Process Mining - 02269

Lecture 1

Introduction

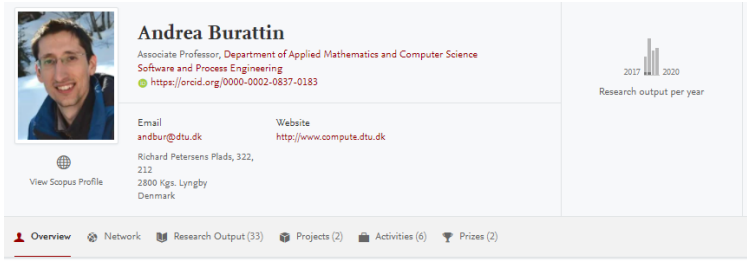
Andrea Burattin

How Microsoft Copilot depicts “Process Mining”

Who am I?

- Ph.D. at University of Bologna, Italy
- Ph.D. visitor for 6 months at TU Eindhoven, The Netherlands
- 2 years post-doc at University of Padova, Italy
- 2.5 year post-doc at University of Innsbruck, Austria
- Since July 2017 at DTU, as associate professor

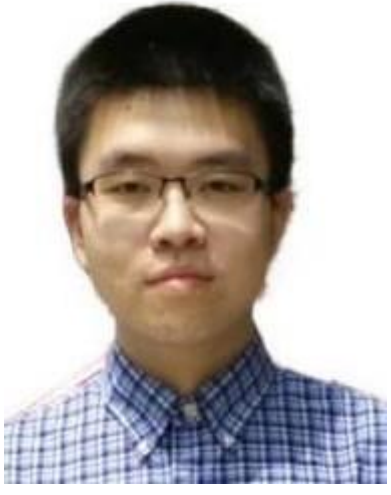
- Info
  - https://andrea.burattin.net
  - https://orbit.dtu.dk/en/persons/andrea-burattin



Who are the TAs?

- We have 3 TAs for this course

Christian Becke



Qixin *(Mark)* Ma

Gemma Di Federico

What is process mining?

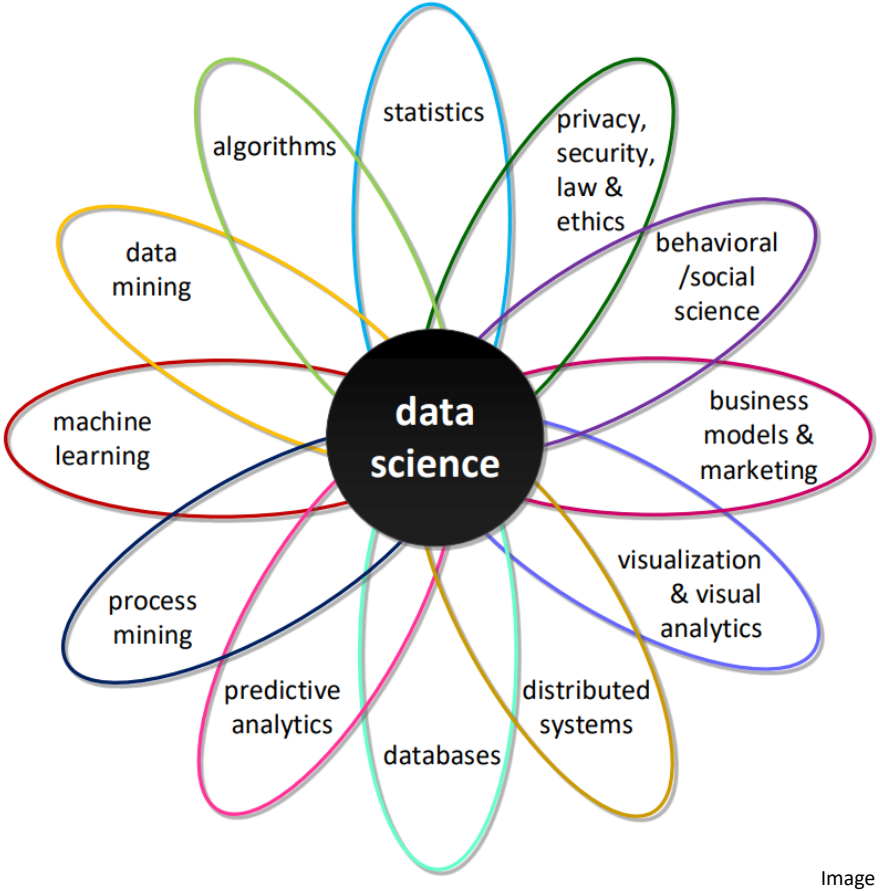


Image source and ©: Wil van der Aalst.

What is process mining?

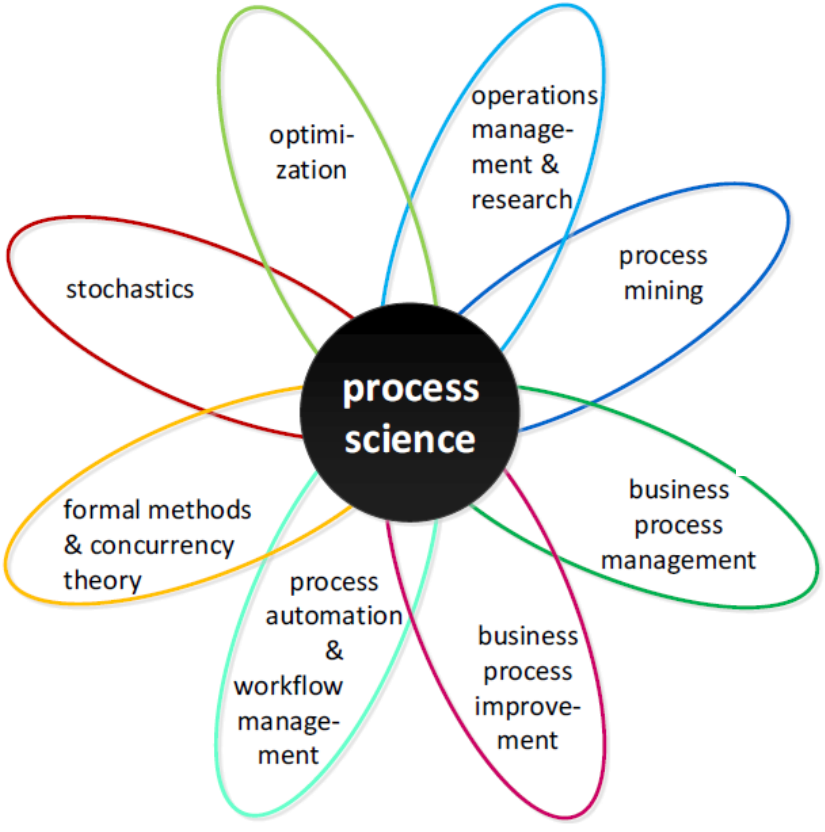


Image source and ©: Wil van der Aalst.

