Initiative Update

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#AI4K12

AI4K12.org Initiative Mission

- Develop national guidelines for teaching AI in K-12
  - Modeled after the CSTA standards for computing education.
  - Four grade bands: K-2, 3-5, 6-8, and 9-12
  - What should students know?
  - What should students be able to do?
- Develop a curated AI resource directory for K-12 teachers
- Foster a K-12 AI Education Community & Resource Developers

The AI4K12 Initiative, a joint project of:

AAAI (Association for the Advancement of Artificial Intelligence)

CSTA (Computer Science Teachers Association)

With funding from National Science Foundation ITEST Program (DRL-1846073)

Carnegie Mellon University
School of Computer Science

Steering Committee

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K-12 Teacher Working Group Members

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Dr. April DeGennaro
Melissa Unger (New)

Grades 3-5
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Grades 6-8
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Grades 9-12
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Academia/Industry Working Group Members

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Overview of
AI for K-12 Guidelines Initiative

K-12 AI Education (Circa May 2018)

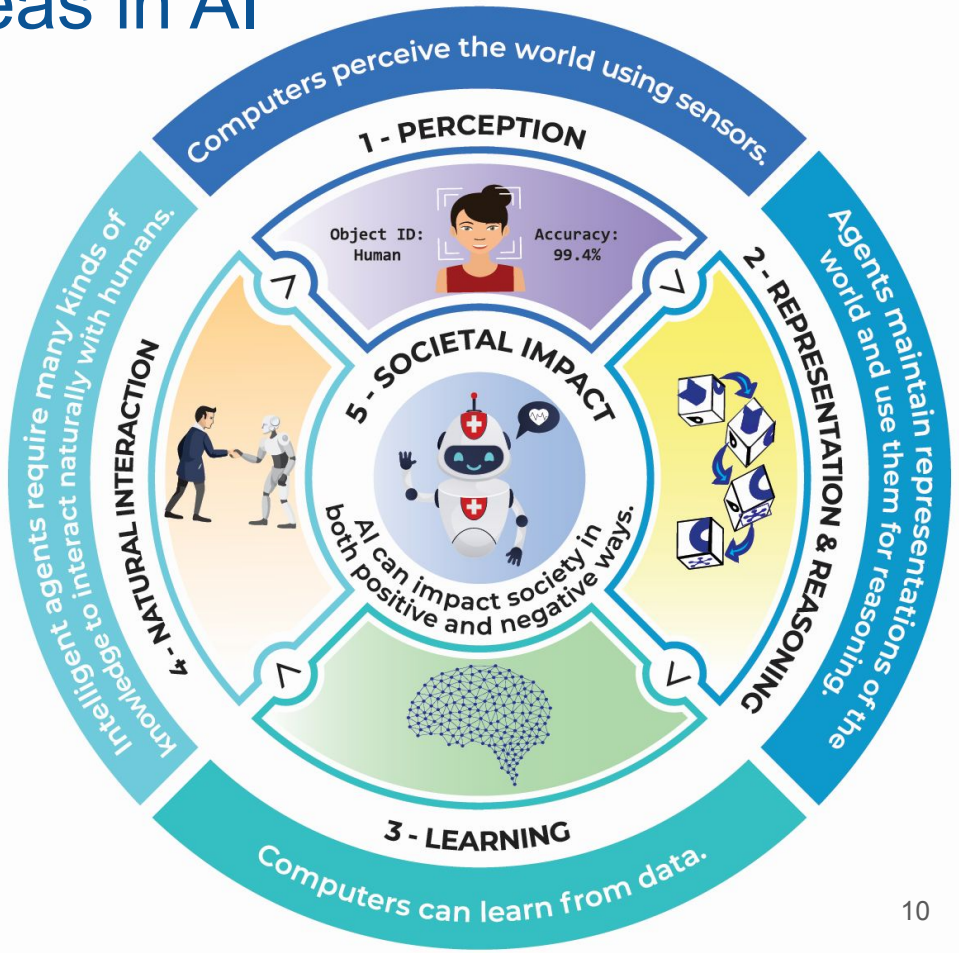
- CS K-12 Education is exploding in the US and abroad.
- We are not as far along when it comes to AI, but many countries are trying China, UK, Thailand, Korea, and EU Countries

- The 2017 CSTA Computing Standards contain just two sentences about AI.
  - Both are for the 11-12 grade band. Nothing for younger students.

