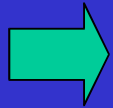
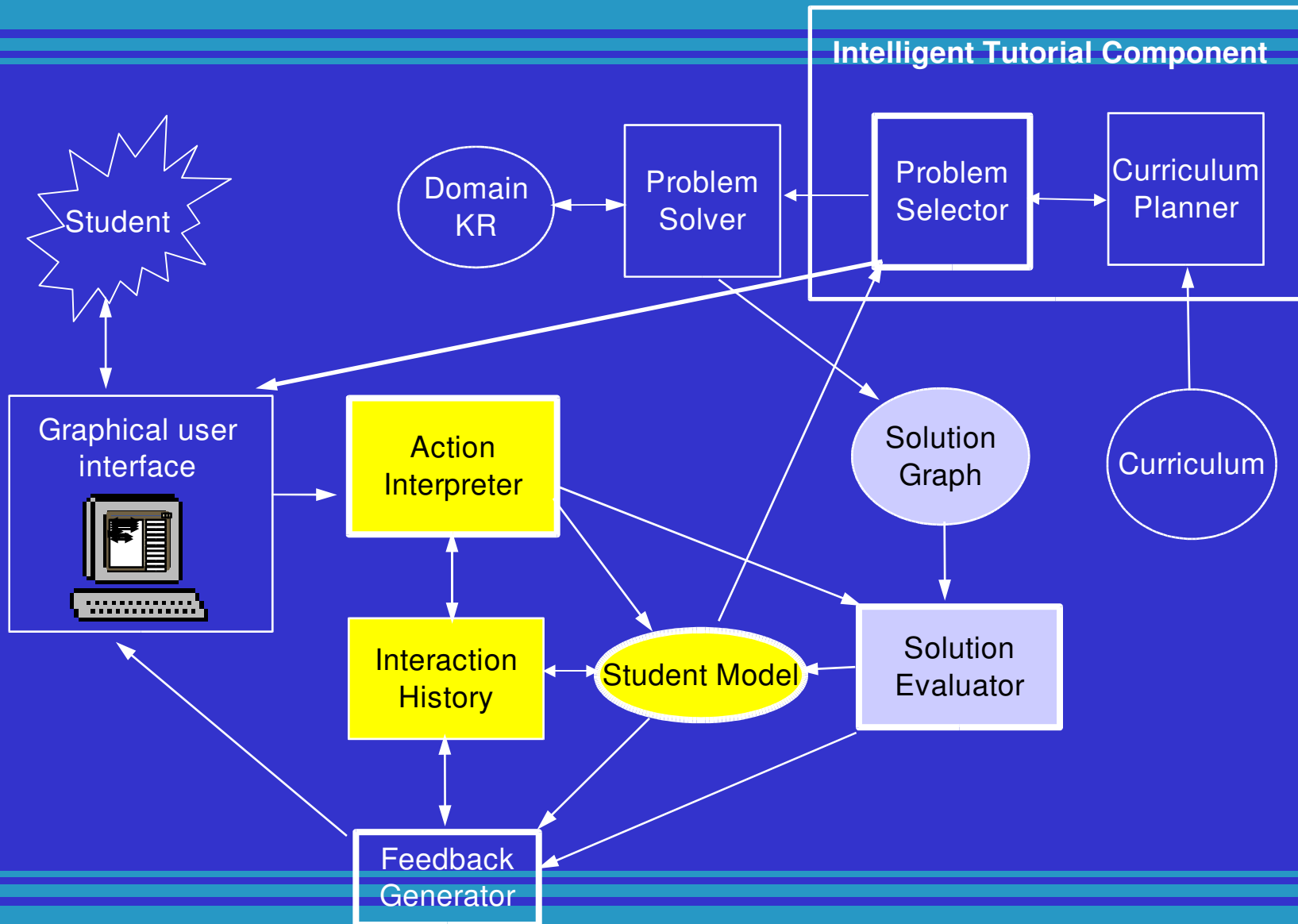


Approximate Plan of the Course

- 21.4. Introduction
- 28.4. ActiveMath Vorstellung /Introduction to ActiveMath
- 12.5. Benutzermodellierung/student modeling
- 19.5. instructional design
- 2.6. XML knowledge representation, adaptive hypermedia
- 9.6. collaborative learning/ Lernen in Gruppen
- 16.6. diagnosis
- 23.6. action analysis
- 30.6. support of meta-cognition
- 7.7 further topics (tutorial dialogues, mobile learning..)
- 14.7. student project reports



A Generic ITS Architecture



Adaptation dimensions

- Technical environment
- Social context
- Personalization
- Situation
- Our first experience:
School type, field, language, curriculum, goals, prerequisites,
field of interest, mastery level, competencies, competency-level



ActiveMath: Russian

ActiveMath - Book Generation - Step 3/3 - Mozilla [Build ID: 2004031616]

File Edit View Go Bookmarks Tools Window Help Debug QA

Back Forward Reload Stop <http://devdemo.activemath.org:8080/ActiveMath2/planner/selectScenario.cmd> Search Print

activeMath Создание книги: [Область](#) -> [Темы](#) -> [Тип книги](#) -> [Обобщение](#) [Обратно в главное меню](#)

Шаг 3/3: имя и тип книги

Здесь Вы можете выбрать один из многих различных типов книг, которые ActiveMath способен для Вас создать. Это неважно, хотите ли Вы интенсивно готовиться к контрольной или только получить общее представление - просто выберите из списка внизу тип, который наиболее подходит под Ваши требования. Для того, чтобы позднее эту книгу на Вашей персональной "книжной полке" было проще найти, рекомендуется присвоить имя.

Заголовок Вашей книги:

Какого типа книгу Вы хотели бы?

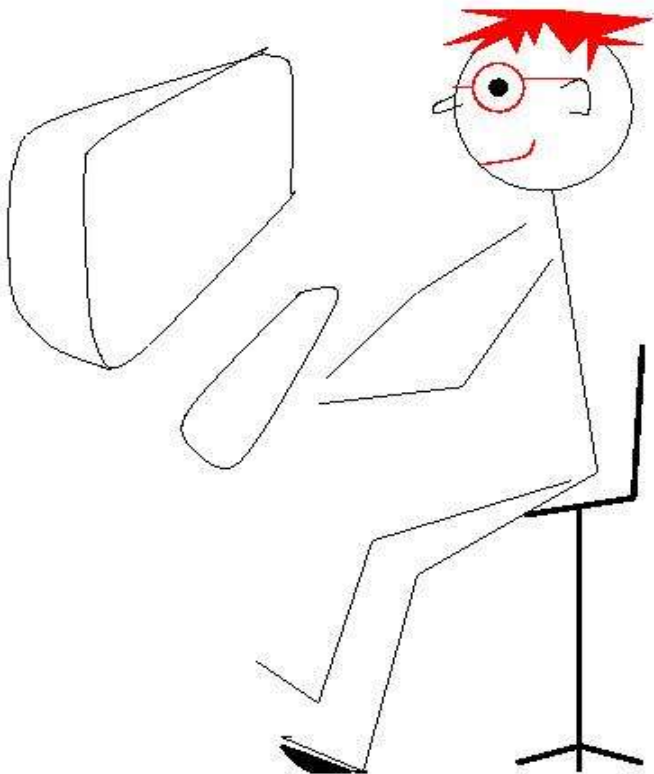
- Я хотел бы книгу, которая мне разъяснит все **детали** выбранной темы.
- Я хотел бы только **короткий обзор** выбранной темы.
- Я хотел бы книгу, которая мне поможет выбранную тему **понимать/описывать/называть**.
- Я хотел бы книгу, которая мне поможет выбранную тему **разъяснять/отождествлять/постигать**.
- Я хотел бы книгу, которая мне поможет выбранную тему **применять**.
- Я хотел бы только **im Polya-стиль** представленные доказательства.
- Я хотел бы **Polya-инспирированную** книгу.
- Я хотел бы в выбранных разделах **подготовиться к контрольной**.
- Я хотел бы в выбранных разделах **решать упражнения**.
- Я хотел бы видеть только те концепции, которые я **ещё не освоил**.
- Я хотел бы выбранные разделы **повторить**.

