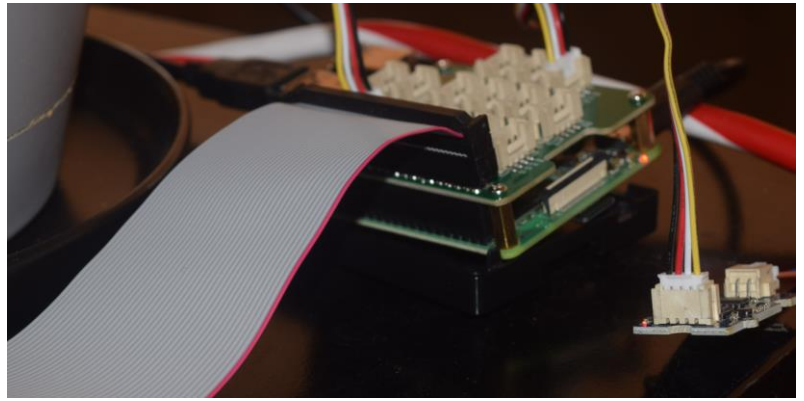
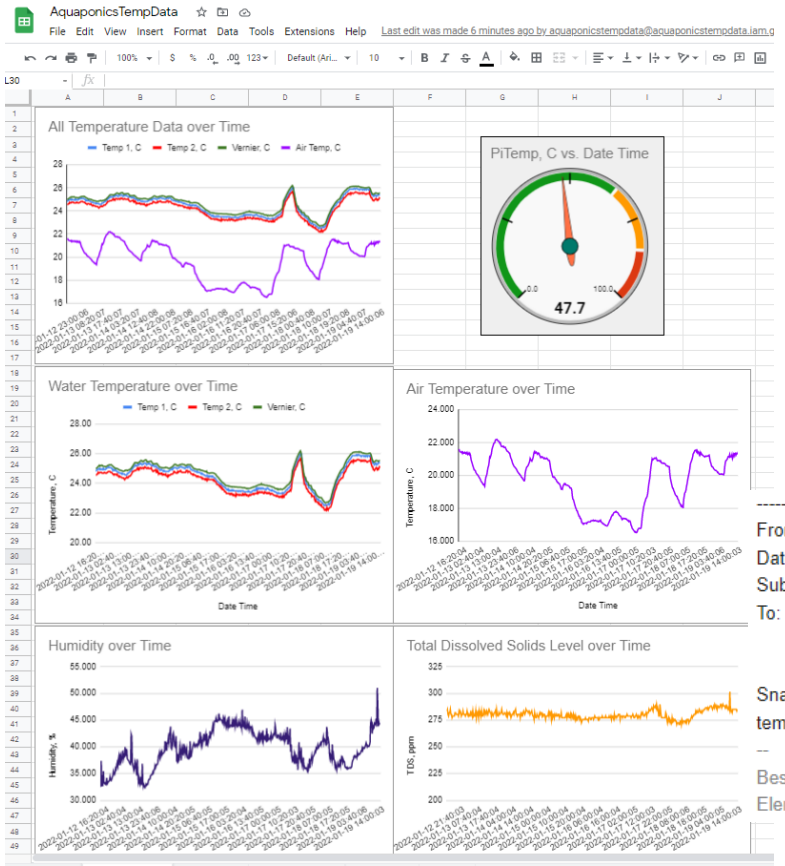
Introduction to IOST
Internet of Science Things



Spring 2022: Chem 4399/5399

Dr. Robert E. Belford



---------- Forwarded message ---------
From: **UALR Aquaponics Pi** <myfoxpi@gmail.com>
Date: Mon, Jan 17, 2022 at 2:40 PM
Subject: [Warning] Water temperature is out of range!
To: <evlisitsyna@ualr.edu>

Snails need your help! Recommended water temperature for Mystery Snails is between 21C and 26C. Current water temperature readings are 25.875(temp1), 25.562(temp2) and 26.135(Vernier) degrees Celsius.

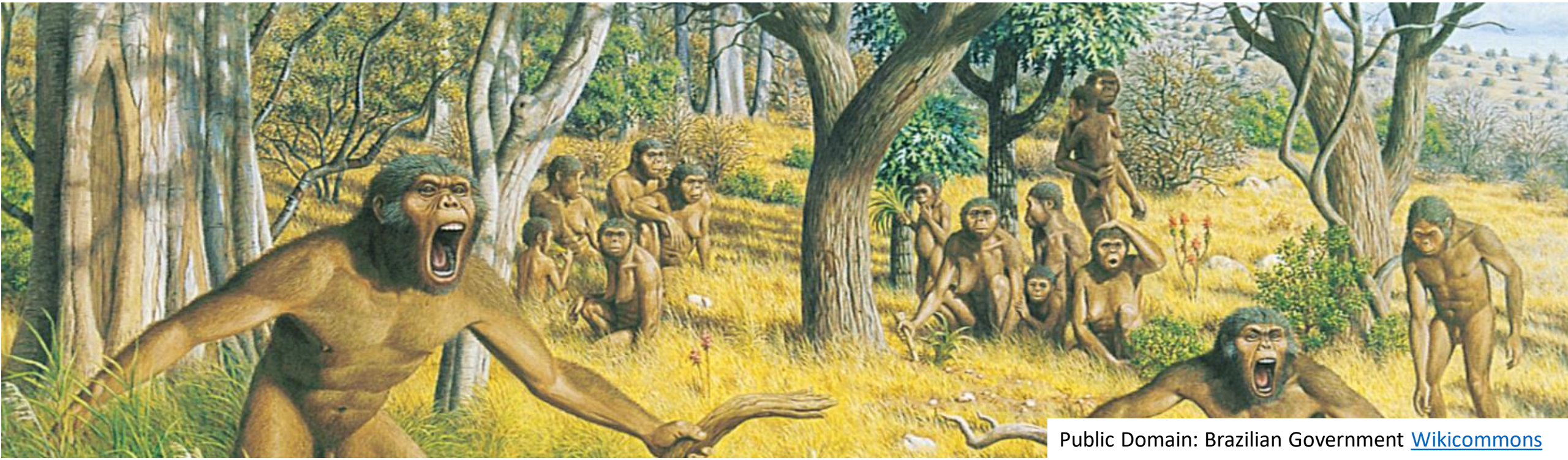
--

Best Regards,
Elena Lisitsyna

What is the Internet of Science Things?

- The Internet is an **ICT**
  - **I**nformation and **C**ommunication **T**echnology
- Science
  - A Philosophy of Knowledge
- IOT: (Internet of Things)
  - The Interconnected Digital Networking of Things
- IOST (Internet of Science Things)
  - Application of IOT Technologies to the Practice of the Philosophy of Science.

Pre-Technology Communication
Primal Howls and Gestures



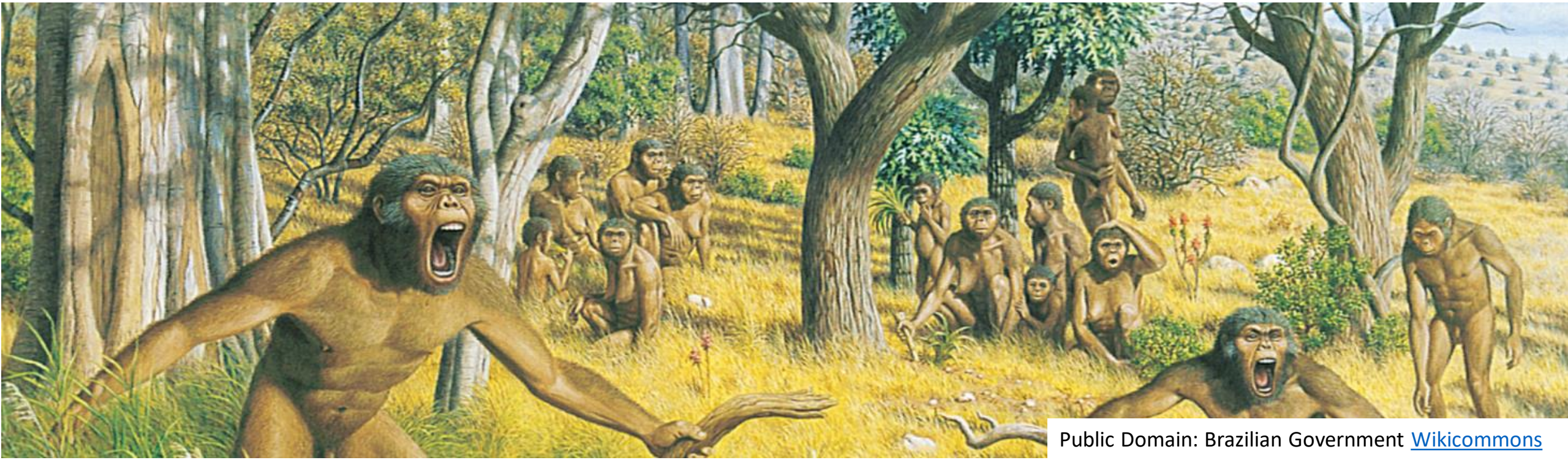
Public Domain: Brazilian Government Wikicommons

(Entity Based)
(Lions, Tigers and Bears)

(Action Based)
(Run, Hide and Fight)

Combined Entity and Action Based
(Climb up Tree)

Howls and Gestures are Ephemeral



Public Domain: Brazilian Government Wikicommons

(Entity Based)
(Lions, Tigers and Bears)

(Action Based)
(Run, Hide and Fight)

Combined Entity and Action Based
(Climb up Tree)

Early ICTs Enable Communication Beyond the Present

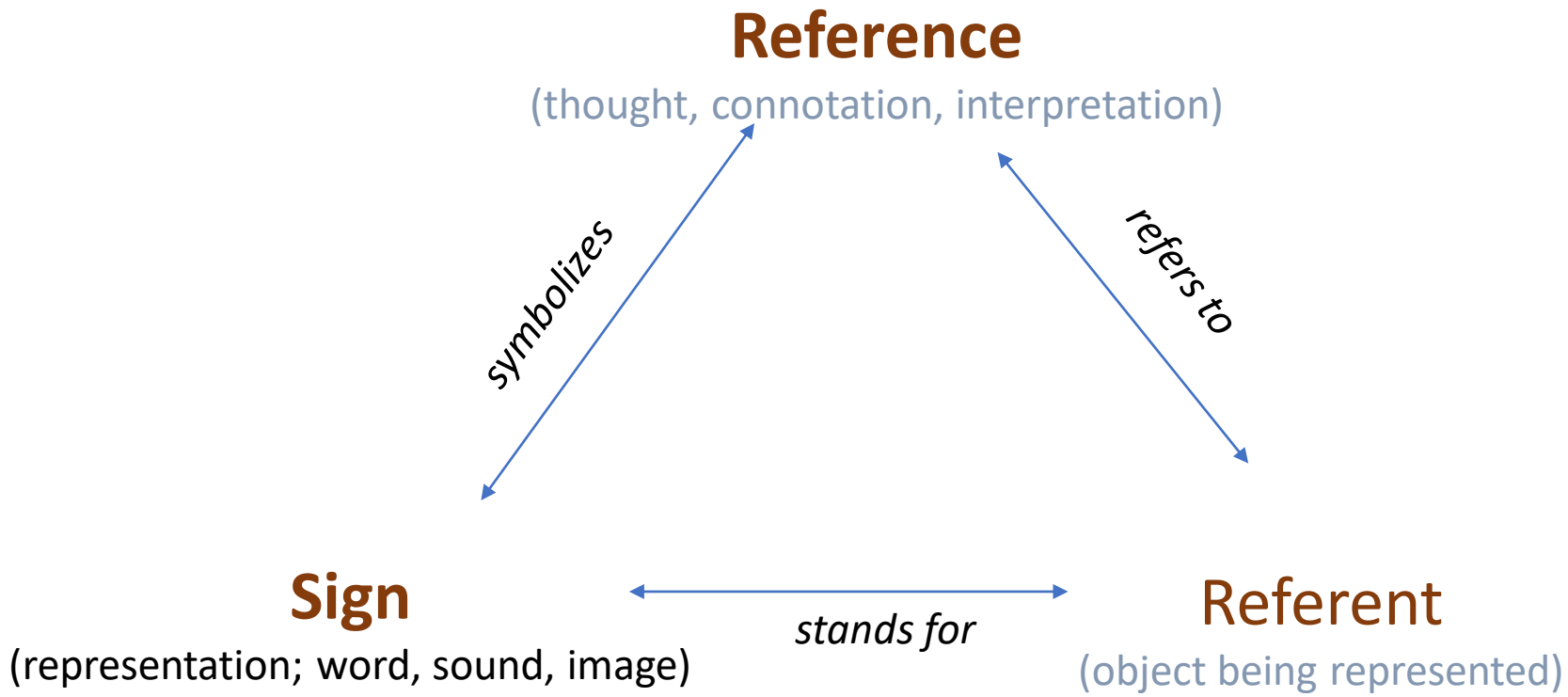
Public Domain: "NK" Wikicommons

What is the story of this post-paleolithic cave drawing from the Magura cave in Bulgaria?