Process mining as the missing link

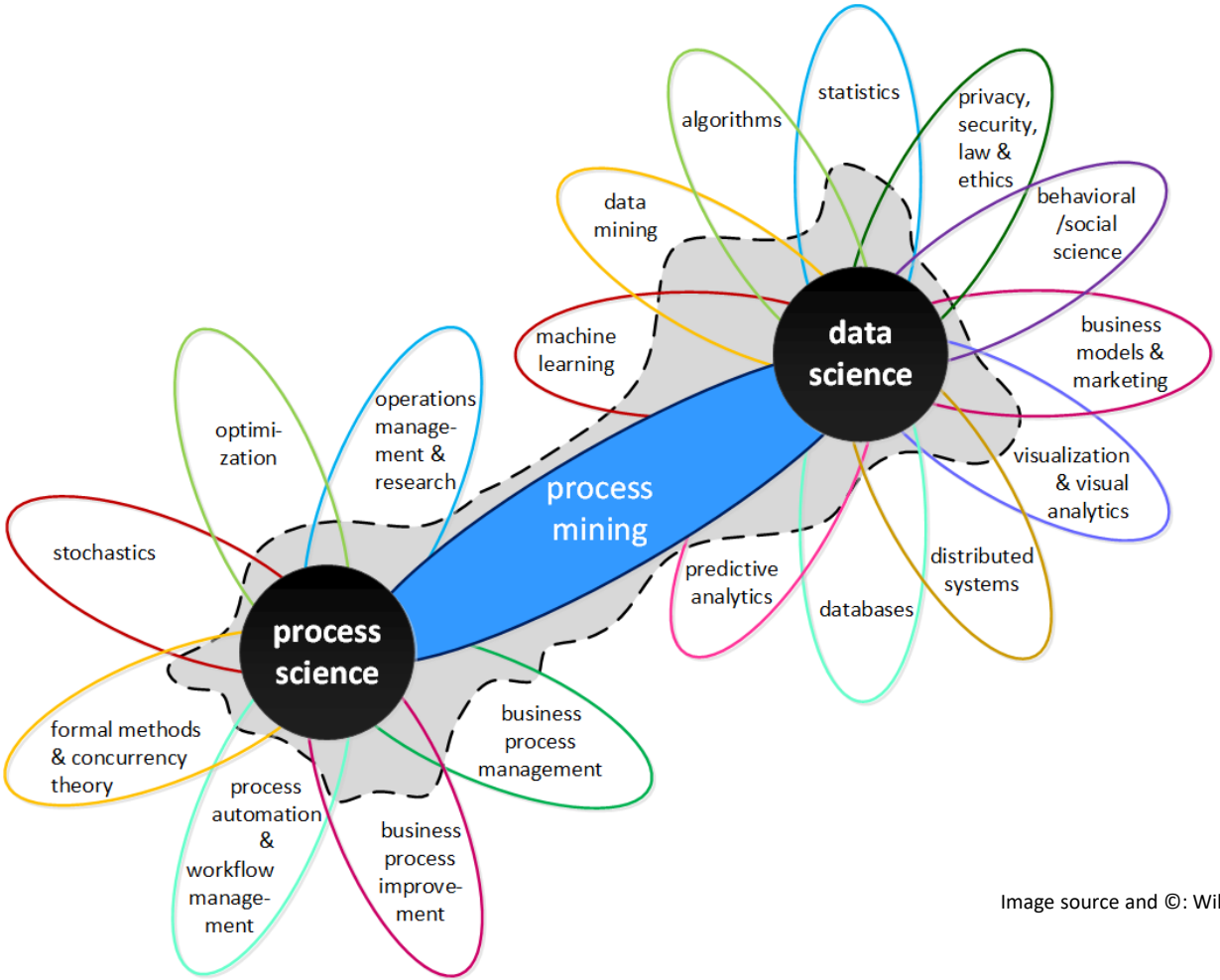


Image source and ©: Wil van der Aalst.

Process mining overview

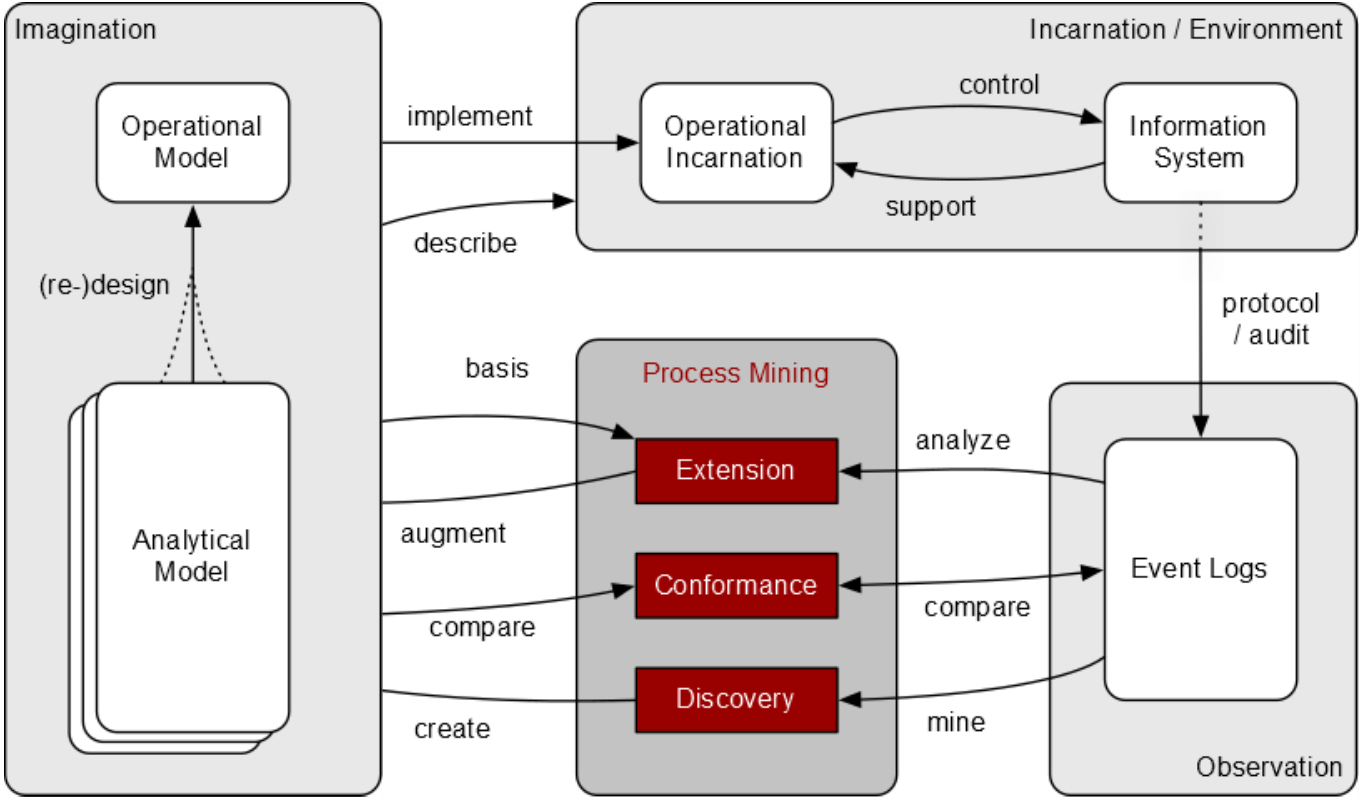
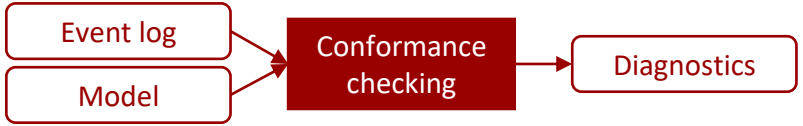


Image source: Christian W. Gűnther. *Process mining in Flexible Environments*. PhD thesis, Technische Universiteit Eindhoven, Eindhoven, 2009.

Process Mining Techniques

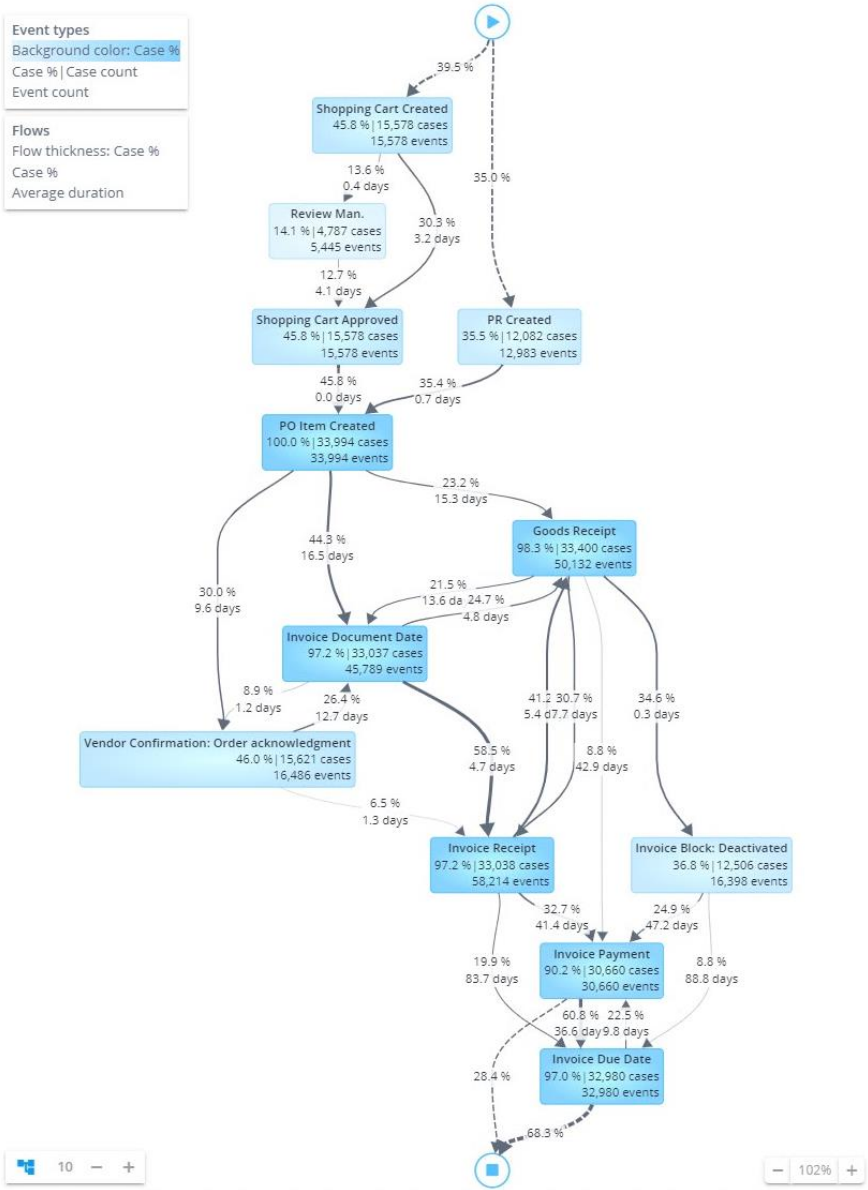
- Discovery
  - Evidence based creation of process models
  - Use information observed during operation inside an organisation
  - Usage of logs that hint at what is going on in an organisation

