



# CSCE 240: Advanced Programming Techniques

## Lecture 24: Intro to AI / ML/ DL

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PROF. BIPLAV SRIVASTAVA, AI INSTITUTE

7<sup>TH</sup> APRIL 2022

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

**Credits:** Some material reused with permission of Dr. Jeremy Lewis.  
Others used as cited with thanks.

# Organization of Lecture 24

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- Introduction Section
  - Recap of Lecture 23
  - News / announcements / clarifications
  - TA and SI Updates
- Main Section
  - Concept: AI as decision support tool
  - Concept: ML and DL
  - Perspective: Successful AI, AI for Society
  - Concept: AI in Software Development
  - Task: HW 6 (Optional) – due today
  - Task: Project – PA #6 starts
- Concluding Section
  - About next lecture – Lecture 25
  - Ask me anything

# Introduction Section

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# Recap of Lecture 23

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- Programming practice for project assignments based on PA#4
- We discussed
  - Templates
  - Class templates
  - Functional templates

# Announcement

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- McNair Junior Fellows program: **30 grantees** this summer, and we sure hope you can encourage your students to explore this opportunity. All details and applications are on: <http://www.cec.sc.edu/mjf> | **Deadline April 8th, 2022!**
  - The program, in its 8<sup>th</sup> year since its foundation, and in its 4<sup>th</sup> year as an official CEC program, provides supports for undergraduate students up to 3k\$ in summer funds and runs activities that helps the students further explore research (as well as research posters, state of the art and other research initiation programs).
  - Contact: Ramy Harik
- Summer Internships at AI Institute
  - You can work with faculty and get paid
  - You can apply to fellowship as well as work with faculty (with/ without pay)
  - You can work on your idea with a faculty to mentor (with/ without fellowship)

# Updates from TA, SU

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- TA update: Yuxiang Sun (Cherry)
- SI update: Blake Seekings

# Main Section

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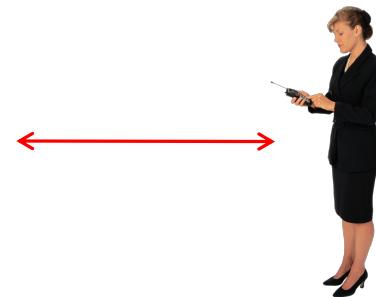
# Concept: AI

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



Agent



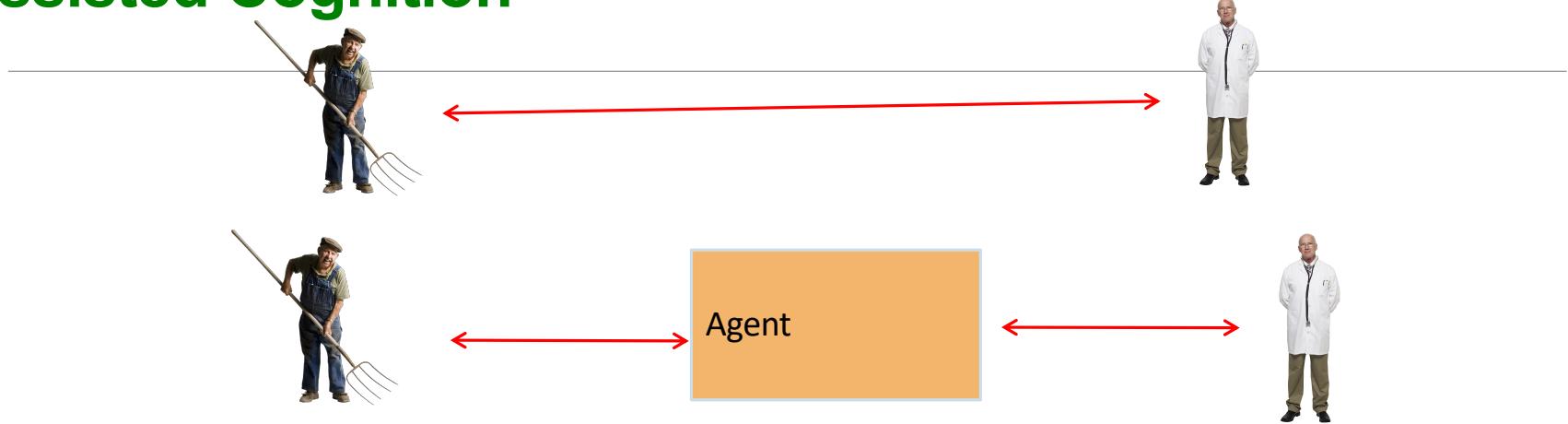
## Expected behavior:

- 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)

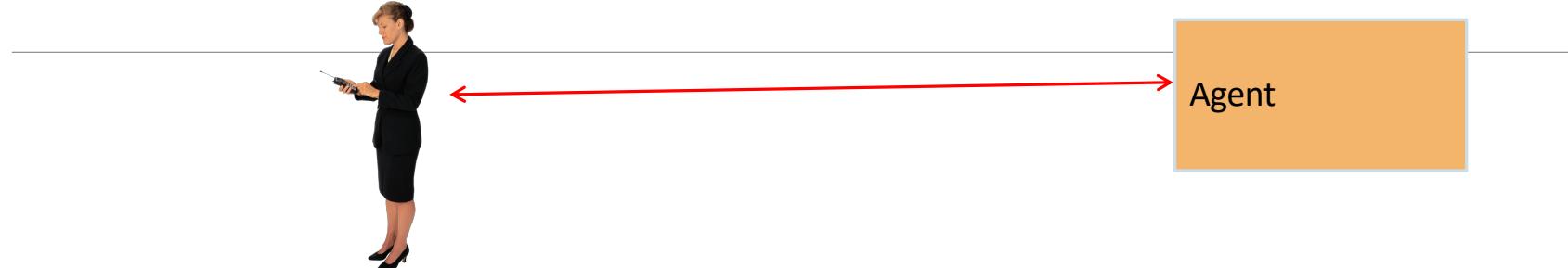
# Example: Taking Care of a Senior **Assisted Cognition**



