Creating an Empirical Basis for Adaptation Decisions

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http://w5.cs.uni-sb.de/~ready/ (slides, etc.)

These slides and the full paper are available from:
http://w5.cs.uni-sb.de/~ready/

Overview

General issue

IUIs often *adapt* their behavior

- to material being presented
- to properties of the situation
- to properties of the user

How can we help them make sound *adaptation decisions*?

Overview

1. *Rule-based* vs. *decision-theoretic* adaptation
2. Method for empirically based decision-theoretic adaptation
3. What to do when this method is infeasible?

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Contents

Basic Concepts

Good Adaptation?

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Good day. You've reached my mobile communication center.
I don't wanna waste your time, so I'm gonna make this really quick.

To leave a voice message, wait for the tag.

To page me, press 5.

You can also leave a voice message after you page me.

Or, email me, at 318-367-3135@airtouch.nick

Well now, mate, that wasn't so bad, was it?

In the original talk, this slide is accompanied by a playback of the answering machine recording.

Rule-Based Adaptation

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Rules for choosing interactors for an interface

If the type of data is *boolean*
and the type of form is a *control panel*
then use a *check box*

If the type of data is *boolean*
and the type of form is a *questionnaire*
then use *radio buttons*

(Cf. the decision trees of Eisenstein & Puerta, IUI2000)

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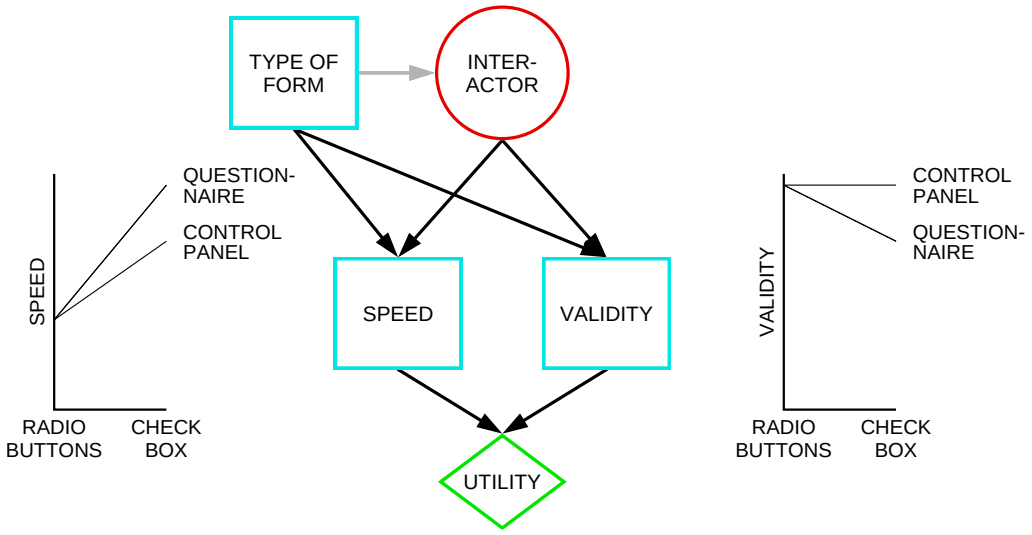
Decision-Theoretic Adaptation



When is decision-theoretic adaptation useful?

- There are multiple criterion variables
- There are quantitative tradeoffs
- The (exact) nature of the relationships is an empirical question

