

Curso

A Tour In Process Mining

From Practice to Algorithmic Challenges

Josep Carmona (UPC)

Red de Excelencia en Ingeniería del Software Dirigida por Modelos

Lunes, 5 de Febrero, 2018 — Barcelona



Wil van der Aalst - Eindhoven University of Technology, The Netherlands

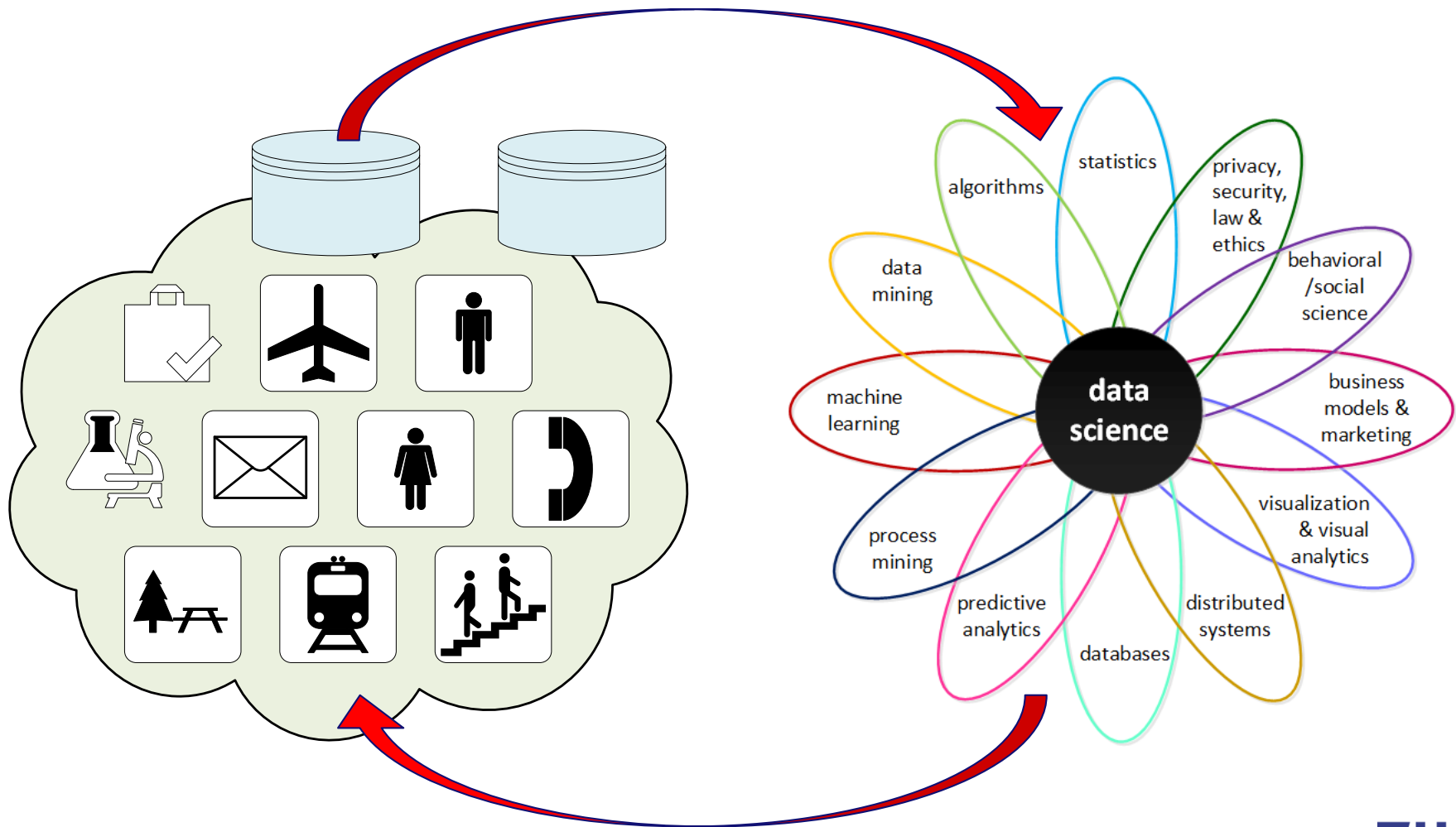
Josep Carmona - Universitat Politècnica de Catalunya, Barcelona, Spain

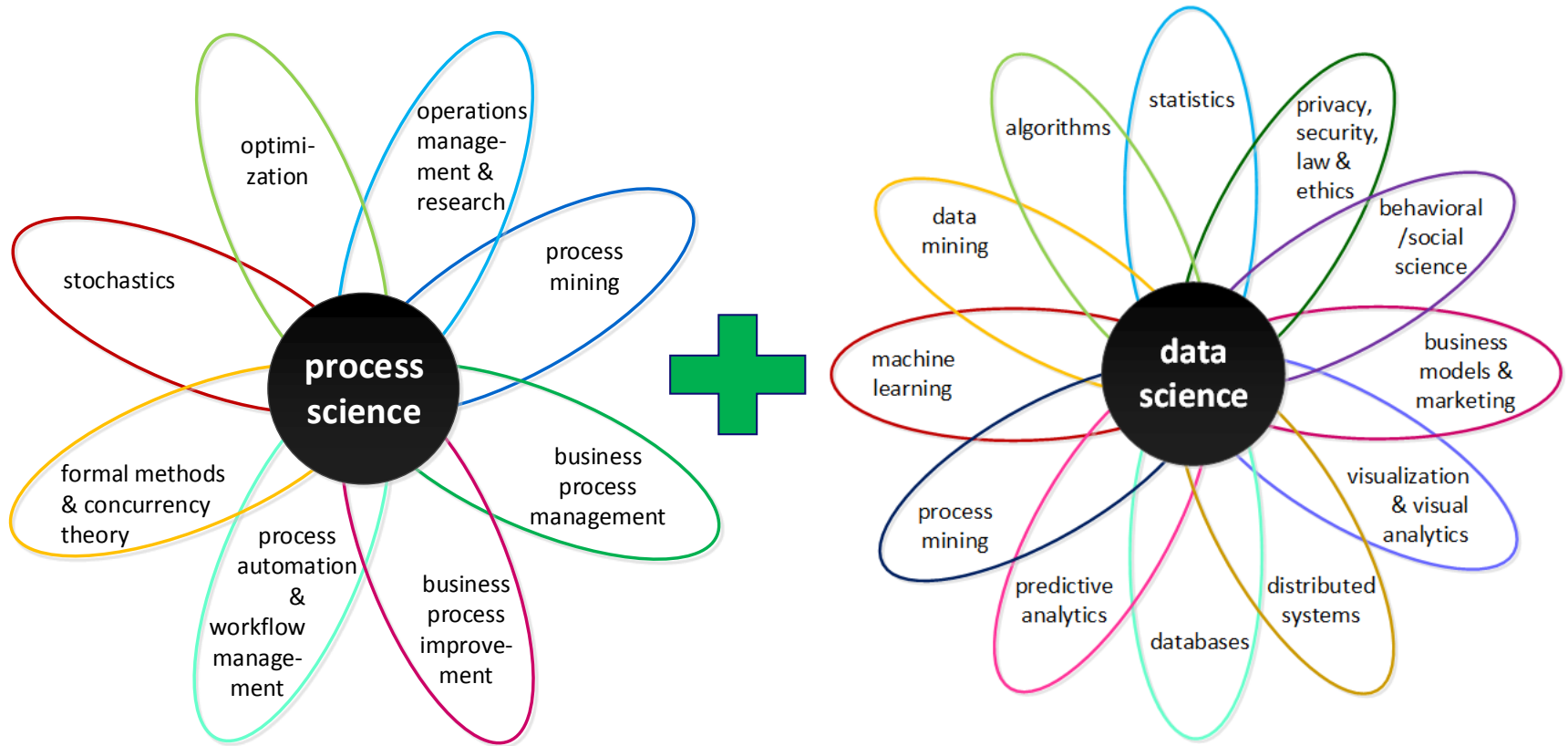
Thomas Chatain - LSV, ENS Cachan, CNRS, INRIA, Cachan, France