(ICT "Tools" were Used in its Generation)

Semiotics

Semiotics: Study of Signs, Symbols, their Interpretation and Communication



- symbols
- icons
- indices

Semiotic (Semantic) Triangle

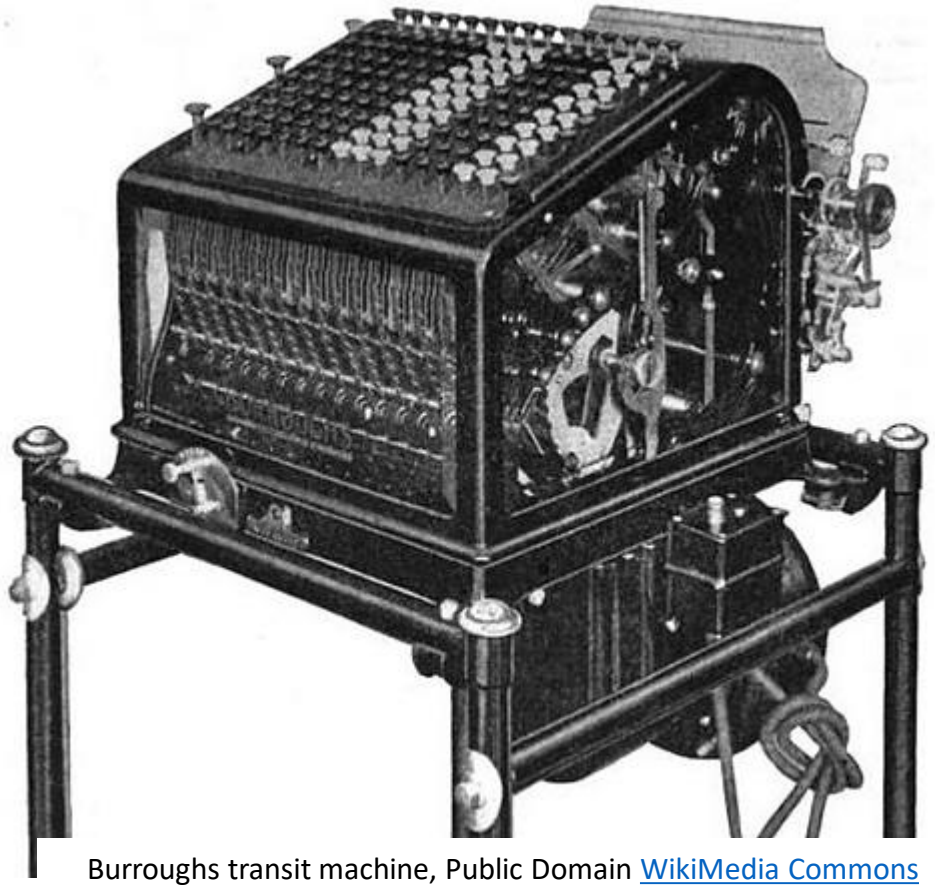
Beyond the Ephemeral: Written Words

Early writing was often developed to track agricultural productivity and commerce

Two types of words

- entities & actions
- numbers (amenable to arithmetic operations)

Printed Words: Mechanical Devices

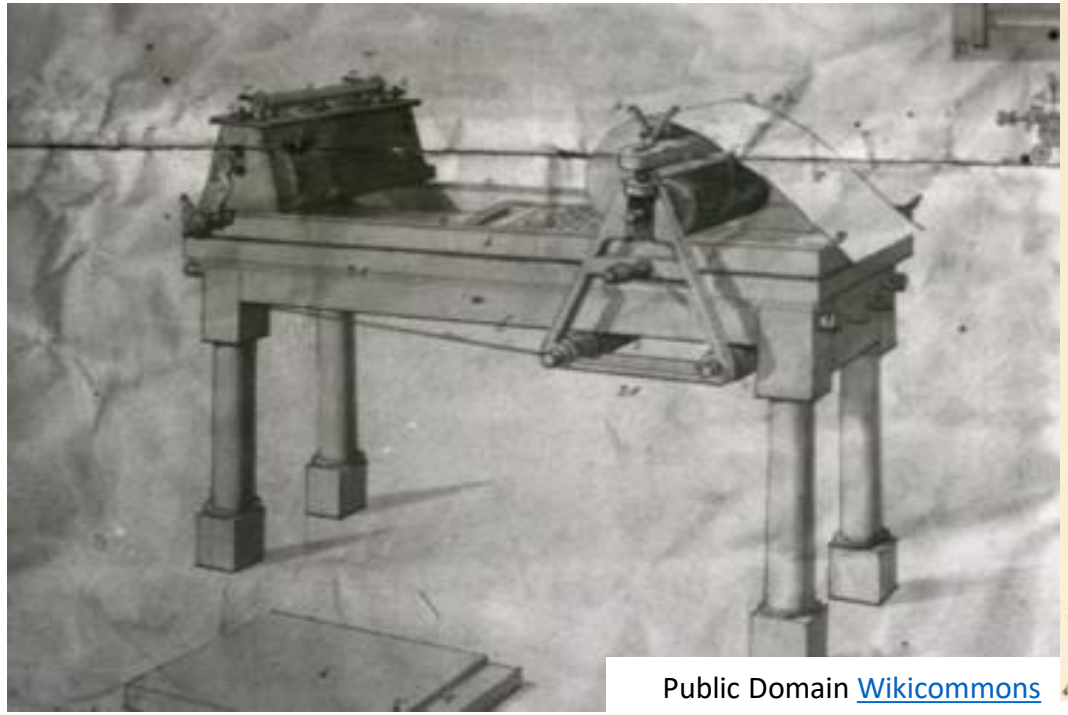


Burroughs transit machine, Public Domain WikiMedia Commons

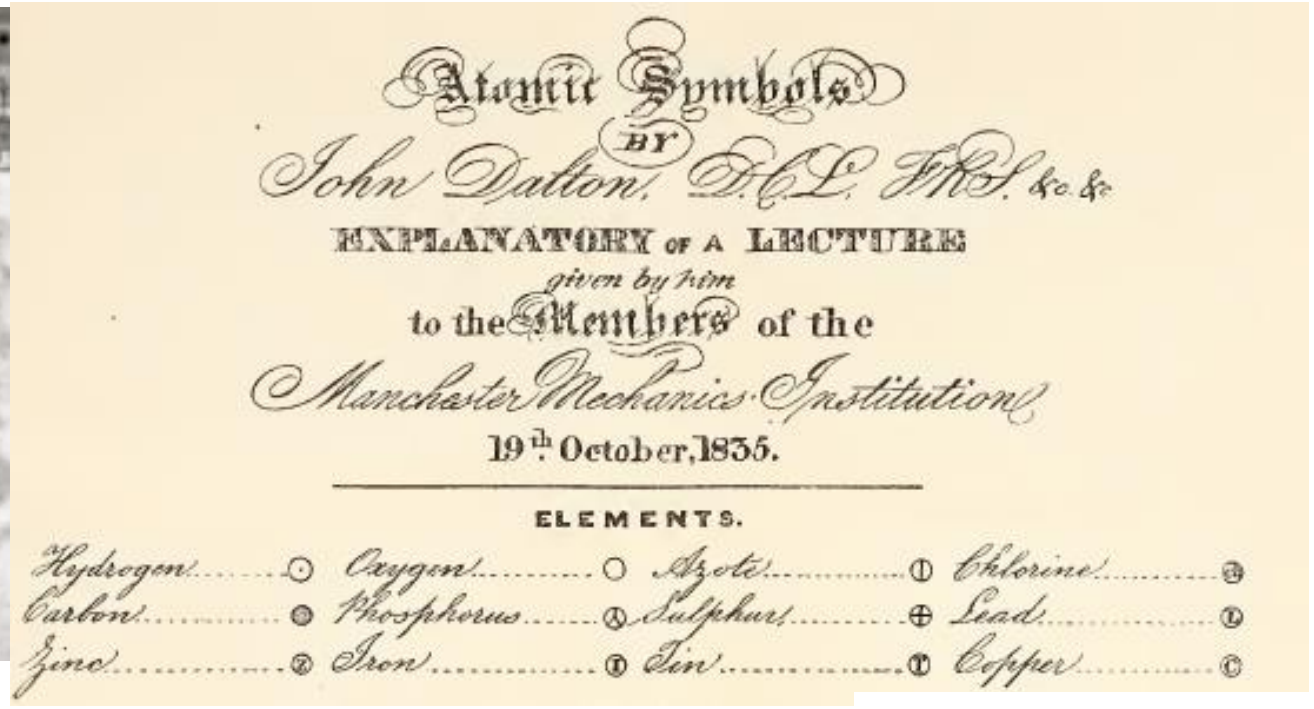
Royal Typewritter, Public Domain: Wikimedia Commons

Mechanical Devices Evolved to Print and Perform Computations

Printed Words: Gutenberg Era ICTS



Public Domain Wikicommons



Atomic Symbols

BY

John Dalton, D.C.L. F.R.S. &c. &c.

EXPLANATORY OF A LECTURE

given by him

to the Members of the

Manchester Mechanics Institution

19th October, 1835.

ELEMENTS.

Hydrogen ⊙	Oxygen ○	Azote ◑	Chlorine ⑤
Carbon ●	Phosphorus ⊗	Sulphur ⊕	Lead ⑫
Zinc ⑭	Iron ⑰	Tin ⑰	Copper ⑰

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The Printed Press Enabled Mass Communication through Printed Texts

Printed Words: Gutenberg Era ICTS

United Nations Educational, Scientific and Cultural Organization

Education

UNESCO » Education » Literacy

Literacy

- Policy
- Capacity-building
- Programme Design & Delivery
- Research
- Advocacy
- Monitoring & Evaluation
- Literacy Prizes

United Nations Literacy Decade (2003 - 2012)

UNLD logo

UNESCO leads the United Nations Literacy Decade (UNLD) under the slogan of "Literacy as Freedom". Launched at UN Headquarters in 2003, the Decade aims to increase literacy levels and to empower all people everywhere. In declaring this Decade, the international community recognised that the promotion of literacy is in the interest of all, as part of efforts towards peace, respect and exchange in a globalizing world. At the request of the UN General Assembly, UNESCO is coordinating the Decade and its international activities. UNESCO launched the Literacy Initiative for Empowerment (LIFE) in 2005 as a framework for achieving the Decade's goals.

