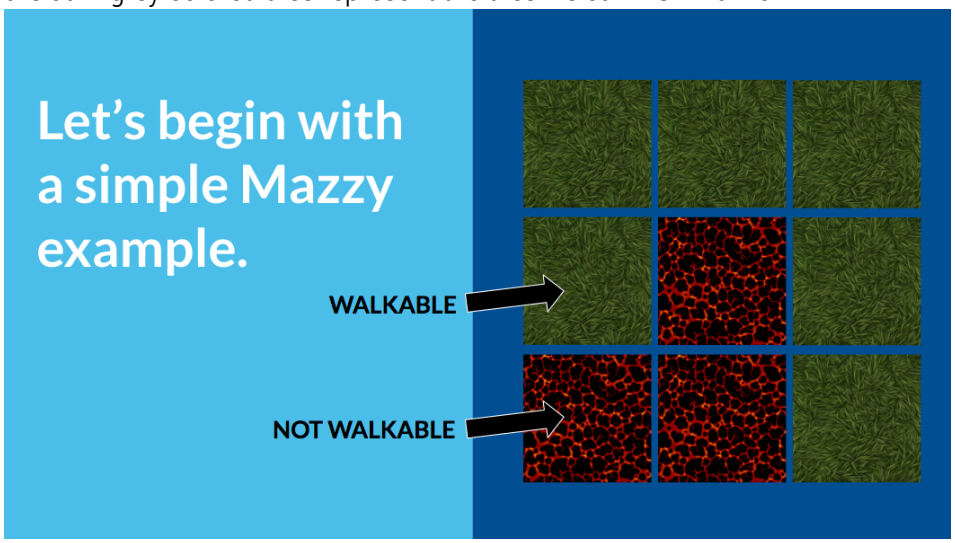
Materials + Preparation
- Computer and Projector

Instructors should identify a map-related game for students to play prior to this workshop. Examples include but are not limited to: Minecraft, PacMan, Legend of Zelda, map games on Scratch, or Mazzy. Please refer to Unit 4: Activity 1 for additional details and guidance.

Activity Instructions
Discussing Map Game Strategies (15 minutes):
- Briefly review the experience students had playing map-related games and have them consider their experience playing the map game and thinking through strategies for finding paths.

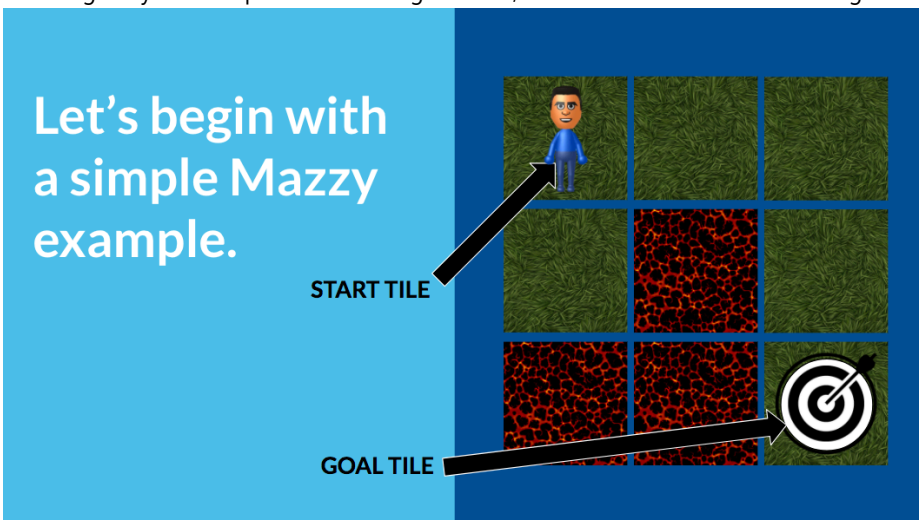
- For example, we can consider a simple map grid in the game Mazzy.

- ASK: What are the elements of the game map that we focus on when trying to get to the goal?
- Discuss the fact that we tend to focus on 4 main elements when playing map games:
  - walkable tiles (where the player can move)
  - non-walkable tiles (where the player is not allowed to move)
  - start tile (where the player avatar is placed at the beginning)
  - goal tile (where the player is supposed to reach to win the level)
- For example, we can consider a simplified representation of the Mazzy game:
  - the light-blue colored tiles represent the tiles we can walk on
  - the dark-grey colored tiles represent the tiles we can NOT walk on

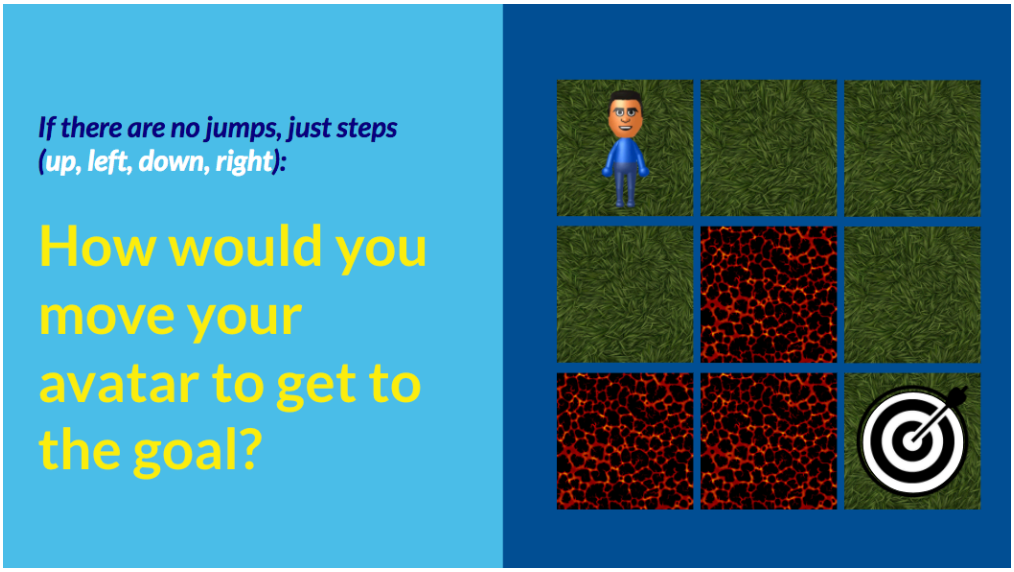


  - the avatar is located at the start tile

- the target symbol represents the "goal" tile, which is where we want to get to

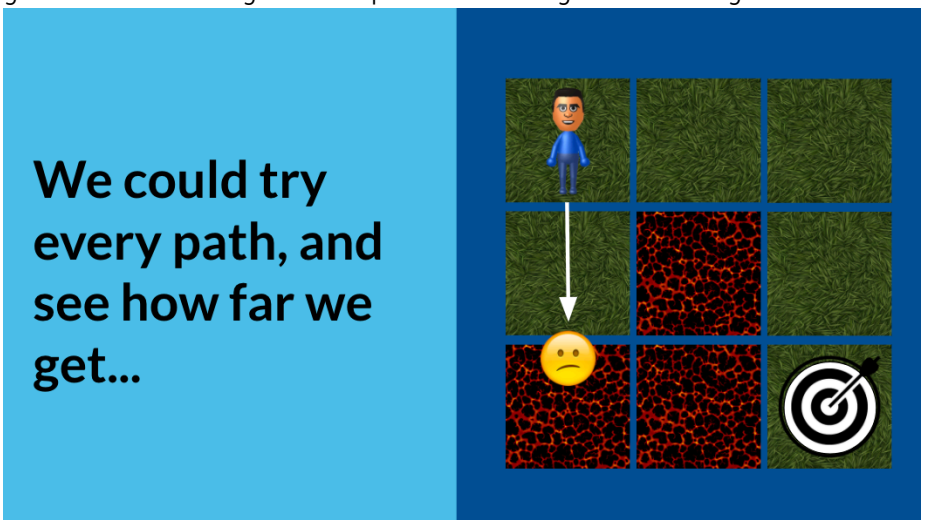


- ASK: What is the simplest way to get from the start tile to the goal tile in the map game?
- Have students "speak out loud" the mental process for how they would think about getting their avatar from the start tile to the goal tile, as if they were explaining it step-by-step to a little brother or sister.
- For example "My avatar is starting at this tile, I am going to look around my avatar and see which tiles it can move to. Then, I will do XYZ."

