



Modular Business Processes in Hospitals

GOR Health Care Management
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Bonn

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Outline

Introduction

Method - modularization techniques

- Organisational Units Approach
- Hierarchical Clustering
- Ford Fulkerson Algorithm
- Edge Betweenness Centrality
- Graph Replacement Approach

Results

Conclusion

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Introduction

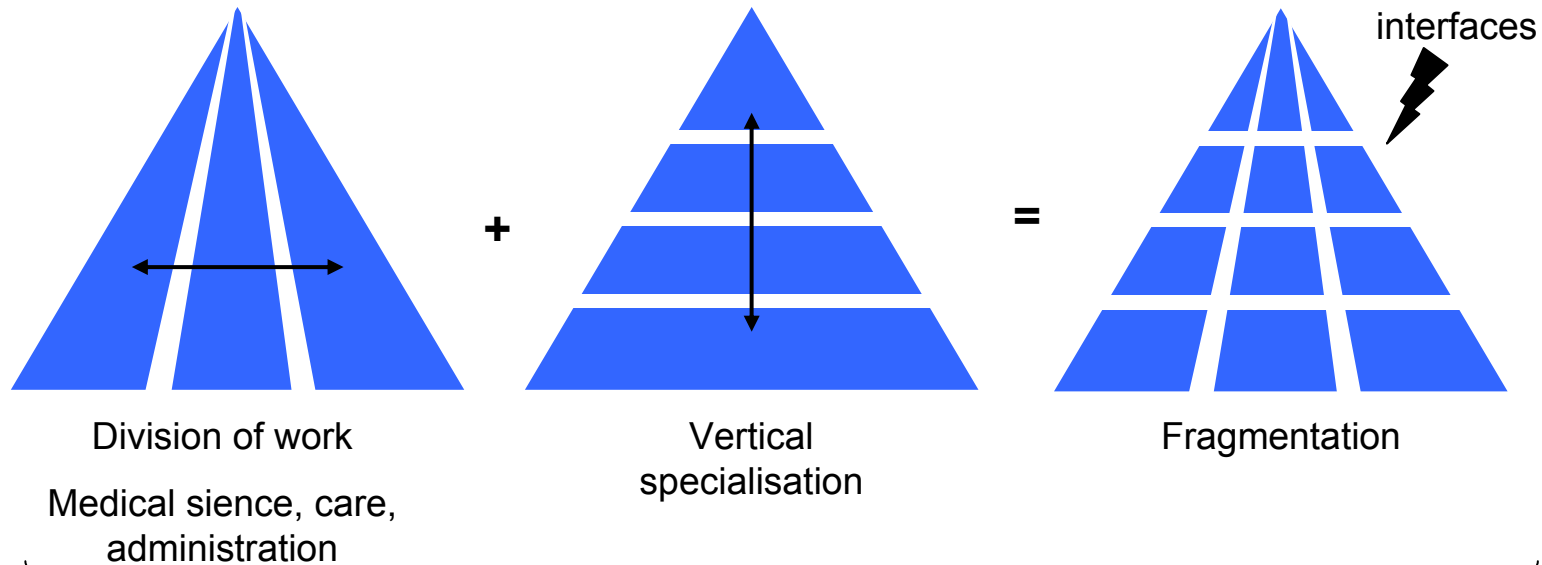
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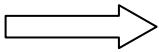
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Initial Position



- separation
- loss of information
- intransparency
- planning problems
- coordination problems



- exposure time, queue time
- duplication of work
- redundant work
- dissatisfied patient
- stressed staff

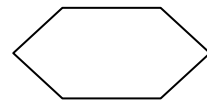
Quantitative Planning of Business Processes

Quantitative Planning of Business Processes in Hospitals

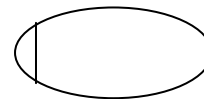
The visualization of hospital business processes as models is a basic requirement for further applications such as:

- of economic methods like monte carlo simulation,
- business process reengineering,
- critical path method, etc.

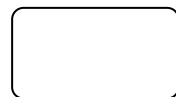
Generic objects:



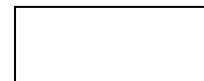
Event



Organisational unit



Activity

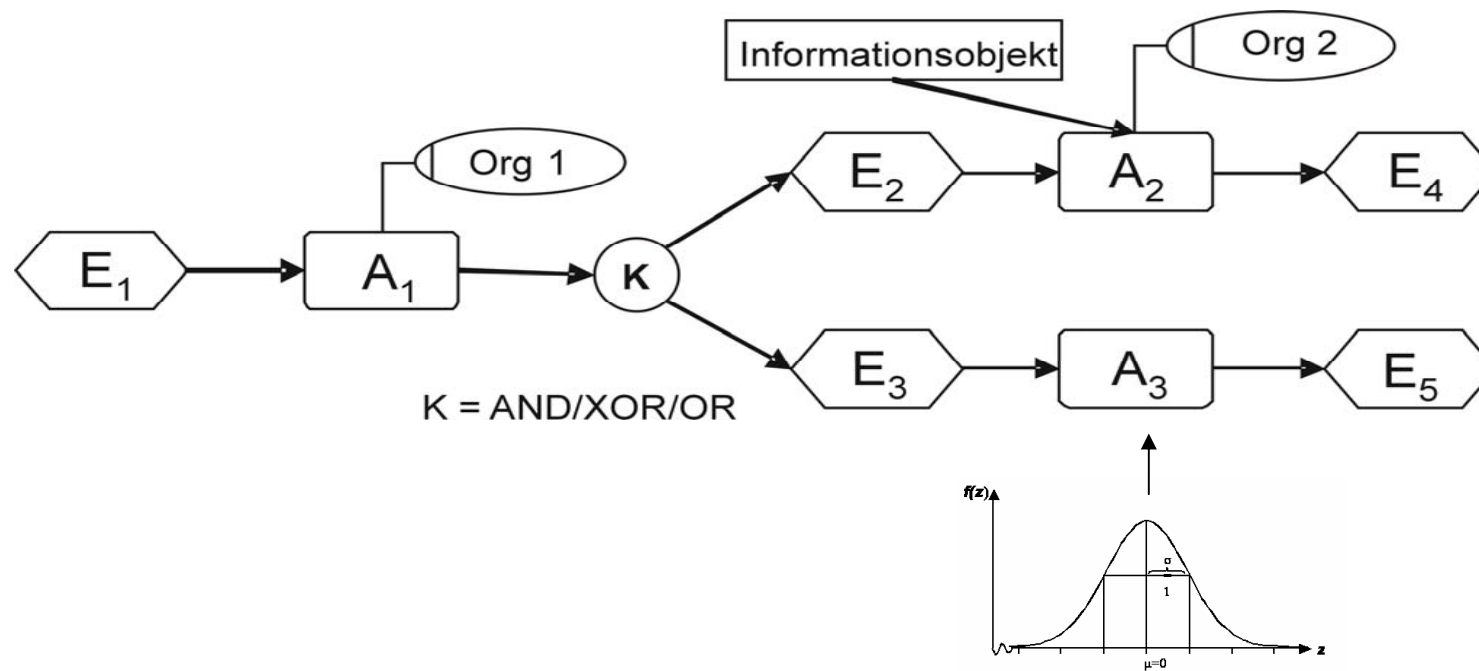


Information, Ressource,
factor of production



Operator/
Rule

Quantitative Planning of Business Processes

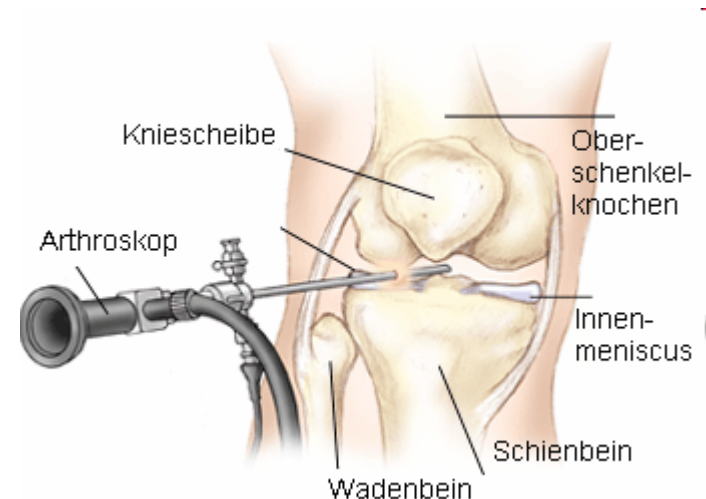


Object of Investigation / Data

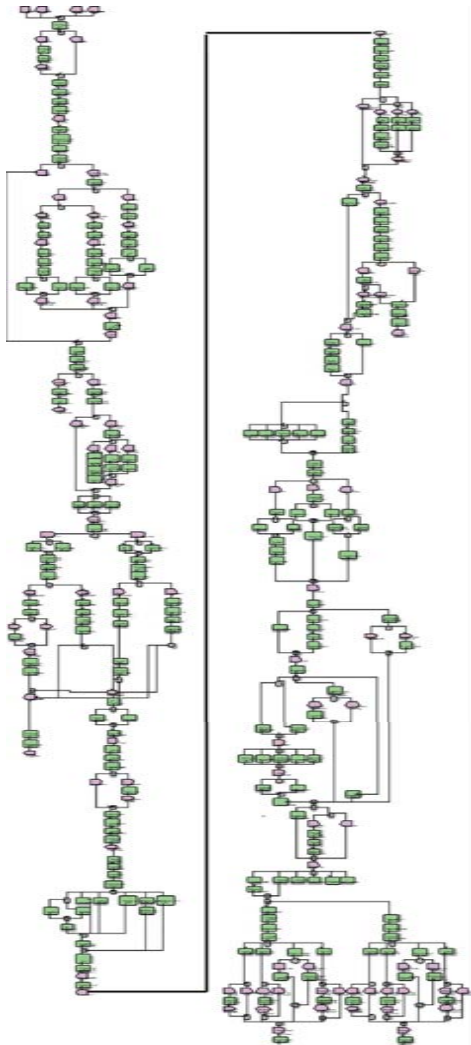
Object of investigation: Gonarthroscopy (arthroscopy of the knee)

To build the process-model we used structural data / qualitative data as well as quantitative data.

The data were collected by **measurement, observation, interviews** in the university hospital Basel, the hospital Olten and the Asana hospital Menziken.



Problems of Modelling Business Processes in Hospitals



Modelling hospital process models was not effective so far.

