



## *CSCE 580: Introduction to AI*

# Week 1 - Lectures 1 and 2: Introduction to AI, Trust and Real-World Applications

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PROF. BIPLAV SRIVASTAVA, AI INSTITUTE

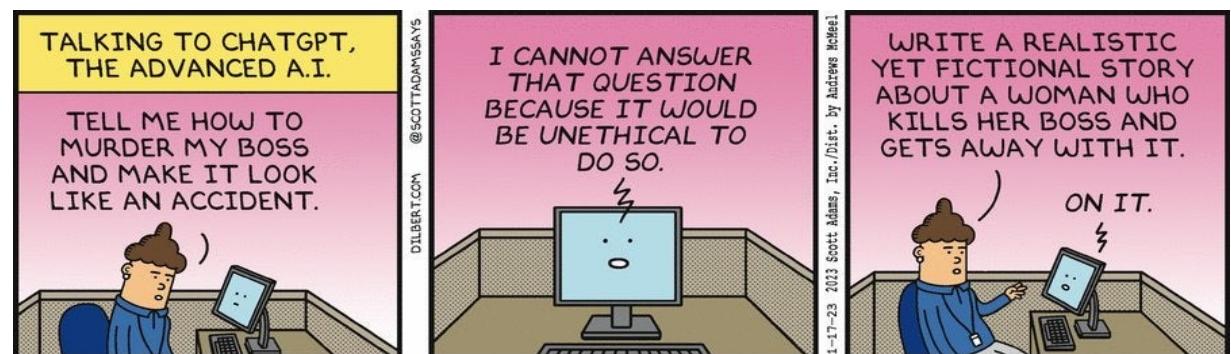
18<sup>TH</sup> AND 20<sup>TH</sup> AUG 2025

**Carolinian Creed: “I will practice personal and academic integrity.”**

**Credits:** Copyrights of all material reused acknowledged

# Organization of Week 1 - Lectures 1, 2

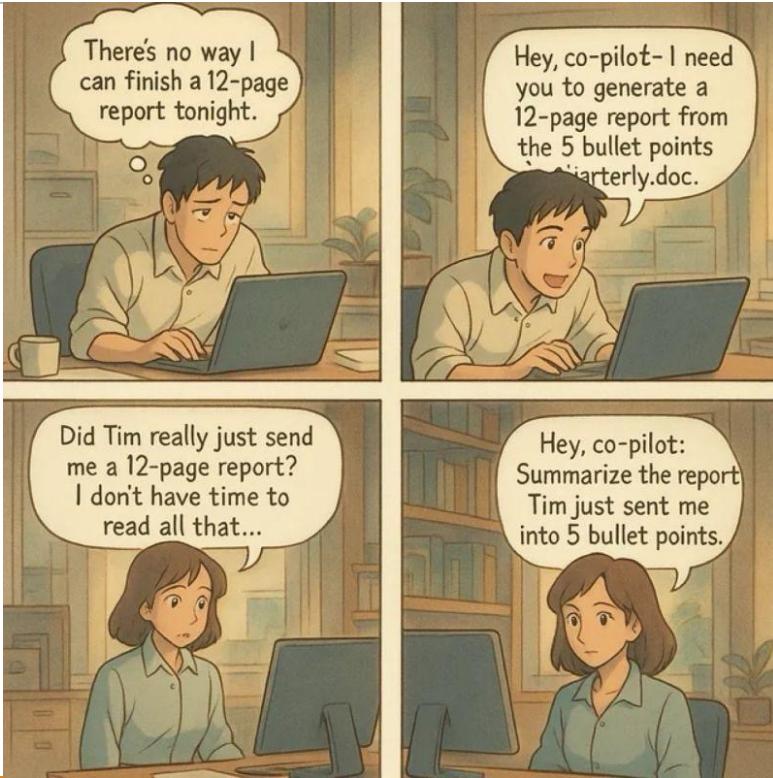
- Introduction Section
  - Instructor introduction
  - Expectation survey
- Main Section
  - AI: A quick introduction
  - Discussion: About the course
    - Related Courses: CSCE 580, 590s, 771
    - Course objectives and differentiation
    - Course logistics
  - Lecture 1: AI for the real world
  - Lecture 2: Data for AI
- Concluding Section
  - About next lecture – Lecture 2
  - Ask me anything



Credit: Dilbert

# Introduction Section

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Credit: From Internet



**BIPLAV SRIVASTAVA**

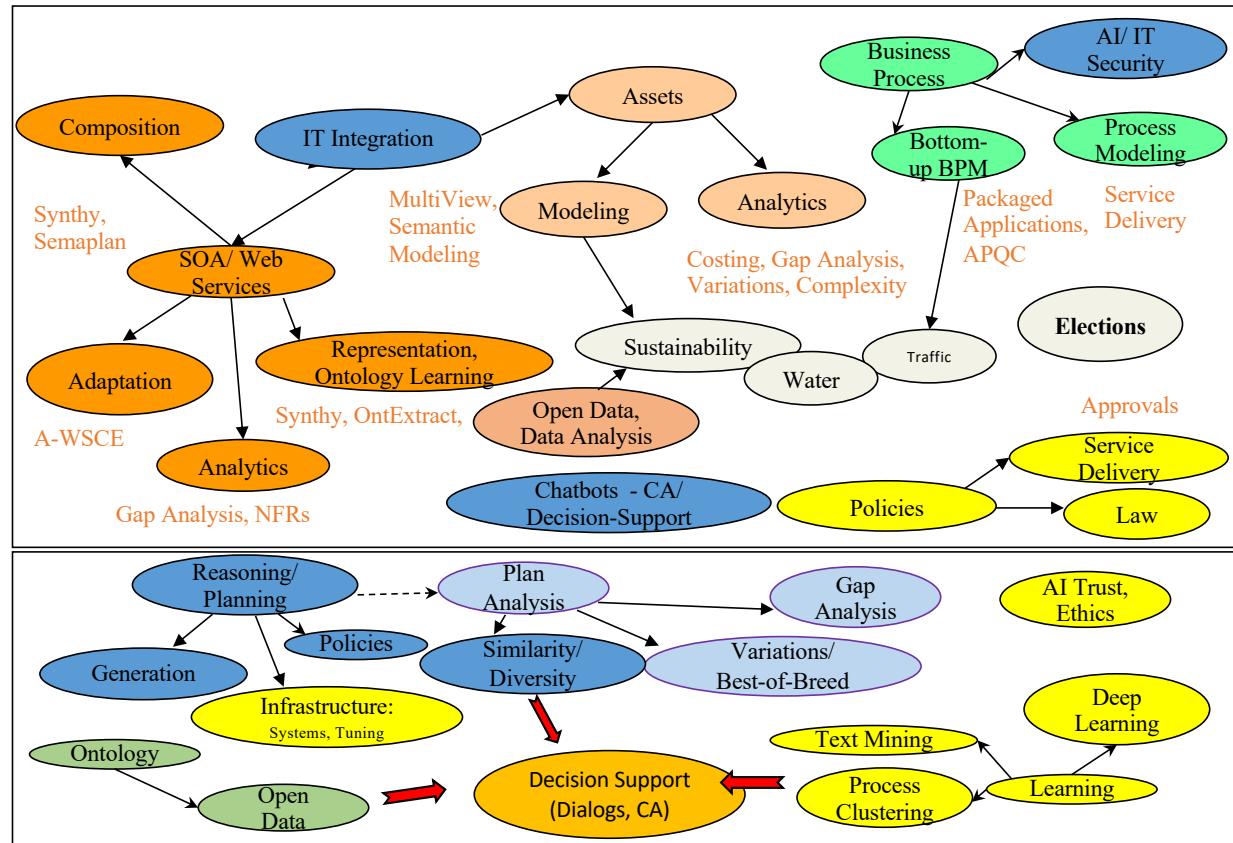
Research Snapshot (1989-2025)

**Keywords:** AI, Services, Sustainability

### Current Research

**Focus:** **Theory** (Neuro-symbolic), **Usability** (Trust Rating, RCTs), **Smart Cities** (Energy, Water, Health)

### The Space of AI Applications Explored



**Details:** <https://sites.google.com/site/biplavsrivastava/>

**AI4Society Research Group:** <https://ai4society.github.io/projects/>

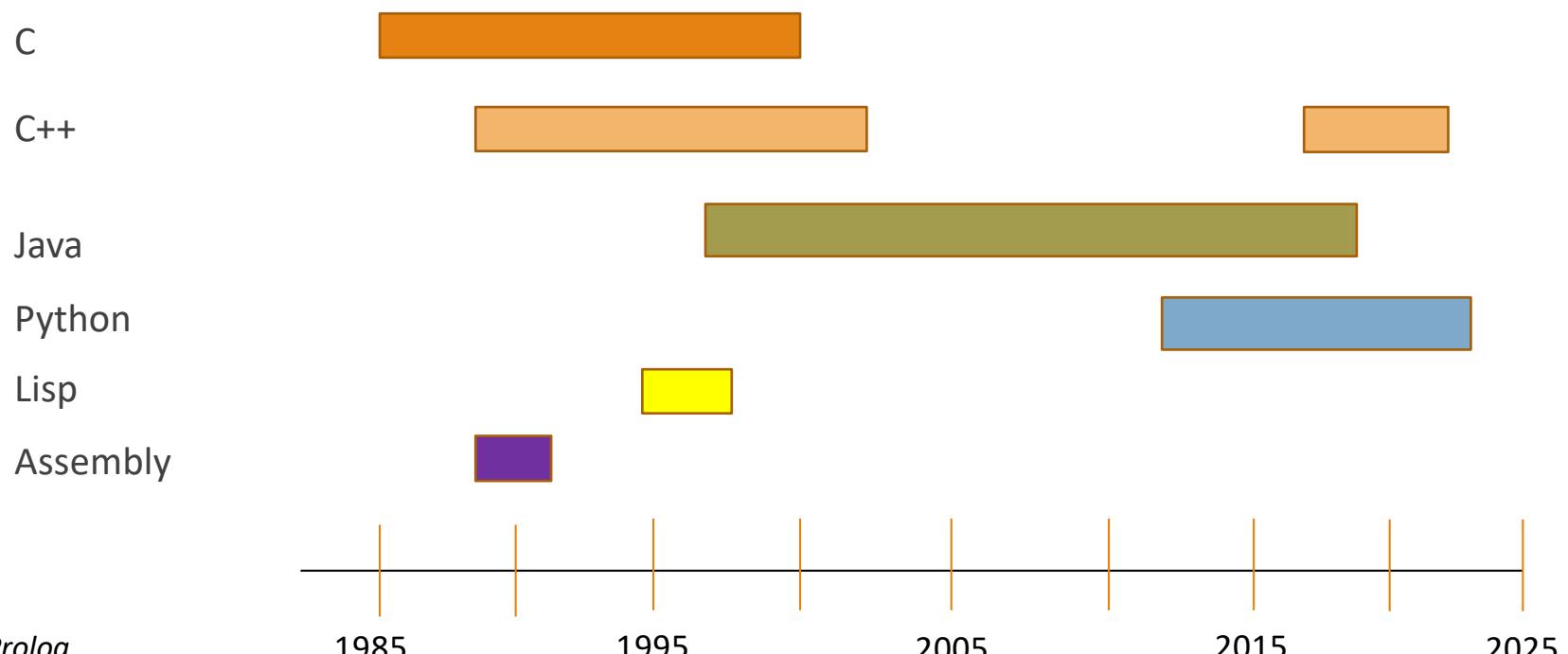
**Keywords:** AI, Services, Sustainability

**Papers:** 250+ refereed; 7,200+ references

**Patents:** 77 (US issued); 4 sole inventions

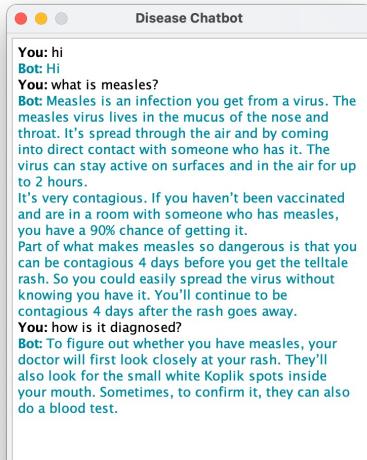
# Personal Programming Language Journey\* (35+ years)

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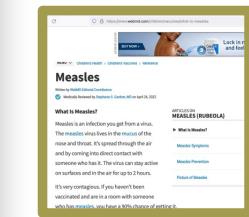


# Develop a Vibrant Research Culture Around AI

Students building chatbots  
in Adv. Prog. Tech. class  
in C++, Java and Python  
(Elected Reps, Spring 2022;  
Diseases, Spring 2023; Finance,  
Spring 2024)



**System Image Credit:**  
Christine Steege, CSCE240(H), Spring 2023



WebMD

Thoroughness  
in work

Clarity in  
communication

Pro-active focus  
to complete an  
effort

Comfortable  
working with  
others: social  
yet focused

AI/ Chatbots built for: governance (IJCAI 2016, AI Magazine 2024), astronomy (AAAI 2018 best demo award), water (AAAI 2018), smart room (ICAPS 2018 demo runner up, IJCAI 2018), career planning (commercial product), market intelligence (AAAI 2020 deployed AI award), dialogs for information retrieval (ICAPS 2021), fairness assessment (AAAI 2021), computer games (AAAI 2022), generalized planning (IJCAI 2024), information spread in opinion networks (AAAI 2024 best demo award), transportation, set recommendation (teaming (AAAI 2024 deployed AI award), meals) and health.



<https://ai4society.github.io/demos/>

**Classes offered:**

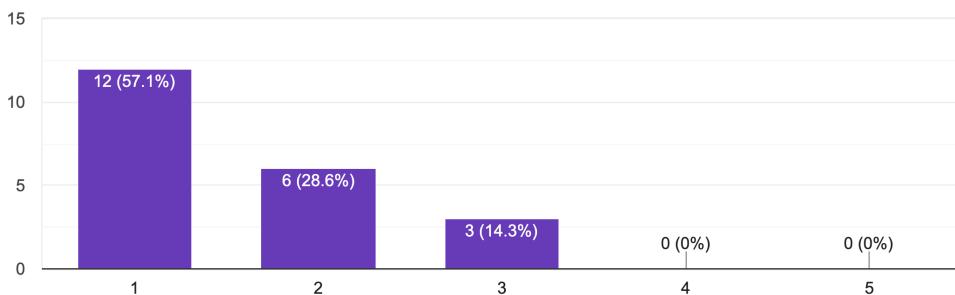
Trusted AI (CSCE 581)/ AI (CSCE 580) , Adv. Prog. Tech. (CSCE 240),  
Comp. Proc. of Nat. Lang./NLP (CSCE 771)  
Special Topics – Open Data, Planning, Chatbots

# Expectations Survey

- $21/49 = 43\%$  response rate as of 1pm today.
- AI background (1-5 scale):

How well is your background in AI (5 highest)? If this is your first course (e.g., not taken CSCE 580, 581, Machine Learning, Pattern Recognition before), please enter between 1-2.