[далее к следующему шагу](#)



Adapting to Users: Anton

ANTON



Netscape: ActiveMath !

File Edit View Go Communicator Help

ActiveMath

Monoids and groups

- Semi-groups
 - Operations
 - Definition of a unary operation
 - Definition of a binary operation
 - Associativity
 - Definition of associativity
 - Semi-groups
 - Definition of a semi-group
 - Definition of a unit of a semi-group
- Monoids
 - Monoids
 - Definition of a monoid
 - Submonoids and special cases of monoids
 - Definition of a morphism of monoids
- Invertibility in monoids
 - Invertibility
 - Definition of invertibility
- Groups
 - Groups and subgroups
 - Definition of a group
 - Morphisms

Definition of a morphism of groups

A morphism (of groups) from G to G' is a map $f : G \rightarrow G'$

with the following properties:

- $f(e) = e'$ (the unit element of G');
- for all $(a, b \in G)$, we have $f((a * b)) = (f(a) * f(b))$;
- for all $(a \in G) : f((a^{-1})) = (f(a))^{-1}$. A bijective morphism is called an isomorphism.

Example

We have to show that the property of associativity holds for the image $fun(G)$. We prove this by using the properties of the domain via the morphism

Exercise

Which of the following maps is a morphism of groups?

Exercise

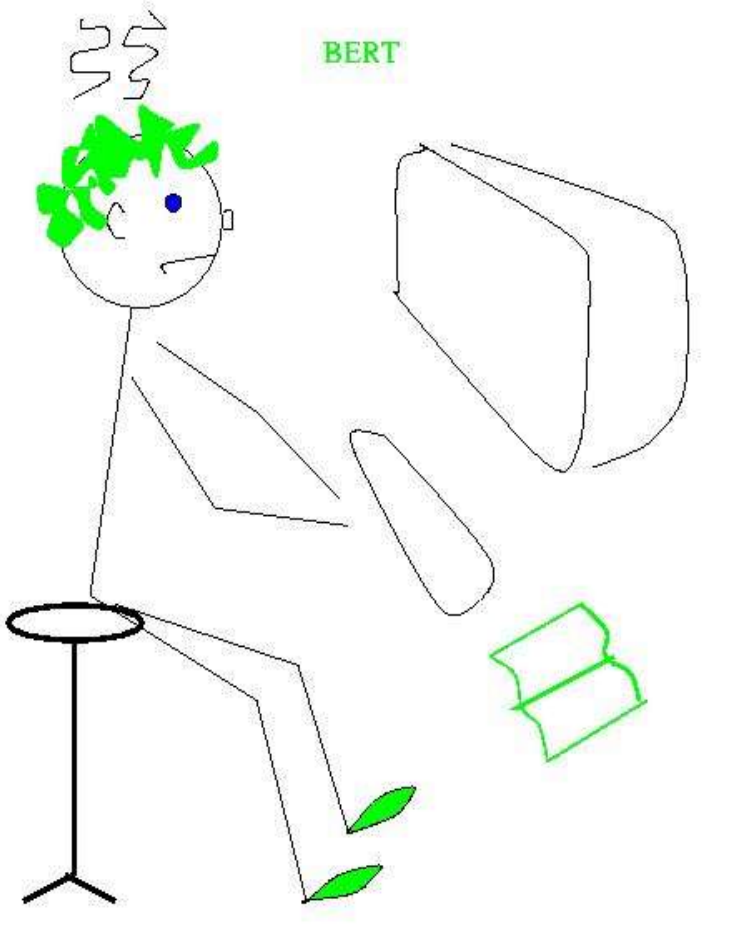
Prove for an morphism $fun : (g, opg) \rightarrow (h, oph)$ between two groups g and h that $fun(g)$ is closed under oph .

logout dictionary menu feedback

100% Document Done

Page 9 of 30

Adapting to Users: Bert


A screenshot of the Netscape ActiveMath web browser interface. The browser window title is "Netscape: ActiveMath!". The address bar is empty. The browser's menu bar includes "File", "Edit", "View", "Go", and "Communicator". The toolbar contains icons for "Back", "Forward", "Reload", "Home", "Search", "Netscape", "Print", "Security", "Shop", and "Stop". The main content area displays the "ActiveMath" logo at the top. Below the logo is a navigation sidebar on the left with the following sections: "Monoids and groups", "Semi-groups", "Semi-groups" (with a yellow dot), "Definition of a unit of a semi-group", "Invertibility in monoids", "Invertibility" (with a red dot), "Definition of invertibility", "Groups", "Groups and subgroups" (with a red dot), "Definition of a group", "Morphisms of groups" (with a red dot), "Definition of a morphism of groups", and "Characterization of morphisms of groups". The main content area contains the following text:

Definition of a morphism of groups
A morphism (of groups) from G to G' is a map $f : G \rightarrow G'$ with the following properties:

- $f(e) = e'$ (the unit element of G');
- for all $(a, b \in G)$, we have $f((a * b)) = (f(a) * f(b))$;
- for all $(a \in G) : f((a^{-1})) = (f(a))^{-1}$. A bijective morphism is called an isomorphism.