Literacy Became a Fundamental Human Right by the 21st Century

Printed Words: Gutenberg Era Legacy Databases

Gmelin Handbook

- 400 vol (1998)
- 1.5 Million Compounds
- 1.3 Million Reactions
- 85,000 Keywords and abstracts
- >800 data fields

Beilstein Handbook, Basic Series to Supplements I-V, Steve Heller

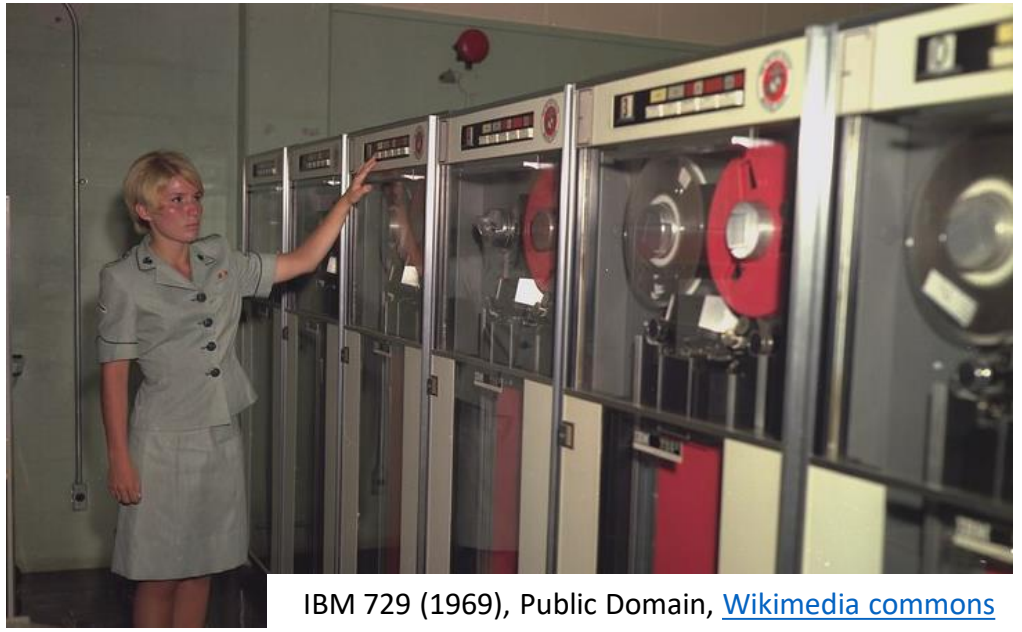
Beilstein Handbook

- 1st Edition (1881)
  - 15,000 Organic Molecules
  - 2 vol (2,200 pages)
- 4th Edition (1918-1998)
  - 503 Volumes
    - >440,000 Pages
  - 1.5 Million Organic Compounds

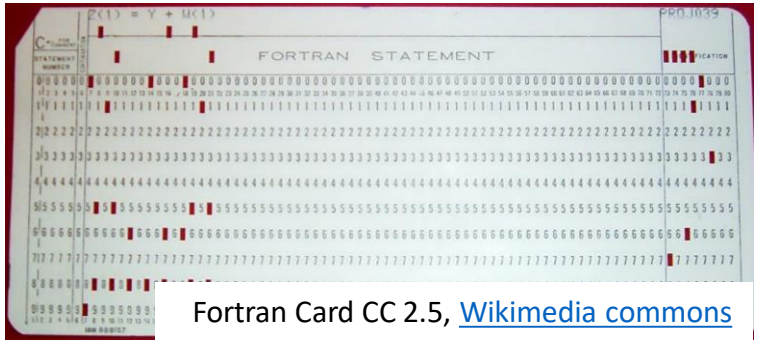
Gutenberg Era ICTs are Inadequate to Handle the Flow of Information but are Firmly Entrenched in the Practice of Science

Digital Words: Beyond Gutenberg

IBM Type 604 (1957). Public Domain, Wikimedia commons



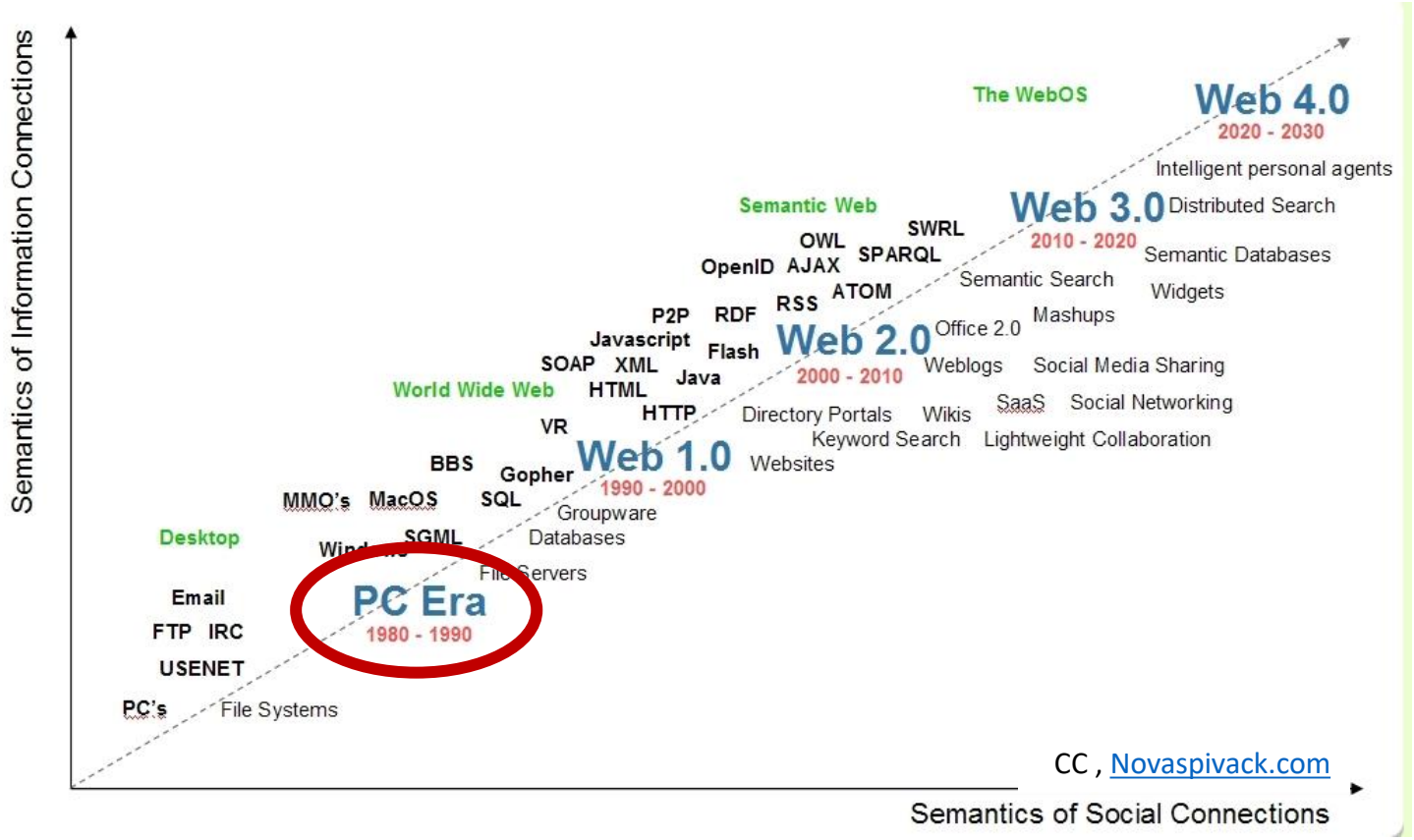
IBM 729 (1969), Public Domain, Wikimedia commons



Fortran Card CC 2.5, Wikimedia commons

The Late 20th Century Saw the Introduction of Digital Words

Evolution of Digital ICT Systems



Let's start with the PC Era

PC Era: Navigating a Document

One hand keyboard and first mouse, CC0.0, Smithsonian Institution

Royal Typewritter, Public Domain: Wikimedia Commons

1968 Douglas Englebart Demonstrated the First Mouse and the Ability to Navigate within a Document. Google "Mother of All Demos"

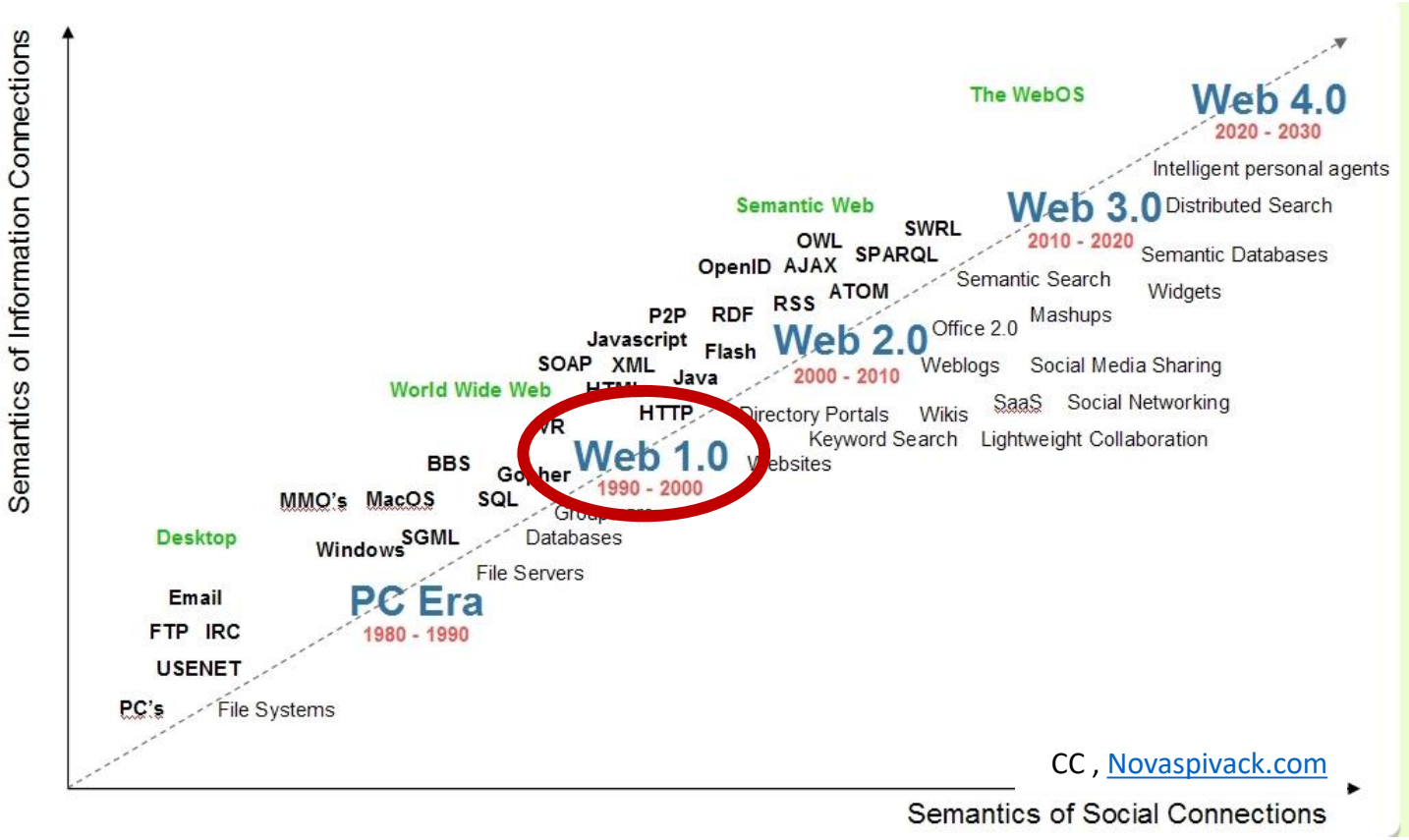
PC Era: Computer as Cognitive Artifact

One hand keyboard and first mouse, CC0.0, Smithsonian Institution

Royal Typewritter, Public Domain: Wikimedia Commons

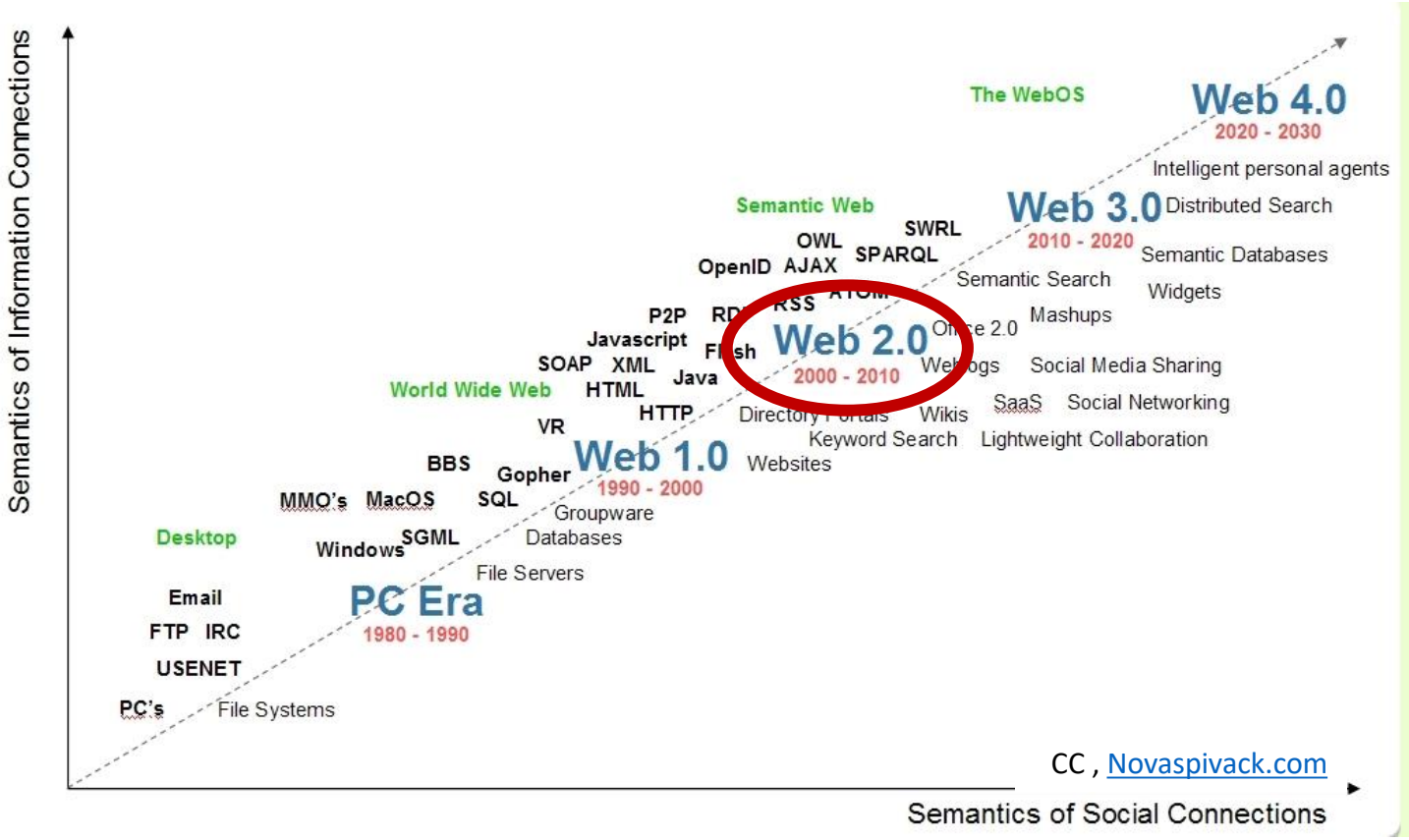
Cognitive Artifact: "Those artificial devices that maintain, display, or operate upon information in order to serve a representational function and that affect human cognitive performance." (Norman, 1991)

