

Katherine Stanton's Spring 2024
Final Exam Portfolio

Artificial Intelligence

History

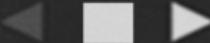
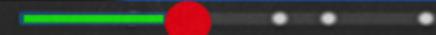
ITAI 1370

Module 01: Introduction to A.I.- Course Setup

1. **Teamwork**- My team (Algorithm Architects) started off the semester strong with weekly meetings and consistent communication, my role initially was the meeting planner and team motivator.

2. **Assignment**- The first week's assignment was insightful towards how other members of my team think (when deciding on a team photo some others opted to use an A.I. image generator as opposed to a real photo of the 7 of us, which was not something that had occurred to me.)

3. **Reading takeaways**- The Six Key Elements of Responsible A.I. Networks
The Trinity of A.I.: Algorithms, Compute, Data
The Three Basic Types of A.I.: Artificial Narrow Intelligence (ANI), Artificial General Intelligence (AGI), Artificial Super Intelligence (ASI).
Definitions of basic concepts in A.I., including Algorithms, Machine Learning, CPUs, GPUs and Neural Networks.



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Online

Module 1 continued...

The screenshot shows a video player interface. At the top, it says "TRINITY OF EXPLAINABLE AI" and "Calibrated, Verifiable, and User-friendly AI". Below this is a diagram consisting of three ovals connected by arrows. The top oval is labeled "Verification of interpretable Tests". The bottom-left oval is labeled "Calibration of Uncertainty". The bottom-right oval is labeled "User-Friendly Interface". Arrows point from "Calibration of Uncertainty" to "Verification of interpretable Tests" and from "Calibration of Uncertainty" to "User-Friendly Interface". The video player has a progress bar at the bottom left showing "1:13 / 31:15". On the right side of the video frame, there is a small video window showing a person's face. The video player interface includes standard controls like play/pause, volume, and a Caltech logo.

Trinity of Explainable AI: Calibrated, Verifiable, and User friendly AI - Anima Anandkumar



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11



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Clip

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Online - LIVE

Calibrated,
Verifiable, and
User-friendly A.I.

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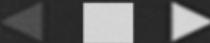
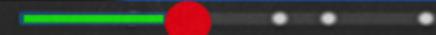
Dr. Animashree Anandkumar's
Trinity of Explainable A.I.

04:00

Module 02: Introduction to A.I.- The Big Issues

1. **Teamwork:** I scheduled our weekly meeting and most of us contributed to the assignment.
2. **Assignment:** Both subjects were interesting, reading about the origin story of Google and looking up A.I. patents issued. It was eye-opening to realize how many patents have been issued in the past 5 years alone.
3. **Reading takeaways:** The integral role Alan Turing played in the early days of Computer Science as well as less familiar names to me; Cantor, Hilbert, Post, Gödel, and Von Neumann. The Turing Test and Turing Nets. That Eliza, the chatbot, was created in 1964. Control Theory and Cybernetics.

©



Module 02 Continued...

the IBM 701, IBM's first stored-program computer.⁶⁶ In 1955 Samuel added learning to the program.

The Bombe

The Bombe is the first milestone in the history of machine intelligence. Central to the Bombe was the idea of solving a problem by means of a guided mechanical search through the space of possible solutions. In this instance, the space of possible solutions consisted of configurations of the Enigma machine (in another case it might consist of configurations of a chess board). The Bombe's search could be guided in various ways; one involved what Turing called the 'multiple encipherment condition' associated with a crib (described in Chapter 6 of Turing's *Treatise on the Enigma*, written in the second half of 1940; this chapter is in *The Essential Turing* and the entire *Treatise* is available online in *The Turing Archive for the History of Computing* <http://www.AlanTuring.net/profs_book>). A search guided in this fashion, Turing said, would 'reduce the possible positions to a number which can be tested by hand methods'.⁶⁷ A crib is a word or phrase that the cryptanalyst believes might be part of the German message. For example, it might be conjectured that a certain message contains 'WETTER FUR DIE NACHT' (weather for the night). Many Enigma networks were good sources of cribs, thanks both to the stereotyped nature of German military messages and to lapses of cipher security. One station sent exactly the same message ('beacons lit as ordered') each evening for a period of several months.⁶⁸

Modern AI researchers speak of the method of *generate-and-test*. Potential solutions to a given problem are generated by means of a guided search. These potential solutions are then tested by an auxiliary method to find out if any is actually a solution. Nowadays in AI both processes, generate and test, are typically carried out by the same program. The Bombe mechanized the first process. The testing of the potential solutions (the 'stops') was then carried out manually—by setting up a replica Enigma accordingly, typing in the cipher text, and seeing whether or not German words emerged.