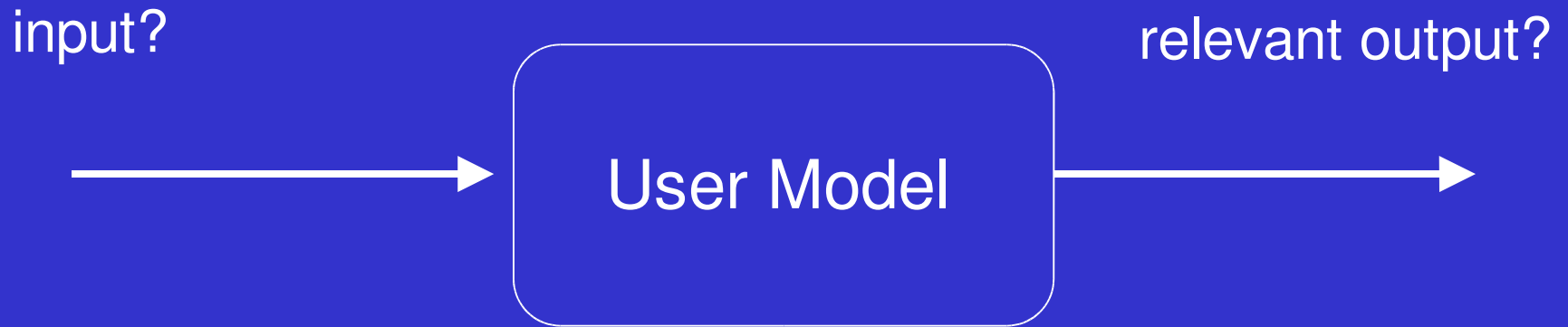
Exercise
Which of the following maps is a morphism of groups?


Exercise
Prove for an morphism $f : G \rightarrow G'$ between two groups G and G' that $f(G)$ is closed with respect to the operation of G' .


Exercise
Given two morphisms $f : G \rightarrow H, g : G \rightarrow K$ for two groups G and H . Prove that $\# : f(G) \rightarrow K$ defined by $\#(f(x)) = g(x)$ is a morphism.


Navigation arrows (back and forward) are visible below the exercises. At the bottom of the page, there is a footer: "This is ActiveMath version 4.0a running on host ospid. This page was generated for user carsten in session discover on Feb 15 at 11:37. URL to this page." Below the footer are links for "logout", "dictionary", "menu", and "feedback". The browser's status bar at the bottom right shows "Page 3 of section".

Systematic approach



Output: e.g., Context modeling

- Social context:
 - home/classroom/museum
 - Collaborative/single
 - Country (geographic)
 - Curriculum
 - school type
 - cultural (not only language)
- Technical context
 - Browser (rendering)
 - PC/PDA/.. (rendering, bandwidth..)
 - Availability of tools on client, Handwriting facility



Output: Individual Variables

- Cognitive (actual)
 - capability, incoming knowledge
 - cognitive style
 - problem solving strategies, preferences
- Psychological (mental)
 - interests
 - Preferences , learning style??
 - Meta-cognitive
- Person-in-situation
 - Exploratory behaviour
 - goals
- Affective
 - motivation, impulsivity
- Personal traits
 - Blind, working memory capacity, attention span, reading performance



Inputs for User Model

- Self-reports:
 - Questionnaire
 - on-task-report
 - Open learner model
- teacher input
- behavioral data
 - performance
 - response to test items (hesitation)
 - time-on-task
 - help or other requests
 - low-level measures
- Context data



Online Questionnaires

Register - Mozilla

File Edit View Go Bookmarks Tools Window Help

Back Forward Reload Search Print

http://localhost:8000/ActiveMath2/nan/register.cxd

active π math

Questionnaire

[Diese Seite auf deutsch](#)

Please complete this form. It will help ActiveMath to present the content adapted to your needs.

Login Information:

Desired username:

Full name:

Email:

Enter desired password:

Enter desired password again:

Information about yourself:

What is your field?

What is your educational level?

Submit!

Done

Open Learner Model in ActiveMath

▼ Semi-groups

▼ Operations

Definition of a unary operation (assessment details / modification)

Definition of a binary operation (assessment details / modification)

▼ Structures

Definition of a structure (assessment details / modification)

▼ Associativity

Definition of associativity (assessment details / modification)

Brackets positioning for an associative operation (assessment details / modification)

▼ Semi-groups

Definition of a semi-group (assessment details / modification)

Definition of a unit of a semi-group (assessment details / modification)

Unit and semi-group (assessment details / modification)

▼ Monoids

▼ Defining Monoids

Definition of a monoid (assessment details / modification)

Definition of commutativity (assessment details / modification)

Student Modeling, techniques

- Stereotypes (deduction)
- Case-based
- Functional heuristic updating
- Bayesian updating
- Bayesian networks
- Dynamic Bayesian Networks
- Fuzzy modeling

