Topics

• Course logistics
• Overview of AI
Classroom Conduct

• Virginia Tech is committed to protecting the health and safety of all members of its community.
  – Wear a mask at all times while in class.
  – Isolate yourself from campus if you test positive for COVID or begin to feel symptoms that might be related to COVID.
  – Keep physical distance when feasible.
  – Check Virginia Tech Ready website for any update.

• Be a good citizen.

• Be committed. Be well.
Course Websites

- Course Homepage: [http://courses.cs.vt.edu/~cs4804/](http://courses.cs.vt.edu/~cs4804/)
  - Tentative schedule
  - Updated throughout this semester
- Canvas: CS4804: [https://canvas.vt.edu/courses/135929](https://canvas.vt.edu/courses/135929)
  - Announcements
  - Homework assignments
  - Project assignments
  - Exams
- CS4804 GitHub: [https://github.com/CS4804](https://github.com/CS4804)
Instructor: Yinlin Chen

- Ph.D. Computer Science, Virginia Tech
- Digital Library Architect and Assistant Professor, University Libraries
- Research Interests:
  - Digital libraries, Machine learning, Deep learning, Cloud computing, Natural language processing, Serverless computing, and Information retrieval.
- Website: https://www.yinlinchen.com/
- Email: ylchen@vt.edu
- Office hours: Tuesday 2:00 PM–3:00 PM, by appointment.
TA: Shakiba Davari

- 4th Year Ph.D. Student
- 3DI Lab
  - Doug Bowman

Research Interests:
- Human Computer Interaction
- AR/VR: UI design and UX
- Context Intelligent Adaptive AR

- Website: [https://www.linkedin.com/in/sdavari/](https://www.linkedin.com/in/sdavari/)
- Email: sdavari@vt.edu
- Office hours: TBD
TA: Ying Shen

- 1<sup>th</sup> Year Ph.D. Student
- Research Interests:
  - Deep Learning
  - Natural Language Processing
- Website: [https://yingshen-ys.github.io/](https://yingshen-ys.github.io/)
- Email: yings@vt.edu
- Office hours: TBD
Office Hours

• Start: 08/30,   End: 12/13
• No office hours on Thanksgiving Week
Course Format

• Lectures (Tue and Thur)
  – In person: 3:30 PM to 4:45 PM, MCB 113
  – You should attend the class
  – We will take attendance
### Course Topics Overview

- **Problem solving**
  - Search, Adversarial Search, Constraint satisfaction problem (CSP)
- **Knowledge, reasoning, and planning**
  - Logic, knowledge representation, automated planning
- **Uncertain Knowledge and reasoning**
  - Probabilistic, Markov decision process (MDP), Bayesian Networks
- **Machine Learning**
  - Reinforce learning / Deep learning / (Un)Supervise learning
- **Researches and Applications**
  - Natural Language Processing (NLP), Computer Vision, Robotics, Ethics
Textbook

  [http://aima.cs.berkeley.edu](http://aima.cs.berkeley.edu)

by Stuart Russell and Peter Norvig

The authoritative, most-used AI textbook, adopted by over 1500 schools.

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- Exercises (website)
- Figures (pdf)
- Code (website): Pseudocode (pdf)

Covers: US, Global
Other VT Courses

- CS3604: Professionalism in Computing
- CS4824: Machine Learning
Homework Assignments

- Canvas
- Written problems
- Exercises based on class material and textbook
- Due at 11:59pm
Projects Assignment

- Canvas
- Programming problems
- Projects give you hands-on experience with the algorithms
- Python 3.6
- Due at 11:59pm
Late assignment policy

• Homework & project assignment submitted late without permission will be penalized according to the following formula:

\[
(Penalized \ score) = (Your \ raw \ score) \times (1 - 0.1 \times (# \ of \ days \ past \ deadline))
\]

• This formula will apply for up to three days, after which the homework will not be accepted and you will receive a grade of zero.
Exam Dates

- Midterm (10/14 3:30pm – 5:30pm):
  - In class or online with time limit
- Final (12/13 10:05am – 12:05pm):
  - In class or online with time limit
- Harder than homework assignments
- You must attend both midterm and final exam in order to pass the course
- No makeup exams
- Let us know (emails) if you cannot attend the exams due to personal reasons.
Grading breakdown

• 7%: Class attendance and participation
• 28%: Homework assignments
• 30%: Project assignments (2%: Project 0)
• 15%: Midterm exam
• 20%: Final exam
Academic integrity

• This course will have a zero-tolerance philosophy regarding plagiarism or other forms of cheating.
• Your assignments must be your own work.
• We will report incidents of academic dishonesty to the Office of the Undergraduate Honor System.
Health and Well-being

- **Cook Counseling**: 540-231-6557 to schedule an appointment and/or 24/7 crisis support. [https://ucc.vt.edu/](https://ucc.vt.edu/)
- **Dean of Students Office**: 540 231-3787 for general advice. 540-231-6411 for after-hours crisis. [https://dos.vt.edu/](https://dos.vt.edu/)
- **Hokie Wellness**: [https://hokiewellness.vt.edu/](https://hokiewellness.vt.edu/)
- **Services for Students with Disabilities (SSD)**: 540-231-3788 or [http://www.ssd.vt.edu/](http://www.ssd.vt.edu/)
- **Full listing of campus resources**: [https://well-being.vt.edu/](https://well-being.vt.edu/)
Why did you choose this course?
What is Artificial Intelligence (AI)?