Potential reasons:
medical, technical and economic progress is very fast → most of the approaches were not flexible enough.

Research Purpose

Goals of this study:

This project intends to build a modular and robust hospital reference model (important basic requirement for the application of economic methods in quantitative planning of health care).



Constructing a modular business process model will lead to better overview and understanding of the processes and to reduction of the complexity.

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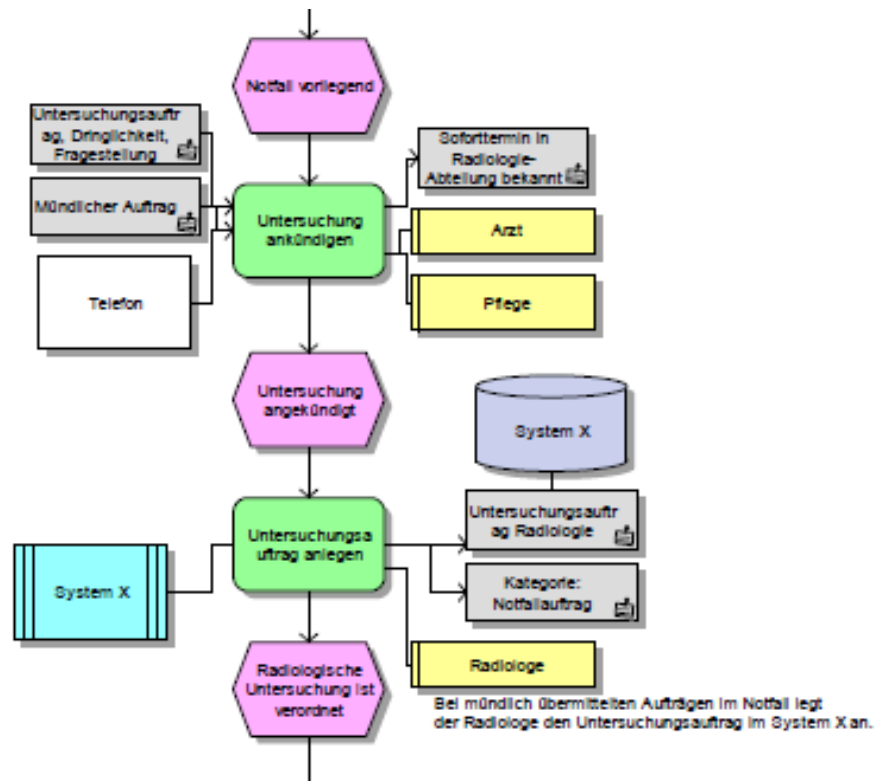
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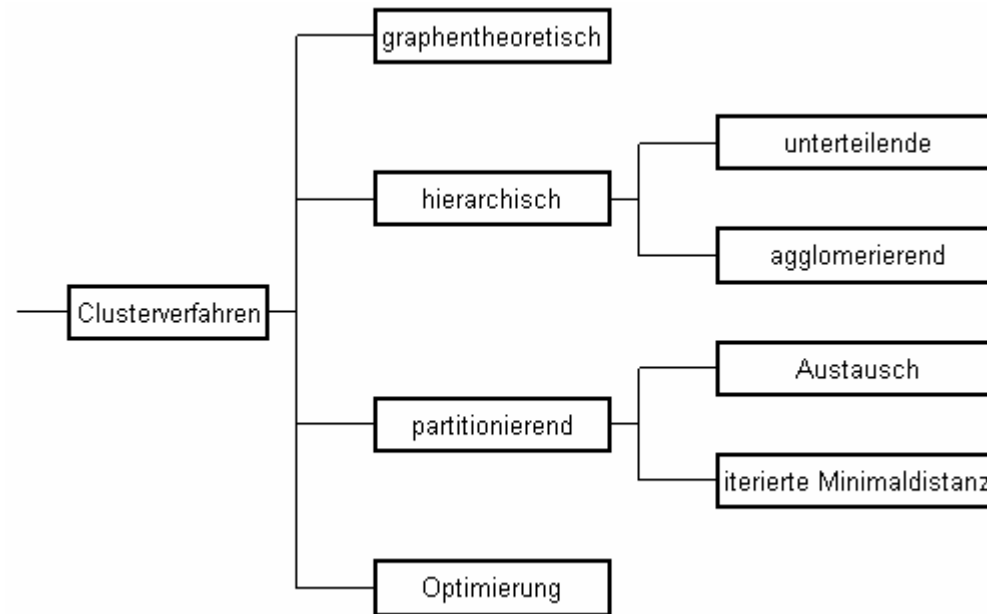
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Organisational Units Approach