- Conformance checking
  - Detect discrepancies between process model and observed information
  - Analyse deviations

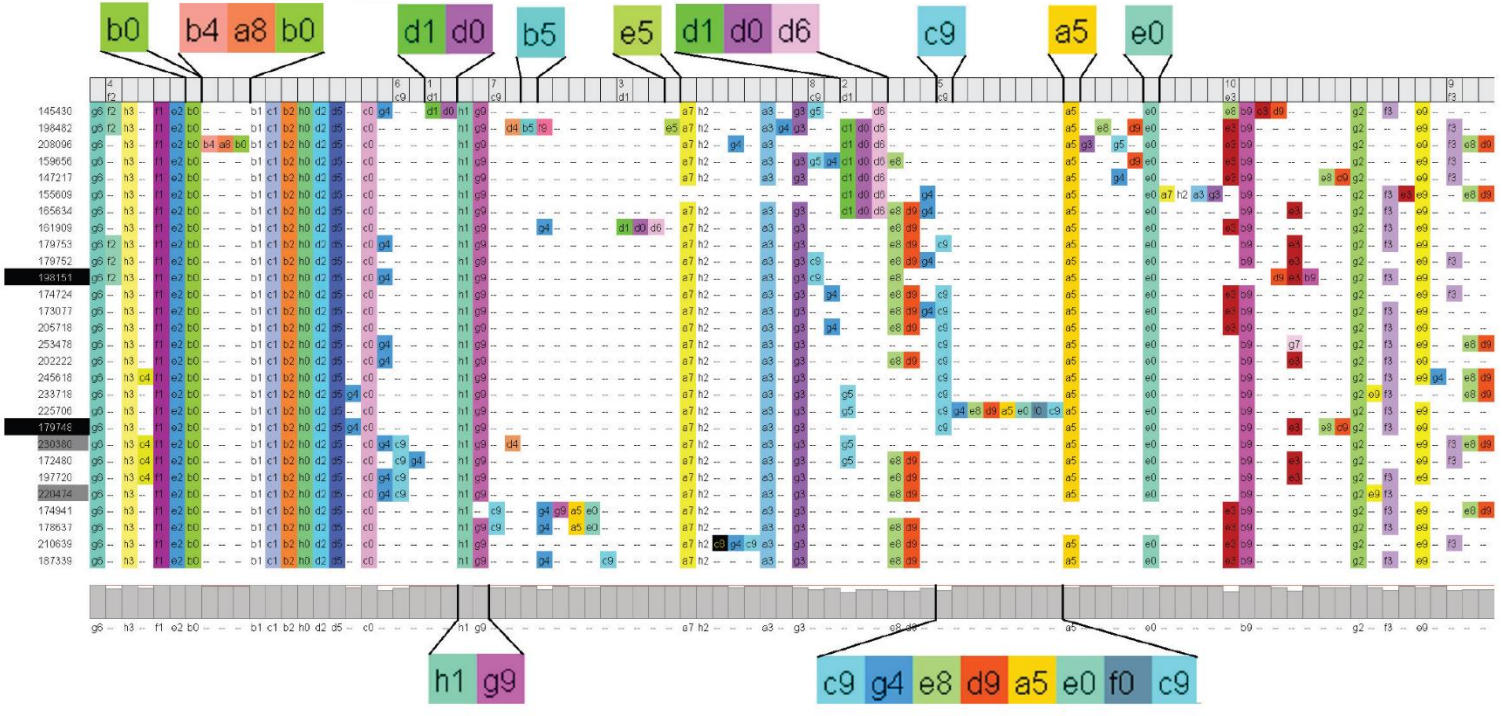


- Enhancement
  - Extend a process model with observed information
  - Example: a model is annotated with performance data

