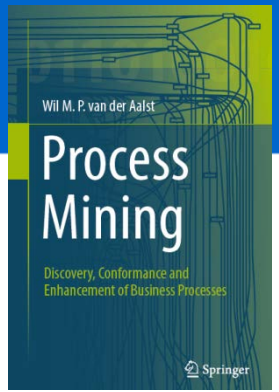
Process Mining: Data Science in Action

Event Logs and Process Models

prof.dr.ir. Wil van der Aalst
www.processmining.org



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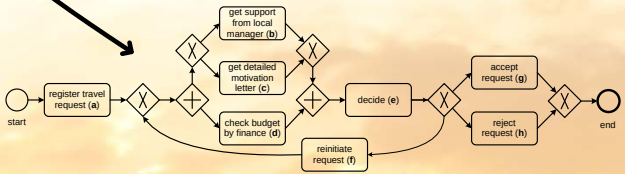
Where innovation starts

Case	Activity	Timestamp	Resource
432	register travel request (a)	18-3-2014:9.15	John
432	get support from local manager (b)	18-3-2014:9.25	Mary
432	check budget by finance (d)	19-3-2014:8.55	John
432	decide (e)	19-3-2014:9.36	Sue
432	accept request (g)	19-3-2014:9.48	Mary

Play-In

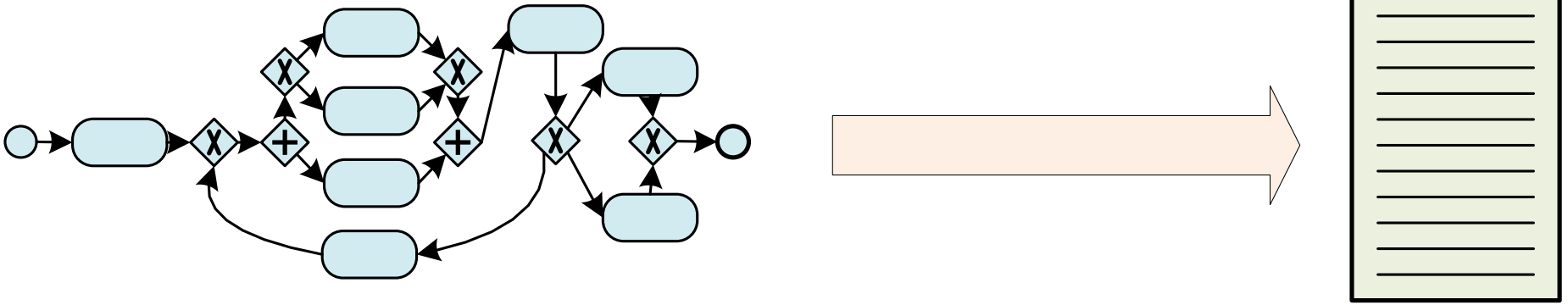
Replay

Play-Out



relating process models and event logs

Play-Out



- **Simulation**
- **Workflow automation**
- **Management games**
- **Model checking**
- **…**

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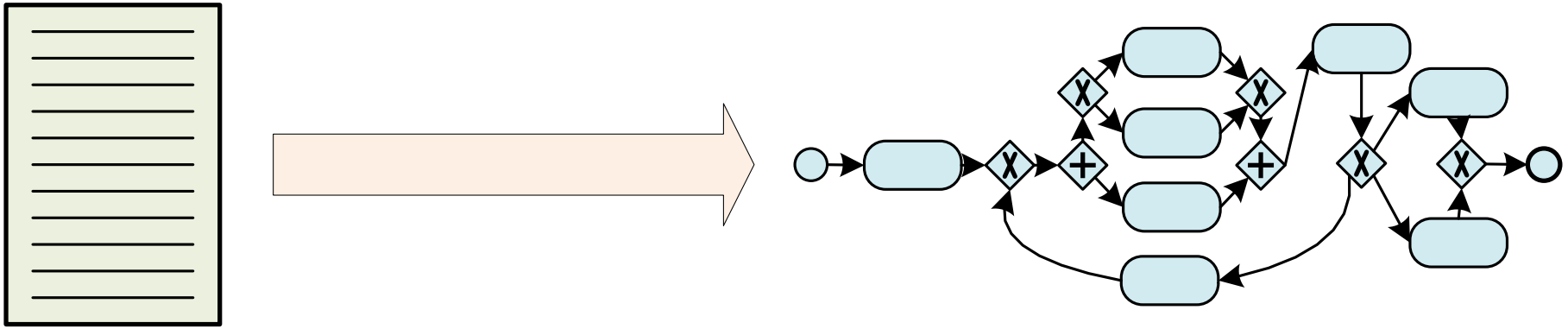
Play-In



Process discovery: learning de facto process models from observed behavior.

