

Dialogue Genres: Tutoring

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Overview

Background

Broad overview of three tutoring systems

Detailed overview of Cordillera

Background

So far, we have looked at information-seeking spoken dialogue systems

- Let's Go!
- Communicator
- How May I Help You?

Information-seeking examples

- S1: Hello. You've reached the [Communicator]. Tell me your full name
U2: *hi i'd like to fly to seattle tuesday morning*
S3: Traveling to Seattle on Tuesday, August eleventh in the morning. Your full name?
U4: *[John Doe]*
S5: Hello, [John], I'm glad to hear from you again. You can now ask me for help.
S6: OK. Let's see I have a United flight departing Pittsburgh at ten forty five a.m. arriving into Seattle at one fifty seven p.m. Is that OK?
U7: *Yes*
S8: Will you return to Pittsburgh from Seattle?
U9: *no i will go to Los Angeles*
S10: Traveling to Los Angeles. on what date
U11: *Sorry can we go back to talk about the previous leg again*
S12: For the first leg, you are on a United flight 1446 departing Pittsburgh at ten forty five A.M. tomorrow, arriving in Seattle at one fifty seven P.M. Do you want to take that?
U13: *actually i want to leave on wednesday*
S14: a flight on wednesday.
S15: I have a flight departing Pittsburgh at ten forty five a.m., arrives Seattle at one fifty seven p.m. Is that OK?
U16: *Yes*

Information-seeking examples

S: How may I help you?
U: *can you tell me how much it is to tokyo?*
S: You want to know the cost of a call?
U: *yes that's right*
S: Please hold on for rate information.

S: How may I help you?
U: *what's the area code for chicago?*
S: You want an area code.
U: *(silence)*
S: The area code for Chicago is 312.

Tutoring

Intelligent Tutoring System (ITS)

Most tutoring systems are text-based

Hypothesized that speech-based systems can be more effective than text-based

Tutoring

Tutor needs to:

- be more than an e-textbook
- understand a student's speech
- offer a variety of activities
- constantly provide rewards

Current research is attempting to close the gap between human and computer tutors

Intelligent tutoring systems - Why?

General: tutoring systems are more effective than classroom instruction alone

Spoken vs text-based:

1. Spoken language contains meta-communicative information
2. Allows student to gesture with hands
3. Higher number of student turns and explanations