Machine intelligence 1945-1948

In designing the ACE, machine intelligence was not far from Turing's thoughts—he described himself as building 'a brain'⁶⁹ and declared 'In working on the ACE I am more interested in the possibility of producing models of the action of the brain than in the practical applications to computing'.⁷⁰ On page 16 of '**Proposed Electronic Calculator**' he said:



Arthur Samuel, creator of the first AI program to run in the United States²⁹



Working in a Bombe room at Outstation Bombe were received from Eastcote, Bletchley Park by teleprinter.³⁰



Module 03: Games, Prelude to A.I.

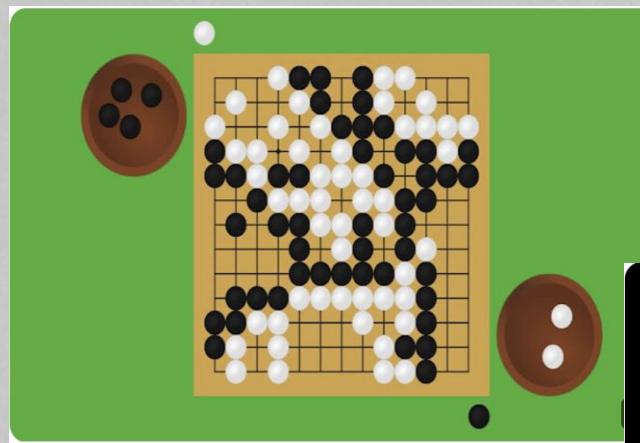
1. **Teamwork:** My entire team worked together to create our video presentation, we tried to split each part of the script into 7 equal sections.
2. **Assignment:** Learning what AlphaStar can't do was much more challenging than learning what it can do! As someone who does not come from a gaming background, it was a lot of fun learning about Google DeepMind and StarCraft II as a cultural phenomena.
3. **Reading takeaways:** Decision theory, Heuristics, Game Theory, and the Markou Decision Process (MDP). All of the projects behind Google DeepMind, including AlphaGo, AlphaZero, and AlphaStar. The Turing Machine and Automata Theory. Noam Chomsky's theories on language and the Chomsky Hierarchy.

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Module 03 Continued...



Go - Basic Rules

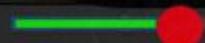
1.7M views • 6 years ago



Udacity

A brief intro to the rules of Go. To learn more about Go please check out these other Udacity video...

4:09 ... rules the flow of the play capturing eternity Rule and scoring make up the game of Go ho...



Online - LIVE

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2500-year-old Chinese board game “Go”, subject of documentary AlphaGo

04:00

Module 04: Games Change Everything

1. **Teamwork:** My entire team contributed, and we split our script into 7 parts for our video presentation.
2. **Assignment:** Learning about raytracing, a graphics-rendering technology I was not familiar with. Very interesting to learn about the ways raytracing aids in creating a photo realistic image incorporating refraction, reflection, shadows, soft shadows, and shading as well as the history of rasterization.
3. **Reading takeaways:** The earliest computer game was Nimatron released in 1940. The different types of Virtual Reality (VR) including, augmented reality, mixed reality, and extended reality (XR). The many ways VR has been utilized in modern applications including the Tesla Suit and Occipital 3-D iOS.

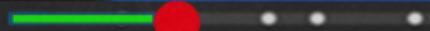
Module 04 Continued...



Neuralink's first recipient of brain implant, Noland Arbaugh; who is quadriplegic, playing Mario Kart against his father.

Module 05: Machine Learning- The Data

1. **Teamwork:** Most of my team contributed, we stopped having weekly meetings due to too many scheduling conflicts. There was some initial confusion about the differences between GPT-3 and ChatGPT where some thought it was the same thing, but we managed to correct the errors.
2. **Assignment:** Learning about the transformer model GPT-3 released in 2020 by OpenAI. Learning about all of the applications of GPT-3 including ChatGPT, DALL-E 3, Sierra, and Sora.
3. **Reading takeaways:** The importance of having good data when it comes to Machine Learning. The process of Machine Learning; a.) Collect the Data b.) Clean and label the data c.) Build a model of what you want the system to learn d.) Train the model e.) Test the model f.) Fix the model g.) Retest h.) Run your ML system based on goals and parameters you have set. ImageNet. The categories of ML: Supervised learning, Unsupervised learning, Reinforcement learning, and Deep learning. As well as Neural Networks and the procedure for training them.