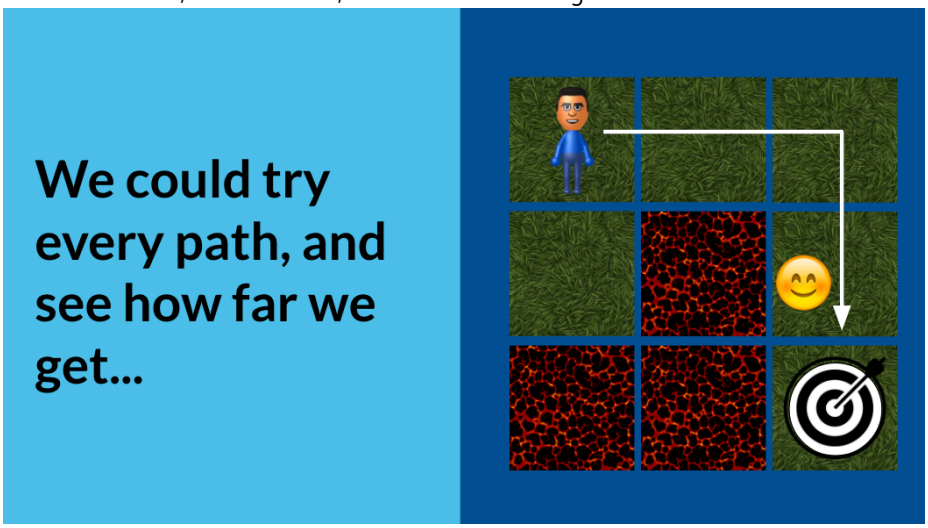


- Explain that the most basic thing to do would be to:
  - choose a path to travel on first

- go as far as we can go on that path to see if it gets us to the goal node

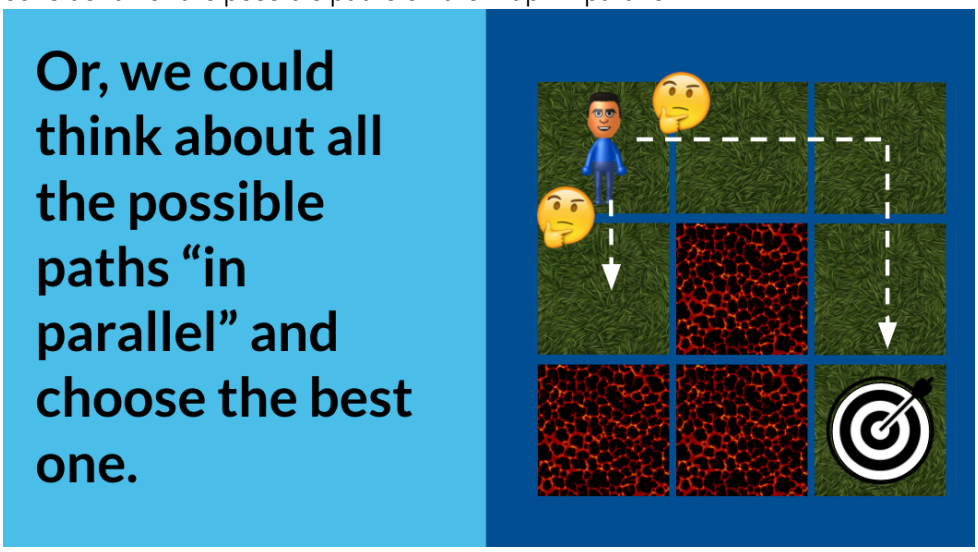


- If it doesn't, start back at the beginning and do the same with the next possible path
- continue so on, and so forth, until we reach the goal tile

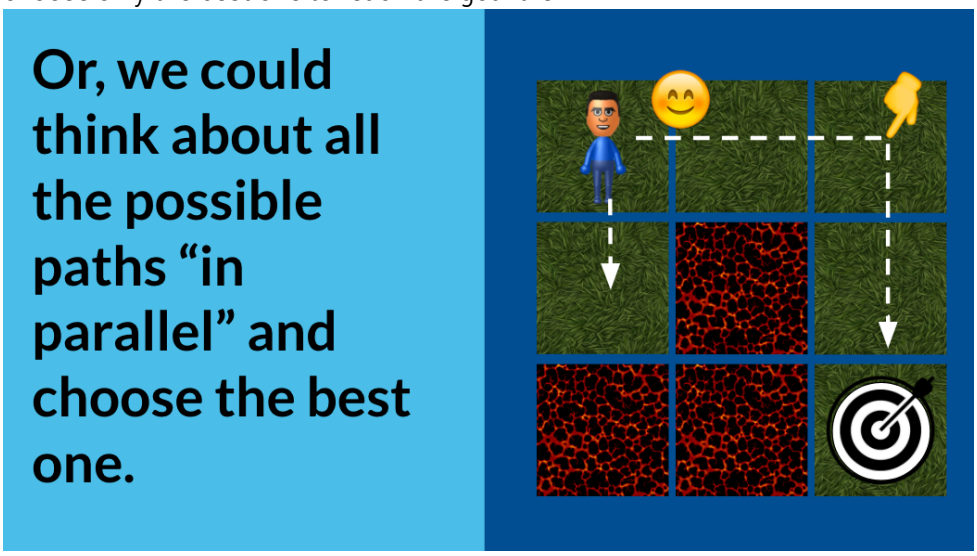


- ASK: Are there more strategic ways to get from the start tile to the goal tile in the map game?
- Explain that a more "sophisticated" thing to do would be to:

- consider all of the possible paths on the map "in parallel"



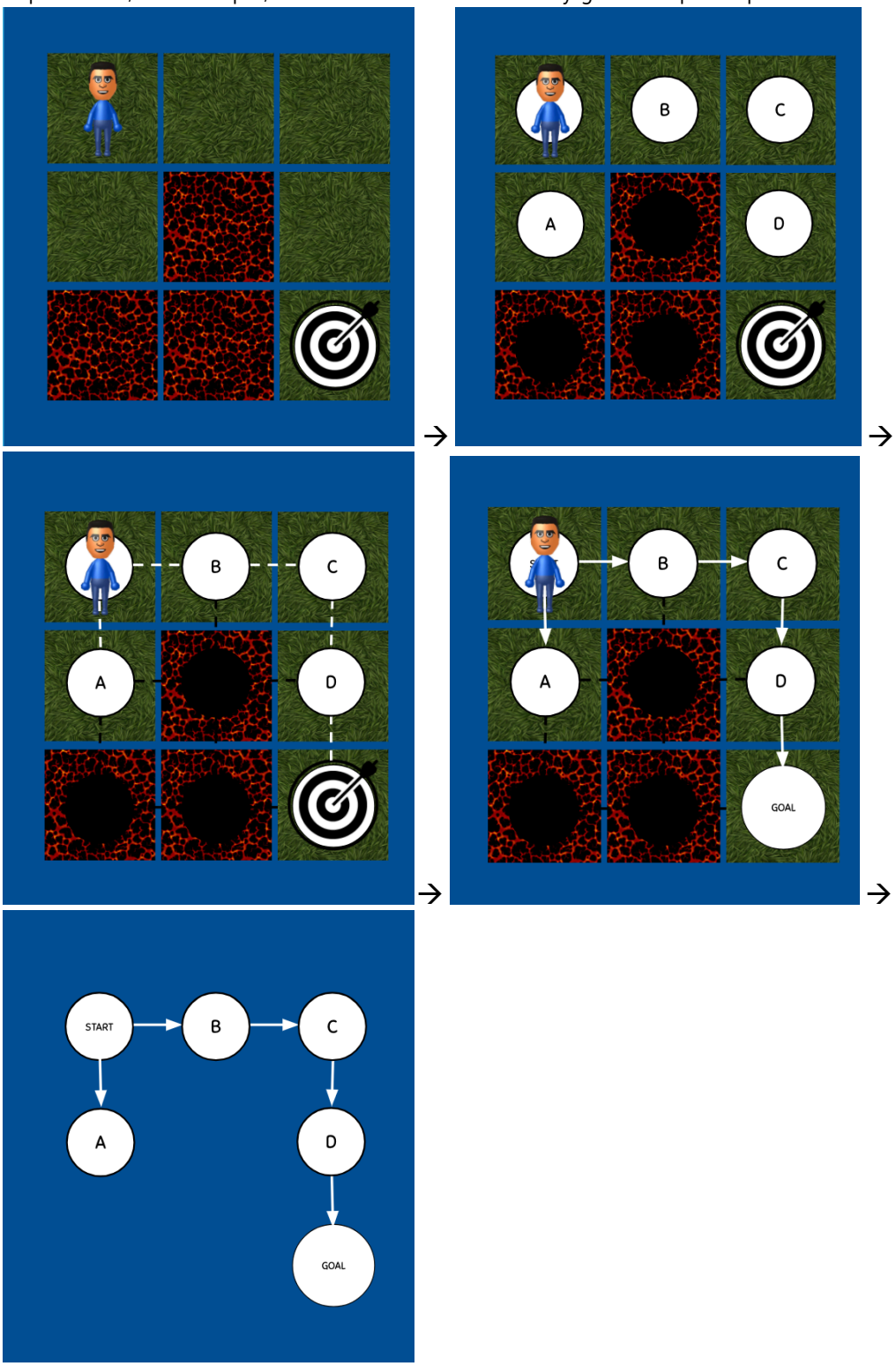
- choose only the best one to reach the goal tile



