The CENTRE for EDUCATION in MATHEMATICS and COMPUTING

Contributions to Computer Science

A CS and Society resource addressing social and cultural issues within the realm of digital technology and computing

This resource will:

- highlight contributions and innovations made to computer science by a diverse selection of individuals, and
- invite you to think about what your impact in the field could be.

Who Do You Know?

Computer science has been shaped by brilliant individuals representing a wide range of genders, races, nationalities, and life experiences. The field continues to advance as people with different perspectives introduce fresh ideas and challenge existing ones. As a dynamic, collaborative discipline, computer science thrives when many voices come together. **Which of these innovators are familiar to you?**

Chieko Asakawa   **Window Snyder**   Emma Yang   **Lynn Conway**   MARK DEAN

Michael Running Wolf   Megan Smith   Ada Lovelace   Grace Hopper   Bill Cameron

Rumman Chowdhury   Shyra Barberstock   Mary Jackson   Alan Turing   JOY BUOLAMWINI

Ada Lovelace (1840s)

Ada Lovelace was a mathematician and a writer, widely celebrated as the world's first computer programmer. She created a detailed, step-by-step algorithm for a mechanical computer called the *Analytical Engine*, which would enable it to calculate Bernoulli numbers. Although the engine was never built due to high costs and a complex design, Lovelace's groundbreaking computer algorithm was rediscovered more than a century after her death. A true visionary, Lovelace understood the concept of a general-purpose computer long before such a machine ever physically existed.

VIDEO

I once said that mathematics requires intense imagination. Do you agree or disagree?

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Image from Computer History Museum

Alan Turing (1930s)

Alan Turing was a British mathematician and gay man who contributed many foundational ideas to the field of computer science, including:

| THE TURING MACHINE | THE HALTING PROBLEM | THE BOMBE MACHINE | THE TURING TEST |

VIDEO

Which of my contributions do you feel has shaped the future the most? In what ways?

Grace Hopper (1950s)

Grace Hopper was a computer scientist, mathematician, and Rear Admiral in the United States Navy. She worked on some of the earliest computers, including the *Harvard Mark I* and *UNIVAC I*. Through her experiences with these machines, she became a strong advocate for programming languages that were more accessible and user-friendly. Hopper believed that programmers should not have to talk like machines, insisting instead that computers should understand and adapt to human language. While many of her contemporaries were satisfied with the status quo, Hopper pushed boundaries and refused to accept inertia.

VIDEO

The most dangerous phrase is: "We've always done it this way."

Image from Wikipedia

Thinking Outside the Box

Grace Hopper had a clock that ran backwards hanging on the wall in her office. This counter-clockwise clock acted as a tangible reminder to always question convention and embrace change.

Presentation

In small groups, re-imagine an everyday object (or combine multiple objects into one) so that it works in a new or unconventional way.

- What inspired your design?
- What problems might your new design solve?
- What new problems might your design create?
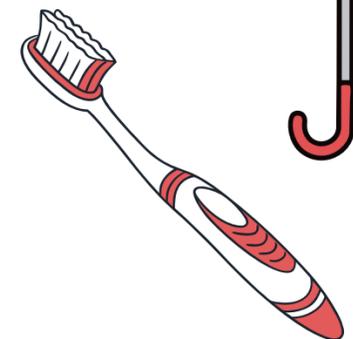
Mary Jackson (1960s)

Mary Jackson began her career at NASA's Langley Research Center as a "human computer" – a highly skilled mathematician who performed by hand complex calculations that were essential to the success of early space missions. She worked extensively with wind tunnel data, helping engineers better understand airflow and aircraft performance. She successfully petitioned for permission to take engineering classes at an all-white school, and became NASA's first Black female engineer. After working as an engineer for nearly 20 years, she made a powerful career shift into the equal opportunity field. Within this new role, she was able to influence and improve the hiring and promotion of women at NASA as well as shape a more inclusive future for the next generation of engineers.

The 2016 film, Hidden Figures, tells the story of my life and work at NASA.