## 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**

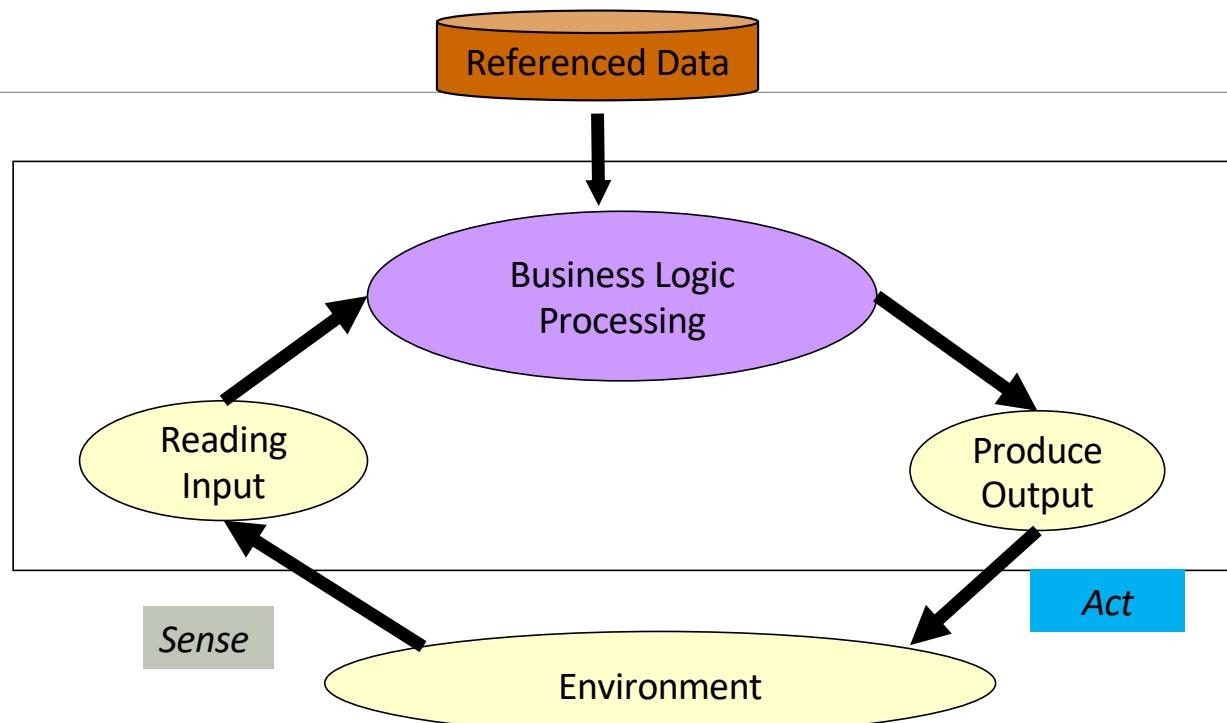


### Expected behavior:

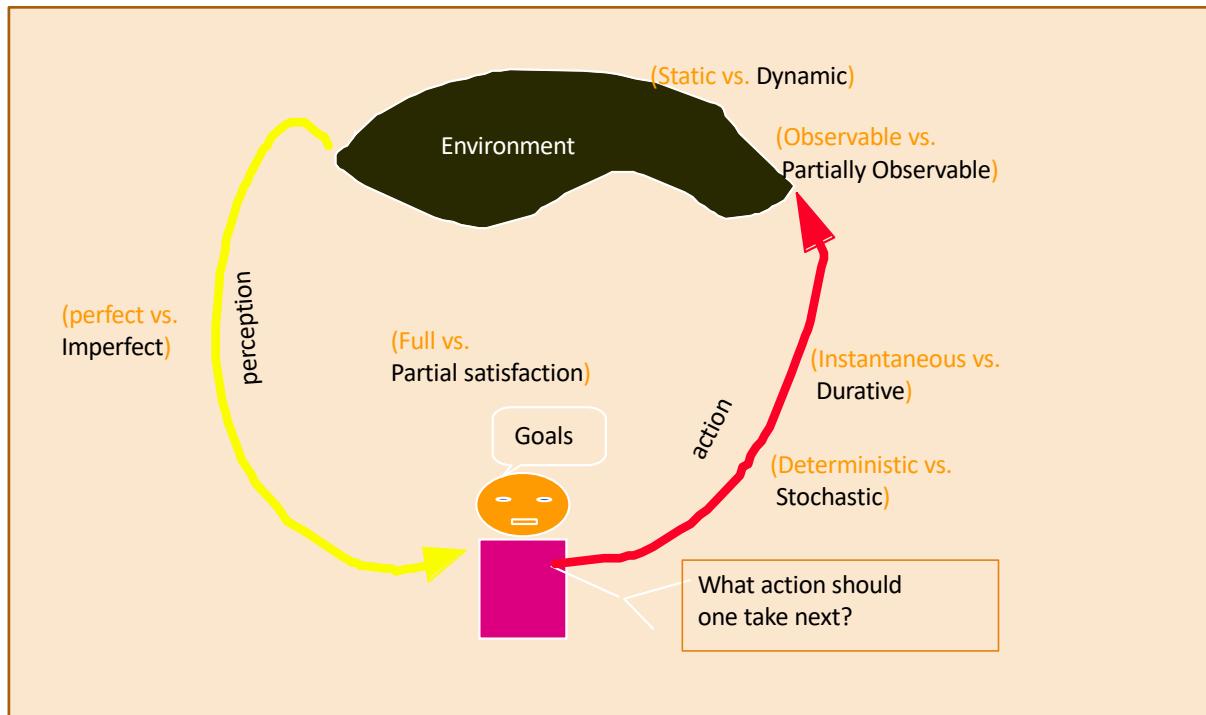
- Inform
  - When missing meetings
  - When missing social commitments
  - Reminding of priorities
  - ...
- Do
  - Make all cancellations / re-bookings when schedule changes
  - Find alternatives to current decisions and give choices (e.g., traffic)
  - ...