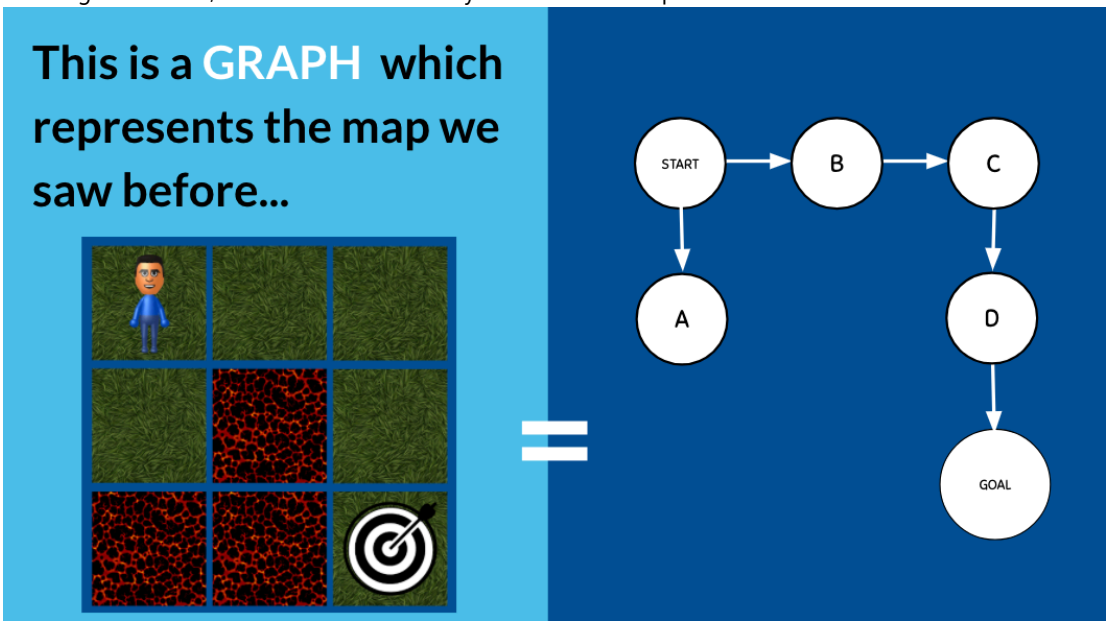
Representing Game Maps With Graphs (20 minutes):

- Explain that in computer science, maps like these can easily be programmed and represented using **"graphs"** which contain nodes and arrows. The directions on the arrows show the ways that we can "traverse" (step) from node to node. So, all that matters is:
  - how the nodes are ordered
  - their connections to one another
- ASK: How can we represent map games in graph form?

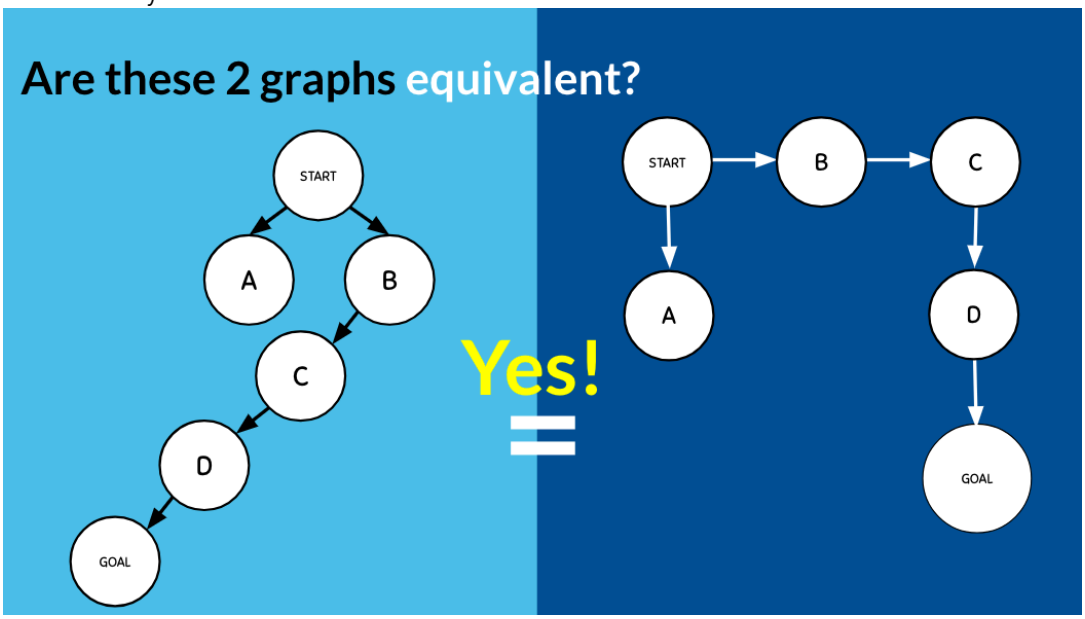
- Explain that, for example, we can transform the Mazzy game map to represent it as a graph:



- Explain that the graph representation of the map would be logically equivalent to the visual map in the game itself, in terms functionality and relationships between nodes.



- Explain that graphs are good for modeling real world problems like representing cities which are connected by roads and finding the paths between cities, air traffic controller systems, etc.
- Have students consider a few examples of graph representations, and check for their understanding of equivalence by ensuring they understand a graph is equivalent if both of the following are the same in both graphs:
    - how the nodes are ordered
    - their connections to one another
- For example, you could consider the following equivalent graphs, which are presenting in two different ways:



- Explain that the strategies we discussed are two common strategies for **"pathfinding"** which involves:
    - searching a graph
    - starting at one point on the graph
    - exploring adjacent nodes until the destination node is reached
    - usually attempting to identify the "cheapest" route
- Transition to the end of the discussion and have students consider how they might represent the neighborhoods within their city or stops on a train using a graph.

UNIT 6: ACTIVITY 2
INTRODUCTION TO SEARCH ALGORITHMS

Activity Overview

This activity builds upon students' understanding of computational pathfinding, introducting the concept of search algorithms and teaching students about the two most commonly used search algoirhtms and how they are used in the real world.