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Tutoring: examples

DIAG - text-based; uses interactive graphical models

ITSPOKE - text-based and spoken; physics

Language learning - web-based with spoken component; Mandarin, game-based

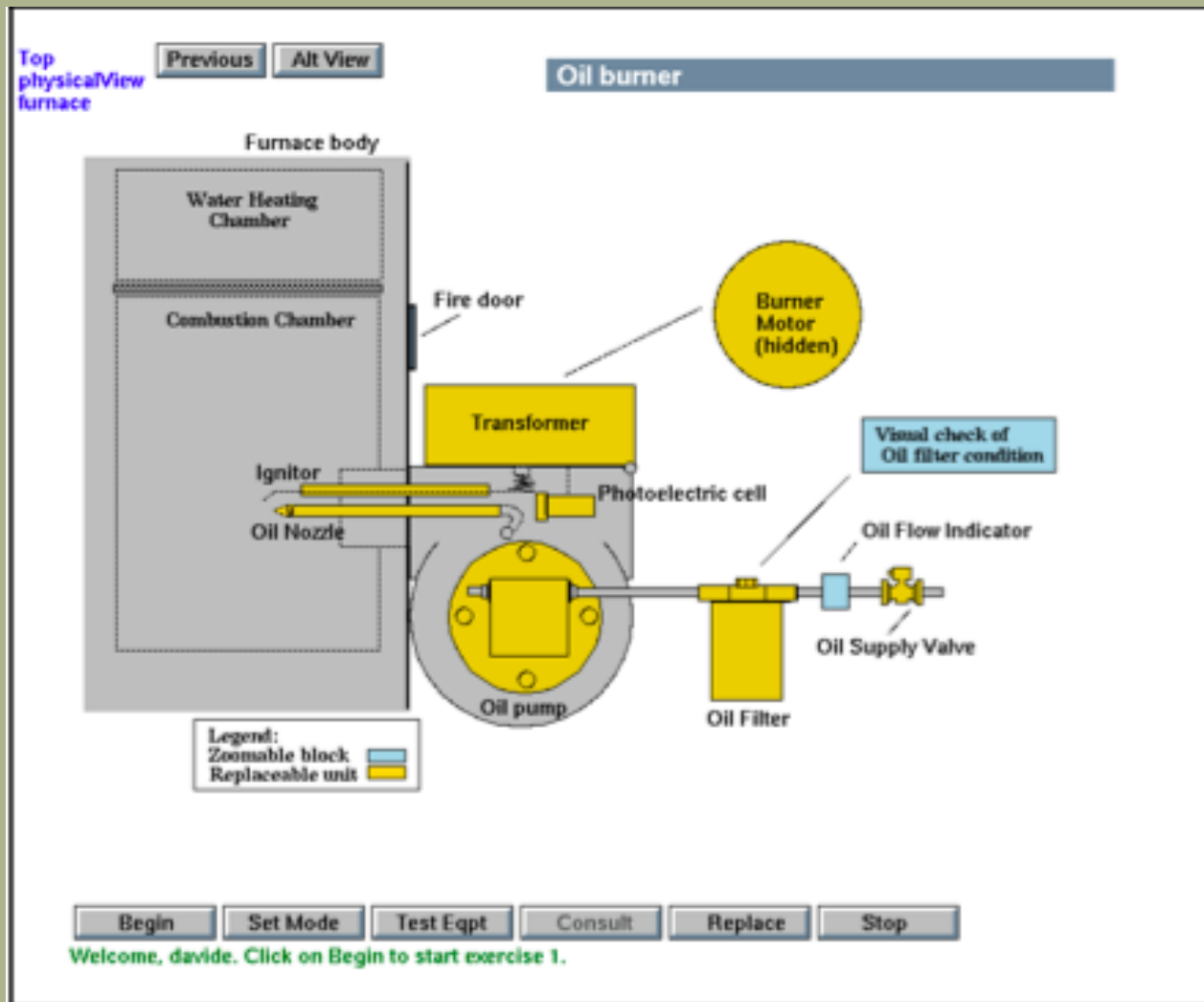
DIAG

Teaches students to troubleshoot complex systems such as home heating and circuitry

RU - replaceable unit

Presents student with increasingly difficult problems

DIAG



DIAG

The visual combustion check is igniting which is abnormal (normal is combusting).

Oil Nozzle always produces this abnormality when it fails.

Oil Supply Valve always produces this abnormality when it fails.

Oil pump always produces this abnormality when it fails.

Oil Filter always produces this abnormality when it fails.

System Control Module sometimes produces this abnormality when it fails.

Ignitor Assembly never produces this abnormality when it fails.

Burner Motor always produces this abnormality when it fails.

The visual combustion check indicator is igniting.

This is abnormal.

Normal is combusting.

Within the furnace system,
this is sometimes caused if
the System Control Module has failed.

Within the Oil Burner
this is never caused if
the Ignitor Assembly has failed.
In contrast, this is always caused if
the Burner Motor, Oil Filter, Oil Pump, Oil Supply Valve, or Oil Nozzle has failed.

The combustion is abnormal.

In the oil burner, check the units along the path of the oil and the burner motor.

