Analysis of Laboratory
Test Requests in a University Hospital:
A Shiny App for Association Analysis as
a Demand Management Tool

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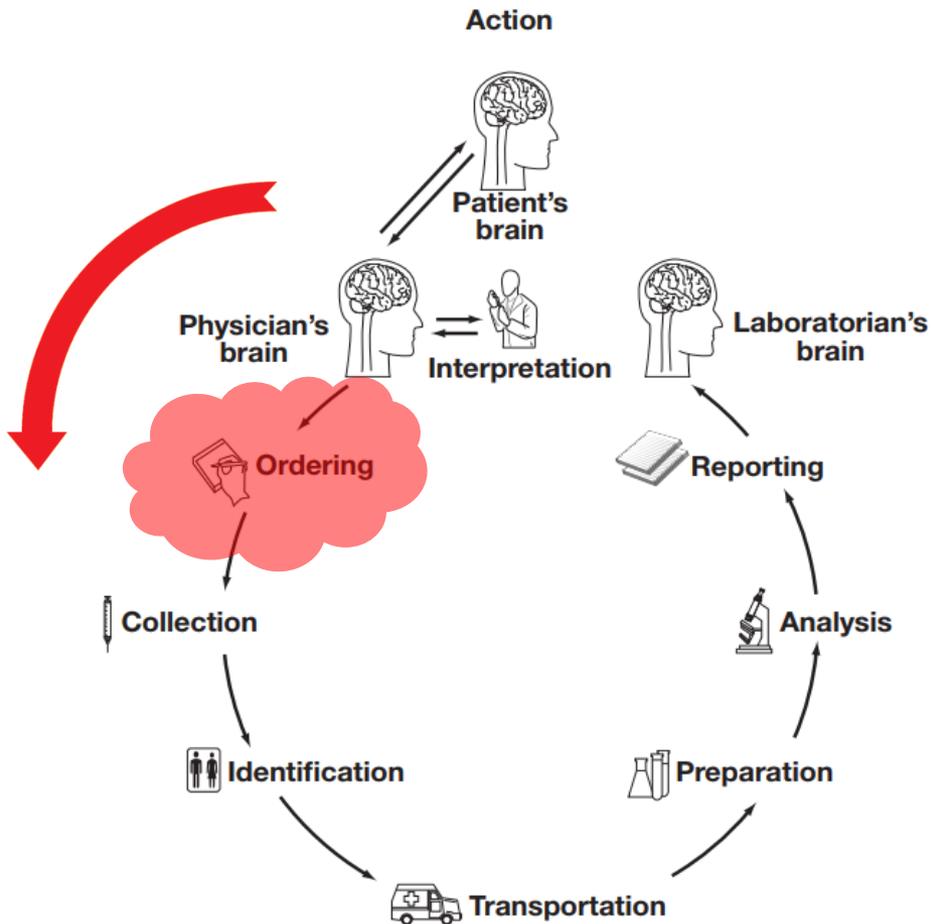
Başkent University

Resume

Primary job:

   – Biochemistry Specialist in a University

Secondary job(s):

   – R enthusiast, 4 years hands-on experience

- Statistics for academic papers
- Test, workflow data mining applications for BI
- Second **useR!** participation

   – BSc in Computer Engineering

- ISO 27001, ISO/IEC 15504 SPICE accreditation project leader
- LIS development consultant

Clinical Laboratory Workflow

Action
Patient's brain
Physician's brain
Interpretation
Ordering
Laboratorian's brain
Reporting
Collection
Analysis
Identification
Preparation
Transportation

Test Ordering

- One of the main steps in total testing process
- Main determinant of
  - Laboratory's workload
  - Cost determination

Clinical Laboratory

«Data driven» in all aspects

- Laboratory Information System (LIS)

