Introduction

The Ohio Department of Education’s Office of Learning and Instructional Strategies is in the process of revising Ohio’s Model Curriculum for Computer Science.

The State Board of Education adopted Ohio’s Learning Standards and Model Curriculum for Computer Science in December 2018. Implemented in the 2019-2020 (FY2020) school year, the purpose of Ohio’s Learning Standards and Model Curriculum for Computer Science is to provide guidance to schools and districts. Ohio educators, many of whom engage daily with Ohio students, led the process to create Ohio’s Learning Standards and Model Curriculum for Computer Science.

The review and revision process presents an opportunity for families, computer science professionals, community members and other educators, to provide suggestions for improving the model curriculum through a public comment survey, open March 2 through March 18.

In the Fall of 2021, the public was invited to provide comments on the current standards and model curriculum. Advisory group members, who have an educational background or professional experience in computer science, met several times to discuss the public comment and make suggestions for revisions. The advisory group then provided direction and guidance to the working groups of Ohio educators, who worked to write the revisions.

The following is a draft of the revised model curriculum available for viewing and public comment. This document contains the revisions to the model curriculum for the Artificial Intelligence strand. This model curriculum addresses new proposed standards and therefore new content.

In your review, please focus on the content of the statements. All materials will be going through additional technical edits, but because of the timeline outlined in HB110, the Department wanted to make these drafts available for public comment at this time.

To see the model curriculum adopted by the Ohio State Board of Education in 2018 please visit the Model Curriculum for Computer Science.
Overview of the Computer Science Standards Framework

Ohio's Computer Science Standards are organized by strands, topics and content statements.

Kindergarten through Grade 8—Content statements are organized by grade level. Below is an example of a content statement for kindergarten and its corresponding content statement code. This content statement addresses the topic of Devices within the Computing Systems strand.
Kindergarten

<table>
<thead>
<tr>
<th>Strand</th>
<th>Artificial Intelligence</th>
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</thead>
<tbody>
<tr>
<td>Topic</td>
<td>Machine Learning</td>
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</table>

AI.ML.K.a With guidance and support use a classifier that recognizes drawings to see if a program can guess what they are drawing.

Expectations for Learning

LEARNING PROGRESSION

In kindergarten, with guidance and support, students use a classifier that recognizes drawings to see if a program can guess what they are drawing. In grade 1, students will discuss how machine learning uses classifiers to recognize drawings.

IMPORTANT CONCEPTS

- Computers can learn from examples

KEY SKILLS/PROCEDURES

- Artificial Intelligence (AI), or the science and engineering of making intelligent machines and computer programs, can assist humans in problem-solving using a classifier

Content Elaborations

CLARIFICATIONS

Demonstrate how to train a computer to recognize something.

CONTENT FOCUS

Computers can learn from data.

COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

1. Extract common features from a set of interrelated processes or complex phenomena.
2. Evaluate existing technological functionalities and incorporate them into new designs.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.
## Computer Science Model Curriculum: Artificial Intelligence, Grade K-2 DRAFT

<table>
<thead>
<tr>
<th>Strand</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Topic</td>
<td>Natural Interactions</td>
</tr>
</tbody>
</table>

**AI.NI.K.a** With guidance and support, identify how computers can recognize different humans using some form of recognition software to see how computers interact with humans.

### Expectations for Learning

**LEARNING PROGRESSION**

In kindergarten, with guidance and support, students identify how computers can recognize different humans using some form of recognition software to understand how computers interact with humans.

In grade 1, students will identify attributes computers use to identify humans.

### IMPORTANT CONCEPTS

- Facial recognition
- Thumbprint recognition
- Iris recognition
- Other concepts

### KEY SKILLS/PROCEDURES

- Use various forms of recognition software to demonstrate AI's working

### Content Elaborations

**CLARIFICATIONS**

AI can use recognition software to recognize humans.