3B-AP-08	11-12	Describe how artificial intelligence drives many software and physical systems.	Algorithms & Programming	Algorithms	Communicating
3B-AP-09	11-12	Implement an artificial intelligence algorithm to play a game against a human opponent or solve a problem.	Algorithms & Programming	Algorithms	Creating

Five Big Ideas in AI

- Organizing framework for the K-12 guidelines.
- 5 big ideas are enough to cover the richness of the field, but small enough to be manageable by teachers.
- CSTA experience shows 5 is a good number.
- Not necessarily the way AI practitioners view their field, but appropriate for the needs of the K-12 audience.



Structure of Working Group & Responsibilities

YEAR 1 Goal: Increase familiarity with AI concepts and leverage knowledge of students capabilities in CS and other disciplines and interests to scope expectations for student learning about AI for their grade band

Monthly

Large Working Group Meeting

AI Bootstrapping

- Introduce the concepts in one of the big ideas (demos, activities, explanations)
- Provide key concepts and Enduring Understandings we want all students to know by they time they graduate from high school

Gradebands Share out Progress

Weekly or Bi-Monthly

Small Working Group Meetings

- **Review & Discuss** key concepts introduced on the call
- **Identify** existing student knowledge, skills, and connections to other disciplines
- **Redefine** concepts from Big Group presentations
- **Scope** to grade band

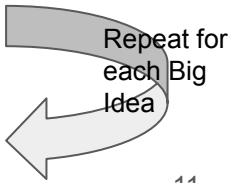
Individual Work

Read

- Scholarly Articles
- Explanatory Articles about AI Concepts
- Research & concepts, activities, and tools

Face-to-Face Meetings

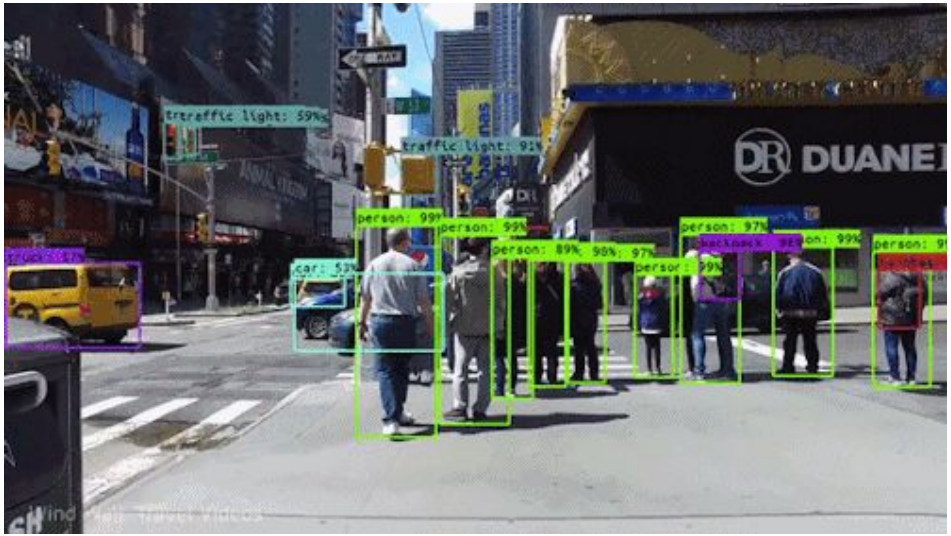
Face-to-Face Meetings



Big Idea #1: Perception

Computers perceive the world using sensors.
Perception is the extraction of *meaning* from sensory signals.

- Human senses vs. computer sensors
- Types of perception: vision, speech recognition etc.
- How perception works: algorithms



Big Idea #1 – What should students be able to do?

