TALK project work at UCAM

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Overview

- TALK project
  - Goals
  - Baseline system
- the Hidden Information State (tHIS) system
  - Proposed system architecture
  - The Speech Understanding (SU) Agent
  - Confidence scores
  - HVS parser
- Current and future work

TALK project:

Tools for Ambient Linguistic Knowledge

Project Goals:

- Implement Information State Update (ISU) approaches
- Develop in-car and in-home multimodal dialog systems
- Learning strategies for the ISU approach
- Integrate multimodality and multilinguality
- Partners include Edinburgh, Gothenburg, DFKI, Saarbrucken, Seville, Bosch, Linguamatics and BMW

TALK project:

UCAM Project Workpackages:

- **WP1:** Unifying Multimodality and Multilinguality
  - New Speech Understanding components
  - Developing notion of multimodal dialog act
  - Closely coupling parser, recogniser and dialog manager

- **WP4:** Adaptivity and Learning
  - Reinforcement learning approaches
  - (Partially Observable) Markov Decision Process dialog managers
  - User modelling approaches

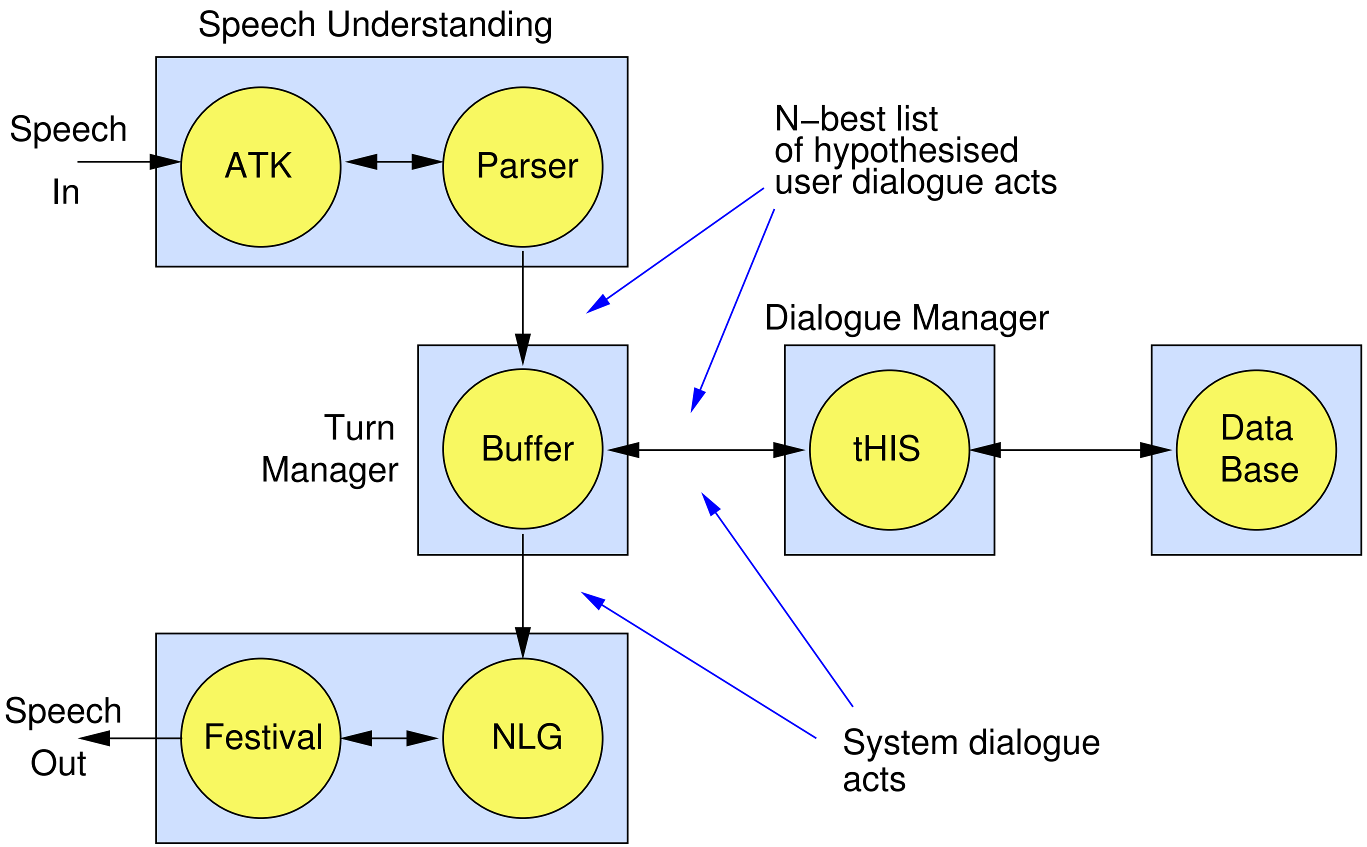
Baseline System:

Current baseline system built with Edinburgh:

- Based on SACTI Tourist Information domain
- **Built using:**
  - DIPPER dialog manager
  - Open Agent Architecture
  - ATK speech recogntion using n-gram language models
  - Word spotting parser
- **Currently features:**
  - Implicit and explicit confirmation
  - Fragmentary clarifications
  - Simple fixed dialog plan (slot filling)
  - Overanswering
  - Multimodal output

Proposed HVS System Overview

System Architecture



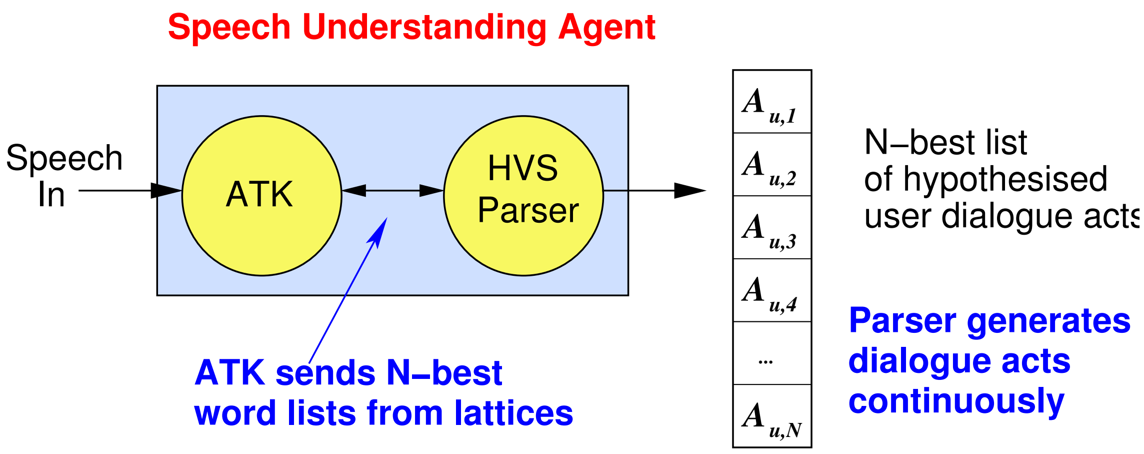
Four agents: Speech Understanding, Turn Manager, Dialogue manager, Speech Generation

Proposed HVS System Overview

Hidden Information State model

- Operates as a MDP over Belief State $B = P(S_d, S_u)$ where S_u=user state and S_d=dialog state
- Similar advantages to POMDP for modelling uncertainty but like an MDP can be optimised using on-line methods
- Belief state is discrete approximation to continuous state space
- Approximation is a *forest* of most likely states
- User state expands according to **application specific** rules
- User state captures domain ontology
- Actions A_s are based on a linear function approximation of $Q(B, A_s)$

Speech Understanding Agent



- Some of UCAM's proposed work focuses on developing the SU agent.
- Uses ATK and the Hidden Vector State (HVS) Parser.
- Outputs an n-best list of user dialog acts with scores.
- Operates asynchronously, forwards dialog acts to the Turn Manager agent.