**CONTENT FOCUS**

The focus of the content is how computers use recognition software to recognize humans.

**COMPUTER SCIENCE PRACTICES**

*Practice 3. Recognizing and Defining Computational Problems*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
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<td>Topic</td>
<td>Perception</td>
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</tbody>
</table>

**AI.P.K.a** With guidance locate sensors on computers, robots and intelligent appliances to understand that devices use sensors to gather information.

### Expectations for Learning

#### LEARNING PROGRESSION

In kindergarten, students identify and are introduced to what sensors are and where they may be located. In grade 1, with guidance, students recognize sensors on computers, robots and intelligent appliances to understand their function (motion, pressure/pouch, temperature, proximity, light, sound, moisture, gases).

#### IMPORTANT CONCEPTS

- Computers use sensors to get information from the world around them
  - Sensors are placed in certain spots

#### KEY SKILLS/PROCEDURES

- Identify sensors to understand why they are placed where they are placed

### Content Elaborations

#### CLARIFICATIONS

Sensors gather information and use that information to interact with us.

#### CONTENT FOCUS

Sensors are needed for computers to gather information.

#### COMPUTER SCIENCE PRACTICES

*Practice 3. Recognizing and Defining Computational Problems*

2. Create a computational artifact for practical intent, personal expression, or to address a societal issue.
## Artificial Intelligence

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**AI.P.K.b** With guidance and support from adults access intelligent agents to demonstrate how it works.

### Expectations for Learning

**LEARNING PROGRESSION**

In kindergarten, students are introduced to intelligent agents. In grade 1, students will use intelligent agents to help answer questions.

**IMPORTANT CONCEPTS**

- Intelligent agents are a form of AI

**KEY SKILLS/PROCEDURES**

- Use intelligent agents to answer a question

### Content Elaborations

**CLARIFICATIONS**

Examples of intelligent agents are virtual assistant technology that can play music, provide information, deliver news, control smart homes and give other information.

**CONTENT FOCUS**

Using an intelligent agent to help them answer simple questions like how to spell a word.

**COMPUTER SCIENCE PRACTICES**

*Practice 4. Developing and Using Abstractions*

1. Extract common features from a set of interrelated processes or complex phenomena.
2. Evaluate existing technological functionalities and incorporate them into new designs.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.
## Artificial Intelligence

### Representation & Reasoning

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<td>Topic</td>
<td>Representation &amp; Reasoning</td>
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**AI.RR.K.a** With guidance and support use a simple decision tree to make a decision to visually and explicitly represent decisions and decision making.

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<th>Expectations for Learning</th>
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<tbody>
<tr>
<td><strong>LEARNING PROGRESSION</strong></td>
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<tr>
<td>In kindergarten, students use a simple decision tree to make a decision to visually and explicitly represent decisions and decision making. In grade 1, students will use decision trees to make decisions.</td>
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</table>

**IMPORTANT CONCEPTS**
- Definition of a decision tree

**KEY SKILLS/PROCEDURES**
- Use a decision tree to make a decision

### Content Elaborations

**CLARIFICATIONS**
Many types of data could be placed on a branch. For a decision tree, the data would be questions and answers.

**CONTENT FOCUS**
Using a decision tree to answer a question, such as what to do if your computer does not turn on or what to do if all your letters are capitalized.

### COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions
1. Extract common features from a set of interrelated processes or complex phenomena.
2. Evaluate existing technological functionalities and incorporate them into new designs.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
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### Computer Science Model Curriculum: Artificial Intelligence, Grade K-2 DRAFT

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<td>Topic</td>
<td>Societal Impacts</td>
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</table>

**AI.SI.K.a** With guidance and support locate AI applications used in daily life to understand how humans use AI.

### Expectations for Learning

**LEARNING PROGRESSION**

In kindergarten, students locate AI applications used in daily life to understand how humans use AI. In grade 1, students will identify an application that is used in daily life.