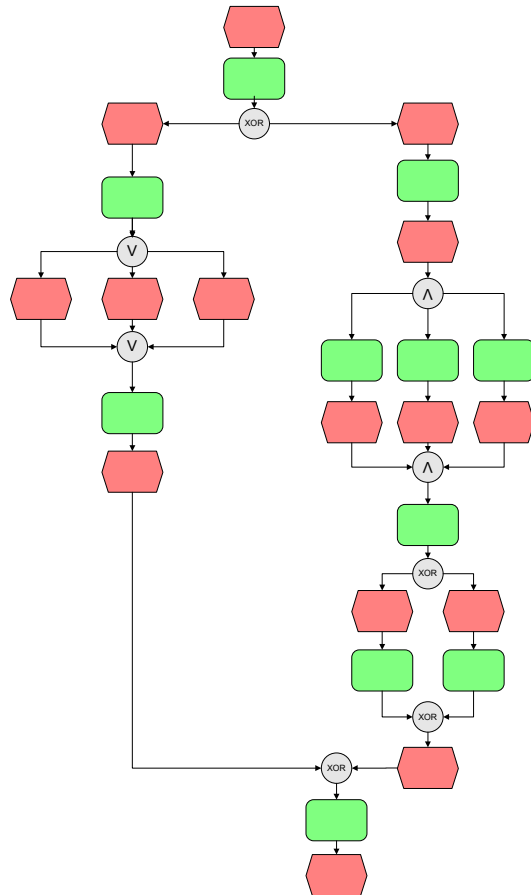
The simplest way to **divide a process into modules** is to cut at the **boundaries of organisational units**.

Hierarchical Clustering



- Single Linkage
- Complete Linkage
- Average Linkage
- Centroid
- Median
- Ward**