Module 05 Continued...

What is ML?

Machine learning (ML) is a branch of [artificial intelligence \(AI\)](#) and computer science that focuses on the using data and algorithms to enable AI to imitate the way that humans learn, gradually improving its accuracy.

How does machine learning work?

[UC Berkeley](#) (link resides outside ibm.com) breaks out the learning system of a machine learning algorithm into three main parts.

1. A Decision Process: In general, machine learning algorithms are used to make a prediction or classification. Based on some input data, which can be labeled or unlabeled, your algorithm will produce an estimate about a pattern in the data.
2. An Error Function: An error function evaluates the prediction of the model. If there are known examples, an error function can make a comparison to assess the accuracy of the model.
3. A Model Optimization Process: If the model can fit better to the data points in the training set, then weights are adjusted to reduce the discrepancy between the known example and the model estimate. The algorithm will repeat this iterative “evaluate and optimize” process, updating weights autonomously until a threshold of accuracy has been met.

Module 06: Machine Learning- The Pipeline

1. **Teamwork:** Half of my team members contributed this week; I recall we were all trying to better adhere to APA style formatting from here on out.
2. **Assignment:** Learning about the text-to-text transformer “T-5” and its differences from GPT-3 (which we had learned about the week prior,) which included a smaller data set and using both encoder and decoder blocks.
3. **Reading takeaways:** The intersections of Business Intelligence (B.I.) and A.I. Use data from a data warehouse (D.W.) or from a data mart. Era of Big Data includes Volume (amount of data,) Variety (number of types of data,) Velocity (speed of data processing,) and Veracity (data uncertainty.) Big Data and the use of Knowledge Graphs and the Semantic Web.



Module 6 Continued...

KNOWLEDGE GRAPH

OTTAWA → CAPITAL → CANADA

PARIS → CAPITAL → FRANCE

CITY OF → ROMAN EMPIRE

IBM Cloud

build different data sources

IBM Subscribe

What is a Knowledge Graph?

IBM Technology 736K subscribers

Subscribe

1.8K

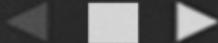
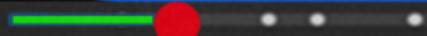
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Module 07: Deep Learning-Neural Networks

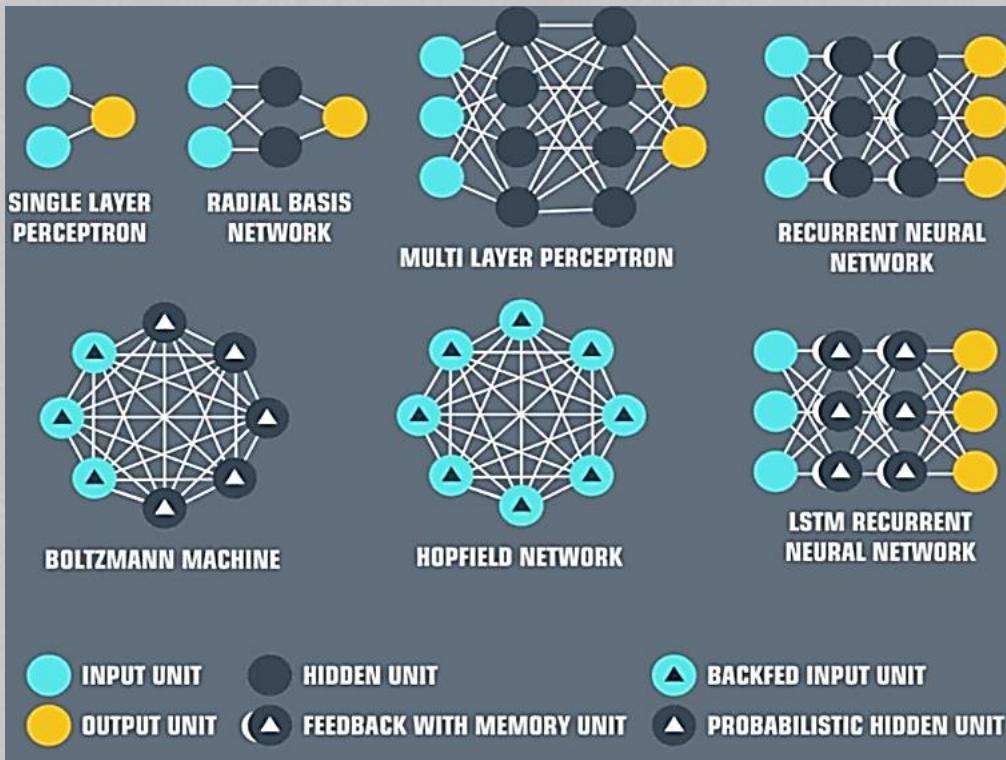
1. **Teamwork:** Only myself and another teammate worked on this week's assignment; this is when participation started to fall off.
2. **Assignment:** Playing and tweaking with the settings of TensorFlow's neural network playground. I previously remembered learning about the input, hidden, and output layers of neural networks and enjoyed the visual representation (colors/ patterns) of the data sets.
3. **Reading takeaways:** Deep Learning (D.L.) is a subset of Machine Learning where Neural Networks learn from large amounts of data. N.N.s are comprised of an Input Layer, Hidden Layers, and Output Layer. "Deep" refers to having more than one hidden layer in the Neural Network. The more layers the more the N.N. learns. Unsupervised Learning is defined as data sets with no specified structure. Weights between neurons equals the importance of the input value, which are incrementally adjusted using Gradient Descent to reduce cost function.