**IMPORTANT CONCEPTS**

- Explore all the ways humans use AI

**KEY SKILLS/PROCEDURES**

- Create a list of the ways humans use intelligent devices to demonstrate that humans use AI to assist them with everyday tasks. (e.g., facial recognition, self-driving cars)

### Content Elaborations

**CLARIFICATIONS**

- AI is all around us and learning from us.

**CONTENT FOCUS**

Students will learn about various forms of new and emerging Artificial Intelligence technology.

### COMPUTER SCIENCE PRACTICES

**Practice 3. Recognizing and Defining Computational Problems**

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
# Artificial Intelligence

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**AI.SI.K.b** Discuss if something is good or bad to understand the concepts.

## Expectations for Learning

### LEARNING PROGRESSION

In kindergarten, students will discuss if something is good or bad to understand the concepts. In grade 1, students will discuss if computers/technology is good or bad.

### IMPORTANT CONCEPTS

- AI is a type of technology and it is a tool for humans to use.

### KEY SKILLS/PROCEDURES

- Create lists of how technology makes life better or worse to see differences in use of technology.

## Content Elaborations

### CLARIFICATIONS

Technology is not always positive and sometimes non-technological ways are better.

### CONTENT FOCUS

The focus of the content is on the ways that technology can help us or harm us.

### COMPUTER SCIENCE PRACTICES

*Practice 3. Recognizing and Defining Computational Problems*

3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
## Grade 1

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<tr>
<th><strong>AI.ML.1.a</strong></th>
<th>With guidance and support discuss how a classifier recognizes drawings to gain an understanding of how machine learning works.</th>
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</table>

### Expectations for Learning

**LEARNING PROGRESSION**

In kindergarten, students were introduced to machine learning through classifiers. In grade 1, students will discuss how a classifier recognizes drawings to gain an understanding of how machine learning works. In grade 2, students will discuss how the machine knows what they are drawing.

**IMPORTANT CONCEPTS**

- Explore how AI can recognize a drawing

**KEY SKILLS/PROCEDURES**

- Apply the use of AI in a classifier to gain knowledge of how machine learning works

### Content Elaborations

**CLARIFICATIONS**

AI can recognize human inputs.

**CONTENT FOCUS**

Students can address this content with or without a computing device. For example, the class can all draw the same thing and look at the differences.

**COMPUTER SCIENCE PRACTICES**

*Practice 3. Recognizing and Defining Computational Problems*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.
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Computer Science Model Curriculum: Artificial Intelligence, Grade K-2 DRAFT

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</table>

**AI.NI.1.a** Using recognition software students will identify attributes that computers use for identification to explain how computers recognize humans.

**Expectations for Learning**

**LEARNING PROGRESSION**

In Kindergarten, students were introduced to recognition software. In grade 1, students use recognition software to identify attributes that computers use for identification to explain how computers recognize humans. In grade 2, students will list possible attributes used by computers to distinguish humans from each other.

**IMPORTANT CONCEPTS**

- Explore how AI uses attributions to recognize humans

**KEY SKILLS/PROCEDURES**

- Create lists of attributions AI might use to identify humans to describe how computers recognize human faces from each other

**Content Elaborations**

**CLARIFICATIONS**

The process of identifying a minimal set of informative features or attributes from the provided dataset is called feature extraction. The performance of machine learning processes can be improved by properly choosing a meaningful set of features.

**CONTENT FOCUS**

The focus of the content is on how computers can recognize humans. Attributions are necessary for AI to identify humans.

**COMPUTER SCIENCE PRACTICES**

*Practice 4. Developing and Using Abstractions*

1. Extract common features from a set of interrelated processes or complex phenomena.
2. Evaluate existing technological functionalities and incorporate them into new designs.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.
### Expectations for Learning

**LEARNING PROGRESSION**

In Kindergarten, students are introduced to sensors. In grade 1, students recognize sensors on computers, robots and intelligent appliances with guidance. In grade 2, students will relate the sensor to the function.