Clinical Laboratory Workflow

Action — Patient's brain

Physician's brain — Interpretation — Laboratorian's brain

Ordering

Collection

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Analysis

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Test Ordering

- One of the main steps in total testing process
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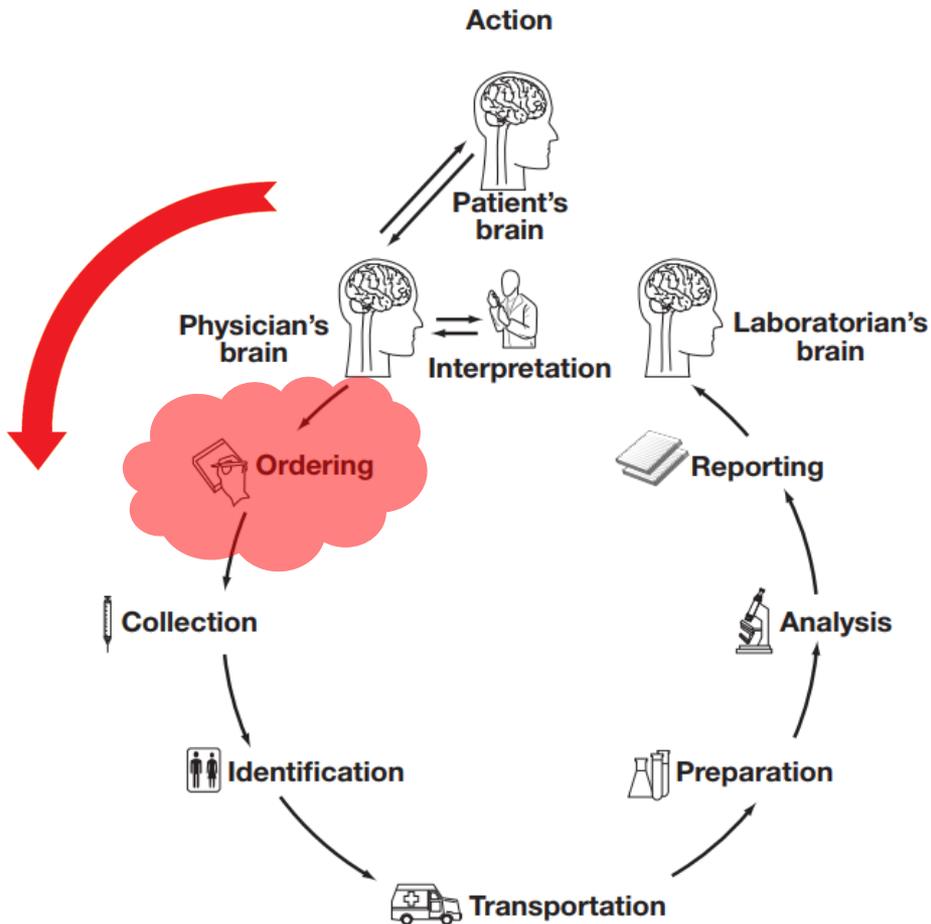 - Laboratory's workload
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Clinical Laboratory

«Data driven» in all aspects

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Demand Management

- Test utilization should be controlled:
  - **«Demand management»** plans
  - Final aim: Test request rationalization

- First step of demand management:
  - Determining common ordering «**patterns**»

Market Basket Analysis

Association Rule Mining
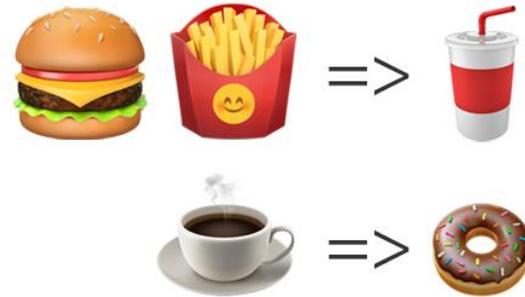
- Pattern mining
- Incredibly useful to evaluating qualitative data
- Simple to use

$$Support = \frac{frq(X,Y)}{N}$$

$$Rule: X \Rightarrow Y \qquad Confidence = \frac{frq(X,Y)}{frq(X)}$$

$$Lift = \frac{Support}{Supp(X) \times Supp(Y)}$$

Apriori Algorithm

- The earliest association rule mining algorithm

- Applied to mine big data in a variety of domains:
  - retail markets
  - medical datasets
  - e-commerce transaction data

- Problems
  - «Rare item problem»

Han, J., Pei, J., Yin, Y., & Mao, R. (2004). Data mining and knowledge discovery, 8(1), 53-87.