Experiment

Everyday Example

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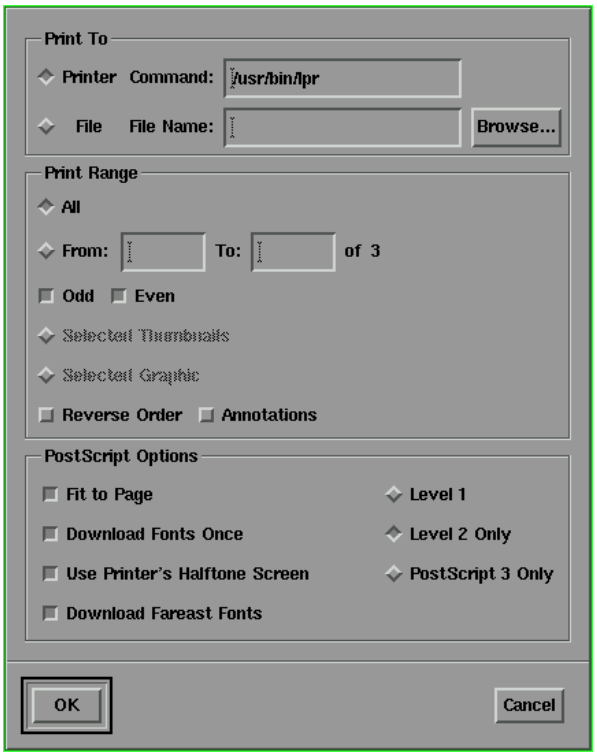

Possible output of spoken help system:

Choose "PostScript Level 2 only"

Set "Fit to Page" to "off".

Set "Print to File" to "on".

Set "Use Printer Halftone Screens" to "on".

Set "Download Asian Fonts" to "off".

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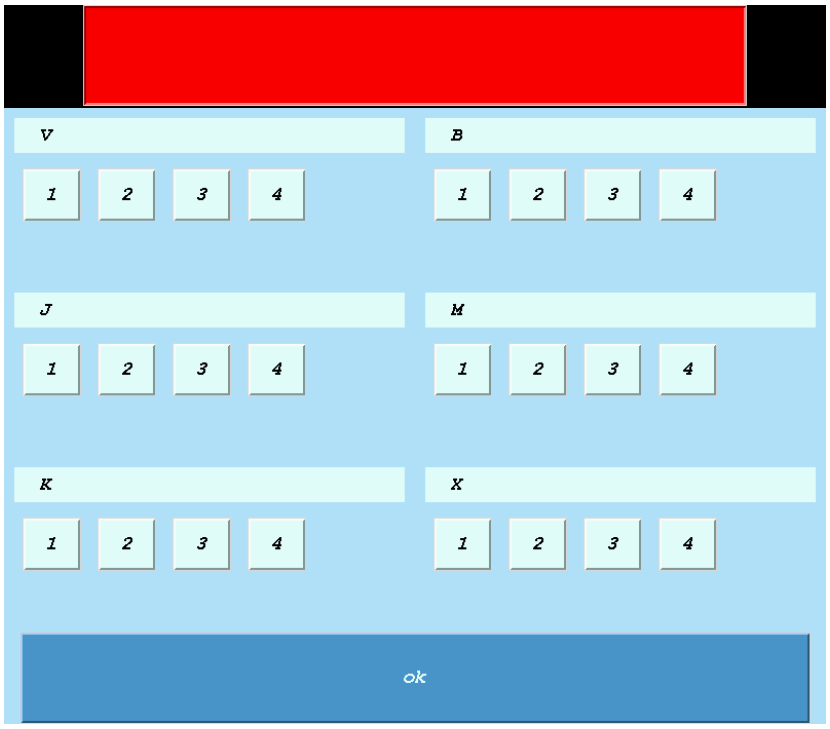
Experimental Setup



Stepwise vs. Bundled Instructions

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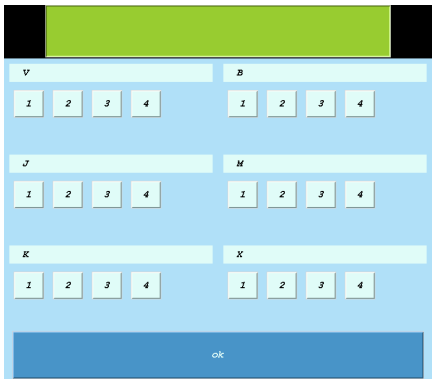

Stepwise:

$\mathcal{S}$: Set *X* to *3*
$\mathcal{U}$: ... OK
$\mathcal{S}$: Set *M* to *1*
$\mathcal{U}$: ... OK
$\mathcal{S}$: Set *V* to *4*
$\mathcal{U}$: ... Done

Bundled:

$\mathcal{S}$: Set *X* to *3*, set *M* to *1*, set *V* to *4*
$\mathcal{U}$: ... ... Done

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Variables in Experiment

Independent variables:

Number of Steps
- 2, 3 or 4 steps

Presentation Mode
- Stepwise vs. bundled

Distraction?
- No secondary task vs. "monitor the flashing lights"

Dependent variables (selection):

Execution Time
- Total time to execute an instruction sequence (including "OK"s, etc.)

Error
- All instructed buttons pressed (and no others)?

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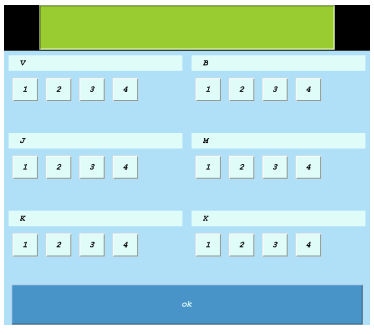
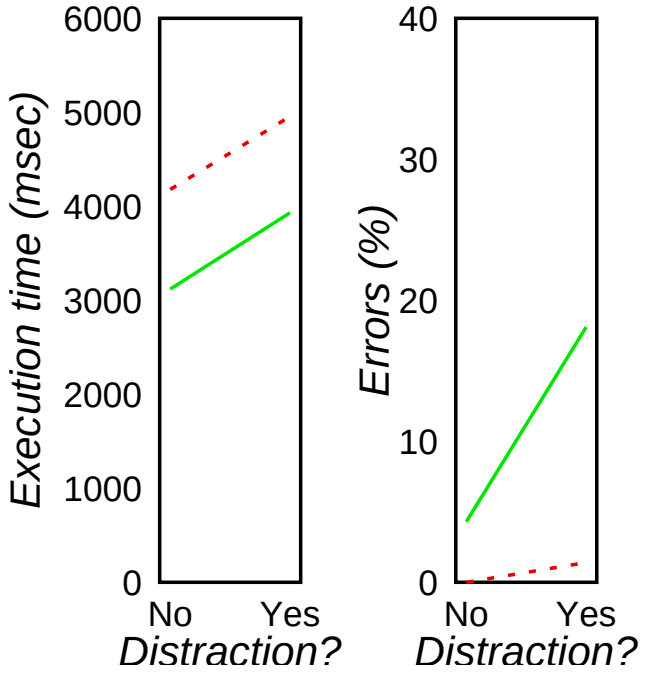
Main Results (1)

Three-step sequences:





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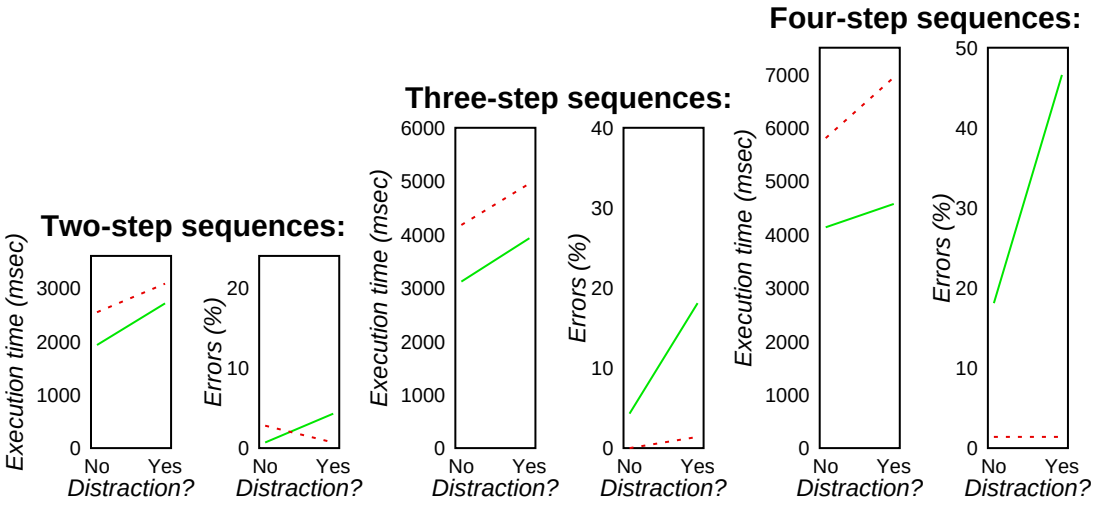
Main Results (2)