**IMPORTANT CONCEPTS**

- Computers use specific types of sensors to gather data

**KEY SKILLS/PROCEDURES**

- Identify different sensors to examine the data they can gather

### Content Elaborations

**CLARIFICATIONS**

Examples of data sensors that can gather data are motion (computer games, tablets), pressure/touch (temperature), proximity (self-driving car), light, sound, moisture (lawn watering) and gases.

**CONTENT FOCUS**

Sensors are needed for computers to gather information.

**COMPUTER SCIENCE PRACTICES**

*Practice 3. Recognizing and Defining Computational Problems*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
2. Decompose complex real-world problems into manageable subproblems that could integrate existing solutions or procedures.
3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
### Expectations for Learning

#### LEARNING PROGRESSION

In Kindergarten, students were introduced to intelligent agents. In grade 1, students use intelligent agents to help answer simple questions with guidance. In grade 2, they will use the intelligent agent to assist in basic research.

#### IMPORTANT CONCEPTS

- Intelligent agents are a form of AI

#### KEY SKILLS/PROCEDURES

- Use intelligent agents to answer questions

#### Content Elaborations

#### CLARIFICATIONS

Examples of intelligent agents are virtual assistant technology which can play music, provide information, deliver news, control your smart home and give you other information.

#### CONTENT FOCUS

Students can use an intelligent agent to help them answer questions, for example, how to spell a word.

#### COMPUTER SCIENCE PRACTICES

**Practice 4. Developing and Using Abstractions**

1. Extract common features from a set of interrelated processes or complex phenomena.
2. Evaluate existing technological functionalities and incorporate them into new designs.
3. Create modules and develop points of interaction that can apply to multiple situations and reduce complexity.
4. Model phenomena and processes and simulate systems to understand and evaluate potential outcomes.
### Expectations for Learning

#### LEARNING PROGRESSION

In Kindergarten, students were introduced to decision trees. In grade 1, students will use a decision tree to make a decision. In grade 2, students will create simple decision trees.

#### IMPORTANT CONCEPTS

- Students can use decision trees to make decisions

#### KEY SKILLS/PROCEDURES

- Identify that decision trees are ways to come up with reasonable answers

### Content Elaborations

#### CLARIFICATIONS

Decision trees have binary answers.

#### CONTENT FOCUS

The focus is to participate in creating a decision tree to solve simple technology problems.

#### COMPUTER SCIENCE PRACTICES

*Practice 6. Testing and Refining Computational Artifacts*

- Systematically test computational artifacts by considering all scenarios and using test cases.
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<tr>
<td>Topic</td>
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</tr>
<tr>
<td>AI.SI.1.a</td>
<td>Identify AI applications that are used in daily life to predict it's use in the future.</td>
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</tbody>
</table>

**Expectations for Learning**

**LEARNING PROGRESSION**

In kindergarten, students located AI applications to understand how humans use AI. In grade 1, students identify AI applications that are used in daily life. In grade 2, students will group applications as AI or not AI.

**IMPORTANT CONCEPTS**

- Give ideas of how AI might help in the future

**KEY SKILLS/PROCEDURES**

- Create a list or ideas of the AI's might work in the future to demonstrate that AI is a growing and changing field and its impacts on humans

**Content Elaborations**

**CLARIFICATIONS**

AI is a new and emerging technology that is constantly changing and adapting to humans use.

**CONTENT FOCUS**

The focus is on AI applications and how they are used in our daily lives.

**COMPUTER SCIENCE PRACTICES**

*Practice 3. Recognizing and Defining Computational Problems*

- 3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
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**AI.SI.1.b** Discuss if computers and other technology are good or bad to create a working construct.

## Expectations for Learning

### LEARNING PROGRESSION

In Kindergarten, students discussed if something is good or bad in terms of computers. In grade 1, students discuss if computers and other technology are good or bad. In grade 2, students will discuss if AI is good or bad.