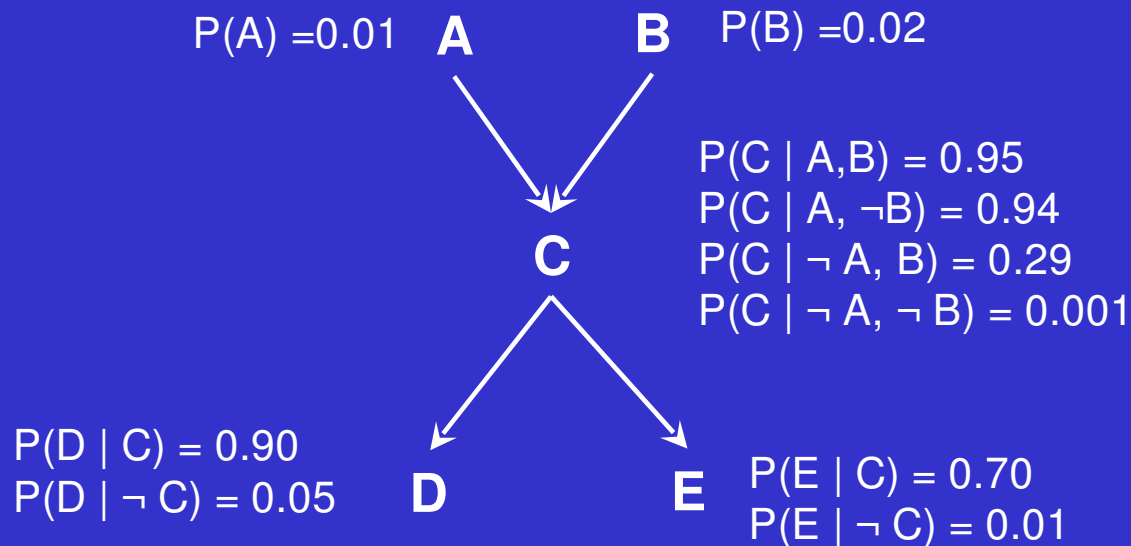
Knowledge tracing

model tracing



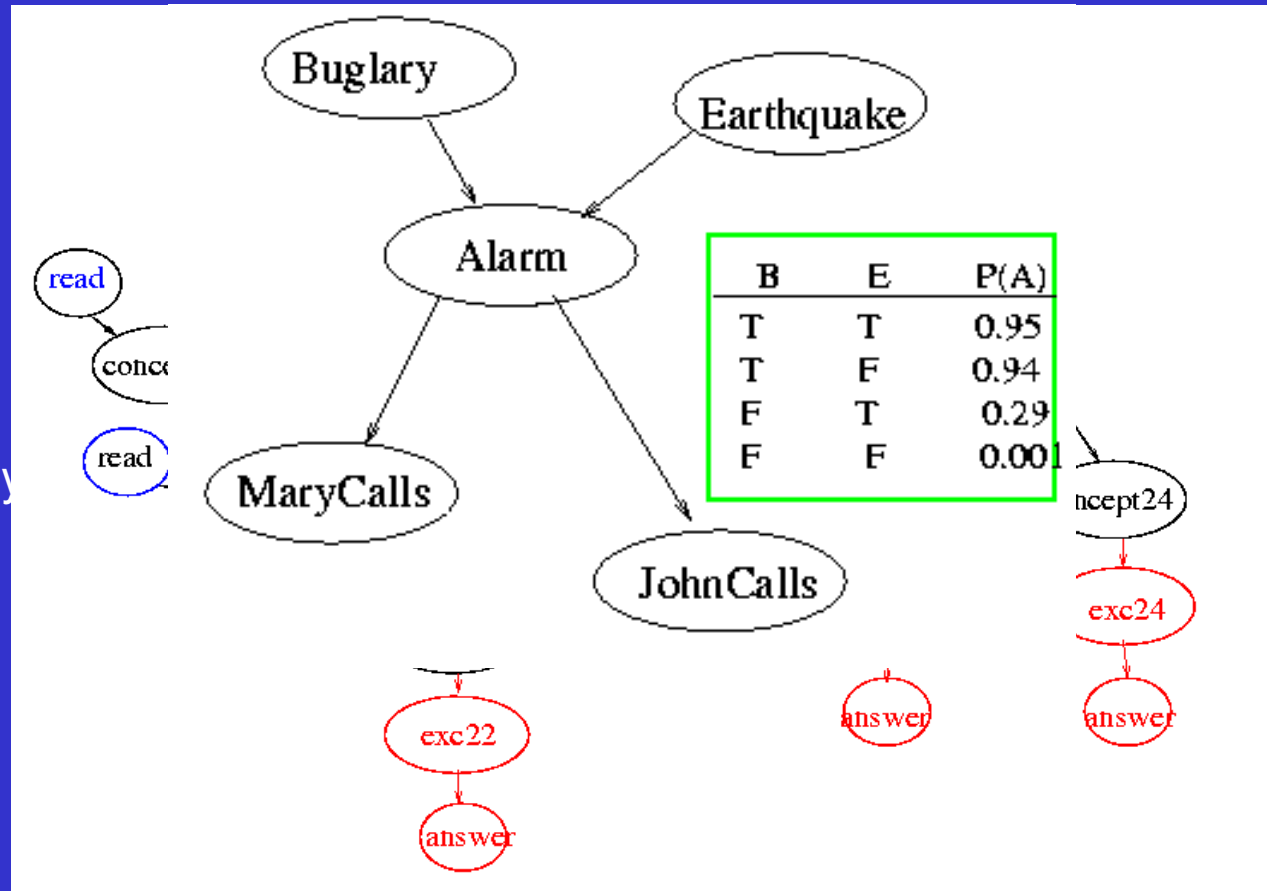
Bayesian networks

- Nodes: set of random variables $X_1 X_2 \dots X_n$
- Links: probabilistic dependencies among variables
- Conditional probabilities: quantify the dependencies



Bayesian Net

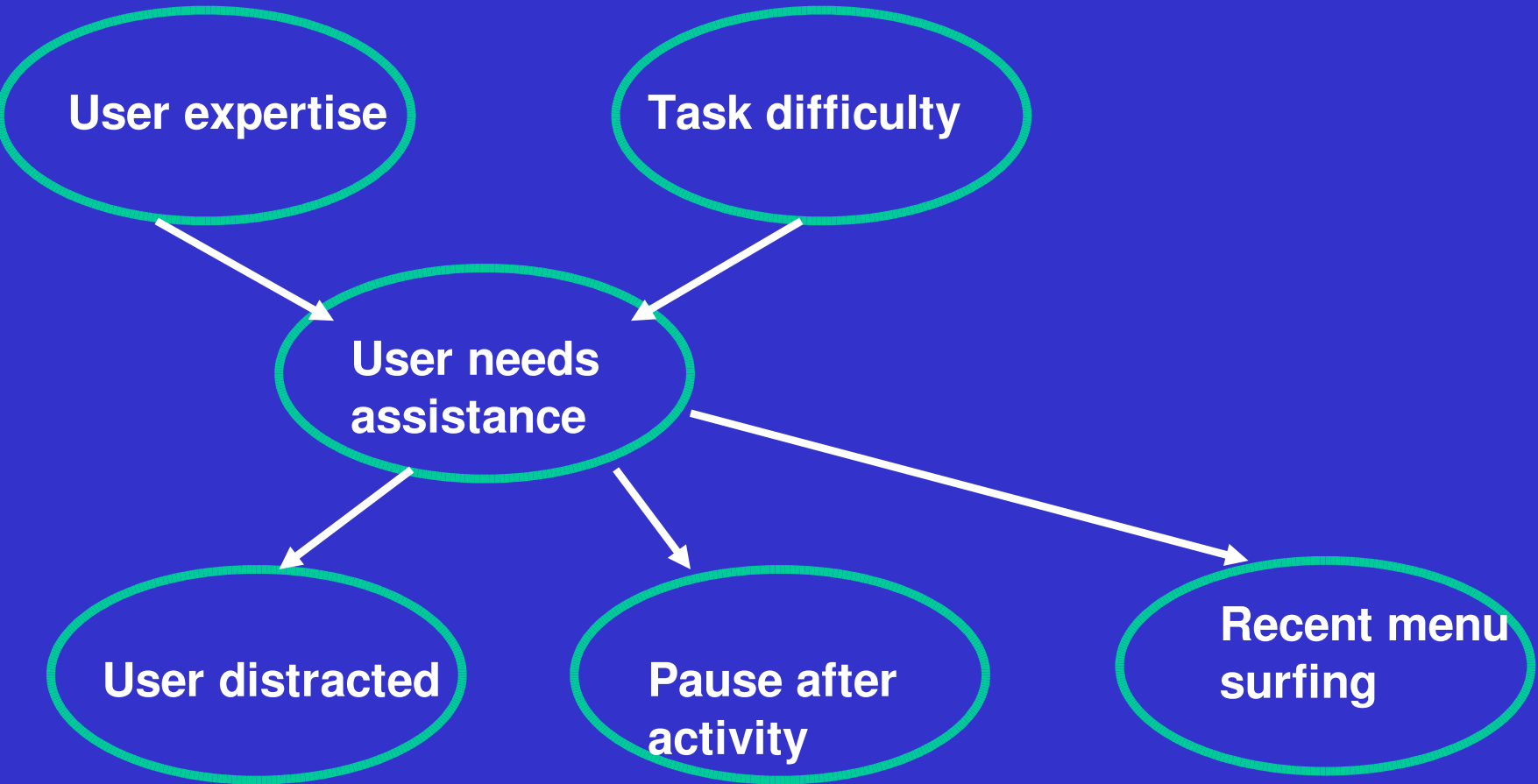
conditional dependences
Probability distribution
events, causes, evidences
diagnostic/causal update
handle noise and uncertainty



In general evaluation of BN is NP-hard...