Image from NASA

Lynn Conway (1970s)

Lynn Conway was a computer scientist, an electrical engineer, and a transgender rights activist whose work has fundamentally shaped modern technology. She co-invented the revolutionary VLSI (Very Large Scale Integration) chip design, alongside Carver Mead. This breakthrough methodology made microchips smaller, faster, and far more efficient, and laid the foundation for the electronics and computing devices we rely on today. Despite the transformative impact of her work, Conway's contributions were largely overlooked for many years, raising important questions about who receives recognition for major technological advances and why.

VIDEO

Why is it important that we revisit and correct historical narratives? What do we gain?

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Image from Wikipedia

Bill Cameron (1980s)

Bill Cameron, a Canadian inventor and engineer, founded the *Neil Squire Society* after a car accident left his cousin, Neil Squire, paralyzed from the neck down and unable to speak. Determined to restore his cousin's ability to communicate, Cameron developed a "sip-and-puff" system that converted sips and puffs of air through a straw into Morse code, which was then translated into text on a computer screen. Building on this success, the Neil Squire Society has since created a wide range of adaptive devices and software programs to help people with physical disabilities access computers and live more independently.

VIDEO

What challenges have you seen or experienced that technology could help with?

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Image from Neil Squire Society
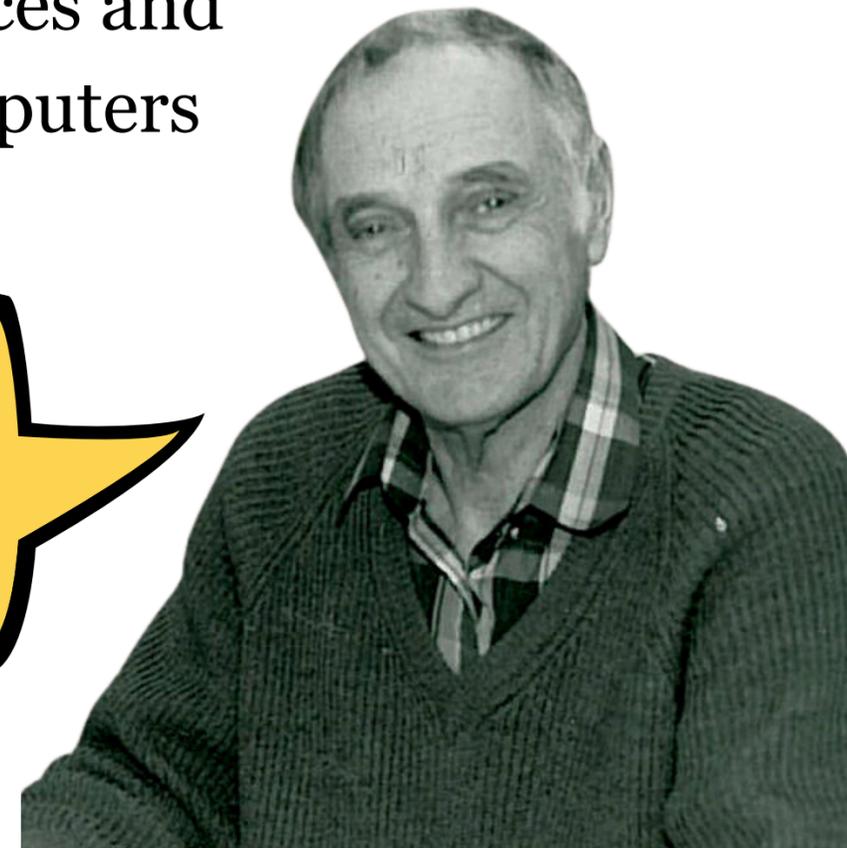
Mark Dean (1980s)

Having a computer at home is commonplace today, and Mark Dean deserves credit for this. An American inventor and engineer, Dean helped make computers more accessible to the general public. He co-created the ISA (Industry Standard Architecture) bus, which made it possible to connect peripheral devices such as printers, keyboards, and monitors to a computer's motherboard. Adding new hardware previously required specialized knowledge, but with the ISA bus, individuals could simply plug them in. Dean also helped develop the colour graphics adaptor which meant displays no longer needed to be monochrome, increasing the appeal of personal computers. In 1995, he was named an IBM Fellow, the first African-American to receive this prestigious honour.

Create a list of all the things you can do with a home or personal computer.