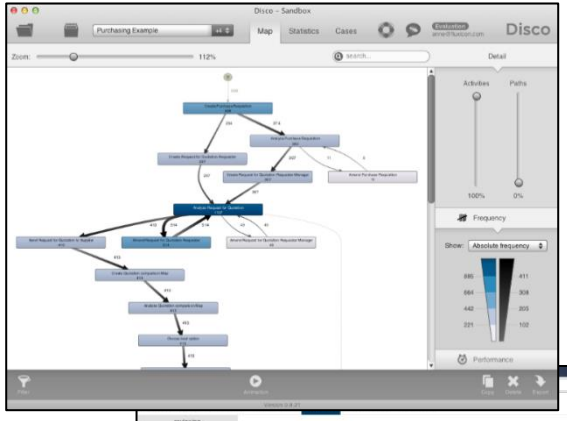
Spotlight: discovery

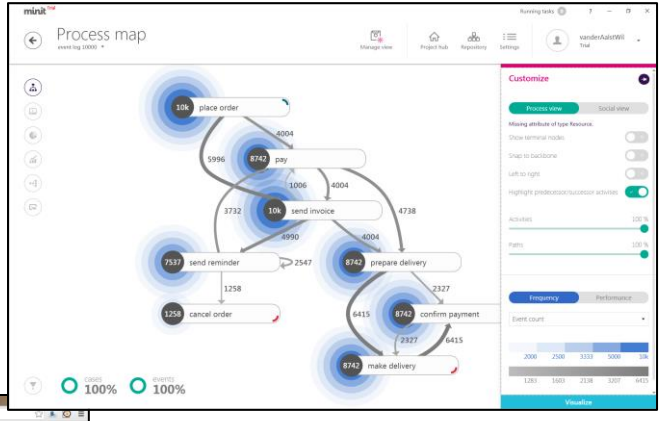


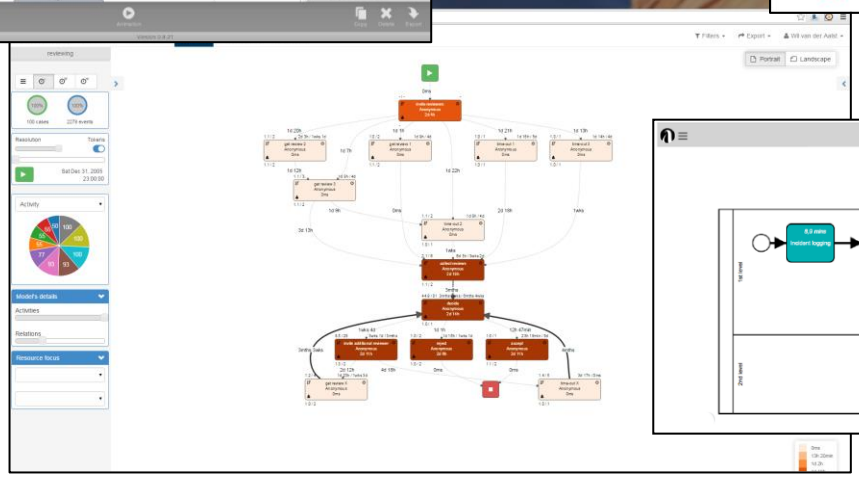
Spotlight: conformance

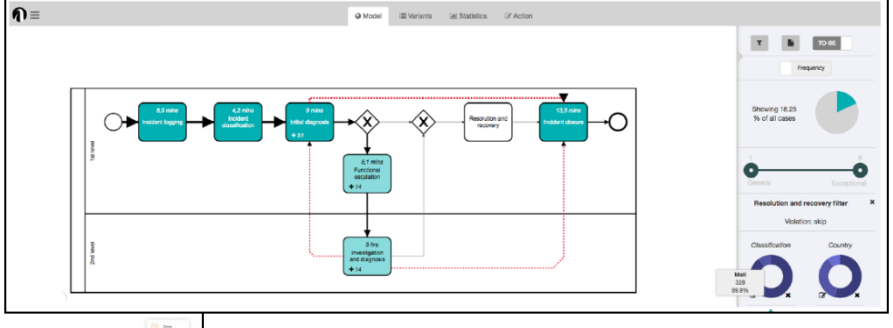


Spotlight: hands-on tutorials









Some of the tools in the process mining market

Vendor	Tool	Website	Acad. ver.
Abbyy	ABBYY Timeline	www.abbyy.com	No
Appian (Lana Labs)	LANA Process Mining	lanalabs.com	No
Apromore	Apromore Enterprise Edition	apromore.org	Yes
bupaR	bupaR	bupar.net	Yes
businessOptix	businessOptix	businessoptix.com	Yes
Celonis	Celonis EMS	celonis.com	Yes
Datricks	Datricks	datricks.com	Yes
DCR	DCR Portal	www.dcrsolutions.net	Yes
Deloitte	Process X-ray	processxray.deloitte.com	No
EverFlow	EverFlow	everflow.ai	No
Fluxicon	Disco	fluxicon.com	Yes
FortressIQ	FortressIQ	fortressiq.com	No
Fraunhofer FIT	PM4Py	pm4py.fit.fraunhofer.de	Yes
Hyland	Onbase	www.hyland.com	No
IBM (myInvenio)	myInvenio	my-invenio.com	No
Integris	Explora Process	integris.it	No
Kofax	Kofax Insight	www.kofax.com	No
livejourney	livejourney	www.livejourney.com	No
Logpickr	Logpickr Process Explorer 360	www.logpickr.com	No
Mavim	Mavim	www.mavim.co	No
Mehrwerk GmbH	MPM	mpm-processmining.com	No
Mindzie	mindzie	mindzie.com	Yes
Minit (Microsoft)	Minit	www.minit.io	Yes
Nintex UK ltd	Nintex	www.nintex.com	No
Oniq	IQ/A	www.oniq.com	No
PAFnow (Celonis)	PAFnow	pafnow.com	No
Process.science	process.science	www.process.science	No
ProcessDiamond	ProcessDiamond	processdiamond.com	Yes
ProcessM	PmBI	processm.com	Yes
Puzzle Data	ProDiscovery	www.puzzledata.com	No
QPR Software	QPR ProcessAnalyzer	www.qpr.com	No
SAP (Signavio)	SAP Signavio	www.signavio.com	Yes
Skan AI	Skan	www.skan.ai	No
Software AG	Aris	aris-process-mining.com	Yes
Soroco	Scout Platform	soroco.com	No
StereoLogic	StereoLogic Process Mining	www.stereologic.com	No
TU/e	ProM	www.promtools.org	Yes
TU/e	RapidProM	www.rapidprom.org	Yes
UI Path	UI Path Process Mining	www.uipath.com	Yes
UltimateSuite	UltimateSuite TM/RPA	www.ultimatesuite.com	No
Upflux	Upflux	upflux.net	No
Worksoft	Worksoft	www.worksoft.com	No

Process Mining tools, from *van der Aalst, W.M.P. (2022). Process Mining: A 360 Degree Overview. In: van der Aalst, W.M.P., Carmona, J. (eds) Process Mining Handbook. Springer.* https://doi.org/10.1007/978-3-031-08848-3_1

Course content

- The course will cover most aspects of process mining
  - The context of process mining
    - Process models definitions and process oriented information systems
    - Event logs and their creation
  - Process / control-flow discovery
    - Mining algorithms
    - Quality dimensions of discovered models
  - Conformance checking
    - Replay-based techniques
    - Alignment-based techniques
  - Enhancement
    - Decision mining
    - Time prediction
  - Advanced and research topics
    - Online process mining
  - Guest lecturer from company *(to be confirmed)*

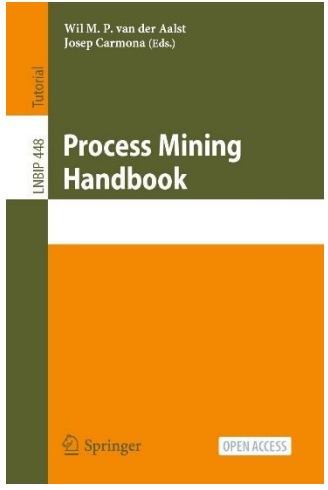
What this course is not and what is not

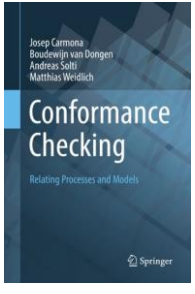
- This course is not
  - A course on formal methods in computer science
  - A course on business process modelling
  - A course on data mining
  - A course where the teacher feeds information to students

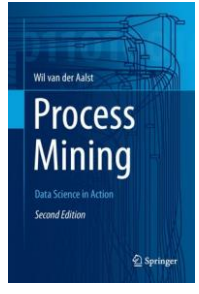
- This course is (i.e., *aims to be*)
  - A master course: students *learn*, the teacher *facilitates* the learning
  - A course where students learn by doing (take action)
  - A research-oriented course: students experience real cutting-edge research
  - An industry-aware course: students will try commercial products

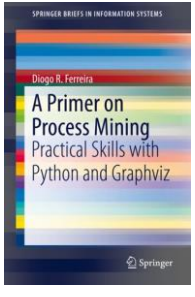
Material of the course

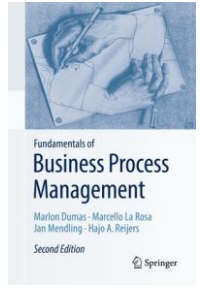
- Slides available
  - Based (with written consent to use) on Matthias Weidlich's course from Humboldt University Berlin and Wil van der Aalst from RWTH Aachen
- Books
  - "*Process Mining*" http://link.springer.com/978-3-662-49851-4
  - "*A Primer on Process Mining*" http://link.springer.com/978-3-319-56427-2
  - "*Conformance Checking*" http://link.springer.com/978-3-319-99414-7
  - "*Process Mining Handbook*" https://doi.org/10.1007/978-3-031-08848-3
  - "*Fundamentals of Business Process Management*"
- Coursera MOOC: https://www.coursera.org/learn/process-mining
- Exercises on Autolab https://autolab.compute.dtu.dk/courses/02269-E24/