Bayesian Networks in **Lumiere**



BN for predicting student performance

Used for selecting problem difficulty
in SQL Tutor

Relevant for
ideal solution
c,p

Relevant for
student solution

Mastered(c)

Performance
c,p

	YY	YN	NY	NN
--	----	----	----	----

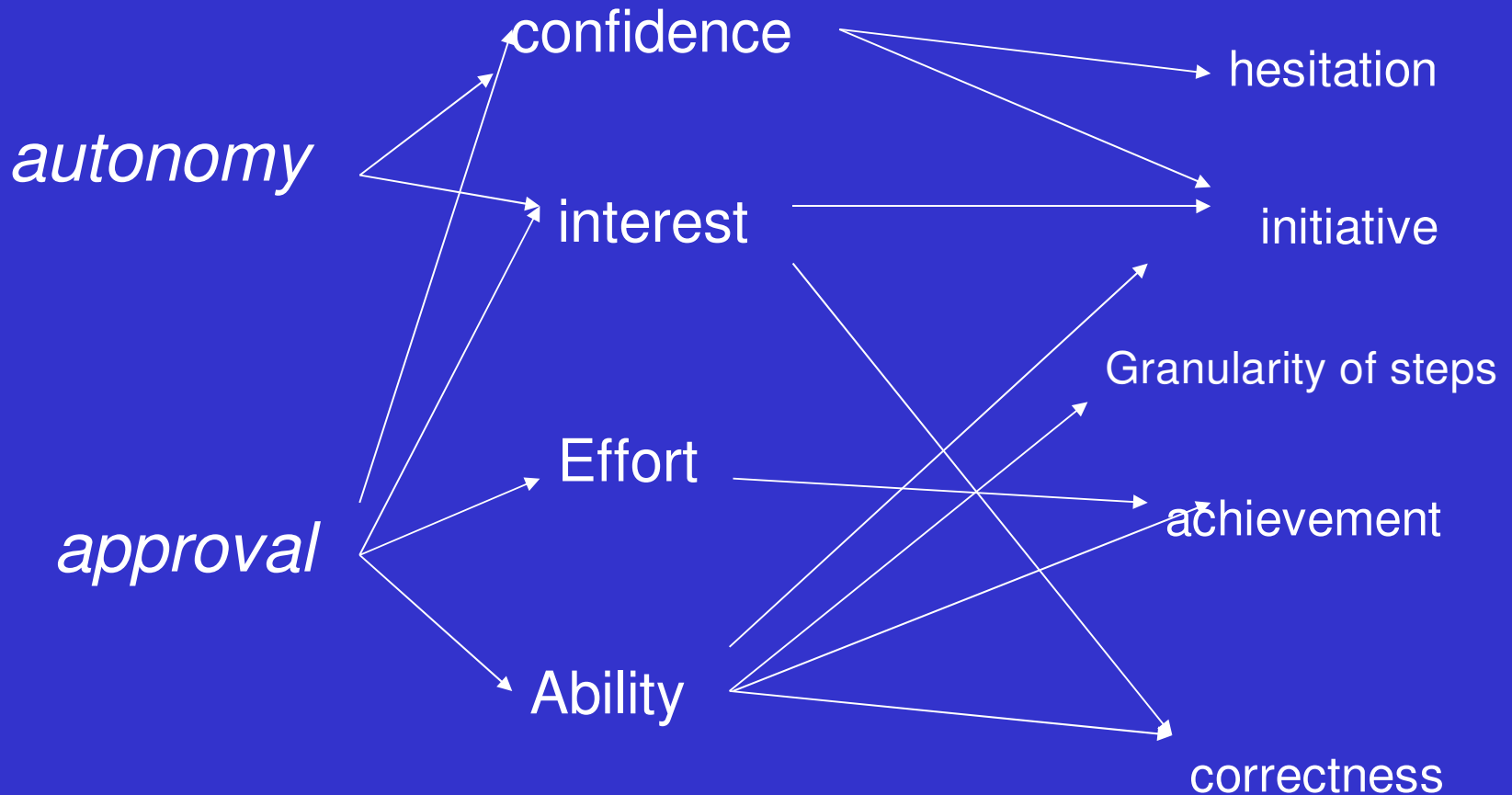
satisfied	1 - slip	guess	0	0
-----------	----------	-------	---	---

violated	slip	1 - guess	0	0
----------	------	-----------	---	---

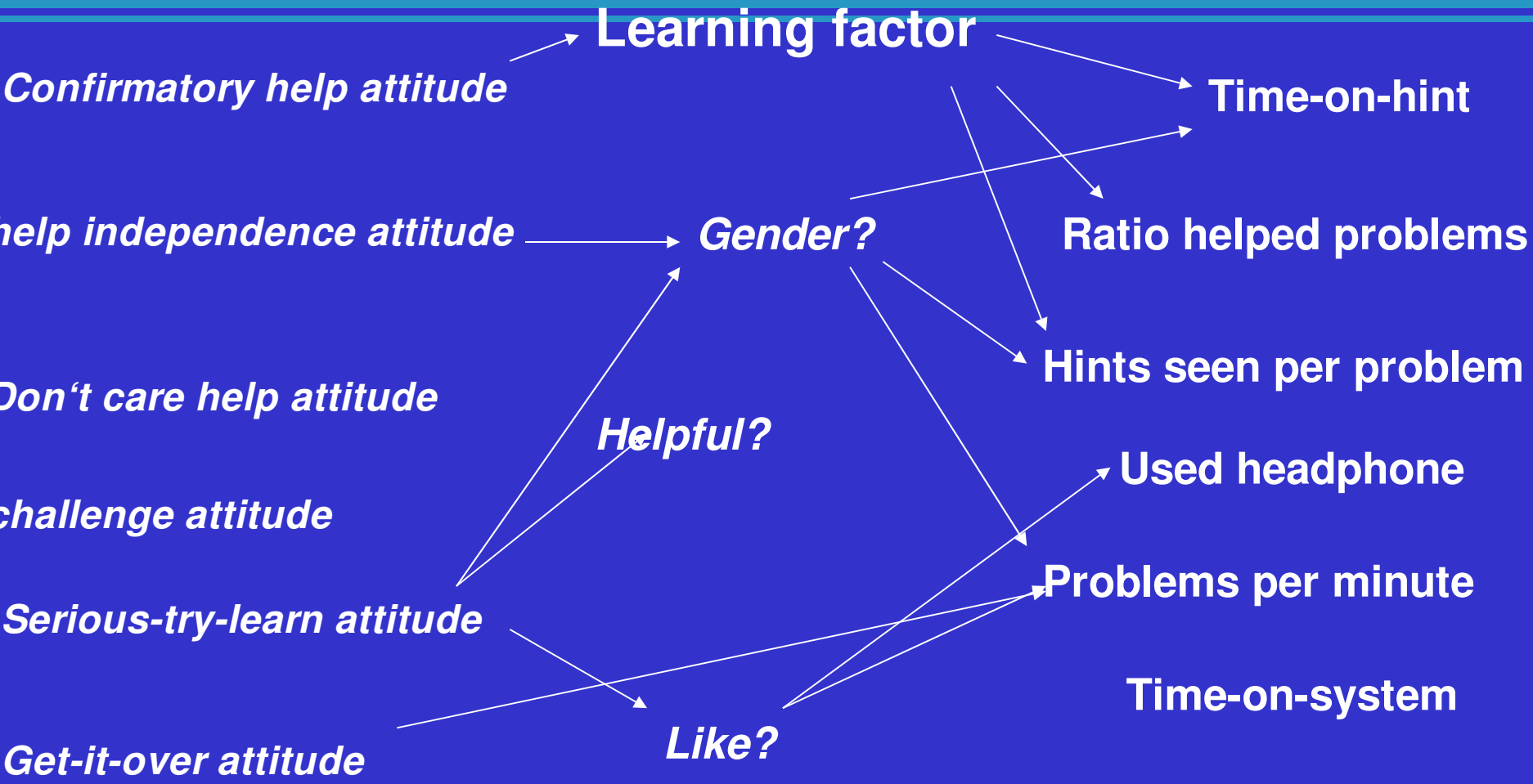
not relev	0	0	1	1
-----------	---	---	---	---



