

Relatie Algebra in een Intelligent Tutoring Systeem

1 April 2017

Esther Hageraats

Student master BPMIT

Faculteit Management, Science & Technology

Examencommissie: L. Rutledge en S. Joosten



Open Universiteit
www.ou.nl



Studie en loopbaan

1982: VWO examen

1990: Vriend liet zien wat programmeren was

1991-1993: C-programmeur

1995 Administratie van software development



Quality Assurance engineer

2005 CMM-auditor

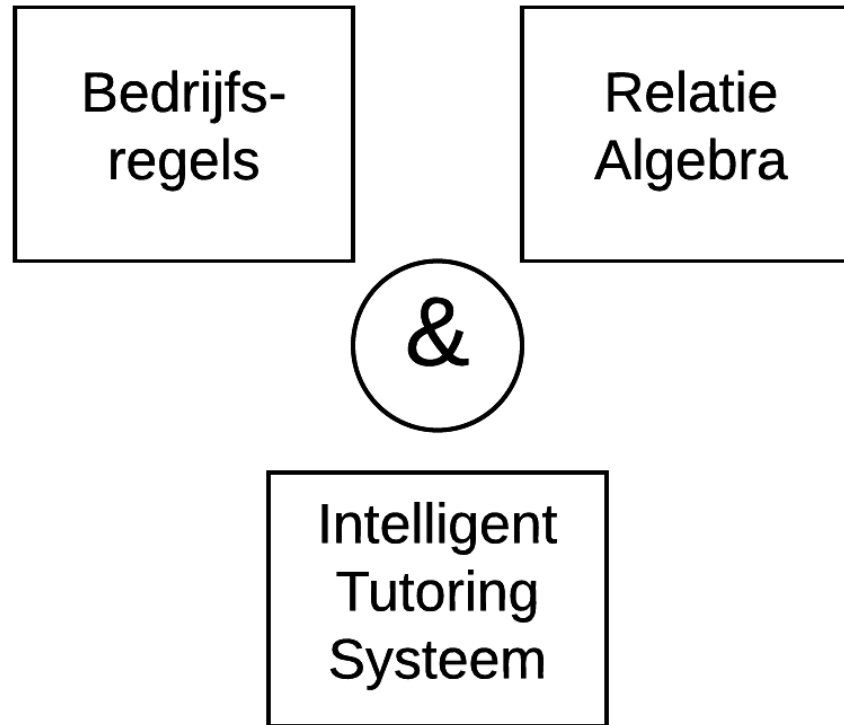
2006 – docent bij IT opleiding van Saxion