Boudewijn van Dongen - Eindhoven University of Technology, The Netherlands

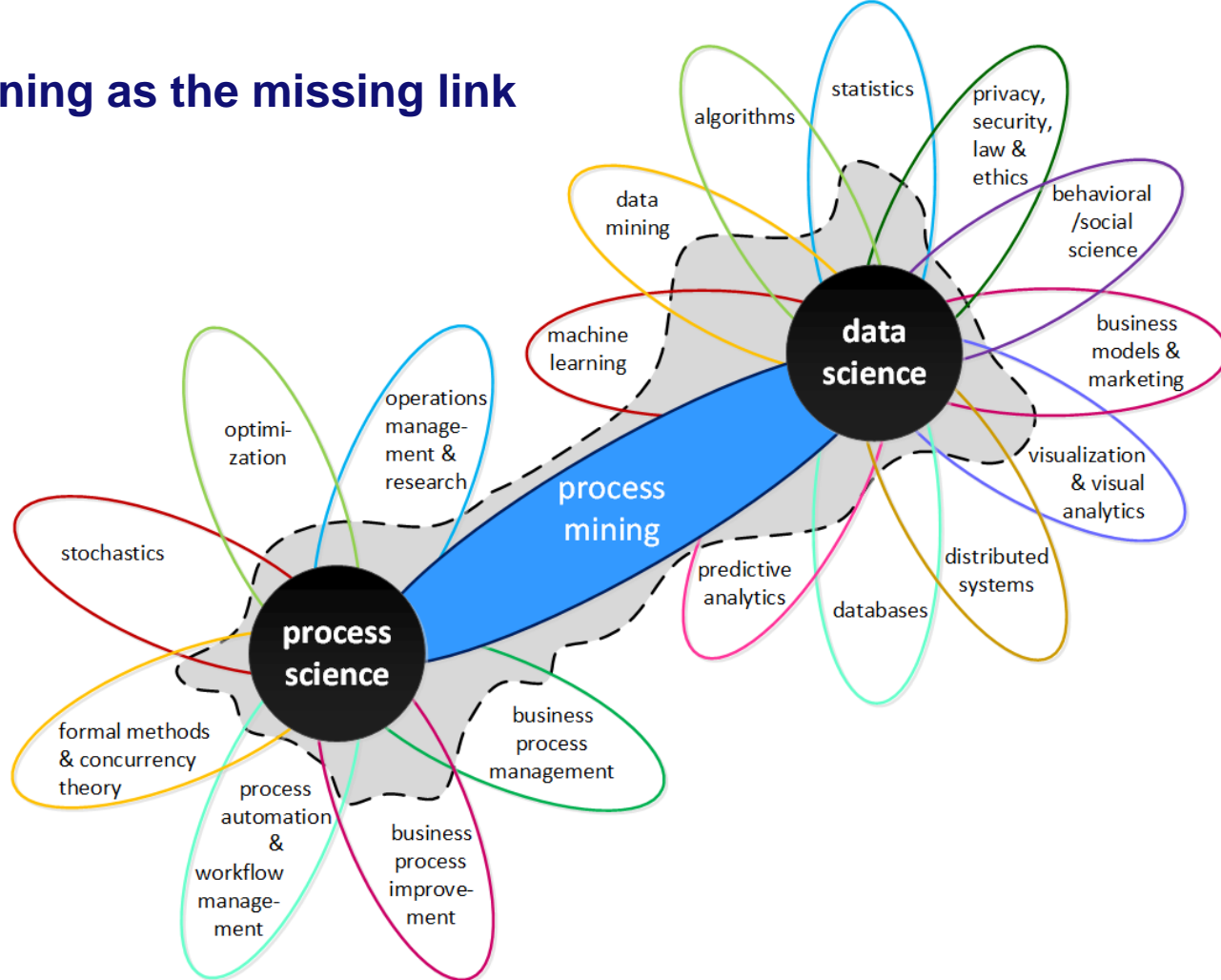
Programa

- **Module I: A Practical Introduction to Process Mining (1h)** - Introduction to process mining with demos of commercial tools (highlighting the incredible relevance and the limitations of existing tools). (10-11)
- **Module II: Discovering Process Models (1.5h)** - Metrics and desired features. Process discovery with inductive mining as an example of scalable discovery technique. [Opt: Process discovery with region-based approaches] (11.10-12.40)
- **Module III: Conformance Checking (1h)** - Token Replay. Alignments. Selected techniques for the computation of alignments. Alignments applications. (12.50-14)
- **Module IV: Enhancement (1.5h)** - Model Repair. Decision Point Analysis. Performance Analysis. Social Network Analysis. (15-16.30)
- **Module V: 'Bring Your Own Data' Session (16:30h - ?)**





process mining as the missing link



Process mining: Spreadsheets for behavior

Spreadsheet: Killer App for early computers

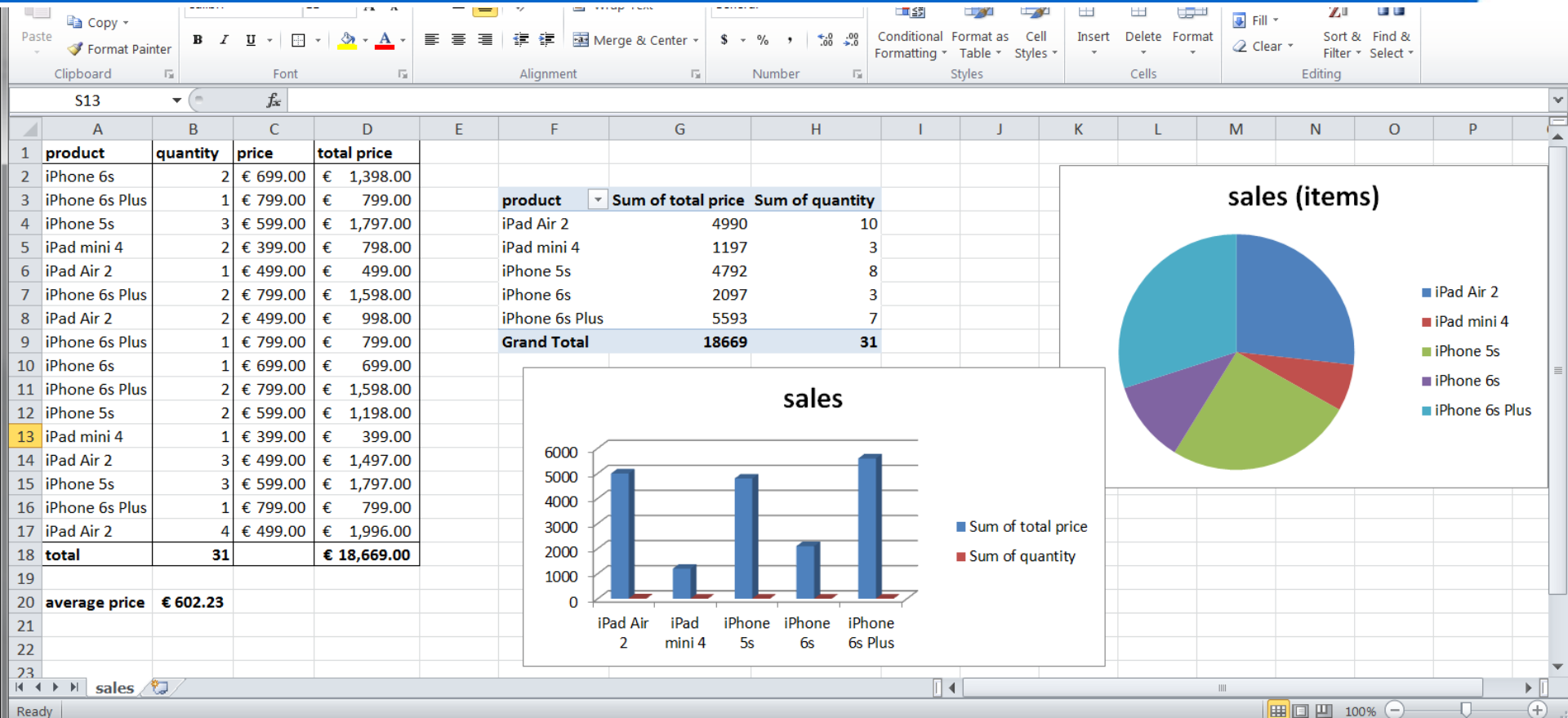
C11 (L) TOTAL C1
25

	A	B	C	D
	ITEM	NO.	UNIT	COST
	MUCK RAKE	43	12.95	556.85
	BUZZ CUT	15	6.75	101.25
	TOE TONER	250	49.95	12487.50
	EYE SNUFF	2	4.95	9.90
			SUBTOTAL	13155.50
			9.75% TAX	1282.66
			TOTAL	14438.16

- **VisiCalc** (killer app for Apple II, Oct. 1979)
- **Lotus 1-2-3** (killer app for IBM PC 1983)
- **Microsoft Excel** (1985)



Spreadsheet: Static data



Spreadsheet: Static data

The image shows a Microsoft Excel spreadsheet with a ribbon at the top and a grid below. The main data is organized into two tables. The first table, on the left, is a source table with columns for product, quantity, price, and total price. The second table, on the right, is a filtered version of the first table, showing only the first seven rows of the source data. Both tables are highlighted with red boxes.

product	quantity	price	total price
iPhone 6s	2	€ 699.00	€ 1,398.00
iPhone 6s Plus	1	€ 799.00	€ 799.00
iPhone 5s	3	€ 599.00	€ 1,797.00
iPad mini 4	2	€ 399.00	€ 798.00
iPad Air 2	1	€ 499.00	€ 499.00
iPhone 6s Plus	2	€ 799.00	€ 1,598.00
iPad Air 2	2	€ 499.00	€ 998.00
iPhone 6s Plus	1	€ 799.00	€ 799.00
iPhone 6s	1	€ 699.00	€ 699.00
iPhone 6s Plus	2	€ 799.00	€ 1,598.00
iPhone 5s	2	€ 599.00	€ 1,198.00
iPad mini 4	1	€ 399.00	€ 399.00
iPad Air 2	3	€ 499.00	€ 1,497.00
iPhone 5s	3	€ 599.00	€ 1,797.00
iPhone 6s Plus	1	€ 799.00	€ 799.00
iPad Air 2	4	€ 499.00	€ 1,996.00
total	31		€ 18,669.00
average price	€ 602.23		

1	product	quantity	price	total price
2	iPhone 6s	2	€ 699.00	€ 1,398.00
3	iPhone 6s Plus	1	€ 799.00	€ 799.00
4	iPhone 5s	3	€ 599.00	€ 1,797.00
5	iPad mini 4	2	€ 399.00	€ 798.00
6	iPad Air 2	1	€ 499.00	€ 499.00
7	iPhone 6s Plus	2	€ 799.00	€ 1,598.00