Web 1.0: Static Web



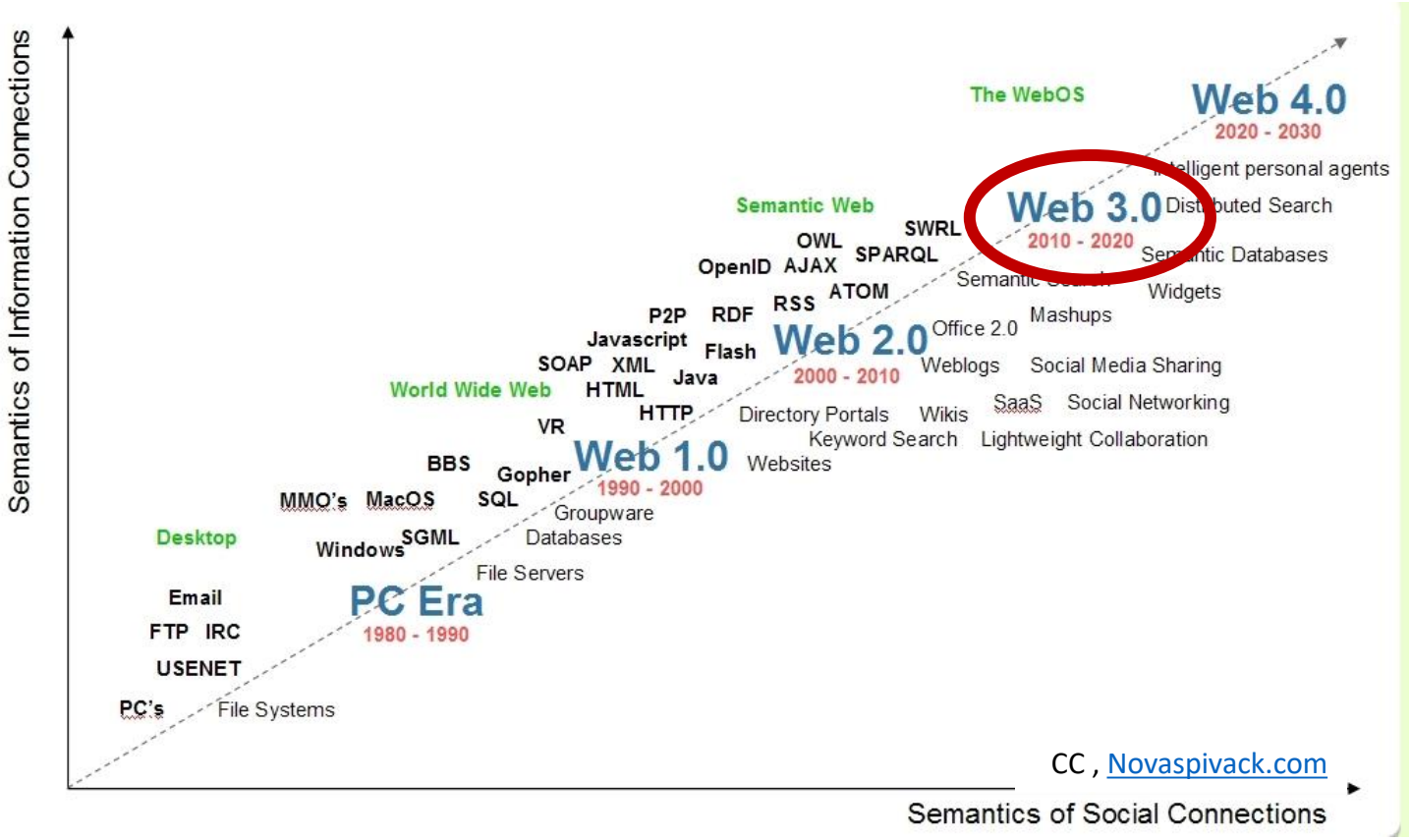
The Ability to Navigate Between Documents (Surfing from Webpage to Webpage)

Web 2.0: Social Web



Collaborative Authoring (Wikis, Blogs and Sites Like Facebook) where the "Webpage" is not a Static Document but Rendered from a Database

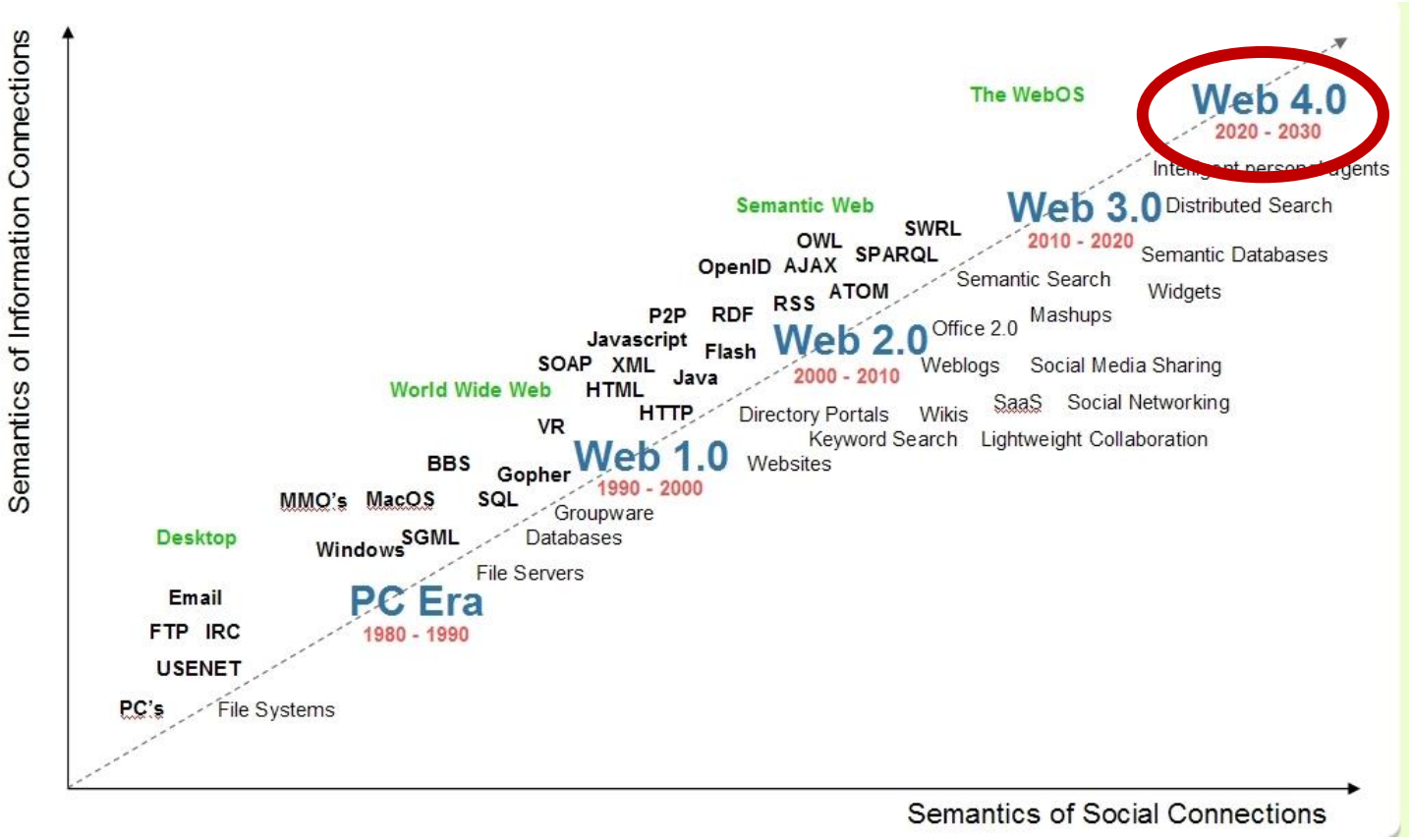
Web 3.0: Semantic Web



Linked Frameworks Not Generate by Authors

- RDF Triplet (Subject, Predicate, Object) Frameworks
- Tag-Base Ontological Frameworks (Folksonomies)

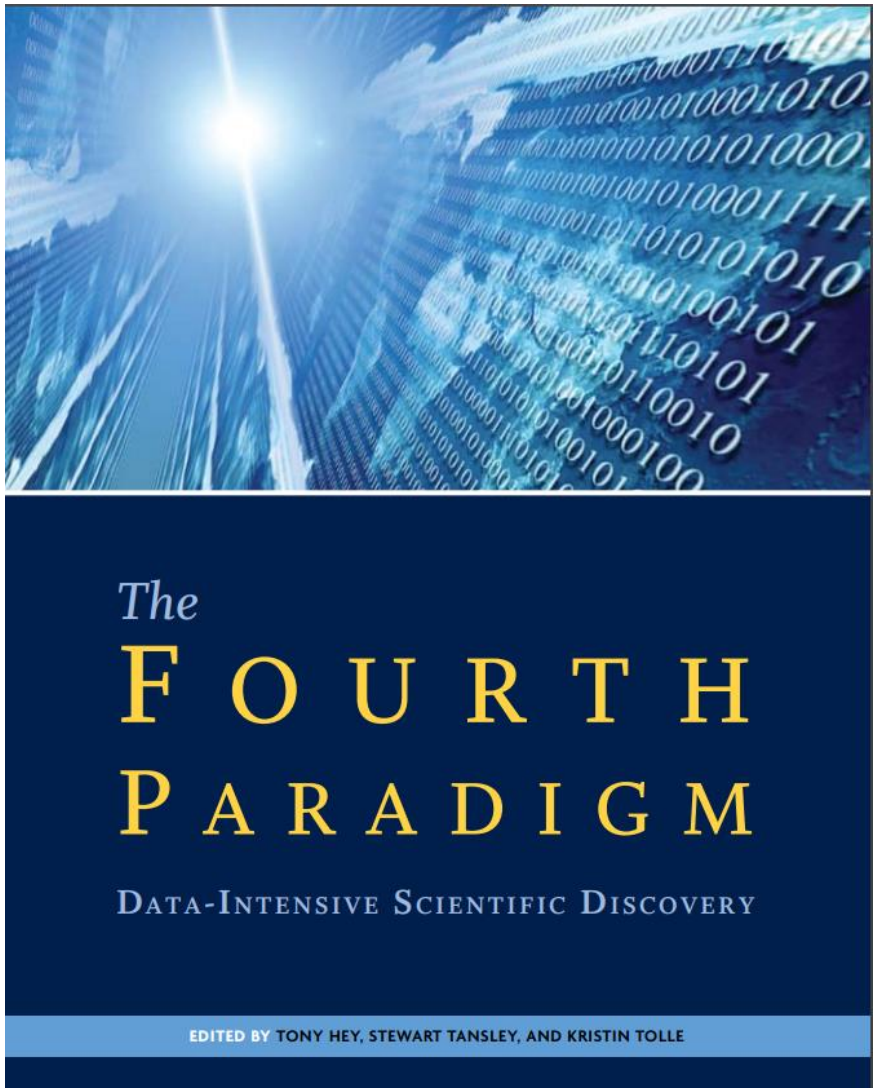
Web 4.0: Symbiotic Web

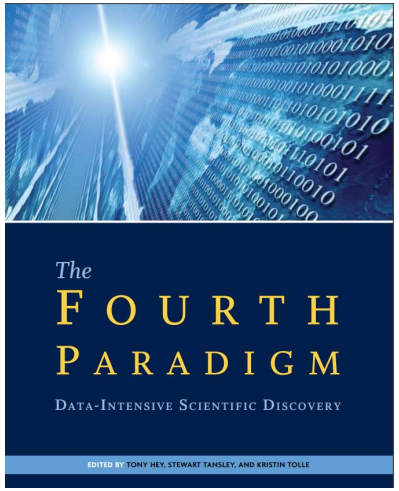


CC , Novaspivack.com

Living Data – The Internet of Things

Paradigms of Science





1st Paradigm: Empirical Science

- Thousands of Years Old
- Science Based on Measurements and Experiments Involving the Physical World