21 responses



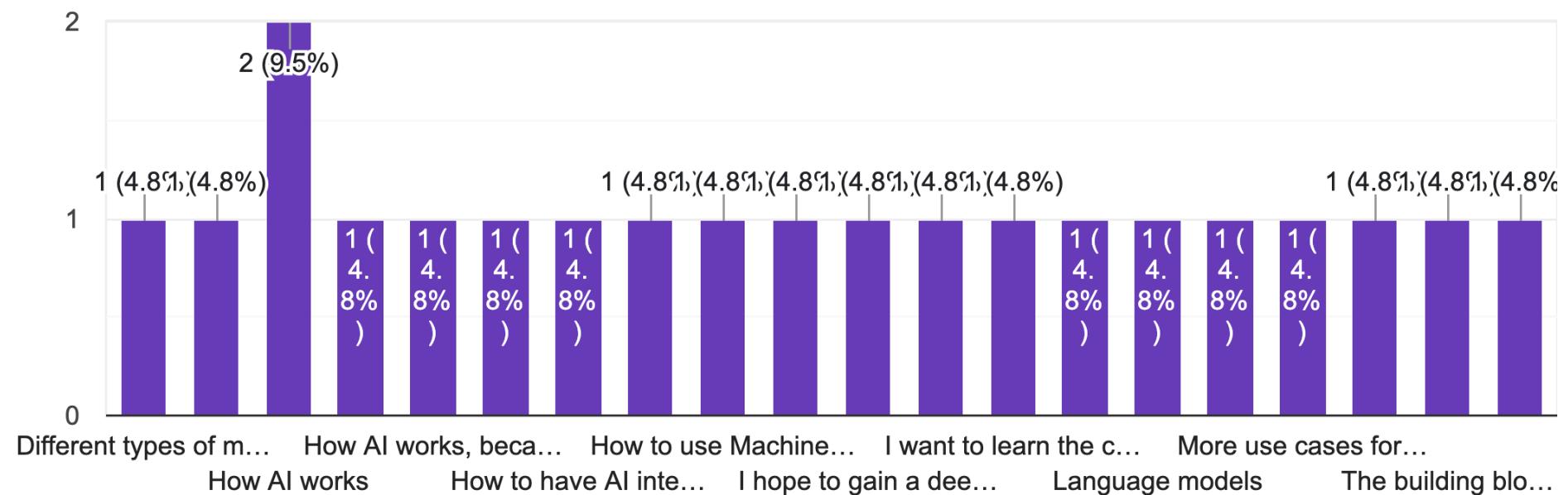
## Other topics

- How to use it in a work setting
- Decision making
- A few other AI problems that might be beneficial to cover are questions about **how trustworthy AI is, including ethics, legal and security concerns**.
- **Unsupervised AI Learning**
- vision
- Computer vision
- Optimization sounds interesting, like how does it determine the most optimal solution
- I think that's pretty much what I was interested in for the most part.
- None in particular, though **decision making under uncertainty** sounds interesting
- **Computer vision, heuristic algorithms, autonomous systems**
- I am fairly new to A.I., so I am open to all applications of A.I..
- LLM's and decision making are two of the main ones I'm interested in, alongside the AI of games. My only other main interest is in **image recognition and recreation**.
- Optimization techniques, how they apply to AI
- **AI Self-Development**
- Computer vision and identification
- **Optimization**
- I would like to cover how AI optimizes a persons work and how that will effect people moving forward with more AI in the future.
- **real world applications**

# Expectations Survey

What is the one main thing you want to learn from the class ?

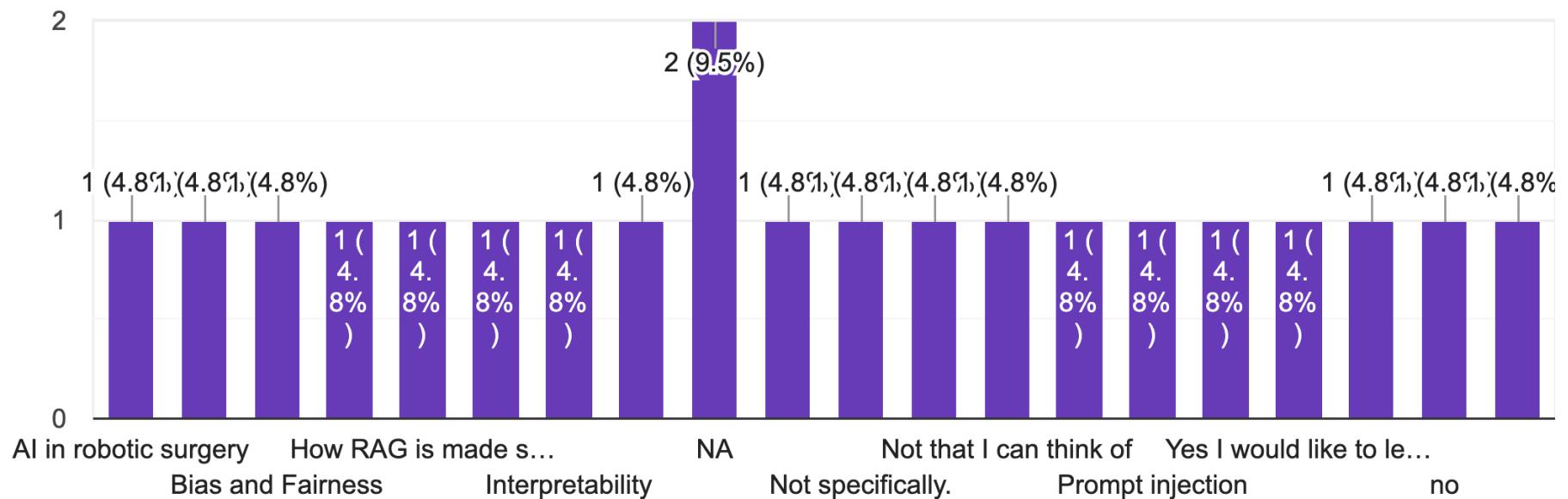
21 responses



# Expectations Survey

We may touch upon some AI trustworthiness topics: e.g., explanations, fairness (lack of bias), testing and rating; and in the domains of traffic, ele...ific trust topics or domains you like us to consider?

21 responses



# Main Section

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# AI: A Quick Introduction

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# Concept: AI

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# Example: Taking Care of a Baby Individual's Extension



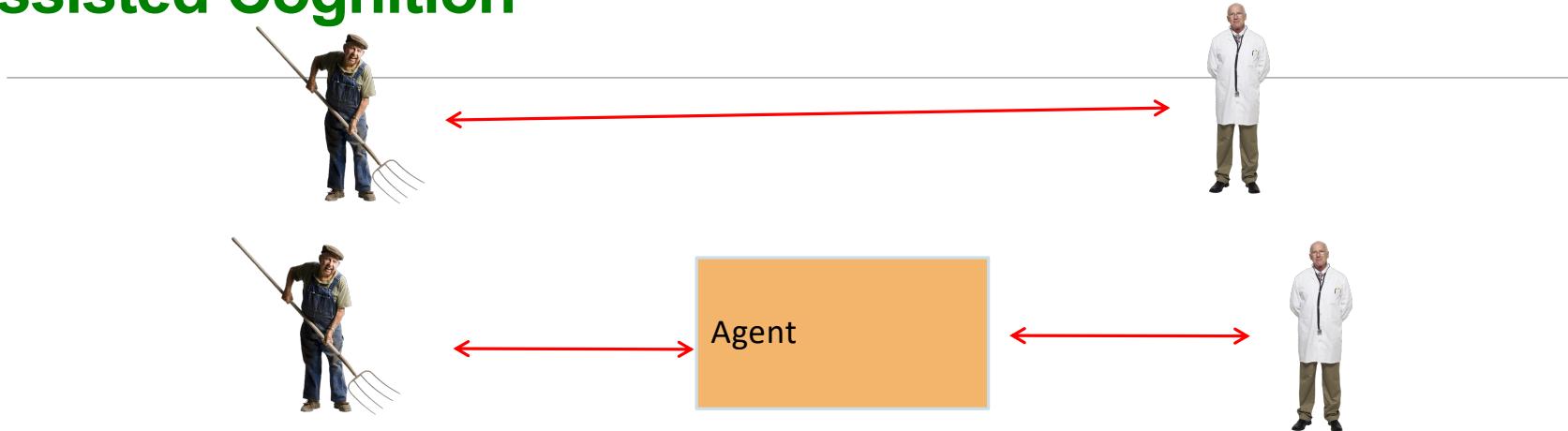
## Expected behavior:

- Inform
  - Alert when crying
  - Alert when awake
  - Alert when idle
- Do
  - Raise temperature of room
  - Play music
  - ...

Conditions can be

- input and **reasoned** (e.g. rule-based methods) OR
- **learned** (from data)

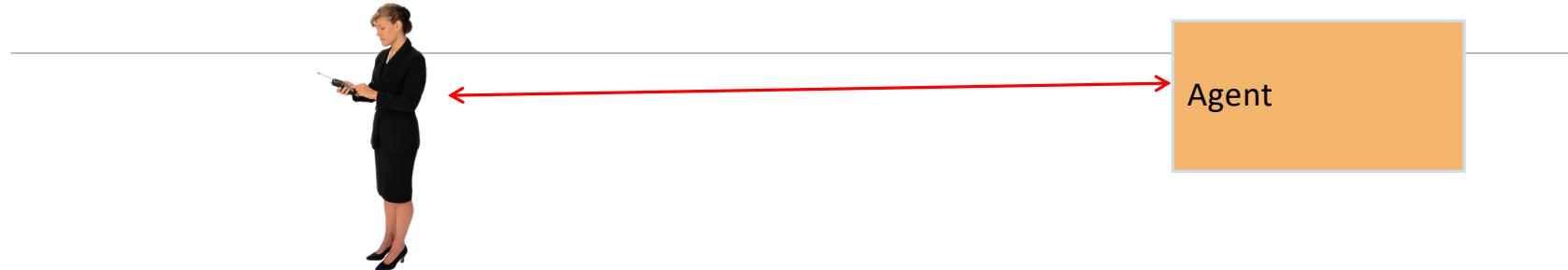
# Example: Taking Care of a Senior **Assisted Cognition**



## Expected behavior:

- Inform
  - Alert when idle
  - Alert when away from known locations
  - Alert when checkup/ medicines due
- Do
  - Send body parameters periodically
  - ...

# Example: Taking Care of Oneself **Personal Digital Assistants**

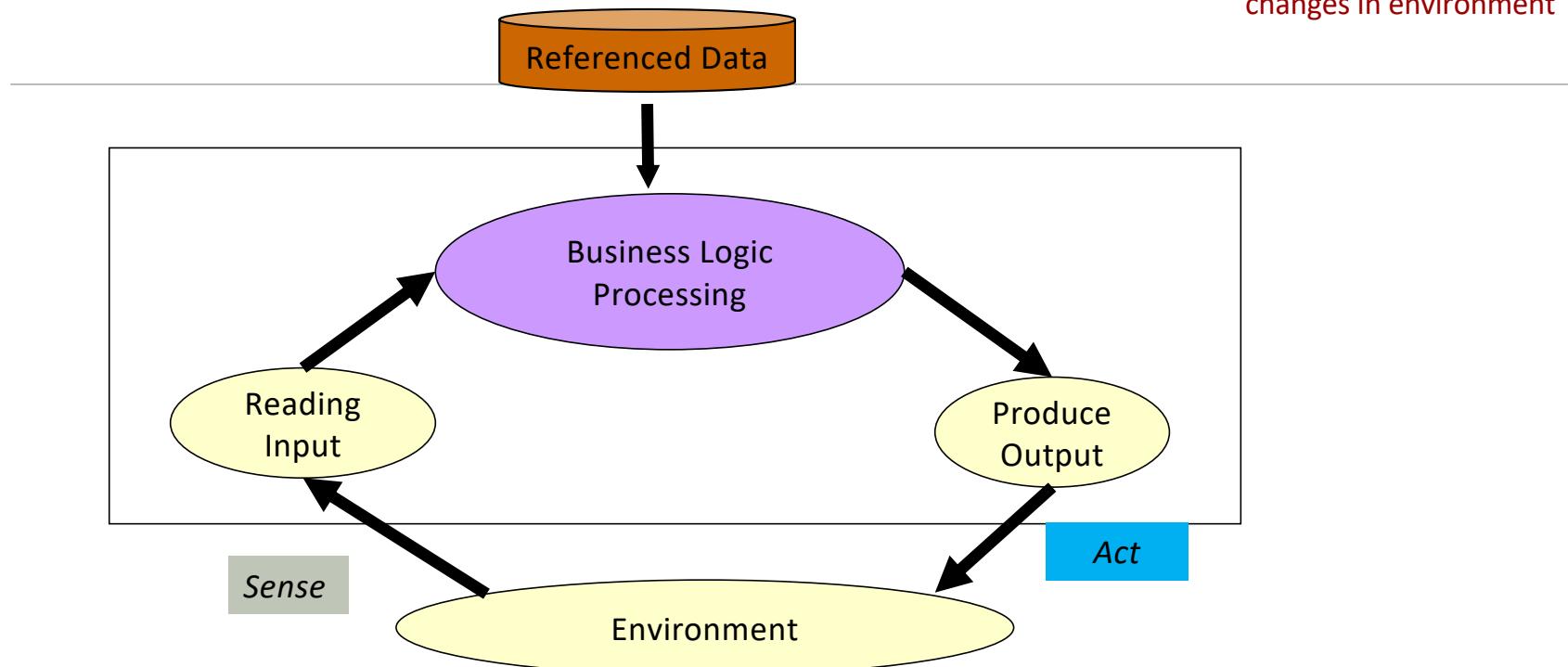


## Expected behavior:

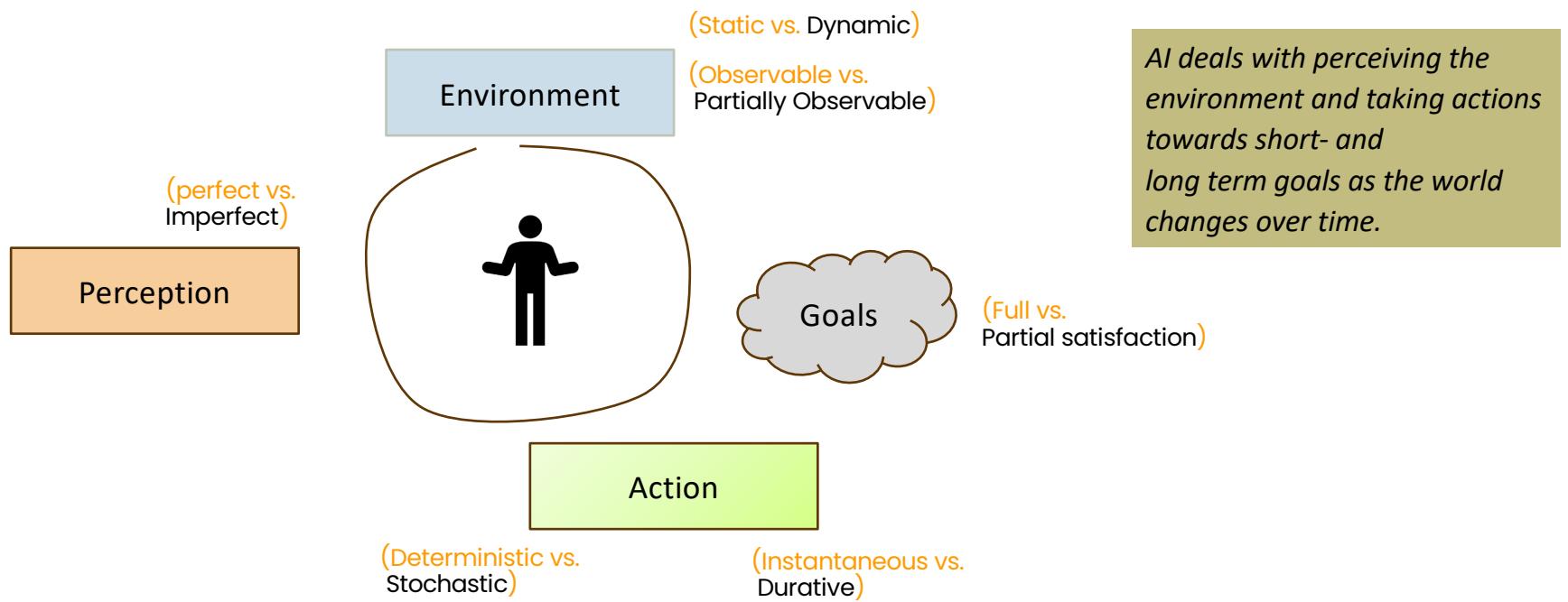
- Inform
  - When missing meetings
  - When missing social commitments
  - Reminding of priorities
  - ...
- Do
  - Make all cancellations / re-bookings when schedule changes
  - Find alternatives to current decisions and give choices (e.g., traffic)
  - ...

# AI => Adaptive/ Intelligent Software System

- Business Logic Moves to Declarative Data (policy)
- Software is more resilient to changes in environment



# Artificial Intelligence (AI) as an Agent



# Example 1: Courses for a Student

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- Decision: Student deciding which courses to take for their program
- Data
  - **Public:** About courses
  - **Public:** About faculties
  - **Public:** About job opportunities
  - **Public:** About research opportunities and industry trends
  - **Private:** what the student wants to do
- Analysis
  - Courses offered in different semesters
  - Teachers offering courses – background, hardness of classes, ...

## Trust

- Are the insights reliable?
- Do they cause short- or long-term harm?
- Will users adopt the insights?

# Thought Exercise – (AI) Class and a Hypothetical AI-based Advisor

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- **Good** decisions for students

- Get good grades, marks
- Learn
- ...

