Introduction to Conversational Artificial Intelligence

Conversational Artificial Intelligence -- EE596
Hao Fang
University of Washington
Course Goals

• Understand basic concepts in conversational AI
• Learn recent advances in conversational AI
• Build a social chatbot using Amazon Alexa Skill Kit

• Expected Background
  • Courses: Natural Language Processing / Artificial Intelligence / Machine Learning
  • Programming Language: NodeJS, Python
  • System: Linux
  • Tools: Git
About the course

• Course website: https://hao-fang.github.io/ee596_spr2018/
• Report submission and course discussion: Canvas
• Labs: BRING YOUR LAPTOP
• Project: up to 5 teams (up to 6 members)
Office Hours

• Hao Fang (Instructor)
  • Tuesday 3:00 – 4:00pm
  • EEB M406: Please knock the door
  • hfang@uw.edu

• Hao Cheng (TA)
  • Friday 4:30 – 5:30pm
  • EE Atrium (EEB 2\textsuperscript{nd} Floor)
  • chenghao@uw.edu
Class Format

• Lectures on Tuesday
  • Lectures cover basic concepts and recent advances in conversational AI
  • We will have two guest lectures in this quarter
  • Paper discussion and presentation

• Labs on Thursday
  • Each lab has 2 sessions (2 weeks)
  • Lab checkoff in either session
  • Lab reports due on the Tuesday after the 2nd lab session

• Final week (May 29)
  • System demo, evaluation, and presentation
  • We may invite external visitors
Syllabus

- Subject to change.
- Slides and links will be uploaded one day after the class.

<table>
<thead>
<tr>
<th>Date</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuesday, Mar 27, 2018</td>
<td>Week 1: Introduction to Conversational AI</td>
</tr>
<tr>
<td>Thursday, Mar 29, 2018</td>
<td>Lab 1(a): Hello Alexa</td>
</tr>
<tr>
<td><strong>Tuesday, April 3, 2018</strong></td>
<td>Week 2: Voice Interfaces and Spoken Language Understanding</td>
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<tr>
<td>Thursday, April 5, 2018</td>
<td>Lab 1(b): Hello Alexa</td>
</tr>
<tr>
<td><strong>Tuesday, April 10, 2018</strong></td>
<td>Week 3: Guest Lecture by Mari Ostendorf – Speech Recognition and Synthesis</td>
</tr>
<tr>
<td>Thursday, April 12, 2018</td>
<td>Lab 2(a): TBA</td>
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<tr>
<td>Tuesday, April 17, 2018</td>
<td>Week 4: Language Generation</td>
</tr>
<tr>
<td><strong>Thursday, April 19, 2018</strong></td>
<td>Project proposal presentation</td>
</tr>
<tr>
<td>Tuesday, April 24, 2018</td>
<td>Week 5: Dialog Management</td>
</tr>
<tr>
<td>Thursday, April 26, 2018</td>
<td>Lab 2(b): TBA</td>
</tr>
<tr>
<td><strong>Tuesday, May 1, 2018</strong></td>
<td>Week 6: Dialog Evaluation</td>
</tr>
<tr>
<td>Thursday, May 3, 2018</td>
<td>Lab 3(a): TBA</td>
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<tr>
<td>Tuesday, May 8, 2018</td>
<td>Week 7: End-to-end neural dialog systems</td>
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<tr>
<td>Thursday, May 10, 2018</td>
<td>Lab 3(b): TBA</td>
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<tr>
<td><strong>Tuesday, May 15, 2018</strong></td>
<td>Week 8: Guest Lecture by Alex Marin – Knowledge Graph</td>
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<tr>
<td>Thursday, May 17, 2018</td>
<td>Lab 4(a): TBA</td>
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<tr>
<td>Tuesday, May 22, 2018</td>
<td>Week 9: Project consulting session</td>
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<tr>
<td>Thursday, May 24, 2018</td>
<td>Lab 4(b): TBA</td>
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<tr>
<td><strong>Tuesday, May 29, 2018</strong></td>
<td>Week 10: Project demo, evaluation and presentation</td>
</tr>
<tr>
<td>Thursday, June 1, 2018</td>
<td>No lecture (get your reports done!)</td>
</tr>
</tbody>
</table>

April 3, 2018 | Team registration
April 10, 2018 | Lab 1 report
April 19, 2018 | Project proposal
May 1, 2018 | Lab 2 report
May 15, 2018 | Lab 3 report
May 29, 2018 | Lab 4 report
June 8, 2018 | Project report
Papers for presentation

• More details next week

• Conferences:
  • SIGDIAL
  • ACL, EMNLP, NIPS, ICML, CVPR

• Other lists
  • https://dialog-systems-class.github.io/readings.html#now
  • https://wammar.github.io/2018sp_uw_cse_599/
Grading Policy

• Labs: 40% (4 x 10%)
  • Lab checkoff: 5%
  • Lab report: 5%
• Paper presentation: 10%
• Project proposal: 10%
• Project demo and presentation: 20%
  • Every team member needs to participate in the presentation
  • Systems will be evaluated by judges (peer students & external panel)
• Project report: 20%
• No late submission!