Bayes Net for Motivational Variables:

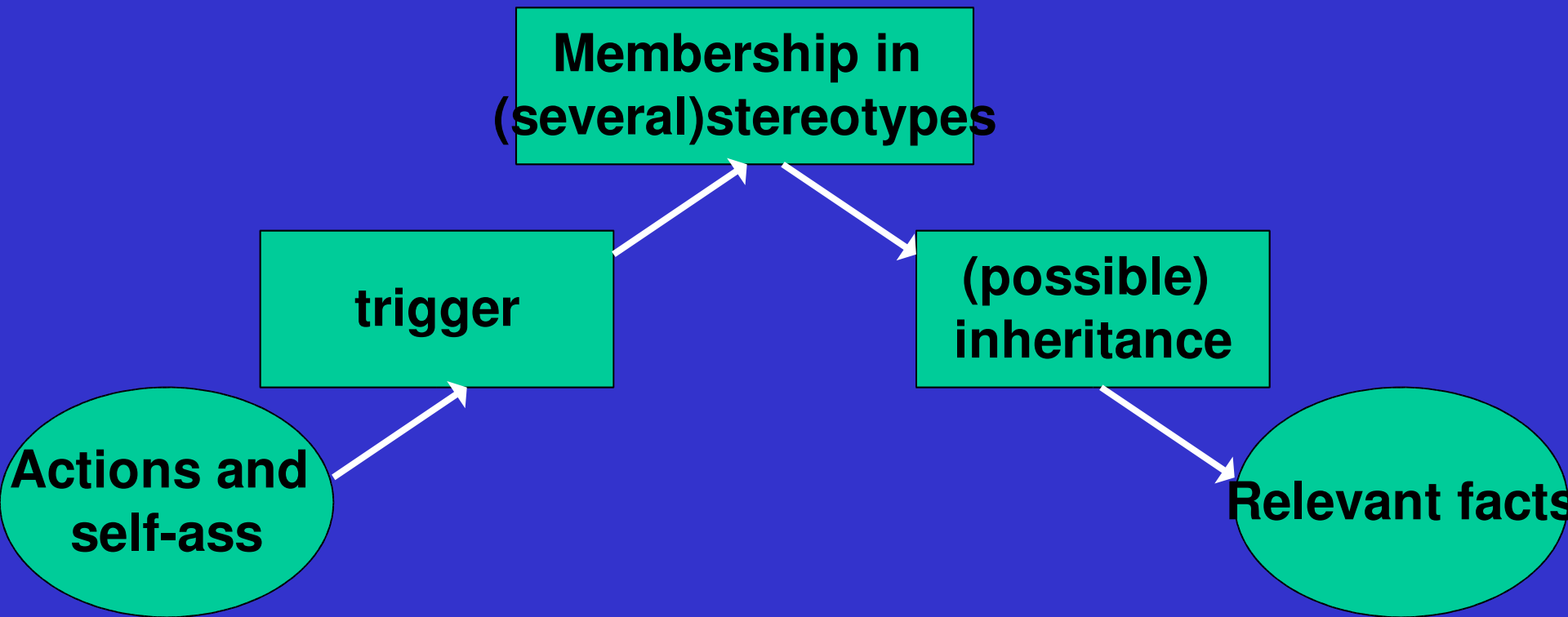


Correlations between Help-Seeking and Learning



Stereotypes

- Stereotype: body + set of triggers
- may be arranged in hierarchies (inheritance)



Stereotypes, rules

- Trigger rules (**Cond Trigger**)
 - self-assessed ‚expert‘ THEN stereo= Expert
 - at least 20 topics K=excellent THEN stereo=Expert
- Rules for evaluation and presentation (**Cond Scoring**)
 - Beginner AND diff(T)=simple THEN ev(T)=10 points
 - knows(T) THEN subtract 20 for appropriate(T)



Knowledge Tracing in **PACT/cognitive tutors**

iterative Bayesian Updating

- $p(L_n) = p(L_{n-1} | \text{evidence}) + (1 - p(L_{n-1} | \text{evidence})) * p(T)$
- $p(L_0)$ initial learning (a priori) probability of rule
- $p(T)$ transition prob following an opportunity of applic.

- $p(\text{correct}) = p(L) * (1 - p(S)) + (1 - p(L)) * p(G)$

- $p(G)$ guess

- $p(S)$ slip

Source: Erica Melis



Model Tracing in **PACT/cognitive tutors**

OVERLAY MODEL

- Pre-defined problem solving space includes rules and mal-rules
- match student's results with nodes in space
 - hypothesize next possible step
 - diagnoses errors



Student Modeling in **Andes**

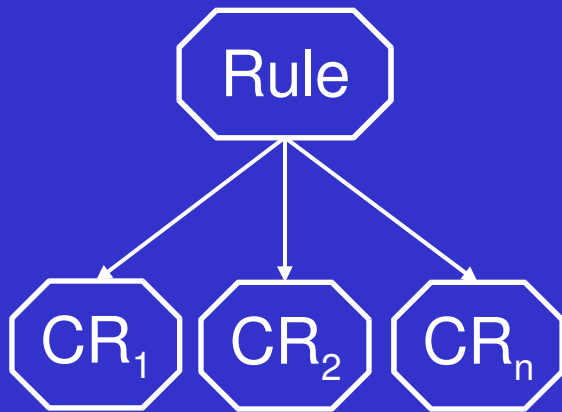
- Static Bayes Net on domain knowledge
- with input from dynamic BNs
 - rule nodes + context rule node for each exercise
- complexity of BN is NP-hard. approximate anytime algo based on statistic sampling
- independence assumption

long-term assessment for domain knowledge



Network structure: Static part

- Rule nodes
 - $P(R = T)$: probability that the student knows the rule
- Context rule nodes
 - $P(CR = T)$: probability that the student can use the rule in the corresponding context