The Decision Mechanism

Learned Bayesian Network (1)

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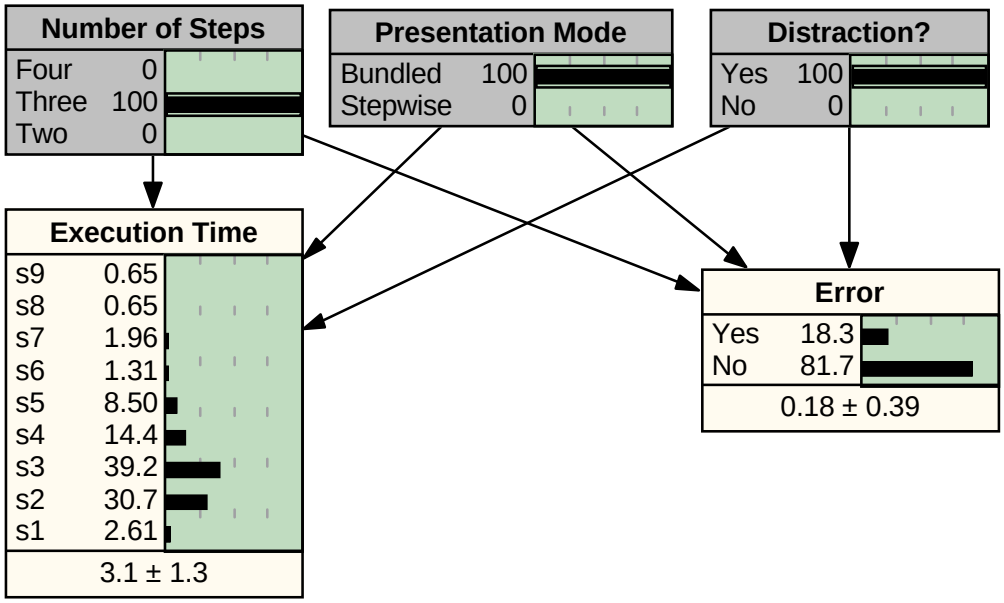

Bayesian network learned on the basis of the experimental data, showing a prediction for a specific combination of values of the independent variables

In the original talk, demonstrations of the example network and influence diagram are given instead of this and the following three slides. The tool depicted is Netica, which is available from http://www.norsys.com.