# 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



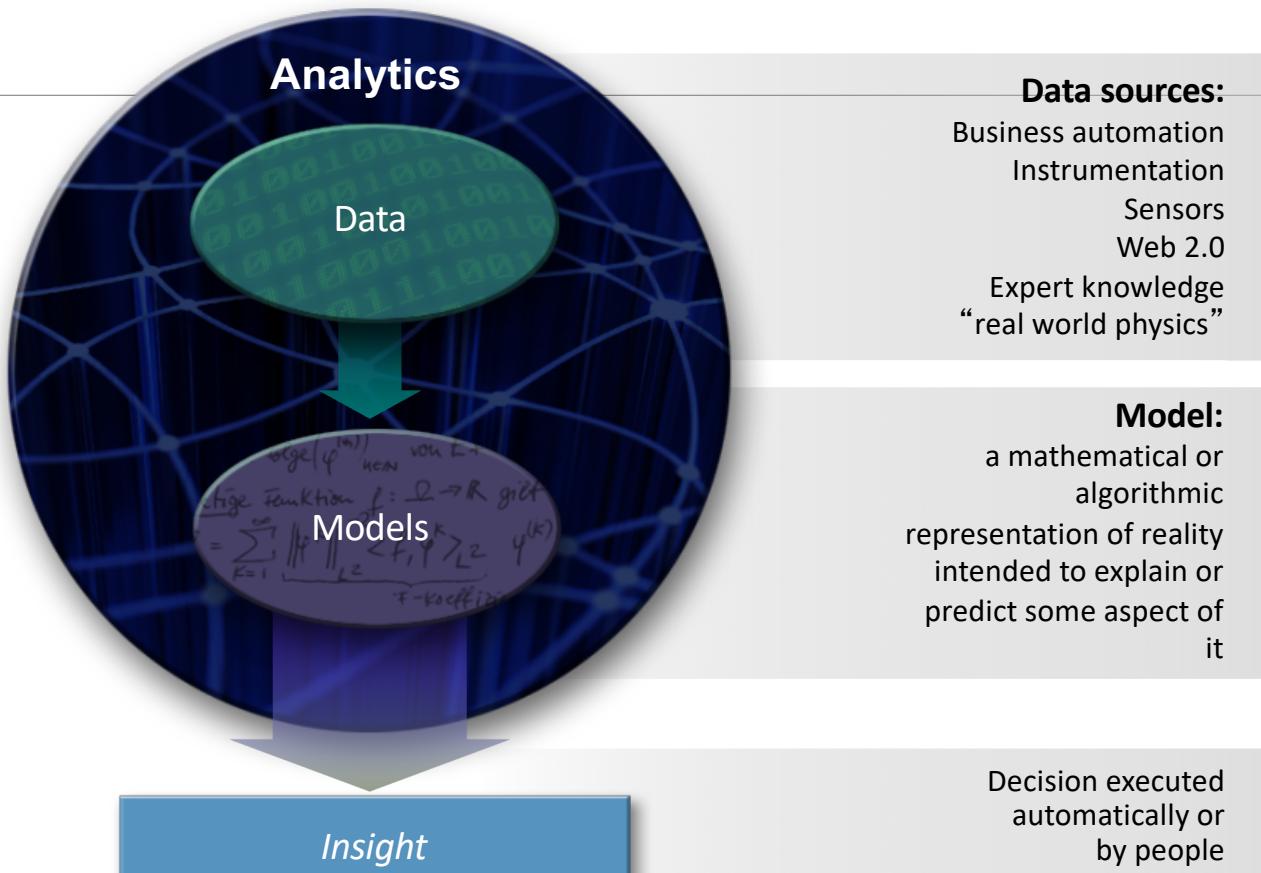
*AI deals with perceiving the environment and taking actions towards short- and long term goals as the world changes over time.*