Image from Vanguard News
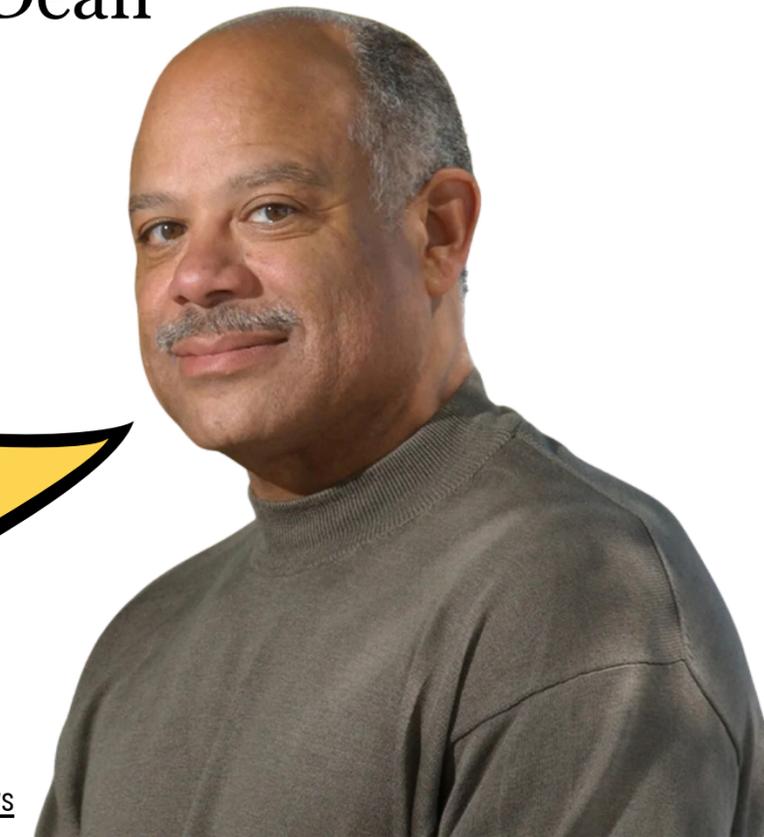
Chieko Asakawa (1990s)

Chieko Asakawa is a Japanese computer scientist who changed how people with no or low vision use technology. After losing her eyesight, she was inspired to create tools that made computers and the internet more accessible. In the 1990s, while working at IBM, she led the development of one of the first practical screen readers for the web. She invented *Home Page Reader* – a software program which turned website text into spoken audio so people could "listen" to the internet and independently navigate online content. She also developed tools that let web designers experience websites the way a blind person would, helping them create more accessible designs.

VIDEO

Invention always starts from our daily needs.

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Accessibility for Everyone

In her TED Talk, Asakawa explains that designing with accessibility in mind makes products and systems that work better for everyone, not just for people with disabilities.

What accessible designs have you benefitted from? Share your experiences using the following poll.

POLL

Window Snyder (2000s)

Window Snyder developed an early interest in hacking, which led her to wonder what was protecting her data from other hackers. She became fascinated with how to defend digital systems. This curiosity drove her to work at Microsoft, where she pushed for security measures to be built into the design process from the very beginning, not added as an afterthought. Throughout her career, Snyder has been known for promoting encryption by default, advancing threat modelling practices, and fostering collaboration between tech companies and outside researchers to uncover and fix vulnerabilities. In 2020, Snyder founded *Thistle Technologies*, a startup focused on securing smart devices commonly found in homes, such as thermostats and internet connected appliances.

What smart devices are in your home? What security risks might they have?

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Image from Dark Reading

Megan Smith (2000s)

Megan Smith is the former Chief Executive Officer (CEO) of *PlanetOut*, an online media company which served the 2SLGBTQ+ community. She later joined Google as a Vice President, where she led major projects including the acquisitions of Google Earth, Google Maps, and Picasa, helping to shape some of the company's most widely used technologies. In 2014, she was appointed United States Chief Technology Officer (CTO) by President Barack Obama, becoming the first woman to hold this position. During her time as U.S. CTO, Smith co-created the *Image of STEM* campaign, an initiative highlighting the achievements of women and minorities in science, technology, engineering, and mathematics, challenging long-standing stereotypes and correcting misconceptions.

What is your image of STEM and those who work in STEM fields?