Key Terms + Concepts

- ALGORITHM is a process or set of rules to be followed by a computer in calculations or other problem-solving operations, including searching through a graph.
- BRUTE-FORCE APPROACH is the most basic trial-and-error problem-solving method in which you go through all possible solutions extensively until a solution is found.
- EFFICIENCY is a property of an algorithm which relates to the number of computational resources, which may include time or space, used by the algorithm.
- DEPTH-FIRST SEARCH (DFS) is an algorithm for searching graphs. It starts at the root (selecting some arbitrary node as the root in the case of a graph) and explores as far as possible along each branch before backtracking.
- BREADTH-FIRST SEARCH (BFS) is an algorithm for searching graphs. It starts at the tree root (or some arbitrary node of a graph, sometimes referred to as a 'search key') and explores the neighbor nodes first, before moving to the next level neighbors.

Key Takeaways

- Search enables people to find things in large information spaces, and computer scientists must design algorithms which find desired information efficiently.
- There are many free, publicly available computer science learning resources available which can enable us to continue to grow our computational problem-solving skills independently.

Driving Questions

- If we don't care about how long it takes, what is an algorithm to find a goal node in a graph?
- If we could explore multiple paths at once, what is an algorithm to find a goal node in a graph?
- How are these common search strategies used in the real world?

- How can we continue to learn about computer science outside of school?

Materials + Preparation

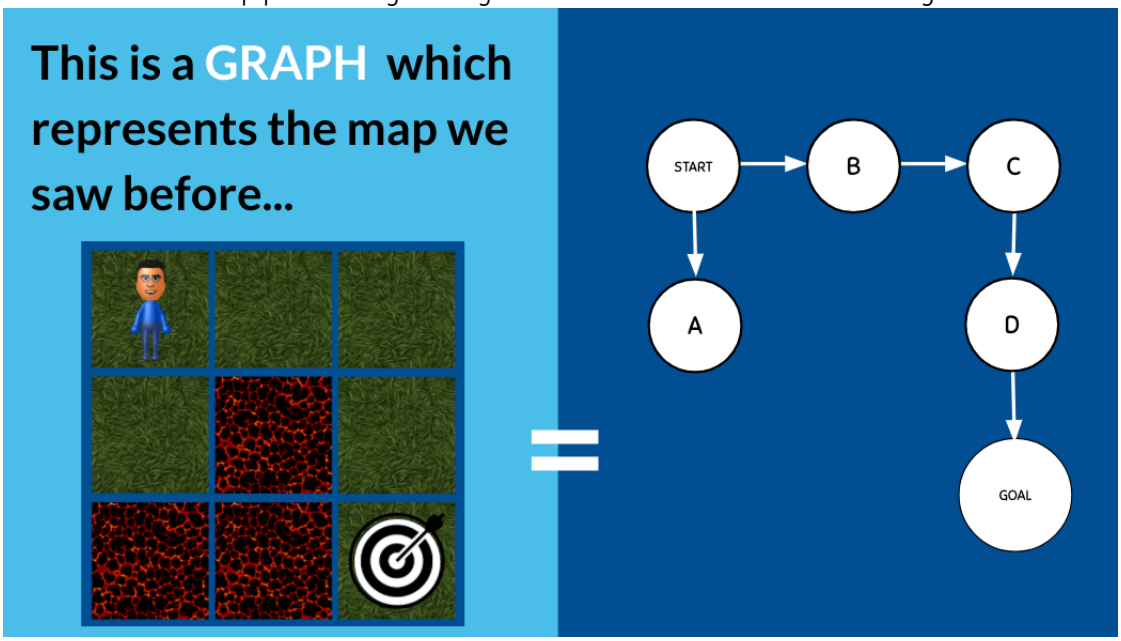
- Computer and Projector
- (Optional) Computer Science Resource Brochures or Flyers

Educators should plan to prepare a list of free, fun, and safe resources for students to continue to learn about computer science following the workshop (printed brochures or handouts are recommended for sharing with parents/guardians). Please refer to the Additional Resources section for a list of preliminary online resources recommended for students and their families.

Activity Instructions

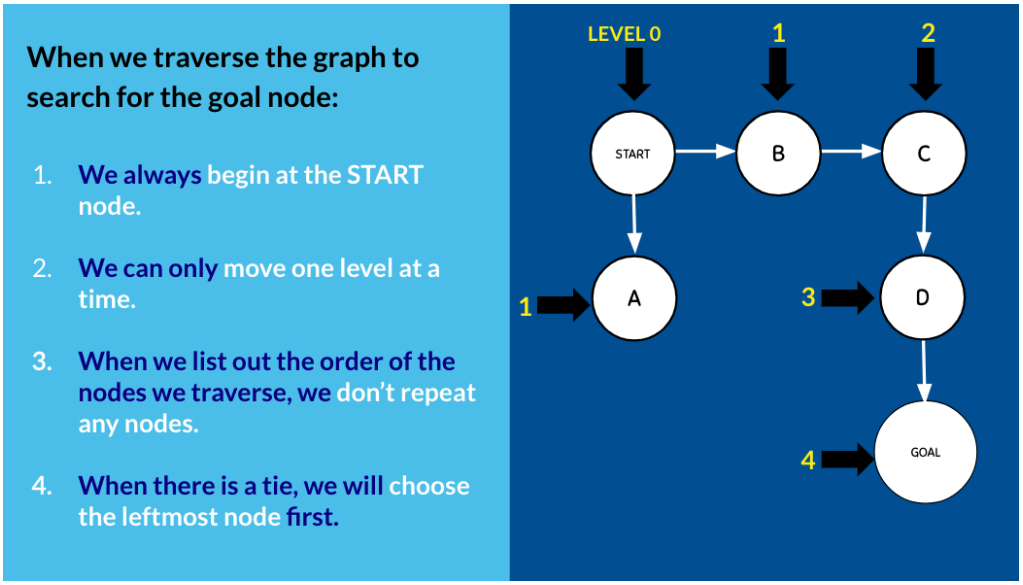
Introduction to Algorithms (15 minutes):

- Have students reflect on and review the major points from the previous exercise of transforming the map game into a graph representation.
- Explain that in computer science, the concept we use to describe the way we think about traversing (or searching) graphs and capturing those strategies with a set of steps is called an **"algorithm"** which is:
  - a self-contained sequence of actions to be performed
  - like a recipe, or list of steps
  - used for accomplishing a task
- We consider the map pathfinding strategies we identified before as search algorithms.



- Define the general "rules" that students will be using to discuss map search algorithms:
  - We always begin at the START node
  - We can only move one level at a time

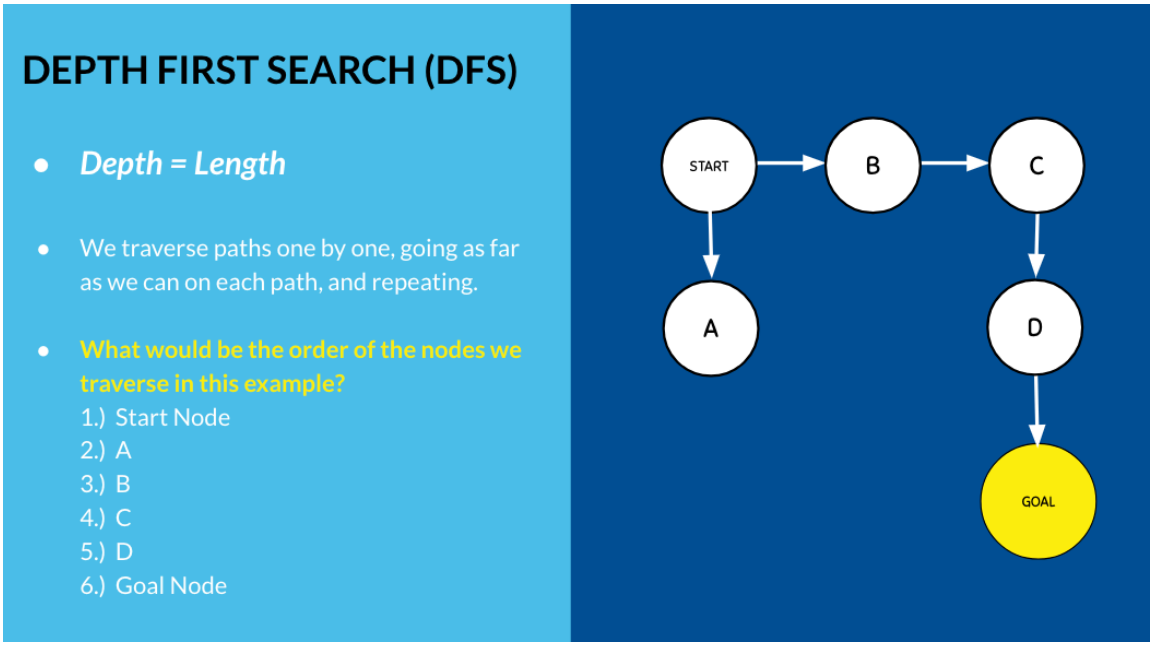
- When we list out the order of the nodes we traverse, we don't repeat any nodes
- When there is a tie, we will choose the leftmost node first