Grades K-2:

- Identify sensors on computers, robots, and intelligent appliances.
- Interact with intelligent agents such as Alexa or Siri.

Grades 6-8:

- Explain how sensor limitations affect computer perception.
- Explain that perception systems may draw on multiple algorithms as well as multiple sensors.
- Build an application using multiple sensors and types of perception (possibly with Scratch plugins, or Calypso).

Grades 3-5:

- Describe how sensor inputs are converted to analog or digital signals.
- Demonstrate a limitation of computer perception.
- Build an application using perception (possibly with Scratch plugins, or Calypso).

Grades 9-12:

- Describe the domain knowledge underlying different forms of computer perception.
- Demonstrate speech recognition difficulty in handling homophones and other types of ambiguity.

Big Idea #2: Representation and Reasoning

Agents maintain representations of the world, and use them for reasoning.

- Types of representations
- Families of algorithms and the work they do
- Representation supports reasoning: algorithms operate on representations

Big Idea #2 – What should students be able to do?

Grades K-2:

- Construct a model of something and compare it to the thing being modeled
- Use a decision tree to make a decision

Grades 3-5:

- Create/design a representation of an (animal) classification system using a tree structure.
- Describe how AI representations support reasoning to answer questions

Grades 6-8:

- Design a graph model of their home or locations in their community and apply reasoning to determine the shortest path to key locations on their map
- Create/design a representation of an (animal) classification system using a tree structure.

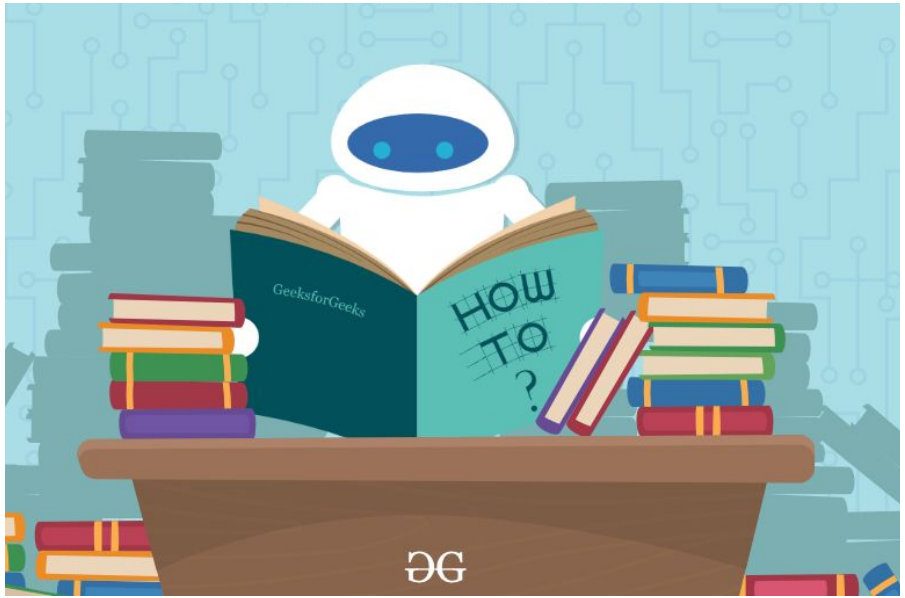
Grades 9-12:

- Draw a search tree for tic-tac-toe
- Describe the differences between types of search algorithms

Big Idea #3: Learning

Computers can learn from data.

- What is learning?
- Fundamentals of neural networks
- Data sets



Big Idea #3 – What should students be able to do?

Grades K-2:

- Learn from patterns in data with “unplugged” activities
- Use a classifier that recognizes drawings. Use Google Autodraw or Cognimates Train Doodle to investigate how training sets work to identify images and discuss how the program knows what they are drawing

Grades 3-5:

- Describe and compare the three different machine learning approaches: supervised, unsupervised and reinforcement learning.
- Modify an interactive machine learning project by training its model..
- Describe how algorithms and machine learning can exhibit biases.