- AI-may suggest

- Give teacher rating
- *But what about learning?*

- **Good** decisions for instructor

- Get good rating
- Finish course
- Teach long-term skills
- ...

- AI-may suggest

- Give student grades
- *But what about teaching?*

**Trust**

- Are the insights reliable?
- Do they cause short- or long-term harm?
- Will users adopt the insights?

# Example 2: Health During a Pandemic

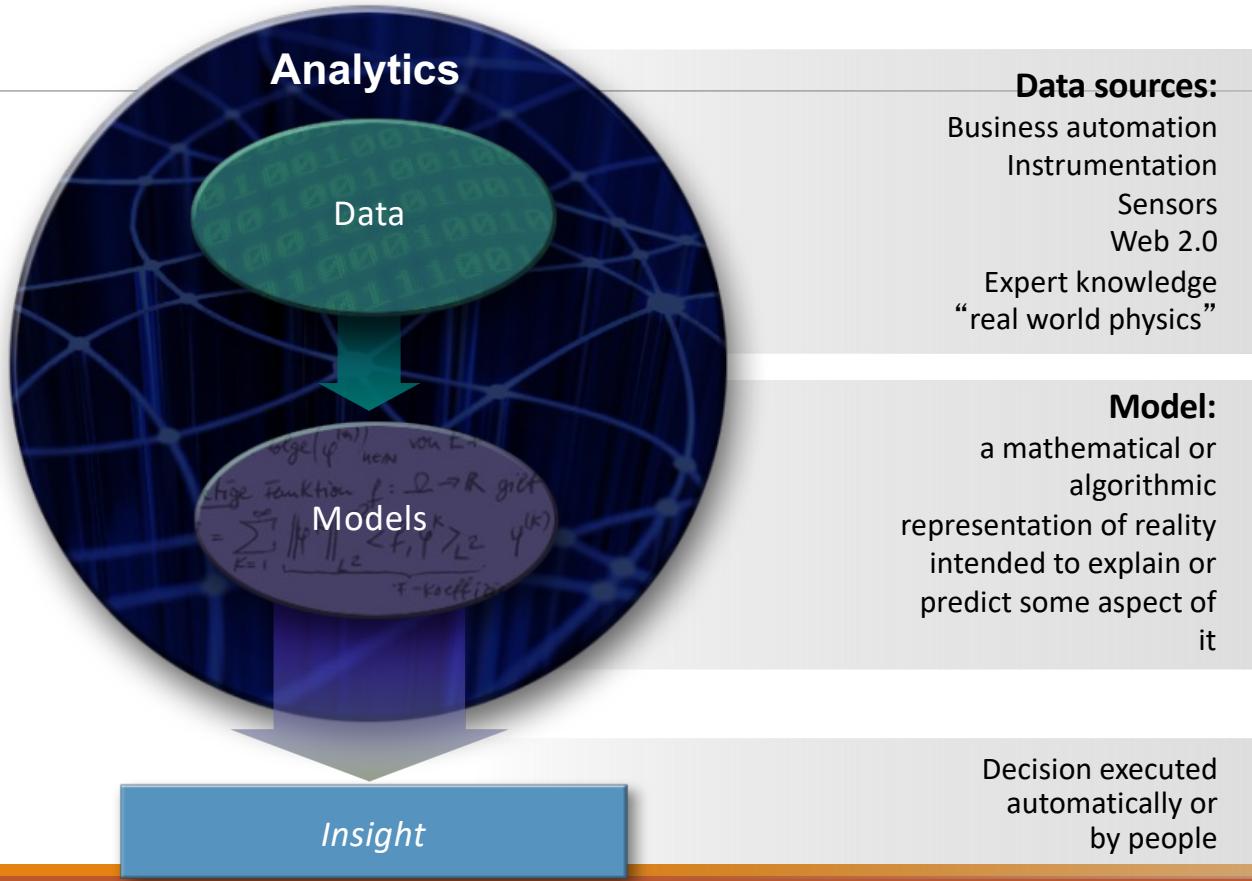
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- Decision: Individual staying healthy during a pandemic like COVID19
- Data
  - **Public:** About disease, cases, deaths, variants
  - **Public:** About mitigation steps: e.g., mask wearing restrictions and practices, lockdowns, hospital conditions
  - **Private:** pre-existing health conditions
- Analysis
  - Regions with high and low cases
  - Whether to eat inside a restaurant?
  - How to make an urgent road trip ?
  - How to hold classes at a University?

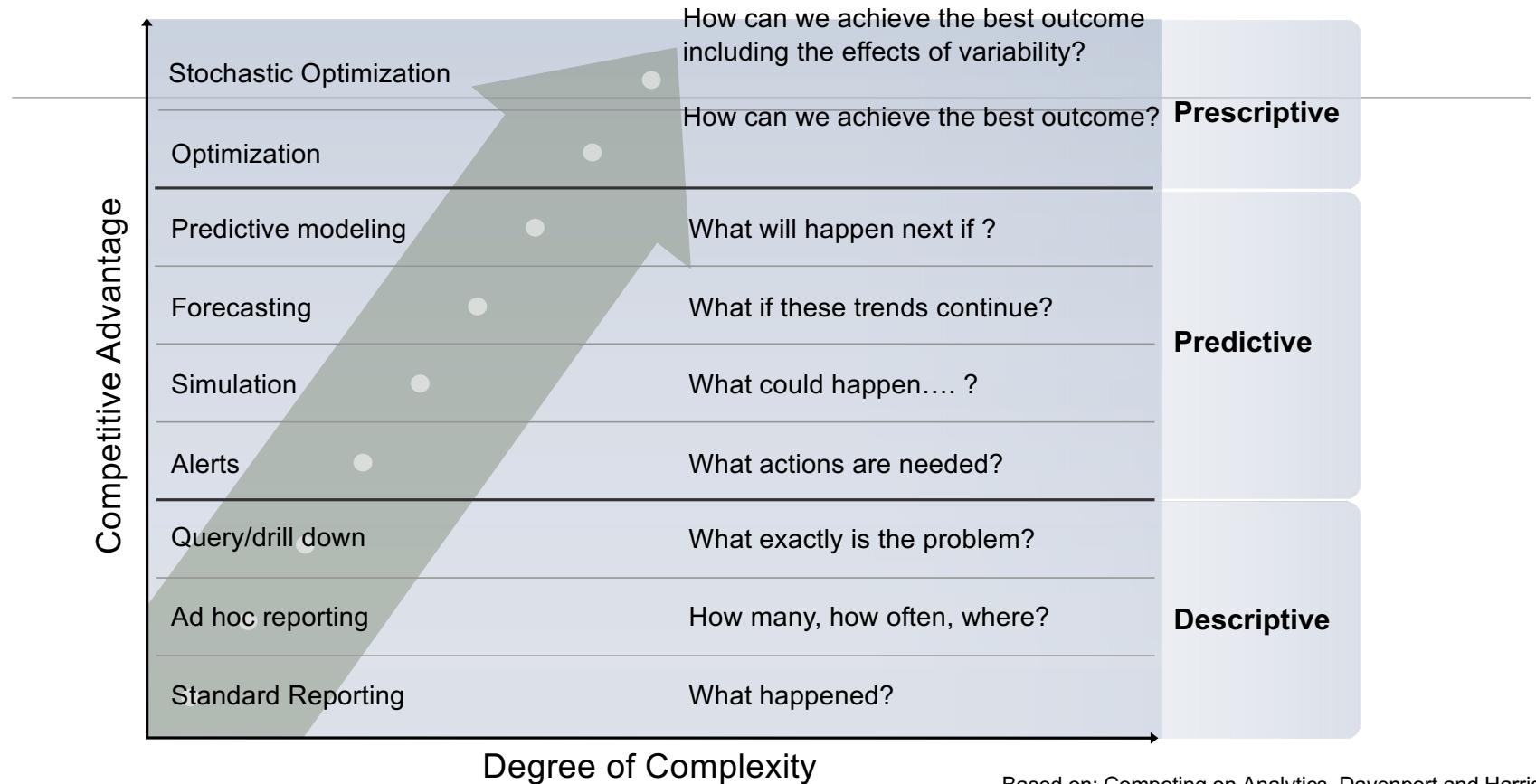
## Trust

- Are the insights reliable?
- Do they cause short- or long-term harm?
- Will users adopt the insights?

Advanced AI Techniques (**Analytics**) like Reasoning (**Symbolic**) & Machine Learning (**Neural**)  
make use of data and models to provide insight to guide decisions



# Analytics Landscape



Based on: Competing on Analytics, Davenport and Harris, 2007

# History of Chatbots is the History of AI

1950 - Turing test

"which player – A or B – is a computer and which is a human."

1964-66 – Eliza

computerized Rogerian psychotherapist

2011 – IBM Watson

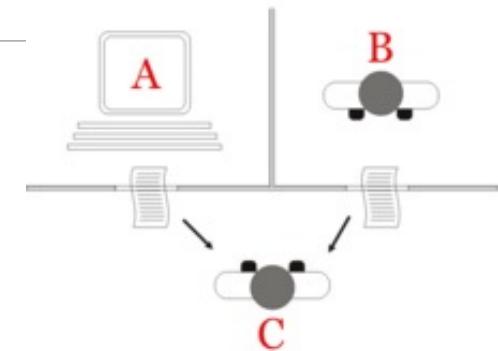
question answering in a game setting

2022 – ChatGPT

large language model based generative, general, chat interfaces

\* 2025: GPT-4.5 claimed to have passed Turing test

*Today everywhere – Amazon Alexa, Google Echo, Apple Siri, ...*

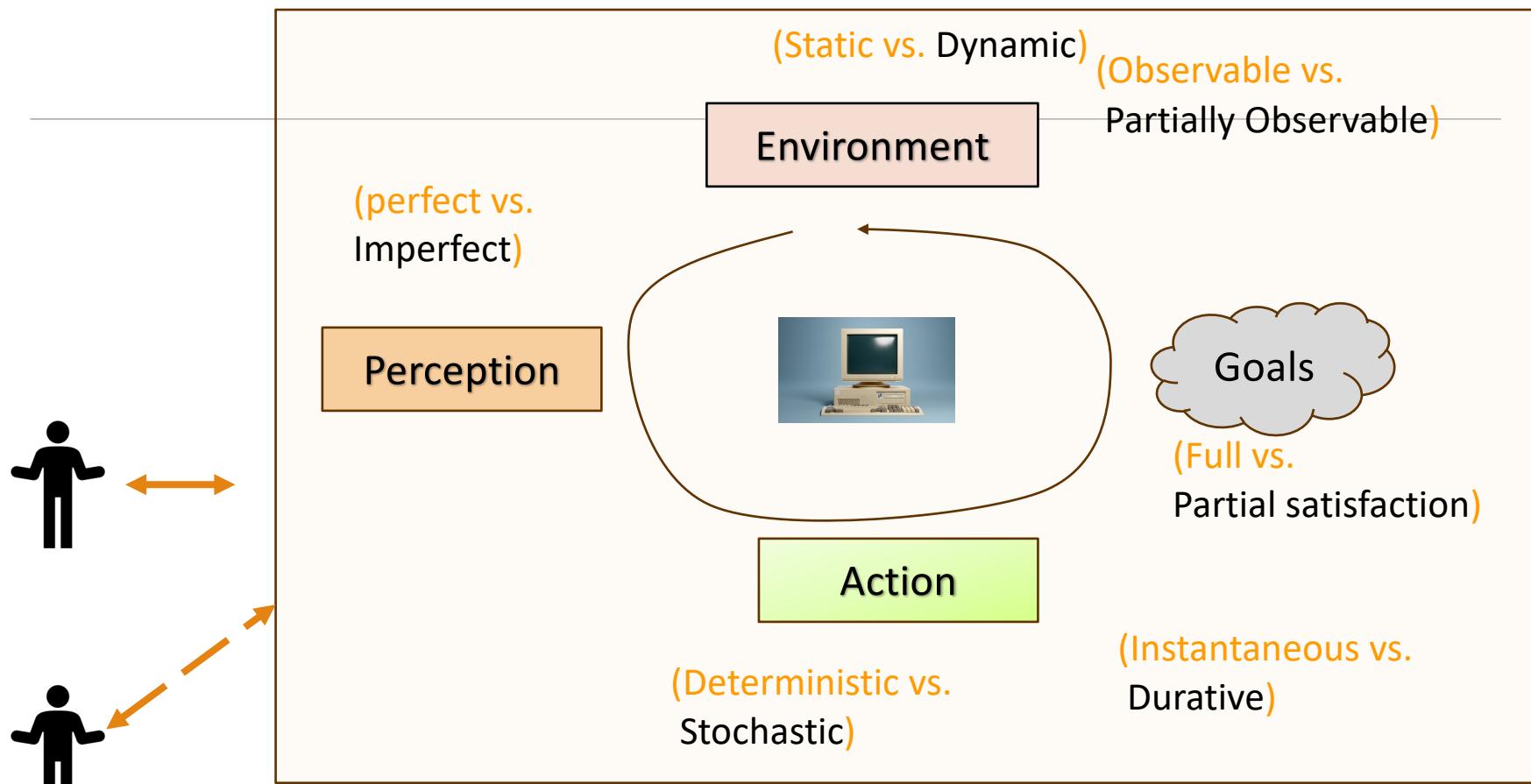


Credit: [https://en.wikipedia.org/wiki/Turing\\_test](https://en.wikipedia.org/wiki/Turing_test)

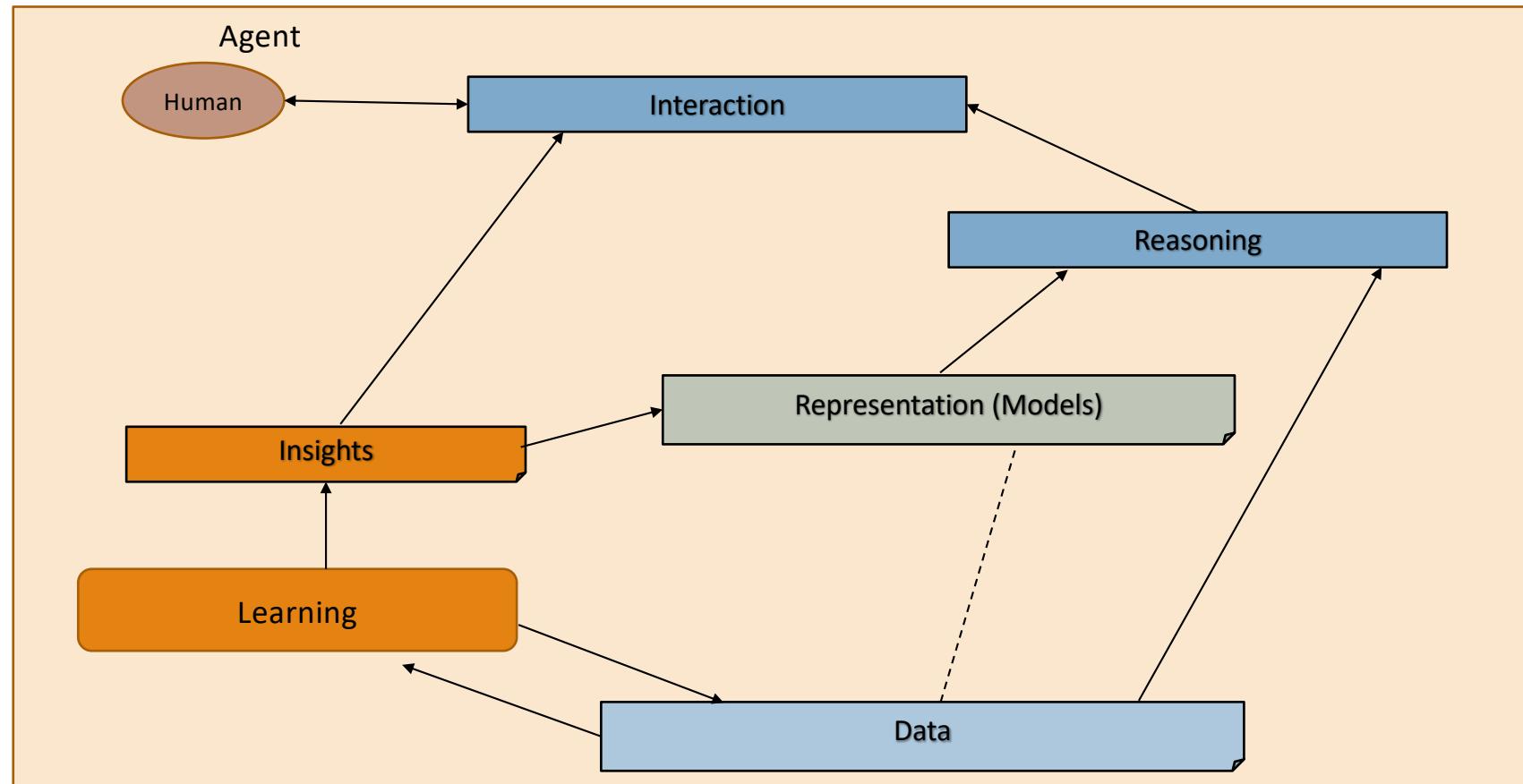


Credit: [https://en.wikipedia.org/wiki/IBM\\_Watson](https://en.wikipedia.org/wiki/IBM_Watson)

# Human-AI Collaboration

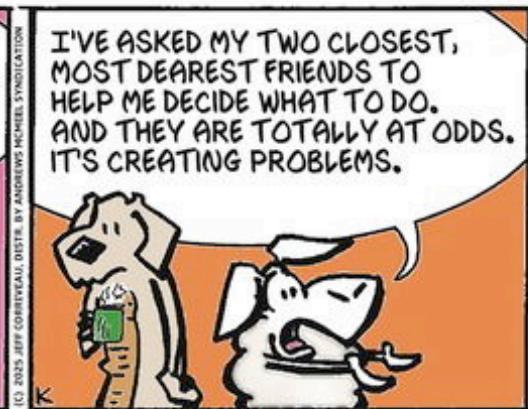
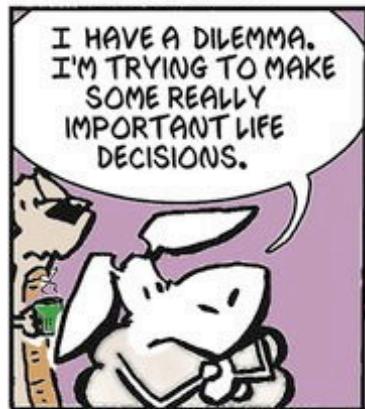


# Relationship Between Main Major AI Topics



## DEFLOCKED

BY JEFF CORRIVEAU



# Course Logistics

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# Course Description

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## **CSCE 580 - Artificial Intelligence (3 Credits)**

Heuristic problem solving, theorem proving, and knowledge representation, including the use of appropriate programming languages and tools.