*From Subbarao Kambhampati's AI Planning Course*

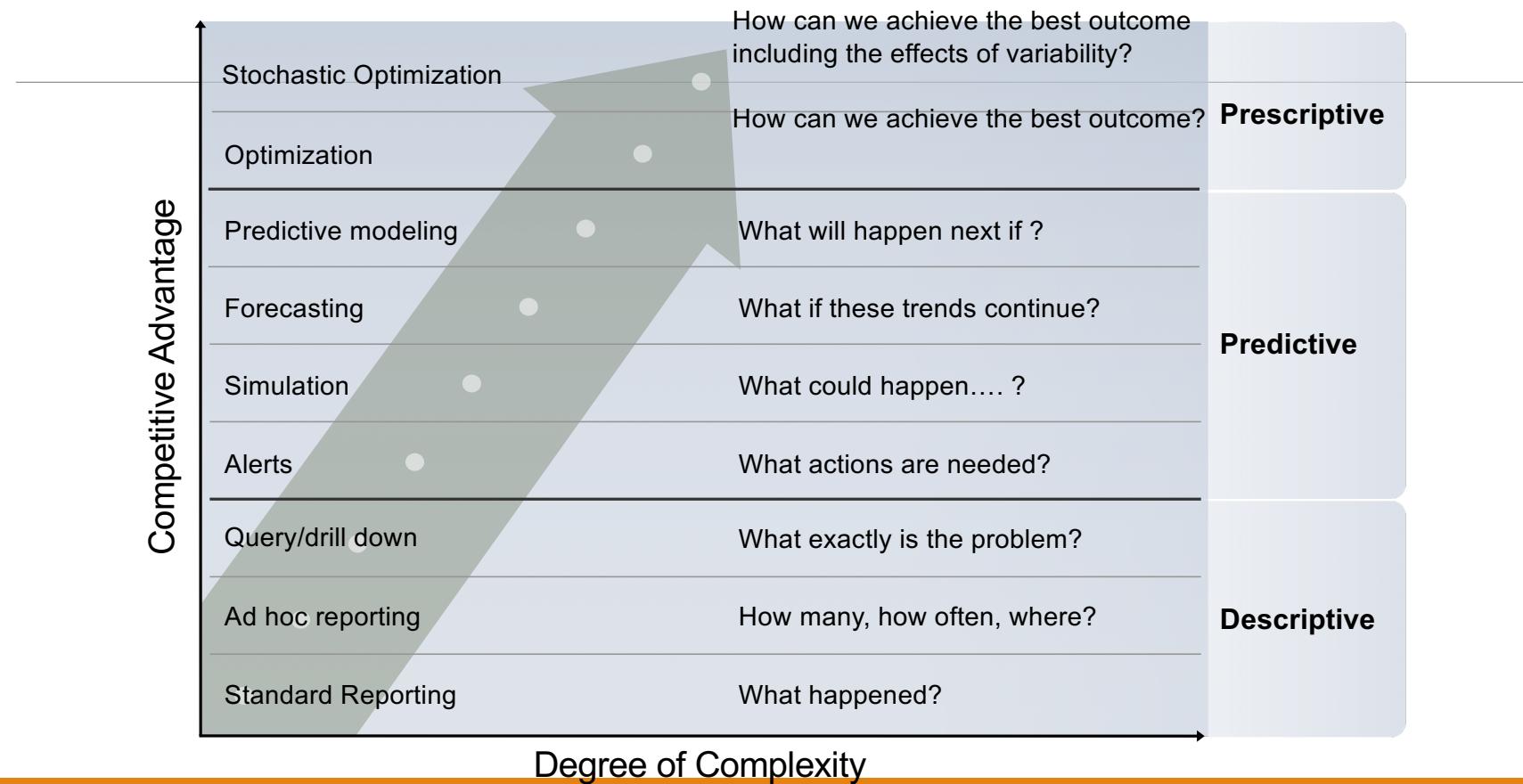
# Concept: ML and DL

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



# Analytics Landscape



# Example: Adv Prog Course (CSCE 240)

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Are they useful? (**Descriptive**)

- Answering needs an assessment about the past courses

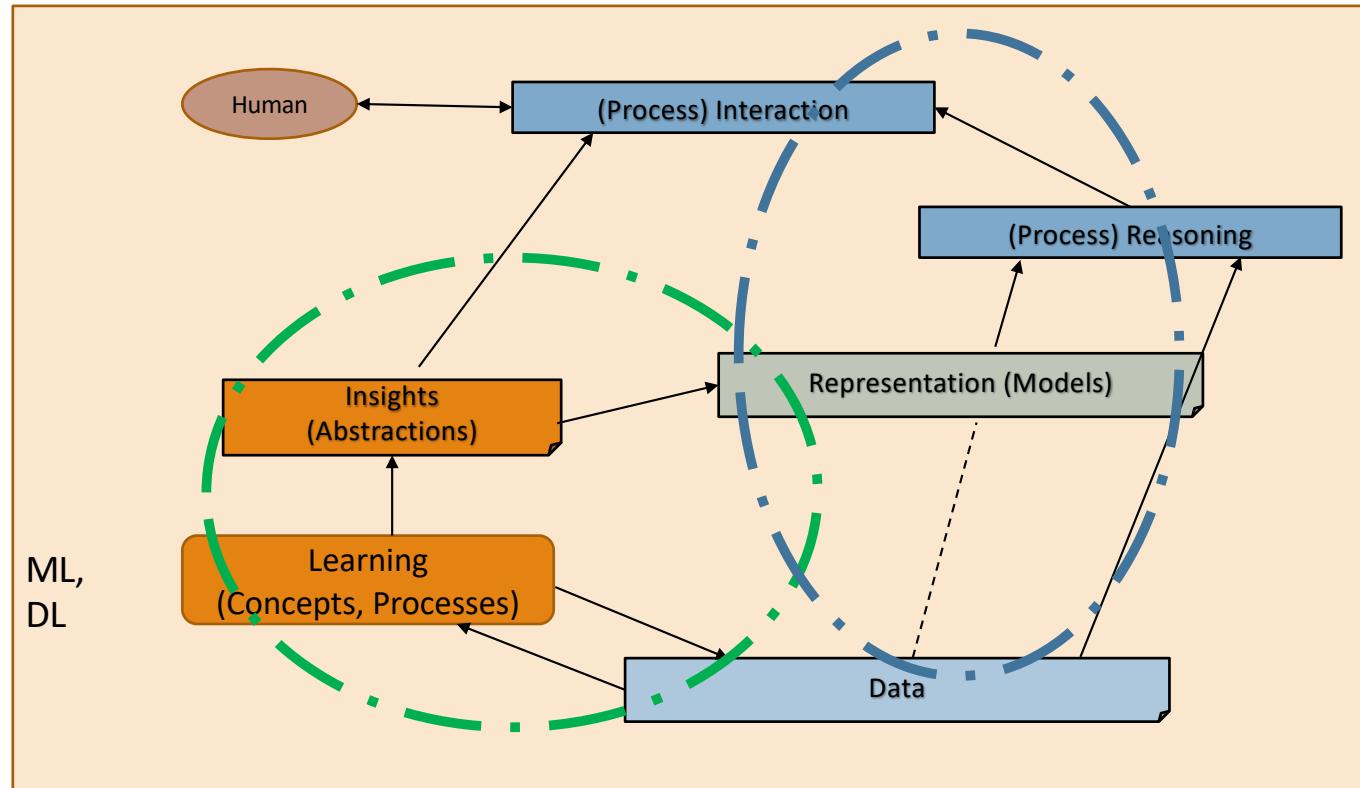
If it happens next time, how many will attend? (**Predictive**)

- Above + Answering needs an assessment about unknowns (e.g., future of prog. language)

Should you attend? (**Prescriptive**)

- Above + Answering needs understanding the goals and current status of the individual

# Slew of AI Methods



Reasoning

ML,  
DL

# AI: Symbolic, ML, DL

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(A) The Cartoon History of AI



(B) The Cartoon History of AI



Image credit: <https://onlinelibrary.wiley.com/doi/full/10.1002/aaai.12036>

# Perspective: Successful AI, AI for Society

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# Before and After: Decision Support

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**Today's tools:** Static, non-interactive, non-contextual, lack explanations

**Future tools:** Dynamic to data, interactive, contextual, explaining with data, anywhere, multi-modal, social (group dependency), societally relevant, ...