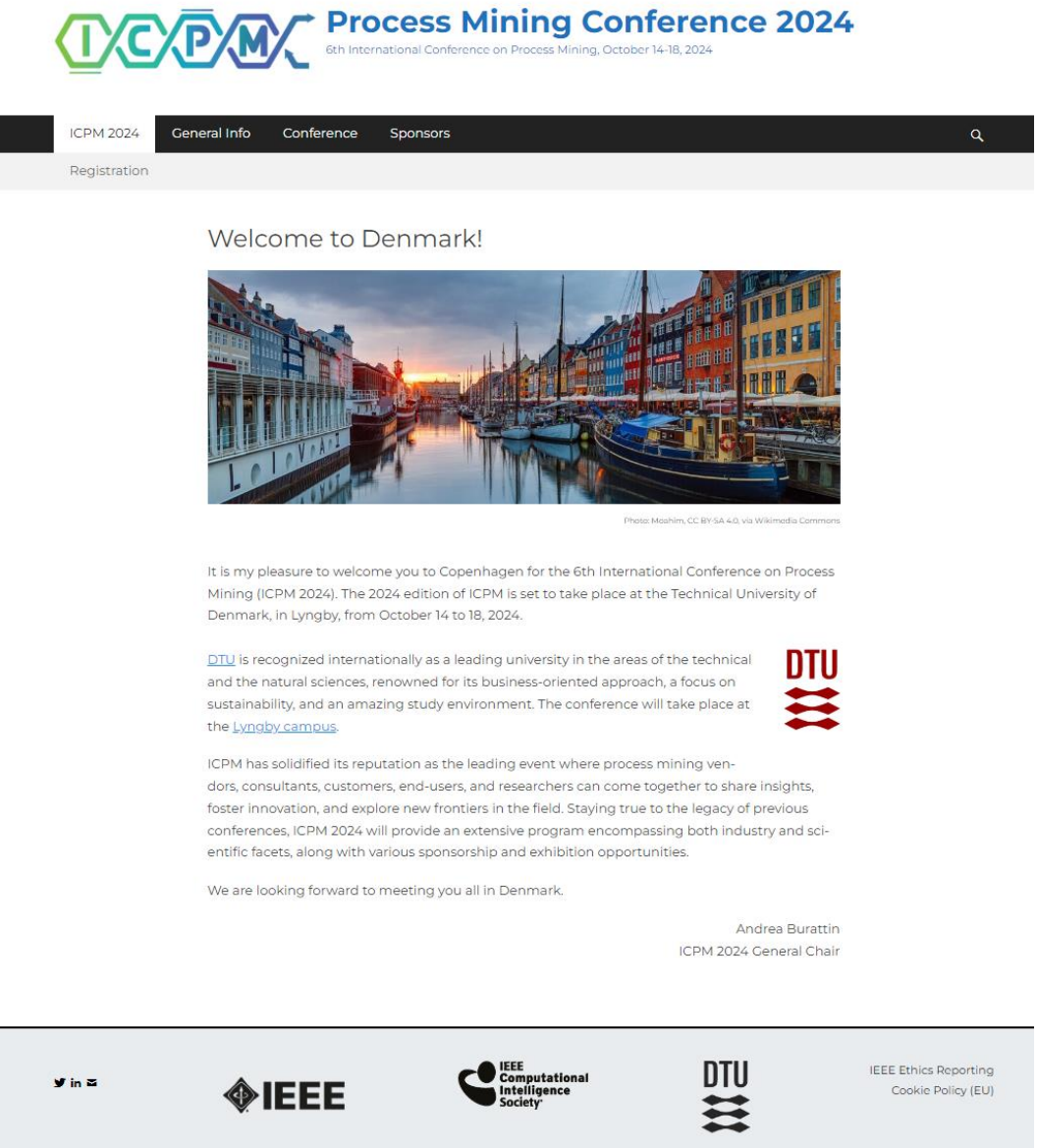


Tentative calendar

			To do **before** the lecture	Activities to do in class	
#	**Date**	**Lecture topic**	**Preparation**	**In class**	**Readings**
1	4 September	- Introduction - Behavioral formalisms - Petri nets		Course presentation Watching videos Petri net and its semantic	B1.§2-3 B4.§3 B5.§1
2	11 September	- Event logs - Alpha Miner		Discovery: dependency graph	B1.§5-6 B3.§1-2 B5.§2
3	18 September	- Heuristics Miner - Fuzzy Miner - Inductive Miner		Whiteboard exercises Discovery with Alpha Miner	B1.§7 B5.§3
4	25 September			**Projects announcement**	
5	2 October	Process Discovery		Discovery	B5.§13
6	9 October	Conformance checking		Whiteboard exercises Conformance checking	B2.§4 B2.§7 B5.§5
7	23 October	Process mining projects		Conformance checking Project work	B1.§13 B1.§14
8	30 October	Quality of models		Project work	
9	6 November			Project work	
10	13 November			**Intermediate presentations**	
11	20 November	Multi-perspective process mining		*(Guest lecture?)* Project work	
12	27 November	Research topics		Project work	
13	4 December			**Final project presentations**	

Exam information

- To pass the exam, you must pass the following:
  Individual assignments + project work in groups + individual exam
  - All individual assignments must be completed in Autolab to pass the course (pass/no pass)
  - Project work must be passed (~75% of final grade)
    - Presentation
    - Report
  - Individual (written) exam must be passed (~25% of final grade)



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Call for volunteer staff: week 42

Why should you participate?

- To witness how a top scientific conference works
- To get to know and interact with our research group
- To interact with top scientists from all over the World (all the names you'll read on papers and books of this course will be there)
- To interact with the most important Process Mining companies of the World (who are sponsoring) and their goodie bags
- Also, the students' party

If you are interested, contact me ASAP: andbur@dtu.dk

The Context

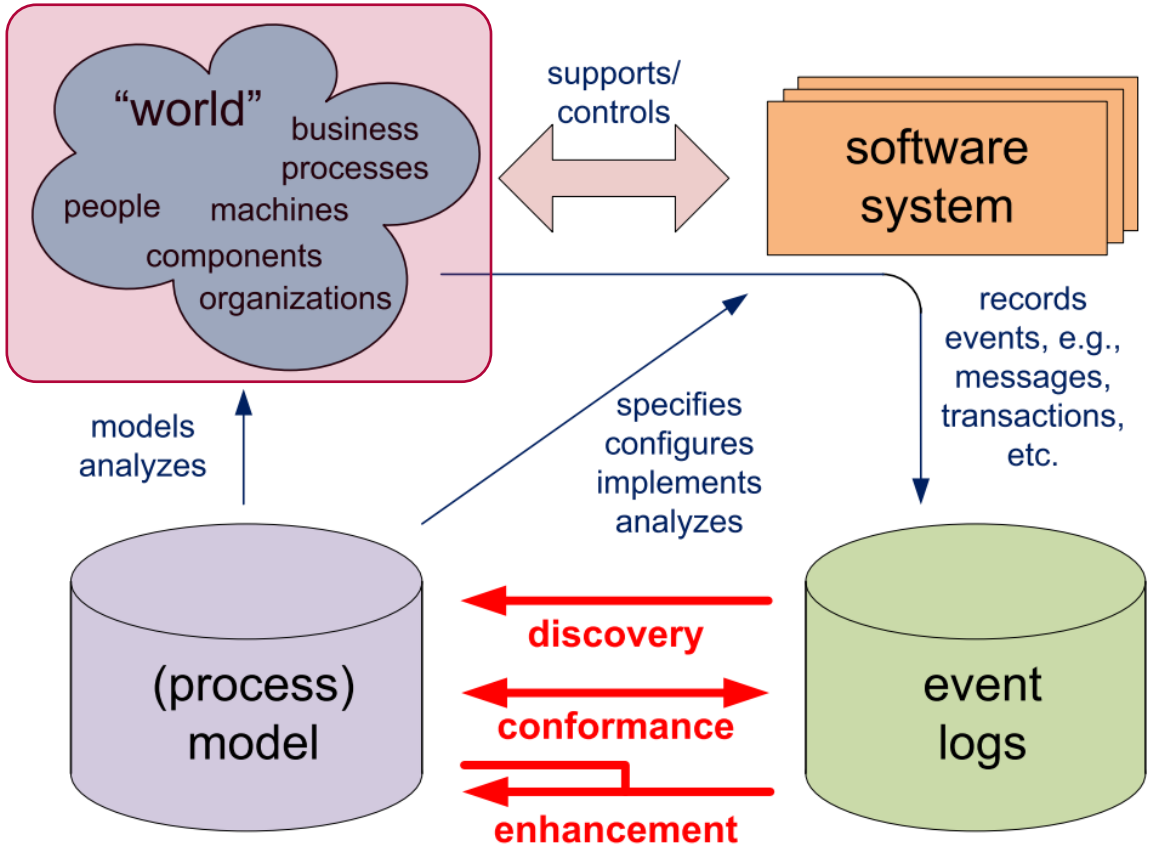


Image source: W. van der Aalst, "Process Mining", 2nd ed, Springer 2016.

Relevance of Business Processes

Business processes are everywhere

- Products and services are provided by activities
- Execution of activities requires coordination
- Success of this coordination influences costs, time, and quality of products and services

"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]

"A set of logically related tasks performed to achieve a defined business outcome for a particular customer or market"

[Davenport 1992]

Scenario: Insurance Claim Handling

- Record claim
- Check coverage
- Request proof of loss
- Do field check
- Take decision
- Inform claimant
- Compensation payment
- Archive claim

Scenario: Online Shop

- Submit order
- Check credit history
- Charge credit card
- Check availability
- Plan shipments
- Aggregate shipments
- Last mile delivery
- Record customer status