Speech Understanding (SU) Agent

Motivation

- Asynchronous, so does not impose a turn-taking model - will allow barge-in.
- Will output the n-best dialog acts
- Use of HVS and ATK will allow statistical confidence measures to be implemented
- HVS model can be incrementally trained on-line with system data.
- Multimodal inputs can be investigated later (WP1 work)

Confidence Scores

Current implementation:

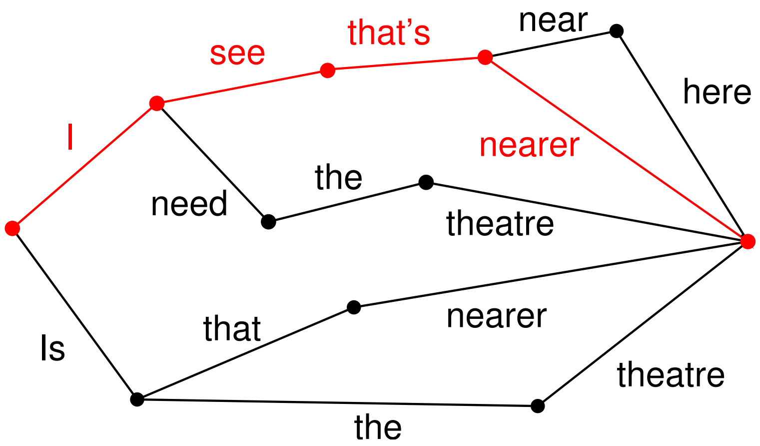
- ATK currently outputs confidence scores based on recognition scores relative to a “background” model
  - Current scores do not contain much information about correctness of hypothesis
- Recent work has enabled use of n-best lists and lattice generation in ATK
  - Need to generate very long n-best lists to get alternative parse hypotheses.

Confidence Scores

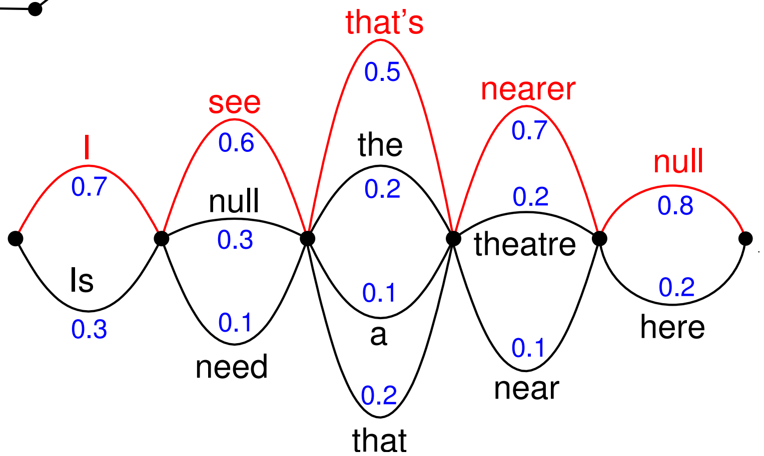
Proposed alternative:

- Generate word posteriors from lattice for each word position
  - Will generate more hypotheses from parser
  - Deletions/insertions handled by “NULL” label
- Can generate alternatives for each word in the best hypothesis
  - Word posteriors have been shown to be more informative
  - Can develop strategies based on fragmentary clarification more easily
- Currently working on generating information on-the-fly
  - Calculating word posteriors requires forward and backward pass through the (complete) lattice

ATK Outputs



Lattice



i see that's nearer	-21.2
is that nearer	-46.1
i see that's near here	-55.4
is the theatre	-59.1
i need the theatre	-61.6