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Image from Wikipedia

Emma Yang (2010s)

Emma Yang is an innovator best known for leveraging technology to solve real-world problems. As a young teenager, Yang created *Timeless**, a mobile app designed to help people living with Alzheimer's or dementia stay connected with loved ones and remember important information. The app gained widespread attention for its thoughtful design and meaningful social impact. Since then, Yang has continued to inspire others through speaking engagements, mentorship programs, and community outreach, highlighting the power of technology, coding, and app development to improve people's lives.

VIDEO

* Emma Yang chose to retire her app when she started college.

Solve the problems you see around you. Solve the problems that matter to you.

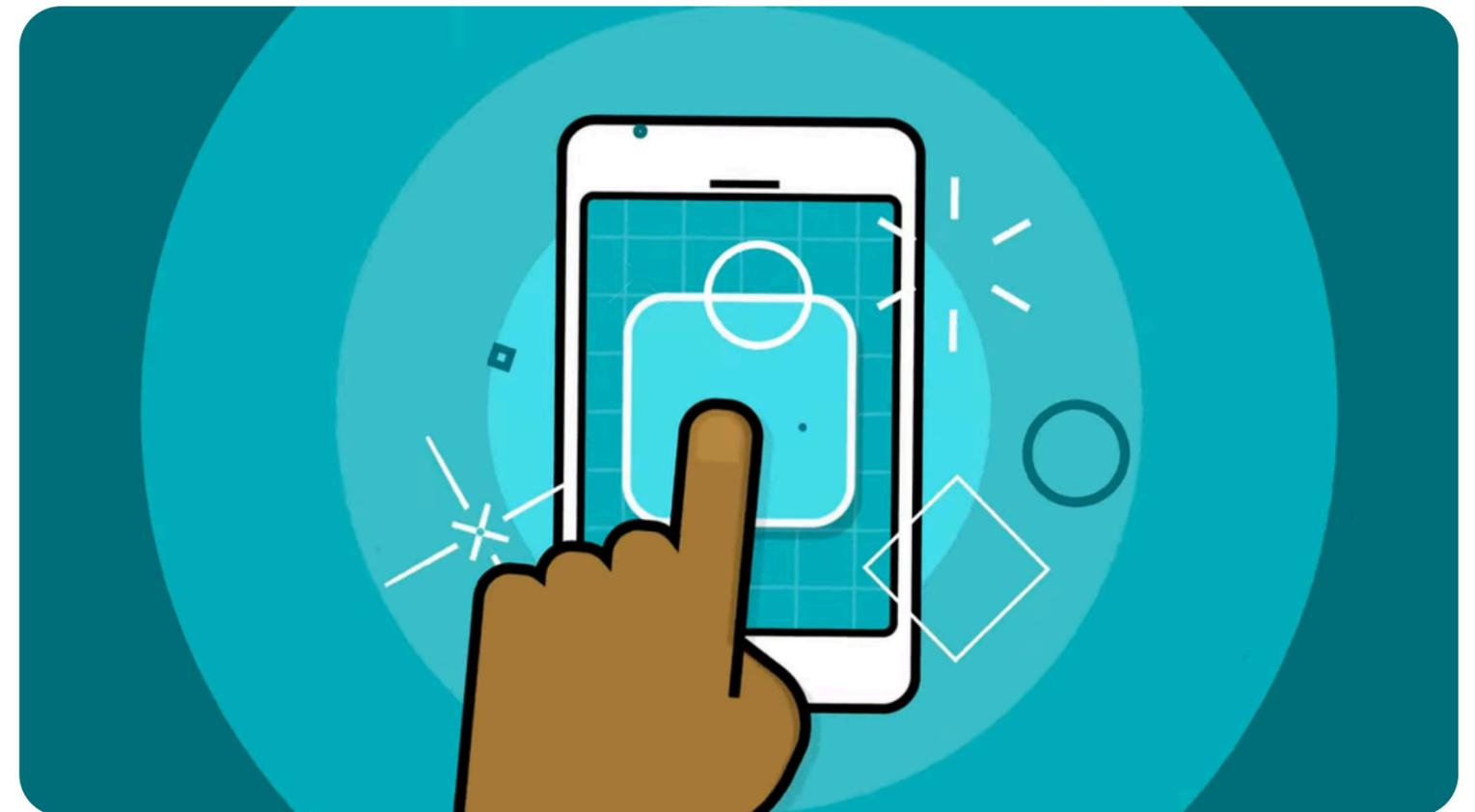Image from Global Student Prize

Intro to App Lab

Discover how you can build your own apps, just like Emma Yang did, using *App Lab*. App Lab is a programming environment designed to make simple apps using Javascript.