2008 – 2014 Bachelor bedrijfskunde

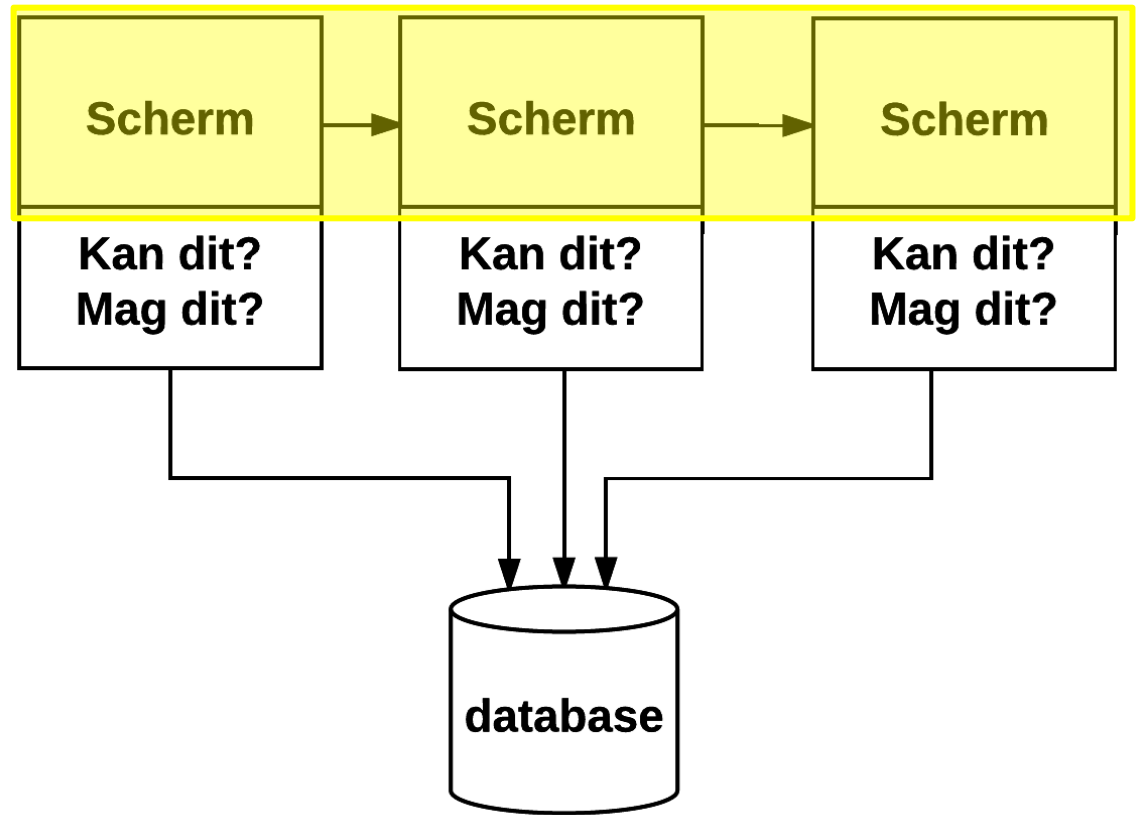
2014 – 2016 BPMIT



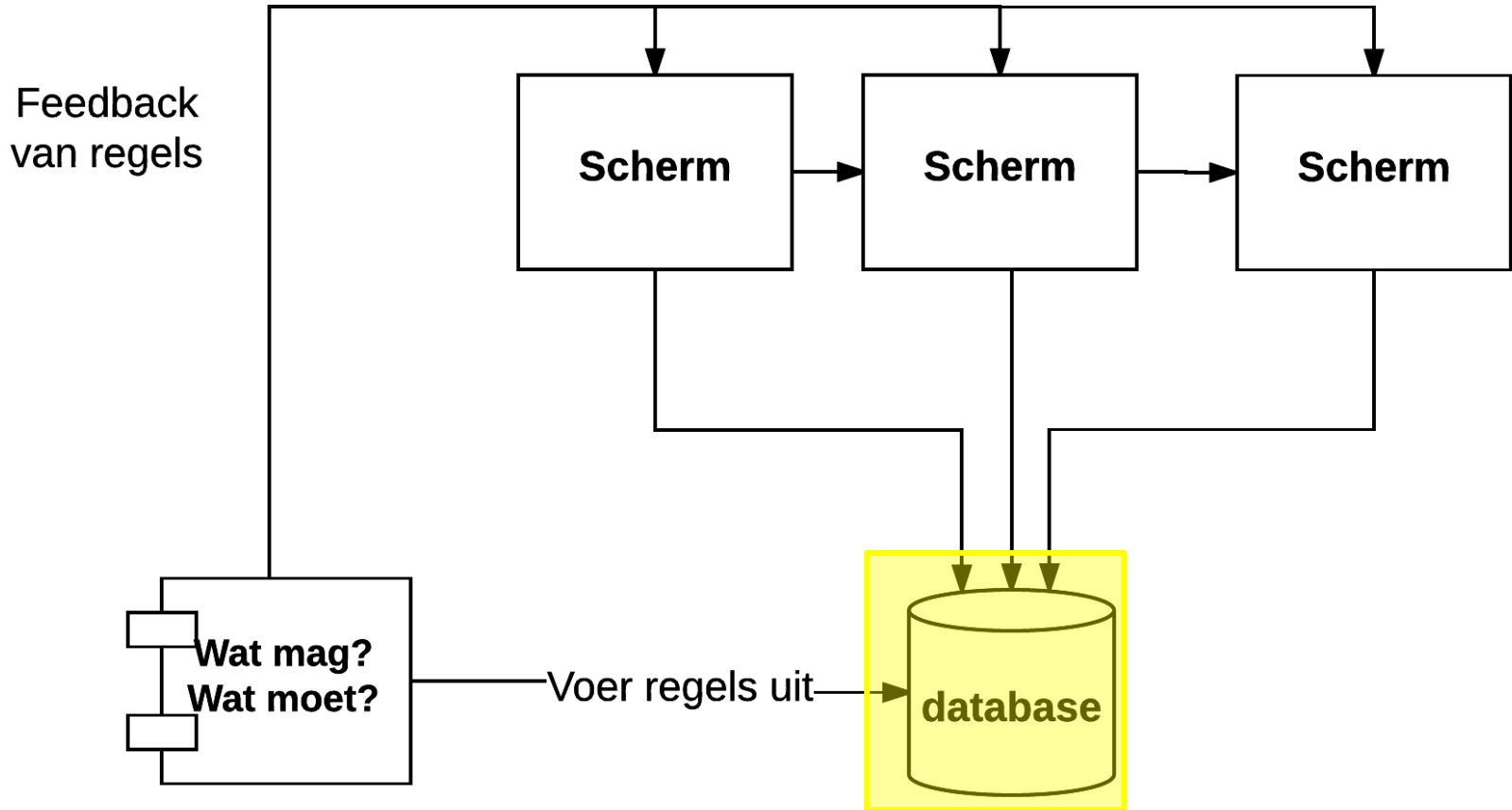
De context



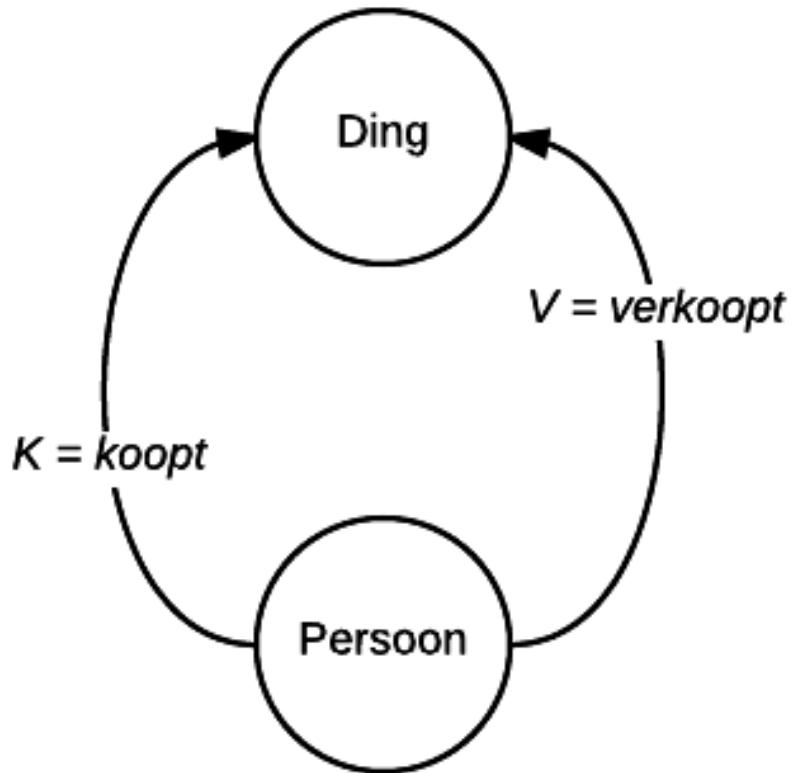
Bedrijfsregels (1)



Bedrijfsregels (2)



Relatie Algebra voor Bedrijfsregels



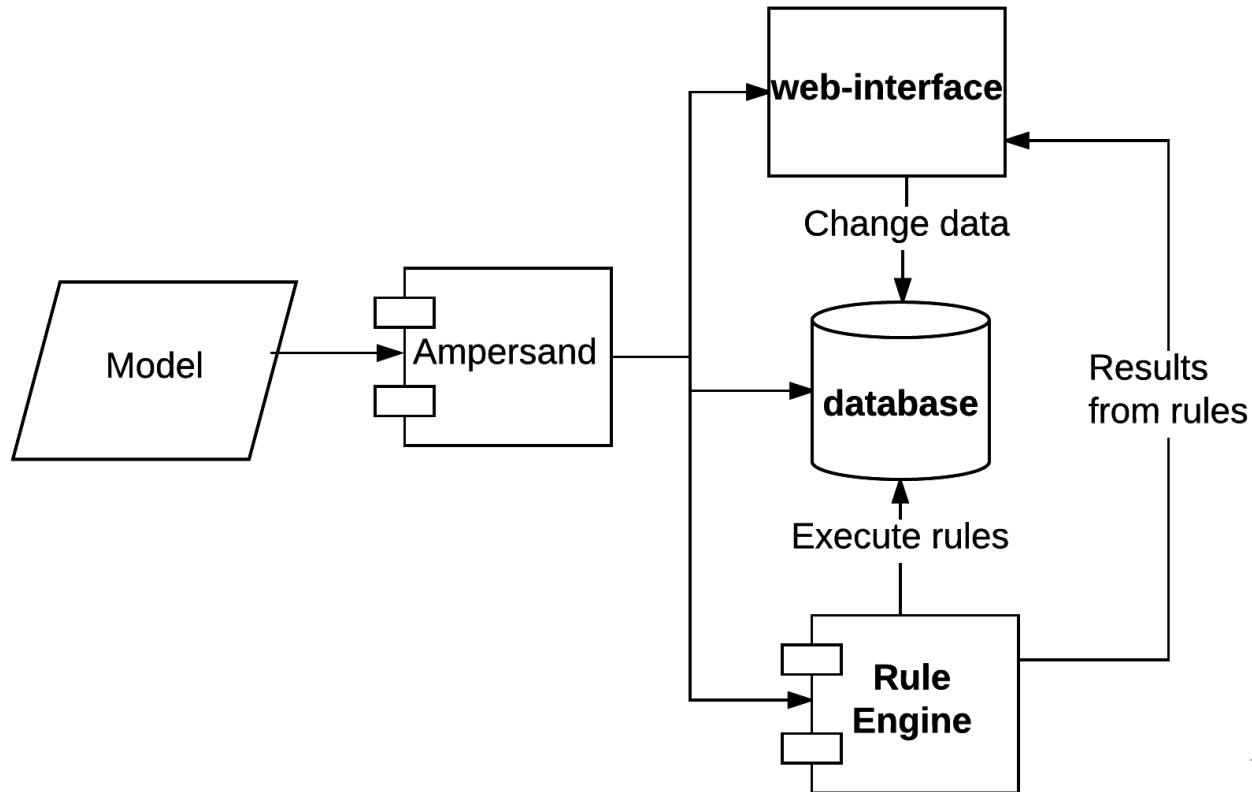
Regel: de koper en verkoper van hetzelfde ding moeten verschillende personen zijn

$$V;K \sim \subset \neg I$$

Relatie Algebra is goed beschreven. De formaliteit geeft vertrouwen dat “berekningen” kloppen.



Ampersand genereert prototypes



Repository for Ampersand Projects v2



Atlas (Play)

CONTEXT files (Design / reload)

Diagnosis

Extra functions

Atlas (Play)

CONTEXT

```

name
FreeGoodsOrderProces
number of RULEs
10
number of relations
11
number of concepts
7

```

PATTERNs

FrontOffice

concepts

```

Fieldmanager
Bestelformulier
Front_Office_medewerker_1
Voorraad
Front_Office_medewerker_2
Bestelling
Nedcargo

```

ISA-relations

relations

```

stuurt_bestelformulier :: Fieldmanager * Bestelformulier
with properties INJ SUR
ontvangt_bestelformulier1 :: Front_Office_medewerker_1 * Bestelformulier
with properties INJ SUR
voert_in_bestelformulier :: Front_Office_medewerker_1 * Bestelformulier
with properties INJ SUR
print_bestelformulier :: Front_Office_medewerker_1 * Bestelformulier
with properties INJ SUR
controleert_voorraad1 :: Front_Office_medewerker_1 * Voorraad
with properties UNI
overhandigt_bestelformulier :: Front_Office_medewerker_1 * Bestelformulier
with properties INJ SUR
ontvangt_bestelformulier2 :: Front_Office_medewerker_2 * Bestelformulier
with properties INJ SUR
controleert_voorraad2 :: Front_Office_medewerker_2 * Voorraad
with properties UNI TOT SUR
stuurt_bestelling :: Front_Office_medewerker_2 * Bestelling
with properties INJ SUR
archiveert_bestelling :: Front_Office_medewerker_2 * Bestelling
with properties INJ SUR
bevestiging_bestelling :: Nedcargo * Bestelling
with properties INJ SUR