Breadth-First Search and Depth-First Search (20 minutes):

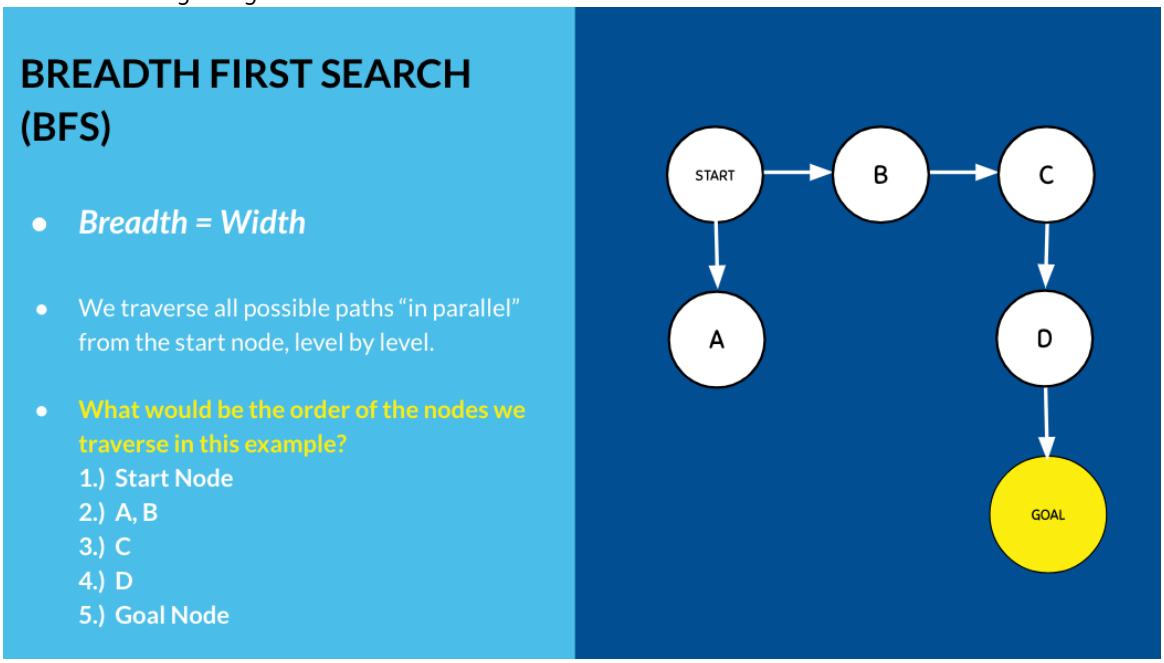
- The breadth first search (BFS) and the depth first search (DFS) are the two most commonly used algorithms used for traversing and searching for a goal node in a graph.
- When we design search algorithms, it's important to consider what constraint we care about the most (e.g.: do we have lots of time? vs. do we have lots of computing power?)
- ASK: If we don't care about how long it takes, what is an algorithm to find a goal node in a graph?
- Explain that if we don't care about how long it would take us and used the Depth-First Search (DFS) algorithm, we would:
  - traverse paths one by one
  - go as far as we can on each path
  - repeat
- As a method for remembering the algorithm, remind students that "depth" is like "length," and in this algorithm, we want to go for as long as we can do until we have reached the goal.

- For example, if we used the DFS algorithm on the following graph, we would visit the root node and then its children nodes until we reached the end node:



- Explain that this is a simple approach, but is not a good algorithm for **"efficiency"** (e.g.: in the case of a huge number of nodes), which describes the rate or speed at which an algorithm enables accurately and successfully completing a task.
- Explain that DFS is a good example of a **"brute-force"** approach, which is a very general problem-solving technique that consists of:
    - systematically enumerating all possible candidates for the solution
    - checking whether each candidate satisfies the problem's statement
- ASK: If we could explore multiple paths at once, what is an algorithm to find a goal node in a graph?
- Explain that if we could explore multiple paths at once (not possible in the map game, but we are just considering this in theory) and used the Breadth-First Search (BFS) algorithm, we would:
    - traverse all possible paths "in parallel" from the start node, level by level
    - continue until the level of the goal node has been reached
- As a method for remembering the algorithm, remind students that "breadth" is like "width," and in this algorithm, we are going "wide" by traversing all nodes for whatever given level we are on.

- For example, if we used the BFS algorithm on the following graph, we would expand 3 levels before reaching the goal node:



- Explain that Breadth First Search (BFS) is basically used to find a shortest path between any two nodes in a graph.
- Provide a few example graphs and have students traverse the graph using both DFS and BFS to check for understanding of how these algorithms work and the pros/cons of each.
- ASK: How are these common search strategies used in the real world?
- Explain that graphs can be used to represent a large number of real life problems such as road networks, computer networks, social networks such as facebook etc. and have students brainstorm ideas for representing information using graphs and how BFS/DFS could be used in those networks.
- For example, the following ideas were shared by users to a Quora post about real-world BFS/DFS applications:
    - GPS Navigation systems: Navigation systems such as the Google Maps, which can give directions to reach from one place to another use BFS. They take your location to be the source node and your destination as the destination node on the graph. (A city can be represented as a graph by taking landmarks as nodes and the roads as the edges that connect the nodes in the graph.) BFS is applied and the shortest route is generated which is used to give directions or real time navigation.
    - Computer Networks: Peer to peer (P2P) applications such as the torrent clients need to locate a file that the client (one who wants to download the file) is requesting. This is achieved by applying BFS on the hosts (one who supplies the file) on a network. Your computer is the host and it keeps traversing through the network to find a host for the required file (maybe your favourite movie).
    - Facebook: It treats each user profile as a node on the graph and two nodes are said to be connected if they are each other's friends. Infact, apply BFS on the facebook graph

and you will find that any two people are connected with each other by atmost five nodes in between. To say, that you can reach any random person in the world by traversing 5 nodes in between. (I did not run BFS on facebook graph, it is a well known fact). What do you think is the new facebook "Graph Search"? (It is not directly BFS, but a lot of modifications over classic graph search algorithms.)

- **Web Crawlers:** It is quite an interesting application. They can be used to analyze what all sites you can reach by following links randomly on a particular website. (Even if you are mildly interested, look into it. It is fun).

Resources for Exploring Computer Science (10 minutes):

- Have students reflect on the major learnings from all of the previous concepts, activities, and discussions covered.
- Have students ask any questions they are still curious and/or confused about, and have a group discussion about the topics they found most interesting.
- ASK: How can we continue to learn about computer science outside of school?
- Explain that there are free and publically available resources designed to connect students of all ages, parents/guardians, and teachers to science and technology learning opportunities both in-person and online. Encourage students to continue exploring computer science using these free online and in-person resources and try to identity in-person mentors with whom they can follow up and discuss these interests.
- For example, you may consider emailing a local college or university's computer science department to see if there are any students, researchers, and/or professors willing to connect with your learning group for mentorship or even tours. Additionally, there are many technology companies which organize volunteer opportunities for community groups and may be willing to sponsor a field trip to provide a guest speaker.
- Consider posting resources to a website, sharing them via email with parents/guardians, and/or printing out a hard-copy brochure or flyer for students to take home which include information about free computer science learning resources.

