



# APPLICATION OF SKILL MAPS: AN EXAMPLE

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Group 7: Knowledge Structures Development for QHelp

15/05/2021



# INTRODUCTION: DEFINITION OF KNOWLEDGE SPACE THEORY

A mathematical theory started by **Jean-Claude Falmagne** and **Jean-Paul Doignon**, for assessing knowledge in humans with the purpose to create “an efficient machine for the assessment of knowledge”

Nowadays there are different applications that reach this purpose (as a computer program/web-based platform) .

Example: **ALEKS system**

Novelties brought by this theory:

production of numerical scores representing the **proficiency** of a student in certain topic  
Specific representation of **the amount of knowledge** obtained and still missing by the student

# COMPONENTS AND REPRESENTATIONS OF KST

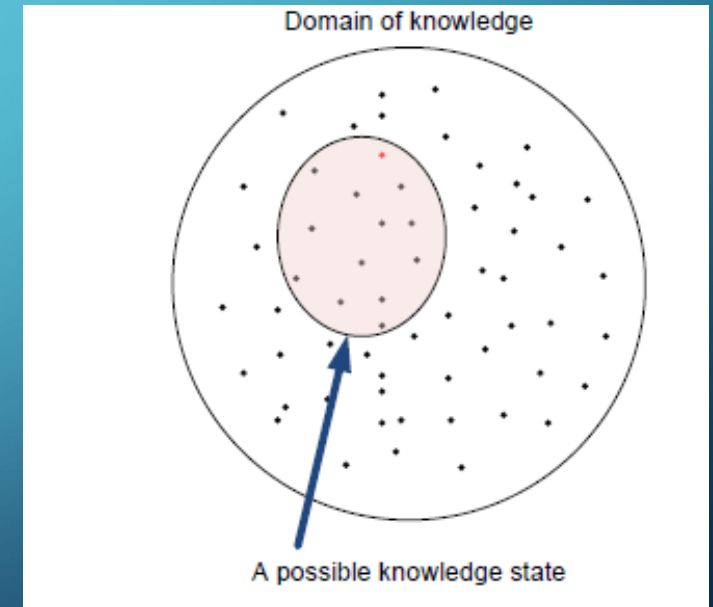
**Deterministic component:** considers discrete math theories (set theory, lattice and order theory, combinatorics) to identify plausible combinatorial structures for the representation of learning

**Probabilistic component:** considers probabilistic methods and models for empirical validation and application of deterministic models in real life

**Domain of knowledge:** a set of questions for a specific topic

**Knowledge state:** subset of questions that the student can correctly answer

**Knowledge structure:** collection of knowledge states

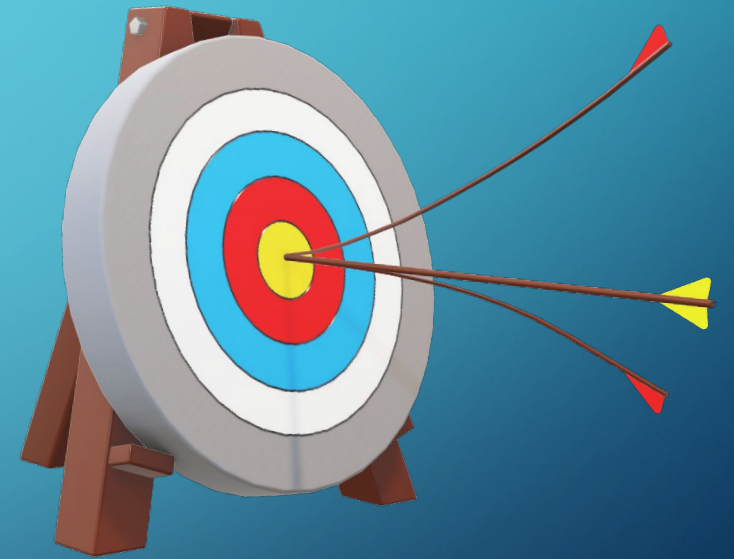




# OBJECTIVE OF THE PROJECT

Creation of a skill map regarding a specific **topic**:

- ✓ -decision of the **main facts**
- ✓ -list of the **skills/abilities** to acquire
- ✓ -creation of **items** evaluating such skills
- ✓ -online **implementation**
- ✓ -**graphical representation** of the model



# MATERIALS

## Package ‘pks’

May 26, 2019

Version 0.4-1

Date 2019-05-24

Title Probabilistic Knowledge Structures

Depends R (>= 3.0.0), stats, sets

Imports graphics

Description Fitting and testing probabilistic knowledge structures, especially the basic local independence model (BLIM, Doignon & Flamagne, 1999), using the minimum discrepancy maximum likelihood (MDML) method (Heller & Wickelmaier, 2013 <doi:10.1016/j.endm.2013.05.145>).

License GPL (>= 2)

URL <http://www.mathpsy.uni-tuebingen.de/wickelmaier>

NeedsCompilation no

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Repository CRAN

Date/Publication 2019-05-25 22:40:04 UTC

Slides of a specific topic as main reference for the exercises: **planning and analysis of interventional studies** (Module 7, **logistic regressions**, prof. Matthias Gondan)

Word file: for notes and listing of **topics** and **exercises** to include

R package: “**pks**” for combining skills and items and creating graphs of all these possible combinations

**Q-Help platform**: for the online implementation of the exercises

# METHODOLOGY

**Selection** of important facts or skills that are supposed to be acquired in order to master a specific topic: e.g regressions in this case. Creation of a **list of items** that test these identified skills

## Skills list (letters)

- a**-Know the components of a linear regression
- b**-Know the difference of each type of linear model (eg. simple regression, multiple regression, t-test for independent samples, analysis of covariance, subgroup analysis)
- c**-Know the features of logistic regression that differentiate it from linear regression
- d**-Chance (odds)
- e**-Odds ratio
- f**-Logistic regressions with R and reading outputs (eg.spss/r)
- g**-Maximum likelihood
- h**-Likelihood ratio test (Wald Test)
- i**-Propensity score matching

## Problems (numbers) and skills required to solve them.

Each problem requires a set of skills that are necessary to solve it.

- 1**-{a}
- 2**-{a, b}
- 3**-{b, c}
- 4**-{d, e}
- 5**-{c, f}
- 6**-{g, h, i}
- 7**-{d, e, h, i}
- 8**-{b, c, f}
- 9**-{e, g, h}
- 10**-{a, b, c}
- 11**-{a, b, c, d, e, g, h, i, f}

# Boolean matrix construction

A boolean matrix is constructed.

The **first column reports the skills** (a, b, c, ...) and the **following columns report the problems** (P1, P2, P3, ...).

If a cell contains the number **'1'**, that problem necessarily **requires that skill** to be solved.