Grades 6-8:

- Identify bias in a training data set and extend the training set to address the bias
- Hand-simulate the training of a simple neural network

Grades 9-12:

- Train a neural net (1-3 layers) *TensorFlow Playground*
- Trace and experiment with a simple ML algorithm

Big Idea #4: Natural Interaction

Intelligent agents require many kinds of knowledge to interact naturally with humans.

- Natural language understanding
- Common Sense Reasoning
- Affective computing & interaction (e.g. with robots, or speech agents)
- Consciousness and philosophy of mind

Humans are among the hardest things for AI agents to understand.

Big Idea #4 – What should students be able to do?

Grades K-2:

- Identify words in stories that have positive and negative connotations.
- Recognize and label facial expressions into appropriate emotions (happiness, sadness, anger) and explain why they are labeled the way they are
- Experiment with software that recognizes emotions in facial expressions

Grades 3-5:

- Identify how humans combine multiple inputs (tone, facial expressions, posture, etc) in order to understand communication.
- Describe some tasks where AI outperforms humans, and tasks where it does not

Grades 6-8:

- Construct a simple chatbot
- Explain and give examples of how language can be ambiguous
- Reason about the nature of intelligence, and identify approaches to determining whether an agent is or is not intelligent.

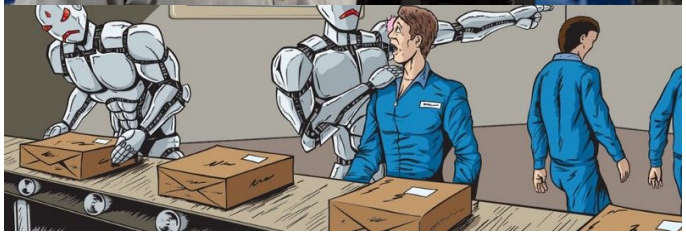
Grades 9-12:

- Demonstrate how sentence parsers handle ambiguity
- Explore the Google Knowledge Graph
- Identify and debate the issues of AI and consciousness

Big Idea #5: Societal Impact

“Artificial Intelligence can impact society in both positive and negative ways.”

- Ethics of AI making decisions about people
- AI & Culture
- Economic impact of AI



Big Idea #5 – What should students be able to do?

Grades K-2:

- Identify common AI applications encountered in their daily lives
- Discuss whether common uses of AI technology are a good or bad thing

Grades 3-5:

- Explore how behavior is influenced by bias and how it affects decision making
- Describe ways that AI systems can be designed for inclusivity

Grades 6-8:

- Explain potential sources of bias in AI decision making
- Understand tradeoffs in the design of AI systems and how decisions can have unintended consequences in the function of a system

Grades 9-12:

- Critically explore the positive and negative impacts of an AI system
- Design an AI system to address social issues (or explain how AI could be used to address a social issue)

Year 2 Goals

Year 2 Guidelines Work

September 2019 - January 2020

Finalize the development of the guidelines through:

- Refinement and alignment of the EKs (Essential Knowledge) and LOs (Learning Objectives) to the concepts
- Form a cohesive grade band progression

When needed to clarify content and scope we plan to augment this progression with

- Vocabulary
- Examples
- Resources
- Activities

Year 2: Guideline Refinement & Progression Chart Development

Weekly or Bi-Monthly

Steering Committee Weekly Meetings

- Review the Grade Band work & Provide Feedback
- Identify themes in concepts and sub-concepts from each grade band for each big idea
- Refine concepts and subconcepts to create consistency across grade bands
- Form a progression chart

Small Working Group Meetings

- **Review & Discuss** refined list of concepts and sub-concepts
- **Fill in the gaps** based on expectations from first pass
- **Scope** to grade band
- **Scope** for all students
- **Identify** activities, resources, connections

Cross-Grade band alignment

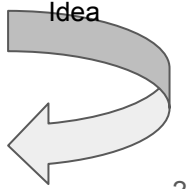
Individual Work

Read

- Scholarly Articles
- Explanatory Articles about AI Concepts
- Research & concepts, activities, and tools