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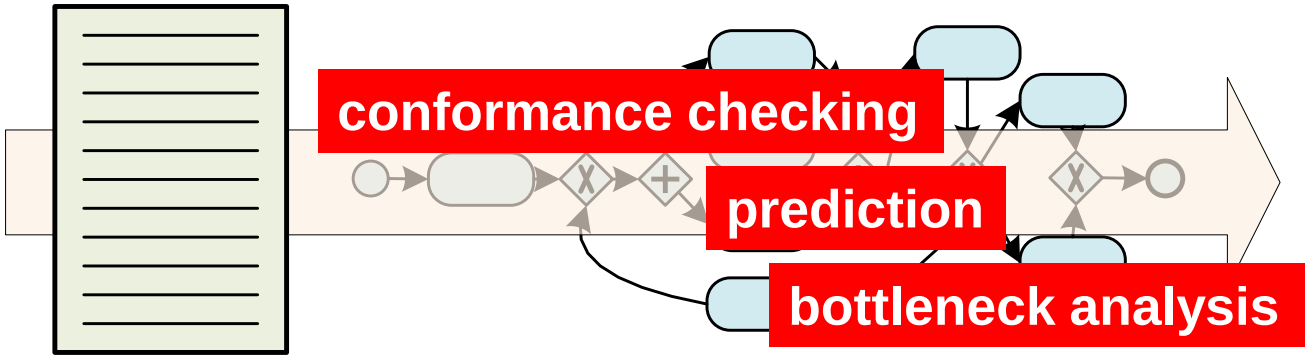
Replay



- extended model showing times, frequencies, etc.
- diagnostics
- predictions
- recommendations

Aligning modeled/discovered and observed behavior:

- **The most important form of process mining!**
- **Confrontation between model and reality.**

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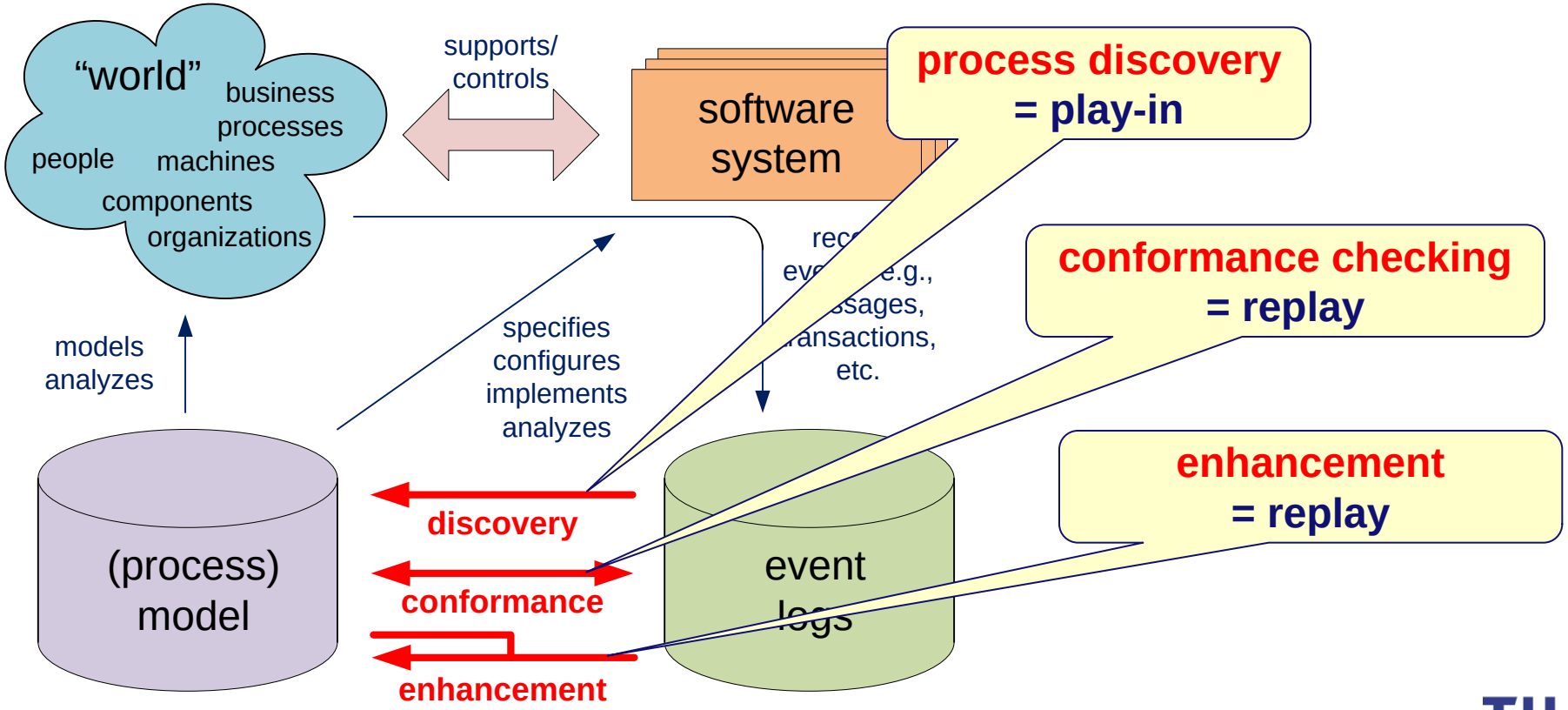
The three main types of process mining:
discovery, conformance, and enhancement