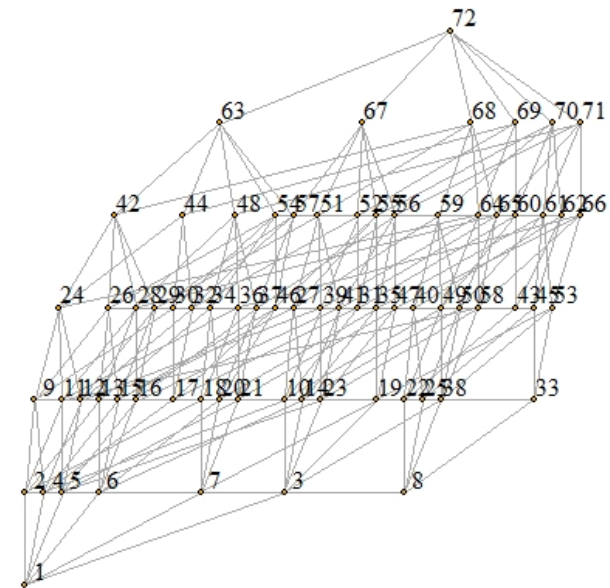
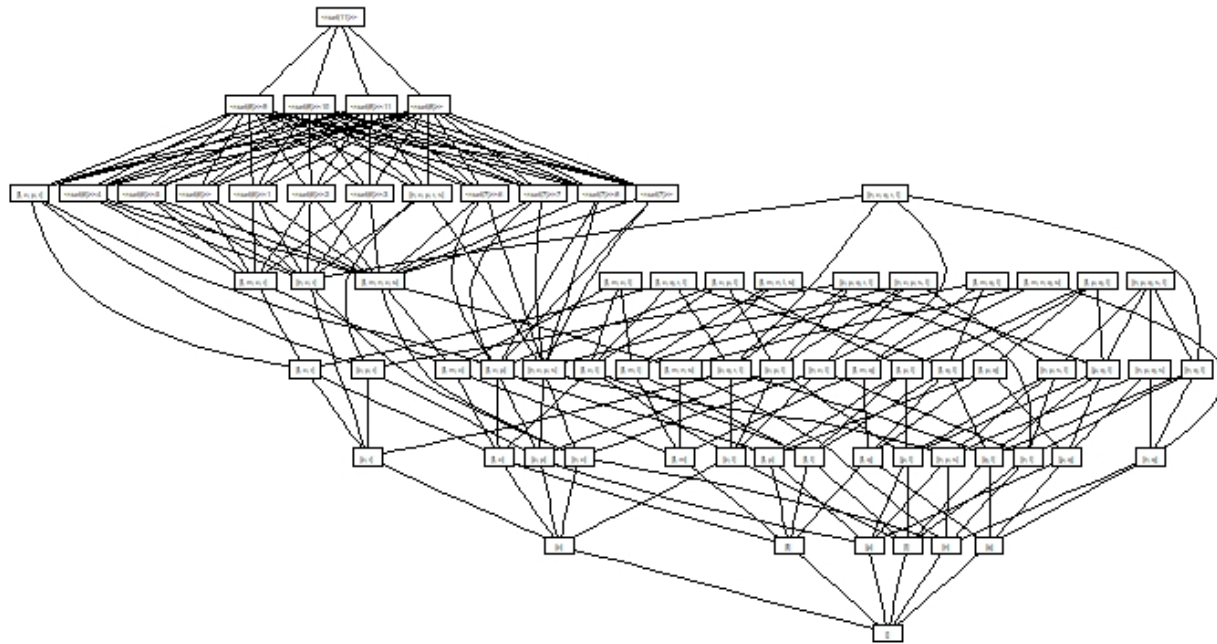
If a cell contains **'0'**, that **skill is not necessary** to solve the problem.

Skills	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	P11		
a	1	1	0	0	0	0	0	0	0	1	1		4
b	0	1	1	0	0	0	0	1	0	1	1		5
c	0	0	1	0	1	0	0	1	0	1	1		5
d	0	0	0	1	0	0	1	0	0	0	1		3
e	0	0	0	1	0	0	1	0	1	0	1		4
f	0	0	0	0	1	0	0	1	0	0	1		3
g	0	0	0	0	0	1	0	0	1	0	1		3
h	0	0	0	0	0	1	1	0	1	0	1		4
i	0	0	0	0	0	1	1	0	0	0	1		4
	1	2	2	2	2	3	4	3	2	3	9		



# Graphical representations

Partial Order





# FUTURE ASPECTS TO CONSIDER



## Population of the Q-Help platform:

Addition of **learning content** (not only evaluation material)

Implementation of **other types of questions** (e.g. more practical and interactive exercises involving the direct use of images or scripts)

**Improvement** of the Q-help platform (**more functions** and options for item editing)

**New topics** to add, blending with the teachers' material