ASSESSMENT OVERVIEW

ASSESSMENT OVERVIEW

Two survey-based assessments were administered prior to and following the workshops: an Exploring Computer Science (ECS) content-based assessment and a Computer Science Assessment (CSA) focusing on computer-science related career goals. These assessments are presented below and educators are encouraged to utilize and/or customize these surveys for their own learning measurement needs and goals.

EXPLORING COMPUTER SCIENCE (ECS) ASSESSMENT

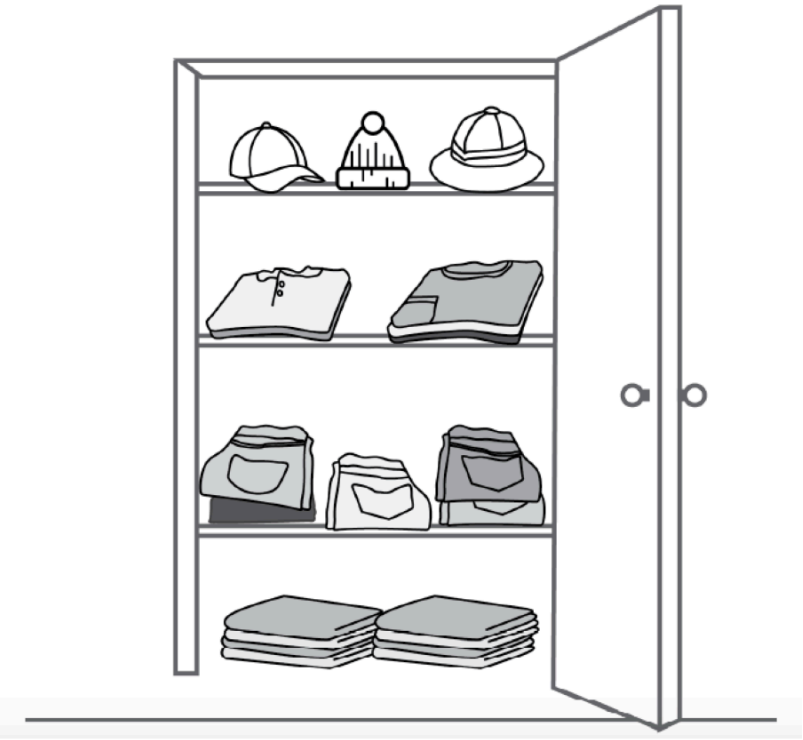
Please complete all of the following questions to the best of your ability.

Your Full Name _____

Problem 1

Carla programmed a robot to select clothes for her. The robot is only able to move around the room, open and close doors, and pick up and drop objects.

Carla's Closet



Below is a set of instructions for the robot once the robot is inside the closet:

- **STEP 1** Take out the top pair of pants from the left side of the third shelf down.
- **STEP 2** Take out a T-shirt.
- **STEP 3** Take out the hat from the top shelf that matches the outfit.

Select one step in the instructions that a robot would have difficulty completing:

- ○ Take out the top pair of pants from the left side of the third shelf down.
- ○ Take out a T-shirt.
- ○ Take out the hat from the top shelf that matches the outfit.

Explain why a robot would have difficulty completing that step:

_____

Problem 2

You are communicating using a social media profile (e.g., on Facebook, Twitter, Instagram).

a) List two pieces of personal information that are typically on a social media profile that you would not want everyone to see:

#1 _____

#2 _____

b) Pick one of the pieces of information from part (a):

_____

Describe a consequence of someone you don't know accessing that information:

_____

c) Describe one benefit of communicating using social media (such as Facebook or a blog):

_____

d) Describe one legal, ethical, or privacy concern from using social media (such as Facebook or a blog):

_____

Problem 3

Jadyn has access to these three different methods of communication:

- Cell phone call
- Text message

- Email message

Jadyn wants to send a secret message quickly to a friend, without any person or organization knowing about it. Assume Jadyn has access to the internet through a computer and a cellphone.

Which of the following are problems with all three methods of communication?

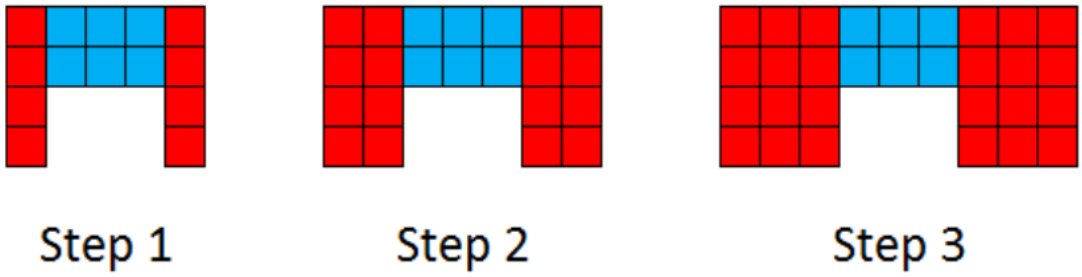
- ○ Message delivery speed
- ○ Cost of sending the message
- ○ Privacy from others

b) Explain why:

_____

Problem 4

Below is a pattern. In step 1 of the pattern, there are 14 blocks:



If you wanted to build a computer program that could continue the pattern, what computing concept should you use?

- ○ Procedural thinking
- ○ Conditional statements
- ○ Loop statements
- ○ Block structuring

b) Explain why:

_____

Problem 5

Stacy runs a food bank.

- The types of cans donated to the food bank are vegetables, fruits, meat, and soup.
- Volunteers put the cans randomly on the storage shelves, wherever they find space.
- Stacy packs the cans into many food boxes a week.
- Each box has the same number and types of canned food.
- It takes Stacy a long time to find the food for each of the boxes.

Stacy wants to create a method for organizing the food on the shelves.

What type of computing method could Stacy use for organizing the food on the shelves?

- ○ Sorting
- ○ Searching
- ○ Block structuring
- ○ Assignment

Problem 6

Zoe wants to make a fan club website for a local band. She wants the website to have information about the band as well as information about the fan club.

List 3 requirements to give to a web design team who are creating Zoe's website:

Be sure that each requirement describes specific content (WHAT information is provided) and specific design (HOW the information should look) for Zoe's website. Zoe has provided one example requirement.

> **EXAMPLE REQUIREMENT:** *A list of shows, including the date and place for each show, with past shows in gray and upcoming shows in green.*

Requirement 1:

_____

Requirement 2:

_____

Requirement 3:

Problem 7

Chantelle and Jasmine are programming an Opinion Game. The game will check to see if two players have the same opinion by comparing their ratings about a topic (e.g.: movies, food.). The two players rate a topic by entering a number from 1 to 5 where 1 means you "don't like it at all" and 5 means you "like it a lot."

The game works as follows:

1. The game asks for the players for a topic.
2. The game then gives each player a turn to rate the topic from 1 to 5.
3. The game then lets the players know if their answers match or not.

For example, two players might rate what they think about vanilla ice cream by each entering a number from 1 to 5. One person rates it as a 3 while the other person rates it as a 5. The game tells them that they don't agree.

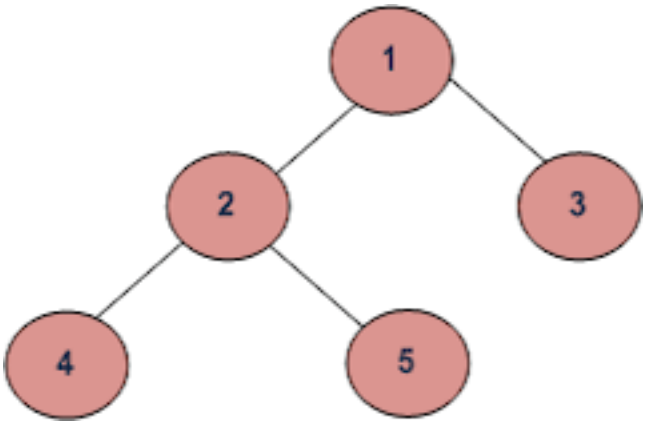
Assume that we are going to create a computer program for the Opinion Game. Which of these computing concepts would be most useful for implementing Step #3?