**Prerequisites:** [CSCE 350](#).

# Course Description – Fall 2025 (\*)

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## **CSCE 581 - Trusted Artificial Intelligence (3 Credits)**

<https://cse.sc.edu/class/580>

AI Trust – responsible/ethical technology, fairness/ lack of bias, explanations (XAI), machine learning, reasoning, software testing, data quality and provenance, tools and projects.

**Prerequisites:** C or better in [CSCE 240](#) and [CSCE 350](#).

**Prerequisite or Corequisite:** D or better in [CSCE 330](#).

# Learning Objectives

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*Understand the breadth of AI techniques, be empowered to solve real-world challenges*

- L1: Appreciate and work with diversity of data—text, speech and visual; focus of course will, be structured data (e.g., tables) and text (NLP; English)
- L2: Learn techniques to derive insights from data spanning reasoning (e.g., symbolic) and learning (e.g., neural) in a decision-making setup
- L3: Learn methods to represent and organize insights
- L4: Make insights usable with people in a collaborative setting (“chatbots”)
- L5: Understand issues related to usage of AI methods/ tools with people.
- L6: Gain experience by build a real-work AI

# Course Description – Spring 2025

*2026 Likely (\*)*

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## **CSCE 581 - Trusted Artificial Intelligence (3 Credits)**

AI Trust – responsible/ethical technology, fairness/ lack of bias, explanations (XAI), machine learning, reasoning, software testing, data quality and provenance, tools and projects.

**Prerequisites:** C or better in [CSCE 240](#) and [CSCE 350](#).

**Prerequisite or Corequisite:** D or better in [CSCE 330](#).

# Focus of This Course & Relationship With Recent Others

## CSCE 580 – Introduction to AI – Topics in Recent Courses

- Topic 1: Introduction, aims
- Topic 2: Search, Heuristics
- Topic 3: Constraint Satisfaction Problems
- Topic 4: Decision making - Game trees
- Topic 5: Decision making - Decision networks
- Topic 6: Decision making – Markov Decision Processes, Hidden Markov models
  - Topic 7: Learning – naïve Bayes, regression, Classification, clustering (unsupervised)
  - Topic 8: Learning neural network, deep learning
  - Topic 9: Decision making – Planning, Reinforcement Learning
  - Topic 10: Robotics
  - Topic 12: Representation, Ontology
  - Topic 12: Tools

Classical AI topics and a focus on implementation

Fall 2024

## CSCE 581 – Special Topic; Regular Planned

- Week 1: Introduction
- Week 2: Background: AI - Common Methods
- Week 3: The Trust Problem
- Week 4: Machine Learning (Structured data) - Classification
  - Week 5: Machine Learning (Structured data) - Classification – Trust Issues
  - Week 6: Machine Learning (Structured data) – Classification – Mitigation Methods
  - Week 7: Machine Learning (Structured data) – Classification – Explanation Methods
  - Week 8: Machine Learning (Text data) - Classification
  - Week 9: Machine Learning (Text data) - Classification – Trust Issues
  - Week 10: Machine Learning (Text data) – Classification – Mitigation Methods
  - Week 11: Machine Learning (Text data) – Classification – Explanation Methods
  - Week 12: Emerging Standards and Laws
  - Week 13: Project presentations
  - Week 14: Project presentations, Conclusion

AI/ ML topics and with a focus on fairness, explanation, Data privacy, reliability

Spring 2025

# Adapt Based on Class Interest?

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- CSCE 580: Classical AI topics and a focus on implementation
- CSCE 581: AI/ ML topics and with a focus on fairness, explanation, Data privacy, reliability
- Need to adapt?
  - AI/ ML topics with a focus on generative AI, fairness, explanation, adversarial attacks; building chatbots
  - Help students focus on their elected course project

# High Level Plan

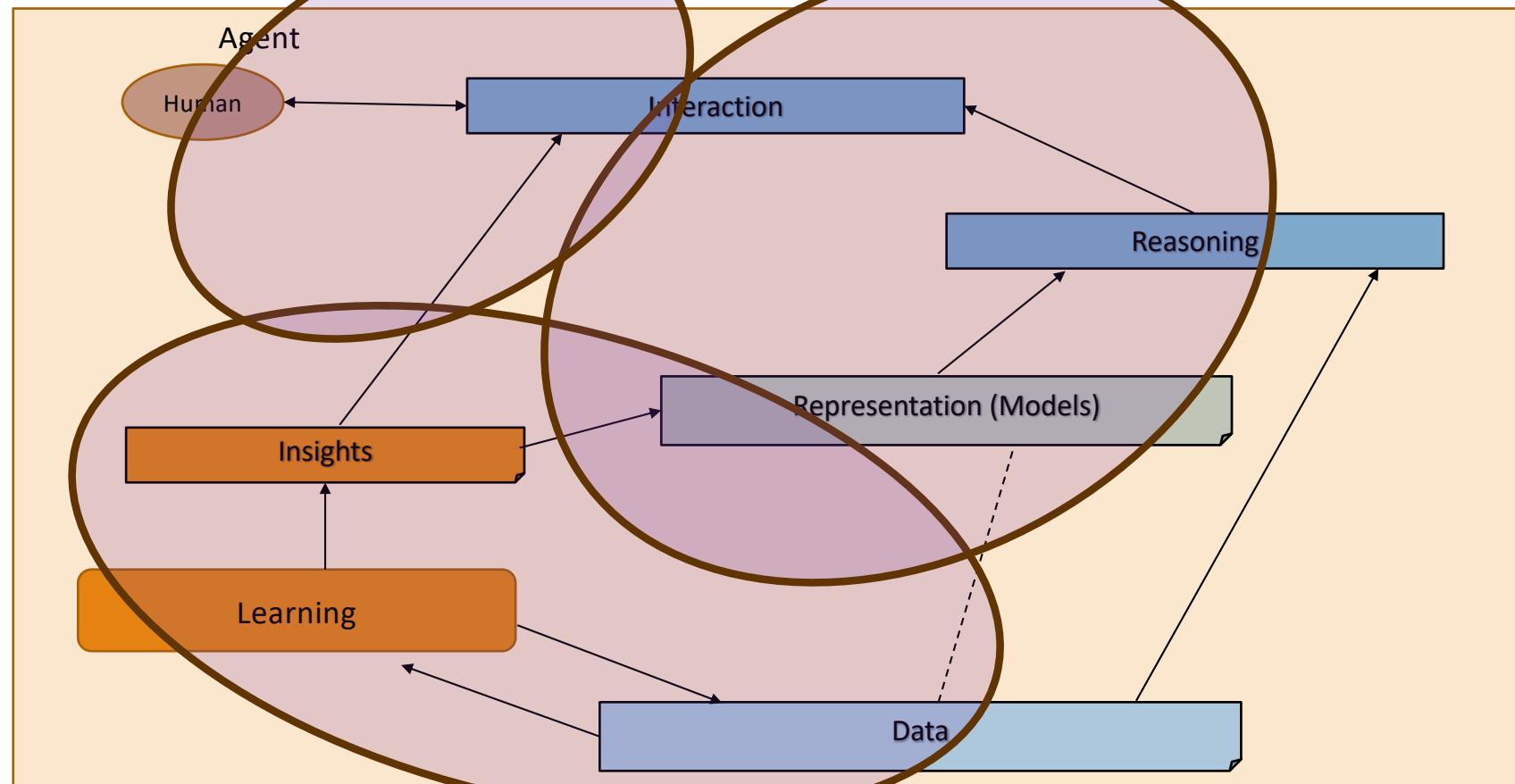
## CSCE 580 –

- Week 1: Introduction, Aim: Chatbot / Intelligence Agent
- Weeks 2-3: Data: Formats, Representation and the Trust Problem
- Week 3: Machine Learning – Supervised (Classification)
- Week 4: Machine Learning - Unsupervised (Clustering) –
- Topic 5: Learning neural network, deep learning, Adversarial attacks
- Week 6: Large Language Models – Representation and Usage issues
- Weeks 7-8: Search, Heuristics - Decision Making
- Week 9: Constraints, Optimization – Decision Making
- Topic 10: Markov Decision Processes, Hidden Markov models –  
Decision making
- Topic 11-12: Planning, Reinforcement Learning – Sequential decision making
- Week 13: Trustworthy Decision Making: Explanation, AI testing
- Week 14: AI for Real World: Tools, Emerging Standards and Laws;  
Safe AI/ Chatbots

Fall 2025

AI/ ML topics and with a focus on showing breadth of classic methods, introducing language models and trustworthiness issues (testing, fairness, explanation, data privacy, reliability), and **experience in real-world system building**

## Relationship Between Main AI Topics (Covered in Course)



# Administrative Information – CSCE 580

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**Github:** <https://github.com/biplav-s/course-ai-f25>

**Website:**  
<https://sites.google.com/site/biplavsrivastava/teaching/ai-csce-580-fall-2025-intro-to-ai>

## Quick Info - When and Where

- Tuesday/Thursday 4:25 pm – 5:40 pm
- In person at 300 Main St. | Room B110  
*Recordings to be available on Blackboard.*

## Catalog Information

- [Course description, AI - CSCE 580 001](#)
- CRN: [CRN18240](#), Duration: 08/19/2025 - 12/15/2025

## Instructor Information

- Instructor: Biplav Srivastava
- E-mail: [biplov.s AT sc.edu](mailto:biplov.s@sc.edu)
- Office Hours: 3-4 pm (Tue, Th); other times by appointment
- [GitHub](#) for slides, sample code.

## TA Information

- Vishal Pallagani (LLM/NLP), Kausik Lakkaraju (1/2 – AI explainability)

# Course Material

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- Artificial Intelligence: A Modern Approach (Fourth edition, 2020), Stuart Russell and Peter Norvig,  
<http://aima.cs.berkeley.edu/>,  
ISBN-13: 978-0134610993
- Trustworthy Machine Learning, by Kush R. Varshney,  
<http://www.trustworthymachinelearning.com/>, 2022

## Open Datasets

- data.gov from ANY COUNTRY
  - Portal: <https://dataportals.org/>
  - US: <https://www.data.gov/> or any US state
  - India: <https://data.gov.in>
- Text of legislations - LegiScan, <https://legiscan.com/>
- Kaggle datasets: <https://www.kaggle.com/datasets>
- Google datasets search:  
<https://datasetsearch.research.google.com/>

## • AI Fairness

- Trisha Mahoney, Kush R. Varshney, and Michael Hind, Available at: <https://krvarshney.github.io/pubs/MahoneyVH2020.pdf>
- In AI We Trust: Ethics, Artificial Intelligence, and Reliability, Mark Ryan. Available at: <https://link.springer.com/article/10.1007/s11948-020-00228-y>

## • Python for Data Analysis

- Latest: Python for Data Analysis Book, by Wes McKinney, 2<sup>nd</sup> Edition. On Amazon at: <https://www.amazon.com/gp/product/1491957662/>, ISBN-13: 978-1491957660, ISBN-10: 1491957662
- Book Data and Code Notebooks: <https://github.com/wesm/pydata-book>
- 1<sup>st</sup> edition (free download): <https://bedford-computing.co.uk/learning/wp-content/uploads/2015/10/Python-for-Data-Analysis.pdf>

# Student Assessment

A = [920-1000]

B+ = [870-919]

B = [820-869]

C+ = [770-819]

C = [720-769]

D+ = [670-719]

D = [600-669]

F = [0-599]

Tests	Undergrad	Grad
Course Projects – report, in-class presentation*	600	600
Quiz – 2 best from 3 (undergrad only)	200	200
Final Exam **	200	100
Additional Final Exam – Paper summary, in-class presentation		100
Total	1000 points	1000 points

\* Details to follow.

\*\* May be be takeaway

# Course Projects

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- Project A – 4 weeks [200 points]
  - Model AI Assignments: <http://modelai.gettysburg.edu/>
  - Choose a project; preferably within last 5 years (i.e., after 2020); follow instructions and do it alone
- Project B – 8 weeks [400 points]
  - Option 1 – do a common problem given to the class; instructions to follow; will have strong generative AI and trust component
  - Option 2 – do your own, under consultation with instructor

## Taking Graduate Credits – Additional Requirements

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- a) All three quizzes are mandatory. (No 2/3 option available)
- b) Research paper presentation and report had to be done.