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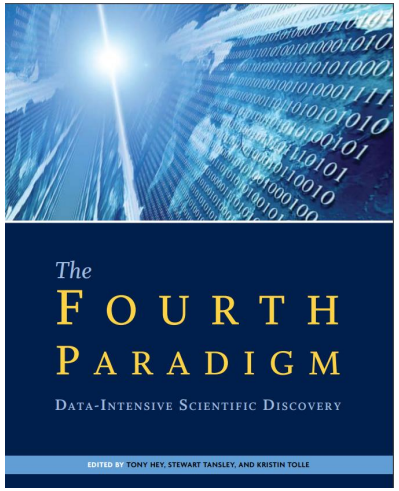
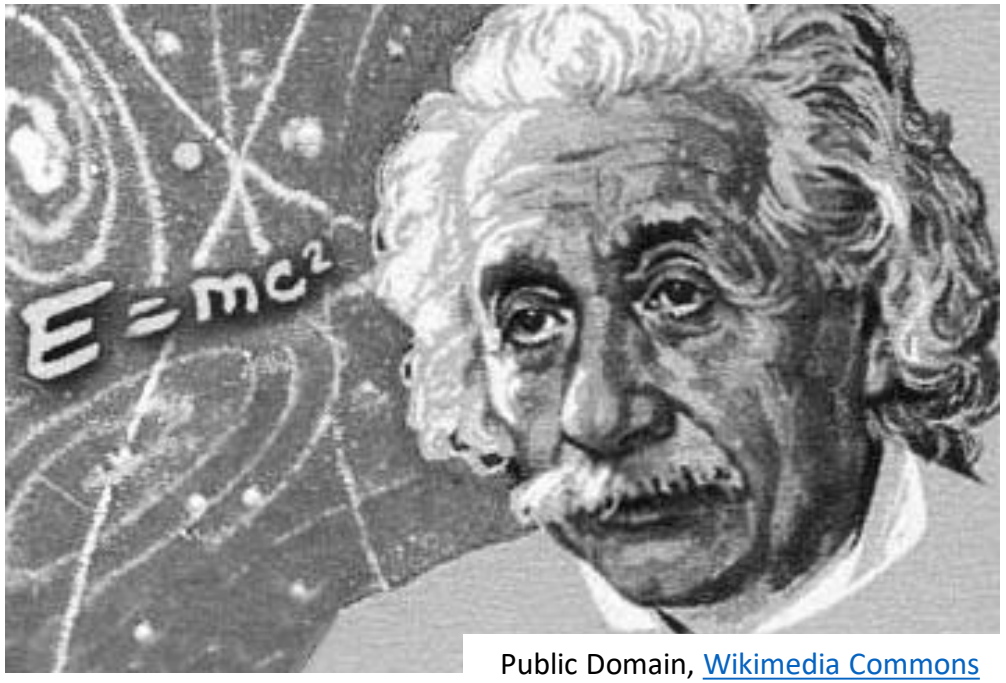


2nd Paradigm: Theoretical Science

- Centuries Old
- Science Based on Theoretical Models



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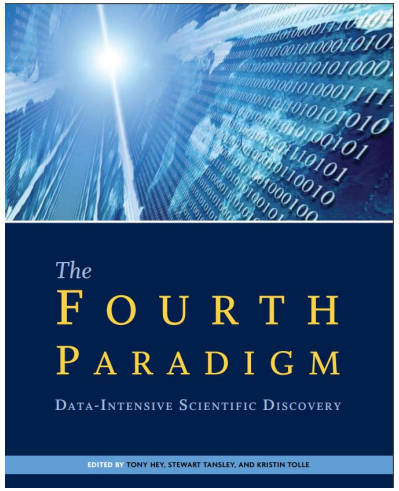


3rd Paradigm: Computational Science

- Decades Old
- Science Based on Complex Computations

- $\hat{F}$ is called the **Fock operator** and
- $\{|\varphi_i\rangle\}$ are the Hatree-Fock orbitals with corresponding energies ϵ_i.

The Fock operator is a one-electron operator and solving a Hartree-Fock equation gives the energy and Hartree-Fock orbital for one electron.

The nature of the Fock operator reveals how the Hartree-Fock (HF) or Self-Consistent Field (SCF) Method accounts for the electron-electron interaction in atoms and molecules while preserving the idea of **independent atomic orbitals**. The wavefunction written as a Slater determinant of spin-orbitals is necessary to derive the form of the Fock operator, which is

$$\hat{F} = \hat{H}^0 + \sum_{j=1}^{N}(2\hat{J}_j - \hat{K}_j) = -\frac{\hbar^2}{2m}\nabla^2 - \frac{Ze^2}{4\pi\epsilon_0 r} + \sum_{j=1}^{N}(2\hat{J}_j - \hat{K}_j) \qquad \text{(Lecture Extra.20)}$$

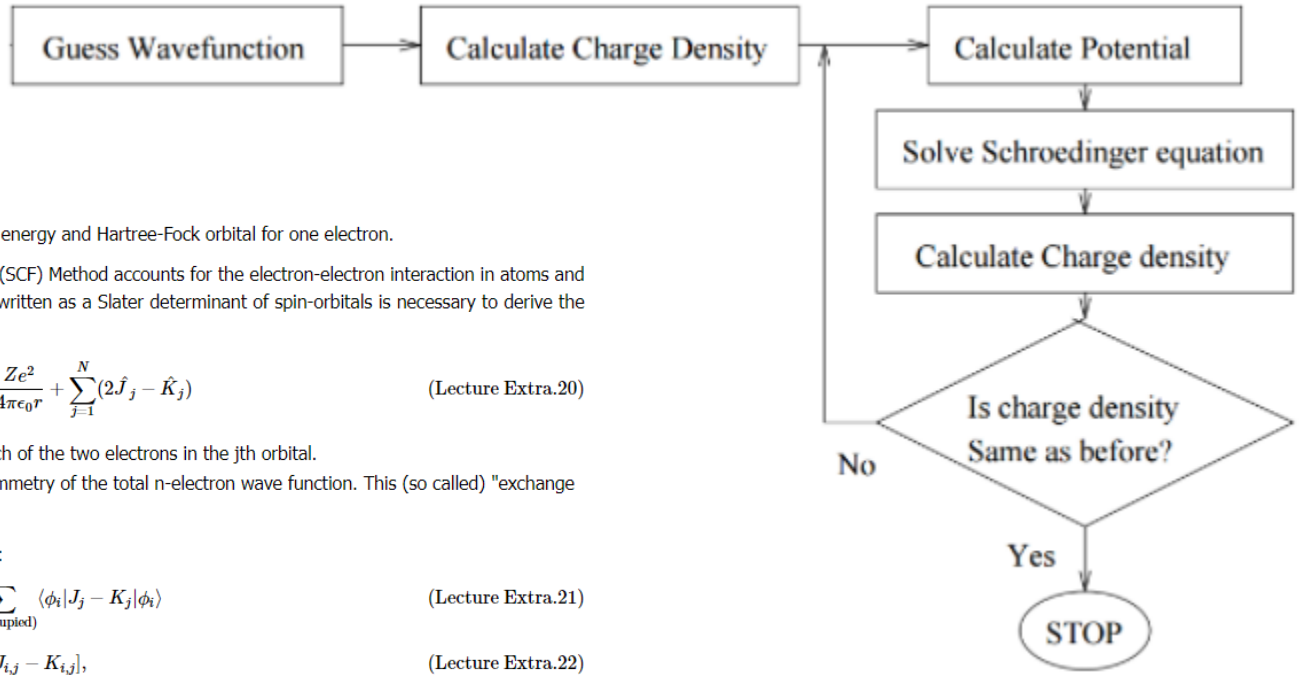
- $\hat{J}$ is the **Coulomb operator,** defining the electron-electron repulsion energy due to each of the two electrons in the jth orbital.
- $\hat{K}$ is the **exchange operator**, defining the electron exchange energy due to the antisymmetry of the total n-electron wave function. This (so called) "exchange energy" operator, K, is simply an artifact of the Slater determinant.

The Hartree-Fock equations $h_e\phi_i = \epsilon_i\phi_i$ imply that the orbital energies ϵ_i can be written as:

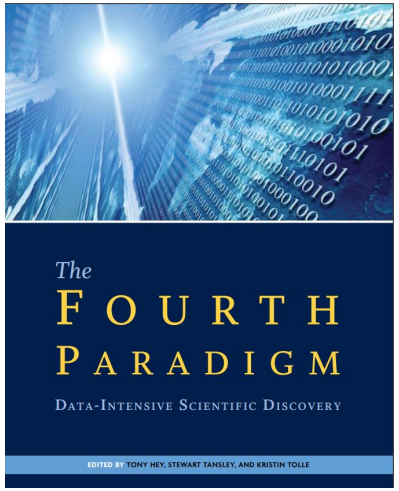
$$\epsilon_i = \langle\phi_i|h_e|\phi_i\rangle = \langle\phi_i|T+V|\phi_i\rangle + \sum_{j(\text{occupied})}\langle\phi_i|J_j - K_j|\phi_i\rangle \qquad \text{(Lecture Extra.21)}$$

$$= \langle\phi_i|T+V|\phi_i\rangle + \sum_{j(\text{occupied})}[J_{i,j} - K_{i,j}], \qquad \text{(Lecture Extra.22)}$$

where $T+V$ represents the kinetic (T) and nuclear attraction (V) energies, respectively. Thus, ϵ_i is the average value of the kinetic energy plus Coulombic attraction to the nuclei for an electron in ϕ_i plus the sum over all of the spin-orbitals occupied in ψ of Coulomb minus Exchange interactions of these electrons with the electron in ϕ_i.