<table>
<thead>
<tr>
<th>Date</th>
<th>Assignment</th>
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<tbody>
<tr>
<td>April 3, 2018</td>
<td>Team registration</td>
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<tr>
<td>April 10, 2018</td>
<td>Lab 1 report</td>
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<td>April 19, 2018</td>
<td>Project proposal</td>
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<td>Lab 2 report</td>
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</tr>
<tr>
<td>May 29, 2018</td>
<td>Lab 4 report</td>
</tr>
<tr>
<td>June 8, 2018</td>
<td>Project report</td>
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</tbody>
</table>
Collaboration

• Students should work as a team on labs, presentations, and projects
  • Each team should submit a lab/project report together
  • The report should include information about the structure of the collaboration (i.e. who did what)

• Use of an open-source software must be identified and credited in comments in your codes
Platform

• Device: Echo dot
  • Each team will get 2 devices.
  • You need to return the device on June 1, 2018 (last class).

• Simulator: Echosim.io
  • https://echosim.io

• Amazon Alexa Skill Kit (https://developer.amazon.com/alexa-skills-kit)

• Amazon AWS Lambda (https://aws.amazon.com/lambda/)

• Programming Language:
  • NodeJS
  • Python
Resources

• See https://hao-fang.github.io/ee596_spr2018/resources.html

• Welcome to contribute to the list
  • Create an issue at https://github.com/hao-fang/ee596_spr2018
Team Registration (due on April 3, 2018)

• Team name
  • The team name will also be the name of your bot
  • https://developer.amazon.com/docs/custom-skills/choose-the-invocation-name-for-a-custom-skill.html

• Team members (up to 6)
  • every team should have one LING student & one ENGINEERING student

• Team vision

• 1-page DOC or PDF

• Register through Canvas

• You must join a team for this course
Student Self-Introduction
Project Ideas -- Chatbots

- Discuss news articles
- Debate
- Quiz + X
- Psychological therapy
- User simulator for Sounding Board
- General chitchat
- Others (e.g., education / medical applications)
Project Proposal (due on April 19, 2018)

• Motivation
  • Explain and motivate the system you are going to build
  • Discuss the target users
  • Examples of user cases

• System overview
  • System architecture
  • High-level description of individual modules

• Potential data, model, evaluation
  • Optional for proposal, but required for final report

• Timeline

• Description of Team Expertise
Project Report (due on June 8, 2018)

• Outline
  • Introduction
  • System description
  • Data
  • Model
  • Evaluation
  • Discussion

• More details to follow towards the end of the course
Conversational Agents
Sci-Fi
If HAL 9000 was Amazon’s Alexa -- [https://youtu.be/JepKVUym9Fg](https://youtu.be/JepKVUym9Fg)
• Classic Chatbots (Turing Test)
  • ELIZA (Weizenbaum, 1966)
  • PARRY (Colby, 1975)
  • ALICE (Wallace, 2009)
  • Leobner Prize (2006 -- )

• Task-oriented systems
  • DARPA Airline Travel Information System (ATIS)
  • DARPA Communicator for travel planning

• Conversational Assistants
  • Amazon’s Alexa
  • Apple’s Siri
  • Google Assistant
  • Microsoft’s Cortana

• Social Chatbots
  • Amazon Alexa Prize (2017 -- )
Break (10 min)
Next: Sounding Board

Try some online chatbots if you want.

https://hao-fang.github.io/ee596_spr2018/resources.html
Sounding Board
A User-centric and Content-driven Social Chatbot

2017 Amazon Alexa Prize Winner

University of Washington

http://sounding-board.github.io
The Sounding Board Team

Students (left-to-right)
Elizabeth Clark, Ariel Holtzman, Hao Fang, Maarten Sap, Hao Cheng

Faculty Advisors
Mari Ostendorf
Yejin Choi
Noah Smith
Agenda

- Amazon Alexa Prize
- Our Approach
- Evaluation
- Future Work
Agenda

- Amazon Alexa Prize
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2017 Amazon Alexa Prize

Advance conversational Artificial Intelligence (AI)

“converse coherently and engagingly with humans on popular topics and current events”

- November 2016 – November 2017
- Competition for university students to develop a socialbot
- 100+ teams applied, 16 teams participated, 3 made it to the finals
  - University of Washington
  - Czech Technical University
  - Heriot-Watt University
- Anyone with an Alexa-enable device can talk to it by saying “let’s chat”
  - Most recent 3 months (post-finals): 500K users, 10M interactions
Socialbots in conversational AI