Spreadsheet: Static data

fact

product	quantity	price	total price
iPhone 6s	2	€ 699.00	€ 1,398.00
iPhone 6s Plus	1	€ 799.00	€ 799.00
iPhone 5s	3	€ 599.00	€ 1,797.00
iPad mini 4	2	€ 399.00	€ 798.00
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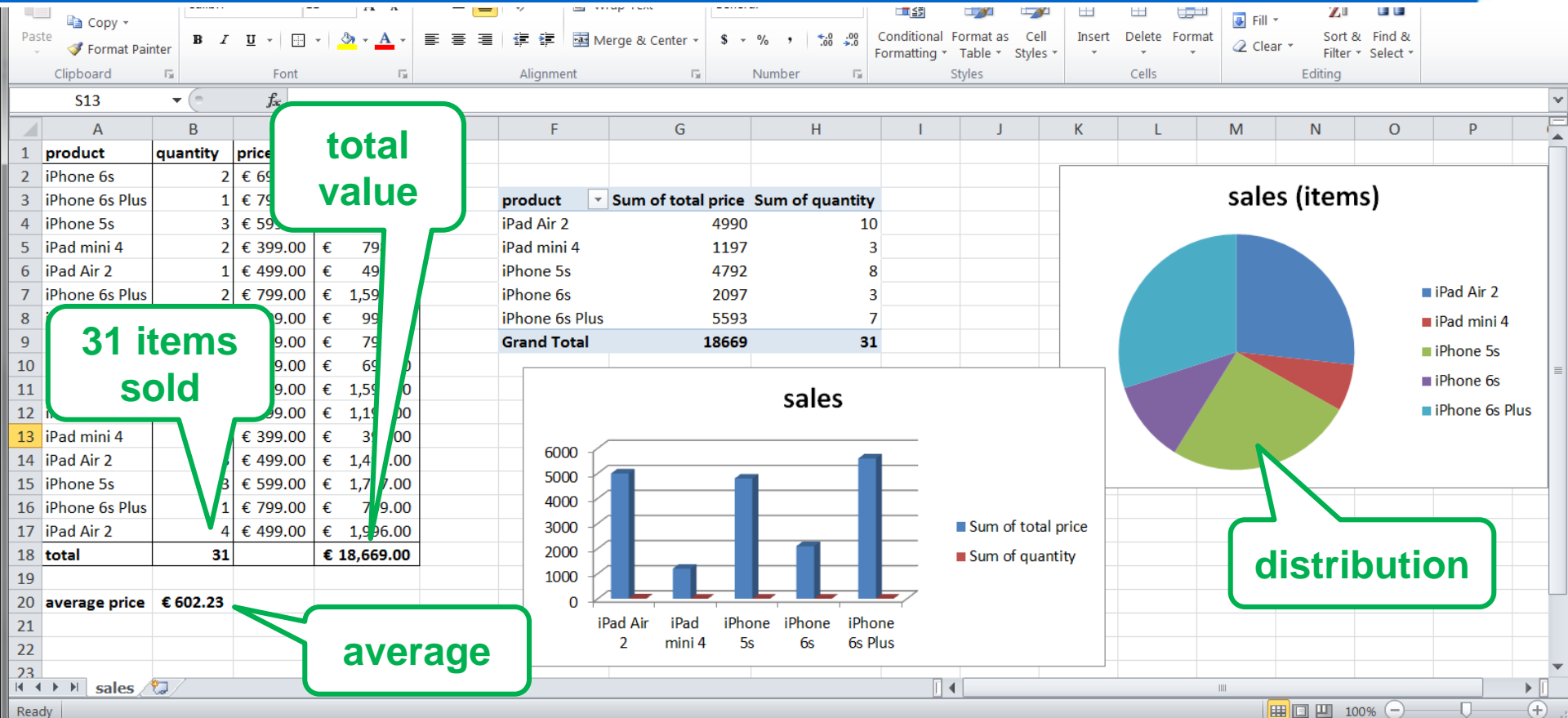
Spreadsheet: Static data

The image shows a Microsoft Excel spreadsheet with two tables. The left table is a summary table with columns 'product', 'quantity', 'price', and 'total price'. The right table is a detailed table with columns 'product', 'quantity', 'price', and 'total price'. A blue callout box labeled 'fact' points to the 'iPhone 5s' row in the right table. A green callout box labeled 'derived' points to the 'total price' column in the right table.

product	quantity	price	total price
iPhone 6s	2	€ 699.00	€ 1,398.00
iPhone 6s Plus	1	€ 799.00	€ 799.00
iPhone 5s	3	€ 599.00	€ 1,797.00
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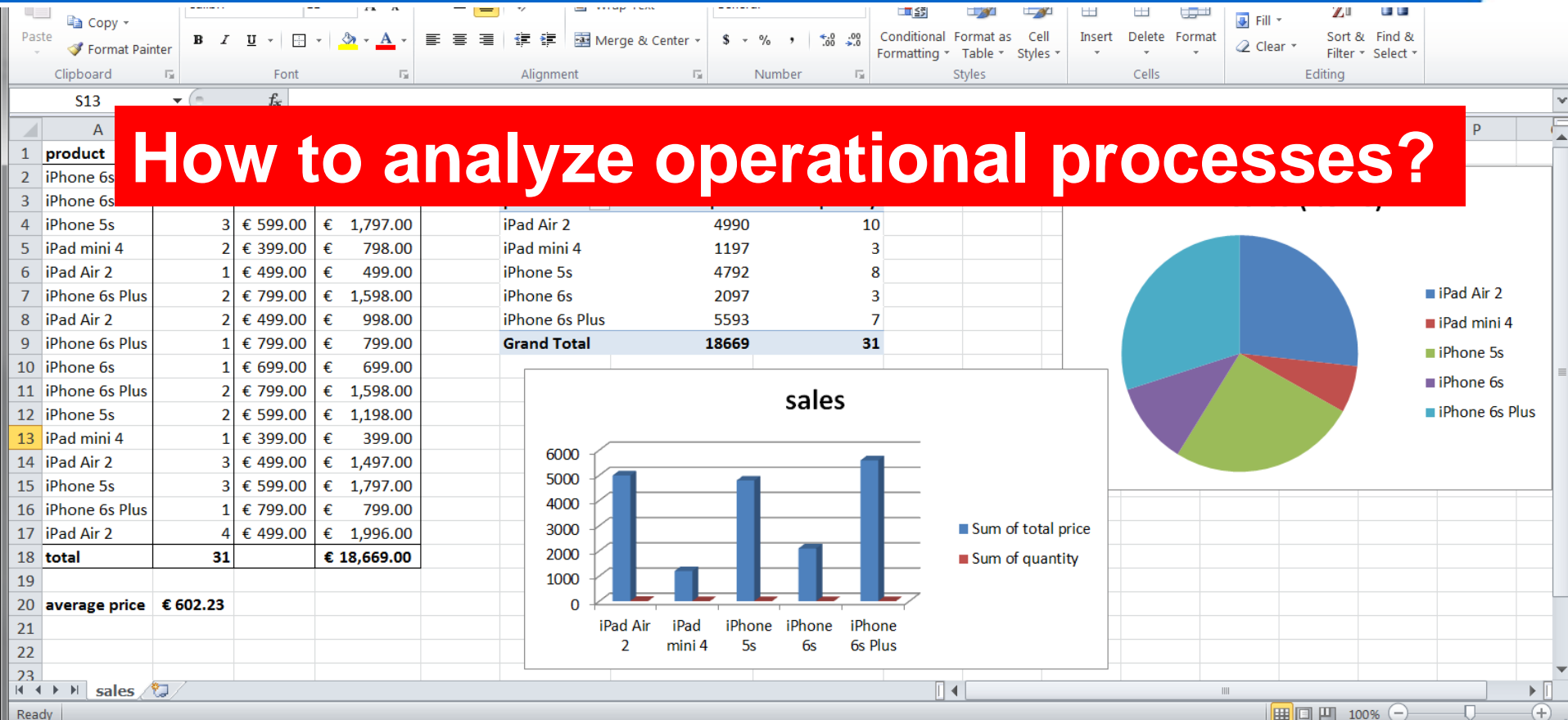
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7	iPhone 6s Plus	2	€ 799.00	€ 1,598.00

Spreadsheet: Static data



Spreadsheet: Static data

How to analyze operational processes?



Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody	2007/09/24 08:39:32.000
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken	somebody	2007/09/24 08:41:26.000
8	185783	120 Plannen eindinspectie	somebody	2007/09/24 08:51:00.000
9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
13	185783	110 Bepalen leegstandsoort	somebody	2007/09/24 10:57:42.000
14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000
16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000
21	185783	170 Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	520 Aanmaken 2e in gebreke stelling	somebody	2007/10/30 11:45:53.000
23	185783	530 Aanmaken werkopdracht	somebody	2007/10/30 11:46:09.000
24	185783	540 Worden er bonussen/ kosten toegekend ?	somebody	2007/10/30 11:46:36.000
25	185783	550 Vastleggen bonussen / kosten	somebody	2007/10/30 11:53:00.000
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	somebody	2007/11/28 12:34:23.000
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

- Input: **events** (“things that have happened”)
- Mandatory per event:
 - **case identifier**
 - **activity name**
 - **timestamp/date**
- Optional
 - **resource**
 - **transaction type**
 - **costs**
 - ...

Process Mining: Spreadsheet for behavior

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7	185783	100 Ger...	somebody	2007/09/24 08:41:26.000
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9	185783	400 Is...	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
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18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
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25	185783	550 Vastleggen bonussen / kosten	somebody	2007/10/30 11:53:00.000
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	somebody	2007/11/28 12:34:23.000
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28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
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row = event

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8	185783	120 Plan...	somebody	2007/09/24 08:51:00.000
9	185783	400 Is er inspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
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16	185783	440 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	70 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
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21	185783	Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	Aanstellen stelling	somebody	2007/10/30 11:45:53.000
23	185783	Aanstellen stelling	somebody	2007/10/30 11:46:09.000
24	185783	Aanstellen stelling toegekend ?	somebody	2007/10/30 11:46:36.000
25	185783	Aanstellen stelling	somebody	2007/10/30 11:53:00.000
26	185783	Aanstellen stelling +afdrucken	somebody	2007/11/28 12:34:23.000
27	185783	Aanstellen stelling en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
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row = event

case identifier

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4	185783	050 Plannen van een formulier voor de inschrijving	somebody	2007/09/11 13:29:34.000
5	185783	060 Aanpassen van een formulier	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e in gebreke staand?	somebody	2007/09/24 08:39:32.000
7	185783	100 Gerichte aanpak maken	somebody	2007/09/24 08:41:26.000
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21	185783	210 Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	220 Opstellen van een offerte	somebody	2007/10/30 11:45:53.000
23	185783	230 Bepalen van de kosten	somebody	2007/10/30 11:46:09.000
24	185783	240 Bepalen van de kosten	somebody	2007/10/30 11:46:36.000
25	185783	250 Bepalen van de kosten	somebody	2007/10/30 11:53:00.000
26	185783	260 Verevenen van de kosten	somebody	2007/11/28 12:34:23.000
27	185783	270 Is contract getekend en geld ontvangen?	somebody	2007/12/10 10:44:06.000
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case identifier

activity name

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5	185783	060 Aanpassen van de huurform.	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e in gebreke sta	somebody	2007/09/24 08:39:32.000
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27	185783	270 Is de woning te stellen	somebody	2007/12/10 10:44:00.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

row = event

case
identifier

activity
name

timestamp

- Input: **events** (“things that have happened”)
- Mandatory per event:
 - **case identifier**
 - **activity name**
 - **timestamp/date**
- Optional
 - **resource**
 - **transaction type**
 - **costs**
 - ...