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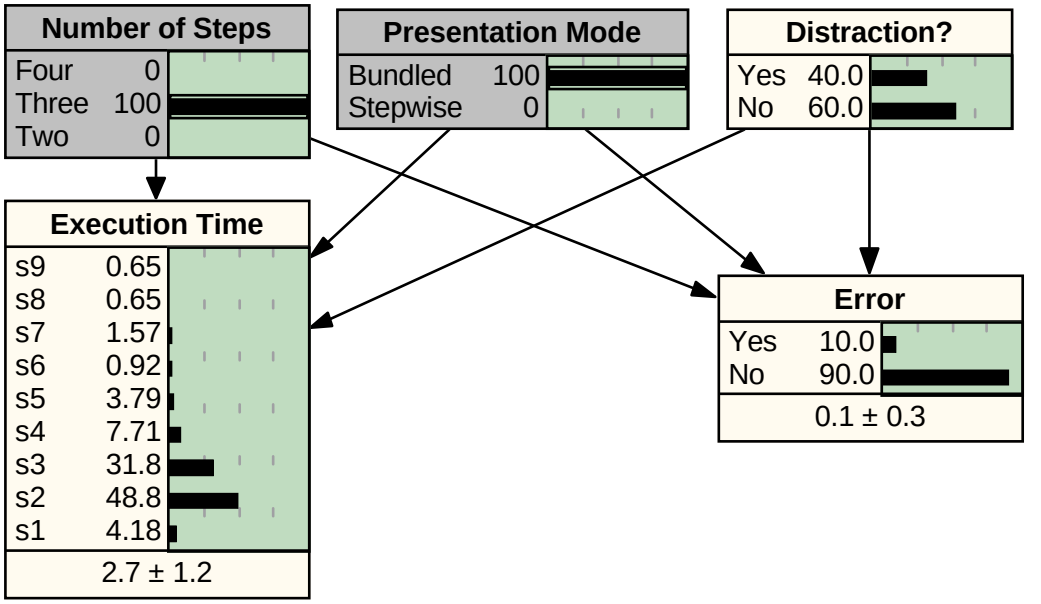
Learned Bayesian Network (2)



The same network as in the previous slide, showing a prediction made under uncertainty about the independent variable "Distraction?"

Learned Bayesian Network (3)

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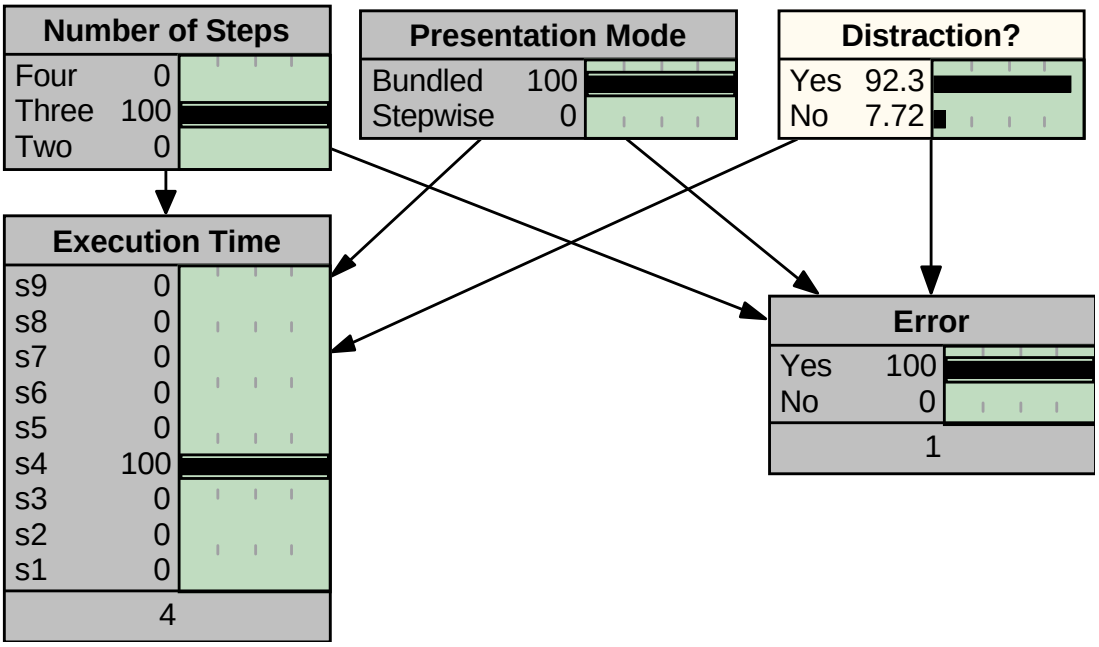

The same network as in the previous two slides, showing the interpretation of an observation of $\mathcal{U}$'s performance