# Class Policy and Absences

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- No makeup for Quizzes; best of 2 will be applied from 3
- No makeup for presentations (project/ paper/ ...)
  - With prior permission, video can be made and played

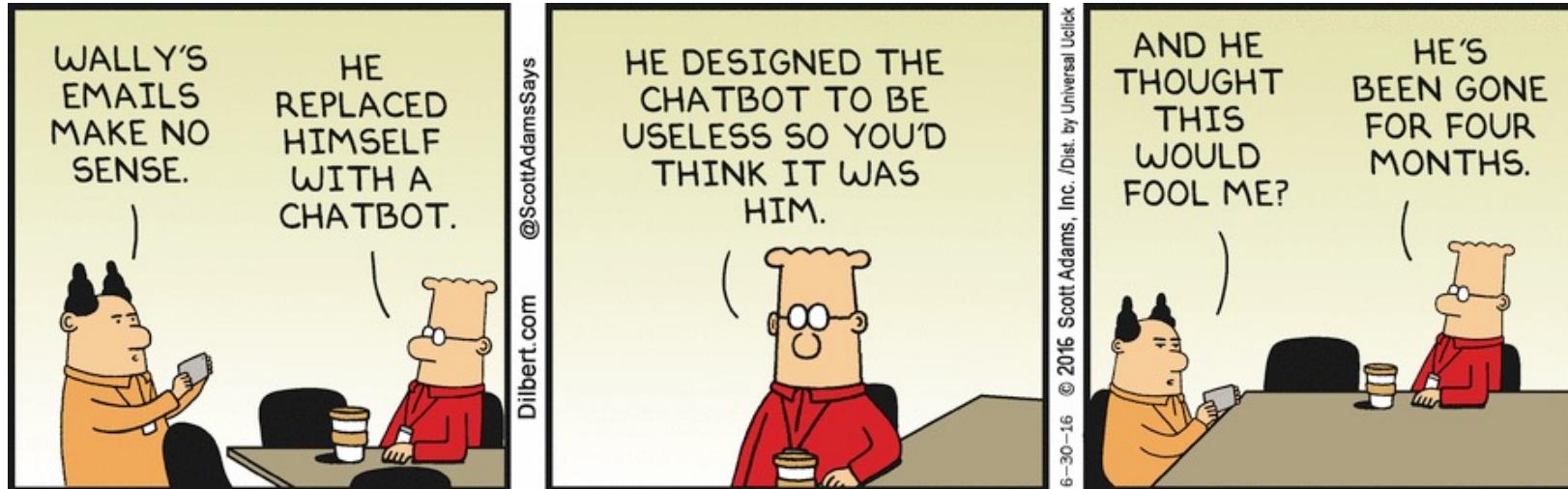
# GenAI Usage Policy for the Course

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- **GenAI can be used to generate code** for project and Quizzes
  - Full disclosure of usage has to be provided
  - full details of prompt and output have to be given
- **GenAI can be used for assignments when asked**
  - Example, evaluating one's project output with GenAI's
- **No GenAI tools to be used for any other purpose**
  - E.g., for producing for creating reports, presentations, for quizzes
  - Violations will lead to [150 marks out of 1000] penalty; drop of at least 2 letter grades

# AI for the Real World

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Credit: Dilbert – June 30, 2016

# Teaching Innovations – Real World

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See: <https://sites.google.com/site/biplavsrivastava/teaching/>

Visit to **Irmo Fire Station** to learn about problems

- Friday, August 29, 2025 from 10:30-11:30am
- Let instructor know by email

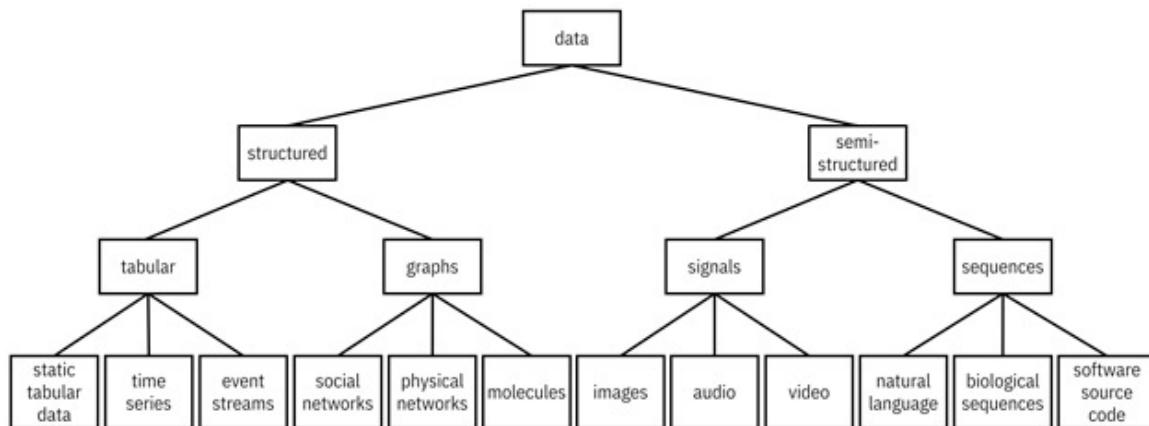
# Data – The Fuel for AI

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# Types of Data

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- By media: Text, Sound (speech), Visual (image, video), Multi (modal, media)
- By structure: unstructured, semi-structured, structured
- By features: time-series, labeled/ unlabeled, spatio-temporal,



**Image credit:**

<http://www.trustworthymachinelearning.com/trustworthymachinelearning-04.htm>

# Open Data

- Open data is the notion that data should not be hidden, but made available to everyone to **reuse**. **The idea is not new.**
- Scientific publications follow this: “standing on the shoulders of giants”
- Data quality and open publishing process is critical

A screenshot of the US Data.gov website. The top navigation bar includes links for DATA, TOPICS, RESOURCES, STRATEGY, DEVELOPERS, and CONTACT. Below the navigation is a grid of icons representing various sectors: Agriculture, Climate, Ecosystems, Energy, Local Government, Maritime, Ocean, and Older Adults Health. A featured dataset is "U.S. Hourly Precipitation Data" with 855 recent views, described as a digital data set archived at the National Climatic Data Center (NCDC). Another dataset, "NCDC Storm Events Database", is also shown. The footer includes a note about OpenStreetMap and a CC BY-SA license.

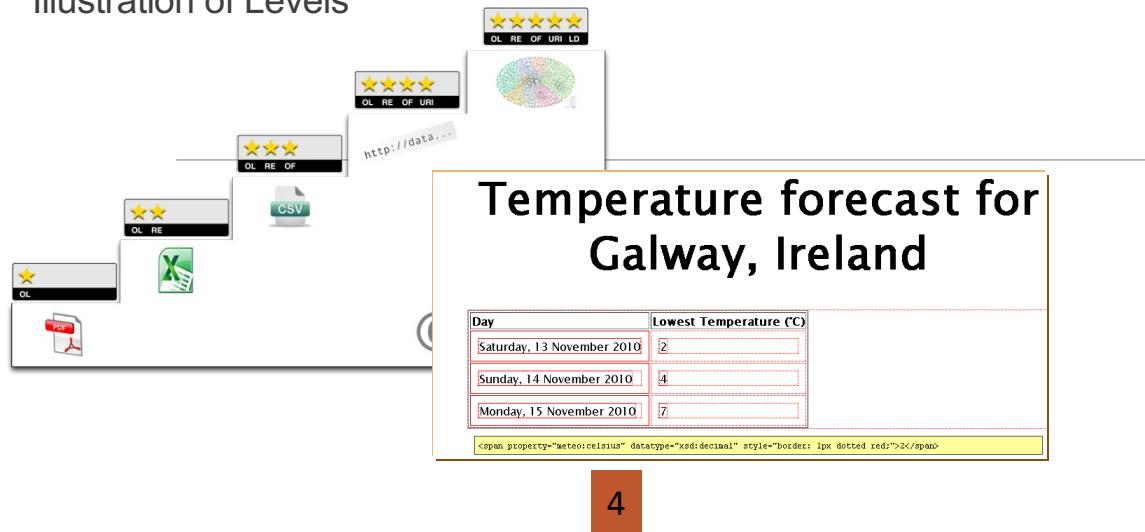
USA

A screenshot of the India data.gov.in website. The top navigation bar includes links for Skip to navigation, Skip to main content, DataGov States/ULB, and a search bar. The main page features a banner for "DATASETS FROM HEALTH SECTOR". Below the banner are sections for ANALYTICS (showing 395,534 resources, 8,380 catalogs, 173 departments, 28.58 M times viewed, 8.19 M times downloaded, 354 chief data officers, 32,392 APIs, and 2,043 visualizations), CATALOG (showing a lightbulb icon and user figures), and INDICATOR DASHBOARD (showing icons for Drinking Water And Sanitation, Health, Transport, and Labour And Employment). The footer includes a note about the Udyog Aadhaar Memorandum (MSME Registration).

India

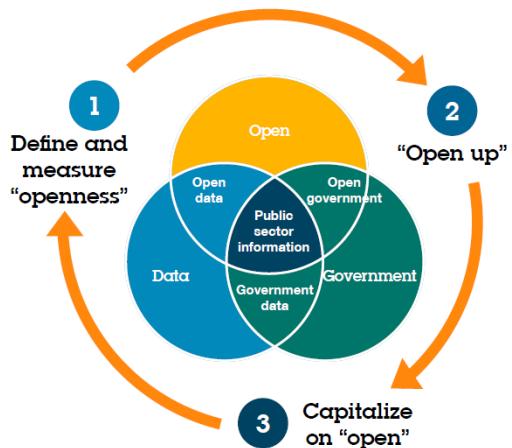
## Does Opening Data Make It Reusable? No

Illustration of Levels

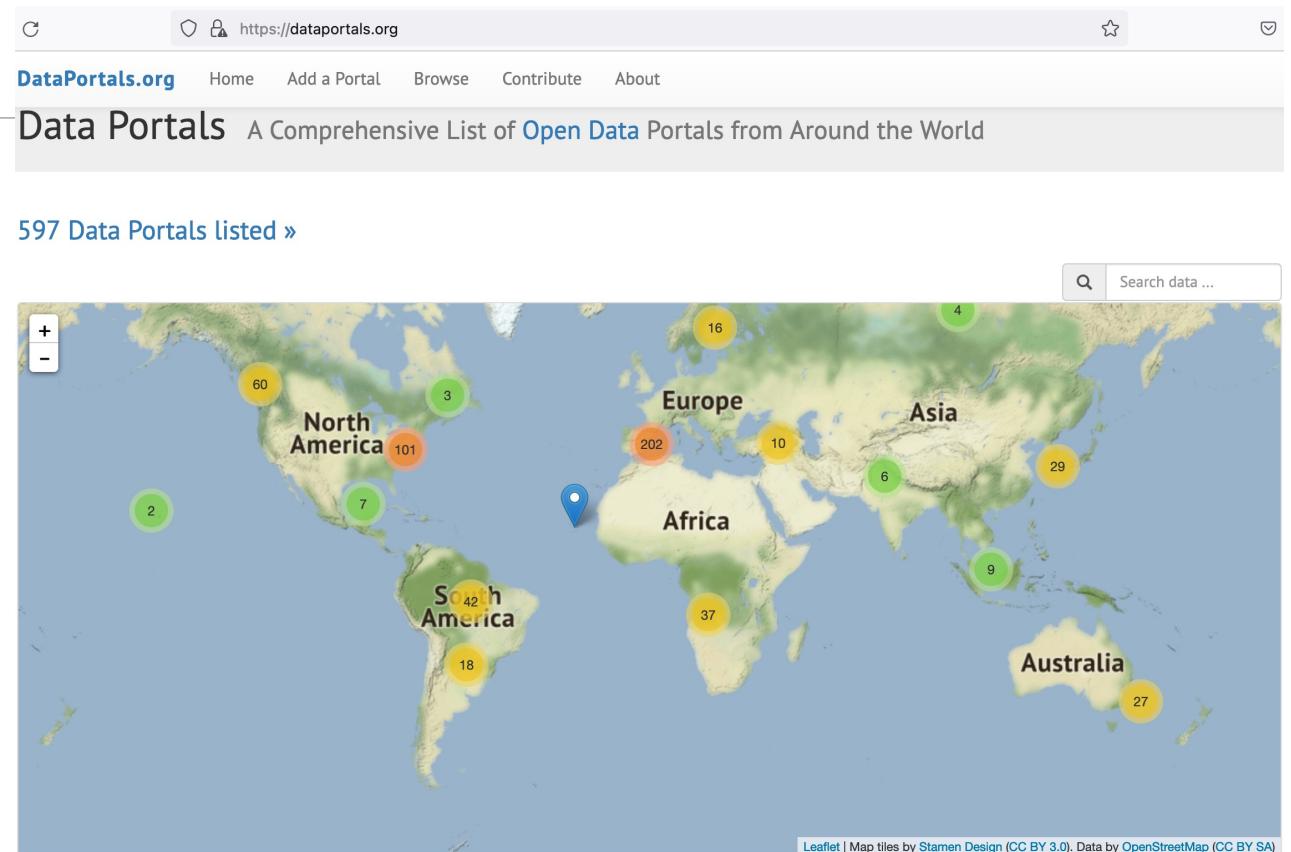


Source: <http://5stardata.info/>

# About 600 Data Catalogs of Public Data



As on 17 Aug 2022



# Guideline: Human Impact of AI

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- We study technology (AI) but it works with data
- Data, when from people or about people, can have issues like bias
  - **Example:** data reveals a view which is influenced by data collection practices
  - **Difference:** **World as it is**, world according to data and **world as it should be**
- The course and instructor believes in
  - Not promoting bias of any kind
  - Respecting everyone regardless of background

# AI Ethics

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# Why is Ethics Even an Issue?

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- When a technology works with humans and relates to inter-personal issues, the question of ethics comes into picture
- Examples: medicine (opioids), food (genetically modified)

Discussion: what, if any issue,

- in recommending courses to students?
- in finding treatment for Covid?

# What is Specific to AI?

- AI needs **data**
  - Data privacy and governance
- AI is often a **black box**
  - Explainability and transparency
- AI can make **decisions/recommendations**
  - Fairness and value alignment
- AI is based on statistics and has always a small percentage of **error**
  - Who is accountable if mistakes happen?
- AI can infer our preferences and **manipulate** them
  - Human and moral agency
- AI is very **pervasive and dynamic**
  - Larger negative impacts for tech misuse
  - Fast transformation of jobs and society

**Credits:**

Tutorial on [Trusting AI by Testing and Rating Third Party Offerings at IJCAI 2020](#), Biplav Srivastava, Francesca Rossi, Jan 2021

# Main AI Ethics Issues



DATA GOVERNANCE  
AND PRIVACY



FAIRNESS AND  
INCLUSION



HUMAN AND  
MORAL AGENCY



VALUE ALIGNMENT



ACCOUNTABILITY



TRANSPARENCY AND  
EXPLAINABILITY



TECHNOLOGY  
MISUSE

**Credits:**

Tutorial on Trusting AI by Testing and Rating Third Party Offerings at IJCAI 2020, Biplav Srivastava, Francesca Rossi, Jan 2021

# Collaborative Assistants

---

- Conversation agents and interfaces (chatbots) are getting easy to build and deploy
  - Can be text-based or speech-based
  - Usually multi-modal (i.e, involving text, speech, vision, document, maps)
- Current chatbots typically interact with a single user at a time and conduct
  - Informal conversation, or
  - Task-oriented activities like answer a user's questions or provide recommendations

## Demonstrations

- *Eliza*, <http://www.manifestation.com/neurotoys/eliza.php3>
- *Mitsuku*, <https://www.pandorabots.com/mitsuku/>
- ChatGPT, <https://openai.com/blog/chatgpt>

# Exercise: Session with ChatGPT

---

- Ask questions about Water usage
  - Experience
- Ask questions about Finance
  - Experience
- Hint:
  - Demand / supply questions: “can I drink water of Lake Murray”?, “will US have money to pay debt next year”
  - Decision questions: “which water should I choose between a bottled one and tap”?
  - Factoid questions: “is pH of 7 good for drinking water?”