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen van afbreuk bij inschrijving	somebody	2007/09/11 13:30:29.000
5	185783	060 Aanpak van afbreuk bij inschrijving	somebody	2007/09/11 13:30:29.000
6	185783	070 Is 1e in gebreke sta	somebody	2007/09/11 13:30:29.000
7	185783	100 Gerichte aanpak van afbreuk bij inschrijving	somebody	2007/09/11 13:30:29.000
8	185783	120 Plannen van afbreuk bij inschrijving	somebody	2007/09/24 10:55:56.000
9	185783	400 Is er sprake van inspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
13	185783	110 Bepalen leegstandsoort	somebody	2007/09/24 10:57:42.000
14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
16	185783	140 Aanmaken 1e in gebreke sta	somebody	2007/09/24 11:01:00.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:00.000
18	185783	160 Aanpassen woningwaardering	somebody	2007/09/24 11:37:00.000
19	185783	170 Harmoniseren huurprijs	somebody	2007/09/24 11:40:00.000
20	185783	180 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:40.000
21	185783	190 Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	200 Is contract getekend en geld ontvangen ?	somebody	2007/10/30 11:00:00.000
23	185783	210 Is contract getekend en geld ontvangen ?	somebody	2007/10/30 11:00:00.000
24	185783	220 Is contract getekend en geld ontvangen ?	somebody	2007/10/30 11:00:00.000
25	185783	230 Is contract getekend en geld ontvangen ?	somebody	2007/10/30 11:00:00.000
26	185783	240 Is contract getekend en geld ontvangen ?	somebody	2007/11/28 12:00:00.000
27	185783	250 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:00.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

row = event

resource

case identifier

activity name

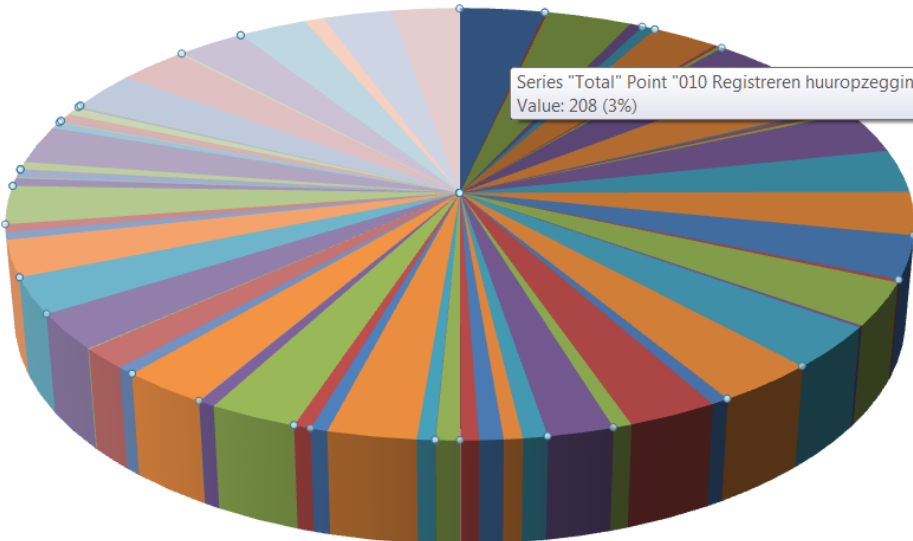
timestamp

- Input: **events** (“things that have happened”)
- Mandatory per event:
 - **case identifier**
 - **activity name**
 - **timestamp/date**
- Optional
 - **resource**
 - **transaction type**
 - **costs**
 - ...

Process Mining: Spreadsheet for behavior

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	Case ID	Activity	Resource	Complete Timestamp											
2	185783	010 Registreren huuropzegging	somebody 2007	09/11 13:21:27.000											
3	185783	030 Vastleggen toekomstige adres	somebody 2007												
4	185783	050 Plannen afspraak 1e inspectie	somebody 2007												
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingfo	somebody 2007												
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody 2007												
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maker	somebody 2007												
8	185783	120 Plannen eindinspectie	somebody 2007												
9	185783	400 Is eindinspectie uitgevoerd ?	somebody 2007												
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody 2007												
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody 2007												
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody 2007												
13	185783	110 Bepalen leegstandsoort	somebody 2007												
14	185783	510 Is opleveringsformulier ondertekend ?	somebody 2007												
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody 2007												
16	185783	140 Aanmaken 1e in gebreke stelling	somebody 2007												
17	185783	150 Is er sprake van ZAV ?	somebody 2007												
18	185783	180 Aanpassen woningwaardering	somebody 2007												
19	185783	190 Harmoniseren huurprijs	somebody 2007												
20	185783	205 Bepalen kandidaat huurder	somebody 2007												
21	185783	170 Aanpassen plattegrond	somebody 2007												
22	185783	520 Aanmaken 2e in gebreke stelling	somebody 2007												
23	185783	530 Aanmaken werkopdracht	somebody 2007												
24	185783	540 Worden er bonussen/ kosten toegekend ?	somebody 2007												
25	185783	550 Vastleggen bonussen / kosten	somebody 2007												
26	185783	240 Registreren voorl. huurovereenkomst +afdrukk	somebody 2007												
27	185783	260 Is contract getekend en geld ontvangen ?	somebody 2007												
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody 2007												
29	185783		somebody 2007												
30	185783		somebody 2007												
31	185783		somebody 2003												
32	185783		somebody 2003												
33	185783		somebody 2003												
34	185783		somebody 2003												
35	246926		somebody 2007												
36	246926		somebody 2007												
37	246926	050 Plannen afspraak 1e inspectie	somebody 2007												
38	246926	060 Aanmaken bevestigingsbrief / huuropzeggingfo	somebody 2007	12/07 12:31:57.000											

activities

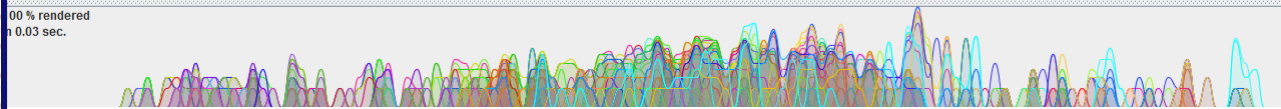
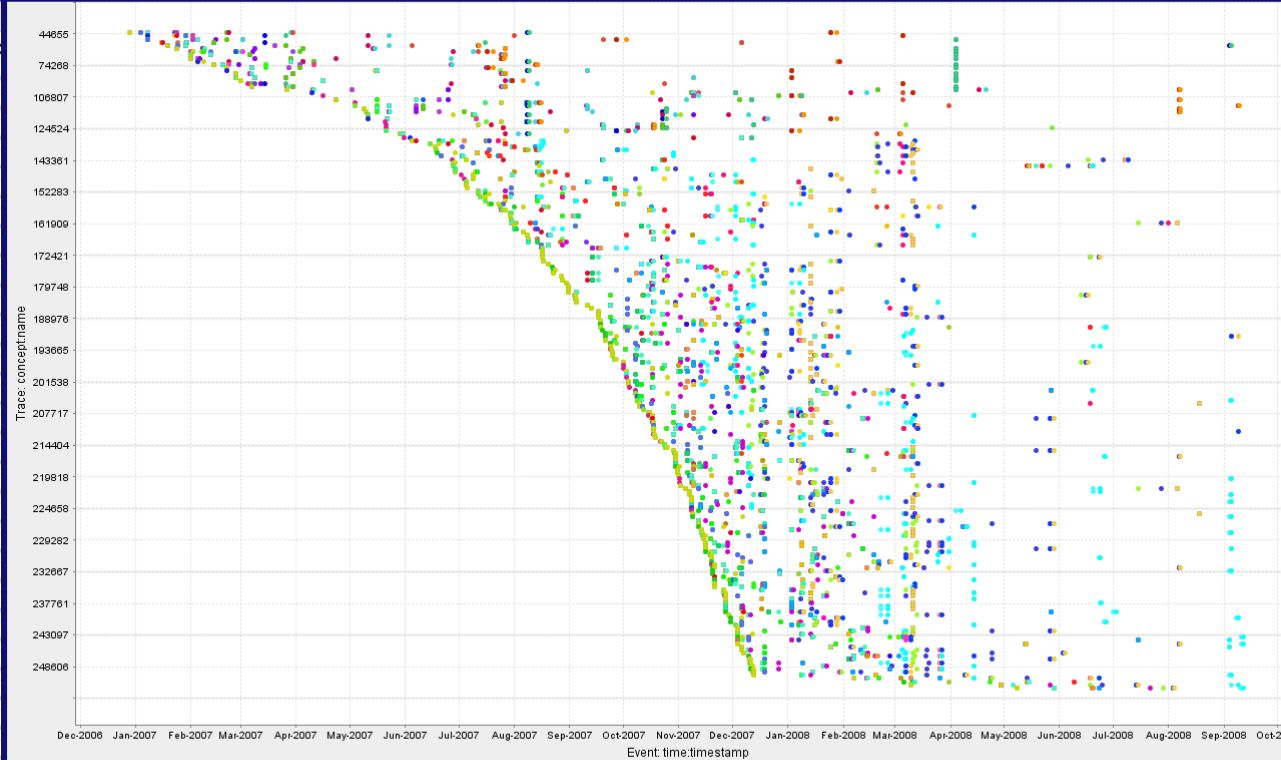