*Future has potential to improve people's lives, promote well-being and reduce waste*

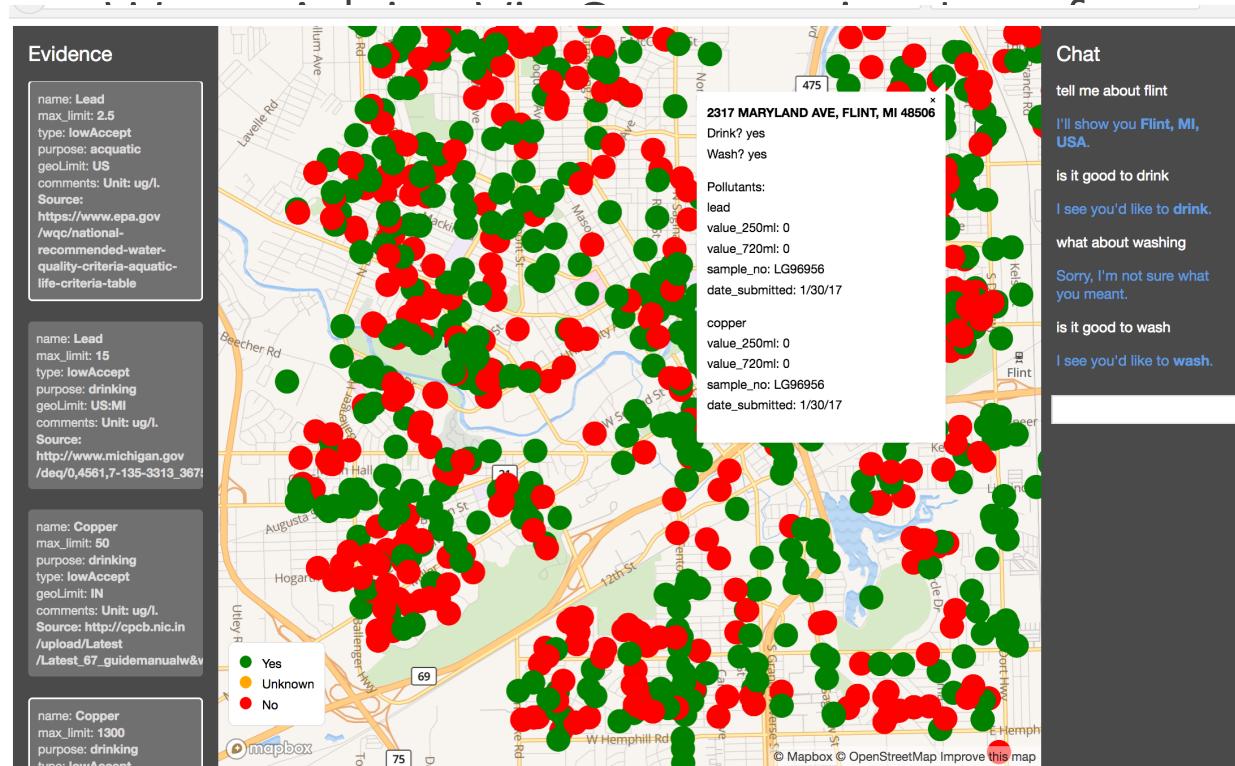
# Water Information to People: Static and Post-Facto Advisories (US)

The screenshot shows a web browser window for the EPA website (<https://www.epa.gov/flint/advice-flint-residents>). The page title is "Advice to Flint Residents". The main content area contains several sections of text and links for resources. On the right side, there is a box containing a list of "DO NOT" and "DO" instructions for water consumption. The "DO NOT" list includes: "DO NOT drink unfiltered water. It's not safe!", "DO NOT cook or brush teeth with unfiltered water", "DO NOT allow babies and children to drink bathwater", and "DO NOT use an NSF-certified water filter rated to remove lead". The "DO" list includes: "DO RUN cold water throughout the house up to 5 minutes every morning to flush pipes" and "EVERYONE CAN wash hands, bathe, or shower with unfiltered water".

Advisories to public for Flint Residents, MI, USA



Physical signage at a lake in Washington, USA



**Video:**  
<https://www.youtube.com/watch?v=z4x44sxC3zA>

Paper: Jason Ellis, Biplav Srivastava, Rachel Bellamy and Andy Aaron, Water Advisor - A Data-Driven, Multi-Modal, Contextual Assistant to Help with Water Usage Decisions, AAAI 2018.  
 [Demonstration paper].

# AI-Based Decision-Support for COVID-19

- Understanding the disease
  - Disease spread and simulation models
  - Insights by visualization
- Tackling the disease
  - Tracking people's movement
  - Fever detection via images
  - Understanding mental depression from social posts
  - Fighting fake news
- Understanding impact
  - Economic – job loss, industrial growth
  - Supply Chain
  - Risks
- Individual actions
  - *Screening/ triage tools*
- Group actions
  - *Models for how to open economy*
  - *Contact tracing*
  - *Matching producers and consumers: food, medical supplies*
- Policy actions
  - *Understanding impact of policy choices (e.g. lockdowns, travel restrictions)*
  - *Design of economic interventions*

Resource: <https://github.com/biplav-s/covid19-info/wiki/AI-and-COVID-19>

# Concept: AI in Software Development (Testing Focus)

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# AI for Code Generation

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Co-Pilot: <https://copilot.github.com/>

*“GitHub Copilot is an AI pair programmer that helps you write code faster and with less work. GitHub Copilot draws context from comments and code, and suggests individual lines and whole functions instantly. GitHub Copilot is powered by OpenAI Codex, a new AI system created by OpenAI. The GitHub Copilot technical preview is available as an extension for Visual Studio Code, Neovim, and the JetBrains suite of IDEs.”*

# AI *for* Testing

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- AI for testing
    - Test case and data generation
    - “Value” based testing
  - Sample of work
    - Blogs: <https://www.perfecto.io/blog/ai-in-software-testing> ; <https://www.testingxperts.com/blog/AI-in-Software-Testing>
    - Papers: Artificial Intelligence in Software Test Automation: A Systematic Literature Review, Anna Trudova, Michal Dolezel, Alena Buchalcevová, Published in ENASE 2020, <https://www.semanticscholar.org/paper/Artificial-Intelligence-in-Software-Test-A-Review-Trudova-Dolezel/ccbe24b348194905edeca78477625500786e55d6>;
- T. M. King, J. Arbon, D. Santiago, D. Adamo, W. Chin and R. Shanmugam, "AI for Testing Today and Tomorrow: Industry Perspectives," *2019 IEEE International Conference On Artificial Intelligence Testing (AITest)*, 2019, pp. 81-88, doi: 10.1109/AITest.2019.000-3.