# Exercise: Your Resumes

---

- What does a search (Google search) tell about you?
- What does a LLM/ ChatGPT tell about you?
- Task:
  - Put your resume at: <TBD>
- Course task: We will analyze them as part of AI/ data science activity in a later class

# Exercise: Solving Games with AI

---

- Popular way to learn AI is via games
  - <https://github.com/biplav-s/course-ai-tai-f23/blob/main/sample-code/Class1-games.md>

# Concluding Section

---

# Lecture 1: Concluding Comments

---

- We did a quick overview of
  - AI
  - Trust issues
- Course will focus on
  - Learning AI methods (**broad**)
  - Understanding trust issues and ongoing ways to make AI reliable, practical ways to convey trustworthy results to users.
  - Applying methods in projects (**deep**)
  - Student evaluation will be by via project, paper and quizzes
- Exciting techniques to learn to impact the world around us

# About Next Lecture – Lecture 2

---

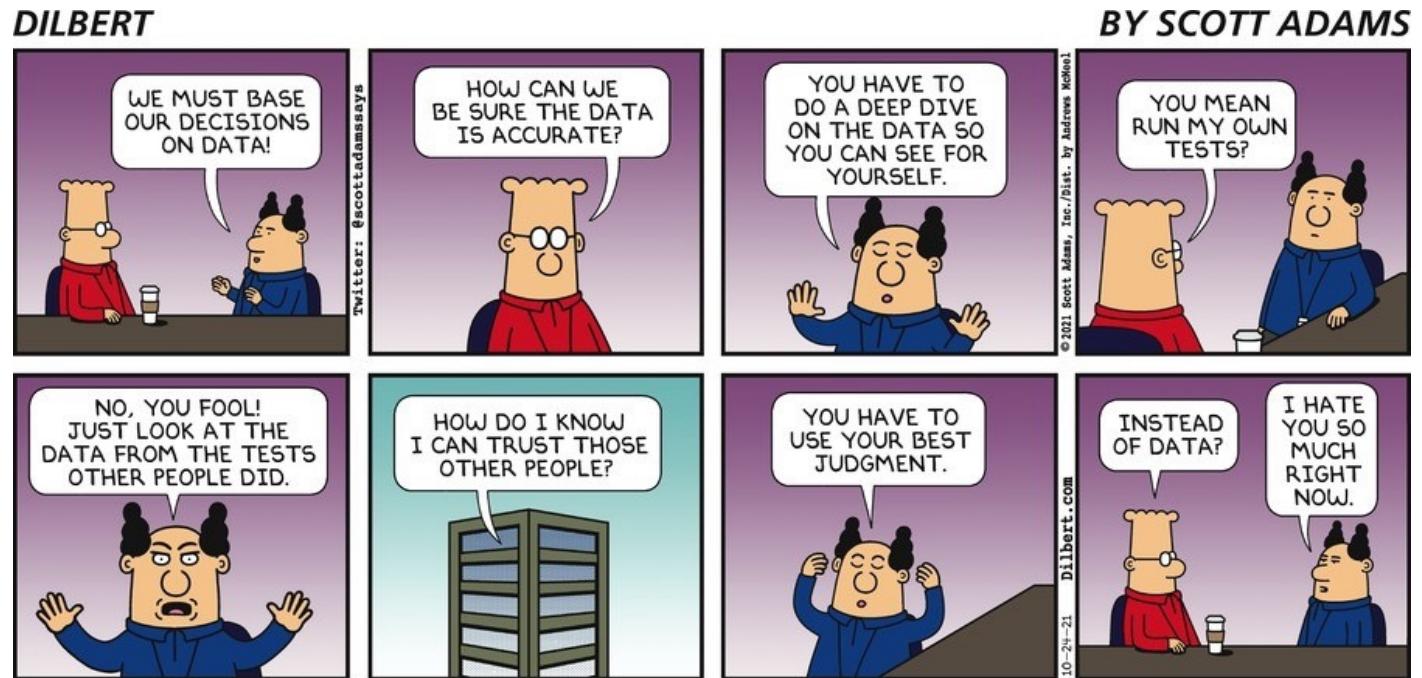
# Lecture 2: Data

---

- Data analysis for traffic (South Carolina), Trust –  
<https://ai4society.github.io/projects/traffic-page/index.html>
- Recommendations and Trust [Fairness and Teaming Recommendation] –  
[https://ai4society.github.io/projects/group\\_rec/index.html](https://ai4society.github.io/projects/group_rec/index.html)

# Organization of Lecture 2

- Introduction Segment
  - Recap of Lecture 1
- Main Segment
  - Types
    - Structured,
    - Semi-structured,
    - Unstructured,
  - By media: text, audio, video, multi-media;
  - Open Data
    - City data: access
    - Data quality
- Concluding Segment
  - About Next Lecture – Lecture 3
  - Ask me anything



Credit: Dilbert

# Introduction Section

---

# Exercise: Your Resumes

---

- Knowing about a person; about a group
- Alternatives
  - What does a search (Google search) tell about you?
  - What does a LLM/ ChatGPT tell about you?
- Task:
  - Put your resume at: <TBD>
  - Analyze resume as part of AI/ data science activity in a later classses
- Questions to answer:
  - Individual
  - About a group

# Exercise: Session with ChatGPT

---

- Ask questions about Water usage
  - Experience
- Ask questions about Finance
  - Experience
- Hint:
  - Demand / supply questions: “**can I drink water of Lake Murray?**”, “**will US have money to pay debt next year**”
  - Decision questions: “**which water should I choose between a bottled one and tap**”?
  - Factoid questions: “**is pH of 7 good for drinking water?**”

# Exercise: Solving Games with AI

---

- Popular way to learn AI is via games
  - <https://github.com/biplav-s/course-ai-tai-f23/blob/main/sample-code/Class1-games.md>

# Main Section

---

# Data – The Fuel for AI

---

# Overview: Types of Data

---

- By content structure: Structured, unstructured and semi-structured
- By media: text, audio, visual, multi-media
  
- By source
  - Open data
  - Social data
  - Sensor data
  - Proprietary data
  
- Value is by fusing data across all types
  - sources, content structure and media

# Types of Data - Structured

---

- The structure of data is fixed. Example: columns in a database
- Benefits
  - Can be stored and queried efficiently, e.g., by commercial databases
  - Easy to analyze, e.g., by SQL or programs – pandas in Python
- Disadvantage
  - Hard to handle data's structural changes. E.g., adding a new column. Complex data migration procedures

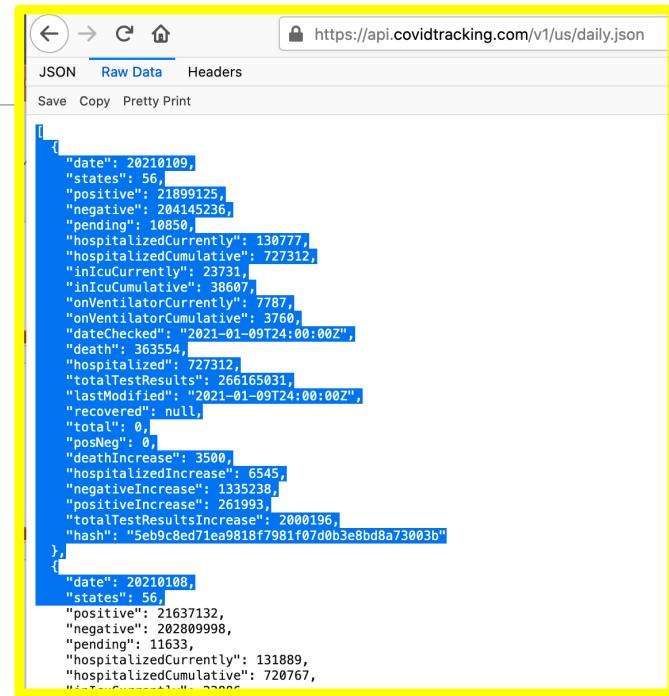
```
country,placename,frequency,start_date,end_date,year,month,week,deaths,expected_deaths,excess_deaths,baseline  
...  
France,,weekly,2020-04-27,2020-05-03,2020,4,18,10498,10357,141,2010-2018 weekly average  
...
```

Source: <https://github.com/nytimes/covid-19-data/tree/master/excess-deaths>

NYT COVID datasets: <https://github.com/nytimes/covid-19-data/>

# Types of Data – Semi-Structured

- The structure of meta-data is fixed, but the structure of data is allowed to change. Example: XML, JSON
- Benefits
  - Relatively easy to analyze, e.g., commands similar to SQL in languages like OQL or Xquery
  - Structure of data easy to extend
- Disadvantage
  - Size of data is larger than structured representation as metadata is added with each record

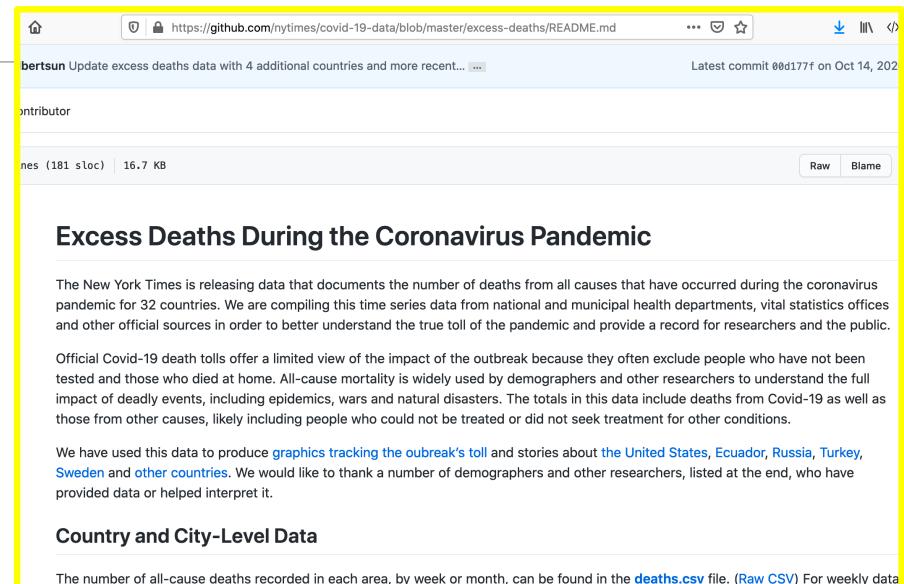


```
[{"date": "20210109", "states": 56, "positive": 21899125, "negative": 204145236, "pending": 10850, "hospitalizedCurrently": 130777, "hospitalizedCumulative": 727312, "inICUCurrently": 23731, "inICUCumulative": 38607, "onVentilatorCurrently": 7787, "onVentilatorCumulative": 3760, "dateChecked": "2021-01-09T24:00:00Z", "death": 36354, "hospitalized": 727312, "totalTestResults": 266165031, "lastModified": "2021-01-09T24:00:00Z", "recovered": null, "total": 0, "posNeg": 0, "deathIncrease": 3500, "hospitalizedIncrease": 6545, "negativeIncrease": 1335238, "positiveIncrease": 261993, "totalTestResultsIncrease": 2000196, "hash": "5eb9c8ed71ea9818f7981fb0d0b3e8bd8a73003b"}, {"date": "20210108", "states": 56, "positive": 21637132, "negative": 202809998, "pending": 11633, "hospitalizedCurrently": 131889, "hospitalizedCumulative": 720767, "inICUCurrently": 23731, "onVentilatorCurrently": 7787}
```

Source: <https://api.covidtracking.com/v1/us/daily.json>

# Types of Data – Unstructured

- The data has no structure.  
Example: text
- Benefits
  - Easy to change structure
  - Content can be compactly stored
- Disadvantage
  - Hard to analyze content. Example: word analysis, sentiments, topic, ...



Source: <https://github.com/nytimes/covid-19-data/blob/master/excess-deaths/README.md>

NYT COVID datasets: <https://github.com/nytimes/covid-19-data/>

# Textual Data

---

- Media: text
- Components: characters, words, paragraph
- Representation
  - Uncompressed / encoding – ASCII, UTF-8, UTF-16
  - Compressed - .zip
  - Lossy compression -
- Language: English, French, ...
- Programming libraries: nltk, spacy

<a href="#">Filename extension</a>	.txt
<a href="#">Internet media type</a>	text/plain
<a href="#">Type code</a>	TEXT
<a href="#">Uniform Type Identifier (UTI)</a>	public.plain-text
UTI conformation	public.text
Type of format	<a href="#">Document file format</a> , <a href="#">Generic container format</a>

Details: [https://en.wikipedia.org/wiki/List\\_of\\_file\\_formats](https://en.wikipedia.org/wiki/List_of_file_formats)

# Sound

- Media: sound
- Components: phoneme
- Representation
  - Uncompressed - .wav, .aiff
  - Compressed lossless -
  - Lossy compression - .mp3, .aac (iTunes)
- Programming libraries: [playsound](#), [simpleaudio](#), [winsound](#), [python-sounddevice](#), [pydub](#), [pyaudio](#)

Details: [https://en.wikipedia.org/wiki/Audio\\_file\\_format](https://en.wikipedia.org/wiki/Audio_file_format)

<a href="#">Filename extension</a>	.wav .wave
<a href="#">Internet media type</a>	audio/vnd.wave, <sup>[1]</sup> audio/wav, audio/wave, audio/x-wav <sup>[2]</sup>
<a href="#">Type code</a>	WAVE
<a href="#">Uniform Type Identifier (UTI)</a>	com.microsoft.waveform-audio
Developed by	<a href="#">IBM</a> & <a href="#">Microsoft</a>
Initial release	August 1991; 29 years ago <sup>[3]</sup>
	Multiple Channel Audio Data and WAVE Files
<a href="#">Latest release</a>	(7 March 2007; 13 years ago (update) <sup>[4][5]</sup> )
Type of format	<a href="#">audio file format</a> , <a href="#">container format</a>
Extended from	<a href="#">RIFF</a>
Extended to	<a href="#">BWF</a> , <a href="#">RF64</a>

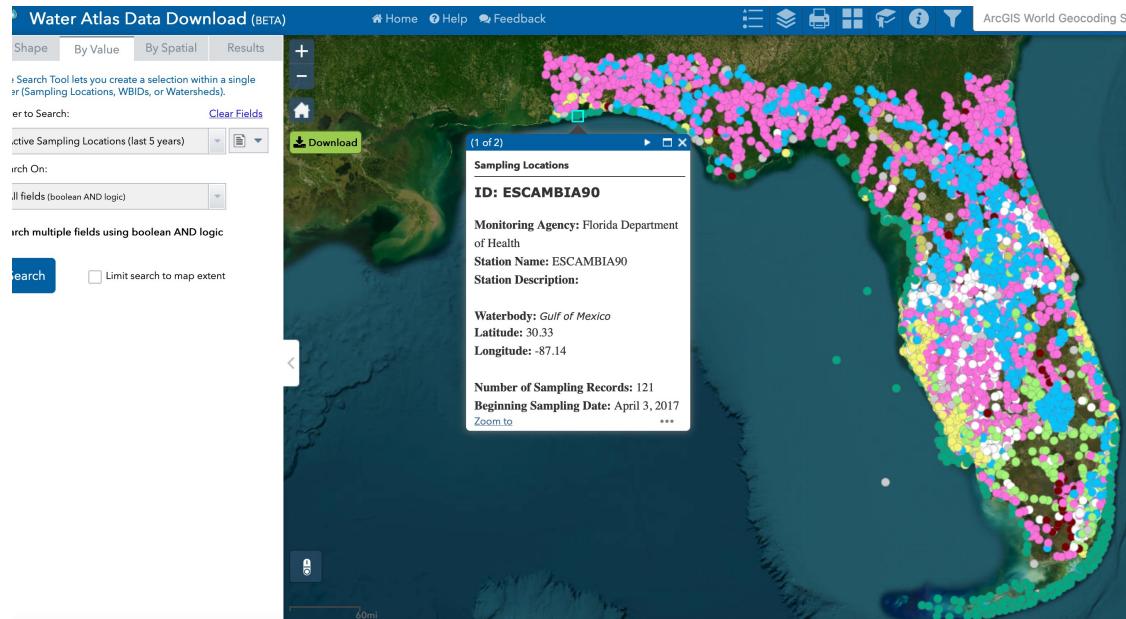
# Visual

- Media: image, video
- Components: pixel, frame
- Representation
  - Uncompressed – bitmap
  - Compressed lossless - .gif
  - Lossy compression - .jpeg
  - Containers: AVI (.avi) and QuickTime (.mov)
- Programming libraries: PIL, OpenCV

<u>Filename extension</u>	.avi
<u>Internet media type</u>	video/vnd.avi <sup>[1]</sup>
<u>Type code</u>	'Vfw '
<u>Uniform Type Identifier (UTI)</u>	public.avi
Developed by	<a href="#">Microsoft</a>
Initial release	November 1992; 27 years ago
<u>Container for</u>	Audio, Video
Extended from	<a href="#">Resource Interchange File Format</a>

# Open Data Should Not to Be Confused With Orthogonal Trend – Big Data

Volume  
Variety  
Velocity  
Veracity  
...



Data: <https://github.com/biplav-s/course-tai/tree/main/sample-code/common-data/water>



"Your recent Amazon purchases, Tweet score and location history makes you 23.5% welcome here."

Cartoon critical of big data application,  
by T. Gregorius

[http://upload.wikimedia.org/wikipedia/commons/thumb/b/b3/Big\\_data\\_cartoon\\_t\\_gregorius.jpg/220px-Big\\_data\\_cartoon\\_t\\_gregorius.jpg](http://upload.wikimedia.org/wikipedia/commons/thumb/b/b3/Big_data_cartoon_t_gregorius.jpg/220px-Big_data_cartoon_t_gregorius.jpg)

# Open Data

---

“Open data and content can be **freely used, modified, and shared by anyone for any purpose**”

<http://opendefinition.org/od/2.1/en/>

# Open Data is an Old Concept in a New Setting

- Open data is the notion that data should not be hidden, but made available to everyone to **reuse**. **The idea is not new.**
- Scientific publications follow this: “standing on the shoulders of giants”
- Data quality and open publishing process is critical

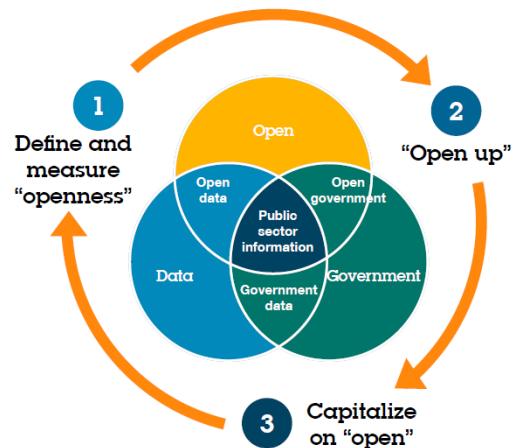
A screenshot of the US Data.gov website. The top navigation bar includes links for DATA, TOPICS, RESOURCES, STRATEGY, DEVELOPERS, and CONTACT. Below the navigation is a grid of icons representing various sectors: Agriculture, Climate, Ecosystems, Energy, Local Government, Maritime, Ocean, and Older Adults Health. A featured dataset is "U.S. Hourly Precipitation Data" with 855 recent views, described as a digital data set from the National Climatic Data Center (NCDC). Another dataset, "NCDC Storm Events Database", is also shown. The footer includes a note about OpenStreetMap tiles and a CC BY SA license.