### IMPORTANT CONCEPTS

- Ways technology can help or harm us

### KEY SKILLS/PROCEDURES

- Create lists of how technology makes life better or worse to see differences in the use of technology

## Content Elaborations

### CLARIFICATIONS

Technology is not always positive and sometimes non-technological ways are better.

### CONTENT FOCUS

AI is a type of technology and it is a tool for humans to use.

### COMPUTER SCIENCE PRACTICES

*Practice 3. Recognizing and Defining Computational Problems*

  3. Evaluate whether it is appropriate and feasible to solve a problem computationally.
### Grade 2

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</table>

**AI.ML.2.a** Use a classifier that recognizes drawings and discuss how the program knows what they are drawing.

**Expectations for Learning**

**LEARNING PROGRESSION**

In grade 1, students will discuss how machine learning uses classifiers to recognize drawings. In grade 2, students use a classifier that recognizes drawings and discuss how the program knows what they are drawing. In grade 3, students will be introduced to specific forms of machine learning.

**IMPORTANT CONCEPTS**

- Discuss how AI can recognize various drawings as a form of machine learning

**KEY SKILLS/PROCEDURES**

- Apply the use of AI in a classifier to gain knowledge of how machine learning works

**Content Elaborations**

**CLARIFICATIONS**

AI can recognize human inputs through the use of classifiers.

**CONTENT FOCUS**

AI uses machine learning to learn new things.

**COMPUTER SCIENCE PRACTICES**

*Practice 7. Communicating About Computing*

1. Select, organize and interpret large data sets from multiple sources to support a claim.
### Strand: Artificial Intelligence

#### Topic: Natural Interactions

<table>
<thead>
<tr>
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<tbody>
<tr>
<td><strong>AI.NI.2.a</strong> List possible attributions computers can use to distinguish humans from each other to compare these attributions.</td>
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</table>

#### Expectations for Learning

**LEARNING PROGRESSION**

In grade 1, students used recognition software and describe attributes the software used. In grade 2, students list possible attributions computers can use to distinguish humans from each other. In grade 3, students identify tasks AI do that humans used to do.

**IMPORTANT CONCEPTS**

- Explore variations in attributions

**KEY SKILLS/PROCEDURES**

- List attributions AI might use to describe how computers recognize human faces from each other

**Content Elaborations**

**CLARIFICATIONS**

Exploring attributions and changes in them such as faces and expressions.

**CONTENT FOCUS**

The focus of the content is on how computers can recognize humans even if humans change their expressions.

**COMPUTER SCIENCE PRACTICES**

*Practice 4. Developing and Using Abstractions*

1. Extract common features from a set of interrelated processes or complex phenomena.
### Strand | Artificial Intelligence
--- | ---
**Topic** | Perception

| **Expectations for Learning** |  |
| **LEARNING PROGRESSION** |  |
| In grade 1, students will recognize various sensors and their functions. In grade 2, students tell where sensors are on computers and intelligent appliances. In grade 3, students will understand the difference in sensor inputs. |

| **IMPORTANT CONCEPTS** |  |
| • Computers use specific sensors in specific places to gather data |  |

| **KEY SKILLS/PROCEDURES** |  |
| • Tell where the sensors are and why they are placed there |  |

| **Content Elaborations** |  |
| **CLARIFICATIONS** |  |
| Students will discover why sensors are placed where they are. For example, accelerometer sensors are placed in smartphones that can track steps. |  |

| **CONTENT FOCUS** |  |
| Sensors are needed for computers to gather information and then use that data to give us information. |  |

| **COMPUTER SCIENCE PRACTICES** | Practice 3. Recognizing and Defining Computational Problems |

**AI.P.2.a** Tell where sensors are on computers, robots, and intelligent appliances to relate their location with their function such as motion, pressure/touch, temperature, proximity, light, sound, moisture or gases.
## Artificial Intelligence

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<td>AI.P.2.b</td>
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**LEARNING PROGRESSION**

In grade 1, students used intelligent agents to answer simple questions. In grade 2, apply the use of intelligent agents to assist in basic research. In grade 3, they will begin to see that there are limitations to intelligent agents.