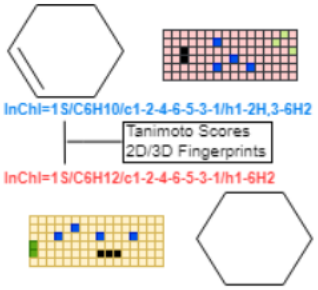
Hartree Fock CC 3.0: Libretexts



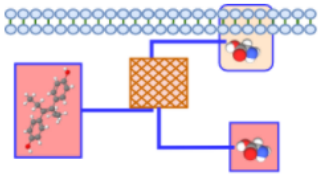
4th Paradigm: Data Intensive Discovery

- Emerging
- Scientific Discovery Based on Data Relationships

6: Molecular Similarity



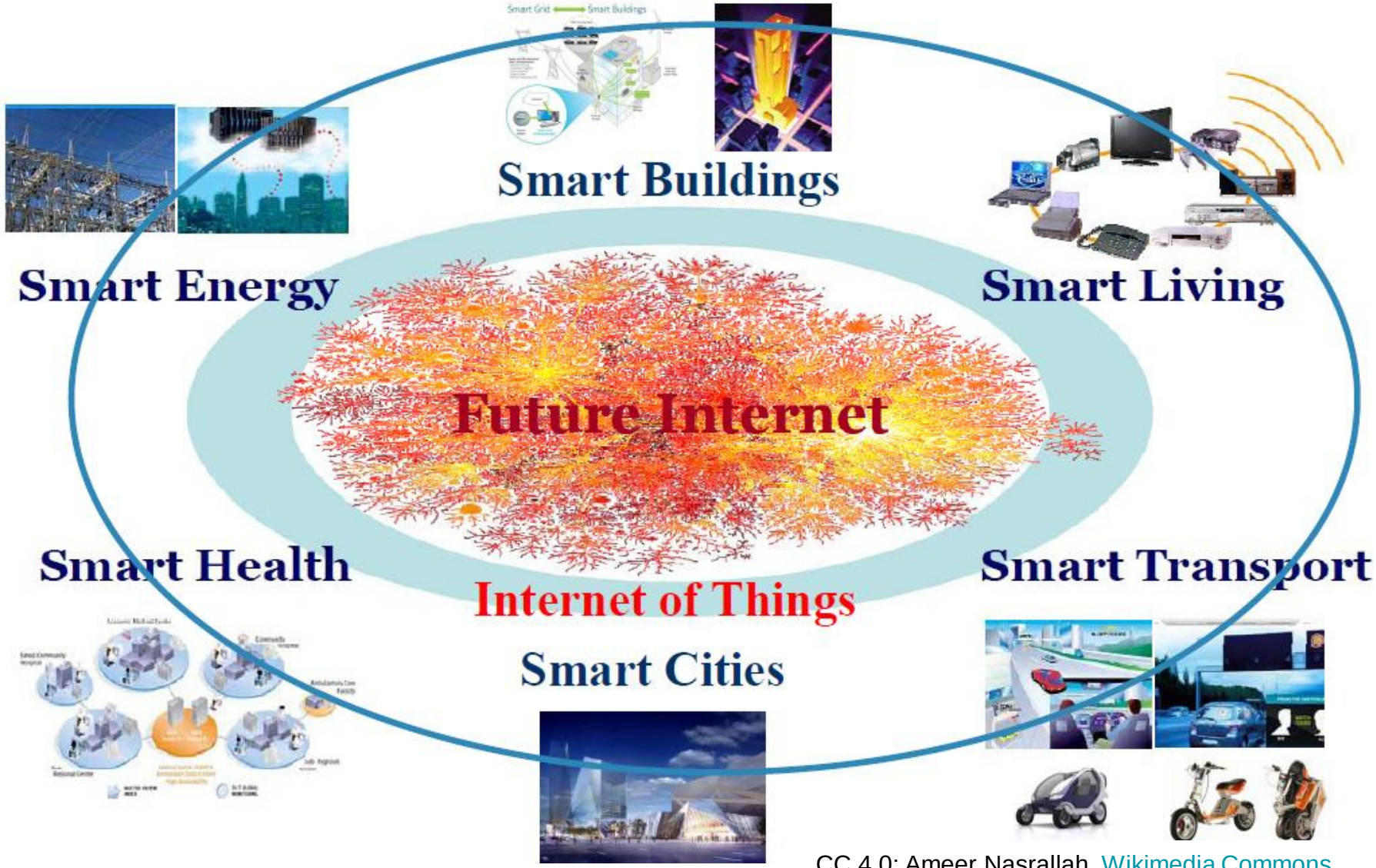
7: Computer-Aided Drug Discovery and Design



8: Machine-learning Basics

Is Science Evolving From Causations to Correlations?

What is the Internet of Things?



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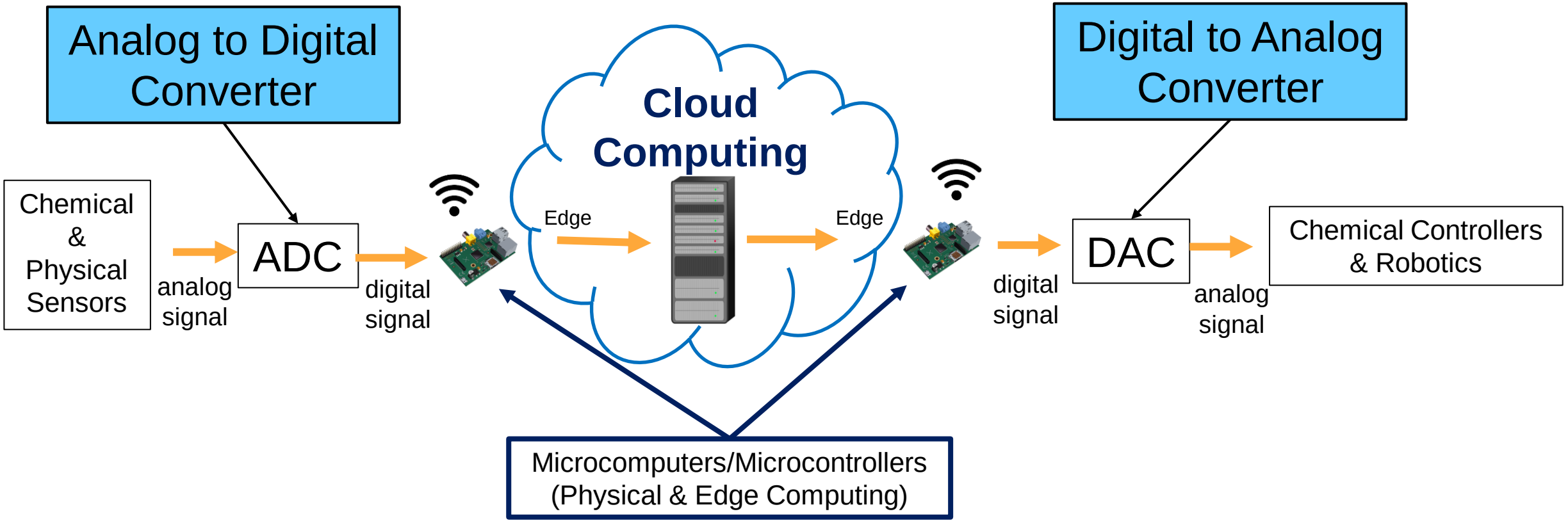
Interconnected Digital Networking of Physical Objects

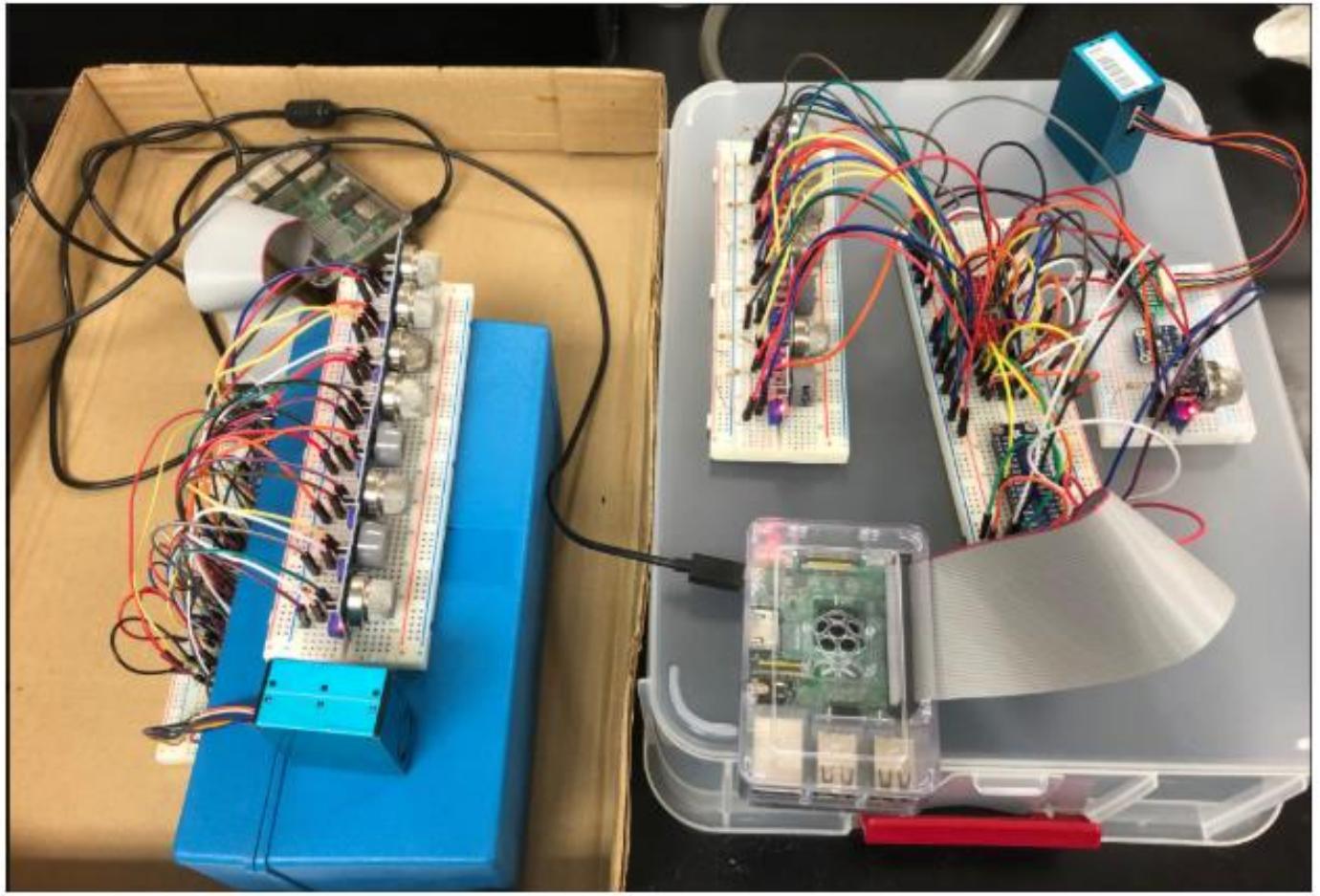
What is the Internet of Science Things?

Interconnected
Digital Networking
of
Physical Objects

Connecting
Empirical Science
to
Data Science



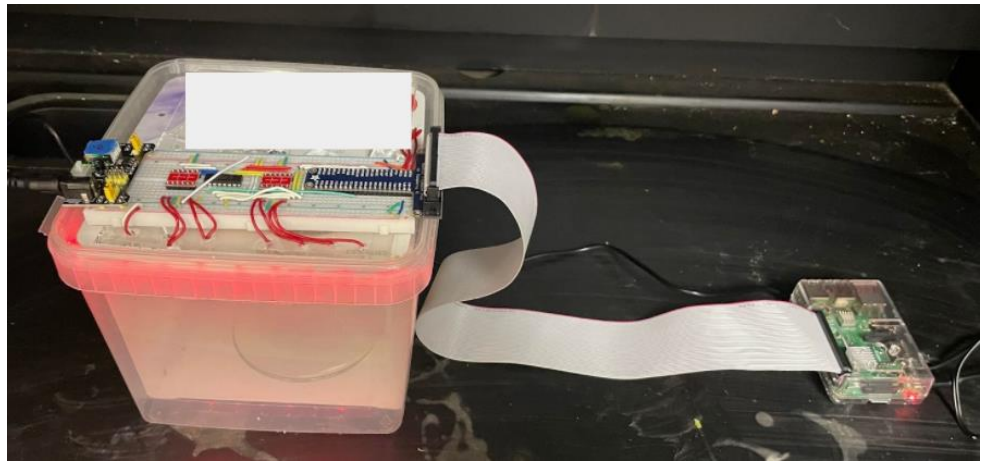
Prior Course Projects

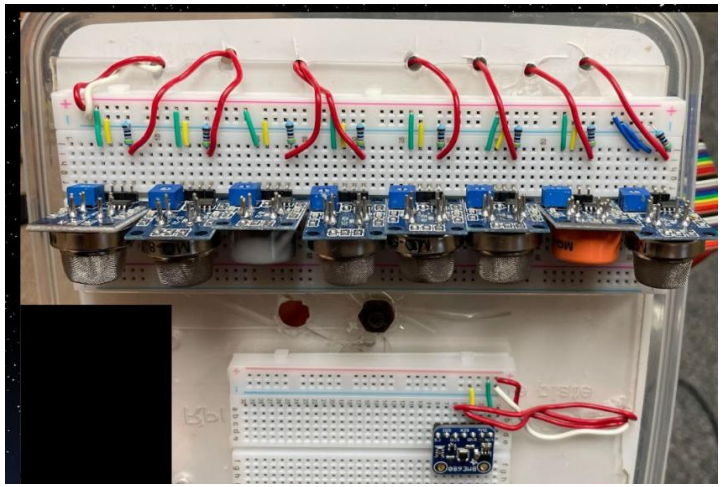


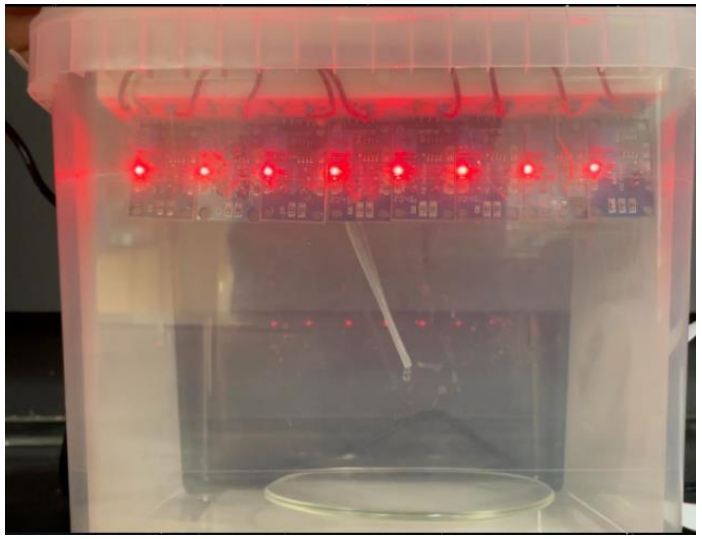
Set up in chemical storage lab.