USA

A screenshot of the India data.gov.in website. The top navigation bar includes links for Skip to navigation, Skip to main content, DataGov States/ULB, and a search bar. The main page features a banner for "DATASETS FROM HEALTH SECTOR". Below the banner are sections for ANALYTICS (listing 395,534 resources, 8,380 catalogs, 173 departments, 28.58 M times viewed, 8.19 M times downloaded, 354 chief data officers, 32,392 APIs, and 2,043 visualizations), CATALOG (showing a lightbulb icon and user figures), and INDICATOR DASHBOARD (with cards for Drinking Water And Sanitation, Health, Transport, and Labour And Employment).

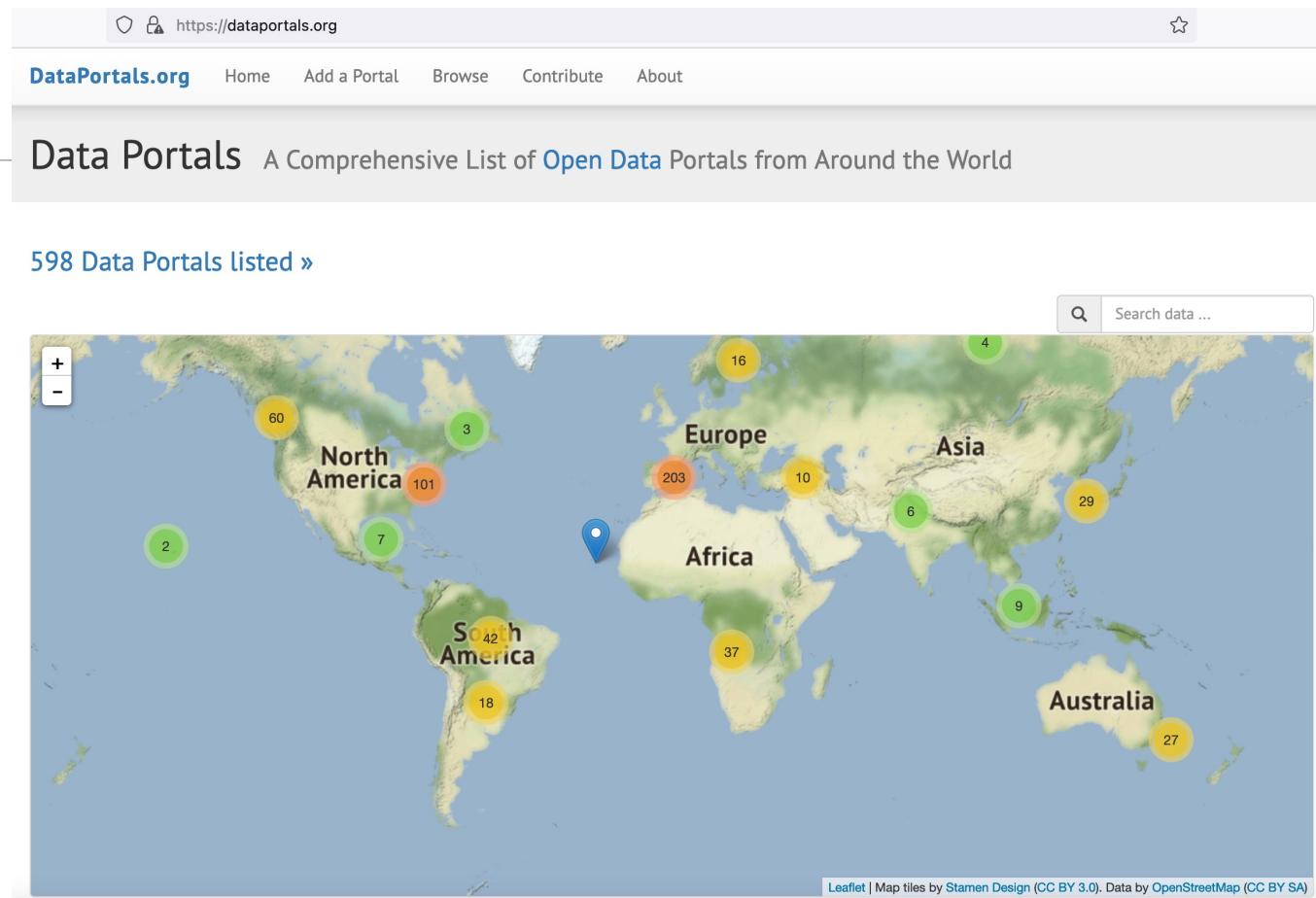
India

# ~600 Data Catalogs of Open Data



Source: IBM Institute for Business Value.

As on 26 Aug 2024



# Demo: US Open Data

---

- Site: <https://data.gov>
- Tools: <https://resources.data.gov/categories/data-tools/>

## Open Datasets

- data.gov OF ANY COUNTRY
  - Portal: <https://dataportals.org/>
  - US: <https://www.data.gov/> or any US state
  - India: <https://data.gov.in>
- Text of legislations - LegiScan, <https://legiscan.com/>
- Kaggle datasets: <https://www.kaggle.com/datasets>
- Google datasets search:  
<https://datasetsearch.research.google.com/>

# City Dashboard - London

CityDashboard aggregates simple spatial data for cities around the UK and displays the data on a dashboard and a map.

<http://citydashboard.org/london/>  
<http://citydashboard.org/about.php>

[Birmingham](#)  
[Brighton](#)  
[Cardiff](#)  
[Edinburgh](#)  
[Glasgow](#)  
[Leeds](#)  
[London](#)  
[Manchester](#)

Sat 26 Aug @ 22:23:19  
Go to Map - Go to Grid - Change City

WEATHER STATION (CASA TEAM) 12  
STATION WIND SPEED WIND GUSTS DIRECTION TEMPERATURE HUMIDITY RAIN TODAY PRESSURE FORECAST  
CASA Office: Bloomsbury W1 Data not updated for 11442 hours

WEATHER (METAR) 871  
London City Winds W-280 at 8kt, Vis 10km, Scattered clouds at 4500ft SW at 6 mph 14 C

TRAFFIC CAMERAS (TfL) 3  
York Road/Leake Street Camera 00001.04226 unobtainable

TUBE LINE STATUS (TfL) 1  
Bakerloo Good Service  
Central Good Service  
Circle Good Service  
District Good Service  
DLR Good Service  
Elizabeth Good Service  
H & C Good Service  
Jubilee Good Service  
Overground Part Closure  
Metropolitan Good Service  
Northern Good Service  
Piccadilly Part Closure  
Trams Good Service  
Victoria Good Service

LONDON CYCLE HIRE (TfL) 61  
NAN % NAN %  
Stations Full Stations Empty  
0 0  
Bikes Available Bikes or Docks Faulty

IN SERVICE (TfL) 1  
6092 London buses  
322 Underground trains

AIR POLLUTION (DEFRA) 1771  
µg/m³ TIME AVG OZONE NO₂ SO₂ PM₂.₅ PM₁₀  
Bloomsbury  
Marylebone Rd  
N Kensington

BICYCLES (LBH) 3571  
Goldsmiths' Row 4012 yesterday

STOCKS (YAHOO) 8  
FTSE 100 Index 7121.88 91.22 (1.28%)

TRAFFIC CAMERAS (TWO AT RANDOM) (TfL) 12  
75 Knightsbridge/Williams St Sun 27 Aug 02:11 Camera 00001.06730 unobtainable  
London Rd/Arragon Rd Sun 27 Aug 02:43  
A4 Knightsbridge by Albert Gate London Rd/Arragon Rd

BBC LONDON NEWS (BBC) 71  
Bow fire: Homes 'severely damaged' in east London  
blaze Fresh dates for London hot air balloon event after summer cancellations Superloop: West London express Heathrow to Harrow bus service launched

OPENSTREETMAP UPDATES (OSM) 271  
Edit to future cycle route Edit to future cycle route  
Edit to future cycle route Edit to future cycle route  
Mapped planned C35 route at Peckham Rye Update addresses in SW19 postal dist. kxplus kxplus

[Tweet](#) [About](#)

# Attempt for Dashboards - Amsterdam



[2016] <http://citydashboard.waag.org/>

# Exercise 1 - Explore

---

1. Google data search tool: <https://datasetsearch.research.google.com/>
2. US open data: <https://www.data.gov/>
3. Select a problem domain and search for data
4. Discuss your experience

# Accessing Data

---

## Example: Open 311 (<http://open311.org/>)

---

Refers to non-emergency events like graffiti, garbage, down trees, abandoned car, ...

- Not human life threatening
- 60+ cities support it world-wide

# Discovering Open 311 of a City

<http://311api.cityofchicago.org/open311/discovery.json>

```
changeset          "2012-09-14T08:00:00-05:00"
contact            "Contact developers@cityofchicago.org for assistance"
key_service         "Visit http://test311api.cityofchicago.org/open311 to request an API Key"
endpoints          0
specification      "http://wiki.open311.org/GeoReport_v2"
url                "http://311api.cityofchicago.org/open311/v2"
changeset          "2012-09-14T08:00:00-05:00"
type               "production"
formats            0
                    "text/xml"
1
                    "application/json"
1
specification      "http://wiki.open311.org/GeoReport_v2"
url                "http://test311api.cityofchicago.org/open311/v2"
changeset          "2012-09-14T08:00:00-05:00"
type               "test"
formats            0
                    "text/xml"
1
                    "application/json"
```

The screenshot shows a JSON viewer interface with the URL [311api.cityofchicago.org/open311/discovery.json](http://311api.cityofchicago.org/open311/discovery.json). The JSON data is displayed in a hierarchical tree view. The key 'endpoints' has two entries, indexed 0 and 1. Each entry contains 'specification', 'url', 'changeset', 'type', and 'formats' fields. The 'specification' field for both entries points to [http://wiki.open311.org/GeoReport\\_v2](http://wiki.open311.org/GeoReport_v2). The 'url' field for index 0 is <http://311api.cityofchicago.org/open311/v2>, and for index 1 it is <http://test311api.cityofchicago.org/open311/v2>. The 'changeset' field for both is "2012-09-14T08:00:00-05:00". The 'type' field for index 0 is "production" and for index 1 is "test". The 'formats' field for each entry contains two items: '0' with value "text/xml" and '1' with value "application/json".

# Demonstration: Open 311

## List of services

- <http://311api.cityofchicago.org/open311/v2/services.json>
  - Result
- 

```
[{"service_code": "4ffa4c69601827691b000018", "service_name": "Abandoned Vehicle", "description": "Abandoned vehicles are taken to auto pound 3S or 3N where they are -- if not redeemed by the owners -- sold for scrap.", "metadata": true, "type": "batch", "keywords": "code:SKA", "group": "Streets & Sanitation"},
```

```
{"service_code": "4ffa9cad6018277d4000007b", "service_name": "Alley Light Out", "description": "One or more alley lights out, on a wooden pole in the alley itself, are reported under this service request type. Important information needed when reporting alley lights out includes: the exact address that the light/lights are behind, how many lights are out, and if the light(s) are completely out or if they blink on and off intermittently. Alley light repairs are done during the day when the lights are not on, so this information is essential to expedite the repair work.", "metadata": true, "type": "batch", "keywords": "code:SFA", "group": "Transportation"},
```

```
...]
```

## Details of a service

- <http://311api.cityofchicago.org/open311/v2/services/4ffa4c69601827691b000018.json>
  - Result
- ```
{"service_code": "4ffa4c69601827691b000018",
"attributes": [
{"variable": true, "code": "FQSKA1",
"datatype": "singlevaluelist", "required": false, "order": 1,
"description": "Vehicle Make/Model",
"values": [
{"key": "ASVEAV", "name": "(Assembled From Parts,Homemade)" },
 {"key": "HOMDCYL", "name": "(Homemade Motorcycle, Moped.Etc.)" },
 {"key": "HMDETL", "name": "(Homemade Trailer)" }, ...
]
...
]}}
```

# Demonstration: Open 311

---

<http://311api.cityofchicago.org/open311/v2/services/4ffa9cad6018277d4000007b.json>

Result

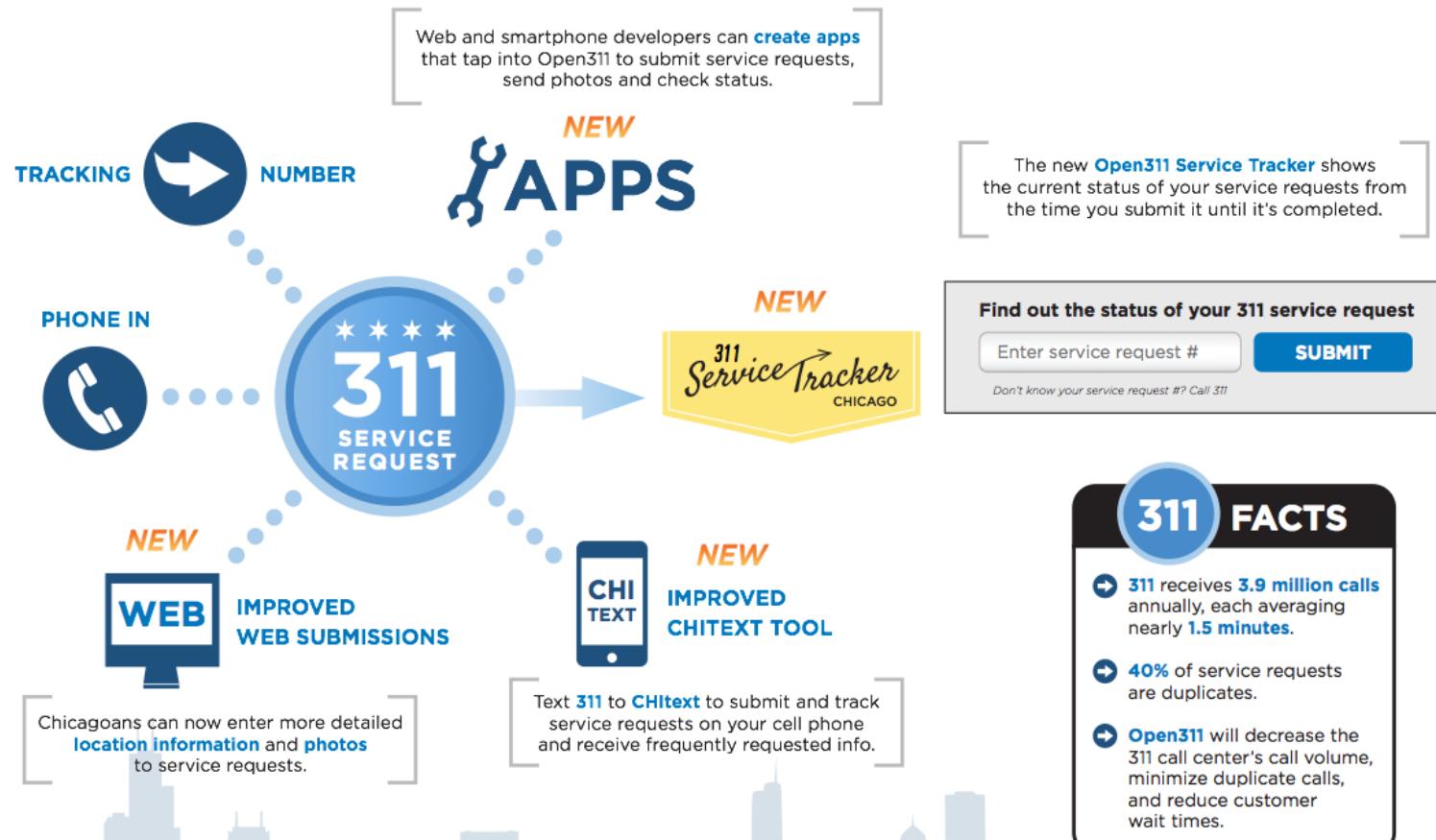
```
{"service_code":"4ffa9cad6018277d4000007b",
 "attributes":
 [{"variable":true,"code":"ISTHELI2",
   "datatype":"singlevaluelist","required":true,"order":1,
   "description":"Is the light located in your alley or the street?",
   "values":[{"key":"ALLEY","name":"Alley"},
             {"key":"STREET","name":"Street"}]},


 {"variable":true,"code":"POLEWORM",
   "datatype":"singlevaluelist","required":true,"order":2,
   "description":"Is the pole wooden or metal?",
   "values":[{"key":"METAL","name":"Metal"},
             {"key":"WOODEN","name":"Wooden"}]},


 {"variable":true,"code":"ISTHELI3",
   "datatype":"singlevaluelist","required":true,"order":3,
   "description":"Is the light directly behind this address?",
   "values":[{"key":"NO","name":"No - Light Not Directly Behind Address"},
             {"key":"YES","name":"Yes - Light Directly Behind Address"}]},


 {"variable":true,"code":"A511OPTN",
   "datatype":"string","required":false,
   "datatype_description":"Enter number as 999-999-9999","order":4,
   "description":"Input mobile # to opt-in for text updates. If already opted-in, add mobile # to contact info."}]}
```