The Context

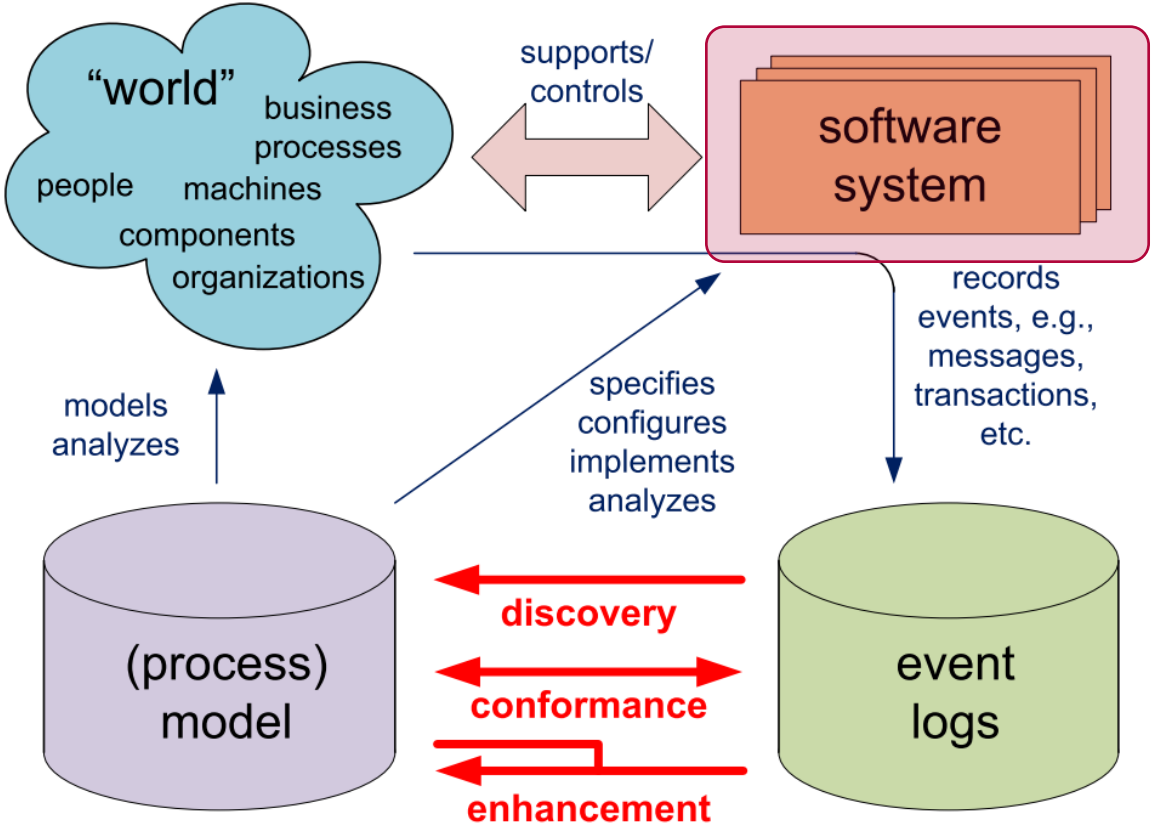


Image source: W. van der Aalst, "Process Mining", 2nd ed, Springer 2016.

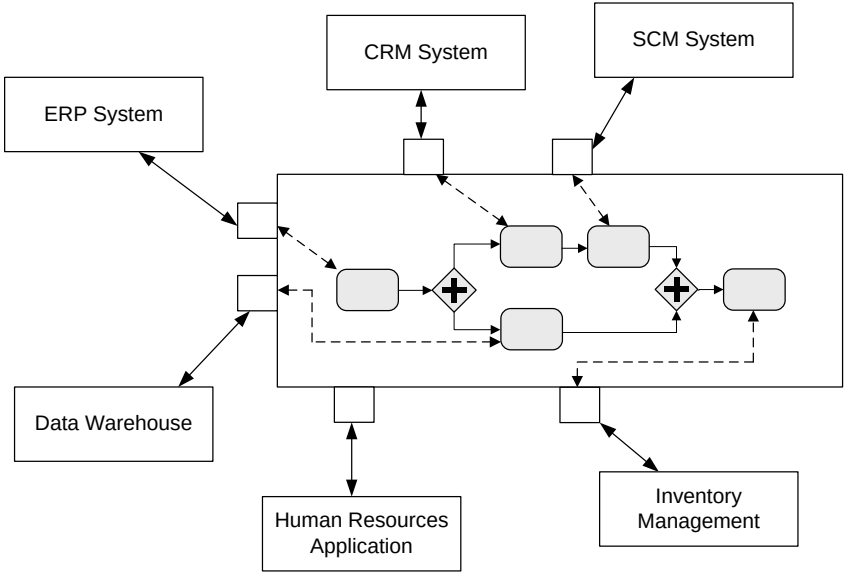
Process-oriented Information System

- Process-oriented (or *aware*) Information System (POIS / PAIS)
  - "*A generic software system that is driven by explicit process representations to coordinate the enactment of business processes*"
    [Weske 2007]

- Process-orchestration
  - "*A system acts as a central agent that controls the execution of the process activities, very similar to a conductor centrally controlling the musicians in an orchestra*"

Process-based Integration

- Integration logic is encoded in process model
- Workflow engine executes the integration process
- System activities vs. human activities



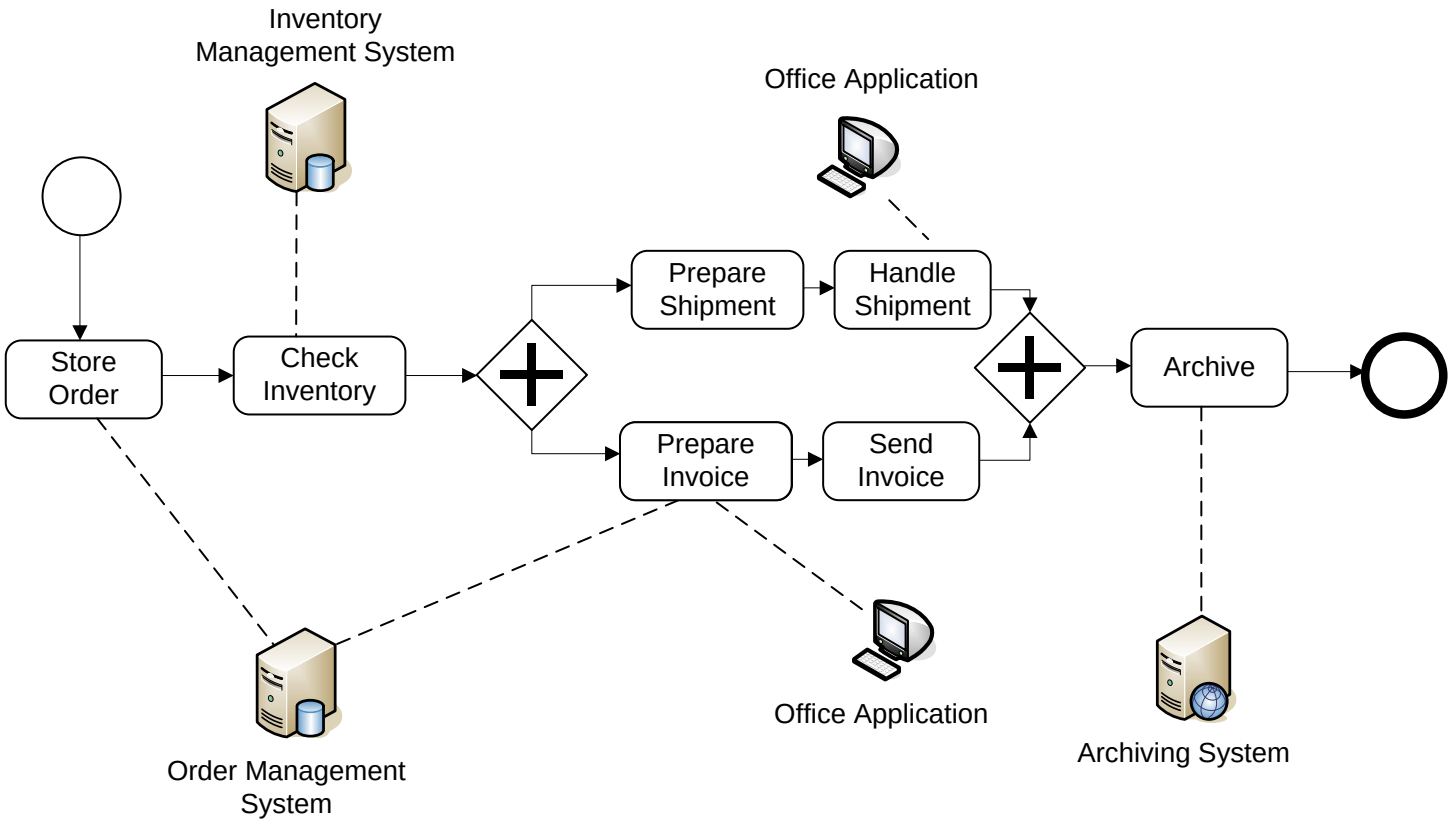
M. Weske: Business Process Management, © Springer-Verlag Berlin Heidelberg 2007

Beyond System Workflows

- Human Interaction Workflows
  - User interaction during process execution
  - Combination of manual and fully automated activities
  - Active control of process by interaction with process participants

- Human workflow systems typically also include
  - Modelling and integration of process participants (roles, capabilities)
  - Provisioning of specific interfaces (work lists)