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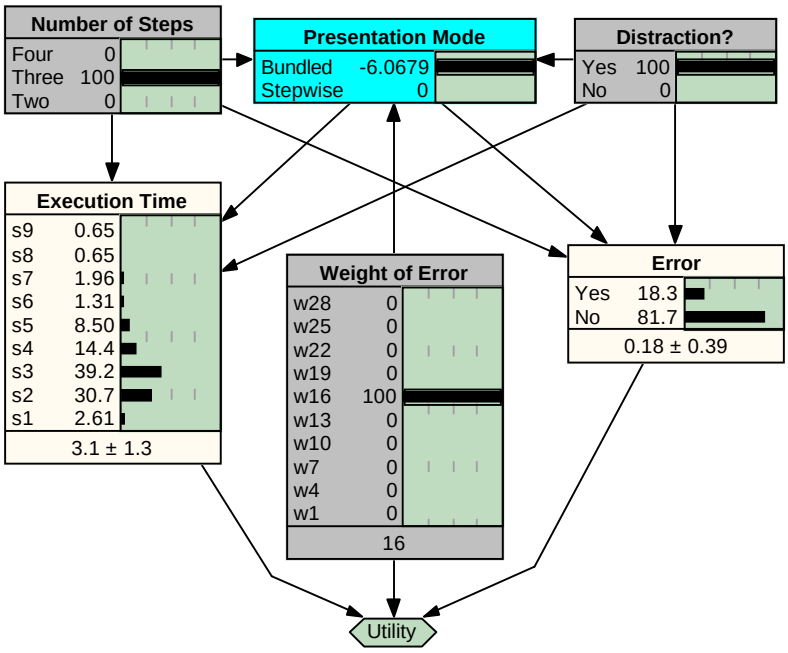
Influence Diagram



An influence diagram defined as an extension to the BN of the previous slides

Properties of the Learned Decision Mechanism

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Learned Bayes net

- Embodies experimental results
- Also allows probabilistic prediction and interpretation

Influence diagram

- Generates a decision for each situation
- Computes general *policies*

Summary of Internal Policy Table

Steps	*Distraction = "No"*	*Distraction = "Yes"*
Four	Stepwise iff w > 9	Stepwise iff w > 3
Three	Stepwise iff w > 21	Stepwise iff w > 6
Two	Always bundled	Stepwise iff w > 9

Fallbacks

19 Fallback 1: Modify the Model by Hand (1)

Motivation

- Real application situation is different from data-collection situation

Procedure

- Replace learned relationships by theoretically based formulas

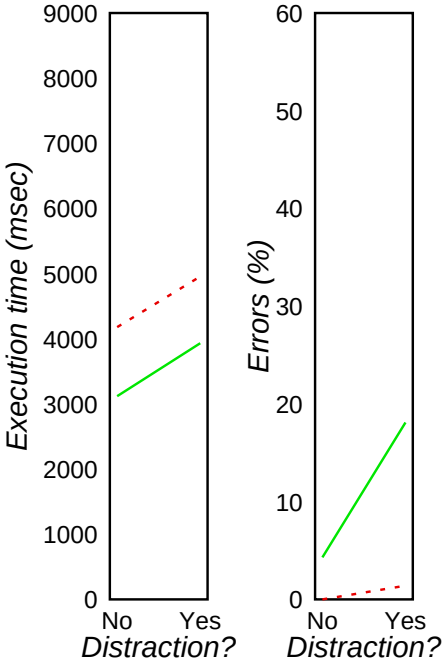
Prospects

− New aspects may be highly speculative

\+ Decision-theoretic tools permit sensitivity analyses

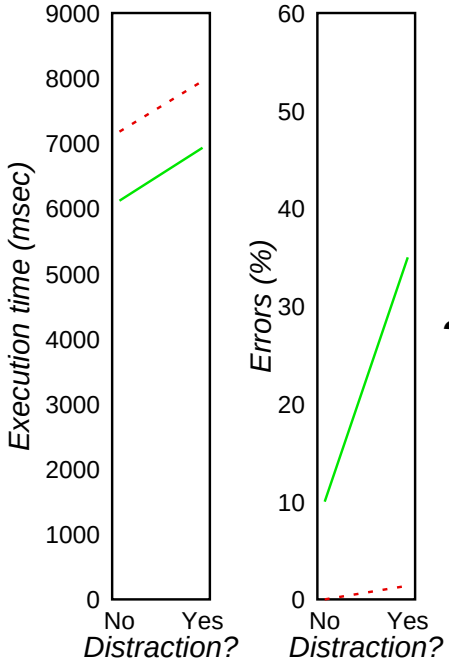
Fallback 1: Modify the Model by Hand (2) 20