2017 Amazon Alexa Prize

Virtual Assistant
- Accomplish tasks
  + 2-way social and information exchange
- Limited content to talk about
  + Limited content to talk about

Socialbot
- execute commands, answer questions
- Social conversation

Chatbot
- chitchat
- No social back and forth
Agenda

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- Future Work
Our Approach

Sounding Board -- a conversational gateway
Our Approach

Sounding Board -- a conversational gateway
Our Approach

Sounding Board -- a user-centric and content-driven social chatbot

User-centric
- User goals
- User personality
- User reactions
- Responsive to abrupt user topic/goal changes

Content-driven
- Content mining
- Knowledge graph
- Actively steer conversation based on content availability
Our Approach

System modules

- What type of things to talk about?
  - Mine and understand online content
  - Time-sensitive, interesting, uplifting, …
  - Organize content as a knowledge graph

- How to talk about them?
  - Understand users
  - Negotiate, execute, abandon sub-dialogs
  - Content should be relevant, diverse, …
  - Conversational style in both word choice & prosody
<table>
<thead>
<tr>
<th>Turn</th>
<th>User</th>
<th>Sounding Board</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Let's chat</td>
<td>Hi! This is an Alexa Prize socialbot. How's your day?</td>
</tr>
<tr>
<td>2</td>
<td>I'm five.</td>
<td>Glad to hear it! We could talk about robots, batman, or superman. Say &quot;next&quot;, to chat about other things.</td>
</tr>
<tr>
<td>3</td>
<td>Superman.</td>
<td>It looks like you wanna chat about superman. I was high up in the cloud when I realized: If people don't recognize Clark Kent as Superman because of his glasses, does his eye doctor know his true identity?</td>
</tr>
<tr>
<td>4</td>
<td>I guess so.</td>
<td>Did you know that Henry Cavill almost missed the call for the role of Superman cause he was playing &quot;World of Warcraft&quot;</td>
</tr>
<tr>
<td>5</td>
<td>Really, I didn't know that.</td>
<td>Weird, right? Speaking of superman, Did you see: Superman? It was released in 1997. It's a comedy.</td>
</tr>
<tr>
<td>6</td>
<td>Yes, it was hilarious.</td>
<td>I'm glad you feel this is hilarious. Which part do you like best about this movie?</td>
</tr>
<tr>
<td>7</td>
<td>The part when he met Lewis leah.</td>
<td>Interesting. meccartin, and raffi co-directed this film. The movie has a 6.3 out of 10 on IMDB. which seems pretty good! do you like the movie's director?</td>
</tr>
<tr>
<td>8</td>
<td>Yeah, he's cool.</td>
<td>Cool! By the way, do you wanna know something interesting about raffi?</td>
</tr>
<tr>
<td>9</td>
<td>Okay, go ahead.</td>
<td>Super! My friend told me that Raffi is a worldwide children's rights activist and has fought against exploitative advertising to children.</td>
</tr>
</tbody>
</table>
Agenda

- Amazon Alexa Prize
- Our Approach
- Evaluation
- Future Work
Evaluation

… for system development and Amazon analysis

- **Interaction Ratings from Alexa users**
  - 1 – 5 ratings, how much they would like to speak with this Socialbot again
  - Initial development period (April – June), Alexa Prize semifinals (July – Aug), post semifinals (Sept – Oct) and ongoing

- **Amazon Analysis**
  - Hand-labeling of conversations for various attributes (Venkatesh et al. NIPS 2017)

- **Alexa Prize Finals**
  - 1 – 5 ratings from Amazon-selected judges, with time as a tie-breaker
Evaluation

Alexa Prize Finals (Nov. 2017)

- Finalists: Czech Technical Univ., Univ. of Washington, Heriot-Watt Univ.
- 3 interactors, 3 judges
  - Interactors engage with the Socialbot in turn-by-turn conversation about popular topics
  - Judges listen to the interaction and give ratings (1 to 5)
  - Interactors end the conversation when 2 judges have requested to stop.
- Sounding Board results:
  - Average score: 3.17
  - Average duration: 10 minutes and 22 seconds
  - “Two judges had clicked out just shy of the 20-minute mark.” – James Vlahos, WIRED.
- 2017 Finals Video
Agenda

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Future Work

Sounding Board faces and tries to address …

**Technical Challenges**
- Collect and understand online content
- Understand user intent and reaction
- Recommend content effectively and efficiently
- Present content through conversational interaction

**User Experience Challenges**
- Exclude undesirable content
- Keep the conversation grounded
- Deflect discussions about taboo topics
Future Work