Example of a Human Interaction Workflow



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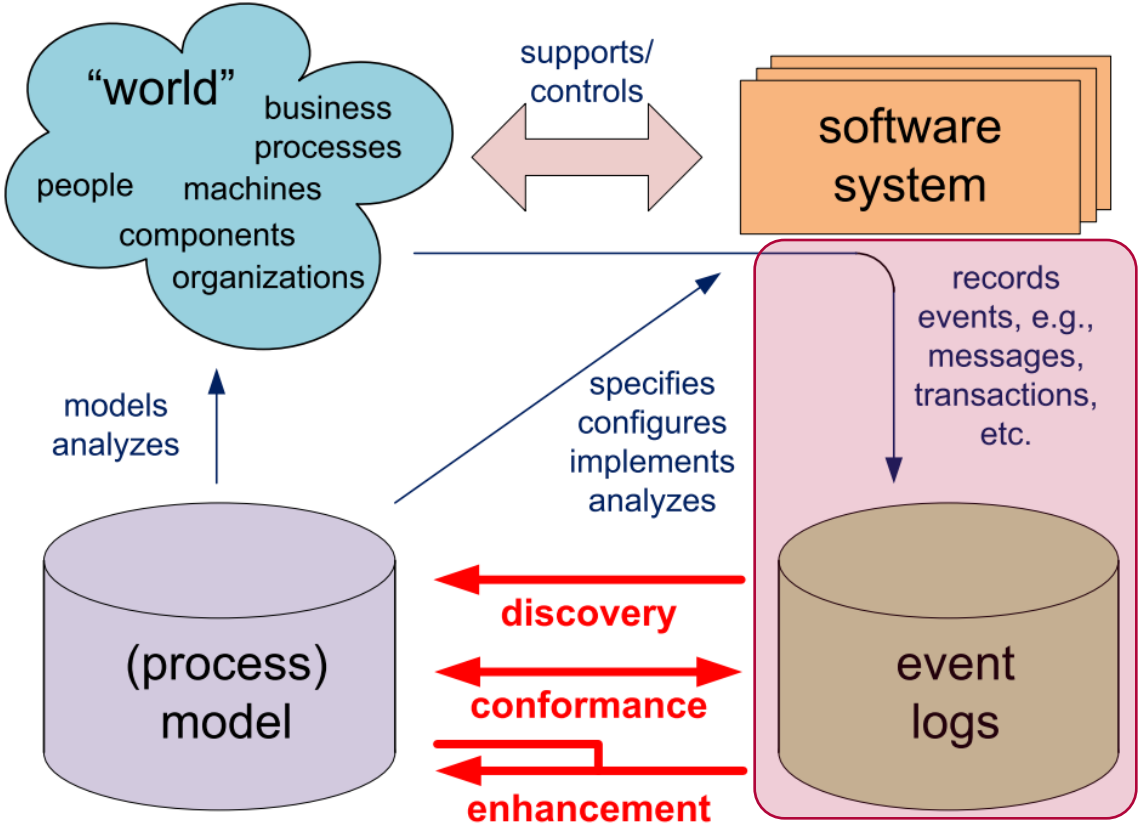

Image source: W. van der Aalst, "Process Mining", 2nd ed, Springer 2016.

Events in Everyday Life

Events in Process Mining

- Event – *happening of interest*
  - Has timestamp: occurrence time, arrival time, …
  - Carries data
  - Typical relational model based on attributes (e.g., corresponding event type, case id)

- Event type – type for events of similar structure and semantics
  - Events are *instances* of *event types*
  - Defines the set of attributes of the events

Event Logs

- Process context
  - Activity – what has been executed?
  - Time – when has it been executed?
  - Case – for which process instance has it been executed?

Case ID	Activity	Start Time	End Time	Resource
8287	Enter customer data	08:34:15	08:37:44	User jsmith
8287	Check credit	08:37:52	08:38:05	Equifax service call
1399	Enter customer data	08:37:59	08:44:40	User sjones
8287	Enter order	08:38:09	08:38:39	ERP system call
1399	Check credit	08:44:58	08:45:06	Equifax service call
4283	Enter order	08:45:01	08:45:35	ERP system call
1399	Enter order	08:45:18	08:45:38	ERP system call

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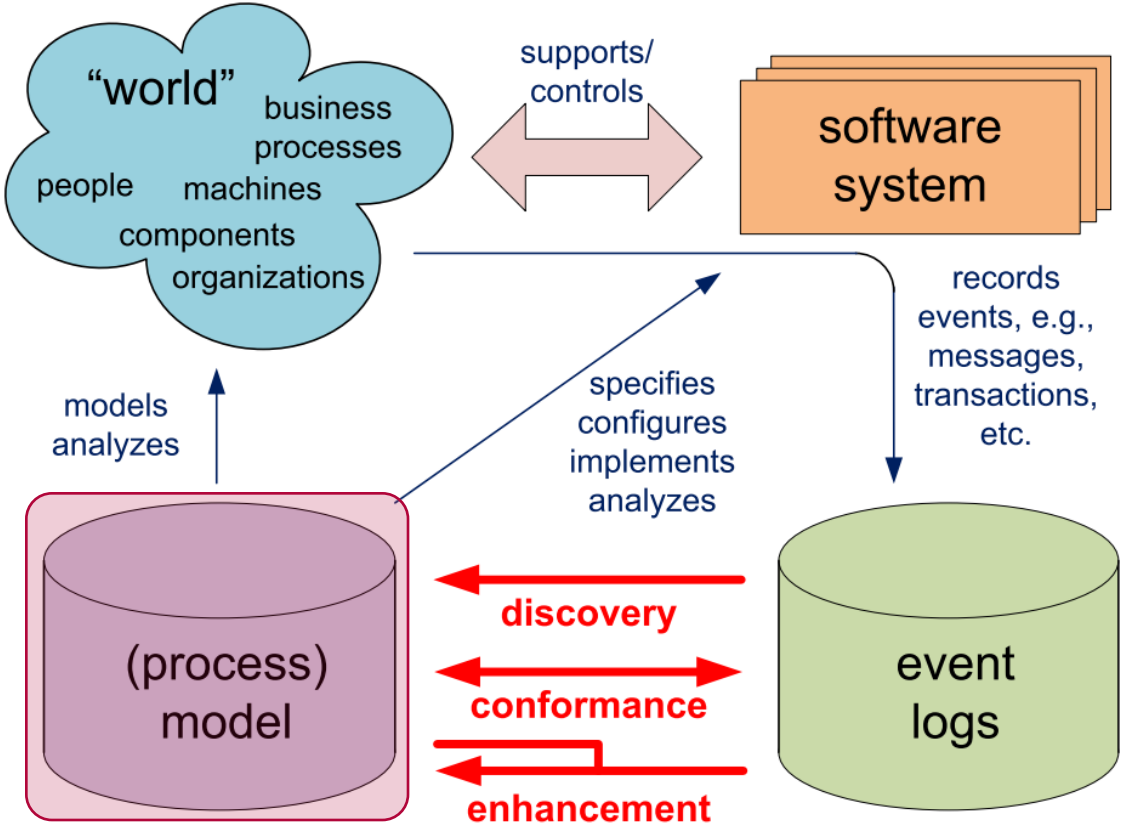
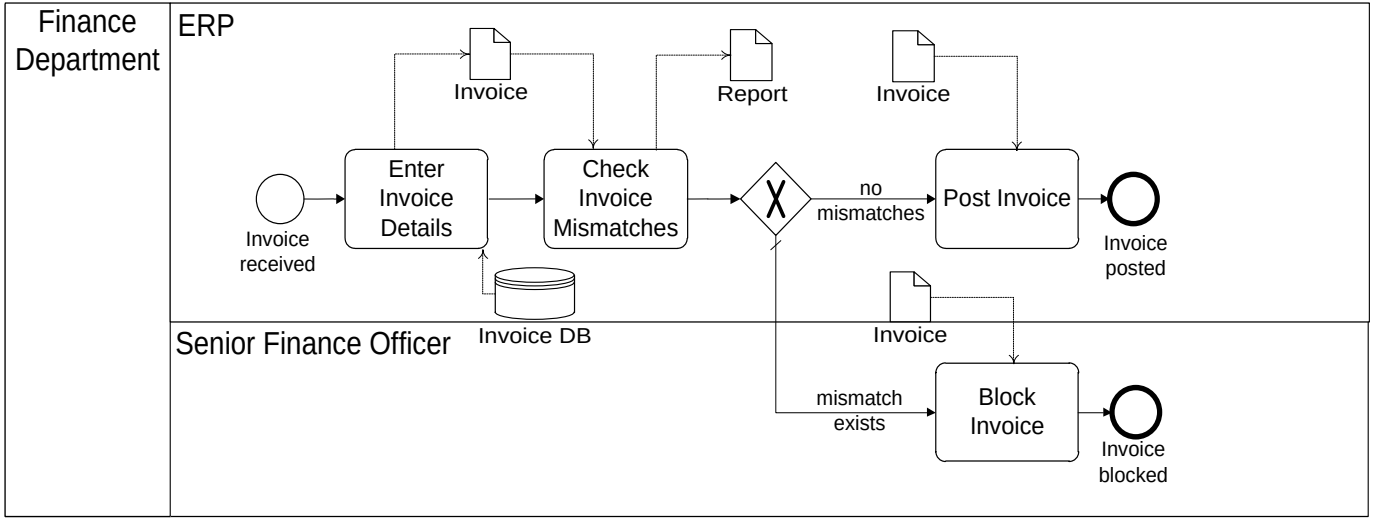


Image source: W. van der Aalst, "Process Mining", 2nd ed, Springer 2016.

