Business Processes Modelling

MPB (6 cfu, 295AA)

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02 - Business processes
Digression...

**Theorem**
A (connected) graph $G$ contains an **Eulerian circuit** if and only if there are no odd vertices.

**Theorem**
A (connected) graph contains an **Eulerian path** if and only if there are 0 or 2 odd vertices.
Digression...

Eu path
no Eu circuit

Eu path
no Eu circuit
Digression...

Exercises: find Eulerian path/circuits in the graphs above or prove that they cannot exist.
Digression...

A childish puzzle

Eu path
no Eu circuit

A childish puzzle
Digression...

Add a dummy arc
Digression...

Find a cycle
Digression...

Find next cycle
Digression...

Done!
Digression...

Trace the path!
Memo: Who are you?

- Enrollment number: 123456
- Bachelor degree: Comp. Sci., Pisa, IT
- MSc course of enrollment: Data Science and BI
- Subjects of interest: Data analysis, AI
Let’s start
Terminology
Terminology

Generic terms, widely applicable to different working situations and companies

We fix preferred terms when possible, but allow synonyms interchangeably

Ch.1 of Workflow Management: Models, Methods, and Systems
Ch.1 of Business Process Management: Concepts, Languages, Architectures
Process Orientation
Products

We need **products** to live our lives (food, clothing, housing, transportation, health)

Immaterial products are also frequent (e.g., credit approval, expertise, music, fun)
products are the outcome of some work: a specific task, duty, function, or assignment often being a part of some larger activity

(do people work to live or do they live to work?)
Market

We are not capable to produce all we need (or all we want, or that we are induced to want) because we are not skilled enough

Products are supplied to people via markets (distribution in exchange of money)

We buy products we cannot make ourselves
New services

Other work emerge, that would not exist (trading, banks, advertising, transportation, regulations, attorneys, insurance companies, eCommerce, eHealth, influencers, …)

There are services and products necessary to keep the organization operating (not making a direct contribution to keep us alive)
People organize specialized **work units**

Relatively autonomous divisions: they know how to do some specific product or how to provide some specific service (limited range of products, highly efficient)

Process orientation is based on a critical analysis of a concept to organize work units originally introduced by Frederick Taylor (1856-1915)
Taylorism

Aim: to improve industrial efficiency

by analysing work, the "one best way" to do it would be found (time and motion study)

Distinction between mental (planning work) and manual labor (executing work)

Detailed plans, specifying the job and how it was to be done, were to be formulated by management and communicated to the workers
Functional breakdown

Taylorism uses functional breakdown of complex work to small granularities.

Then, highly specialized work force can efficiently conduct these work units of small granularity.

Taylorism has proved successful in manufacturing and fuelled the industrial revolution (assembly lines).
Road to Taylorism

<table>
<thead>
<tr>
<th>worker's focus</th>
<th>worker's capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>entire process for all products</td>
<td>pure generalist</td>
</tr>
<tr>
<td>entire process for a single product</td>
<td>intermediate specialist</td>
</tr>
<tr>
<td>single part of a process for a single product</td>
<td>pure specialist</td>
</tr>
</tbody>
</table>

Prehistoric times | Ancient times | Middle Ages | Industrial times
Handovers

Fine-grained activities require many handovers of work in order to process a given task.

Until early nineteenth century the products were typically assembled in a few steps only, so handovers were not introducing much delays.

Moreover, tasks were of simple nature and did not require any context information on previously conducted steps.
Pitfall of Taylorism

Steps of a business process are often related to each other

Context information on the whole case is required during the process

The handovers of work cause a major problem because of that (workers required knowledge)

In the end, plain functional breakdown proved inefficient in modern business organizations that mainly process information
Complexity

Modern society is too complex for people to see how their work fits in the overall scheme (alienation can become a major social problem)

The same scheme applies to large companies: high degree of work specialization cause the big picture to be lost by employees (why do they have to do the things they are told to do?)
Process Orientation

Alienation from work can have negative effects on productivity (and human life as well!)

Companies can allow employees to know they are working for a particular customer (increase motivation, self-esteem, productivity)

Not only process orientation serves to capture the activities a company performs, but also to **study** and **improve** the **relationships** between activities
Process perspective

It is instrumental to combine multiple units of work of small granularity into work units of larger granularity to reduce the handover of work.

As a consequence, workers must have broader skills and competencies (knowledge workers must have a broad understanding of the ultimate goal of their work).