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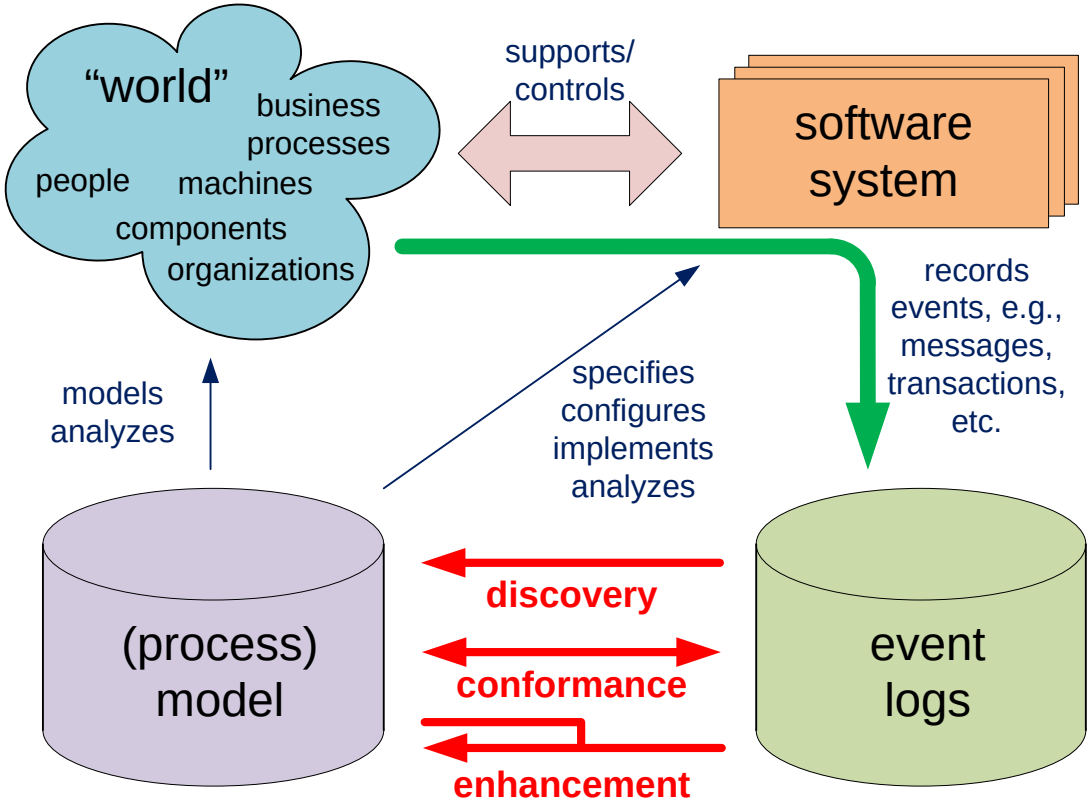
Getting the "right" data …



Event log

- We assume the existence of an event log where each event refers to a case, an activity, and a point in time.
- An event log can be seen as a collection of cases.
- A case can be seen as a trace/sequence of events.