N-Best

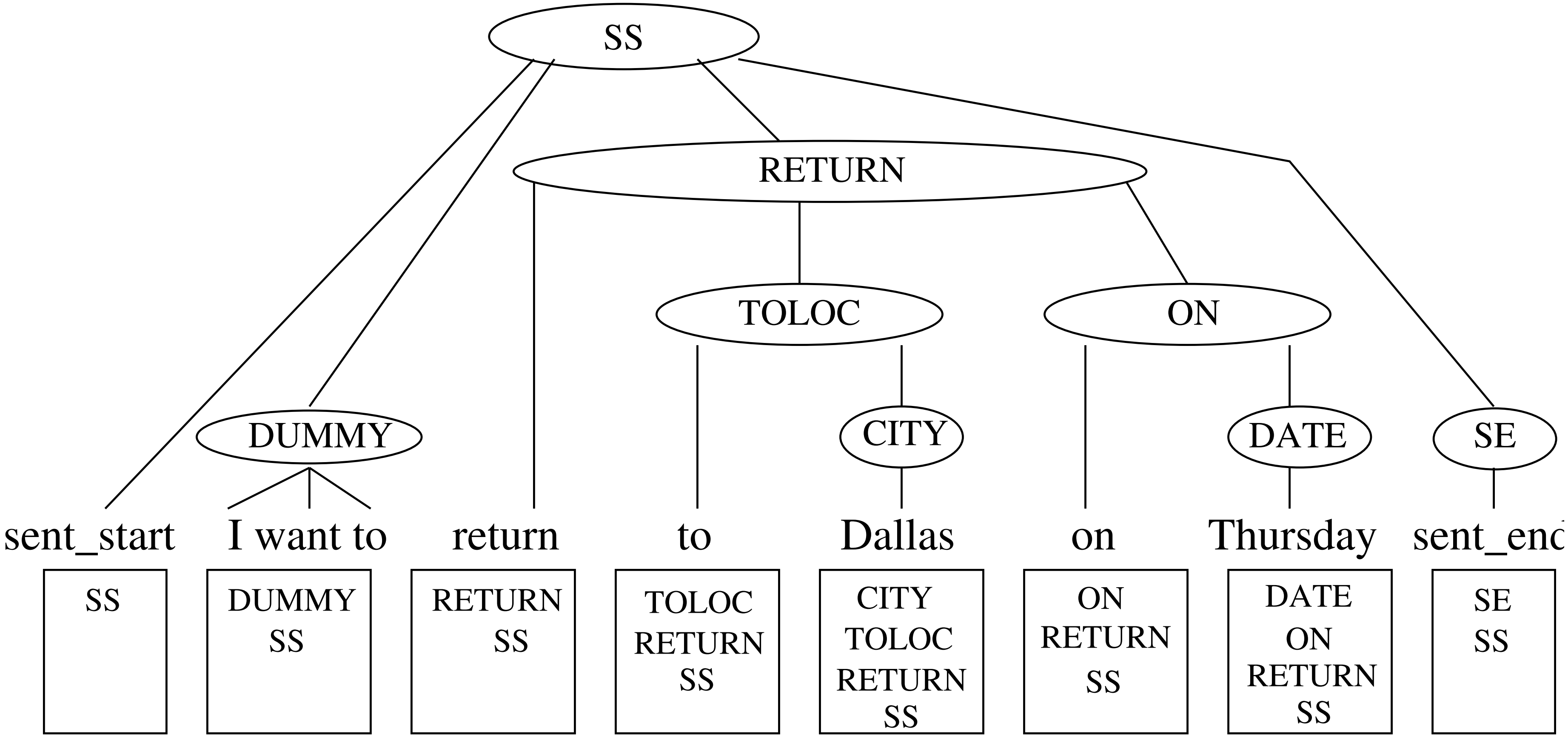
Confidence Network

The Hidden Vector State (HVS) model for Semantic Parsing

Overview

- Trade-off between flat-concept and hierarchical models
- Flat-concept HMM model extended by expanding each state
- States encode stack of push-down automata
- Model is right branching
  - encodes hierarchical context
  - avoids tractability issues of a PCFG approach