Our App

installed.packages()

```r
library(shiny)
library(shinydashboard)
library(shinyBS)

library(arules)
library(arulesViz)

library(visNetwork)

library(tidyverse)
```

Application

- 1 year LIS data import with **.csv**
- Standard data cleaning
- Ranking and grouping tests according to
  - Patient Demographics
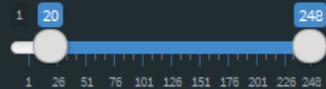 - Clinical Information
  - Test frequency

Test Order Status

	TOTAL ORDERS			TOTAL TESTS			FILTERS
	166,882			**942,477**			**Applied**

Patient Type

☑ Outpatient
☑ InPatient

Age Group

☑ Adult
☑ Infant/Child

Department

All

Test Frequency

1 — 20 —————————————— 248

1 26 51 76 101 126 151 176 201 226 248

☑ Apply filter

Rule Dashboard

Test Frequency

Advanced Settings

Support

0.01   0.5

0.01 0.11 0.21 0.31 0.41 0.5

Confidence

0.01   0.5

0.01 0.11 0.21 0.31 0.41 0.5

Generate Rules

Rules Table | Rules Graph

Show 10 entries   Search:

LHS	RHS	Sup.	Conf.	lift
Ig A (Kantitatif),Ig G (Kantitatif)	Ig M (Kantitatif)	0.013	0.988	76
Ig A (Kantitatif),Ig M (Kantitatif)	Ig G (Kantitatif)	0.013	0.997	69
Ig M (Kantitatif)	Ig G (Kantitatif)	0.013	0.994	69
Ig G (Kantitatif)	Ig M (Kantitatif)	0.013	0.891	69
Glukoz (Tokluk-Diyaliz),Ürik Asit	Bikarbonat	0.014	0.999	62
Glukoz (Tokluk-Diyaliz),Paratiroid Hormon	Bikarbonat	0.014	0.998	62
Glukoz (Tokluk-Diyaliz),Serb.Demir Bağlama Kap.(UIBC)	Bikarbonat	0.014	0.998	62
Demir,Glukoz (Tokluk-Diyaliz)	Bikarbonat	0.014	0.998	62
Ferritin,Glukoz (Tokluk-Diyaliz)	Bikarbonat	0.014	0.998	62
ALP (Alkalen Fosfataz),Glukoz (Tokluk-Diyaliz)	Bikarbonat	0.014	0.998	62

Showing 1 to 10 of 73,495 entries

Previous | 1 | 2 | 3 | 4 | 5 | … | 7350 | Next

Test Order Status

☰

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TOTAL TESTS	**942,477**
FILTERS	**Applied**

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All

Test Frequency

1 20   248

1 26 51 76 101 126 151 176 201 226 248

☑ Apply filter

Rule Dashboard

Test Frequency

Advanced Settings

Support

0.01   0.5

0.01   0.11   0.21   0.31   0.41   0.5

Confidence

0.01   0.5

0.01   0.11   0.21   0.31   0.41   0.5

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Previous 1 2 3 4 5 … 7350 Next

Test Order Status

Patient Type
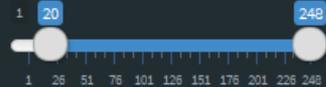- ☑ Outpatient
- ☑ InPatient