Three-step sequences:



Original situation

Three-step sequences:



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Sliders instead of buttons

21 Fallback 2: Collect Real Usage Data

Motivation

- Experiment is not feasible or could not be realistic

Procedure

- Learn influence diagrams while system is in real use

Prospects

− Massively missing data may make useful learning impossible

Fallback 3: Do Analysis Without Data 22

Motivation

- [Same problems as above]
- Unwillingness to deal with decision-theoretic tools

Procedure

1. Draw influence diagrams on paper
2. Graph hypotheses about causal relationships
3. What’s the reasoning behind adaptation?

Prospects

+ You can check the assumptions on which your adaptation policy is based
+ You may decide to change or reject the policy

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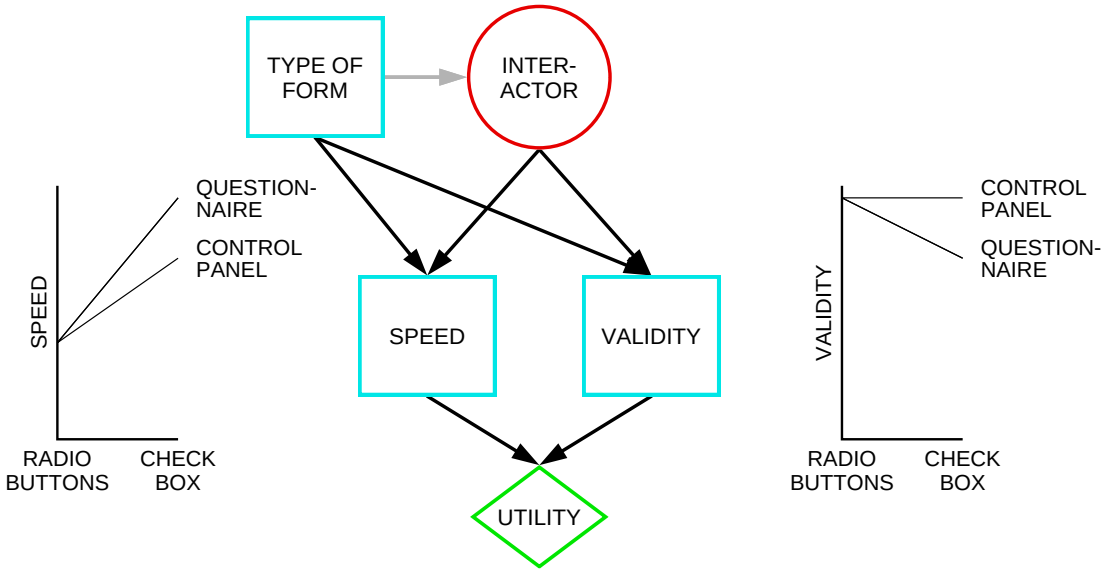
Interactors Revisited



Check boxes or radio buttons for Boolean data?

Conclusions

Conclusions

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Content

[Empirical results and theoretical analysis concerning ways of presenting instructions]

Methodology

1. Rule-based adaptation is often too simple
   ⇒ Consider decision-theoretic adaptation
2. An optimal adaptation mechanism can in principle be learned fully automatically from empirical data
   And it has useful additional functions
3. Theory-based tweaking is often necessary
   It can be more or less reliable
   Decision-theoretic tools can help explore possible strategies
4. Even purely conceptual decision-theoretic analysis can be useful