ITSPOKE

Intelligent Tutoring **SPOKE**n dialogue system

Adds spoken interface to the existing Why2-Atlas physics tutoring system

Combination of text-based and spoken

ITSPOKE

Why2 - Atlas - Mozilla [Build ID: 2002052918]

File Edit View Go Bookmarks Tools Window Help

http://gentoo.lrdc.pitt.edu/itspoke/

ITSPOKE

58. Suppose a man is in a free-falling elevator and is holding his keys motionless right in front of his face. He then lets go. What will be the position of the keys relative to the man's face as time passes? Explain.

Dialogue:

Tutor said: What you have is not a sufficient explanation. If gravity is the only force acting on an object, will it be moving or staying still?

You said: it will be moving

Tutor said: Correct. Not only are the person, keys, and elevator moving, they have only gravitational forces on them. When an object is falling and has only gravitational force on it, it is said to be in what?

You said: free fall

Enter your essay here:

The keys will hit the floor of the elevator because of the force of gravity.

Tell Tutor:

Applet Interface/My started

ITSPOKE

ITSPOKE: I didn't understand. What force acts on all objects within close proximity to earth?

STUDENT: uh the force of gravity

ITSPOKE: Fine. Besides the Earth's gravitational force, are there any other forces acting on the person, keys, and elevator after the release?

STUDENT: no

ITSPOKE

ITSPOKE: Yep. Thus, keep in mind that after the release, the only force on the person, keys, and elevator is the force of gravity. If gravity is the only force acting on an object, will it be moving or staying still?

STUDENT: it will be moving

ITSPOKE: Fine. Not only are the person, keys, and elevator moving, they have only gravitational forces on them. When an object is falling and has only gravitational force on it, it is said to be in what?

STUDENT: freefall

CALL

Mandarin Chinese

Two domains: general travel and flights

Three games:

- reading game
- translation game
- question-answering game

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Cordillera

Uses natural language to tutor on the subject of physics

This study: investigates using reinforcement learning to induce pedagogical strategies from existing corpora

Reinforcement Learning (RL)

Machine learning method

Maximizes expected rewards

This study: RL is used to derive pedagogical strategies

Reinforcement Learning (RL)

Previously used mostly in non-tutoring systems. Can RL be effectively used in tutoring systems?

RL in tutoring vs previous applications

- rewards are delayed
- interaction time/turns is much longer
- communication efficiency only one aspect of success
- state model is much larger

Tutorial Decisions

Two types of decisions

- Elicit/Tell (ET)
 - "should the tutor elicit the next problem-solving step? or tell the student the next step directly?"
- Justify/Skip (JS)
 - "should the tutor justify a step or not?"

No consensus on how to choose.

This study: attempt to derive policies for these decisions.

RL & Pedagogical Strategies

Markov Decision Processes

4-tuple (S, A, T, R)

- S : state space
- A : action space
- T : transition probabilities
- R : rewards for state transitions

$$S_i \xrightarrow{A_i, R_i} S_{i+1}$$

RL & Pedagogical Strategies: rewards

$$\text{Normalized Learning Gain} = \frac{\text{post-test} - \text{pre-test}}{1 - \text{pre-test}}$$

NLG not available until tutoring session ends

Only terminal dialogue states have non-zero rewards

Knowledge Components (KC)

atomic unit of knowledge

This study: 8 KCs from physics domain

Optimal policies differ between KCs, they are (assumed to be) independent.