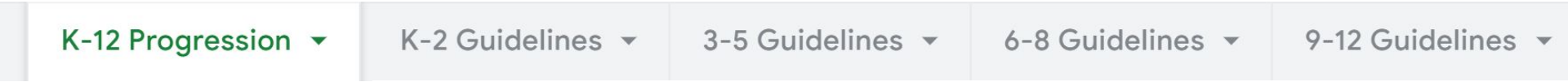
Face-to-Face Meetings

Repeat for each Big Idea



Template for Progression Chart - Big Idea Progression Chart

Navigating the Progression Charts Tabs



Overall Progression Chart Across grade bands

Each grade band tab highlights

- Enduring Understanding
- Learning Goals
- Filling in gaps in concepts/subconcept
- Filling gaps in the progression

Stretch Goal

Help others to understand the scope of what you expect students to understand

As you work note relevant

- activities and resources
- Cross-curricular connections
- standards

Principles for Refinement & Scoping Guidelines

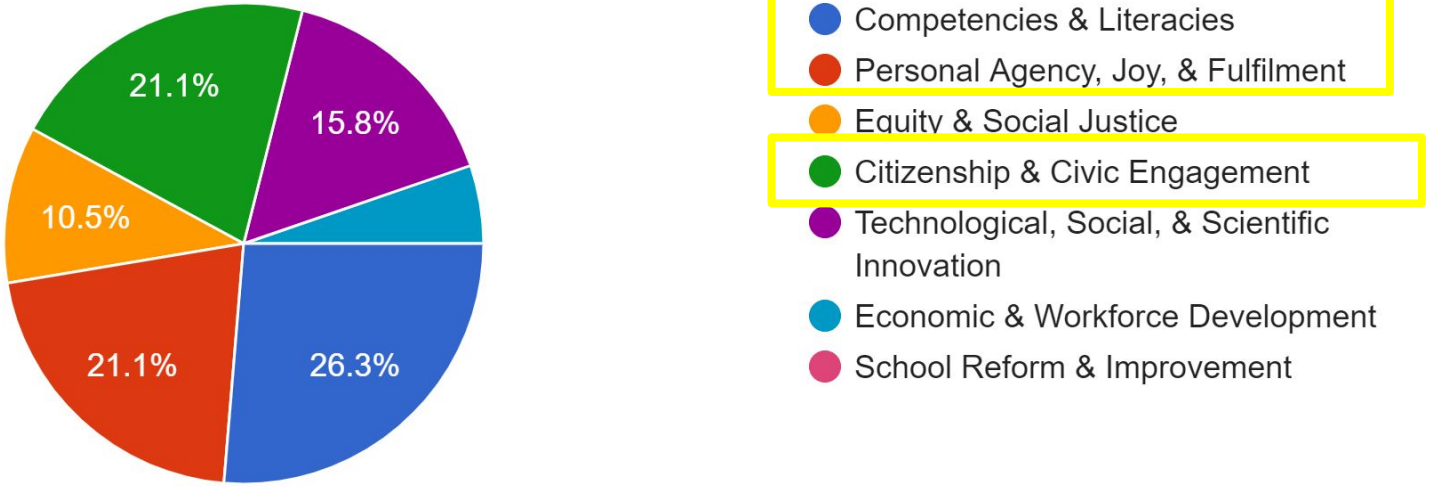
Guidelines need to have real-world relevance to students in that gradeband

1. E.g., guidelines would enable students to explain how a self-driving car works and the types AI systems or subsystems involved in decision making
2. E.g., guidelines would enable students to explain the process by which ML models are developed from data collection to types of training and sources of bias etc
3. E.g., guideline would equip students with the skills to use, modify, and create AI systems using developmentally appropriate tools
4. E.g., understand the implications of AI on ….