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Event data may come from …

- a database system (e.g., patient data in a hospital),
- a comma-separated values (CSV) file or spreadsheet,
- a transaction log (e.g., a trading system),
- a business suite/ERP system (SAP, Oracle, etc.),
- a message log (e.g., from IBM middleware),
- an open API providing data from websites or social media, …

An example log

student name	course name	exam date	mark
Peter Jones	Business Information systems	16-1-2014	8
Sandy Scott	Business Information systems	16-1-2014	5
Bridget White	Business Information systems	16-1-2014	9
John Anderson	Business Information systems	16-1-2014	8
Sandy Scott	BPM Systems	17-1-2014	7
Bridget White	BPM Systems	17-1-2014	8
Sandy Scott	Process Mining	20-1-2014	5
Bridget White	Process Mining	20-1-2014	9
John Anderson	Process Mining	20-1-2014	8
…	…	…	…

case id **activity name** **timestamp** **other data**

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Another event log: order handling

order number	activity	timestamp	user	product	quantity
9901	register order	22-1-2014@09.15	Sara Jones	iPhone5S	1
9902	register order	22-1-2014@09.18	Sara Jones	iPhone5S	2
9903	register order	22-1-2014@09.27	Sara Jones	iPhone4S	1
9901	check stock	22-1-2014@09.49	Pete Scott	iPhone5S	1
9901	ship order	22-1-2014@10.11	Sue Fox	iPhone5S	1
9903	check stock	22-1-2014@10.34	Pete Scott	iPhone4S	1
9901	handle payment	22-1-2014@10.41	Carol Hope	iPhone5S	1
9902	check stock	22-1-2014@10.57	Pete Scott	iPhone5S	2
9902	cancel order	22-1-2014@11.08	Carol Hope	iPhone5S	2
…	…	…	…	…	…

case id **activity name** **timestamp** **resource** **other data**

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Another event log: patient treatment

patient	activity	timestamp	doctor	age	cost
5781	make X-ray	23-1-2014@10.30	Dr. Jones	45	70.00
5541	blood test	23-1-2014@10.18	Dr. Scott	61	40.00
5833	blood test	23-1-2014@10.27	Dr. Scott	24	40.00
5781	blood test	23-1-2014@10.49	Dr. Scott	45	40.00
5781	CT scan	23-1-2014@11.10	Dr. Fox	45	1200.00
5833	surgery	23-1-2014@12.34	Dr. Scott	24	2300.00
5781	handle payment	23-1-2014@12.41	Carol Hope	45	0.00
5541	radiation therapy	23-1-2014@13.57	Dr. Jones	61	140.00
5541	radiation therapy	23-1-2014@13.08	Dr. Jones	61	140.00
…	…	…	…	…	…

case id **activity name** **timestamp** **resource** **other data**

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not always so clear …

Question: Take your mail box

- An e-mail has:
  - a sender ("From"),
  - a set of receivers ("To"),
  - a subject,
  - a timestamp ("Date"),
  - a body,
  - etc.
- Assume an e-mail represents an event.
- What is a possible mapping onto an event log (which field is the case id, which field is the activity name, etc.)?

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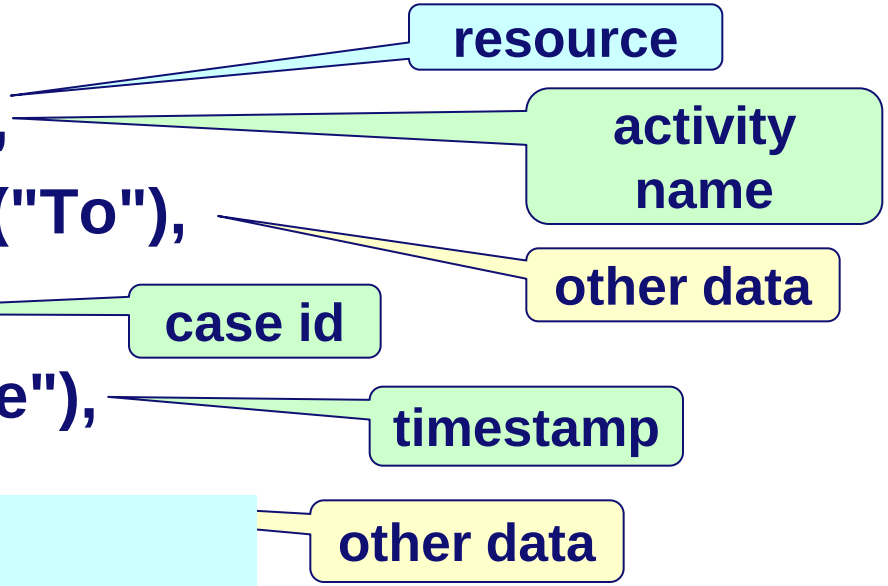
Answer: Several possible mappings!