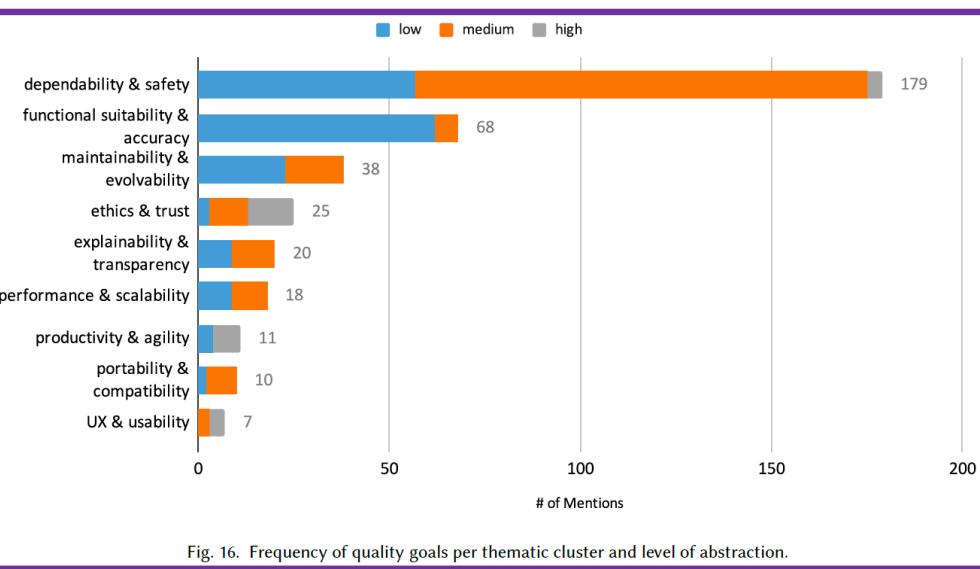
# Testing *for* AI

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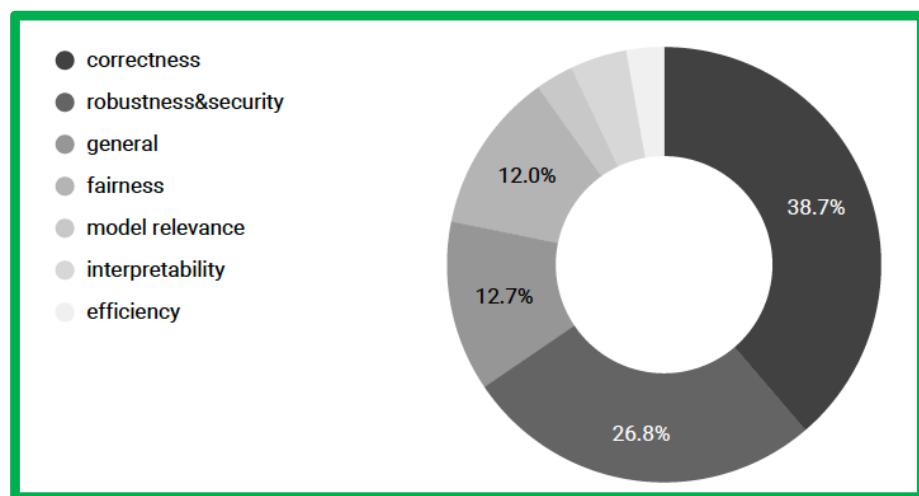
- Papers

- A. Aggarwal, S. Shaikh, S. Hans, S. Haldar, R. Ananthanarayanan and D. Saha, "Testing Framework for Black-box AI Models," *2021 IEEE/ACM 43rd International Conference on Software Engineering: Companion Proceedings (ICSE-Companion)*, 2021, pp. 81-84, doi: 10.1109/ICSE-Companion52605.2021.00041. Video: <https://youtu.be/984UCU17YzI>
- Machine Learning Testing: Survey, Landscapes and Horizons, Jie M. Zhang, Mark Harman, Lei Ma, Yang Liu, <https://arxiv.org/abs/1906.10742>, 2019
- Software Engineering for AI-Based Systems: A Survey, Silverio Martínez-Fernández, Justus Bogner, Xavier Franch, Marc Oriol, Julien Siebert, Adam Trendowicz, Anna Maria Vollmer, Stefan Wagner, <https://arxiv.org/abs/2105.01984>, 2021

# What is AI Being Tested For?



**Figure Source:** Software Engineering for AI-Based Systems: A Survey, Silverio Martínez-Fernández, Justus Bogner, Xavier Franch, Marc Oriol, Julien Siebert, Adam Trendowicz, Anna Maria Vollmer, Stefan Wagner, <https://arxiv.org/abs/2105.01984>, 2021



**Figure Source:** Machine Learning Testing: Survey, Landscapes and Horizons, Jie M. Zhang, Mark Harman, Lei Ma, Yang Liu, <https://arxiv.org/abs/1906.10742>, 2019

# Concept: Problems with AI

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# An Unstable Collaboration

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## Human over AI

- Common AI tools for image, speech and text tools (translators)
- Vehicles: Cruise control, Park Assist

## AI over Human

- Self parking of car\*
- Automated trading\*
- Cognitive biases in human decision making\*\*