Features:

✓ Rapid Prototyping

✓ Blocks to Text

✓ Instantly Interactive

✓ Databases Made Easy

✓ Shareable

APP LAB

Shyra Barberstock (2010s)

Shyra Barberstock is a Canadian Anishinaabe entrepreneur and community leader. Adopted and raised by a non-Indigenous family, she did not learn of her Indigenous ancestry until she met her birth mother later in life. This discovery inspired her to seek deeper cultural roots. Alongside her partner, she co-founded the *Okwaho Network* – a social networking platform designed to connect, promote, and amplify Indigenous individuals and businesses worldwide. Barberstock has also co-founded *Kebaonish Inc.*, an Indigenous-and-woman-led social enterprise in the tea and coffee industry. Her work is focused on Indigenous economic empowerment and strengthening communities that have historically been underrepresented in online spaces.
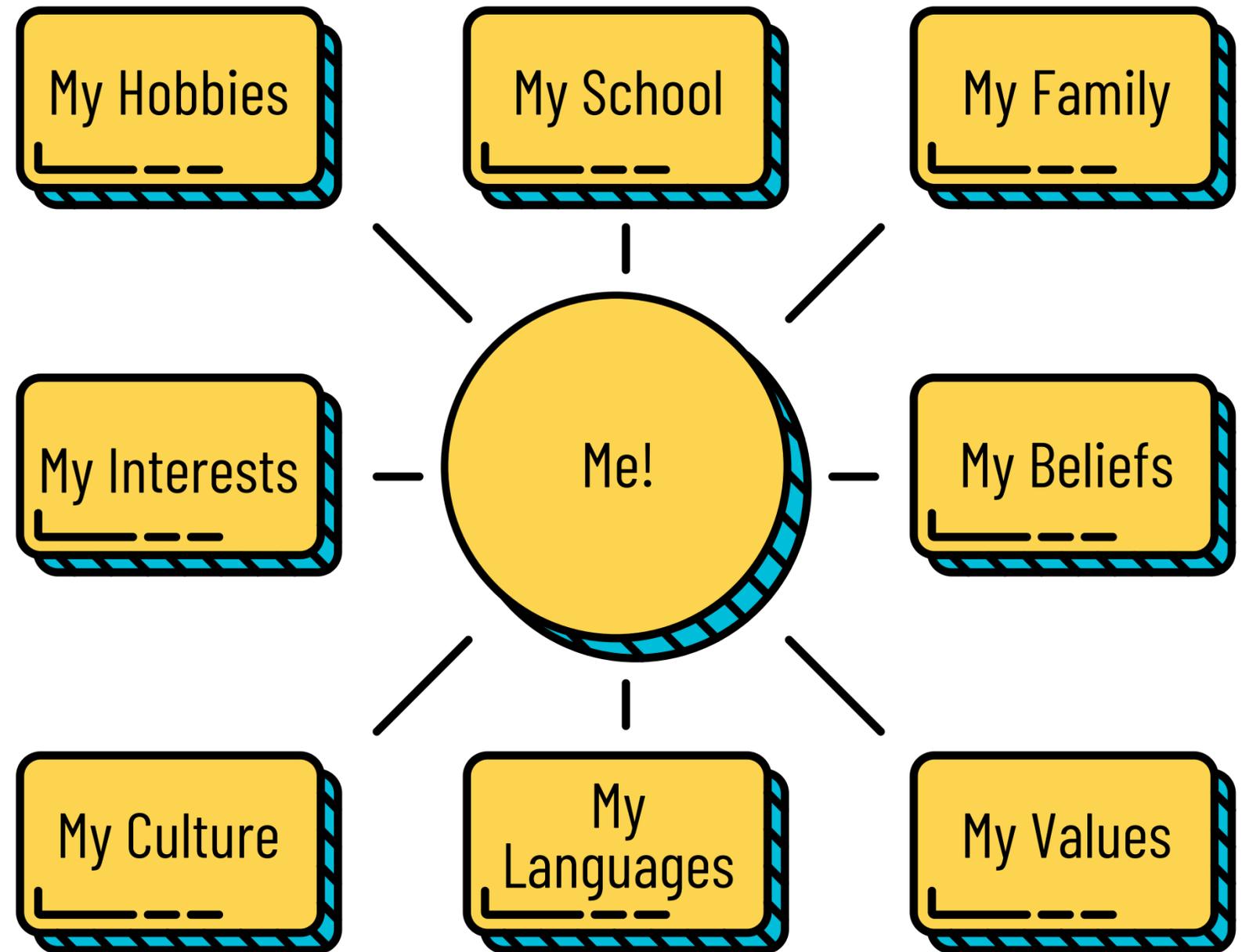
Why do online spaces matter to communities?