Research directions

- Improved capability of understanding users
- Deeper discussion about news events and online content
- Automatic evaluation and diagnosis of human-bot conversations
- More use of machine learning algorithms for system design
Future Work

Beyond the conversational gateway to social media…

- Information-oriented (timely content important)
  - Conversational gateway to information for education
  - Voice-based help-desk information service
  - Debate/info-bot (e.g. for political campaigns)

- Chat-oriented (social interaction important)
  - Conversational “practice” for language learning
  - Companionship
  - Medical domains (diagnosis & therapeutics)

- Art exhibit
Thank you
Language Understanding

Multi-dimensional utterance representation

- Directive: command, question
- Non-directive: confirmation, sentiment, opinion
- Topics: primary topic, candidate topics

no but that's cool can we talk about something else
i don't like sports let's talk about spider man homecoming
Dialogue Management

Hierarchical dialogue managers

- Conversational miniskills
  - greeting / goodbye / menu / topics
  - probe user personality
  - discuss a news article
  - discuss a movie
  - tell a fact / thought / advice / joke
  - ask a factual question

- Engagement principle
  - promote topic and style diversity
  - detect user dissatisfaction

- Coherence principle
  - retrieve content from knowledge graph
  - avoid duplicated contents

- User experience principle
  - conversation grounding
  - instruction
  - error handling
Language Generation

- Phrase generation
  - Grounding ("Interesting.")
  - Inform ("Did you know that ...")
  - Request ("Do you like the movie’s director?")
- Prosody adjustment
- Utterance purification
Content Management

- Harvest online contents
  - news, fact, thought, advice, joke
  - movie
  - question answering
- Build knowledge graph
  - connect content nodes
  - efficient query and recommendation
- Content filtering
  - sexual / violent / controversial
  - uncomfortable / depressing
  - overly complex / long
- Content formatting
  - text normalization for TTS
Profiling Personality

Big 5 personality traits (Costa & McCrae, 1992)

- Agreeable and Open users have longer conversations
- Extraverted, Agreeable, and Open users tend to like Sounding Board more

<table>
<thead>
<tr>
<th>Trait</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>ext</td>
<td>news, fashion</td>
<td>A.I., time travel, batman, food, cats</td>
</tr>
<tr>
<td>agr</td>
<td>N/A</td>
<td>pokemon, cats, christmas, robots</td>
</tr>
<tr>
<td>ope</td>
<td>A.I., time travel, batman, aliens</td>
<td>video games</td>
</tr>
<tr>
<td>con</td>
<td>N/A</td>
<td>movies, video games, disney, pokemon, minecraft</td>
</tr>
<tr>
<td>neu</td>
<td>A.I.</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Choose Your Team Name

• Please refer to Alexa Skill Kit document
  • https://developer.amazon.com/docs/custom-skills/choose-the-invocation-name-for-a-custom-skill.html

• One-word invocation names are not allowed

• Invocation names which are names of people or places are not allowed
  • unless they contain other words in addition to the name (e.g., "molly's horoscope").

• Two-word invocation names are not allowed if one of the words is
  • definite article ("the")
  • indefinite article ("a", "an")
  • preposition ("for", "to", "of").
  • For example, "a bicycle", "an espresso", "to amuse", "for fun".
Choose Your Team Name

- The invocation name must not contain any of the Alexa skill launch phrases and connecting words.
  - Launch phrases: "launch", "ask", "tell", "load", "begin", and "enable".
  - Connecting words: "to", "from", "by", "if", "and", "whether".
- The invocation name must not contain
  - the wake words "Alexa", "Amazon", "Echo", "Computer",
  - or the words "skill" or "app".
Choose Your Team Name

• The invocation name must contain only
  • lower-case alphabetic characters
  • spaces between words
  • possessive apostrophes (for example, "sam's science trivia")
  • periods used in abbreviations (for example, "a. b. c.").

• Other characters like numbers must be spelled out
  • For example, "twenty one".
  • The name must be easy to pronounce correctly and be phonetically distinct to avoid being misinterpreted as other similar sounding words.

• For acronyms, the invocation name must contain single letters, each followed by a period and a space.
  • The invocation name cannot spell out phonemes.
  • For example, a skill titled "USC Trivia" would need "USC" represented as "u. s. c. " and NOT "you ess see".
March 29: Lab 1 – Hello Alexa

• Sign up for Amazon AWS using your @uw.edu account.
  • You will get Free Tier access (https://aws.amazon.com/free) for your labs and projects.

• Apply for AWS Educate using your @uw.edu account.
  • https://www.awseducate.com
  • You will get $100 credit in addition to the Free Tier access. (You need to use your @uw.edu account).
  • FAQ: https://www.awseducate.com/faqs

• Create an Amazon Developer Account.
  • https://developer.amazon.com