**Objection:** *When have humans liked control over them?*

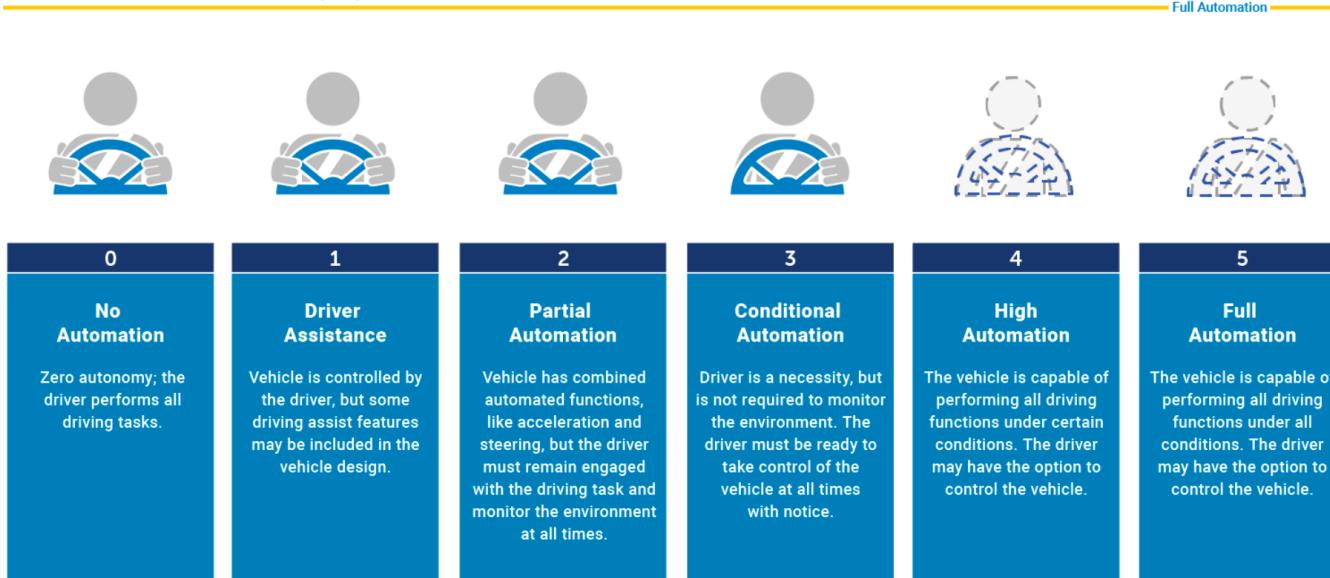
## Human and AI as equal collaborators is ambiguous

What does this mean in a practical sense ? No clear answer.

- \***Human AI Collectives**, By N. R. Jennings, L. Moreau, D. Nicholson, S. Ramchurn, S. Roberts, T. Rodden, A. Rogers, Communications of the ACM, December 2014, Vol. 57 No. 12, Pages 80-88, 10.1145/2629559, <https://cacm.acm.org/magazines/2014/12/180791-human-agent-collectives/fulltext>
- \*\* **Thinking, Fast and Slow** by Daniel Kahneman, [https://en.wikipedia.org/wiki/Thinking,\\_Fast\\_and\\_Slow](https://en.wikipedia.org/wiki/Thinking,_Fast_and_Slow)

# Misleading Levels of Automation for Vehicles

SOCIETY OF AUTOMOTIVE ENGINEERS (SAE) AUTOMATION LEVELS



## Sources:

- SAE: <https://www.nhtsa.gov/technology-innovation/automated-vehicles>
- \* Consumer Report: <https://www.consumerreports.org/autonomous-driving/levels-of-car-automation/>

## Questions:

- What is the problem being solved?
- Are humans ready to take over?

*Recall the case when humans were not ready to take over?*

**Hint:** A flying vehicle with professional drivers!

- Are you the **driver**, or are you a **passenger** in a self-driving car?\*

## Fear:

- Getting away with incompetence?
- Getting away with murder!

# Instability of AI is Well Recorded

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[Text] [Su Lin Blodgett, Solon Barocas, Hal Daumé III, Hanna Wallach](#), Language (Technology) is Power: A Critical Survey of “Bias” in NLP, Arxiv - <https://arxiv.org/abs/2005.14050>, 2020 [NLP Bias]

[Image] Vegard Antun, Francesco Renna, Clarice Poon, Ben Adcock, and Anders C. Hansen, On instabilities of deep learning in image reconstruction and the potential costs of AI, <https://doi.org/10.1073/pnas.1907377117>, PNAS, 2020

[Audio] Allison Koenecke, Andrew Nam, Emily Lake, Joe Nudell, Minnie Quartey, Zion Mengesha, Connor Toups, John R. Rickford, Dan Jurafsky, and Sharad Goel, Racial disparities in automated speech recognition, PNAS April 7, 2020 117 (14) 7684-7689, <https://doi.org/10.1073/pnas.1915768117>, March 23, 2020

# References for AI

## Textbook

- AI – A Modern Approach (AIMA), S. Russell & P. Norvig, <http://aima.cs.berkeley.edu/>

## Tools and demos

- Code sample in AIMA book
- Learning tools and model libraries
  - <https://ai.google/tools/>
  - Watson library:  
<https://www.ibm.com/watson/products-services/>
  - Exciting startups:  
<https://www.prowler.io/>
  - Interchange standards:  
<https://onnx.ai/>

## Articles and Papers

- New York Time, AI Special Issues,  
<https://www.nytimes.com/spotlight/artificial-intelligence>,  
April 2020
- McKinsey, Notes from the AI Frontier modeling the impact of AI on the world economy,  
<https://www.mckinsey.com/featured-insights/artificial-intelligence/notes-from-the-ai-frontier-modeling-the-impact-of-ai-on-the-world-economy>, 2018
- Henry A. Kautz, The third AI summer: AAAI Robert S. Engelmore Memorial, 2022,  
<https://onlinelibrary.wiley.com/doi/full/10.1002/aaai.12036>
- Biplav Srivastava, Understanding AI and Cognitive Systems – a Perspective on Its Potential and Challenges While Putting Them to Work with People, AI & Cognitive Systems, Issue 4, Vol 2- Issue 1, 2018.