- **Mapping:**
  - a sender ("From"),
  - a set of receivers ("To"),
  - a subject,
  - a timestamp ("Date"),
  - a body



- **Problems:**
  - Unclear what the cases are (senders, subjects, etc.).
  - Unclear what the activities are.
- **Context and questions needed.**

Question

student id	course	exam date	gender	nationality	mark
884362	Logic	15-4-2014	male	Dutch	6
884978	Logic	15-4-2014	female	Chinese	8
884362	Statistics	17-4-2014	male	Dutch	9
885087	Statistics	17-4-2014	female	German	9
882876	Statistics	17-4-2014	female	Dutch	5
..	..	..	..	..	..

- **Assume each row (an exam attempt) represents an event.**
- **What is a possible mapping onto an event log (which field is the case id, etc.)?**

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Answer

student id	course	exam date	gender	nationality	mark
884362	Logic	15-4-2014	male	Dutch	6
884978	Logic	15-4-2014	female	Chinese	8
884362	Statistics	17-4-2014	male	Dutch	9
885087	Statistics	17-4-2014	female	German	9
882876			female	Dutch	5
..	..		..		

resource

timestamp

other data

case id

activity name

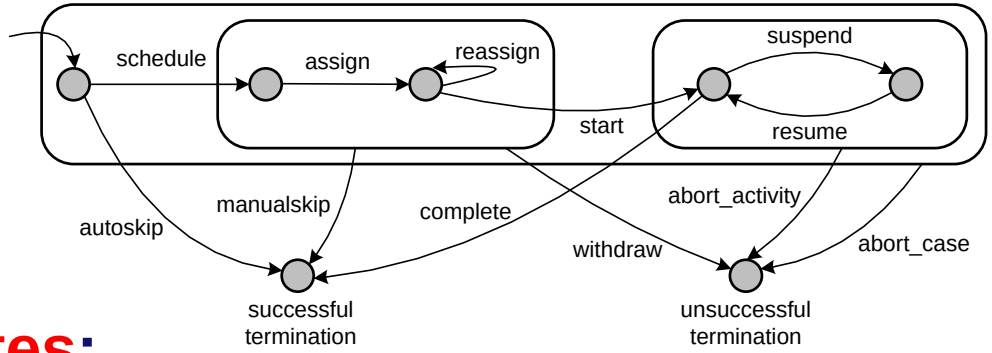
other data

other data

- **Again alternative mappings possible!**
  For example, the course is the case, the student is the activity, and the nationality is the resource.
- **Context and questions needed.**

Extensions

- **Transactional information on activity instances:**
  An event can represent a start, complete, suspend, resume, abort, etc.



- **Case versus event attributes:**
  - **case attributes do not change, e.g., the birth date or gender of a patient,**
  - **event attributes are related to a particular step in the process.**