Different perspectives

- What needs be done and when? – *Control flow*
- What do we need to work on? – *Data*
- Who's doing the work? – *Resources (human & systems)*



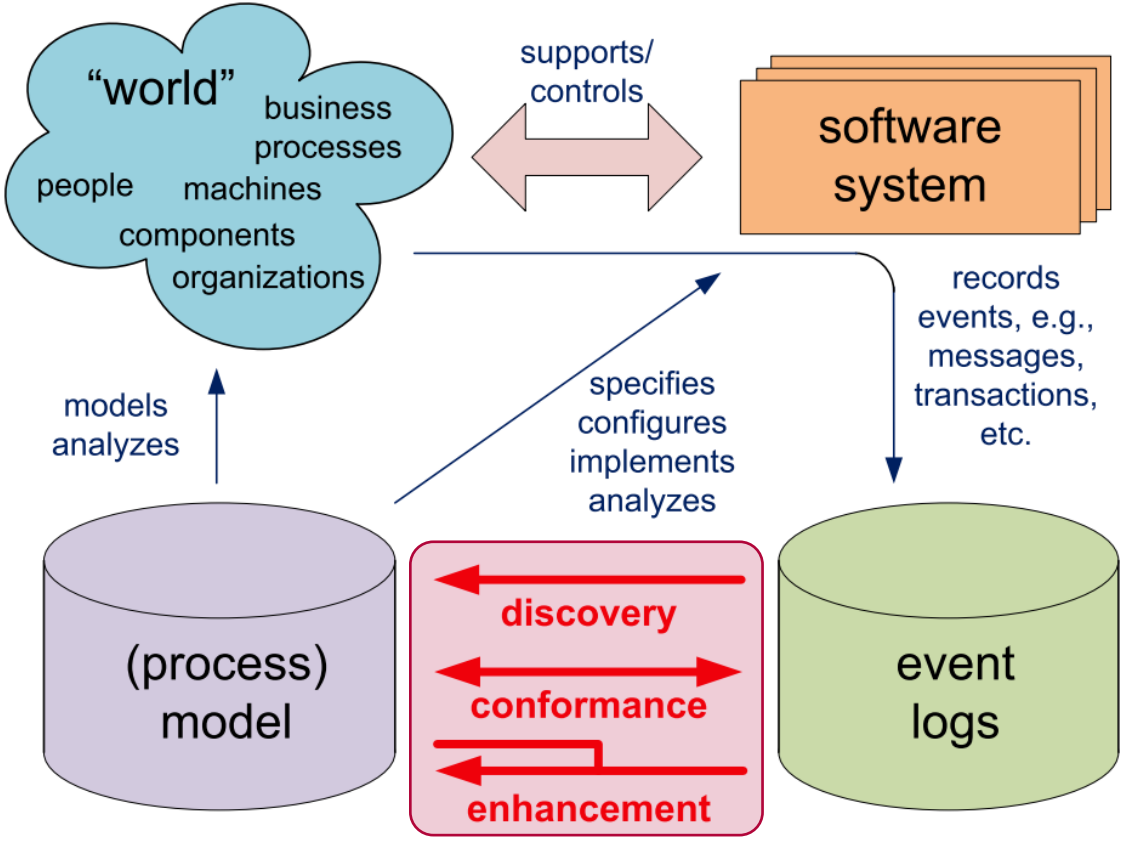
Purposes of Modelling

- Business purposes
- Information systems purposes

Purposes of Modelling (cont.)

- Business purposes
  - Documentation, guidelines, work instructions
  - Process redesign, from as-is to to-be
  - Staff planning, often using statistical annotations
  - Quality certification
- Information systems purposes
  - Enterprise Resource Planning (ERP) system selection
    - ERP systems provide business functionality
    - System selection based on delta-analysis of own processes and implemented process
  - Software development
    - Process models as requirement documents
  - Process implementation
    - Workflow system supports execution of cases
    - Different degrees of automation of activities

The Context



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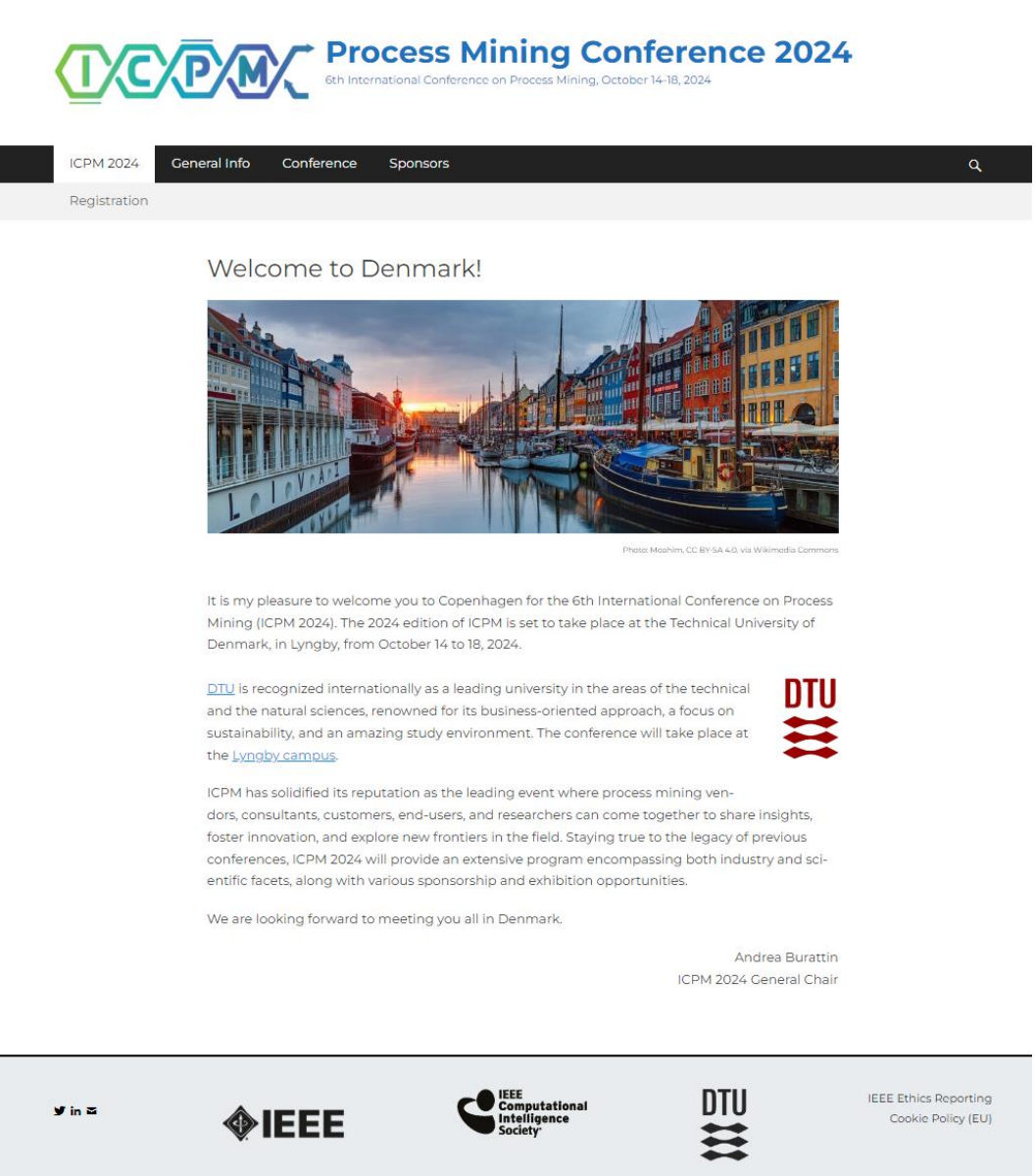

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