- ○ Abstraction
- ○ Conditional statement
- ○ Loop statement
- ○ Block structuring

Problem 8

This question will assess your ability to apply the Breadth First Search (BFS) and Depth First Search (DFS) algorithms to a directed graph.

Starting with node 1 and choosing the leftmost node to break any ties, give the list of expanded nodes in order for the below graph figure based on the search algorithm.



What is the correct order of node expansion for the above graph if we use Breadth-First Search (BFS)?

_____

What is the correct order of node expansion for the above graph if we use Depth-First Search (DFS)?

_____

COMPUTER SCIENCE ASSESSMENT (CSA)

Your Full Name _____

Please answer to the degree you agree or disagree with each of the following statements. There are no right or wrong answers. Don't be afraid to put down what you really think. Don't spend a lot of time on any one item. Move quickly!

I plan to major in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Generally I have felt secure about attempting computer programming problems.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am sure I could do advanced work in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am sure that I can learn programming.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I think I could handle more difficult programming problems.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I can get good grades in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I have a lot of self-confidence when it comes to programming.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I'm no good at programming.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I don't think I could do advanced computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I'm not the type to do well in computer programming.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

For some reason even though I work hard at it, programming seems unusually hard for me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Most subjects I can handle O.K., but I have a knack for flubbing up programming problems.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Computer science has been my worst subject.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

It would make me happy to be recognized as an excellent student in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I'd be proud to be the outstanding student in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I'd be happy to get top grades in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

It would be really great to win a prize in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Being first in a programming competition would make me pleased.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Being regarded as smart in computer science would be a great thing.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Winning a prize in computer science would make me feel unpleasantly conspicuous (attracting notice or attention).

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

People would think I was some kind of a nerd if I got A's in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

If I had good grades in computer science, I would try to hide it.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

If I got the highest grade in computer science I'd prefer no one knew.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

It would make people like me less if I were a really good computer science student.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I don't like people to think I'm smart in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Females are as good as males at programming.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Studying computer science is just as appropriate for women as for men.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I would trust a woman just as much as I would trust a man to figure out important programming problems.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Women certainly are logical enough to do well in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

It's hard to believe a female could be a genius in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

It makes sense that there are more men than women in computer science.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I would have more faith in the answer for a programming problem solved by a man than a woman.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Women who enjoy studying computer science are a bit peculiar.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I'll need programming for my future work.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I study programming because I know how useful it is.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Knowing programming will help me earn a living.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Computer science is a worthwhile and necessary subject.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I'll need a firm mastery of programming for my future work.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I will use programming in many ways throughout my life.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Programming is of no relevance to my life.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Programming will not be important to me in my life's work.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I see computer science as a subject I will rarely use in my daily life.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Taking computer science courses is a waste of time.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

In terms of my adult life it is not important for me to do well in computer science in college.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I expect to have little use for programming when I get out of school.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I like writing computer programs.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Programming is enjoyable and stimulating to me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

When a programming problem arises that I can't immediately solve, I stick with it until I have the solution.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Once I start trying to work on a program, I find it hard to stop.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

When a question is left unanswered in computer science class, I continue to think about it afterward.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I am challenged by programming problems I can't understand immediately.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Figuring out programming problems does not appeal to me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

The challenge of programming problems does not appeal to me.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

Programming is boring.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I don't understand how some people can spend so such time on writing programs and seem to enjoy it.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I would rather have someone give me the solution to a difficult programming problem than to have to work it out for myself.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

I do as little work in computer science courses as possible.

	1	2	3	4	5	
Strongly Disagree	○	○	○	○	○	Strongly Agree

ADDITIONAL RESOURCES

You can find a brochure containing the below information online here: http://bit.ly/2vGPeEd

FREE COMPUTER SCIENCE ENRICHMENT RESOURCES

The following resources are free and publically available resources designed to connect students of all ages, parents/guardians, and teachers to science and technology learning opportunities both in-person and online.

FAB FOUNDATION

The Fab Foundation provides widespread access to modern means for invention. They began as an outreach project from MIT's Center for Bits and Atoms. CBA assembled millions of dollars in machines for research in digital fabrication, ultimately aiming at developing programmable molecular assemblers that will be able to make almost anything. The South End Technology Center is a fab lab that provides free or low-cost access and training in most aspects of computer-related technology.

For more information, visit https://www.fablabs.io/southendtechnologycenter

MAKERSPACES

Makerspaces, sometimes also referred to as hackerspaces, hackspaces, and fab labs are creative, DIY spaces where people can gather to create, invent, and learn. In libraries they often have 3D printers, software, electronics, craft and hardware supplies and tools, and more.

For more information, visit:
Boston Makers, Inc.: http://www.bostonmakers.org
Artisans Asylum: https://artisansasylum.com

CODE FOR BOSTON

Code for Boston is a Code for America Brigade - a volunteer civic innovation organization created by Boston-area developers, designers, urban planners, data geeks, and researchers with an interest in solving civic and social problems through the use of creative technology. Code for Boston meets weekly at the Cambridge Innovation Center in Kendall Square, from 7 - 9:30pm.

For more information, visit http://www.codeforboston.org

MIT OUTREACH PROGRAMS

Explore MIT through outreach programs which offer a glimpse inside our labs, our classrooms and our innovative spirit. Stay for an hour at a workshop, come to an evening of science-inspired theater, or join us for a summer program. Meet us at our teaching and learning centers in Cambridge, or use our digital resources at home or in your classrooms.

For more information, visit https://outreach.mit.edu

MIT APP INVENTOR

MIT App Inventor is an innovative beginner's introduction to programming and app creation that transforms the complex language of text-based coding into visual, drag-and-drop building blocks. The simple graphical interface grants even an inexperienced novice the ability to create a basic, fully functional app within an hour or less.

For more information, visit http://appinventor.mit.edu

CODEACADEMY

Learn to code interactively, for free through different challenges in your web browser.

For more information, visit http://www.codecademy.com

DASH

Dash teaches HTML, CSS, and JavaScript, which are the building blocks of designing websites, through fun projects you can do in your web browser. Learn how to design and build websites and Tumblr layouts as you move through the tutorials.

For more information, visit https://dash.generalassemb.ly

TALEBLAZER

TaleBlazer is a platform for making and playing location-based mobile AR games. TaleBlazer players download a mobile app to their device (Android or iOS) to play games geolocated in real-world locations and to interact with virtual characters and artifacts within the context of real landscapes. The web-based editor uses a visual, blocks-based programming environment that allows both novices and experts to create their own location-based AR games.

For more information, visit www.taleblazer.org

SPLODER

Sploder is a place where anyone can make games online and share them with the world. Make your own platformer games, space-themed shoot-em-ups, retro arcade games, and even complex physics-based puzzle games. No programming skill is necessary. All you need is a good imagination and a desire to be creative.

For more information, visit http://www.sploder.com

MINECRAFT

Minecraft is a game about breaking and placing blocks. At first, people build structures to protect against nocturnal monsters, but as the game grew players worked together to create wonderful, imaginative things.

For more information, visit http://minecraft.net

COMPUTER CLUBHOUSE

Founded in 1993 by The Computer Museum (now a part of the Museum of Science, Boston) in collaboration with MIT Media Lab, the Clubhouse encourages young people around the world to explore their own ideas, develop new skills, and build confidence in themselves through the use of technology. The Clubhouse is a free program for Boston area youth ages 10-18.

For more information, visit http://computerclubhouse.org

KHAN ACADEMY

Learn how to program drawings, animations, and games using JavaScript & ProcessingJS, or learn how to create webpages with HTML & CSS. You can share whatever you create, explore what others have created and learn from each other.

For more information, visit http://www.khanacademy.org/computing/computer-programming

SKILLSHARE

Skillshare is an online learning community for creators. Unlike traditional study, online classes at Skillshare are taught by industry experts and focus on learning by doing. The courses accept anyone who wants to learn. The majority of courses focus more on interaction than lecturing, with the primary goal of learning by completing a project. The main categories of learning are creative arts, design, entrepreneurship, lifestyle, and technology, with subtopics covering a myriad of skills

For more information, visit https://www.skillshare.com

COURSERA

Coursera is an education platform that provides universal access to the world's best education, partnering with top universities and organizations worldwide to offer courses online for anyone to take. Explore a variety of topics, like computing, not just coding at Coursera.

