Finite State Dialogue Management

- A bunch of states and some global variables $\rightarrow$ states of system
- TTS output specified for each state $\rightarrow$ actions of system
- Transitions define what successor states system might be in depending on response of user

But...
- Tedious to specify all of the states (e.g., for shortcuts)
- Tedious to specify all of the transitions (e.g., repeat shortcuts)

Overview

- Review
- Philosophy of Language
- Artificial Intelligence
What have we learned though?

- System behavior specified as:
  - What states the system can be in
  - What should it do in a particular state
  - What states the system can be in when the user does something

Rather than continue on this engineering approach, let’s turn to philosophy.

Form-Filling Dialogue Manager

- Agenda + Value + Domain defines system’s state
- Dialogue manager uses system’s state to determine what to say
- Dialogue manager uses system’s state to determine what the user can say
- Code in dialogue manager determines how to update system’s state
- Behavior of system is buried in the dialogue manager code

But, not applicable to many types of applications that are not form-based.
What does a particular sentence mean?

Some sentences can be viewed as being true or false:

Snow is white

But what about other sentences?

I want to go to Boston

Some sentences can be viewed as being true or false:

Lifting a box changes the world

Saying 'I want to go to Boston' is an action the speaker does to change the beliefs of the hearer.

Speaking is action.
Under what conditions can a given speech act be made?

Searle was interested in the necessary and sufficient conditions

Necessary: what conditions if not met will guarantee the speech act will fail

Sufficient: what conditions if met will guarantee the success of the action

Necessary \( \subset \) Sufficient

Are the listener already knows this?
- If you don't want to go?
- Can you say 'I want to go to Boston'?

Types of Actions

Locutionary act: act of saying something
- Sounds and words that are produced
- Illocutionary acts: acts performed in saying something
- Communicative force: inform, request, suggest, warn, apologize
- Perlocutionary acts: acts performed by saying something
- Intent of the speaker
- Locus of the act is in the hearer
- Intended to have an effect on the hearer

Illocutionary acts

- Inform: 'it is cold in here'
- Request: 'turn on the heat'
- Suggest: 'you should go to bed'
- Warn: 'it is dangerous'
- Apologize: 'I'm sorry for disturbing you'
- Persuasion, surprise

Perlocutionary acts

- Achieve effects that are special to the particular situation of the utterance rather than the conventional nature of the communication

Illocutionary acts

- Sounds and words that are produced
- Communicative force: inform, request, suggest, warn, apologize
- Perlocutionary acts: acts performed in saying something
- Locus of the act is in the hearer
- Intended to have an effect on the hearer
- Intent of the speaker

Locutionary acts

- 'it is cold in here'
- 'turn on the heat'
- 'you should go to bed'
- 'it is dangerous'
- 'I'm sorry for disturbing you'
- 'I want to go to Boston'
- 'I don't want to go'

Necessary \( \subset \) Sufficient
Overview

Overview

Arts of Artificial Intelligence
Philosophy of Language
Review

Searle: Types of Conditions

- Normal input-output conditions
  + Intelligible, paying attention
- Propositional content conditions
  + A promise must be about something in the future
- Preparatory conditions
  + If I tell you someone I must be intending to tell you something
- Essential conditions
  + Constraints on the world that make the speech act useful
- Sincerity conditions
  + Constraints on the world that make the speech act useful
  + Hearer recognizing the speaker's intended attitudes with what was said
  + Speaker should be intending to do what they are doing
  + Alignment of the speaker's actual attitudes with what was said
  + Speaker's intentions to say something in the future
  + Essential conditions on the world that make the speech act useful
  + Constraints on the world that make the speech act useful

Review

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Formalizing Planning

- How can we guarantee reasoning is...
  - sound: a plan that is found is guaranteed to work
  - complete: if there is a plan that will work, it can be found

Much work in AI on formalizing planning

Actions and Planning

- A lot of work had taken place in AI on automated planning

What sequence of actions will solve the Tower of Hanoi problem?

How to determine sequence of actions for a robot to solve a problem?

What are the actions needed to solve the problem?

After an action is performed, what will be true about the world?

What must be true of world to do an action?

- Preconditions:
- Effects:
- Plan reasoning:
Theory of Speech Acts Based on Planning Should Specify the Following

What is needed for system to plan speech acts?

- Theory of Speech Acts based on planning should specify the following:
  - formal language for describing states of the world
  - how the system decides what action(s) to say
  - a set of plan construction inferences
  - formal language for describing states of the world
  - a set of plan construction inferences
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  - formal language for describing states of the world
  - a set of plan construction inferences
  - formal language for describing states of the world

Goals of Formalizing Speech Acts

- Goals of Formalizing Speech Acts
  - Preconditions:
    - Conditions for a particular speech act to be performed in utterance
    - Conditions for a particular speech act to be performed in utterance
    - Conditions for a particular speech act to be performed in utterance
    - Conditions for a particular speech act to be performed in utterance
    - Conditions for a particular speech act to be performed in utterance
  - Effects:
    - How is the meaning of an utterance $x$ related to the acts that be performed in utterance
    - How is the meaning of an utterance $x$ related to the acts that be performed in utterance
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Axioms about modal operators

- $X$ is true, conclude $\text{bel}(a,X)$
- $\text{bel}(\neg \text{bel}(a,X)) \rightarrow \text{bel}(a,X)$
- Negative introspection: $\neg \text{bel}(a,X) \rightarrow \text{bel}(a,\neg \text{bel}(a,X))$
- Positive introspection: $\text{bel}(a,X) \rightarrow \text{bel}(\neg \text{a},\neg \text{bel}(a,X))$
- T: reflexity axiom: $\text{bel}(a,X) \leftrightarrow \text{bel}(a,\neg \text{bel}(a,X))$
- K: distribution axiom: $\text{bel}(a,X) \rightarrow \text{bel}(a,bel(a,X))$
- Negative introspection: $\neg \text{bel}(a,X) \rightarrow \text{bel}(a,\neg \text{bel}(a,X))$
- $\text{bel}(a,bel(a,X)) \rightarrow \text{bel}(a,X)$
- $X$ is true, conclude $\text{bel}(a,X)$

Logic of Beliefs and Wants

- System has beliefs about what is true
- Modal operator $\text{bel}(a,p)$
- $\text{bel}$ is a modal operator because it takes propositions (things that can be true or false) as an argument
- System has things it wants to be true
- Modal operator $\text{want}(a,p)$
- System has things it wants to be true

Here are some to consider:

- This way, do not have to specify everything
- Can use these rules to conclude stuff
- Are there general rules about belief and want?
Formalize actions in terms of modal logic

Request

Inform