Image from Kebaonish

Connecting Identities

Shyra Barberstock understood the importance of having ways for Indigenous people to connect over their shared identity.

In the *Connecting Identities* activity found under <u>additional materials</u>, create a poster that illustrates parts of your identity and the ways that you can connect online with other similar individuals.

My Hobbies

My School

My Family

My Interests

Me!

My Beliefs

My Culture

My Languages

My Values

Rumman Chowdhury (2010s)

Rumman Chowdhury is a data scientist and leading AI ethicist. She developed the *Fairness Tool,* a framework that uses statistical methods to detect and measure bias in artificial intelligence systems as well as suggest ways to reduce or prevent it. Biased AI algorithms can reinforce existing inequalities by producing unfair or harmful outcomes. Chowdhury's work stands out because it combines computer science, mathematics, and the social sciences, allowing her to examine not only how AI systems function technically, but also how they impact real people and communities. Her contributions help make AI systems more ethical, transparent, trustworthy, and fair for society.

VIDEO

How might AI systems become biased in the first place?

Image from CSEdWeek

Joy Buolamwini (2010s)

Joy Buolamwini is a Canadian-American computer scientist and digital activist whose work has helped expose bias in facial recognition systems. While working on an art project, she discovered that commercially available AI tools could not detect her face unless she wore a white mask. This inspired her *Gender Shades* study, which found that facial analysis systems had an error rate of less than 1% on light-skinned males, but a rate of over 30% for dark-skinned females. In 2016, Buolamwini founded the *Algorithmic Justice League*, an organization whose mission is to fight against harmful and discriminatory applications of artificial intelligence.

VIDEO

If you could redesign one piece of technology to make it more fair, what would it be? Explain.

Image from MIT Technology Review

Michael Running Wolf (2020s)

Many Indigenous languages are in danger of disappearing as the number of fluent speakers declines. Michael Running Wolf, a Northern Cheyenne software engineer and AI researcher, uses his technical expertise to help preserve and revive these languages. He works on improving Indigenous Automatic Speech Recognition (ASR), a technology that can understand, transcribe, and process spoken language. By improving ASR tools for Indigenous languages, Running Wolf helps communities record, teach, and share their languages with younger generations. He not only works to support language revitalization, but he ensures communities maintain ownership and control over their own linguistic data.

VIDEO

If we don't build our own systems, we'll always be subject to someone else's.

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Image from Indigenous AI

Common Voice

Automatic Speech Recognition (ASR) does not work well on voices and languages that it does not have experience with. Most dataset sound bites come from English speaking, adult, white, male speakers, resulting in voice recognition devices that don't work for large portions of the world's population.

Common Voice is an initiative to teach machines how all people speak. Its goal is to create a high quality, diverse, and publicly open dataset.

Consider supporting the mission by donating your unique voice!