# Home Work 6 (Optional)

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Due Thursday, April 7, 2022

# Home Work (#6) – C++ - Understand Code Optimization

- Consider BubbleSort algorithm for sorting (shown on right)
- Processing
  1. Generate n random numbers – called S
  2. (Store and Sort as Array)
    1. Store the numbers of S in an array: allocated with size n at the start
    2. Sort using Bubble Sort
  3. (Store and Sort as Vector)
    1. Store the numbers of S in a vector: allocated with size 1 and size increased one by one number until n
    2. Sort using Bubble Sort
  4. Measure time difference in both cases with n = 100, 1000, 10000, 100000
- Output
  1. Make a graph showing any difference in timing
  2. Check the sorted results and confirm they are same

## Algo 3 (BubbleSort):

```
• current_array = a = Input
• For (i=0; i<N-1; i++) {
    • For (j=(i+1); j<N; j++) {
        • If(a[i] > a[j])
            • Swap(a[i], a[j])
        • }
    • }
• Return current_array
```

# Home Work (#6) – C++ - Requirement

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- So, write a program named:  
***SortRandomN***
- It will support inputs/ arguments in the format:
  - n: number // numbers to sort
- Output:
  - Time for array // computed value
  - Time for vector // computed value
  - Result\_checked (Boolean) = True/ False // compare the results in both cases

## Example invocation

```
> SortRandomN 1000  
Time for array: 1 sec  
Time for vector: 2 sec  
Result_checked: True
```

# Discussion: Course Project

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# Course Project – Assembling of Prog. Assignments

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- **Project:** Develop collaborative assistants (chatbots) that offer innovative and ethical solutions to real-world problems ! (*Based on competition - <https://sites.google.com/view/casy-2-0-track1/contest>*)
- Specifically, the project will be building a chatbot that can answer questions about a South Carolina member of state legislature from:  
<https://www.scstatehouse.gov/member.php?chamber=H>
  - Each student will choose a district (from 122 available).
  - Programming assignment programs will: (1) extract data from the district, (2) process it, (3) make content available in a command-line interface, (4) handle any user query and (5) report on interaction statistics.

# Core Programs Needed for Project

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- Prog 1: extract data from the district [\*\*\[prog1-extractor\]\*\*](#)
- Prog 2: process it (extracted data) based on questions [\*\*\[prog2processor\]\*\*](#)
- Prog 3: make content available in a command-line interface [\*\*\[prog3-ui\]\*\*](#)
- Prog 4: handle any user query [\*\*\[prog4-userintent2querymapper\]\*\*](#)
- Prog 5: report statistics on interaction of a session, across sessions [\*\*\[prog5-sessionlogger\]\*\*](#)

# Prog 6: Assembling the Chatbot

- Have a program - **[myrep-chatbot]**
- User interacts with the chatbot with any utterance and the system has to answer
  - see right
- User can ask about statistics and query log
  - Same as PA5
  - See next slide

[#1] “Quit” or “quit” or just “q” => Program exits  
[#2]“Tell me about the representative”, “Tell me about the rep” => Personal Information (Type-I2)  
[#3]“Where does the rep live” => Contact Information (Type-I1): Home Address  
[#4]“How do I contact my rep ” => Contact Information (Type-I1)  
[#5]“What committees is my repo on” => Committee Assignments (Type-I3)  
[#6]“Tell me everything” => Give all information Extracted  
[#7] “What district do you support for Q/A” => Give district number and name  
[#8] *<User can enter any other text and the program has to handle it>* => “I do not know this information” or “Here is my guess - ” + <query> + <answer>. “Did I answer correctly ? “

# All Queries to be Supported

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[#1] "Quit" or "quit" or just "q" => Program exits  
[#2] "Tell me about the representative", "Tell me about the rep" => Personal Information (Type-I2)  
[#3] "Where does the rep live" => Contact Information (Type-I1): Home Address  
[#4] "How do I contact my rep" => Contact Information (Type-I1)  
[#5] "What committees is my rep on" => Committee Assignments (Type-I3)  
[#6] "Tell me everything" => Give all information Extracted  
[#7] "What district do you support for Q/A" => Give district number and name  
[#8] <User can enter any other text and the program has to handle it> => "I do not know this information" or "Here is my guess - " + <query> + <answer>. "Did I answer correctly ? "

**myrep-chatbot** –summary

=> There are 12 chats to date with user asking 23 times and system respond 24 times. Total duration is 456 seconds.

• **myrep-chatbot** –showchat-summary 2=> Chat 2 has user asking 2 times and system respond 2 times. Total duration is 4 seconds.

• **myrep-chatbot** –showchat 2

=> Chat 2 chat is:

...

• **myrep-chatbot** –showchat 200

=> ERROR: there are only 12 chat sessions. Please choose a valid number.

# Project – PA#6

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- Code organization
  - Create a folder in your GitHub called “**myrep-chatbot**”
  - Have sub-folders: src (or code), data, doc, test
  - Have data directory as shown in previous slide
    - ./data/**chat\_sessions**/
    - ./data/ **chat\_statistics.csv**
  - Write a
    - Report in ./doc sub-folder. Credit reuse
    - Create a presentation in ./doc sub-folder
  - Put a log of system interacting in ./test
  - Send a confirmation that code is done by updating Google sheet; optionally, send email to instructor and TA
- Use concepts learned in class
  - Exceptions
  - File operations
  - PA1 to PA5 from yourself or others; credit reuse in Readme, report and presentation

# Concluding Section

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# Lecture 24: Concluding Comments

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- Programming practice for project assignments based on PA#4
- We discussed
  - Templates
  - Class templates
  - Functional templates
- Project – due on Tuesday

# About Next Lecture – Lecture 25

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# Lecture 25: Review for Quiz 2

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- Review of concepts
- Project due – PA1 to PA6

20	Mar 24 (Th)	Advanced: Operator overloading	Prog 4 - end
21	Mar 29 (Tu)	Advanced: Memory Management	Prog 5 - start
22	Mar 31 (Th)	Advanced: Code efficiency	
23	Apr 5 (Tu)	Advanced: Templates	Prog 5 – end, Optional HW-6
24	Apr 7 (Th)	AI / ML and Programming	Prog 6 - assembling
25	Apr 12 (Tu)	Review material for Quiz 2	Project due
26	Apr 14 (Th)	In class test	Quiz 2 – In class