**IMPORTANT CONCEPTS**

- Intelligent agents are a form of AI

**KEY SKILLS/PROCEDURES**

- Use intelligent agents to assist in research

**Content Elaborations**

**CLARIFICATIONS**

Examples of intelligent agents are virtual assistant technology that can play music, provide information, deliver news, control smart homes and give other information.

**CONTENT FOCUS**

Students can use an intelligent agent to help them do simple research that can be used to report back to the class.

**COMPUTER SCIENCE PRACTICES**

*Practice 4. Developing and Using Abstractions*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.
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| 1.1.RR.2.a | With guidance and support create a simple decision tree (conditionals) to create a pathway for decisions. |

<table>
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**LEARNING PROGRESSION**

In grade 1, students used simple decision trees. In grade 2, students create a simple decision tree with guidance and support. In grade 3, students will create a decision tree to help understand how computers "think."

**IMPORTANT CONCEPTS**
- Creation of decision trees

**KEY SKILLS/PROCEDURES**
- Demonstrate the creation of a decision tree to find a logical solution to a problem

**Content Elaborations**

**CLARIFICATIONS**
Decision trees are a way of organizing information.

**CONTENT FOCUS**
Students can draw a tree by repeatedly splitting each branch into sub-branches multiple times and putting a piece of data at each branch.

**COMPUTER SCIENCE PRACTICES**

*Practice 5. Creating Computational Artifacts*
1. Plan the development of a computational artifact using an iterative process that includes reflection on and modification of the plan, considering key features, time and resource constraints, and user expectations.
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<td><strong>AI.SI.2.a</strong></td>
<td>Group applications used as AI or not AI to determine how AI can help in daily life.</td>
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### Expectations for Learning

#### LEARNING PROGRESSION

In grade 1, students identified AI applications in their daily life. In grade 2, students group applications used as AI or not AI to determine how AI can help in daily life. In grade 3, students will discuss how AI can be inclusive.

#### IMPORTANT CONCEPTS

- AI devices are used to help everyone have equal access to technology

#### KEY SKILLS/PROCEDURES

- Identify the use of AI in daily life and show how it can help everyone have equal access to technology

#### Content Elaborations

#### CLARIFICATIONS

Some of the different ways humans can access technology include speech, typing, motion and thought.

#### CONTENT FOCUS

Not everyone accesses technology the same way. AI can help everyone access technology equally.

#### COMPUTER SCIENCE PRACTICES

Practice 4. Developing and Using Abstractions

1. Extract common features from a set of interrelated processes or complex phenomena.
## Artificial Intelligence

### Societal Impacts

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**AI.SI.2.b** Discuss AI and how it can be used for good or bad to discuss the ethical use of AI.

### Expectations for Learning

#### LEARNING PROGRESSION

In grade 1, students discussed if computers and/or technology being good or bad. In grade 2, students discuss AI and how it can be used for good or bad. In grade 3, students are introduced to the concept of bias.

#### IMPORTANT CONCEPTS

- Technology can help or harm us depending on how we interact with AI and its data sets

#### KEY SKILLS/PROCEDURES

- Demonstrate the use of a data set to show that AI's use data sets
  - Data sets can be incorrect and may make our life better or worse

### Content Elaborations

#### CLARIFICATIONS

Technology has faults. For example, facial recognition, various skin colors and accents may or may not be recognizable.

#### CONTENT FOCUS

AI uses data sets to learn more about its surroundings and those data sets can be incomplete.

#### COMPUTER SCIENCE PRACTICES

*Practice 3. Recognizing and Defining Computational Problems*

1. Identify complex, interdisciplinary, real-world problems that can be solved computationally.