```

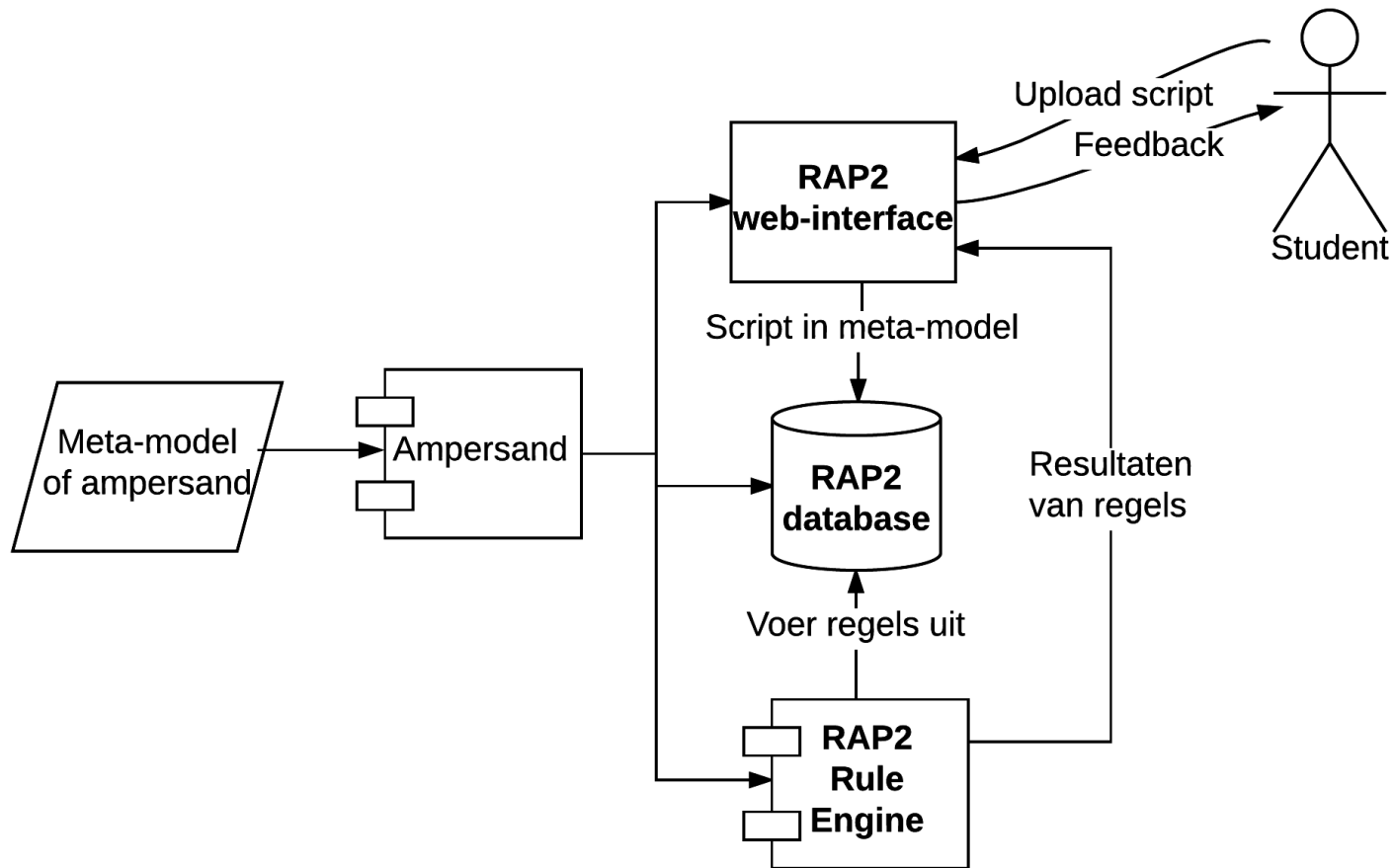
RULEs

```

Versturen bestelformulier
Ontvangen bestelformulier
Invoer bestelformulier
Print bestelformulier
Controle voorraad
Overhandigen bestelformulier
Controle invoer bestelformulier
Versturen bestelling
Archiveren bestelling
Bevestiging bestelling

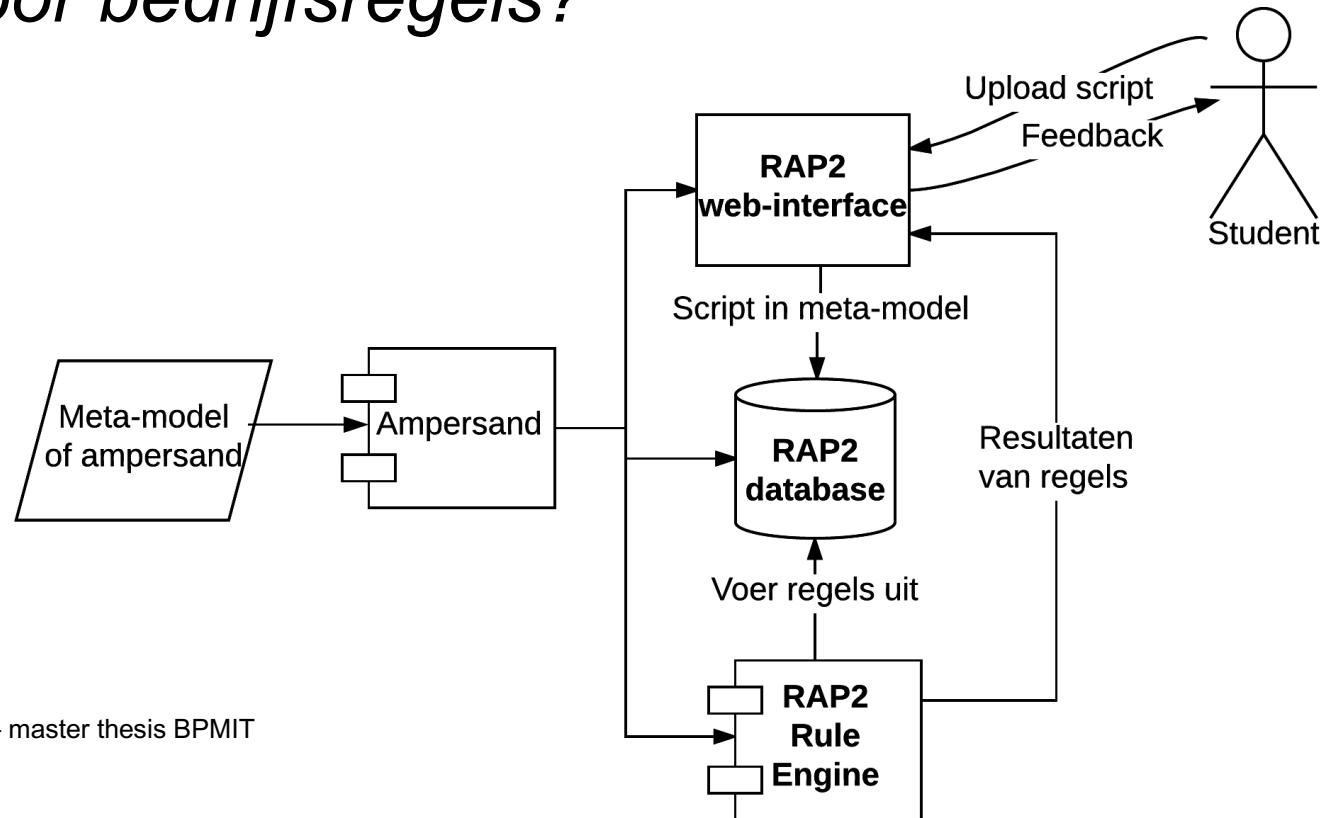
```


RAP2 – voor/met bedrijfsregels



Onderzoeksvraag

Hoe kan relatie algebra worden gebruikt om feedback te creëren voor studenten op hun model voor bedrijfsregels?



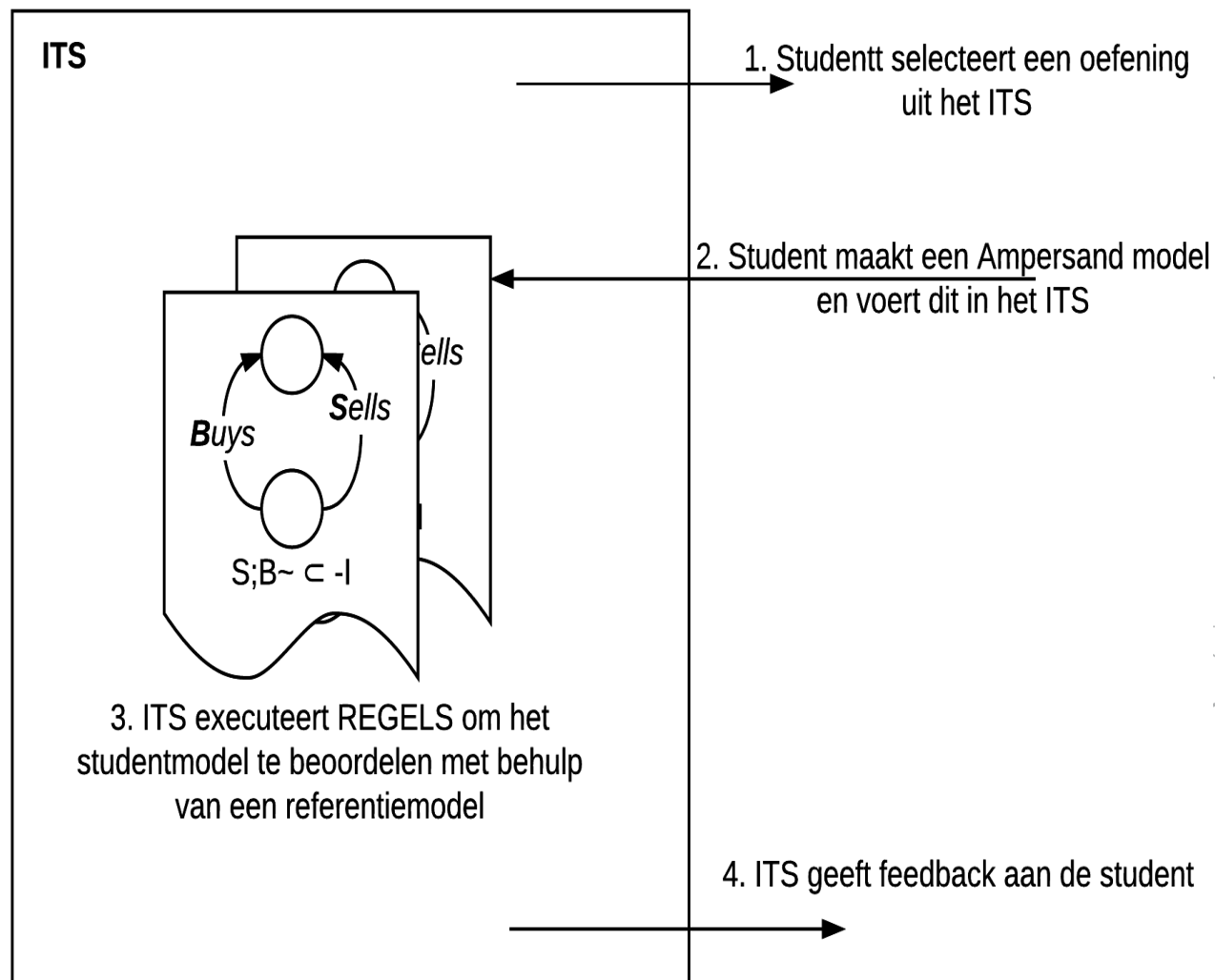
Belangrijkste bronnen en tools

- Veel literatuur over Intelligent Tutoring Systemen
- Gesprek met Hieke Keuning
- Proefschrift van Gerard Michels – bouwer RAP2 meta-model
- Ampersand – XAMPP – installatie
- Gitbook en de Ampersand Research Group