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Module 07 Continued...



Module 08: Deep Learning- Real Learning Good Analytics

1. **Teamwork:** No teamwork this assignment, I did everything myself including filming the timelapse video, uploading it to YouTube and writing a small excerpt about what I learned.
2. **Assignment:** I already knew how to film a timelapse video prior to this week but did not know the specifics on how to best capture it like having either a still background or foreground. It was also interesting to learn that the longer you film the final video will still be around the same length but compressed and faster.
3. **Reading takeaways:** “Big Data is data that is difficult or impossible to manage with traditional software tools and tech.” Also, that “demand for data analytics in real time has led to the creation of Big Data analytics.”



Module 08 continued...

But with the tsunami of AI and GenAI initiatives in the last 18 months or so, the need for huge volumes of data has become paramount. AI systems and the large language models that power them need lots of data for training and operations and that's fueling demand for platforms and tools to collect and manage all that data.

Collecting, managing, preparing, analyzing and sharing data has become a humongous task, however. The volume of data created, captured, copied and stored is projected to reach 175 zettabytes by 2025, according to an International Data Corp. "Datasphere" forecast, or exceed 180 zettabytes by that year, according to researcher Statista.com.

Adding to the data management challenge is the fact that an increasing amount of data – structured, semi-structured and unstructured – is often dispersed across many locations in multiple cloud and on-premises systems.

Not surprisingly, as businesses and organizations wrestle with big data challenges, demand for big data products will soar. Market researcher MarketsandMarkets is forecasting that spending for big data tools, software and systems will grow at a CAGR of 12.7 percent from \$220.2 billion last year to \$401.2 billion in 2028.

This [article](#) by Rick Whiting for CRN, highlights the vast number of companies and their contributions to the field of Big Data analytics. I found it eye-opening and informative to the sheer number of companies involved today and helpful to become familiarized with the big names.

Module 09: Computer Vision- Image Processing

1. **Teamwork:** A couple of my teammates worked to complete this assignment, I was unable to contribute as the game required a Windows OS and I work on a Mac.
2. **Assignment:** I learned through my team that TrackMania is another game that users have incorporated the use of A.I. to beat previously held records within the game, not dissimilar to AlphaStar.
3. **Reading takeaways:** Computer Vision began in the late 1960's and is meant to mimic the human visual system. Includes object detection, panoramas, pattern recognition, thermal imaging and many more which can be used in various professional fields including the medical field.

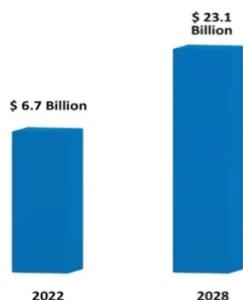
Module 09 continued...