Snapshot:
AI For K-12 Working Group Perspective on the Guidelines

What is your primary reason for wanting K-12 students to learn about AI

19 responses



Timeline

Public Feedback

Feb 3 - First Published Draft of Guidelines

Feb 3 - March 15 - Public Feedback on the Guidelines

- CSTA Chapter Reviews
- Webinars
- Online Feedback
- Conferences

Conference Proposals Submitted

Feb 7- Feb 12 - AAAI Sessions *(pending)*
Mar 11-14 - SIGCSE Sessions *(pending)*

May 1-15 - Second Published Draft for Public Review
June 15 - Published Final AI for K-12 Guidelines

June 28 - July 1 - ISTE 2020 - Presenting the Final AI for K-12 Guidelines *(pending)*
July 11 - 15 - CSTA 2020 - Presenting the Final AI for K-12 Guidelines *(pending)*

2018 - 2019 Accomplishments Summary

Public Activities & Dissemination

#AI4K12

***AI for K-12 Breakfast* @ #csta2018**
sponsored by Carnegie Mellon AI and The Robotics Hub
July 2018

AI for K-12 Symposium
@AAAI Fall Symposium, Washington, DC
October 20, 2018

AAAI 2019 Conference (Hawaii)
AAAI Workshop K-12 Teacher Workshop (Sun)
EAAI Panel - Now
Senior Member - Blue Sky Talk (Wed. 3:30pm)
Envisioning AI for K-12: What should every child know about AI?

SIGCSE 2019
Special Session: AI For K-12 Initiative February 2019
Birds of a Feather: AI for K-12: Making Room for AI in the K-12 CS Curriculum

ASU GSV 2019 Panel: An AI Curriculum in the K12 Classroom -- Preparing Students for the Future. (San Diego, CA)

ISTE 2019 (June, Philadelphia)
K-12 Guidelines for Artificial Intelligence: What Students & Teachers Should Know

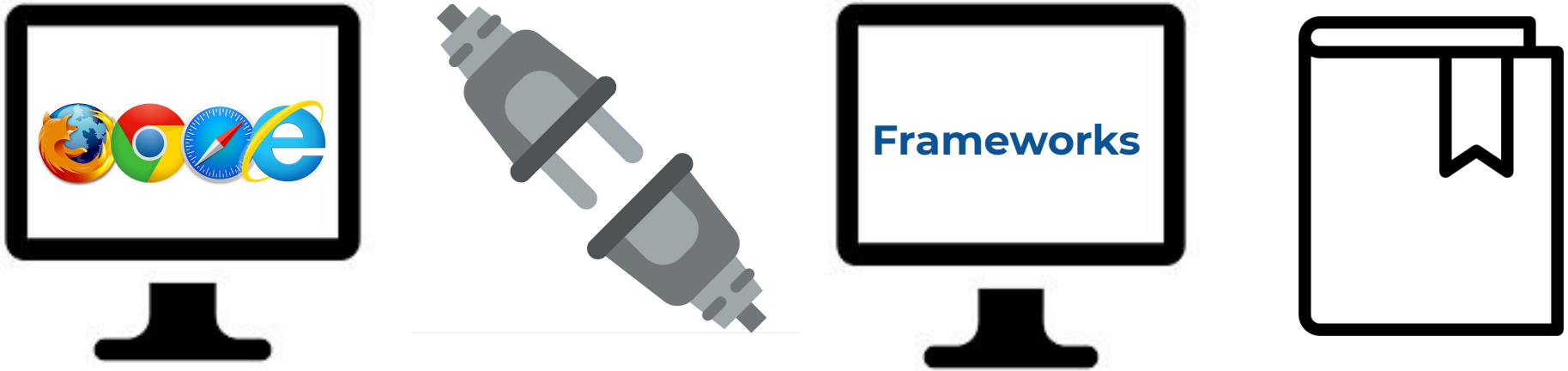
CSTA 2019 (July, Phoenix; two events)
Workshop: K-12 AI Playground
Special Session: How to teach AI across K-12

CSforALL 2019 Summit (Salt Lake City, Utah)
CS For All Webinar: "Incorporating AI in K-12 CS", webinar presented by CS For All, May 30, 2019,

AIAED 2019 "How Should K-12 Students Experience AI?" (Beijing, China), May 24-25, 2019.

CoSN 2019 - Envision 2030: Leadership for Learning."Preparing ALL Students for an Era of Continuous Digital Disruption" (Portland, OR.)