Embedded Case Study Ontwerp

Oefeningen om te leren modelleren in Ampersand



Embedded Case Study Ontwerp

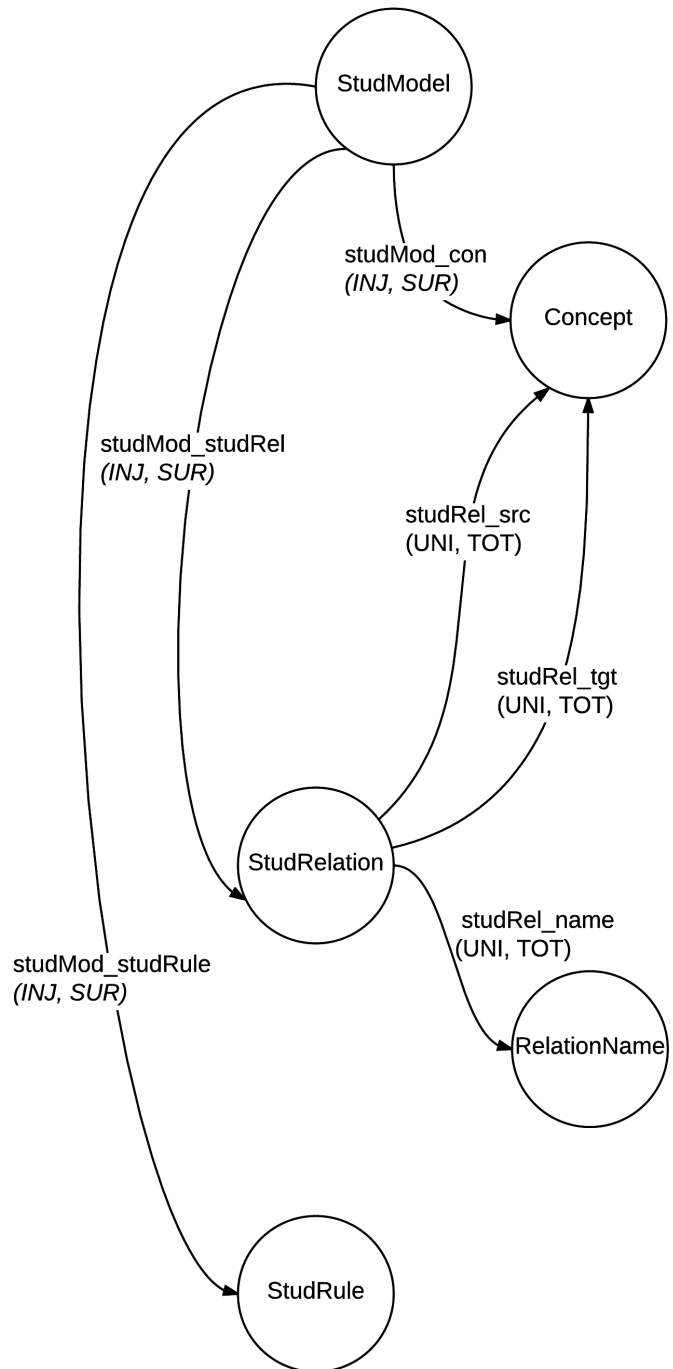
- Meta-model
 - Gebaseerd op Michels, G., *Development Environment for Rule-based Prototyping* [THESIS]. 2015.
- 5 oefeningen:
 - Opdracht
 - Referentiemodel
 - Regels om het studentmodel te beoordelen
 - Studentmodellen (correct en incorrect)

Hoe goed identificeren de regels de problemen in het studentmodel?