Main effect, at the organizational level, process orientation led to the characterization of high-level operations, called organizational business processes.
Organizational Structures
Organizational structure

An *organizational structure* establishes how the work, authorities and responsibilities are divided up amongst its staff *(roles and functions)*

A single person can fulfill several roles, at the same time or at different times
Most relevant forms of organizational structure

Hierarchical: structured as a “tree”
What is a “tree”

We have seen the notion of a graph (vertices + edges)

tree: a graph such that any two vertices are connected by exactly one path

or equivalently

tree: a connected acyclic graph

leaf: a vertex of degree 1

rooted tree: a tree with one distinguished vertex (the root) its edges can be implicitly oriented away from the root
A rooted tree
Most relevant forms of organizational structure

Hierarchical:
structured as a “tree”,
internal nodes are individual roles/functions,
leaves are staff or departments,
branches are authority relationships
(independent of cases)
Hierarchical structure

Legend: — Line Authority
       -- Staff Relationship
Most relevant forms of organizational structure

Matrix:
add (dynamic) functional dimension:
one row for each project

(each person can have one or more functional bosses, known as **project leaders**)
Matrix structure
Most relevant forms of organizational structure

Network:
autonomous actors collaborate
to supply products or services

(non-hierarchical structure, ad-hoc clustering,
outsourcing, dynamic joining of team members)
Network structure
Actors
Most people’s work is assigned or outsourced to them by other people: their principals (they can be company departments or firms)

We can divide principals in two forms: boss and customer

Assignments ordered by bosses are often related to work for customers
Contractors

A person who is assigned a task is called contractor
(assignments can be carried out by machines and computer applications as well as people)
Actors

An actor can be a principal or a contractor, or play both roles at the same time (contractors may redirect work to third parties)
Contract

A contract exists between a principal and a contractor about the case to be performed (deadline for completion, price to be paid)

A communication protocol can be established between a principal and a contractor to exchange information
Protocol example

Principal

Contractor

specification

quote

assignment

confirmation

order

completion
Contract tree example

Principal

Contractor Principal

Contractor

transport from A to Z

transport from A to Q

transport from A to D

transport from Q to Z

transport from D to Q
Cases and Procedures
Case

Many different types of work exist (baking bread, making furniture, design a building, collect surveys to compile a statistic)

They have in common the **case**: often one tangible thing produced or modified (bread, furniture, house, diagram) but more abstract cases are also possible (a lawsuit, an insurance claim, digital data)

**Synonyms**: work, job, product, service, item
Procedure

Working on a case is typically discrete in nature

Every case has a beginning and an end

Each case can be distinguished from any other case

Each case involves a procedure being performed: the tasks to be carried out and the conditions that determine the order of the tasks

**Synonyms**: process, project
A **task** is a logical unit of work that is carried out as a single whole
Example: Make a Pizza

1. Check ingredients
2. Check tools
3. Make the dough balls
4. Prepare toppings (while dough rises)
5. Shape dough balls into pizza
6. Top it
7. Cook it

Tasks?
Procedures?
Cases?
Knowledge

Some tasks can be performed by a computer without human intervention

Executing some tasks may require human intelligence: a judgement or a decision (a bank employee decides about a loan request)

Persons need knowledge to execute tasks (their past experience, company guidelines)
A resource is the generic name for a person, machine or group of persons or machines that is responsible for a task.
Activity

An activity is the performance of a task by a resource.

Various cases may share the same procedure, but each case may involve different activities to be carried out, depending on case attributes (one insurance claim may involve objections and another one may not).
Example: Make a Pizza

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Knowledge?
Resources?
Activities?
Example: Make a Pizza

Knowing the procedure is essential, but

Not all recipes are the same

Not all pizzas taste the same

Execution is important

Training is important
Cases vs procedures

The number of procedures in a company is (generally) finite and far smaller than the number of cases to be handled.

Example

it is easier to make one hundred skirts with the same pattern than one hundred skirts using different patterns

(off-the-rack is cheaper than made-to-measure)
Economy of scale

The cost per case falls as the number of cases increases

**Strategy**: keep the number of procedures small and make the number of cases that each can perform as high as possible
Insurance companies want to keep the number of claims as low as possible, but this is generally a factor they cannot control. They can try to keep low the number of procedures, but the risk is to make them too much complex (a unique procedure to handle all cases is possible in principle, but inefficient in practice).

**Ideal situation:**
a small number of good procedures, with a lot of cases to be handled by each of them.
Counter-examples?

What about tailor-made suits? one case per process?

What about architects and houses? each case designed from scratch?
Not so different?

Tailors and architects can exploit standard approaches for each case

Tailor process:
take customer’s measurement,
show a number of patterns,
modify the chosen pattern,
choose the fabric,
draw the pattern

Observation:
task execution can be highly dependent on cases
Process Orientation
What BPs are about

Each **product** that a company provides to the market is the outcome of a number of **tasks** to be performed.

Business processes are about activities **understanding**, **correlation**, **organization** and **improvement**.
Awareness

Process management systems support and encourage communication between employees and make their activities more controllable.