STARS 2019 Invited Talk K-12 AI Education and Outreach (San Diego, CA)



Curated Resource Library:
AI Tools & Resources for K-12

https://github.com/touretzkyds/ai4k12/wiki/Resource-Directory

Five Big Ideas in Artificial Intelligence

1. Perception

Computers perceive the world using sensors. Perception is the process of extracting meaning from sensory signals. Making computers "see" and "hear" well enough for practical use is one of the most significant achievements of AI to date.

2. Representation & Reasoning

Agents maintain representations of the world and use them for reasoning. Representation is one of the fundamental problems of intelligence, both natural and artificial. Computers construct representations using data structures, and these representations support reasoning algorithms that derive new information from what is already known. While AI agents can reason about very complex problems, they do not think the way a human does.

3. Learning

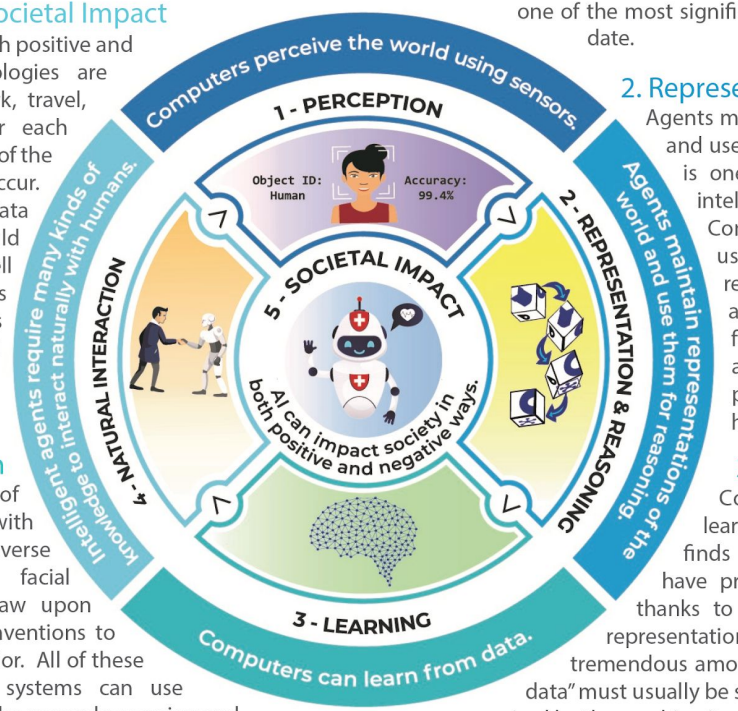
Computers can learn from data. Machine learning is a kind of statistical inference that finds patterns in data. Many areas of AI have progressed significantly in recent years thanks to learning algorithms that create new representations. For the approach to succeed, tremendous amounts of data are required. This "training data" must usually be supplied by people, but is sometimes acquired by the machine itself.

4. Natural Interaction

Intelligent agents require many kinds of knowlege to interact naturally with humans. Agents must be able to converse in human languages, recognize facial expressions and emotions, and draw upon knowledge of culture and social conventions to infer intentions from observed behavior. All of these are difficult problems. Today's AI systems can use language to a limited extent, but lack the general reasoning and conversational capabilities of even a child.

5. Societal Impact

AI can impact society in both positive and negative ways. AI technologies are changing the ways we work, travel, communicate, and care for each other. But we must be mindful of the harms that can potentially occur. For example, biases in the data used to train an AI system could lead to some people being less well served than others. Thus, it is important to discuss the impacts that AI is having on our society and develop criteria for the ethical design and deployment of AI-based systems.