Age Group
- ☑ Adult
- ☑ Infant/Child

Department
All

Test Frequency
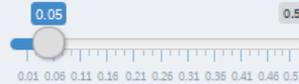
☑ Apply filter

Rule Dashboard

Test Frequency

Advanced Settings

TOTAL ORDERS
166,882
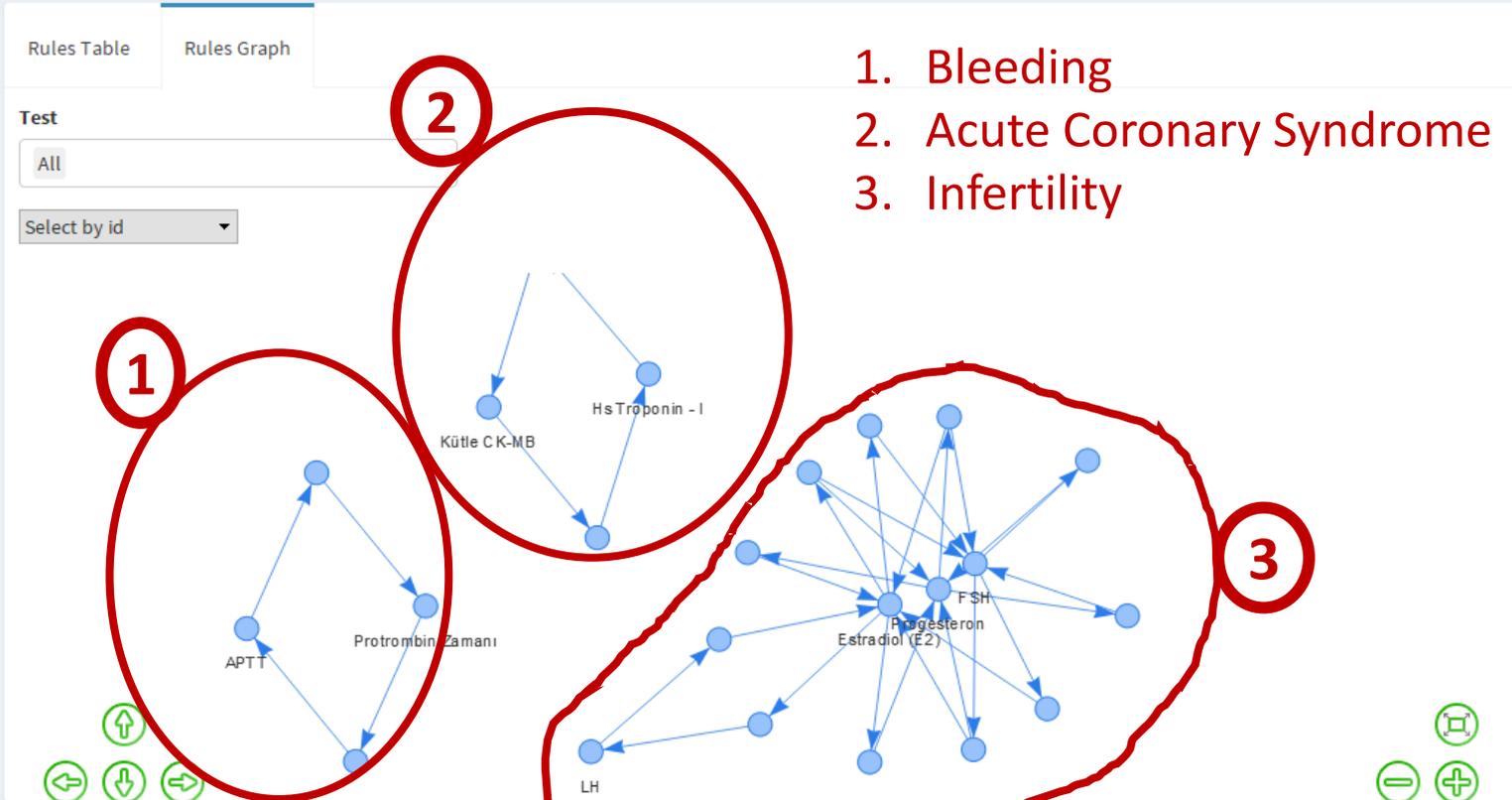
TOTAL TESTS
942,477

FILTERS
Applied

Support

0.05 — 0.5

0.01 0.06 0.11 0.16 0.21 0.26 0.31 0.36 0.41 0.46 0.5

Confidence

0.01 — 0.25 — 0.5

0.01 0.06 0.11 0.16 0.21 0.26 0.31 0.36 0.41 0.46 0.5

Generate Rules

Rules Table | Rules Graph

Test

All

Select by id

1. Bleeding
2. Acute Coronary Syndrome
3. Infertility

Kütle CK-MB · Hs Troponin - I

APTT · Protrombin Zamanı

FSH · Progesteron · Estradiol (E2) · LH

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Test Frequency

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▨ Apply filter

Rule Dashboard

Test Frequency

Advanced Settings

Test Frequency

Show 10 ▼ entries   Search: [   ]

Test	Number of Test	Frequency
Tam İdrar Analizi	53537	10
Albumin	53402	11
TSH	52458	12
Glukoz (Açlık)	52287	13
Fosfor	42695	14
ALP (Alkalen Fosfataz)	41710	15
GGT	38720	16
Magnezyum	37223	17
Total Bilirubin	36495	18
Ürik Asit	33913	19

Showing 1 to 10 of 288 entries   Previous 1 2 3 4 5 … 29 Next

Future Planning

- Multiple Support Thresholds   (**MSApriori)**

- Advanced Test Grouping

- Database Integration

- Reporting   (**Markdown)**

Conclusion

- Managing test requests is an emerging topic

- Data science tools can help laboratory medicine specialists
  - R with Shiny is effective for pattern mining

Thank You…

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