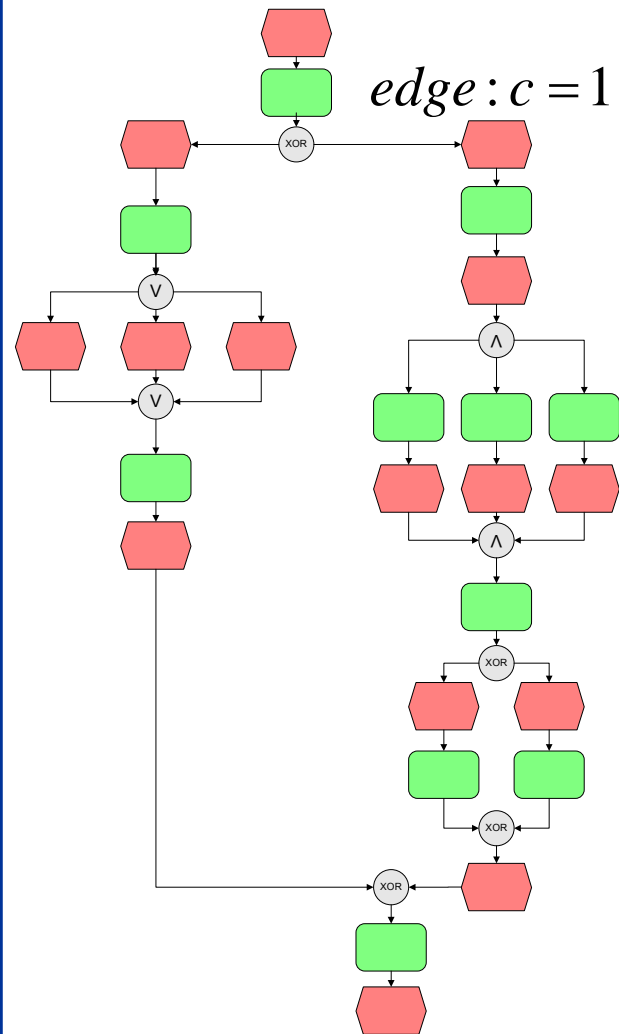
Hierarchical Clustering



distance measure matrix

	Spalte 1	Spalte 2	Spalte 3	Spalte 4	Spalte 5	Spalte 6	Spalte 7	Spalte 8	Spalte 9	Spalte 10	Spalte 11	Spalte 12	Spalte 13	Spalte 14	Spalte 15	Spalte 16	Spalte 17
1	0	1	4002	4003	7504	5504	8004	9505	9506	1003	1004	1005	1006	1007	1008	1007	1006
2	1	0	4001	4002	7503	5503	8003	9504	9505	1002	1003	1004	1005	1006	1005	1008	1005
3	4002	4001	0	1	3502	1502	4002	5503	5504	10000	10000	10000	10000	10000	10000	10000	10000
4	4003	4002	1	0	3501	1501	4001	5502	5503	10000	10000	10000	10000	10000	10000	10000	10000
5	7504	7503	3502	3501	0	0	0	3501	3502	10000	10000	10000	10000	10000	10000	10000	10000
6	5504	5503	1502	1501	0	0	0	1501	1502	10000	10000	10000	10000	10000	10000	10000	10000
7	8004	8003	4002	4001	0	0	0	4001	4002	10000	10000	10000	10000	10000	10000	10000	10000
8	9505	9504	5503	5502	3501	1501	4001	0	1	10000	10000	10000	10000	10000	10000	10000	10000
9	9506	9505	5504	5503	3502	1502	4002	1	0	10000	10000	10000	10000	10000	10000	10000	10000
10	1003	1002	10000	10000	10000	10000	10000	10000	10000	0	1	2	3	4	3	4	3
11	1004	1003	10000	10000	10000	10000	10000	10000	10000	1	0	1	2	3	2	3	2
12	1005	1004	10000	10000	10000	10000	10000	10000	10000	2	1	0	1	2	1	2	1
13	1006	1005	10000	10000	10000	10000	10000	10000	10000	3	2	1	0	1	0	1	0
14	1007	1006	10000	10000	10000	10000	10000	10000	10000	4	3	2	1	0	1	0	1
15	1008	1005	10000	10000	10000	10000	10000	10000	10000	3	2	1	0	1	0	1	0
16	1007	1006	10000	10000	10000	10000	10000	10000	10000	4	3	2	1	0	1	0	1
17	1006	1005	10000	10000	10000	10000	10000	10000	10000	3	2	1	0	1	0	1	0
18	1007	1006	10000	10000	10000	10000	10000	10000	10000	4	3	2	1	0	1	0	1
19	1008	1007	10000	10000	10000	10000	10000	10000	10000	5	4	3	2	1	2	1	2
20	2509	2508	10000	10000	10000	10000	10000	10000	10000	1506	1505	1504	1503	1502	1503	1502	1503
21	2510	2509	10000	10000	10000	10000	10000	10000	10000	1507	1506	1505	1504	1503	1504	1503	1504
22	4509	4508	10000	10000	10000	10000	10000	10000	10000	3506	3505	3504	3503	3502	3503	3502	3503
23	4510	4509	10000	10000	10000	10000	10000	10000	10000	3507	3506	3505	3504	3503	3504	3503	3504
24	6011	6010	10000	10000	10000	10000	10000	10000	10000	3008	3007	3006	3005	3004	3005	3004	3005
25	7012	7011	9505	9504	7503	5503	8003	4001	4000	4009	4008	4007	4006	4005	4006	4005	4006
26	7013	7012	9506	9505	7504	5504	8004	4002	4001	4010	4009	4008	4007	4006	4007	4006	4007