Meta-model

Gebaseerd op het
bestaande
meta-model voor
RAP2

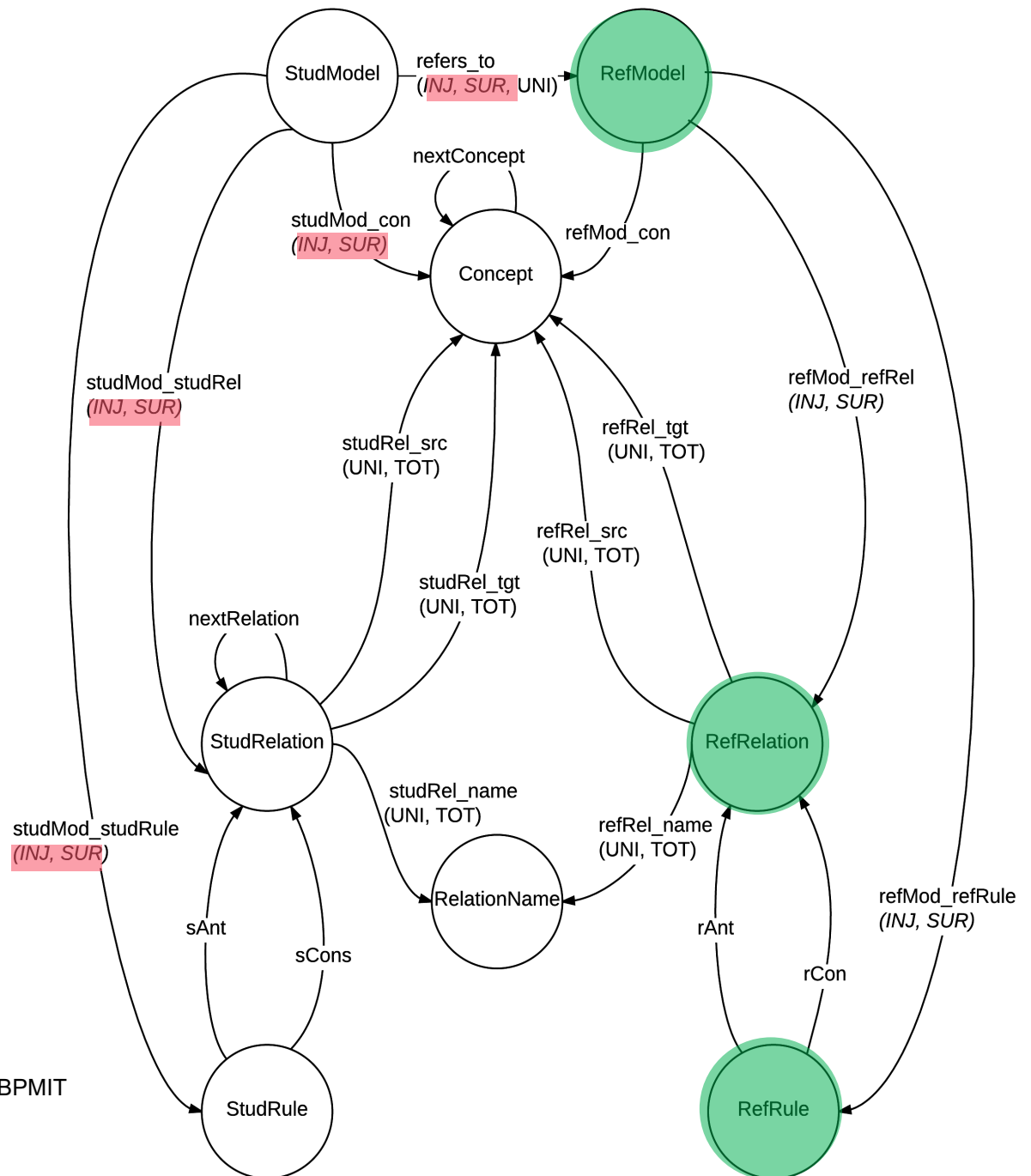


Meta-model

Gebaseerd op het
bestaande
meta-model voor
RAP2

Referentie
model

INJ, SUR =
beperking van
de case study

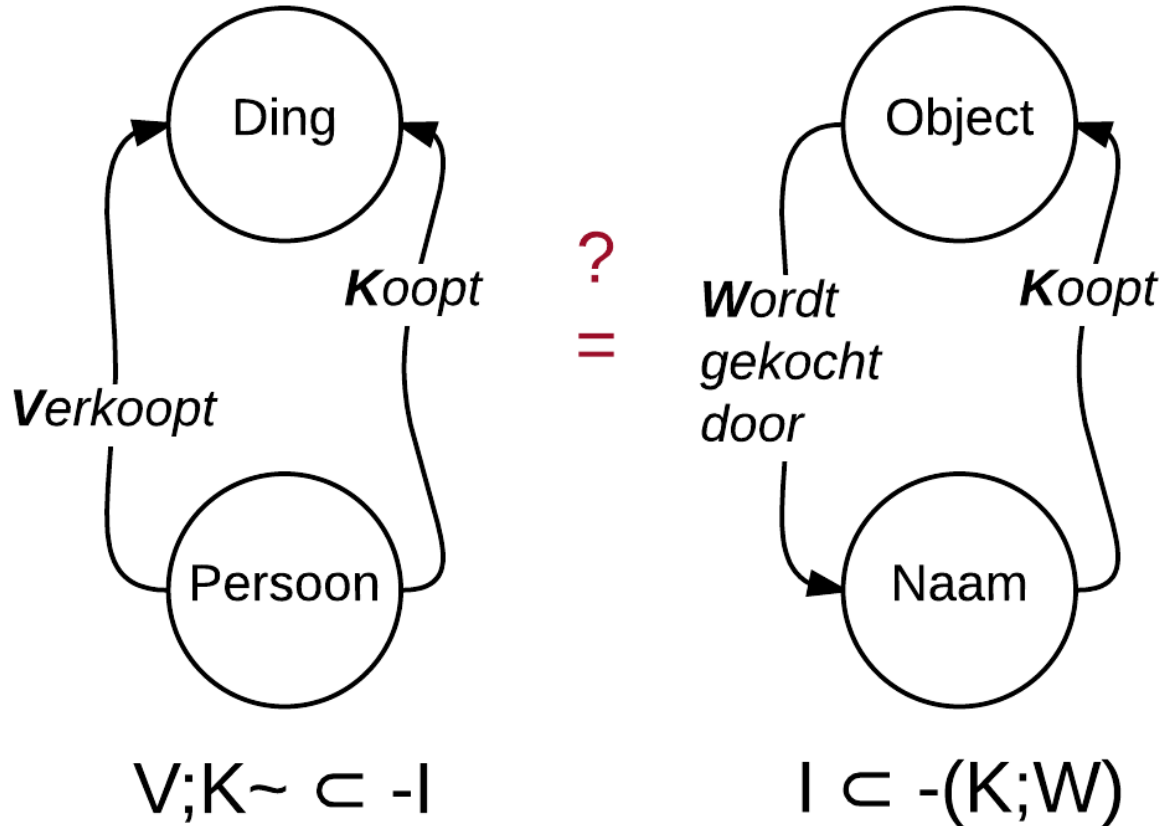


Probleem

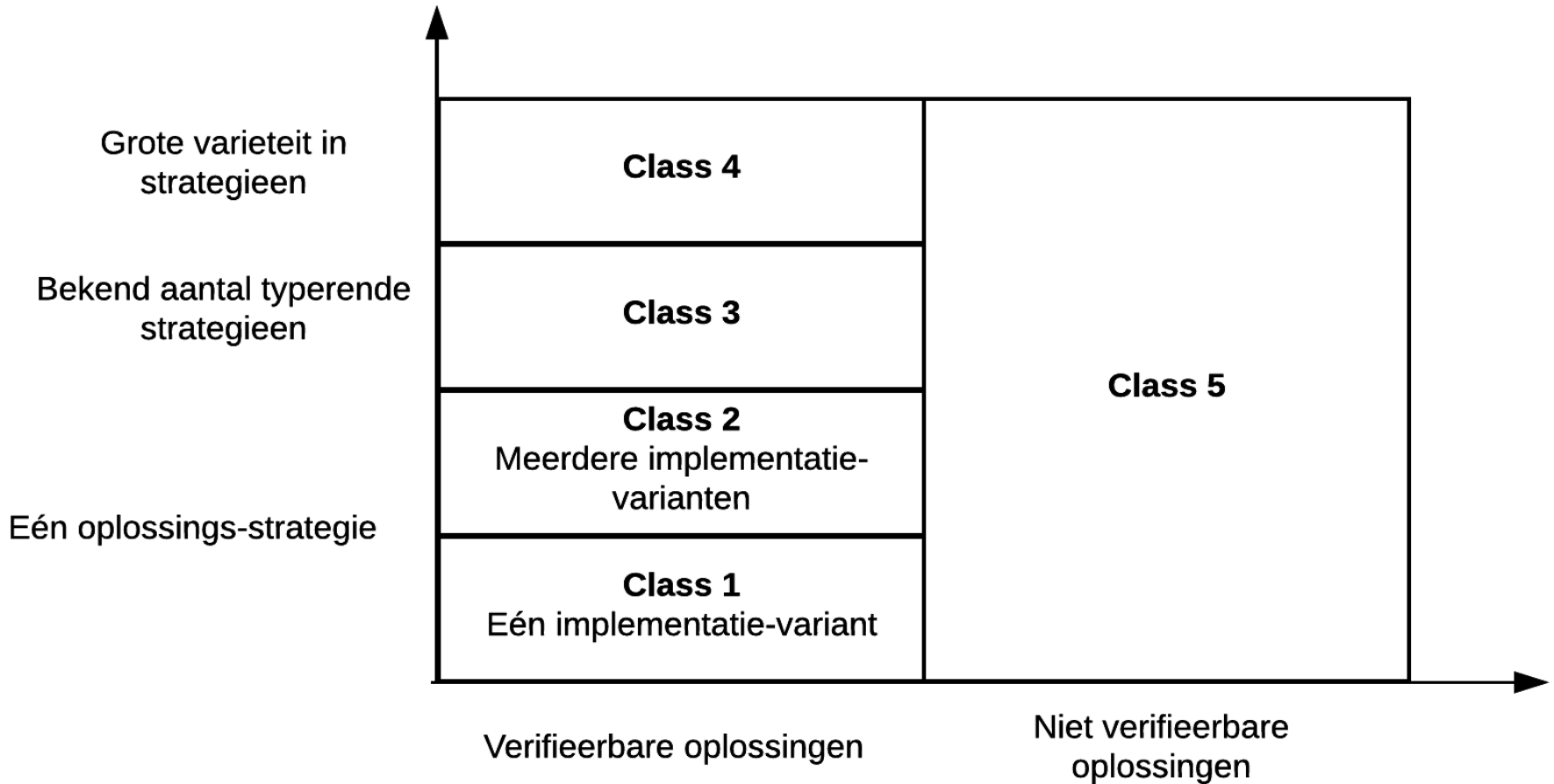
VERIFIEERBAARHEID



Het probleem van verifieerbaarheid

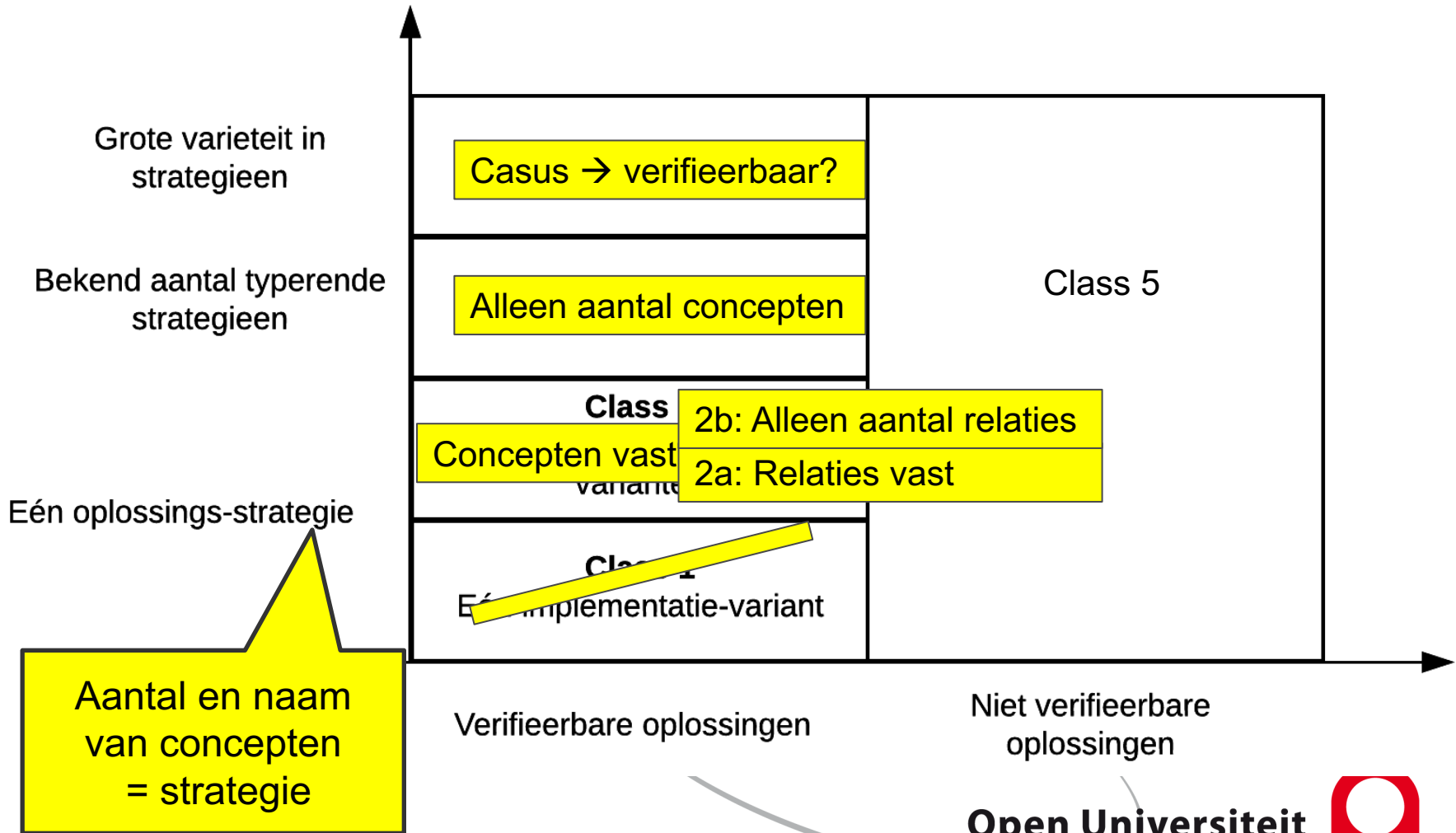


Classificatie van educatieve problemen



Le, N.-T., F. Loll, and N. Pinkwart, *Operationalizing the continuum between well-defined and ill-defined problems for educational technology*. Learning Technologies, IEEE Transactions on, 2013.