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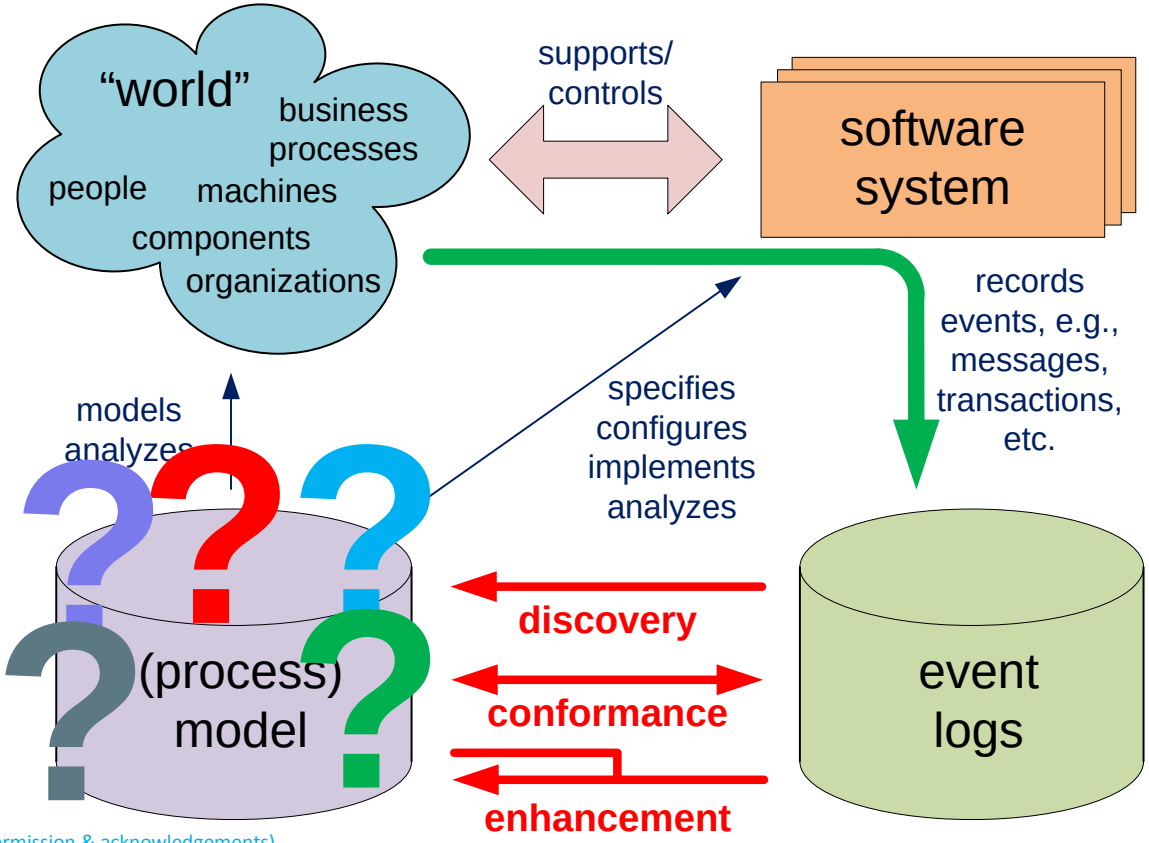
XES (eXtensible Event Stream)

- Adopted by the IEEE Task Force on Process Mining.
- The format is supported by tools such as ProM and Disco (used in this course).
- Predecessors: MXML and SA-MXML.
- Conversion from other formats (CSV) is easy if the right data are available.
- XML syntax and OpenXES library available.
- See www.xes-standard.org.

Selecting the "right" representation…



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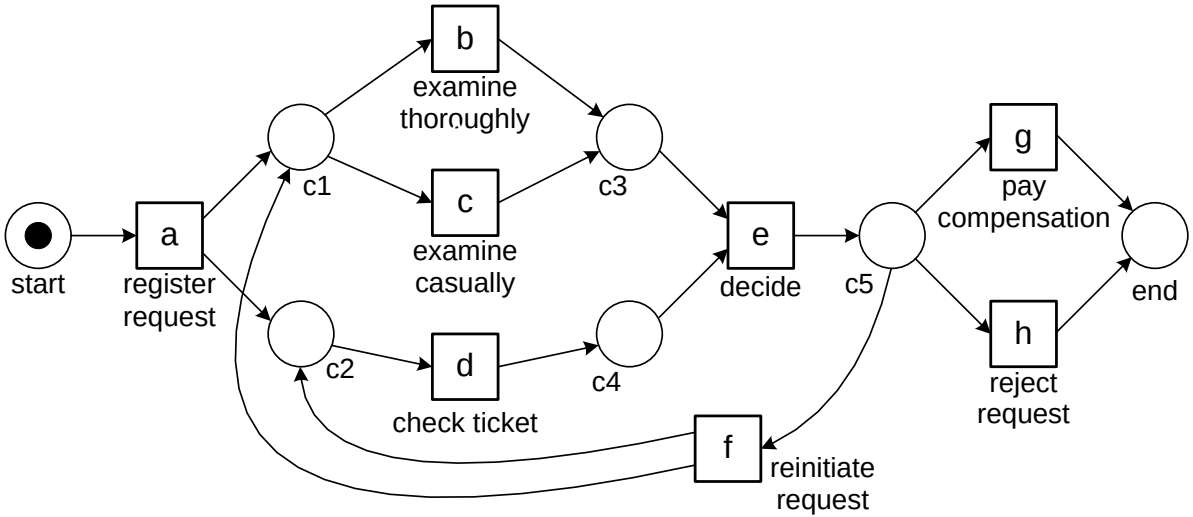
Just control-flow
(represented as a Petri net)

- Case starts with *a* and ends with *g* or *h*.
- Activity *d* is concurrent with *b* or *c*.
- Activity *e* has to wait until (*d* and *b*) or (*d* and *c*) have completed.
- There are three possible decisions: *f*, *g*, or *h*.
- …