COMMON VOICE
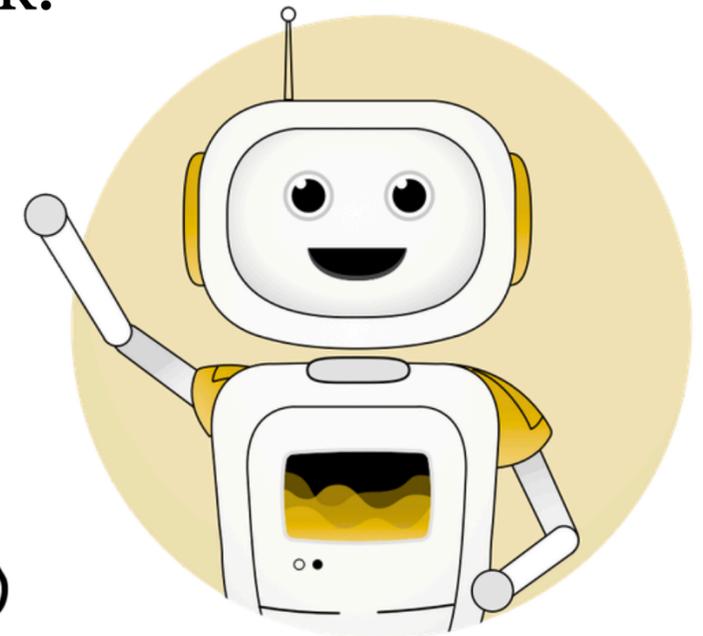
Your Name

*Design a slide that highlights **you** and the ways that you can have an impact in computer science and society.*

Will you design a new app? Build a key piece of hardware? Conduct important research? Dream big!

A question for future generations to think about.

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More Diverse Contributors

- John von Neumann (1940s)
- Mary Golda Ross (1950s)
- Christopher Strachey (1950s)
- James C. Marsters (1960s)
- Sister Mary Kenneth Keller (1960s)
- Katherine Johnson (1960s)
- Evelyn Boyd Granville (1960s)
- Edith Windsor (1960s)
- Elayne Arrington (1960s)
- Sophie Wilson (1980s)
- Etta Zuber Falconer (1980s)

- Radia Perlman (1980s)
- Shafi Goldwasser (1980s)
- Tracy Monteith (2000s)
- Audrey Tang (2000s)
- Corey Ashley (2010s)
- Josiah Hester (2010s)
- Parisa Tabriz (2010s)
- Mikaela Jade (2010s)
- Jason Edward Lewis (2010s)
- Irma Olguin Jr. (2010s)
- Soledad Antelada Toledano (2010s)

- Nina da Hora (2010s)
- Jon Corbett (2010s)
- Timnit Gebru (2010s)
- Marissa Spang (2020s)
- Christine M'Lot (2020s)
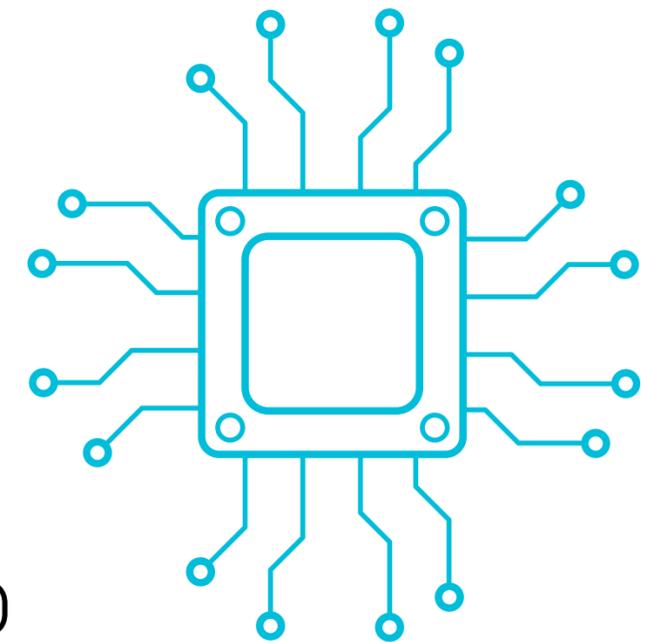
Additional Materials