Ampersand modeler-problemen



Embedded Case Study Ontwerp

Regel	Beschrijving	Class 2/ Rule-only	Class 2/ Rule-rel	Class 3
1	Identieke Namen	X		
2	Identieke Bron	X		
3	Gerelateerde Concepten	X	X	
4	Antecedent	X	X	X
5	Anoniem Model			X



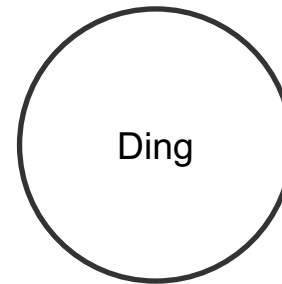
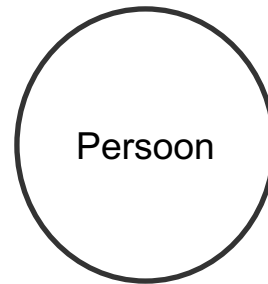
Voorbeeld 1

GERELATEERDE CONCEPTEN



Gerelateerde concepten (1)

- Oefening: *“Definieer 2 relaties tussen de gegeven concepten en definieer 1 regel die stelt dat koper en verkoper van een ding niet dezelfde persoon kunnen zijn.”*

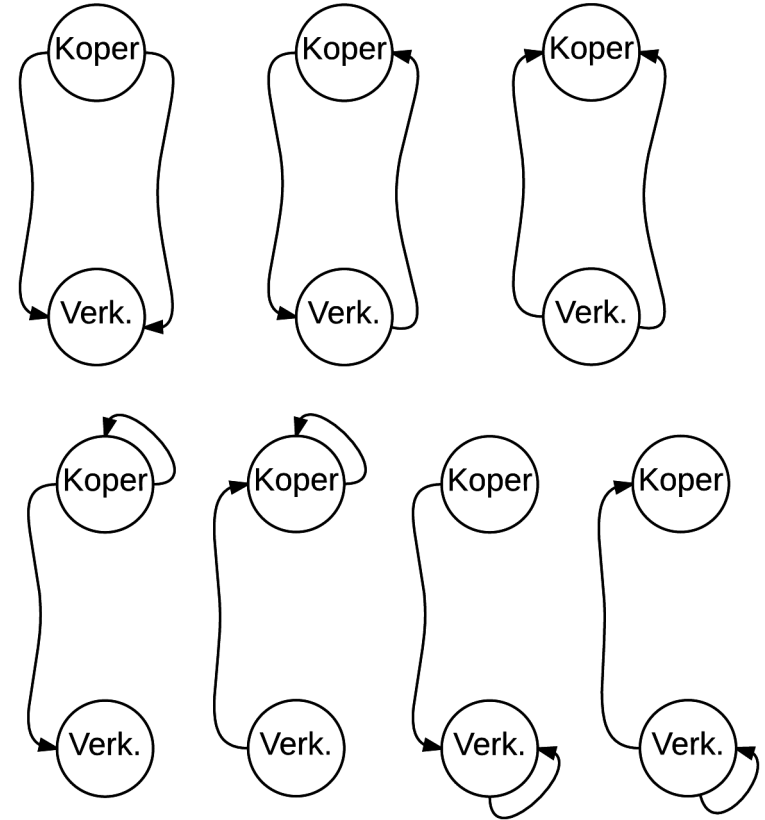


- Class 2/Rule-rel
 - Concepten zijn gegeven
 - Student maakt relaties en regels



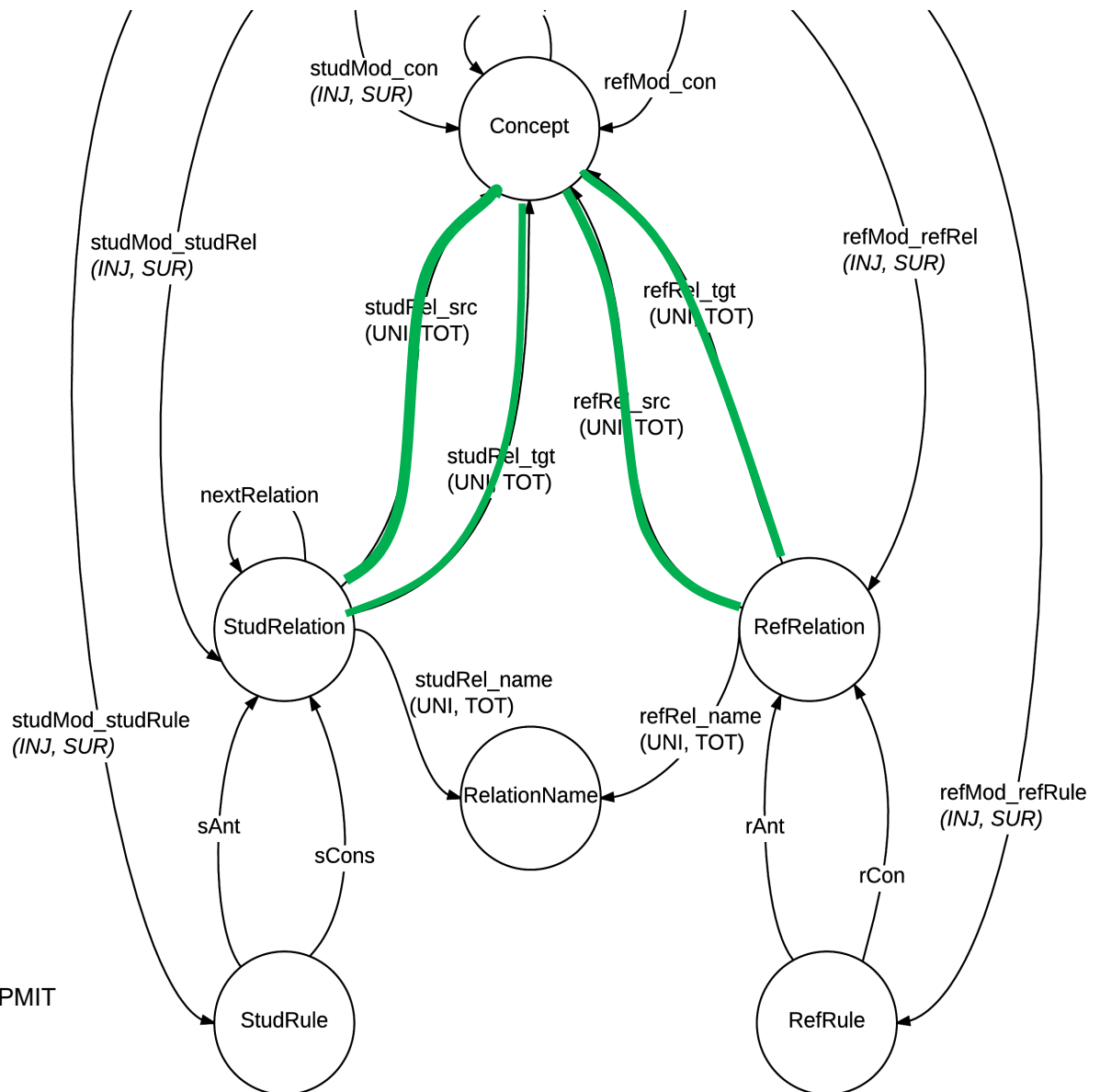
Gerelateerde concepten (2)

- Verifieerbaarheid:
 - Elk patroon heeft een beperkt aantal typerende oplossingen



Gerelateerde concepten (3)

Regel:
Twee concepten die gerelateerd zijn in het studentmodel zijn ook gerelateerd in het referentiemodel.





EHCase3.adl

```
1 CONTEXT EHCase3
2 IN ENGLISH
3 INCLUDE "EHCase3.xlsx"
4
5 PURPOSE CONTEXT EHCase3
6 {+
7 This model is the meta-model designed in the Master thesis of Esther Hageraats 2016
8 All code below the rule is the same for cases 1 to 4
9 The rule is Case3 of this thesis.
10 It's a check whether the concepts that are paired in a relation in the student model are also paired in a relation in the reference model.
11 -}
12
13
14 RULE "related_concepts":
15     studRel_src~;studRel_tgt |- (refRel_src~;refRel_tgt) \/ (refRel_tgt~;refRel_src)
16     MEANING "Working of the rule: the sign of relation in the student model is also present in the reference model"
17     VIOLATION (TXT "You have connected the concepts '", SRC I, TXT "' and '", TGT I, TXT "'", but this combination is not allowed")
18     ROLE Student MAINTAINS "related_concepts"
19
20 -- remedy rules
21 RULE "same_sign":
22     (studRel_src;studRel_src~) /\ (studRel_tgt;studRel_tgt~) |- I
23     MEANING "A source-target combination cannot be used twice in the student model"
24     VIOLATION (TXT "There are relations that have the same sign: ", SRC I)
25     ROLE Student MAINTAINS "same_sign"
26
27 RULE "flipped_sign":
28     (studRel_src;studRel_tgt~) /\ (studRel_tgt;studRel_src~) |- I
29     MEANING "A source-target combination cannot be used twice in the student model"
30     VIOLATION (TXT "There are relations that have each other's flipped sign: ", SRC I)
31     ROLE Student MAINTAINS "flipped_sign"
32
```



Violation of rule 'related_concepts'

You have connected the concepts 'Concept1' and 'Concept3', but this combination is not used in the reference model.