For more information, visit https://www.coursera.org

EDX

EdX is an online learning destination and online course provider, offering high-quality science, technology, engineering, art, and math courses from the world's best universities and institutions to learners everywhere for free.

For more information, visit http://www.edx.org

MIT OFFICE OF ENGINEERING OUTREACH PROGRAMS

The MIT OEOP exists to empower middle and high schoolers from diverse backgrounds to become future scientists and engineers through enriching science and engineering programs which are free of charge for students to attend.

For more information, visit http://oeop.mit.edu

10 TIPS FOR INTERNET SAFETY

by the National Children's Advocacy Center

1. Spend time having fun with your parents online and helping them understand technology!

2. Never post your personal information, such as a cell phone number, home number, home address, or your location on any social networking site or through mobile apps like Snapchat or Instagram.

3. Never meet in person with anyone you first "met" on the internet. If someone asks to meet you, tell your parents or guardian right away. Some people may not be who they say they are.

4. Check with your parents before you post pictures of yourself or others online. Do not post inappropriate pictures of anyone.

5. Never respond to mean or rude texts, messages, and e-mails. Delete any unwanted messages. You may need to delete friends who continuously bother you or post things that are not

appropriate.

6. NEVER share your password with anyone, including your best friend. The only people who should know your password are your parents or guardian.

7. If you wouldn't say something to another person's face, don't text it or post it online.

8. Do not download or install software or anything on your computer or cell phone before checking with your parents or guardian.

9. Use the privacy settings of social networking sites.

10. If anything makes you feel uncomfortable online, while gaming or when using your cell phone, talk with your parents or guardian right away.

SLACK FACILITATION GUIDE

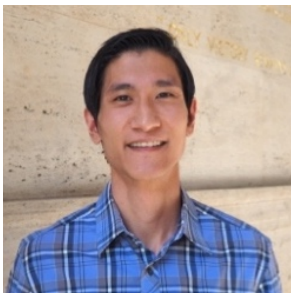
Slack is a popular work-friendly chat app that is a hybrid of a text messaging, chatroom, and instant messaging experience and used at many technology companies around the world. In order to both introduce students to a new and relevant technology as well as collect rich data about students' workshop engagement, we provided a comprehensive guide to students at the beginning of the workshops to have them sign up for and use the platform.

You can access and download a copy of the Slack account registration guide here: http://bit.ly/2vw2b5y

ABOUT THE AUTHORS

D. Fox Harrell, Ph.D. is Associate Professor of Digital Media at MIT. He is appointed in both the Comparative Media Studies Program and the Computer Science and Artificial Intelligence Laboratory. He founded and directs the Imagination, Computation, and Expression Laboratory (ICE Lab) at MIT. His research explores the relationship between imagination and computation. He develops new forms of computer gaming, social media, and related digital media based in computer science, cognitive science, and digital media arts. He has been awarded multiple grants from the National Science Foundation for studying virtual identity and to help middle and high school students become excited about computer science. His recent book, Phantasmal Media: An Approach to Imagination, Computation, and Expression, was published in 2013 by the MIT Press. Learn more here: http://groups.csail.mit.edu/icelab

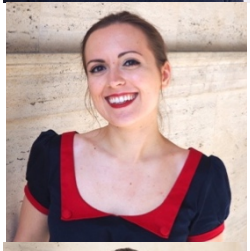
Sneha Veeragoudar Harrell, Ph.D. is a learning scientist who is dedicated to getting young people excited about computing as a means of empowerment, problem solving, and self-expression. Her research centers on fostering transformative computer-based learning experiences for marginalized youth. She has directed research projects in California and Georgia, leading computational literacy interventions with an alternative school for students expelled from the mainstream and a year-long critical ethnography with an independent school for refugee girls. She completed her Ph.D. in Cognition and Development at the University of California, Berkeley, where her dissertation was a finalist for Best Dissertation of the Year in the Graduate School of Education and completed a Post-Doctoral Fellowship with TERC, a Cambridge-based non-profit STEM education research think tank. She proudly serves as Co-Chair of the Social Sciences Advisory Board for the National Center for Women in Information Technology.



Dominic Kao is a Ph.D. Candidate at MIT in the Electrical Engineering Computer Science Program, interested in writing his dissertation at the intersection of learning and computing. A key component of his dissertation work is Mazzy, a central gaming component of the MazeStar system to introduce students to computing while supporting their own identities. Dominic comes to MIT from Princeton where he studied Computer Science.

Maya M. Wagoner is a Master's student in Comparative Media Studies at MIT who is interested in building digital platforms with principles of social justice, collaborative design, and critical pedagogy in mind. Prior to studying at MIT, she grew up all around California, worked as a UX designer and usability researcher for major tech companies, and was an organizer of both the African/Black Student Alliance at the University of California, Santa Cruz and Code for San Francisco, a civic technology volunteer group. She currently lives in Somerville and fosters wayward cats in her home.

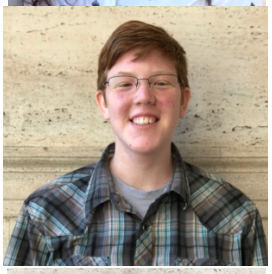
Pablo Ortiz is a Ph.D. Candidate at MIT in the Electrical Engineering and Computer Science department. Prior to MIT, he studied Computer Science at UC Santa Barbara. He currently studies the intersection between machine learning, games, and role-play.



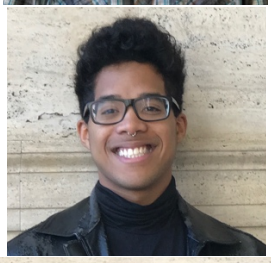
Laurel Carney is a writer from California. She is currently a graduate student in MIT's Comparative Media Studies/Writing program, and earned her bachelor's degree in English from the University of California, Davis. A lifelong gamer, she is interested in moderating and hacking, interactive fiction, online role-playing games, and communities formed around rule-breaking in virtual worlds.

Danielle Olson is a Ph.D. Student in Electrical Engineering & Computer Science at MIT. Danielle graduated with a B.S. in Computer Science & Engineering from MIT in 2014. While at MIT, Danielle founded Gique Corporation, an educational nonprofit 501(c)(3) that exists to inspire & educate Boston-area youth in STEAM. Following her graduation from MIT, Danielle worked as a Program Manager at the Microsoft New England Research & Development Center and Summer Program Coordinator for the MIT Online Science, Technology, and Engineering Community (MOSTEC).

Aziria Rodriguez is a political science graduate from the University of Puerto Rico, community organizer, and web developer. In Puerto Rico she worked for two major non-profits, tackling problems of government transparency, technology accessibility, capacity building and economic development. She is currently a graduate student in MIT's Comparative Media Studies/Writing program, where she studies collective cultural and media creation, with an emphasis on the development of participatory and collective tools that promote empowerment, equality and justice.



Sofia Ayala is a sophomore undergraduate student at MIT studying Computer Science and Comparative Media Studies. She is currently helping to develop a curriculum that teaches aspects of virtual identities. She has a background in animation and game design, and hopes to create games professionally in the future. Other projects she has worked on include small digital games, board games, and a VR demo.



Jacob Higgins is a Sophomore at MIT studying Comparative Media Studies. They are interested in building tools to empower people to understand and participate in their communities. Because of this, they have spent a lot of time asking people "What makes you you?" and "Why do you do what you do?", but they strive to combine Design, Computer Science, and Sociology to understand people better.

Raul Boquin is a senior in the Department of Mathematics with Computer Science and serves as part of the leadership of the MIT Latino Cultural Center. Originally from Miami, Florida, he grew up with a love for mathematics and education. At MIT, he discovered the breadth of educational research that, combined with his background, gave him a passion to research education in unique ways. Raul hopes to go into graduate studies in computer science and education after MIT.