Ford Fulkerson Algorithm



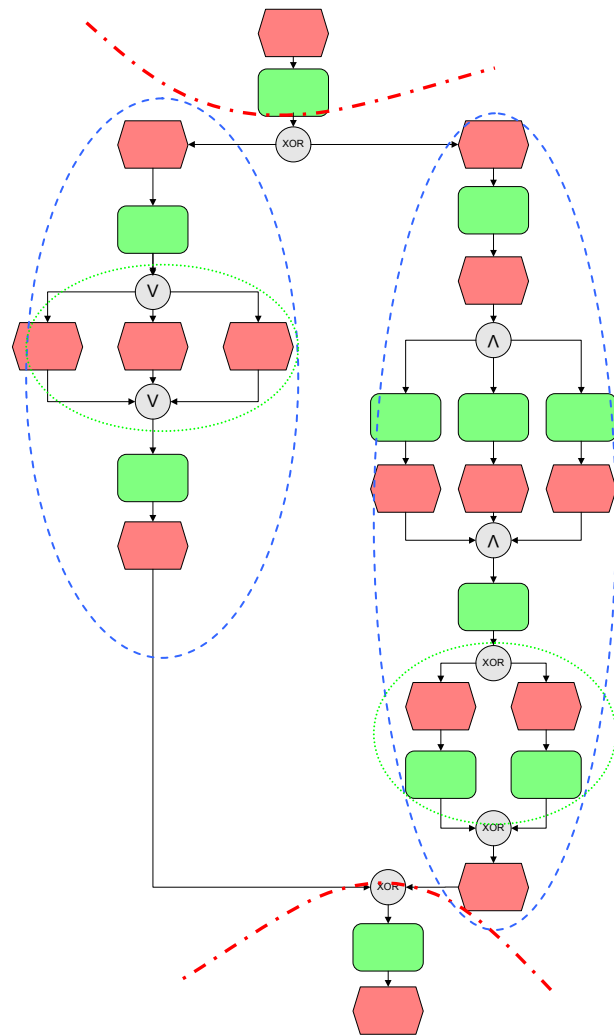
Max-Flow Min-Cut Theorem

The important duality theorem* : the value of a **maximum value network flow** is equal to the total capacity of a **minimum network cut**.

* Ford and Fulkerson (1956)

$$0 \leq f(u, v) \leq c(u, v)$$

Ford Fulkerson Algorithm



Max-Flow Min-Cut Theorem

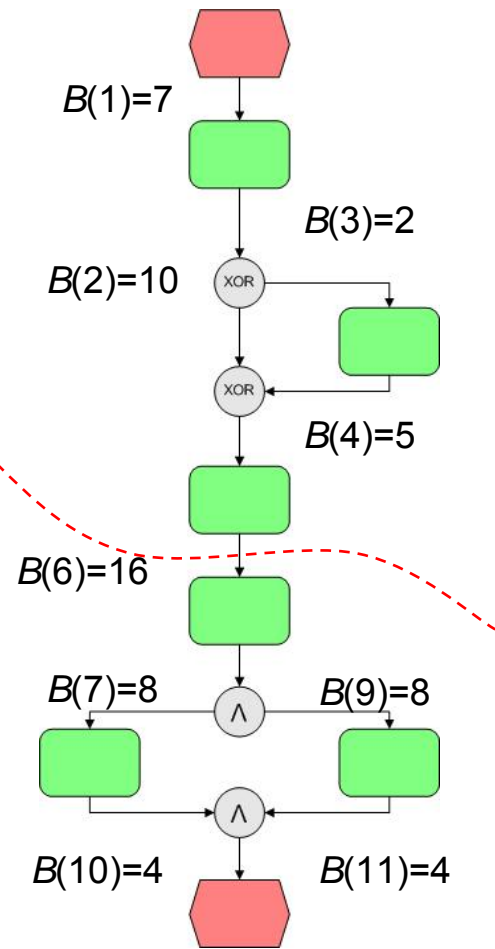
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min cut, max flow

- First step: - . - . - .
- Second step: - - - - -
- Third step:

Edge Betweenness Centrality



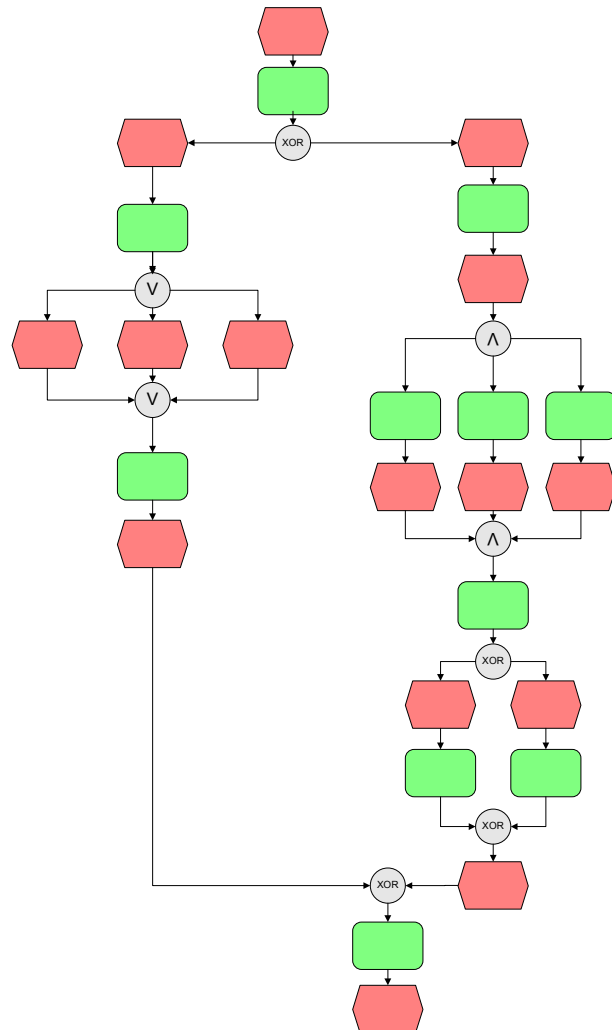
The **Girvan-Newman algorithm** (2002) = method to detect communities in complex systems.