Connecting Identities

Add your name to the centre circle. Fill the surrounding boxes with parts of your identity, and online spaces where you can connect with others who also share these attributes.
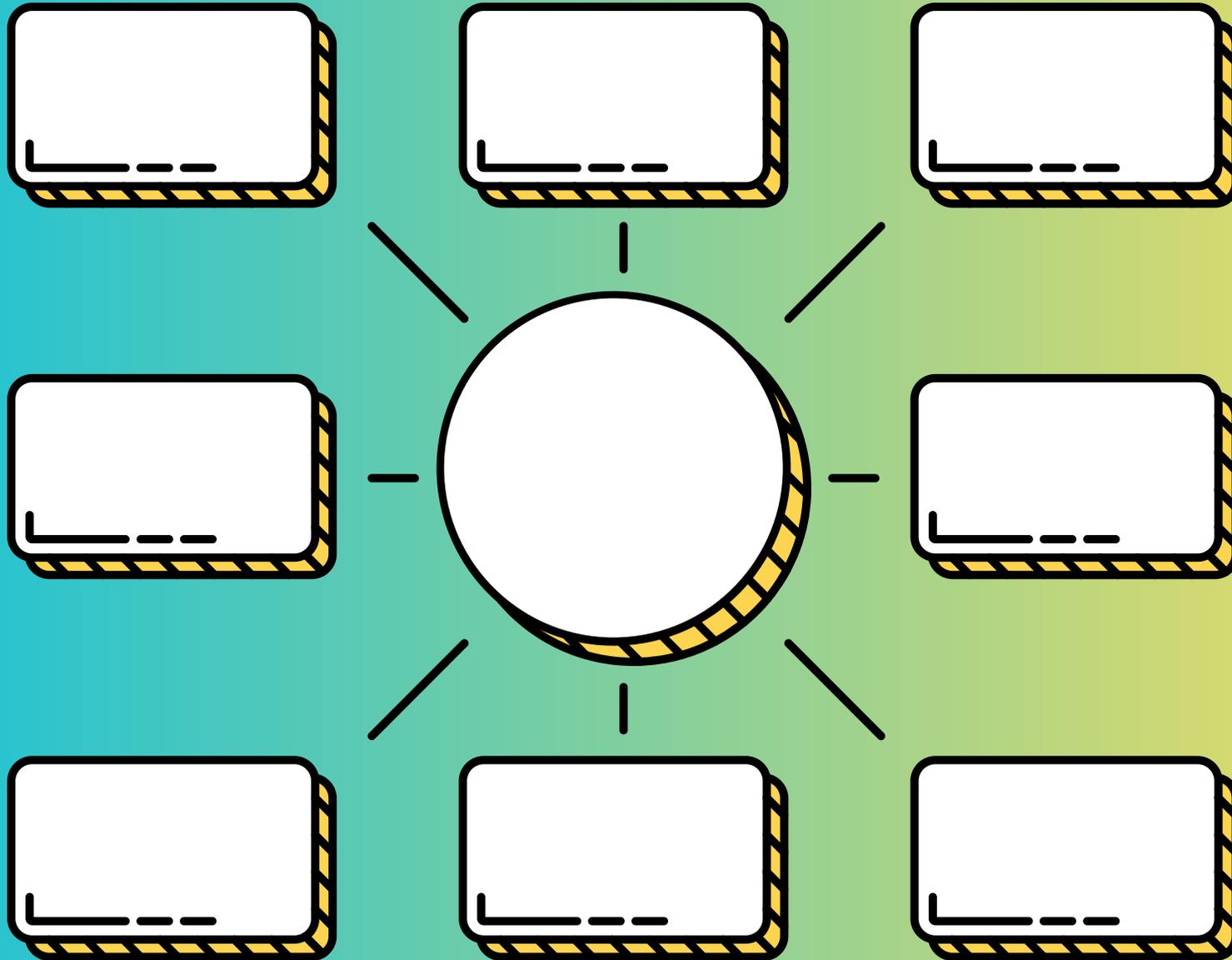
Connecting Identities - Example

Add your name to the centre circle. Fill the surrounding boxes with parts of your identity, and online spaces where you can connect with others who also share these attributes.

Book Lover
🔗 Goodreads
_ __ __ __

Coder
🔗 Scratch
_ __ __ __

Filipino
🔗 Rappler
_ __ __ __

Guitarist
🔗 Ultimate Guitar
_ __ __ __

Morgan Ramos

Roman Catholic
🔗 Catholic Answers
_ __ __ __

Vegan
🔗 Vegan Society
_ __ __ __

Animal Lover
🔗 Yummypets
_ __ __ __

Hiker
🔗 Hiking Herd
_ __ __ __

Activity to accompany slide: _Connecting Identities_