- 010 Registreren huuropzegging
- 020 Vastleggen datum van overlijden
- 030 Vastleggen toekomstige adres
- 040 Vastleggen toekomstig adres medehuurder
- 050 Inplannen afspraak 1e inspectie
- 050 Plannen afspraak 1e inspectie
- 055 Plannen eindinspectie bedryfsr/gar/ber/park/op
- 057 Plannen eindinspectie bedryfsr/gar/ber/park/op
- 058 Aanmaken bevest.brief huuropzegging(b/g/bsop)
- 060 Aanmaken bevestigingsbrief / huuropzeggingform.
- 065 Aanmaken bevest.brief huuropzegging(b/g/bsop)
- 070 Is 1e inspectie uitgevoerd ?
- 075 Bepalen leegstandsoort bedr/gar/berg/park/op
- 080 Versturen brief "Niet thuis"
- 090 Herplannen 1e inspectie
- 100 Gereedmelden 1e insp. / Voorcalculatie maken
- 110 Bepalen leegstandsoort
- 120 Plannen eindinspectie
- 130 Is het opleveringsformulier ondertekend ?
- 140 Aanmaken 1e in gebreke stelling
- 150 Is er sprake van ZAV ?
- 160 Registreren ZAV
- 170 Aanpassen plattegrond

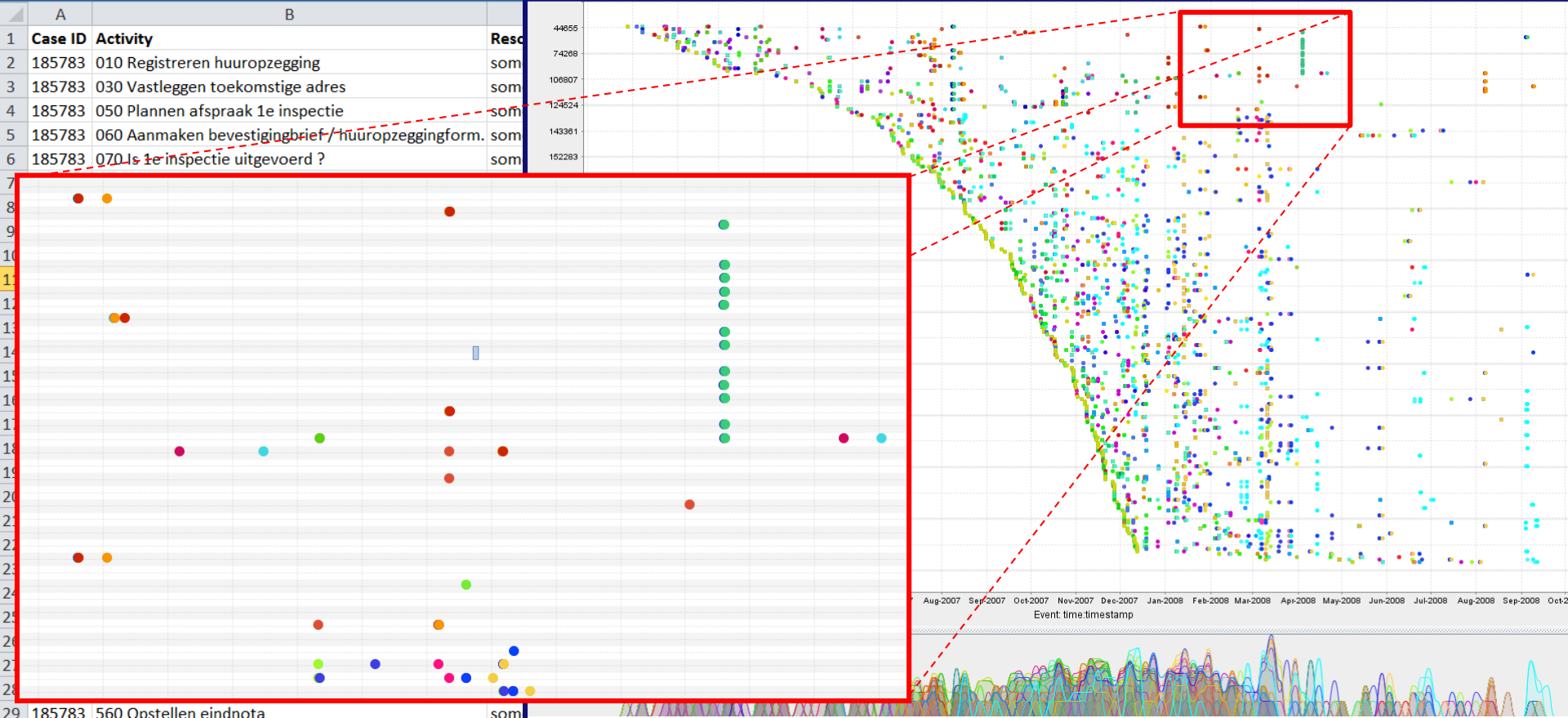
208 cases
5987 events
74 activities

Process Mining: Spreadsheet for behavior

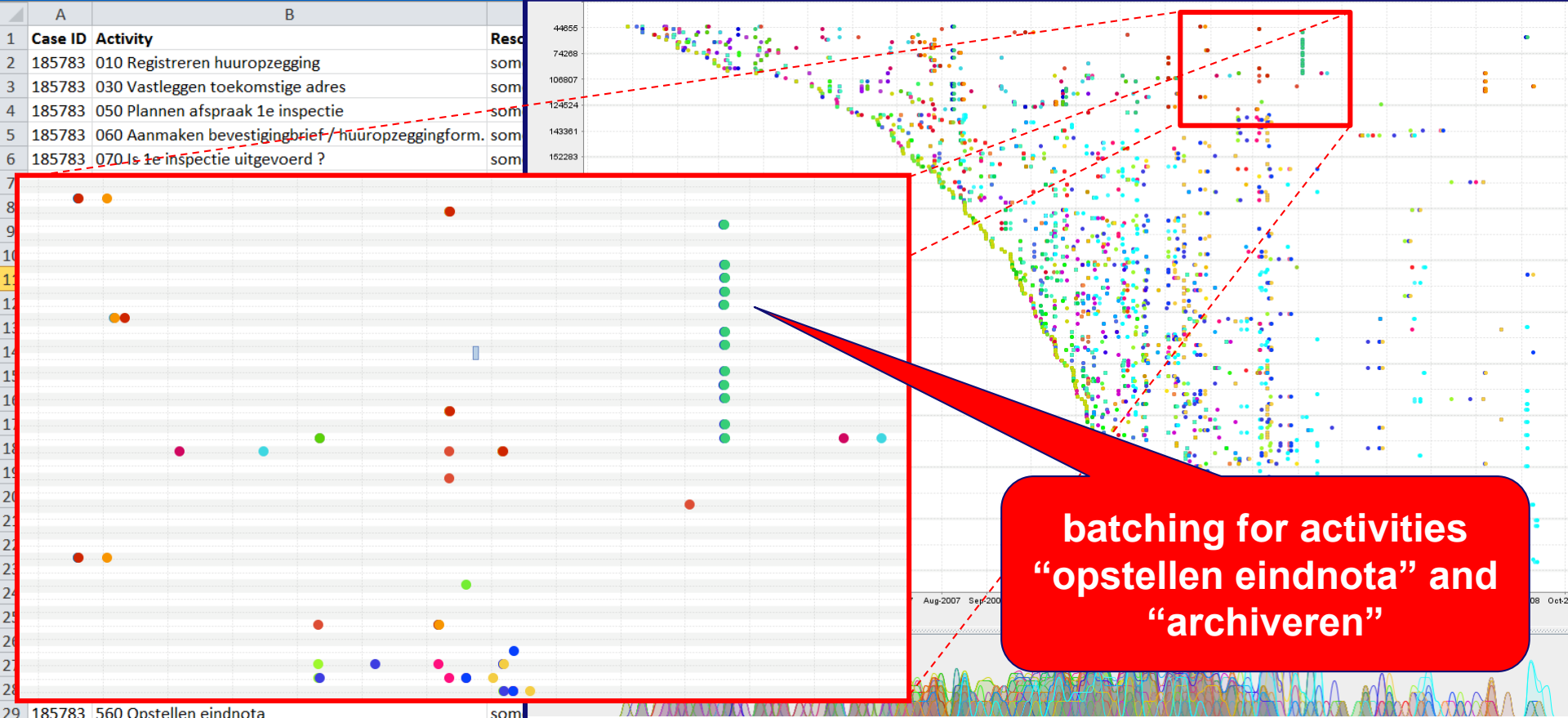
	A	B	
1	Case ID	Activity	Resc
2	185783	010 Registreren huuropzegging	som
3	185783	030 Vastleggen toekomstige adres	som
4	185783	050 Plannen afspraak 1e inspectie	som
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	som
6	185783	070 Is 1e inspectie uitgevoerd ?	som
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken	som
8	185783	120 Plannen eindinspectie	som
9	185783	400 Is eindinspectie uitgevoerd ?	som
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	som
11	185783	450 Krijgt de huurder tijd om te herstellen ?	som
12	185783	500 Beoordelen/wijzigen leegstandsoort	som
13	185783	110 Bepalen leegstandsoort	som
14	185783	510 Is opleveringsformulier ondertekend ?	som
15	185783	130 Is het opleveringsformulier ondertekend ?	som
16	185783	140 Aanmaken 1e in gebreke stelling	som
17	185783	150 Is er sprake van ZAV ?	som
18	185783	180 Aanpassen woningwaardering	som
19	185783	190 Harmoniseren huurprijs	som
20	185783	205 Bepalen kandidaat huurder	som
21	185783	170 Aanpassen plattegrond	som
22	185783	520 Aanmaken 2e in gebreke stelling	som
23	185783	530 Aanmaken werkopdracht	som
24	185783	540 Worden er bonussen/ kosten toegekend ?	som
25	185783	550 Vastleggen bonussen / kosten	som
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	som
27	185783	260 Is contract getekend en geld ontvangen ?	som
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	som
29	185783	560 Opstellen eindnota	som