Parse Tree generated by the Hidden Vector State Model



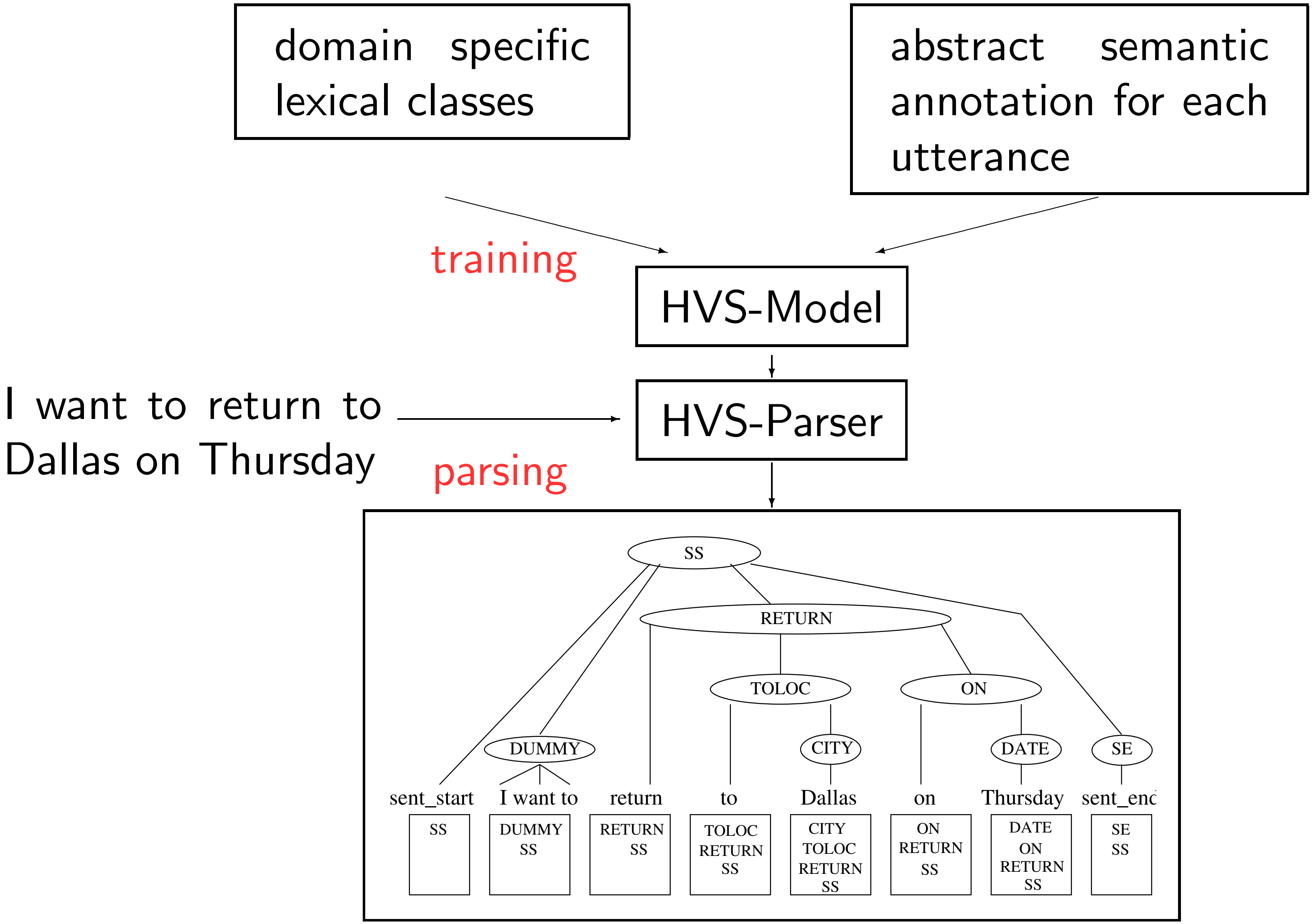
- Parse tree of semantic concepts is right branching
- Tree is represented in vector state sequence below

The Hidden Vector State (HVS) model for Semantic Parsing

Motivation

- HVS is a statistical semantic parser
  - Fits well into UCAM's plan for a statistical dialogue modelling approach
  - Gives n-best acts together with probability/confidence scores
- HVS model is data-driven
  - allows on-line/incremental adaptation/training
  - requires only lightly supervised data
- HVS can be adapted to work on-the-fly
  - will allow barge-in
  - can use more complicated turn-manager

Training and Parsing with the Hidden Vector State Model



Current work

- Training HVS and word-spotting model on SACTI data for subset of tasks.
- Encapsulate HVS parser as an ATK component
- Make speech understanding (ATK+HVS) OAA agent
- Modify ATK to produce word-posterior networks with associated confidence scores

Future plans (SU) Agent

- Combine ATK and HVS probabilities for a parser confidence score
- Adapt HVS approach to work with this data format
- Current parser results using HVS and word-spotting techniques are relatively poor
  - SACTI data is not ideal: will perform a new data collection to bootstrap parser and language models
  - Collection will feature abstract prompts of all features desired in final system
  - May also do some collections with baseline system
  - Plan to use a real town (Cambridge?) for new data collection with a much larger database extracted from Google maps/Yell.com