Business process reengineering is based on the understanding that rapid, radical redesign of business processes can be the road to success.
Process orientation roots (1990’s)

Seminal book advocating the radical redesign of the business process of a company (as opposed to evolutionary improvements)

A business process is a collection of activities that take one or more kinds of input and create an output that is of value to the customer

- Hammer & Champy (1993)
How vs What

The main innovation is the shift of focus on the business logic of the process (how work is done), instead of the product perspective (what is done)
Keywords

Hammer & Champy: collection, input, output
Definability

Processes must have clearly defined boundaries, input and output
Collection

Processes wrap up a collection of tasks
Process orientation roots (1990’s)

The transformation that occurs in the process should add value to the input and create an output that is more useful and effective to the recipient.

A process is a set of linked activities that take an input and transform it to create an output.

- Johansson et al. (1993)
Keywords

Hammer & Champy: collection, input, output

Johansson et al.: recipient, linked
Process orientation roots (1990’s)

Processes as structured sets of activities designed to produce a specific output for a particular market

A process is a specific ordering of work activities across time and space, with a beginning and an end.

- Davenport (1993)
More from Davenport

Unless designers or participants can agree on the way work is and should be **structured**, it will be very difficult to systematically improve, or effect innovation in, that work.

Following a structured process is generally a good thing, and there is nothing inherently slow or inefficient about acting along process lines.
Keywords

Hammer & Champy: collection, input, output

Johansson et al.: recipient, linked

Davenport: structure, ordering, time, space, begin, end
Customer

The process output has a recipient
Ordered

Process tasks are ordered according to their position in time and space
Linked

Process activities are linked along a value-added chain (order of execution)
Example

a set of tasks

\[ S = \{a, b, c, d, e, f\} \]

a precedence relation \( \sqsubseteq \)

\[ a \sqsubseteq b \sqsubseteq d \sqsubseteq f \quad a \sqsubseteq c \sqsubseteq e \sqsubseteq f \quad c \sqsubseteq d \]

Which of the following are correct execution traces?

- \( a b c d e f \)
- \( a b c e d f \)
- \( a b d c e f \)
- \( a c e b d f \)
- \( a c b e d f \)
- \( a c e f b d \)
Processes that are clearly structured are amenable to measurement in a variety of dimensions have cost, time, output quality, and customer satisfaction. When we reduce cost or increase customer satisfaction, we have bettered the process itself.
Processes also need clearly defined owners to be responsible for design and execution.

Ownership must be seen as an additional or alternative dimension of the organizational structure.

During periods of radical process change, ownership takes precedence over other organizational structures. Otherwise process owners will not have the power or legitimacy needed to implement process designs that violate organizational charts and norms.
Keywords

Hammer & Champy: collection, input, output

Johansson et al.: recipient, linked

Davenport: structure, ordering, time, space, begin, end, measurement, ownership
Measurability

The process output can be measured and evaluated
Ownership

There is one responsible for the performance and continuous improvement of the process.
Cross-functionality

A process can span several functions within and across the organizational structure
Some processes result in a product or service that is received by an organization's external customer. We call these *production* processes.

Other processes produce products that are invisible to the external customer but essential to the effective management of the business.

- Rummler & Brache (1995)
Primary process

Produce company’s products (production processes)

Customer-oriented, even if sometimes the customer is not known in advance

Generate income for the company

Examples: raw materials purchase, service sale, design and engineering, distribution
Secondary process

Support primary processes
(support processes)

Examples: machinery purchase and maintenance, personnel management (recruitment and selection, training, work appraisal, payrolls, dismissal), financial administration, marketing
Tertiary process

Direct and coordinate primary and secondary ones (managerial processes)

Fix objectives, allocated resources and preconditions for the managers of other processes

Examples: maintenance of contracts with financiers and other stakeholders
production

provide resources

support

return resources after use

resources

disposal of resources

means to buy resources

income reports

managerial

objectives, capital

performance, profit

products, services

income reports

orders, components, raw materials

provide resources

assignments, purchasing budgets

resources

means to buy resources

1, 2, 3
Standardization
The need of standard

Organizational business aspects

Information technology
Diagrammatic notation

**Visual languages** offer an important communication mean
(intuitive, universal, immediate, non-technical, no / little prior knowledge required)

Natural choice:
nodes and arrows (oriented graphs)
Standard

A predefined (small) set of shapes and lines with non-ambiguous meaning

different colors, borders, symbols can be used to assign different meaning or add some information

e.g., different arrows for different dependencies
Exercise

Invent your own diagrammatic notation to describe the following interaction protocol (choose symbols, shapes, colours carefully).

Alice wants to sell her car, Bob is interested in buying it. Alice asks some quote. Bob can accept the bargain, refuse it or make a counteroffer. Alice can accept or make a counteroffer and so on, Until either the bargain is accepted or refused.

Send your solutions to: bruni@di.unipi.it