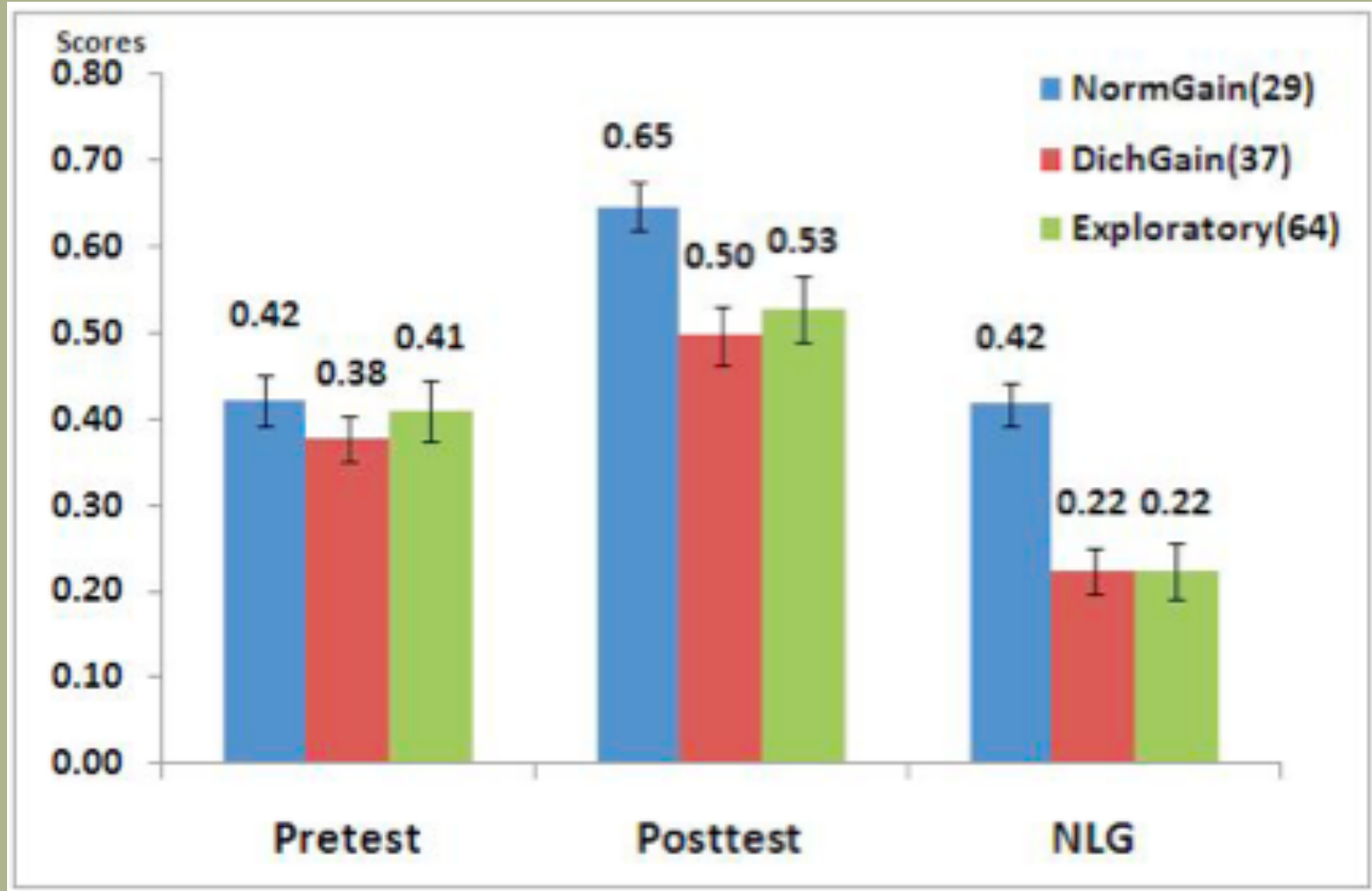
What is the best way to teach each KC?

Experiments

Cordillera

- random-Cordillera: 64 students, 2007
 - generated Exploratory Corpus
- DichGain-Cordillera: 37 students, 2008
 - generated DichGain Corpus
 - reward: two levels
- NormGain-Cordillera: 29 students, 2009
 - used Exploratory Corpus, DichGain Corpus, and Exploratory + DichGain corpus
 - reward: NLG x 100

Results



Conclusions

Improved the NL tutoring system

Showed that RL-induced rules are effective

The learning context features that make the most difference are not the ones that you would think of

Dialogue genre: tutoring

Questions?