Movie: I, Robot (2014)

Movie: Terminator(s)
1984
1991
2003
2009
2015
2019
What is AI?
What is AI in Computer Science?

“The science and engineering of making intelligent machines, especially intelligent computer programs”.

- John McCarthy
History of Artificial Intelligence

1642 - First mechanical calculating machine built by French mathematician and inventor Blaise Pascal.

1837 - First design for a programmable machine, by Charles Babbage and Ada Lovelace.

1943 - Foundations of neural networks established by Warren McCulloch and Walter Pitts, drawing parallels between the brain and computing machines.

1950 - Alan Turing introduces a test—the Turing test—as a way of testing a machine's intelligence.

1955 - 'Artificial intelligence' is coined during a conference devoted to the topic.

1965 - ELIZA, a natural language program, is created. ELIZA handles dialogue on any topic; similar in concept to today's chatbots.

2009 - Google builds the first self-driving car to handle urban conditions.

2011 - IBM's Watson defeats champions of US game show Jeopardy!

2011-2014 - Personal assistants like Siri, Google Now, Cortana use speech recognition to answer questions and perform simple tasks.

2014 - Ian Goodfellow comes up with Generative Adversarial Networks (GAN).

2016 - AlphaGo beats professional Go player Lee Sedol 4-1.

Most universities have courses in Artificial Intelligence.

AI System

- AI System = Code (model/algorithm) + Data
  - Model-centric AI
  - Data-centric AI
Overview of AI

Artificial Intelligence

Machine Learning

Deep Learning
What is learning?

• 1, 2, 3, 5, 8, 13, 21, ?, ?, ?

• I study at the CS@VT, I should learn how to <....>?
State of the Art

Computer Vision

- Semantic Segmentation
  - 102 benchmarks
  - 1874 papers with code
- Image Classification
  - 240 benchmarks
  - 1652 papers with code
- Object Detection
  - 209 benchmarks
  - 1410 papers with code
- Image Generation
  - 155 benchmarks
  - 632 papers with code
- Denoising
  - 100 benchmarks
  - 612 papers with code

Natural Language Processing

- Language Modelling
  - 21 benchmarks
  - 1182 papers with code
- Machine Translation
  - 69 benchmarks
  - 1135 papers with code
- Question Answering
  - 90 benchmarks
  - 1066 papers with code
- Sentiment Analysis
  - 57 benchmarks
  - 687 papers with code
- Text Generation
  - 62 benchmarks
  - 515 papers with code
State of the Art

Speech

- Speech Recognition
  - 116 benchmarks
  - 472 papers with code
- Speech Synthesis
  - 2 benchmarks
  - 106 papers with code
- Dialogue Generation
  - 9 benchmarks
  - 86 papers with code
- Speech Enhancement
  - 11 benchmarks
  - 80 papers with code
- Voice Conversion
  - 1 benchmark
  - 62 papers with code

Medical

- Medical Image Segmentation
  - 81 benchmarks
  - 177 papers with code
- Drug Discovery
  - 14 benchmarks
  - 125 papers with code
- Lesion Segmentation
  - 6 benchmarks
  - 86 papers with code
- Medical Diagnosis
  - 3 benchmarks
  - 53 papers with code
- Brain Tumor Segmentation
  - 8 benchmarks
  - 53 papers with code

VT Virginia Tech
The Berkeley Crossword Solver

2012, 11th place
2021, 1st place

Deep learning

Trained on a database of 6 million paired clues and answers
AutoML-Zero: Evolving Code that Learns

```
def Setup():
    s4 = 1.8e-3  # Learning rate

def Predict():  # v0 = features
    v2 = v0 + v1  # Add noise
    v3 = v0 - v1  # Subtract noise
    v4 = dot(m0, v2)  # Linear
    s1 = dot(v3, v4)  # Multi.interac.
    m0 = s2 * m2  # Copy weights

def Learn():  # s0 = label
    s3 = s0 - s1  # Compute error
    m0 = outer(v3, v0)  # Approx grad
    s2 = norm(m0)  # Approx grad norm
    s5 = s3 / s2  # Normalized error
    v5 = s5 * v3
    m0 = outer(v5, v2)  # Grad
    m1 = m1 + m0  # Update weights
    m2 = m2 + m1  # Accumulate wghts.
    m0 = s4 * m1  # Generate noise
    v1 = uniform(2.4e-3, 0.67)
```

Computers Making Computers

Definition of AI

- AI has focused on the study and construction of agents that do the right thing.
- AI is concerned mainly with rational action. An ideal intelligent agent takes the best possible action in a situation.
- A rational agent is to achieve the best outcome or the best expected outcome.
Things to do This Week

• Course homepage and Canvas
• Mark exam dates in your calendar
• Reading: AIMA 2.1 – 2.4
Reading and Next Class

• Overview of AI: AIMA 1
• Next class:
  – Agents: AIMA 2.1 – 2.4
Self-Driving Bike