Multi-Variable Sensor Array for Air Quality Machine Leaning

Prior Course Projects

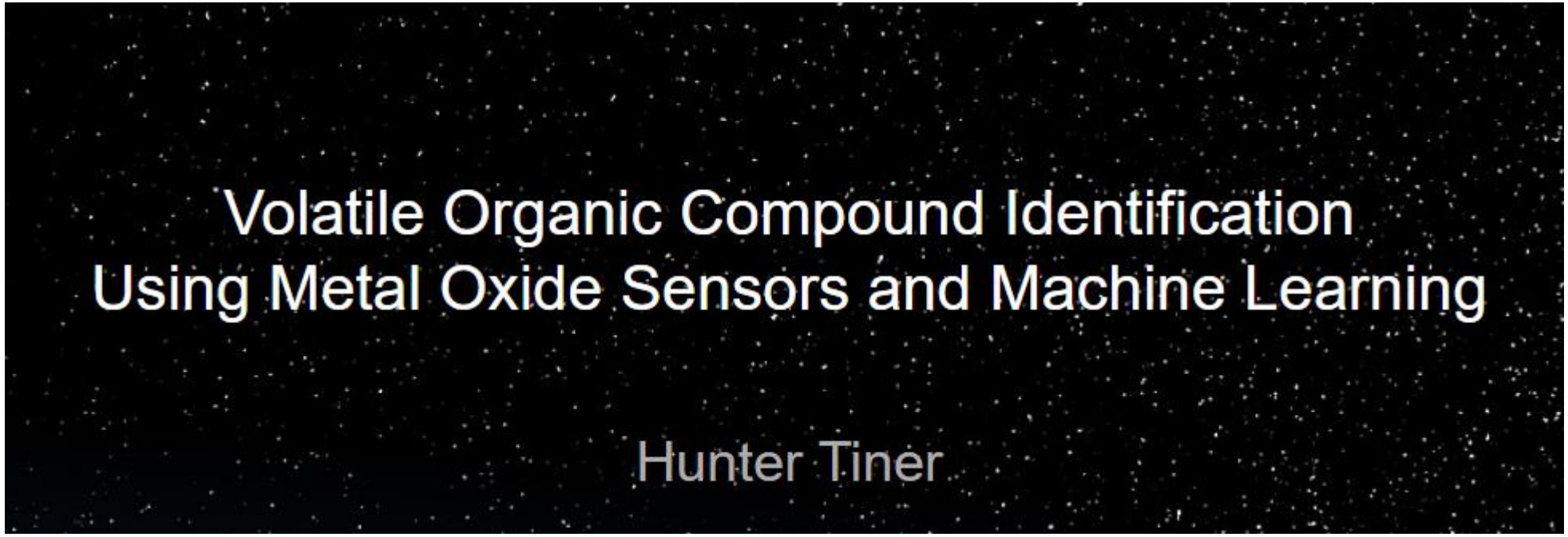






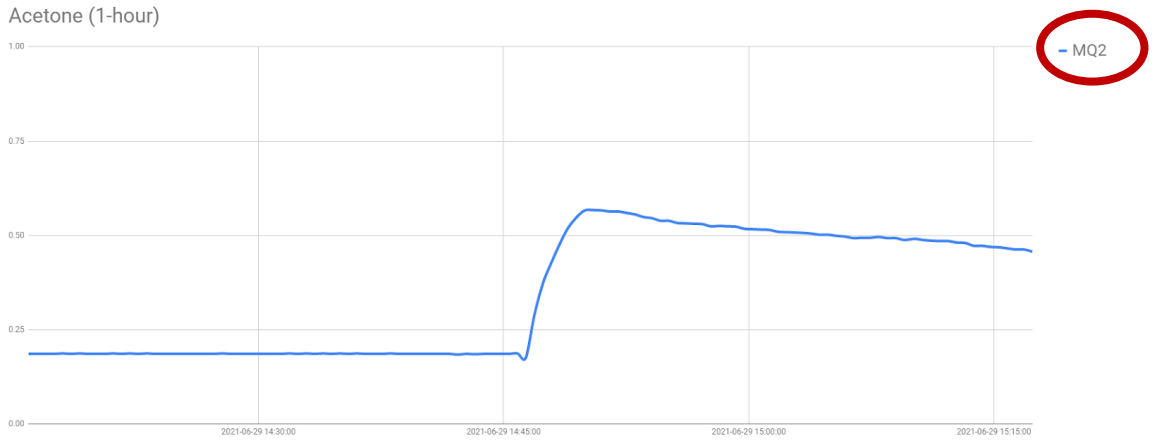
Multi-Variable Sensor Array for Air Quality Machine Leaning

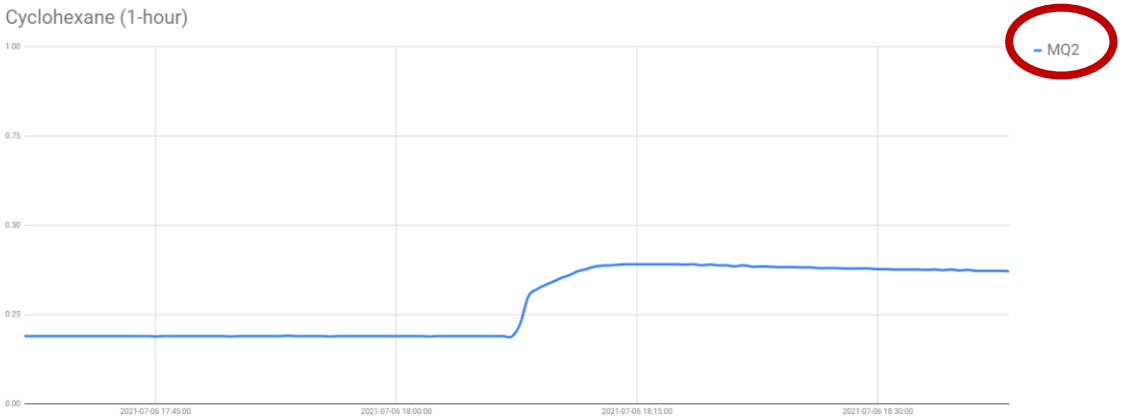
Thesis Project

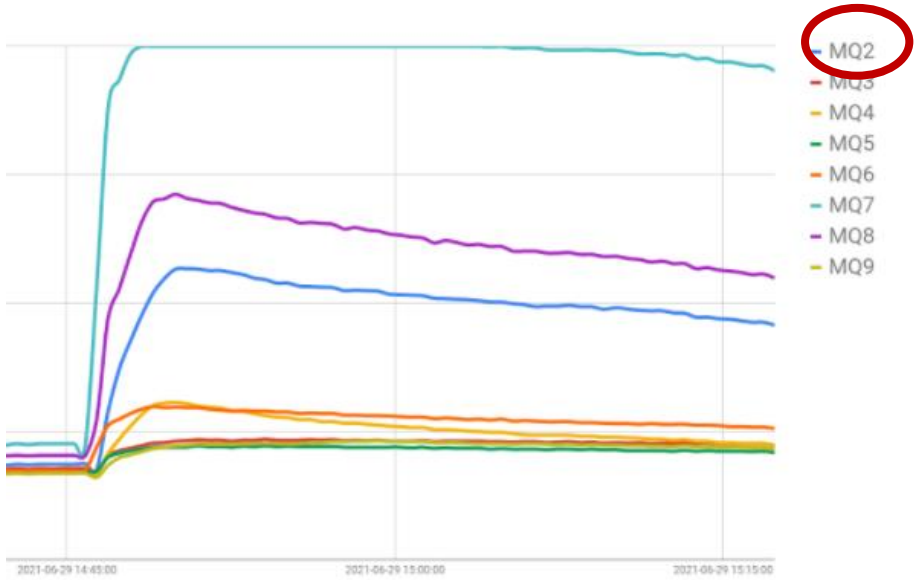


Multi-Variable Sensor Array for Air Quality Machine Leaning

Thesis Project







Multi-Variable Sensor Array for Air Quality Machine Leaning

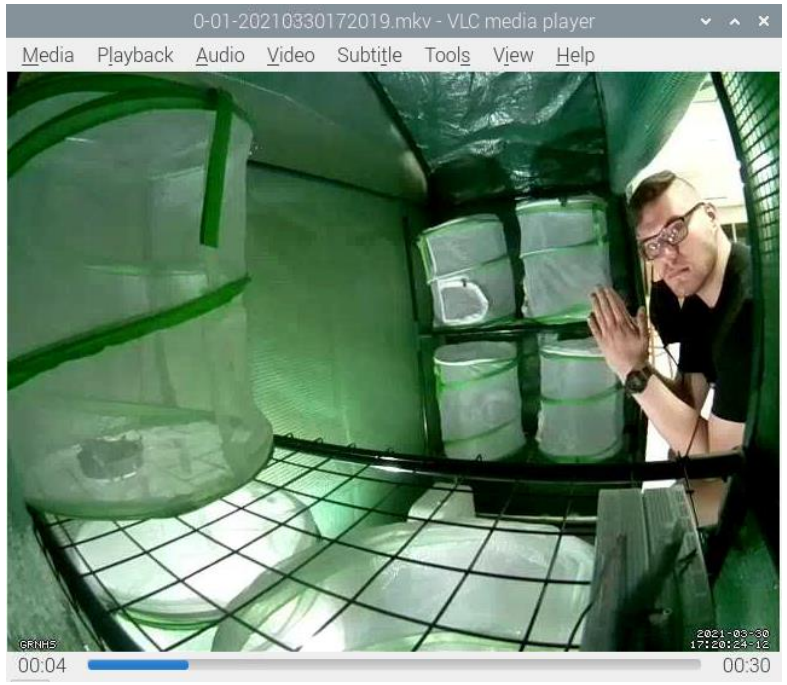
Thesis Project

Chemical Prediction

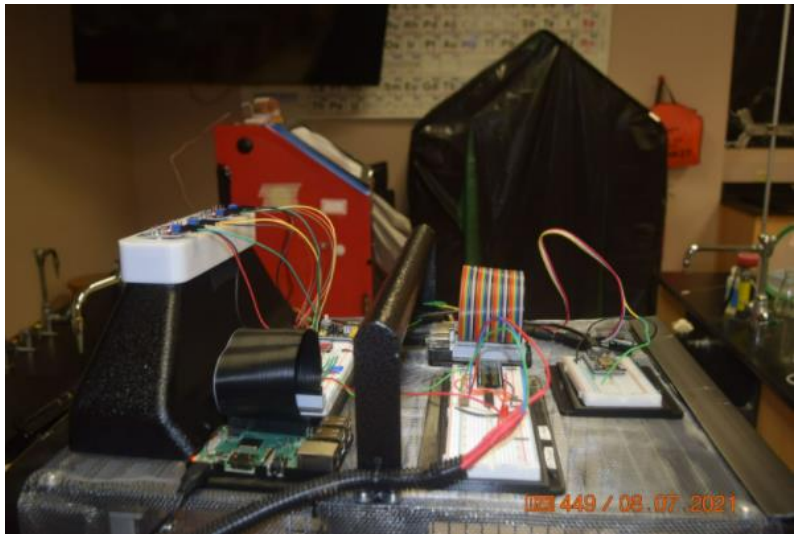
	25			50			100		
Learner	**Acc**	**Prec**	**Recall**	**Acc**	**Prec**	**Recall**	**Acc**	**Prec**	**Recall**
GNB	93.5%	93.5%	95.4%	94.5%	94.5%	95.7%	96.5%	96.5%	97.4%
KNN	94.5%	94.5%	96.1%	94.5%	94.5%	96%	96%	96%	97%
RF	100%	100%	100%	98%	98%	98%	96%	96%	97.3%
SVM	97%	97%	97.9%	98%	98%	98.6%	96%	96%	97.2%