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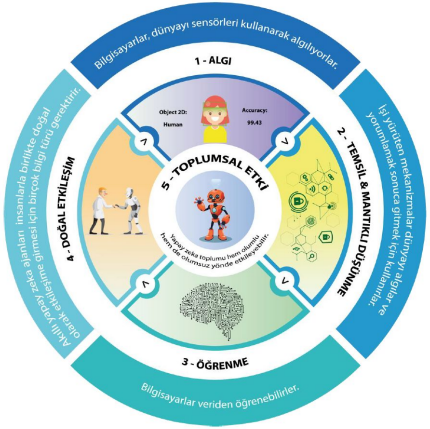
AI4K12.org

11x14 Poster available for free download at AI4K12.org

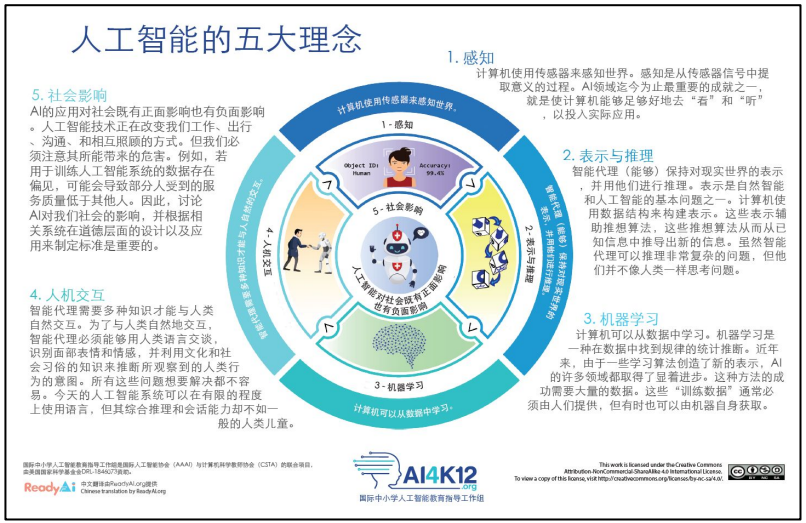
Adoption of the Big Ideas

- Now being adopted by curriculum developers in the US and elsewhere.
- Translations available in Chinese, Korean, and Turkish.

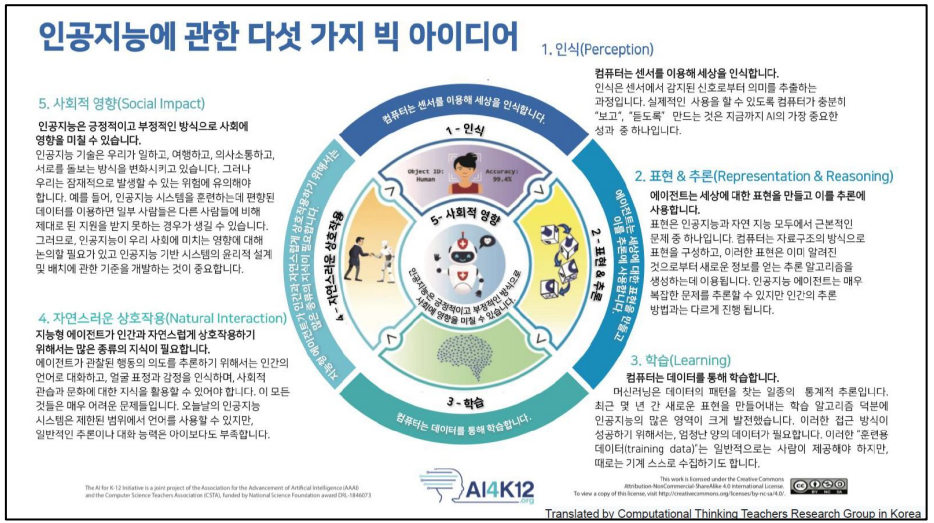
Turkish



Chinese



Korean



Grow the Community

Develop
Video, Web-based Demo,
& Tool frameworks

- **Your research**
- **Basic AI concepts**
- **How AI works** through the lens of everyday technologies

Develop for all grade bands: K-2, 3-5, 6-8, and 9-12 & work with teachers & students

Start thinking of
AI K-12 Demo ideas for
EAAI 2021

AI outreach in your local community

Align your curricula, PD, activities to the Five Big Ideas in AI

Feedback on guidelines

Join us in Sparking AI Curiosity

Visit us:

http://AI4K12.org

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https://aaai.org/Organization/mailing-lists.php