Student

Relations in the student model

Name	Source	Target	+
Relation1	Concept1	Concept2	
Relation2	Concept1	Concept3	
Relation3	Concept3	Concept4	
<input type="text" value="Select"/>			

+

Relations in the reference model

Name	Source	Target	+
Relation1	Concept1	Concept2	
Relation2	Concept2	Concept3	
Relation3	Concept3	Concept4	
<input type="text" value="Select"/>			

+

Rules in the student model

Antecedent	Consequent	+
<input type="text" value="Select"/>		



Voorbeeld 2

PATRONEN VOOR REGELS

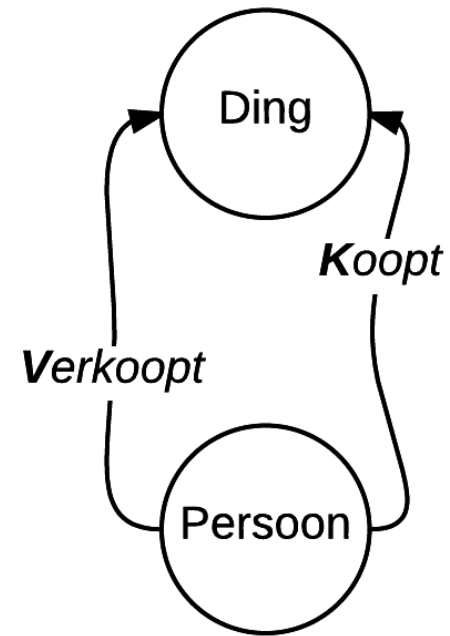


Antecedent/Consequent (1)

Veel voorkomend patroon:

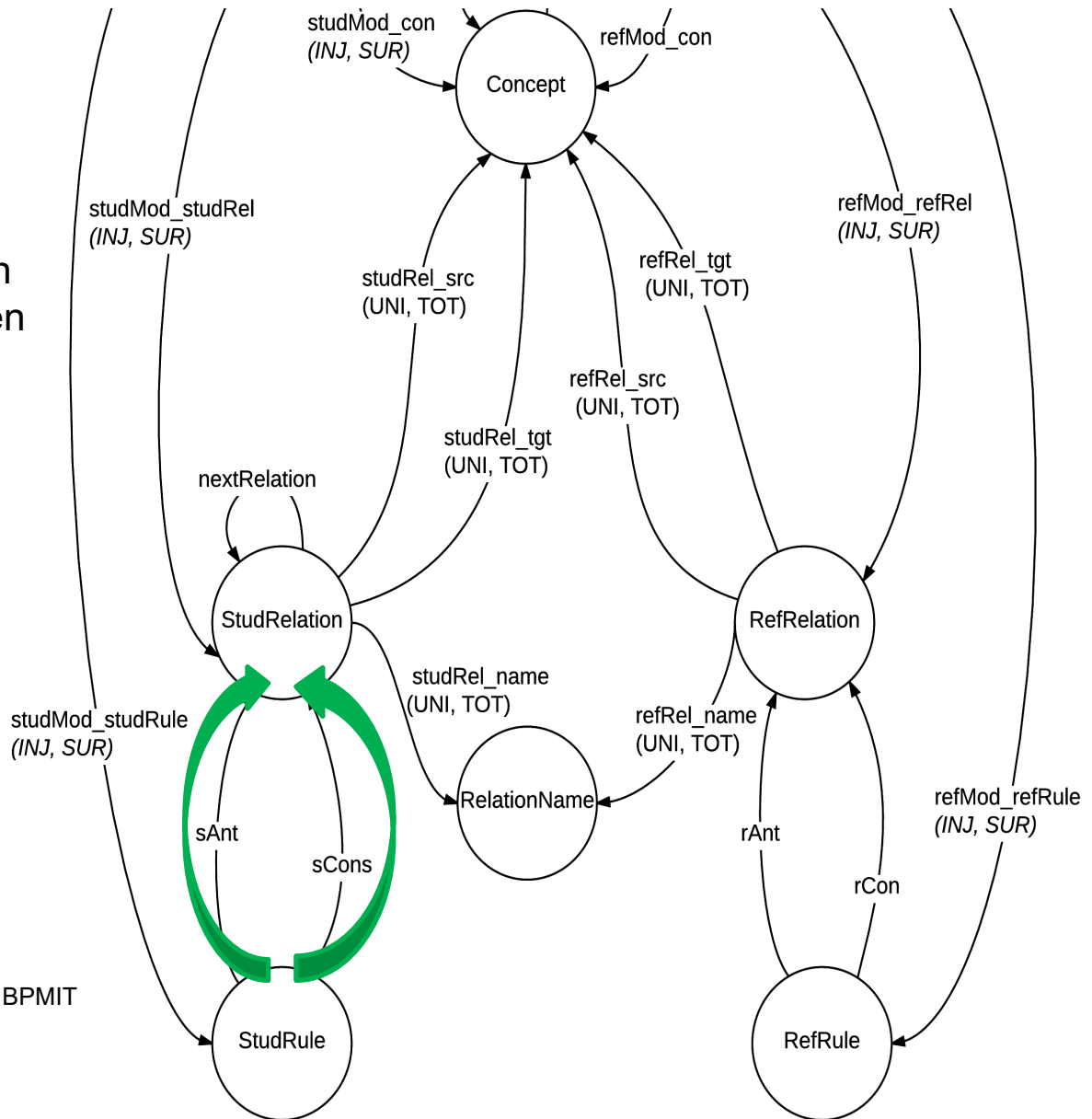
Alle relatie expressies in een regel staat aan één kant.

De constante 'I' of 'V' aan de andere kant.


$$V;K\sim \subset -I$$
$$K;V\sim \subset -I$$
$$I \subset -(K;V\sim)$$
$$I \subset -(V;K\sim)$$


Antecedent/Consequent (2)


Regel:
Alle relatie expressies in de regel moeten aan één kant staan, in de antecedent of de consequent.



Antecedent/Consequent (3)

```
RULE "at_one_side": (sAnt;sAnt~) |- -(sCons;sCons~)
```


```
VIOLATION (TXT "Rule '", SRC I, TXT "' has relation terms in both the antecedent and consequent.")
```


 Violation of rule 'at_one_side'

Rule 'StudentRule' has relation terms in both the antecedent and consequent.

Student

Rules in the student model

Antecedent	Consequent	
Stud_Rel1 Stud_Rel2	Stud_Rel1 Stud_Rel2	
<input type="text" value="Add StudRelation"/>	<input type="text" value="Add StudRelation"/>	
<input type="text" value="Select"/>		





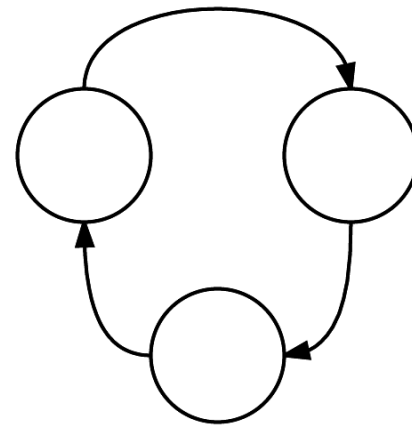
Voorbeeld 3

ANONIEM MODEL



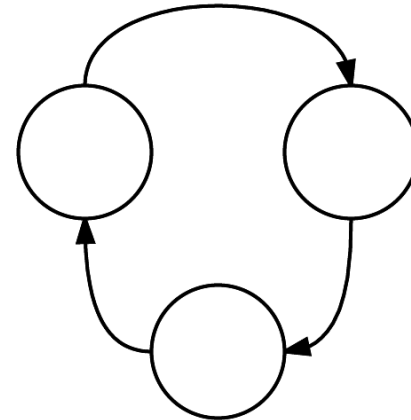
Verifieerbaarheid van classe 3

- Alleen het aantal concepten is gegeven
- Verifieerbaarheid
 - Het aantal typerende oplossingen is bekend



Anoniem model (1)

- Oefening: “*Definieer een model met 3 concepten om te controleren of de straat waar iemand woont, bestaat in de stad waar deze persoon is geregistreerd.*”



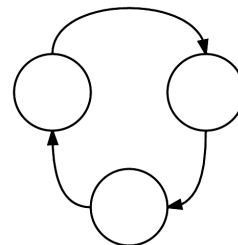
Patroon:

- 3 concepten,
- 3 relaties,
- elk concept is gerelateerd met de 2 andere concepten.