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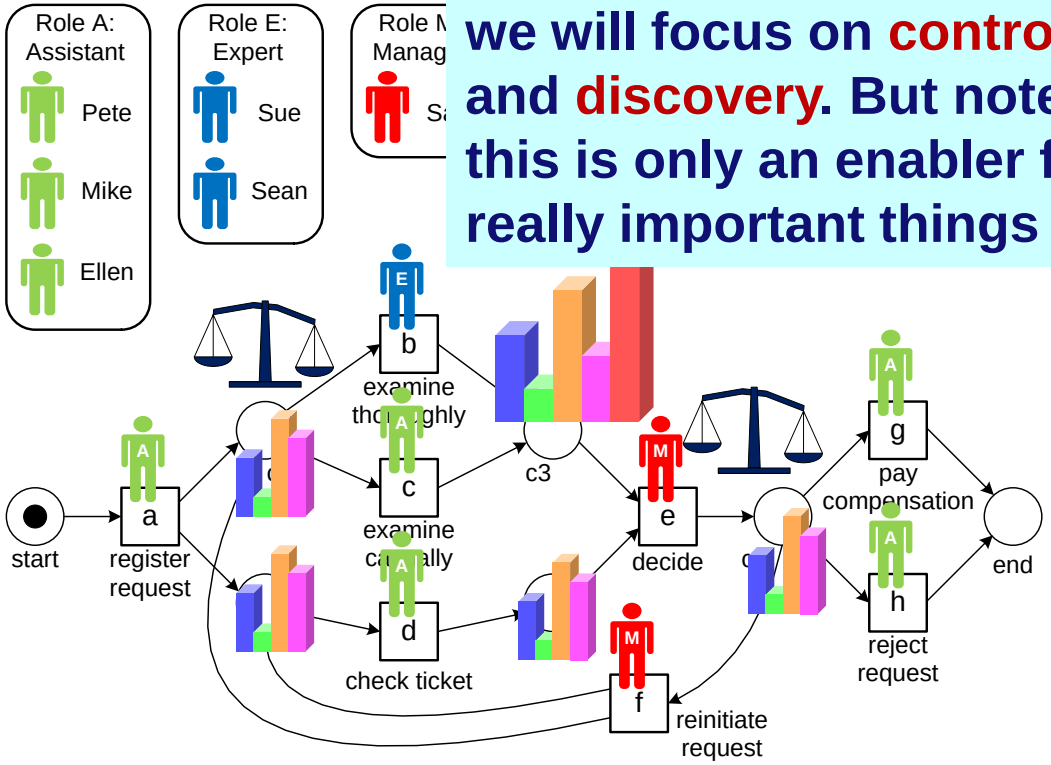
Additional perspectives

In the first part of this course, we will focus on control-flow and discovery. But note that this is only an enabler for the really important things …



- control-flow
- data-flow
- time
- resources
- costs
- risks
- …

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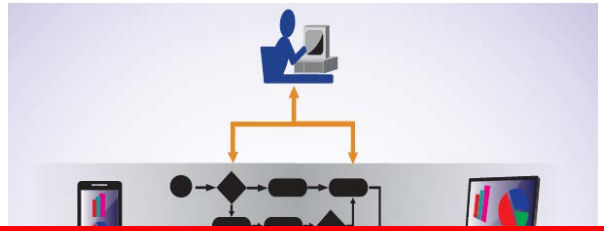
Alternative control-flow notations