The AI camera market is a part of the camera industry that incorporates artificial intelligence (AI) technologies into imaging devices. These advanced cameras use algorithms and computational power to improve various aspects of photography and videography, providing users with better functionalities, performance, and user experiences. The AI camera market includes various types of imaging devices such as smartphones, digital cameras, action cameras, drones, surveillance cameras, and automotive cameras. This market is fueled by advancements in AI technology, increasing demand for intelligent imaging solutions, and the growing prevalence of applications that require sophisticated image processing capabilities.

According to the report by BCC Research, **the global AI camera market** is projected to reach \$23.1 billion by 2028, growing at a CAGR of 23.8% from 2023 through 2028. The growth can be credited to the growing consumer inclination toward technologically advanced devices based on the latest technologies such as Artificial Intelligence (AI) and Machine Learning (ML). As a result, AI-based cameras are gaining massive traction not only across photography and videography domains but across several other verticals, such as government and law enforcement, consumer electronics, sports, agriculture, automotive, healthcare, manufacturing, etc. The increasing product demand in various industries is driving the expansion of the market.

A Feb. 2024 BBC research [blog](#) by Amrita Kumari explaining recent developments in A.I. cameras as well as the big names involved in producing them. Very informative and succinct.

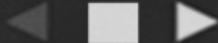
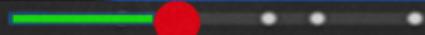
Global AI Camera Market
Market forecast to grow at a CAGR of 23.8%



BCC Research

Module 10: Computer Vision- Image Understanding

1. **Teamwork:** About half of my team contributed to this assignment.
2. **Assignment:** For this assignment I learned about all the intricacies that go into the Image Understanding Process. Learning about the applications of this technology beyond just autonomous vehicles but also in medical settings like MONAI's ability to create synthetic images of the human body.
3. **Reading takeaways:** Image Understanding steps are a.) Image Acquisition b.) Image preprocessing and manipulation c.) Image segmentation d.) Image representation and description e.) Image understanding f.) Result (output.) Visual odometry is the process of determining the position and orientation of a robot by analyzing the associated camera images. The importance of sensors, which collect and measure information.



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Online

Module 10 continued...

How computers learn to recognize objects instantly

Joseph Redmon

1.1M views • 6 years ago



TED



Online - LIVE

Joseph Redmon
describes in his TED
Talk his work with
YOLO

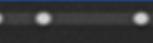
21 of 70

Shows examples of using
both object detection
and image classification 04:00

Module 11: Natural Language Processing- Basics

1. **Teamwork:** Half of my team worked together to complete this assignment.
2. **Assignment:** For the assignment, I read John Ball's paper on Patom Theory but found it easier to understand after finding his videos on YouTube breaking his theory down into simpler concepts. Though it seems complicated and abstract to a beginner, the intersections of neuroscience and A.I. are fascinating.
3. **Reading takeaways:** Natural Language Processing is the ability of a computer program to understand human language as it is spoken and understood. Applied to Machine Translation, Blocking Spam, Detecting Emotion, Information Extraction, Question Answering and Chatbots.

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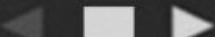
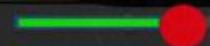
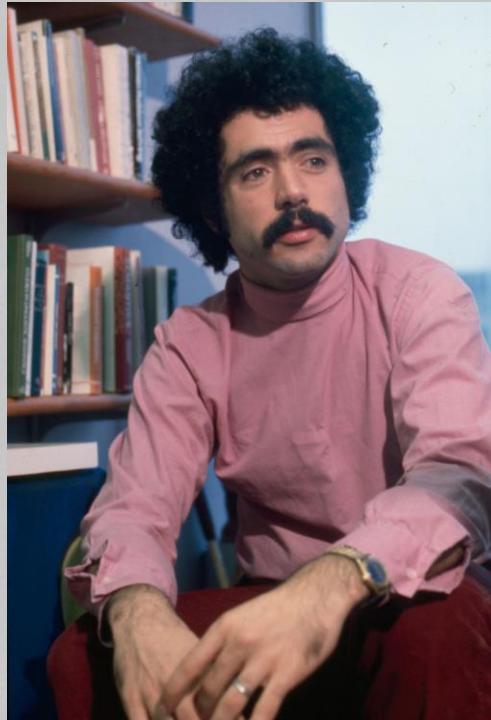


Module 11 Continued...