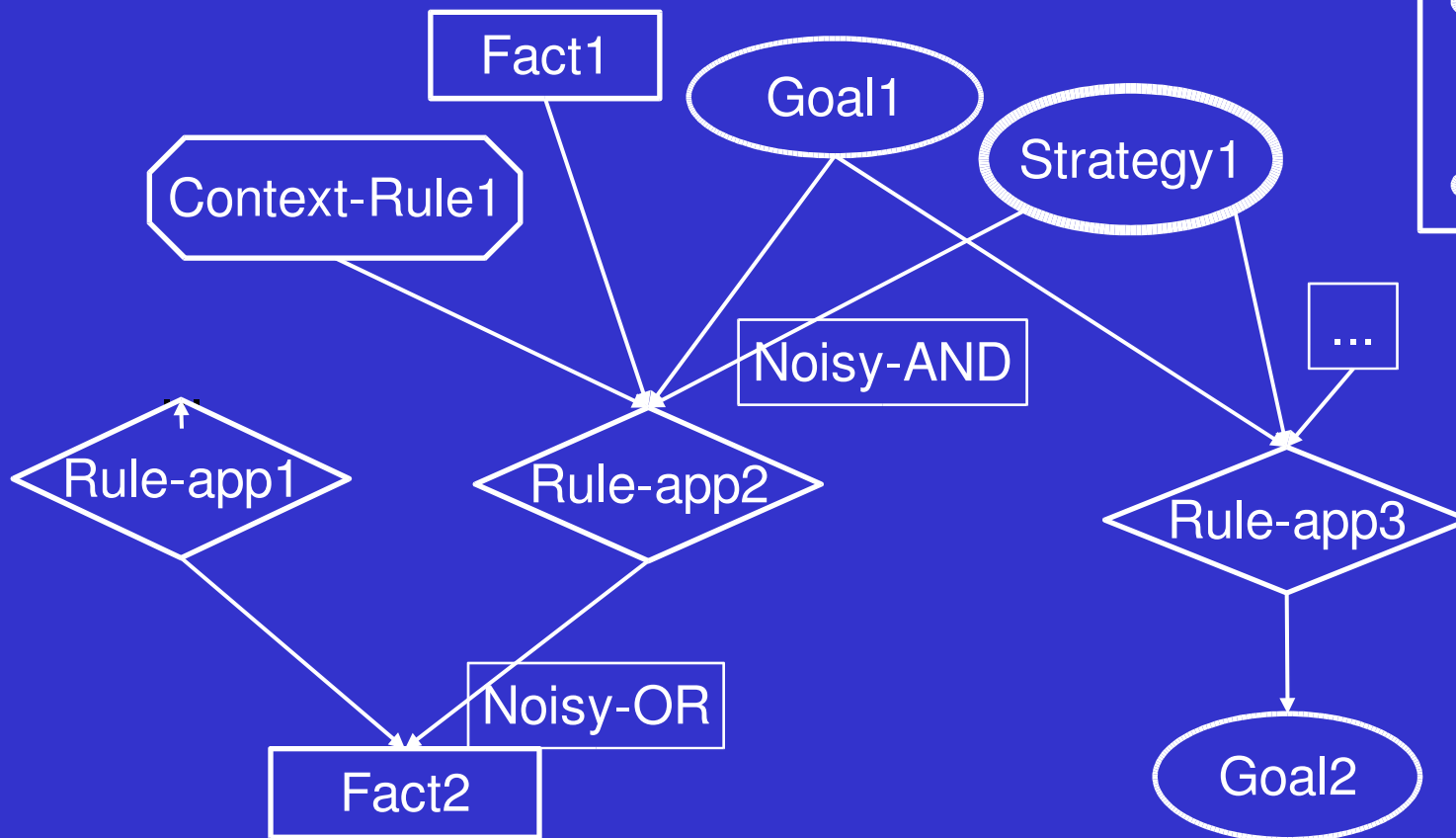


$$P(CR_i=T | R=T) = 1$$

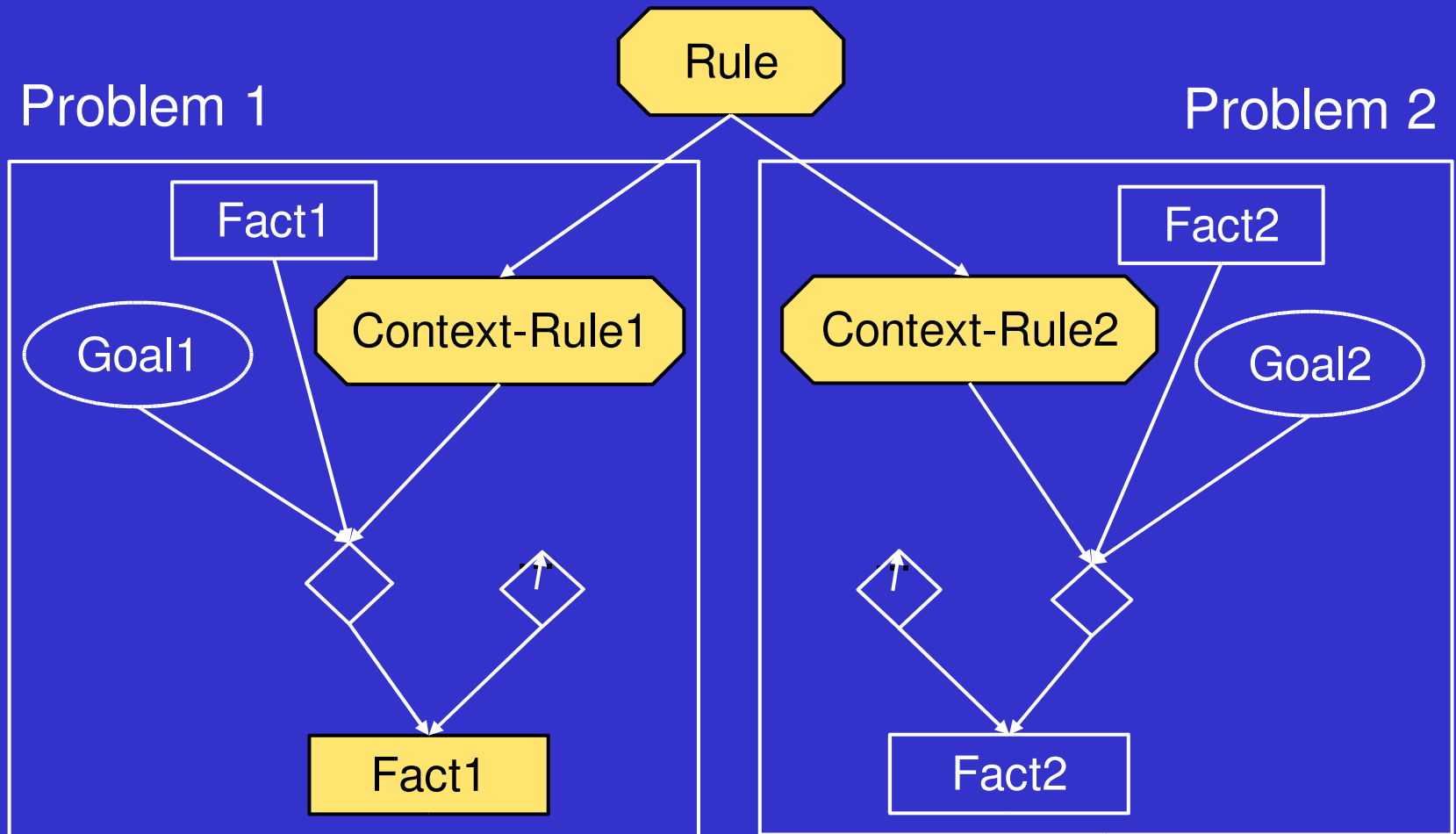
$P(CR_i=T | R=F)$ estimates the level of difficulty of context i