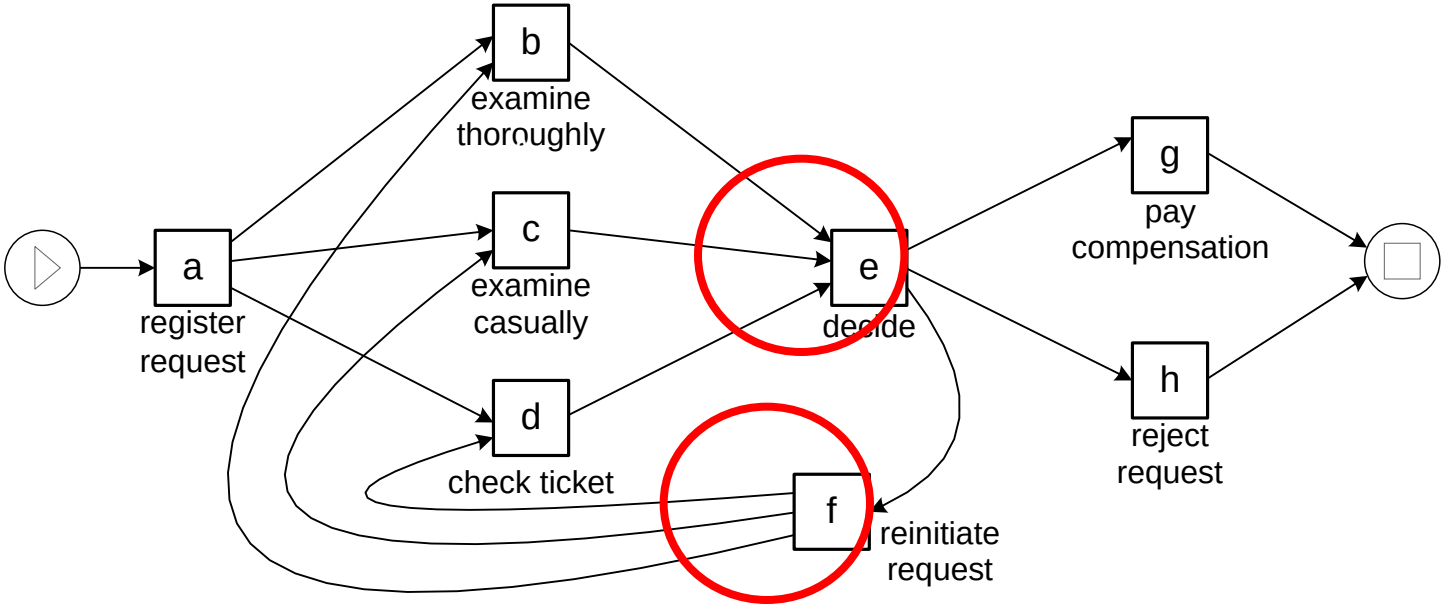
- BPMN (Business Process Model and Notation) diagrams
- UML activity diagrams
- Event-driven process chains
- Petri net variants
- Causal nets (C-nets)
- Transition systems
- (Hidden) Markov cha
- Process algebras (CS
- Fuzzy models
- YAWL models
- Declare models
- ...



Notation:

- search space: finding a model that captures reality well
- visualization: what do end-users need to see?

Class of "Fuzzy models"



Fuzzy models are not executable like Petri nets, but they allow for a simpler representation.

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Install ProM and Disco

ProM: 600+ plug-ins

dozens of model types

XES, MXML, CSV files

www.promtools.org

www.processmining.org

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Disco: Simple, fast, and easy

fuzzy models

XES, MXML, CSV files

www.fluxicon.com

www.fluxicon.com/academic/

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Part I: Preliminaries

- Chapter 1: Introduction
- Chapter 2: Process Modeling and Analysis
- Chapter 3: Data Mining

Part II: From Event Logs to Process Models

- Chapter 4: Getting the Data
- Chapter 5: Process Discovery: An Introduction
- Chapter 6: Advanced Process Discovery Techniques

Part III: Beyond Process Discovery

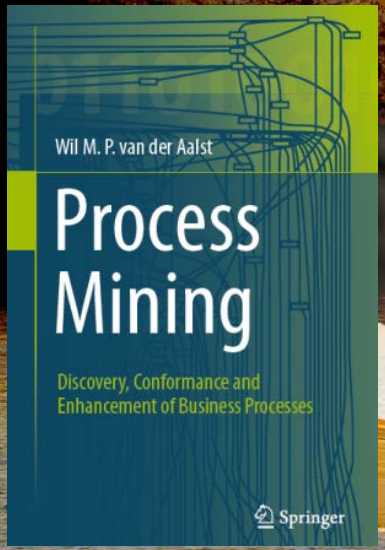
- Chapter 7: Conformance Checking
- Chapter 8: Mining Additional Perspectives
- Chapter 9: Operational Support

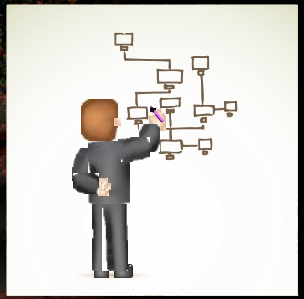
Part IV: Putting Process Mining to Work

- Chapter 10: Tool Support
- Chapter 11: Analyzing "Lasagna Processes"
- Chapter 12: Analyzing "Spaghetti Processes"

Part V: Reflection

- Chapter 13: Cartography and Navigation
- Chapter 14: Epilogue





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