Puzzle of the day answered:

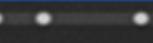
SHRDLU is a program for understanding natural language, written by Terry Winograd at the M.I.T. Artificial Intelligence Laboratory in 1968-70. SHRDLU carried on a simple dialog (via teletype) with a user, about a small world of objects (the BLOCKS world) shown on an early display screen (DEC-340 attached to a PDP-6 computer).

Winograd describes the origins behind the name; “the arrangement of the keys on Linotype typesetting machines was not QWERTY, but frequency arranged columns: ETAOIN was the first column (reading downward), SHRDLU the second.”



Module 12: Natural Language Processing- Speech Does It All

1. **Teamwork:** Myself and one other teammate worked on this assignment, no one else contributed.
2. **Assignment:** I learned about the vast number of apps that use this technology (animating facial features), though it was harder to find one that would allow us to both upload our own audio and to just use an image of a mouth without a whole face accompanying it. The app Chatter Pix worked for this assignment, but it seemed more rudimentary compared to how Yakit was described in the initial assignment's description.
3. **Reading takeaways:** Google's three projects BERT, Elmo, and Big Bird. BERT stands for Bidirectional Encoder Representations from transformers. Word Embedding- text converted into numbers. Modern applications include Apple Home Kit, Advanced Driver Assistance (ADAS,) Siri, Alexa, and Nvidia's Misty.



©



Module 12 continued...



Online - LIVE

Amazon's chatbot
Rufus was unveiled in
Feb. 2024.

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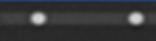
Marketed as, “a new,
generative, AI-powered,
conversational shopping
experience.

04:00

Module 13: Robotics- Grand Tour

1. **Teamwork:** Half of my team worked on this final assignment.
2. **Assignment:** We found a couple different models of micro-robots, the Everest S Servo Drive and TowerPro SG90 Micro specifically. It was interesting to learn about the various applications they're used for, especially robots used for precision surgery.
3. **Reading takeaways:** Early history includes Joseph Engelberger starting the first robotics company called Unimation in the 1950's. In 1961 the first robot, Unimate, was deployed at a GM Assembly plant. Today robots are in many fields especially industries like manufacturing and agriculture. Both Autonomous Vehicles and 3-d printers are robots. NASA and Boston Dynamics are big names in the robotics field.

©



Module 13 Continued...

Puzzle of the Day answered:

The world's smallest motorcycle is called "Small Toe" built by Tom Wiberg in 2003.



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Online - LIVE

[Wiberg's Youtube video](#)
displaying how one
rides Small Toe.

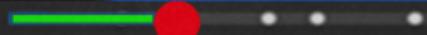
04:00

Module 14: Robotics- Hard and Soft Issues

1. Teamwork: N/A

2. Assignment: N/A

3. **Reading takeaways:** Smart cities, where everything (communication, public services, like police and EMS etc.) are interconnected. “The Edge- highly distributed processes across many multiples of smart, powerful devices right where the action is taking place (like factory floors, in the car, mid process, etc.)” Soft robots can fluidic soft robots, The Right Trousers, while hard robots can range in size from nano to large enough to build a house (3-d printed homes.) “Embedded systems- require less power, low cost, task specific, time specific, minimal user interface, highly stable, high reliability, and high efficiency from the Apollo Guidance Computer to HVAC systems.



Module 14 continued...



MORPHING MATTER LAB



The team designed a wood-based biodegradable seed carrier that mimics seeds of *Erodium*, a genus of plants with seeds that unwind coiled tails to act as a drill to plant into the ground. The seed carrier has three coiled tails attached that unwind when moistened and can carry seeds as large as those of whitebark pine trees, which are about 11 mm long and weigh about 72 mg. Increasing the number of unwinding tails ensures the drill bit is better angled to the surface for burrowing. The seed carriers had an 80% success rate of getting seeds into the ground on flat land, reducing the risk of them blowing away or being eaten by animals. Under the same terrain conditions, the natural *Erodium* seed's success rate was 0%. The carriers could also be used to deploy fertilizers or other materials (such as sensors) that could be beneficial for agricultural and conservation applications, the authors conclude.

Online - LIVE

Team at Morphing
Matter Labs created
the E-SEED

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It's a self-seeding carrier
that could help with "post-
fire reforestation or wildland
restoration"

04:00