Process Mining: Spreadsheet for behavior



Process Mining: Spreadsheet for behavior



**Loesje van
der Aalst**

desire line

Process Discovery



Process Mining: Spreadsheet for behavior

process discovery

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody	2007/09/24 08:39:32.000
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken	somebody	2007/09/24 08:41:26.000
8	185783	120 Plannen eindinspectie	somebody	2007/09/24 08:51:00.000
9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
13	185783	110 Bepalen leegstandsoort	somebody	2007/09/24 10:57:42.000
14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000
16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000

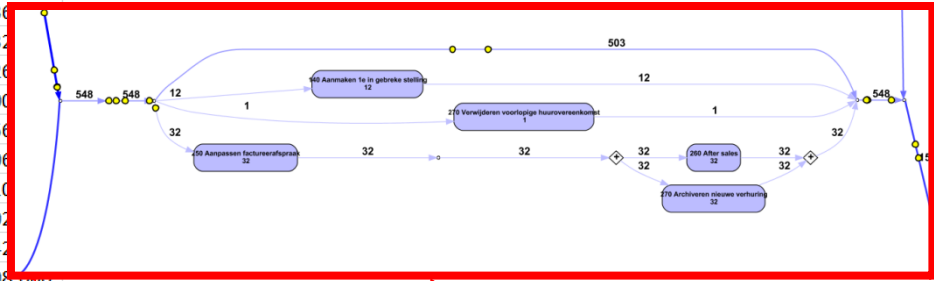


27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody	2007/09/24 08:39:32.000
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken	somebody	2007/09/24 08:41:26.000
8	185783	120 Plannen eindinspectie	somebody	2007/09/24 08:51:00.000
9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
13	185783	110 Bepalen leegstandsoort	somebody	2007/09/24 10:57:42.000
14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000
16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000

process discovery



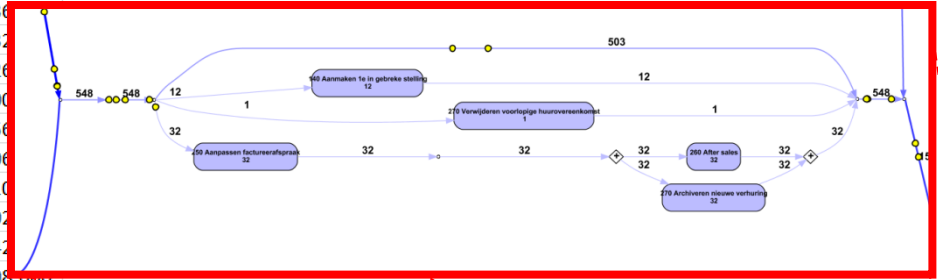
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody	2007/09/24 08:39:32.000
7	185783	100 Aanmaken offerte / Voorcalculatie maken	somebody	2007/09/24 08:41:26.000
8	185783	120 Is offerte gemaakt ?	somebody	2007/09/24 08:51:00.000
9	185783	400 Is offerte aangenomen ?	somebody	2007/09/24 10:55:56.000
10	185783	400 Is offerte aangenomen ?	somebody	2007/09/24 10:56:06.000
11	185783	400 Is offerte aangenomen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Is offerte aangenomen ?	somebody	2007/09/24 10:57:02.000
13	185783	110 Is offerte aangenomen ?	somebody	2007/09/24 10:57:42.000
14	185783	510 Is offerte aangenomen ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000
16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijis	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000

process discovery

**NO
modeling
needed!**



27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000

process discovery

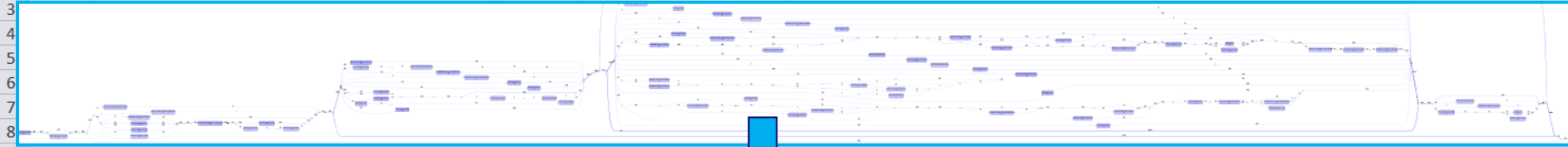


9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
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14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000
16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000
21	185783	170 Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	520 Aanmaken 2e in gebreke stelling	somebody	2007/10/30 11:45:53.000
23	185783	530 Aanmaken werkopdracht	somebody	2007/10/30 11:46:09.000
24	185783	540 Worden er bonussen/ kosten toegekend ?	somebody	2007/10/30 11:46:36.000
25	185783	550 Vastleggen bonussen / kosten	somebody	2007/10/30 11:53:00.000
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	somebody	2007/11/28 12:34:23.000
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000

process discovery



9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	140 Registreren huuropzegging	somebody	2007/09/24 11:01:58.000

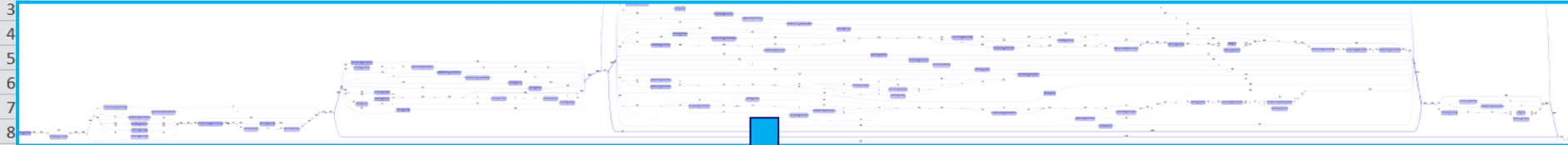


16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000
21	185783	170 Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	520 Aanmaken 2e in gebreke stelling	somebody	2007/10/30 11:45:53.000
23	185783	530 Aanmaken werkopdracht	somebody	2007/10/30 11:46:09.000
24	185783	540 Worden er bonussen/ kosten toegekend ?	somebody	2007/10/30 11:46:36.000
25	185783	550 Vastleggen bonussen / kosten	somebody	2007/10/30 11:53:00.000
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	somebody	2007/11/28 12:34:23.000
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000

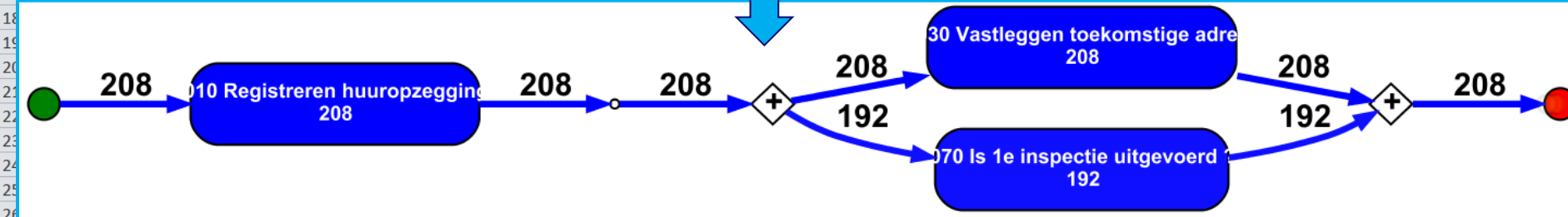
process discovery



9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
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16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000



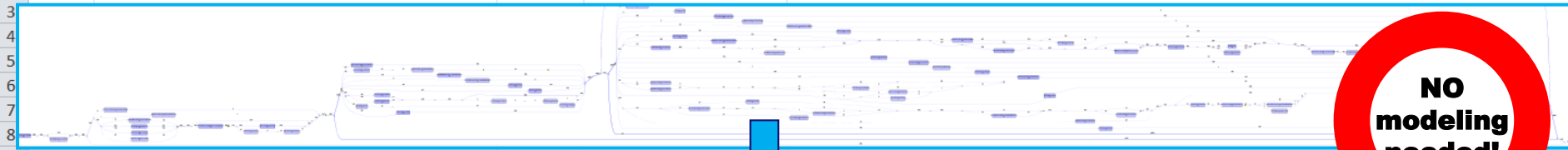
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000

process discovery

NO modeling needed!