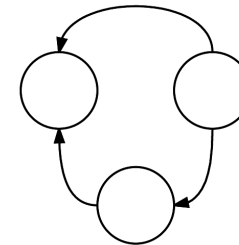


Anoniem model (3): 5 regels voor een patroon

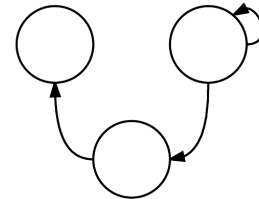
- Regels :
 - Drie concepten
 - Drie relaties
 - Geen endo-relaties
 - Unieke sign
 - Geen flipped sign



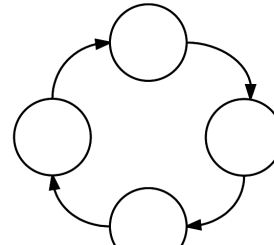
Correct Model a



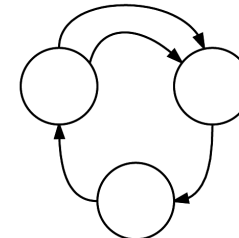
Correct Model b



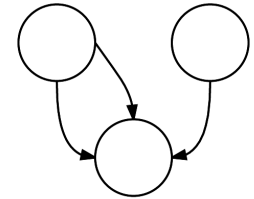
Incorrect Model c
an endo-relation



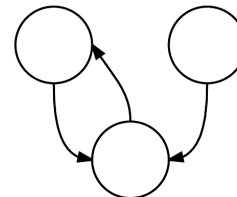
Incorrect Model d
more than 3 concepts



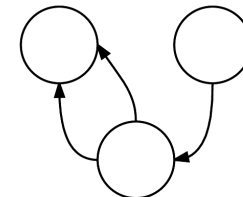
Incorrect Model e
more than 3 relations



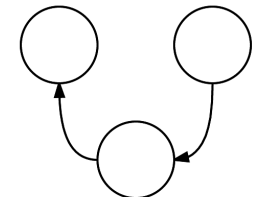
Incorrect Model f
three times target



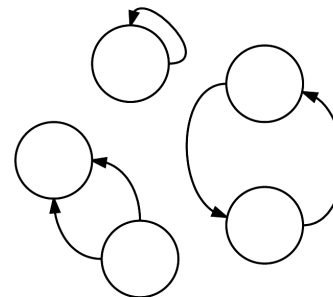
Incorrect Model g
flipped sign



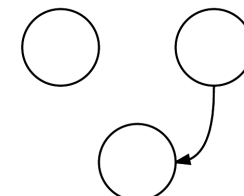
Incorrect Model h
equal sign



Incorrect Model i
two relations



Incorrect Model j
all five rules must trigger a
violation

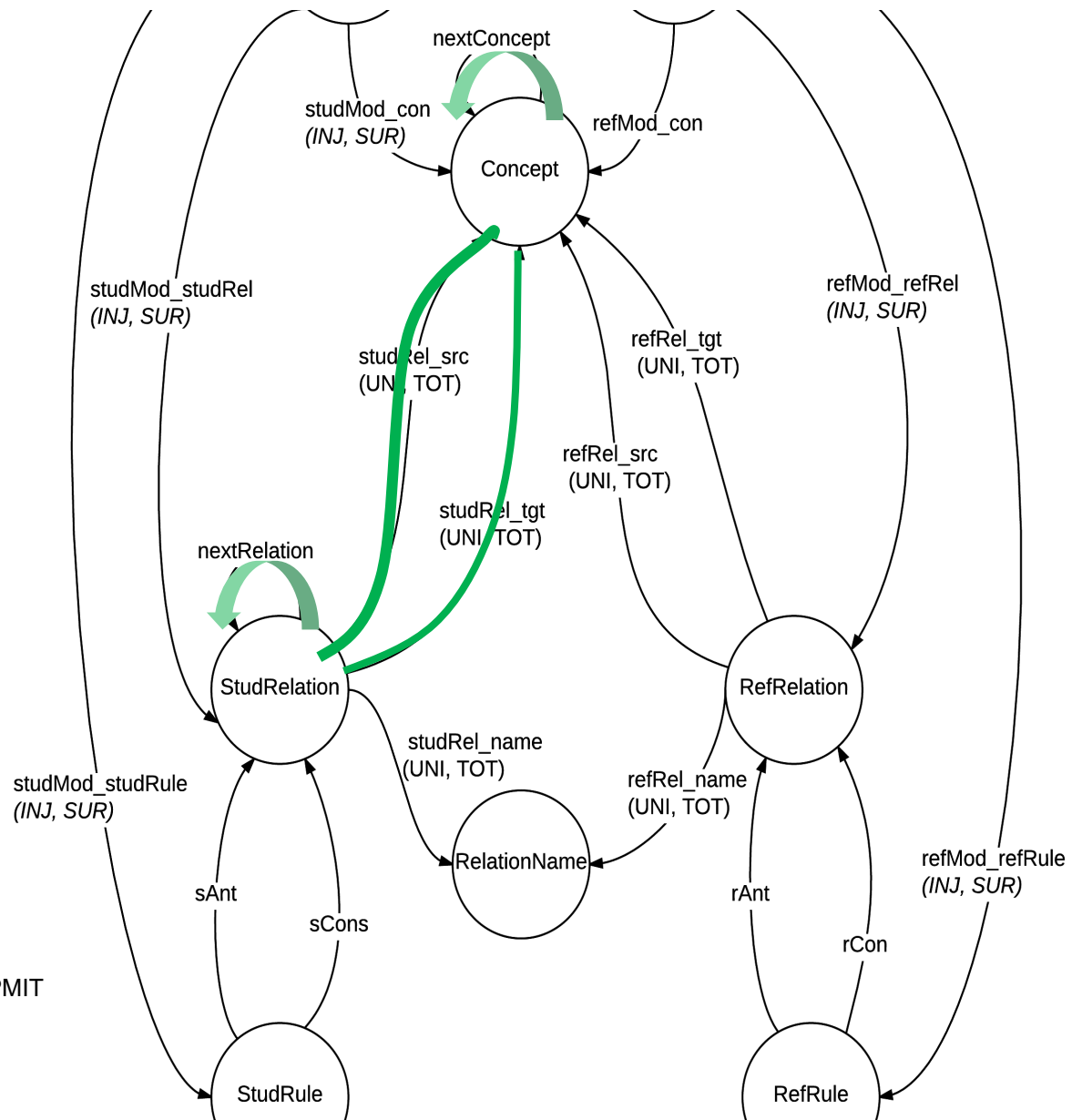


Incorrect Model k
one relation



Anoniem model (4)

Relaties
“nextRelation” en
“nextConcept”
om te kunnen tellen



⚠ Violation of rule 'Unique_sign' 2

Relation 'Relation_D' has a src-tgt combination that is used by another relation too.

Relation 'Relation_E' has a src-tgt combination that is used by another relation too.

⚠ Violation of rule 'No_endo' 1

You have defined an endorelation with concept 'Concept1'.

⚠ Violation of rule 'Flipped_sign' 2

The relation 'Relation_C' has a sign that is the flipped version of another relation.

The relation 'Relation_B' has a sign that is the flipped version of another relation.

⚠ Violation of rule 'Three_relations' 5

There should be three relations in this model.

There should be three relations in this model.

There should be three relations in this model.

There should be three relations in this model.

There should be three relations in this model.

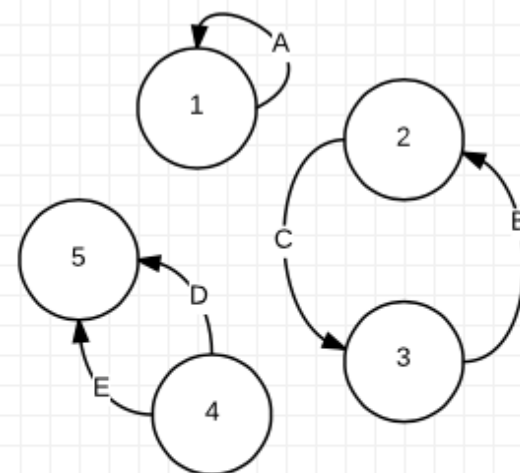
⚠ Violation of rule 'Three_concepts' 1

There should be three concepts in this model.

There should be three concepts in this model.

There should be three concepts in this model.

There should be three concepts in this model.



CONCLUSIE



Conclusie

Hoe kan relatie algebra worden gebruikt om feedback te creëren voor studenten op hun model voor bedrijfsregels?

1. Meta-model, referentiemodel en regels
2. Niet alle varianten die studenten kunnen bedenken worden herkend. Dit is gebruikelijk bij ITS-en.
3. Het meta-model kan worden uitgebreid voor meer regels.
4. Conditionele feedback is niet mogelijk.



Discussie: mogelijk, ook wenselijk?

- Bedrijfsregels om een leerproces te ondersteunen
 - Bedrijfsproces \neq leerproces
 - Scaffolding is tijdelijk, bedrijfsregels niet
- Advies: Bouw het Ampersand-ITS met Haskell
- Advies: Maak oefeningen voor class 2 en class 3
- Toekomstig onderzoek:
 - Patronen voor Ampersand modellen
 - Didactisch onderzoek: analyse van gegevens in RAP2



e.m.hageraats@saxion.nl

e.hageraats@home.nl

<http://portal.ou.nl/web/informatica>

ou.nl/informatica