"community structure" ~ clustering.

community = subset of nodes with dense node-node connections + less dense edges to nodes in other communities.

$$B(e) = \sum_{u,v \in V} \frac{g_e(u,v)}{g(u,v)}$$

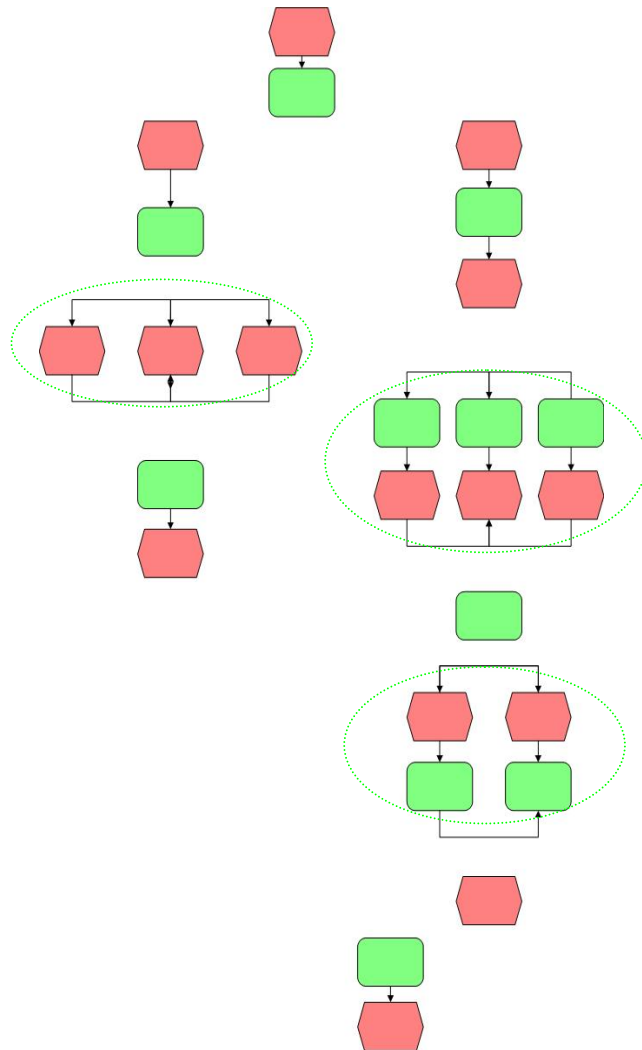
Graph Replacement



Like in syntax diagrams (railroad diagrams) for programming languages process graphs can be composed of subgraphs according to rules (Graph Replacement).

A hierarchical modularization is the result of removing all the connectors. All events/activities that are not separated by connectors, can be combined in modules.

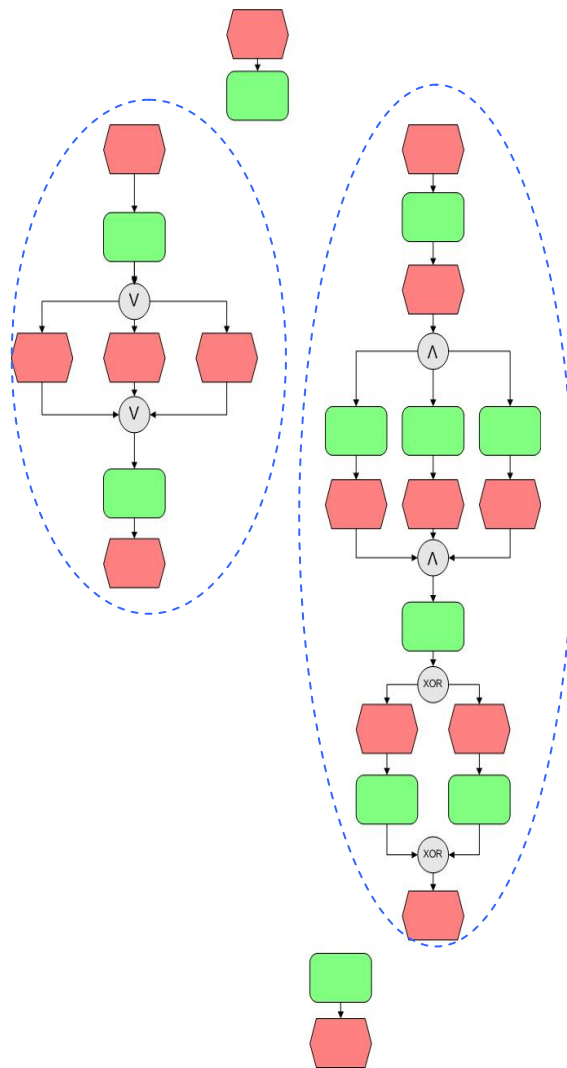
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A **hierarchical modularization** is the **result of removing all the connectors**. All events/activities that are not separated by connectors, can be combined in modules.