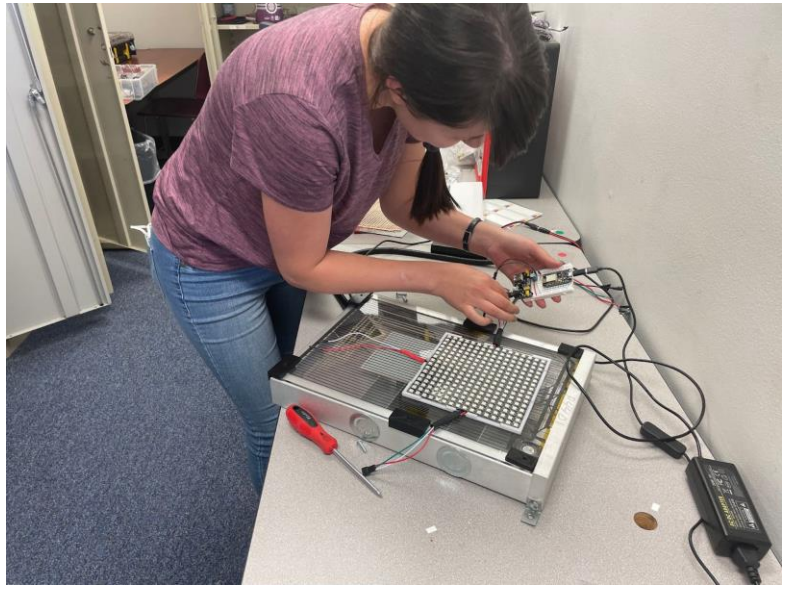
- Scores are averaged of the 10 splits

Multi-Variable Sensor Array for Air Quality Machine Leaning

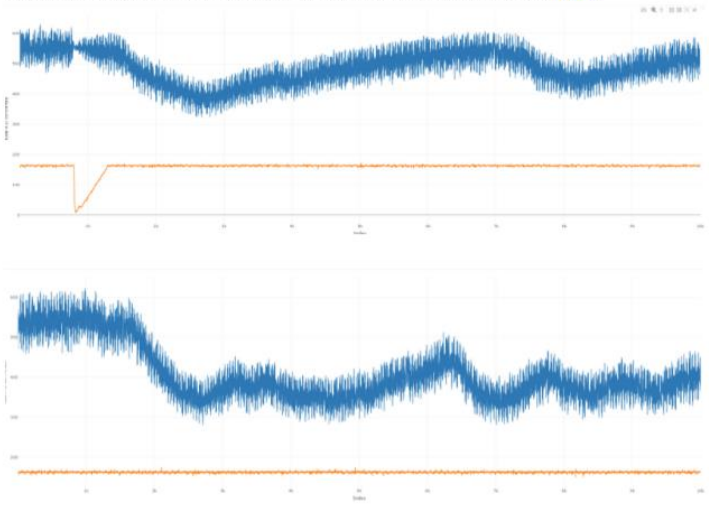


SolaRid

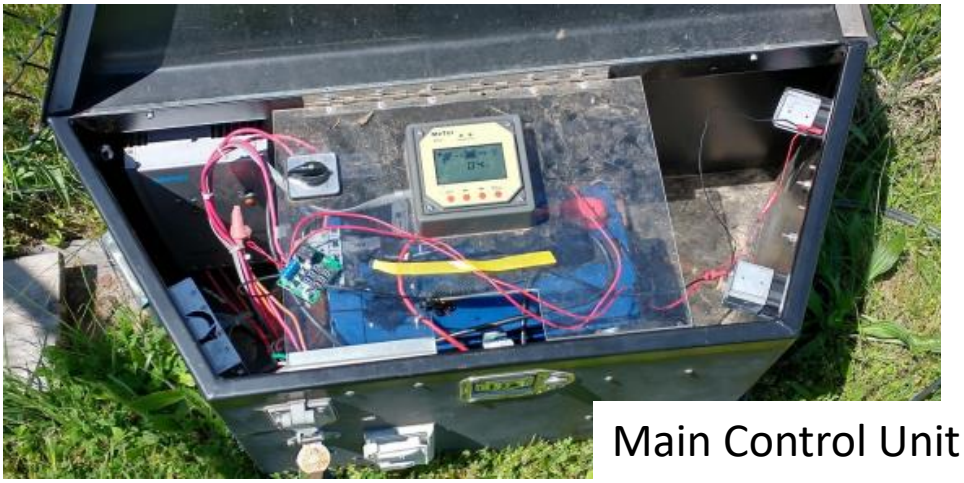




8. Real bug zap was caught on video and the voltage data was also recorded. Video



GAN:



Main Control Unit

GARDEN AREA NETWORK PROJECT

Capstone Project Report

Prepared for

Capstone II, SYEN 4385

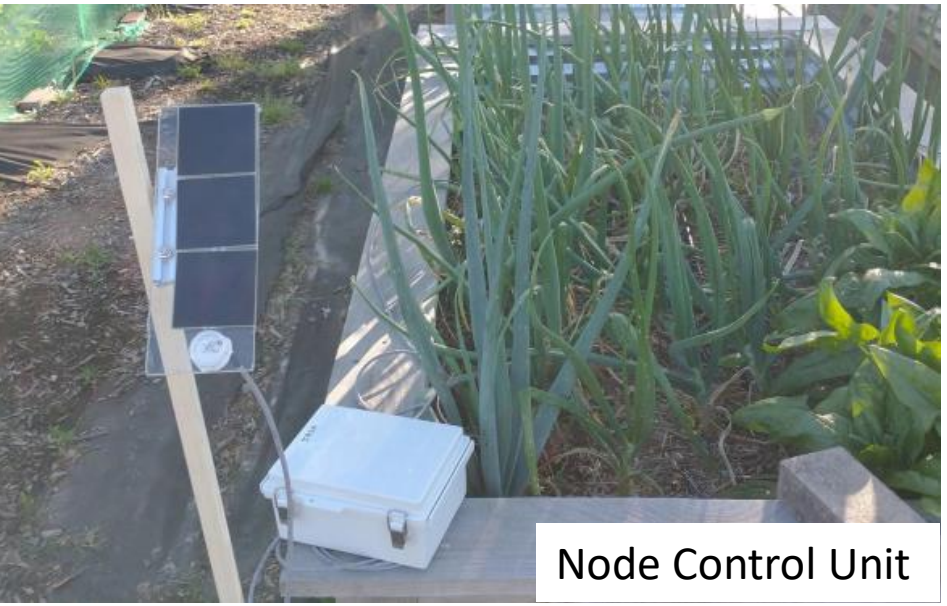
Dr. Jing Zhang

Capstone Advising Professor
Associate Professor, Systems Engineering
University of Arkansas at Little Rock

By

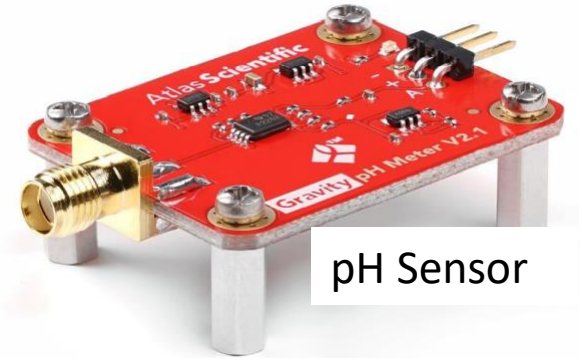
Joshua Mitchell, Electrical and Computer Systems Engineering, Project Lead
Abdulaziz Alotaibi, Electrical and Computer Systems Engineering
John Harty, Electrical and Computer Systems Engineering
Samuel Jordan, Electrical and Computer Systems Engineering
Elizabeth Rivera, Electrical and Computer Systems Engineering

10 May, 20

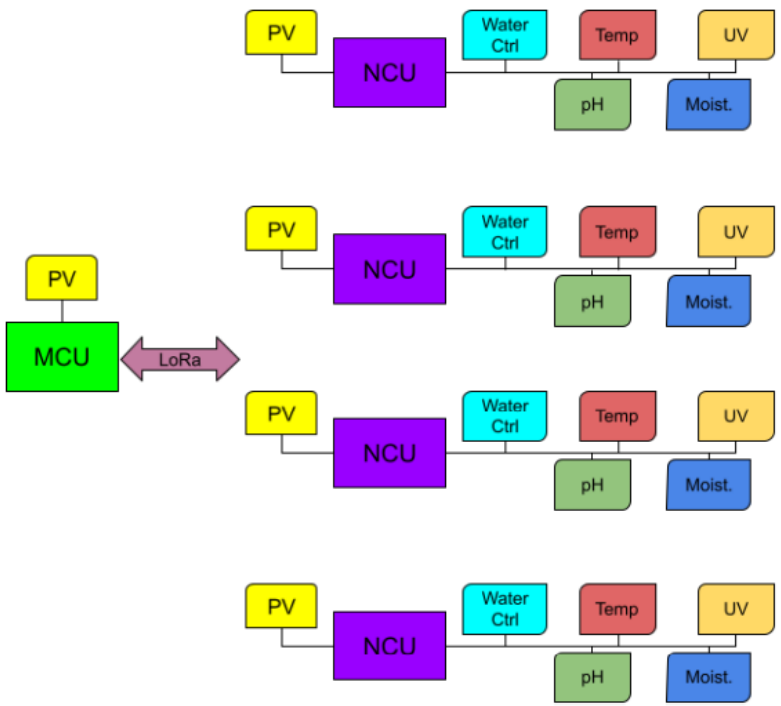


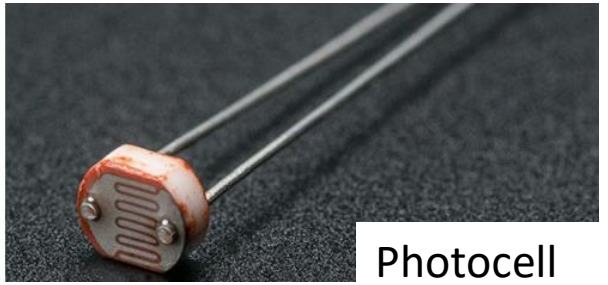
Node Control Unit

Soil Moisture Sensor



pH Sensor

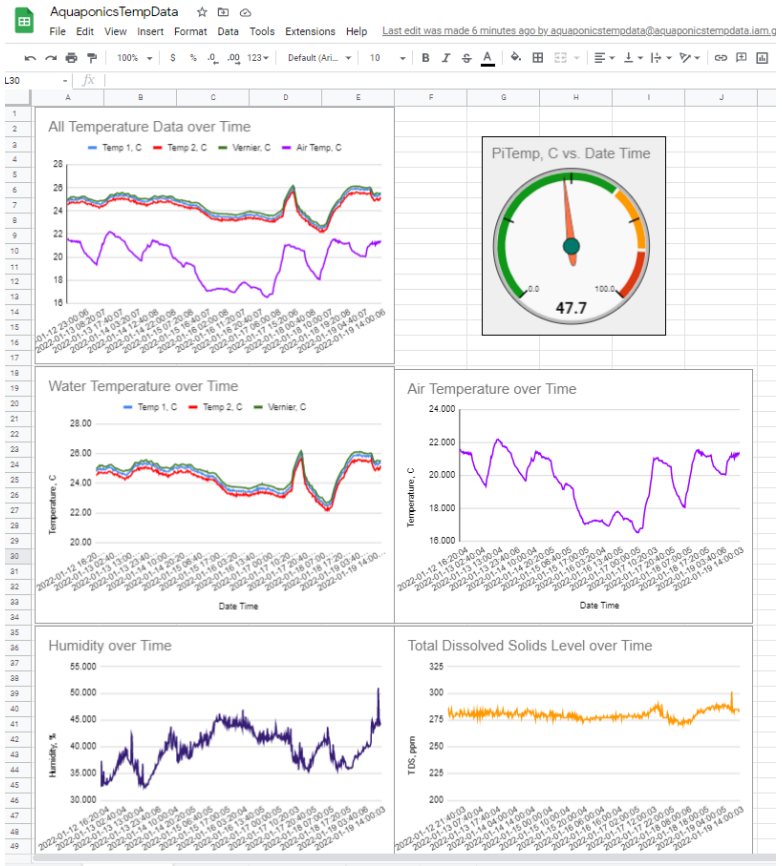




Photocell

Heifer Aquaponics

[AquaponicsTempDataSheet]



---------- Forwarded message ---------
From: **UALR Aquaponics Pi** <myfoxpi@gmail.com>
Date: Mon, Jan 17, 2022 at 2:40 PM
Subject: [Warning] Water temperature is out of range!
To: <evlisitsyna@ualr.edu>

Snails need your help! Recommended water temperature for Mystery Snails is between 21C and 26C. Current water temperature readings are 25.875(temp1), 25.562(temp2) and 26.135(Vernier) degrees Celsius.

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Best Regards,
Elena Lisitsyna