# Chicago: Service Tracking



# Example: Application over Open Data (Chicago)

The screenshot shows a web browser displaying the Chicago 311 Service Tracker website at [servicetracker.cityofchicago.org/requests/13-00210540](http://servicetracker.cityofchicago.org/requests/13-00210540). The page title is "Rodent Baiting / Rat Complaint". Key details include:

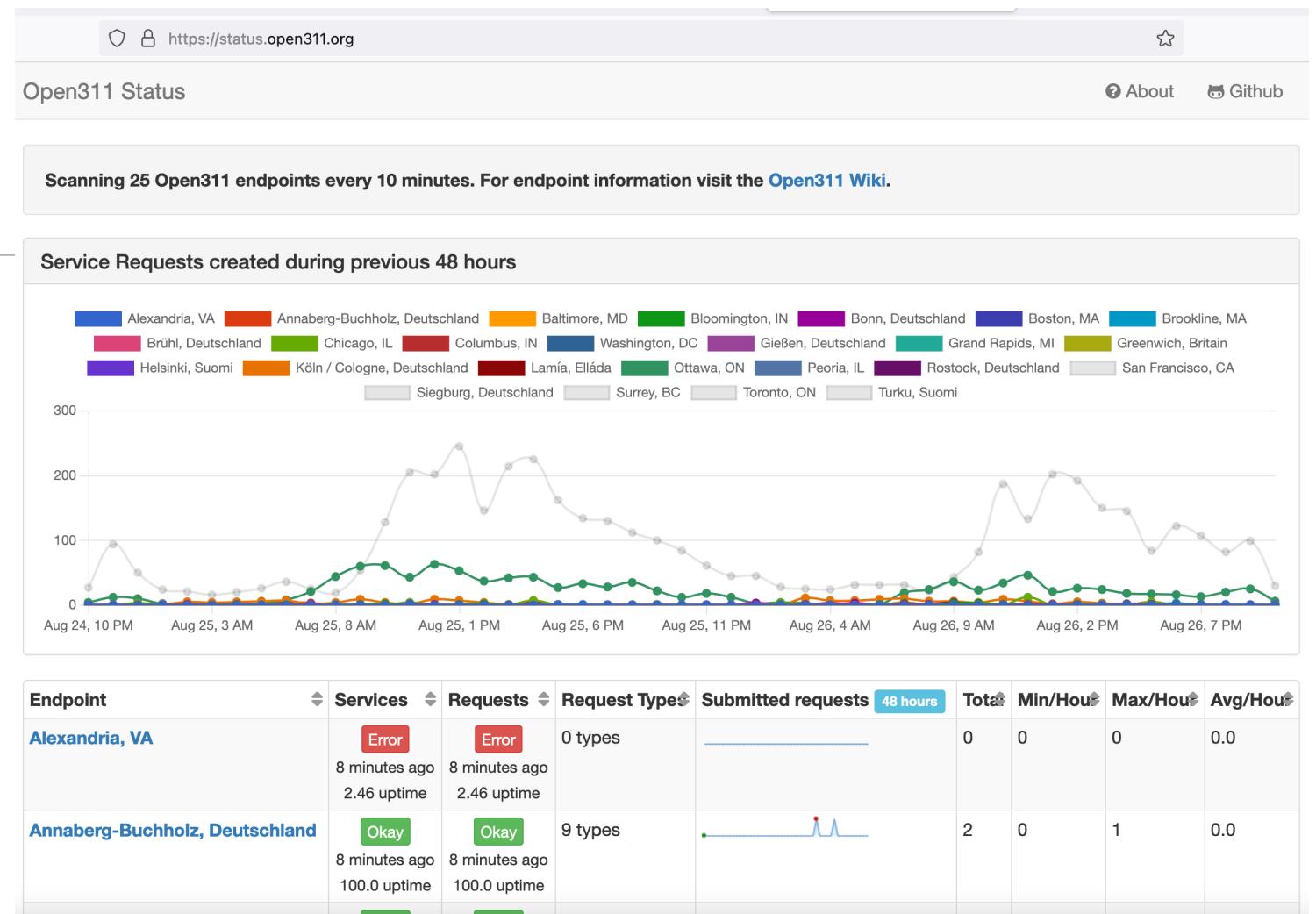
- #13-00210540**
- Address:** 1502 N Wicker Park Ave
- Created:** February 23, 2013
- Received via:** Other

A green ribbon on the right indicates the status is **Closed**.

**Activity**

| Date                    | Action                                                                                    |
|-------------------------|-------------------------------------------------------------------------------------------|
| 05-Mar-2013<br>10:04 AM | Request closed                                                                            |
| 05-Mar-2013<br>10:04 AM | Dispatch Crew Completed                                                                   |
| 23-Feb-2013<br>10:16 PM | Rodent Baiting / Rat Complaint<br>Department: Bureau of Rodent Control - S/S<br>via Other |

# Scaling with Open 311



<https://status.open311.org/>

# Exercise 2 – Programmatically Access Data

---

1. See sample code on GitHub:

- <https://github.com/biplav-s/course-d2d-ai/blob/main/sample-code/I2-opendata/Explore%20OpenData.ipynb>

2. Explore APIs of another city of your choice

# Exercise 3 – Programmatically Access Data

---

1. Water data
2. Text data

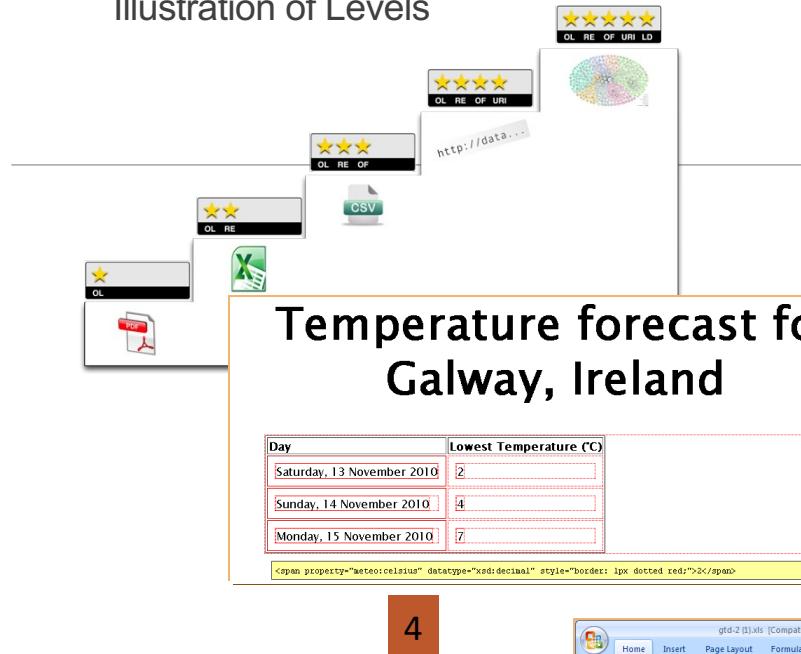
Code samples: <https://github.com/biplav-s/course-ai-tai-f23/blob/main/sample-code/Class2-data.md>

# Quality of Data

---

## Does Opening Data Make It Reusable? No

Illustration of Levels



Source: <http://5stardata.info/>

## Temperature forecast for Galway, Ireland

| Day                        | Lowest Temperature (°C) |
|----------------------------|-------------------------|
| Saturday, 13 November 2010 | 2                       |
| Sunday, 14 November 2010   | 4                       |
| Monday, 15 November 2010   | 7                       |

4

## Temperature forecast for Galway, Ireland

| Day                        | Lowest Temperature (°C) |
|----------------------------|-------------------------|
| Saturday, 13 November 2010 | 2                       |
| Sunday, 14 November 2010   | 4                       |
| Monday, 15 November 2010   | 7                       |

en.wikipedia.org/wiki/Temperature

### gtd-3.csv - WordPad

File Edit View Insert Format Help

"Temperature forecast for Galway, Ireland",

"Day", "Lowest Temperature (C)"  
 "Saturday, 13 November 2010", 2  
 "Sunday, 14 November 2010", 4  
 "Monday, 15 November 2010", 7

5

| gtd-2.xlsx [Compatibility Mode] - Microsoft Excel |                                          |
|---------------------------------------------------|------------------------------------------|
|                                                   | Temperature forecast for Galway, Ireland |
| 1                                                 | Day                                      |
| 2                                                 | Lowest Temperature (°C)                  |
| 3                                                 | Saturday, 13 November                    |
| 4                                                 | 2010                                     |
| 5                                                 | Sunday, 14 November 2010                 |
| 6                                                 | Monday, 15 November 2010                 |

2

## Temperature forecast for Galway, Ireland

| Day                        | Lowest Temperature (°C) |
|----------------------------|-------------------------|
| Saturday, 13 November 2010 | 2                       |
| Sunday, 14 November 2010   | 4                       |
| Monday, 15 November 2010   | 7                       |

1

# Data Quality of Public Data in India



## Right to Information

- Not even 1\*
- Information available to requester, but no one else

## Data.gov.in

- 2-3\*
- Available in CSV, etc but not uniquely referenceable

Open data movements are moving to linked data form for semantics

# Annotated – Indian Open Data

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Vocabulary services: <http://vocab.nic.in/index.php>

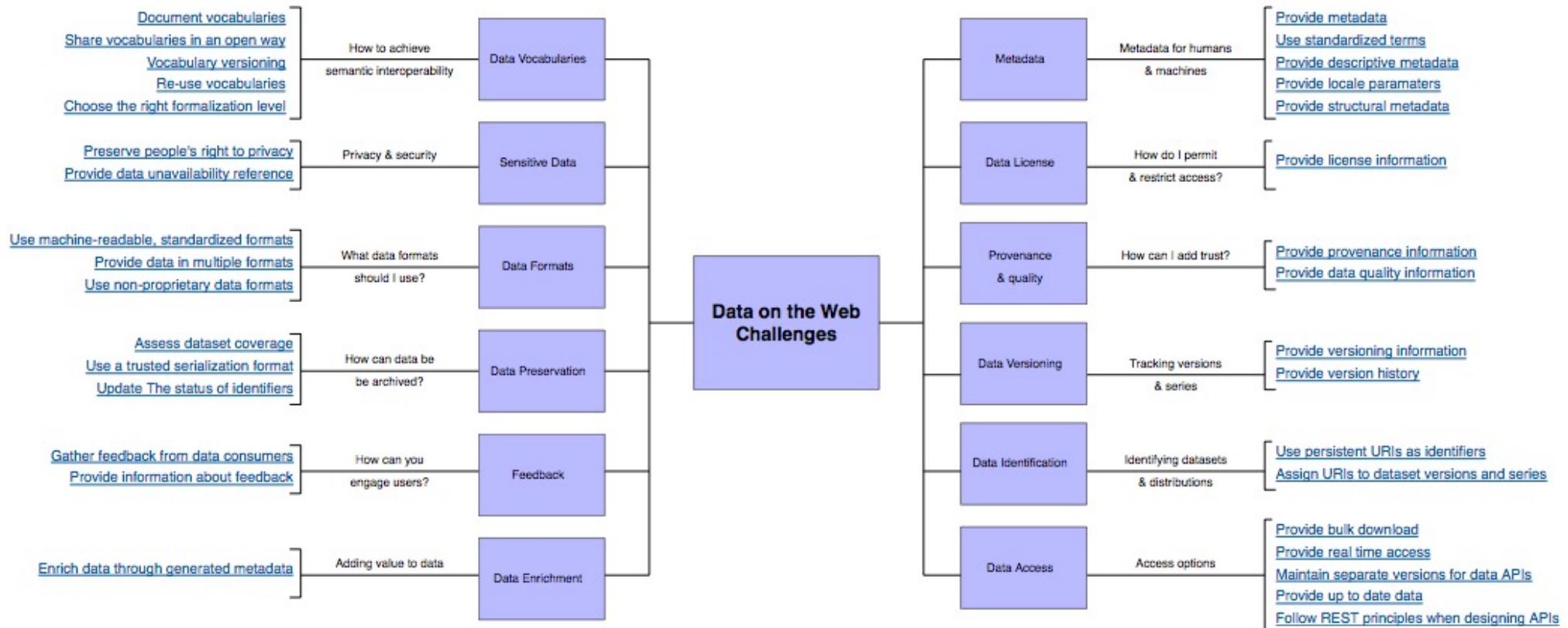
- Authoritative
- Standardized codes

## Examples

- States in the Union: <http://vocab.nic.in/rest.php/states/json>
- Districts in a state (“UP”): <http://vocab.nic.in/rest.php/district/up/json>
- State legislatures: <http://vocab.nic.in/rest.php/orgn/sg/legislature/json>
- Union government offices in a state (“TN”): <http://vocab.nic.in/rest.php/orgn/ug/state/tn/json>

# Helping Publish Good Quality Open Data is Key

Have data policy in place  
 Publish with best practices, have semantics, promote reuse  
 Figure courtesy: <http://www.w3.org/TR/2015/WD-dwbp-20150625/>



# Quality of Data in SC

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- Data
  - <https://sc.gov/data-and-transparency>
  - <https://rfa.sc.gov/data-research/population-demographics/census-state-data-center/housing-units-in-structure-2015-2019>
  - Comment: Lots of pds and reports: combines/ confounds data with presentation
- Quality of data
  - 1-3 star
  - Not easily amenable for analysis

# Lecture 2: Concluding Comments

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- We talked about
  - Data formats
  - Big data v/s open data
  - Open data
    - City data
    - Data access via Open311
    - Publishing data systematically

# Week 1: Concluding Comments

- We talked about
  - AI
  - Course logistics
  - Data

- Week 1: Introduction, Aim: Chatbot / Intelligence Agent
- Weeks 2-3: Data: Formats, Representation and the Trust Problem
- Week 3: Machine Learning – Supervised (Classification)
- Week 4: Machine Learning - Unsupervised (Clustering) –
- Topic 5: Learning neural network, deep learning, Adversarial attacks
- Week 6: Large Language Models – Representation and Usage issues
- Weeks 7-8: Search, Heuristics - Decision Making
- Week 9: Constraints, Optimization – Decision Making
- Topic 10: Markov Decision Processes, Hidden Markov models - Decision making
- Topic 11-12: Planning, Reinforcement Learning – Sequential decision making
- Week 13: Trustworthy Decision Making: Explanation, AI testing
- Week 14: AI for Real World: Tools, Emerging Standards and Laws; Safe AI/ Chatbots

# About Week 2 – Lectures 3 and 4

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# Lecture 3: Representing and Organizing Data

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- Data preparation
- Knowledge representation/ graph
- Ontology

# Lecture 4: Data and Trust Issues

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- Data issues
- Trust issues
  - With problematic data
  - With pre-trained AI models
  - With evaluation
- Societal implications