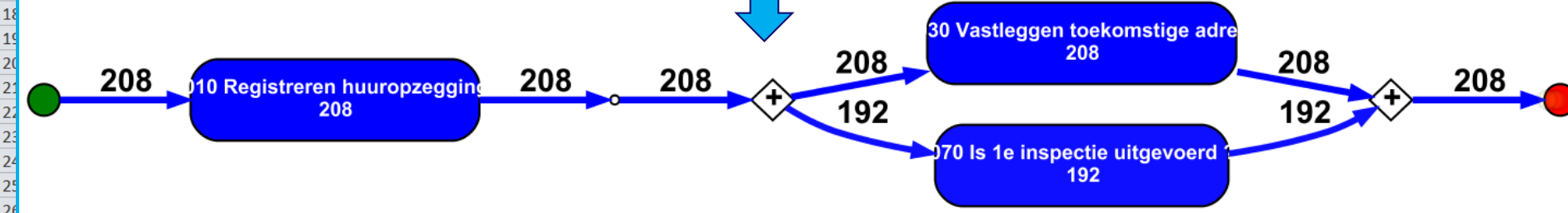


9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
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16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
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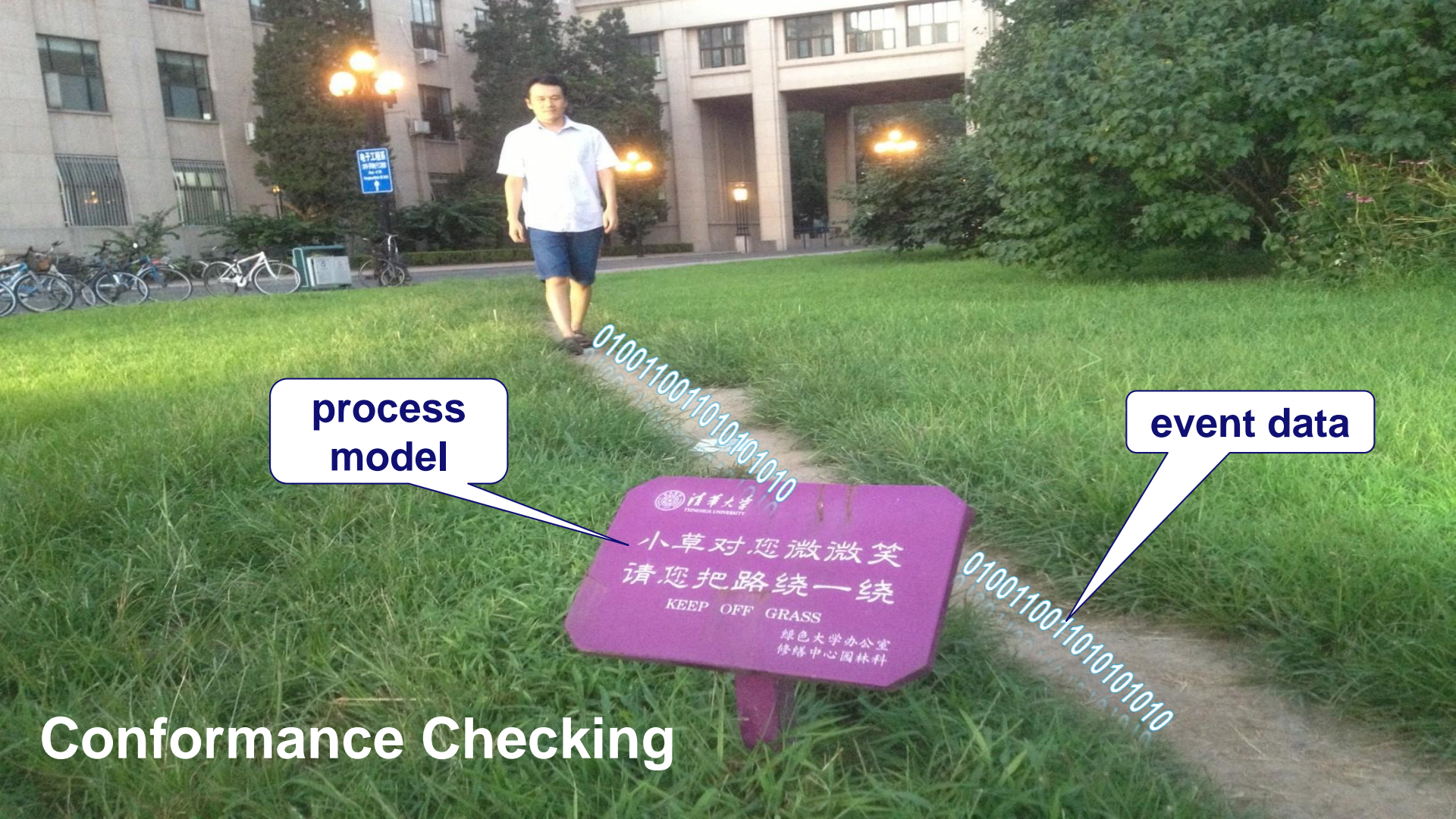
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
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27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
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28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
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29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000
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**process
model**

event data

Conformance Checking



desire line

**very safe
system**

Conformance Checking

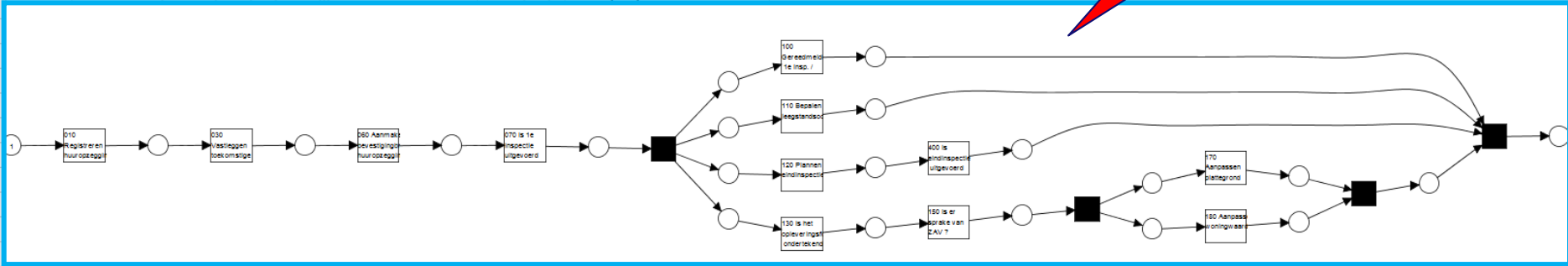
Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	somebody	2007/09/11 13:41:36.000
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody	2007/09/24 08:39:32.000
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken	somebody	2007/09/24 08:41:26.000
8	185783	120 Plannen eindinspectie	somebody	2007/09/24 08:51:00.000
9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?	somebody	2007/09/24 10:56:06.000
11	185783	450 Krijgt de huurder tijd om te herstellen ?	somebody	2007/09/24 10:56:10.000
12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
13	185783	110 Bepalen leegstandsoort	somebody	2007/09/24 10:57:42.000
14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000

conformance checking



discovered or hand-made

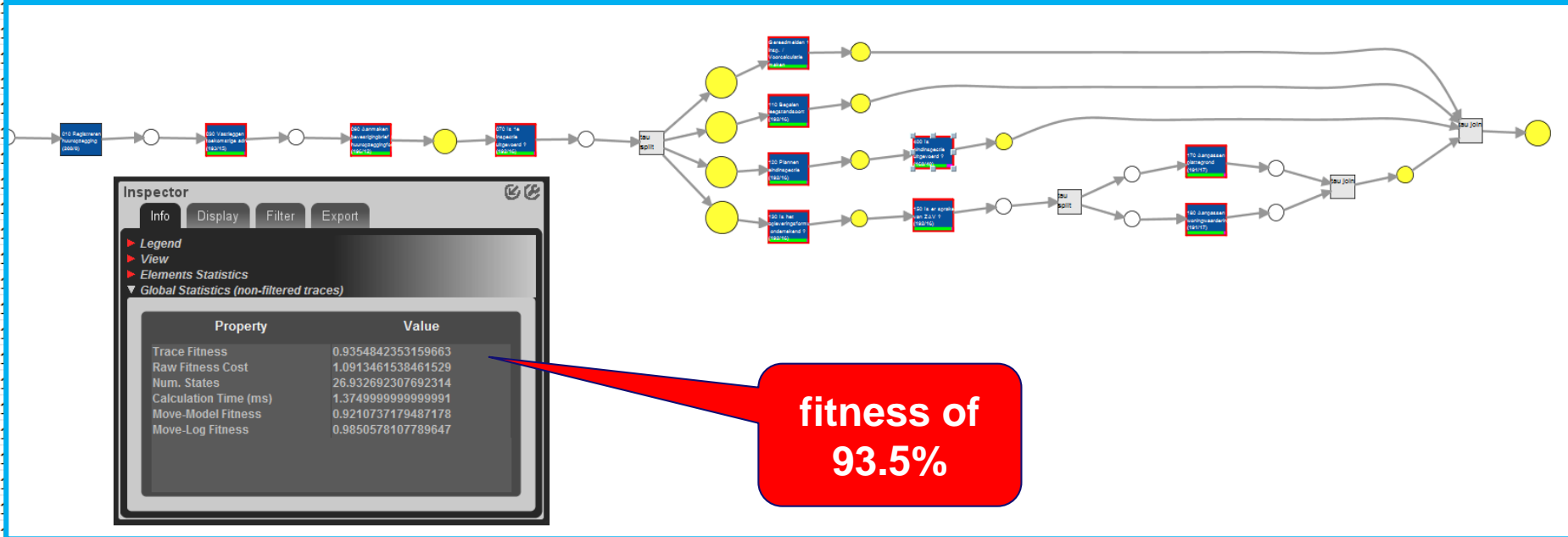


27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000

conformance checking



27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toeko		2007/09/11 13:26:28.000
4	185783	050 Plannen afspraak		2007/09/11 13:26:28.000
5	185783	060 Aanmaken bevest		2007/09/11 13:26:28.000
6	185783	070 Is 1e inspectie uit		2007/09/11 13:26:28.000
7	185783	100 Gereedmelden 1e		2007/09/11 13:26:28.000
8	185783	120 Plannen eindinspe		2007/09/11 13:26:28.000
9	185783	400 Is eindinspectie u		2007/09/11 13:26:28.000
10	185783	440 Zijn er nieuwe of		2007/09/11 13:26:28.000
11	185783	450 Krijgt de huurder		2007/09/11 13:26:28.000
12	185783	500 Beoordelen/wijzi		2007/09/11 13:26:28.000
13	185783	110 Bepalen leegstan		2007/09/11 13:26:28.000
14	185783	510 Is opleveringsfor		2007/09/11 13:26:28.000
15	185783	130 Is het opleverings		2007/09/11 13:26:28.000
16	185783	140 Aanmaken 1e in g		2007/09/11 13:26:28.000
17	185783	150 Is er sprake van Z		2007/09/11 13:26:28.000
18	185783	180 Aanpassen wonin		2007/09/11 13:26:28.000
19	185783	190 Harmoniseren hu		2007/09/11 13:26:28.000
20	185783	205 Bepalen kandida		2007/09/11 13:26:28.000
21	185783	170 Aanpassen platte		2007/09/11 13:26:28.000
22	185783	520 Aanmaken 2e in g		2007/09/11 13:26:28.000
23	185783	530 Aanmaken werko		2007/09/11 13:26:28.000
24	185783	540 Worden er bonus		2007/09/11 13:26:28.000
25	185783	550 Vastleggen bonus		2007/09/11 13:26:28.000
26	185783	240 Registreren voorl		2007/09/11 13:26:28.000
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigens status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