Network structure: Dynamic part



Propagating evidence



Andes⁴ Model Tracing Usage in Exc

- Assess intention -> useful hints
- if error + help request -> best explanation
- low mastery of important rules -> mini-lesson



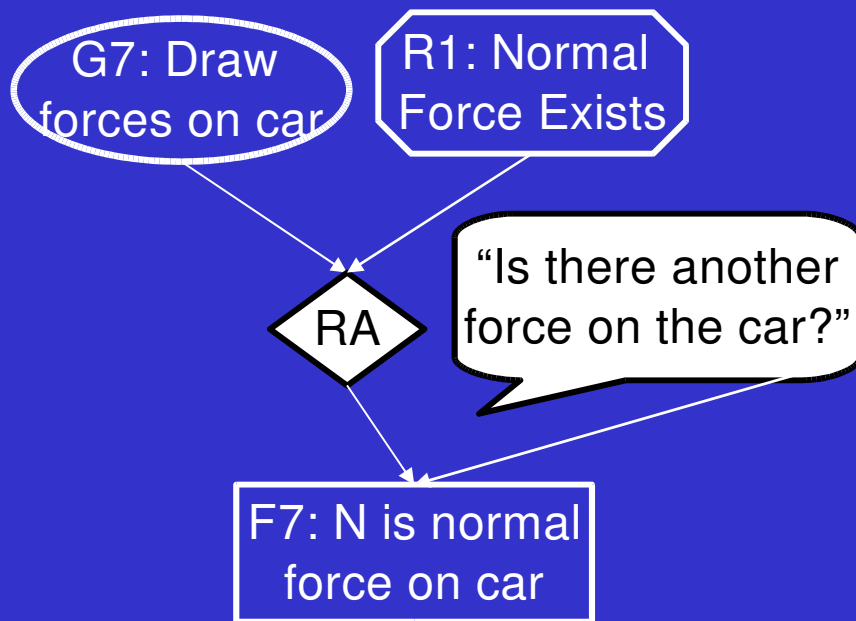
Selecting a Hint, algo

- Step 1: Goal inference
 - Start with last observed student entry
 - Find closest unsatisfied goal node
 - At decision points, choose highest probability node (most likely goal)
- Step 2: Prediction
 - Start from goal found in step 1
 - Find path from goal to “stuck node” ($p < 0.8$)
 - At decision points, choose lowest probability node (most help needed)



Updating the Student Model

- Student Model should reflect hints
- Hints have a direct influence on the probability of action



	RA		\neg RA	
	Hint	\neg Hint	Hint	\neg Hint
F7	1.0	1.0	h	g
\neg F7	0.0	0.0	1-h	1-g

h = strength of hint
g = likelihood of guess



Example Hint Sequence

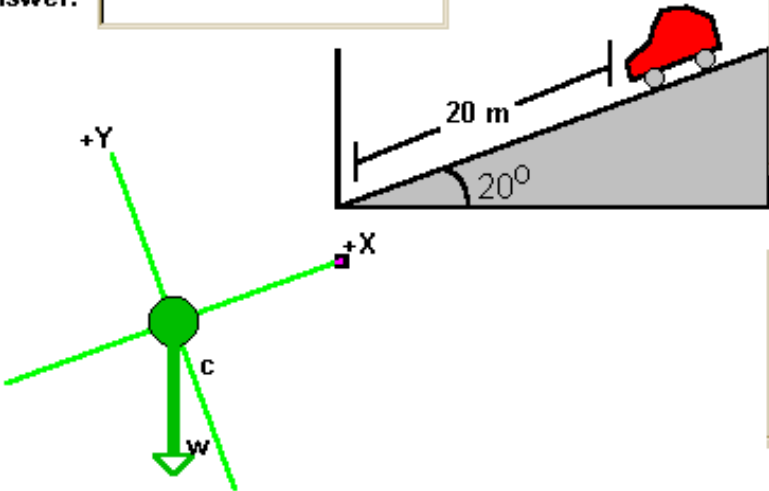
ANDES Physics Workbench - [P11-2.fbd]

File Edit Diagram Variable View Help

A 2000-kg car in neutral at the top of a 20-degree inclined driveway 20 m long slips its parking brake and rolls down. Assume that the driveway is frictionless.

At what speed will it hit the garage door?

Answer:



Think about what you need to do in order to have a complete **free body diagram** for the car.

Draw all the **forces** acting on the car as part of your **free body diagram**.

Do you know of any other **forces** acting on the car?

Is there a **force** exerted by the driveway on the car?

The driveway exerts a **normal force** on the car.

For Help, press F1

16:51:05

Problems with Model Tracing

- Correct domain rules provide *positive* evidence only
- for *negative* evidence buggy rules needed
- assessors most accurate if
 - student kept along a given solution path
 - student has to provide every step
- Bayes theoretically optimal but some parameter values hard to obtain



User model in I-Help

- knowledge
- interests
- eagerness
- helpfulness
- cognitive style
- preferences in helper
- preferred people
- banned people
- banned topics
- help-load

Info from:

user
peers
I-Help private
I-Help Public

*For finding and ranking
candidate helpers
for protecting users*

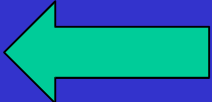


Test of User Models

- Never fully reliable...
- Empirical test with users
 - protocols, written..teacher assessors
- introspectable and modifiable user models
 - student/teacher revises
 - dialogue about student's beliefs
- test with artificial users



Which Properties to Adapt to? (WOz)

- course presentation
 - sequencing
 - content, difficulty
 - language
 - Feedback
 - Feedback strategies
 - global suggestions
 - learning plan
 - prompts
 - motivation support
 - role playing in collaboration
- 
- Mastery level
 - learning goals
 - user actions
 - exercise performance
 - learning context
 - field
 - presentation preferences
 - language...
 - learner type
 - gender
 - motivational state
 - context



Wizard of Oz

- Which adaptation targeted?
- Write user's and context's relevant properties on cards
- Input – Output?
- Observe learner's relevant properties, e.g. motivation
- Dependencies of properties?

- add properties and dependencies, if necessary
- are different levels of knowledge needed, which?
- is history needed, if yes, why?
- Is motivational state needed, if yes, which info?



Source: Erica Melis



Domain Reasoning (e.g. BEETLE)

- Model tracing
- Dynamic generation of problem solving subspace
- Diagnosis of errors
- hints for next steps