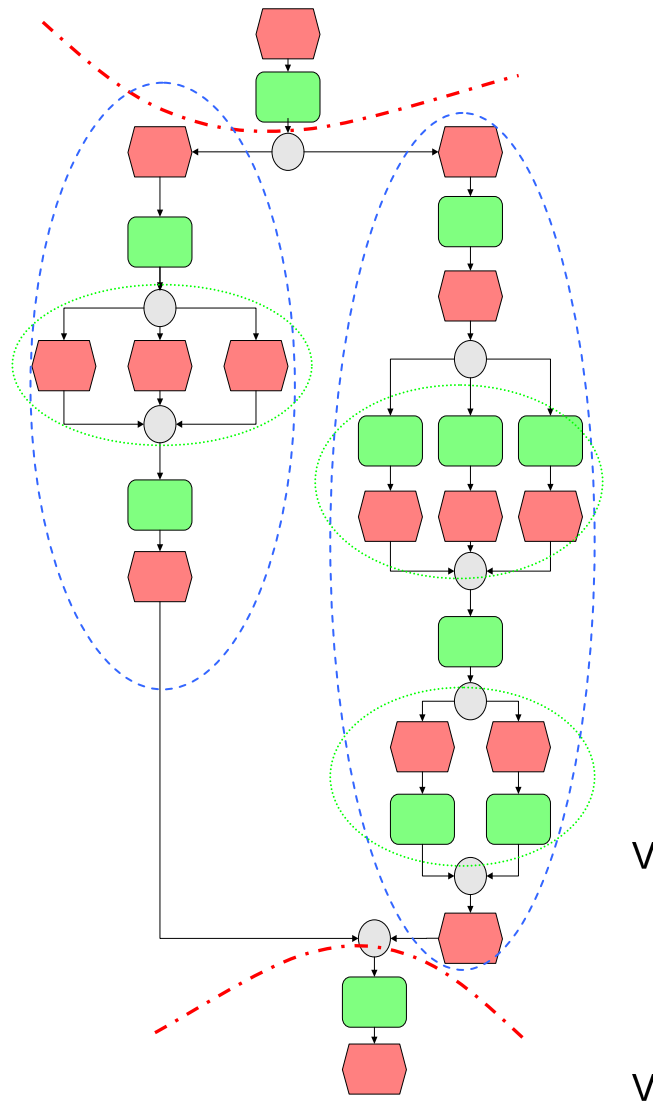
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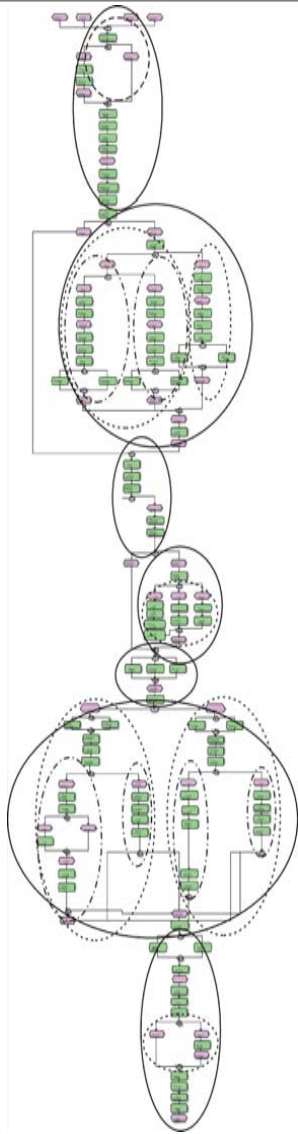
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Robustness Analysis



Robustness = ability of the modular models to keep their reliably even during future process structure changes.

For the example of the gonarthroscopy business process model changes of the last 10-15 years were analyzed (backcasting) respectively the expected changes in the next 10-15 years (forecasting) were mapped in the model

Results: Robustness Analysis

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Conclusion - Further Steps



Next we will test this modularization techniques also in business process models for hip surgery and for coronary interventions in myocardial infarction to exclude random results.

Contact

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