conformance checking

Inspector

Info Display Filter Export

Legend View

Elements Statistics

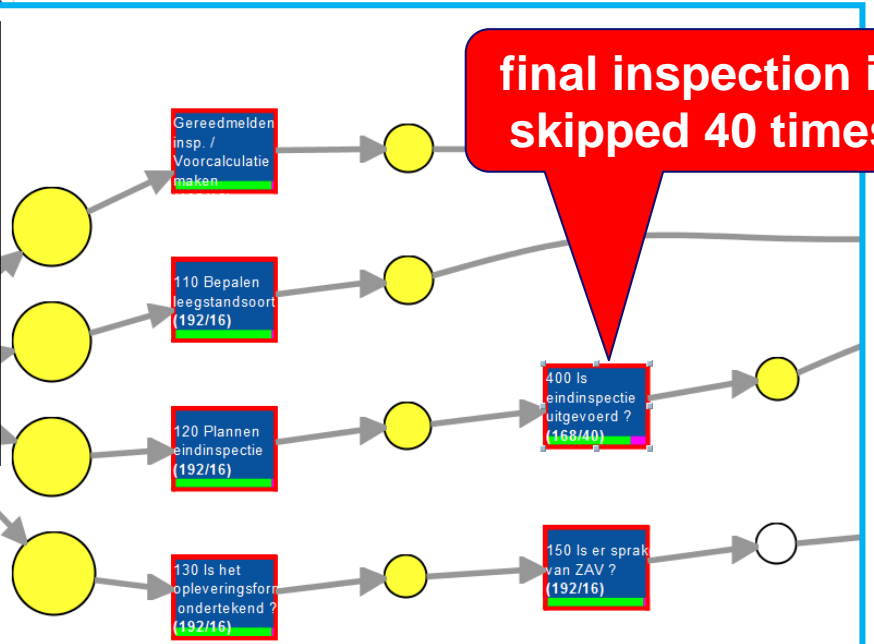
Selected elements* 400 Is eindinspectie uitgevoerd ?

Property	Value
#Move log+model (total)	168
#Move log+model (in 100% fitting traces)	142
#Traces where move log+model occur	168
#Move model only (in all traces)	40
#Traces where move model only occur	40

070 Is 1e inspectie uitgevoerd ?

* Click a place/transition on the projected model to see its stats, or use combobox

Global Statistics (non-filtered traces)



final inspection is skipped 40 times

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres		
4	185783	050 Plannen afspraak 1e inspectie		
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.		
6	185783	070 Is 1e inspectie uitgevoerd ?		
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken		
8	185783	120 Plannen eindinspectie		
9	185783	400 Is eindinspectie uitgevoerd ?		
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?		
11	185783	450 Krijgt de huurder tijd om te herstellen ?		
12	185783	500 Beoordelen/wijzigen leegstandsoort		
13	185783	110 Bepalen leegstandsoort		
14	185783	510 Is opleveringsformulier ondertekend ?		
15	185783	130 Is het opleveringsformulier ondertekend ?		
16	185783	140 Aanmaken 1e in gebreke stelling		
17	185783	150 Is er sprake van ZAV ?		
18	185783	180 Aanpassen woningwaardering		
19	185783	190 Harmoniseren huurprijs		
20	185783	205 Bepalen kandidaat huurder		
21	185783	170 Aanpassen plattegrond		
22	185783	520 Aanmaken 2e in gebreke stelling		
23	185783	530 Aanmaken werkopdracht		
24	185783	540 Worden er bonussen/ kosten toegekend ?		
25	185783	550 Vastleggen bonussen / kosten		
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken		
27	185783	260 Is contract getekend en geld ontvangen ?		
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)		
29	185783	560 Opstellen eindnota		

conformance checking

Case id(s): 248499

Num. Cases	2
Is Alignment Reliable?	Yes
Trace Fitness	1

Alignment
16 events

Case id(s): 80437

Num. Cases	2
Is Alignment Reliable?	Yes
Trace Fitness	0.96

Alignment
16 events

Case id(s): 172192

Num. Cases	1
Is Alignment Reliable?	Yes
Trace Fitness	0.88

Alignment
18 events

Case id(s): 192867

Num. Cases	1
Is Alignment Reliable?	Yes
Trace Fitness	0.92

Alignment
18 events

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging		
3	185783	030 Vastleggen toekomstige adres		
4	185783	050 Plannen afspraak 1e inspectie		
5	185783	060 Aanmaken bevestigingsbrief / huuropzeg		
6	185783	070 Is 1e inspectie uitgevoerd ?		
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie		
8	185783	120 Plannen eindinspectie		
9	185783	400 Is eindinspectie uitgevoerd ?		
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?		
11	185783	450 Krijgt de huurder tijd om te herstellen ?		
12	185783	500 Beoordelen/wijzigen leegstandsoort		
13	185783	110 Bepalen leegstandsoort		
14	185783	510 Is opleveringsformulier ondertekend ?		
15	185783	130 Is het opleveringsformulier ondertekend ?		
16	185783	140 Aanmaken 1e in gebreke stelling		
17	185783	150 Is er sprake van ZAV ?		
18	185783	180 Aanpassen woningwaardering		
19	185783	190 Harmoniseren huurprijs		
20	185783	205 Bepalen kandidaat huurder		
21	185783	170 Aanpassen plattegrond		
22	185783	520 Aanmaken 2e in gebreke stelling		
23	185783	530 Aanmaken werkopdracht		
24	185783	540 Worden er bonussen/ kosten toegekend ?		
25	185783	550 Vastleggen bonussen / kosten		
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken		
27	185783	260 Is contract getekend en geld ontvangen ?		
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)		
29	185783	560 Opstellen eindnota		

move on model
(something should have
happened, but did not)

conformance checking



Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging		
3	185783	030 Vastleggen toekomstige adres		
4	185783	050 Plannen afspraak 1e inspectie		
5	185783	060 Aanmaken bevestigingsbrief / huuropzeg		
6	185783	070 Is 1e inspectie uitgevoerd ?		
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie		
8	185783	120 Plannen eindinspectie		
9	185783	400 Is eindinspectie uitgevoerd ?		
10	185783	440 Zijn er nieuwe of niet herstelde gebreken ?		
11	185783	450 Krijgt de huurder tijd om te herstellen ?		
12	185783	500 Beoordelen/wijzigen leegstandsoort		
13	185783	110 Bepalen leegstandsoort		
14	185783	510 Is opleveringsformulier ondertekend ?		
15	185783	130 Is het oplevering		
16	185783	140 Aanmaken 1e i		
17	185783	150 Is er sprake van		
18	185783	180 Aanpassen wor		
19	185783	190 Harmoniseren i		
20	185783	205 Bepalen kandid		
21	185783	170 Aanpassen plat		
22	185783	520 Aanmaken 2e i		
23	185783	530 Aanmaken werkop		
24	185783	540 Worden er bonussen/ kosten toegekend ?		
25	185783	550 Vastleggen bonussen / kosten		
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken		
27	185783	260 Is contract getekend en geld ontvangen ?		
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)		
29	185783	560 Opstellen eindnota		

conformance checking

move on model
(something should have happened, but did not)

move on log
(something happened that should not happen)

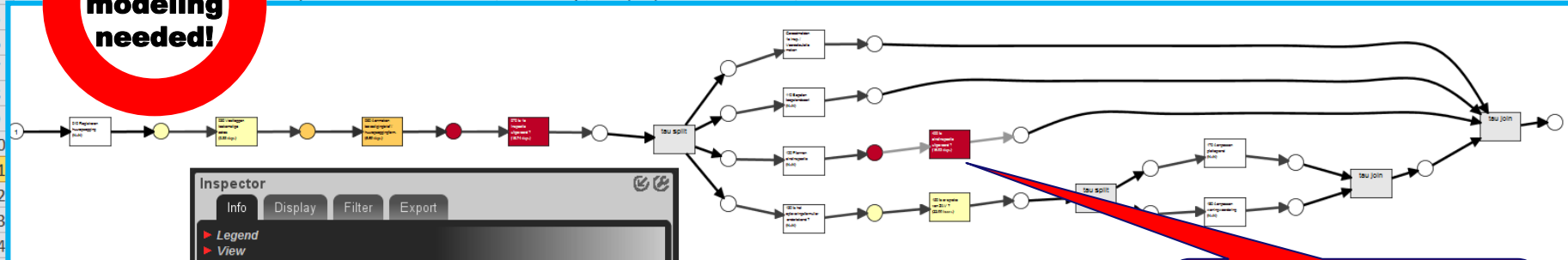


Process Mining: Spreadsheet for behavior

Case ID	Resource	Complete Timestamp
185783	somebody	2007/09/11 13:21:27.000
185783	somebody	2007/09/11 13:26:29.000
185783	somebody	2007/09/11 13:29:34.000

performance analysis

NO modeling needed!



Inspector

Info Display Filter Export

- Legend
- View
- Element Statistics
- Global Statistics

Case Property	Value
#Cases	208
#Perfectly-fitting cases	142
#Non-fitting cases	66
#Properly started cases	208
Case Throughput time (avg)	1.92 months
Case Throughput time (min)	7.80 min
Case Throughput time (max)	10.86 months
Case Throughput time (std. dev)	1.50 months
Observation period	18.81 months

bottleneck

average flowtime is 1.92 months

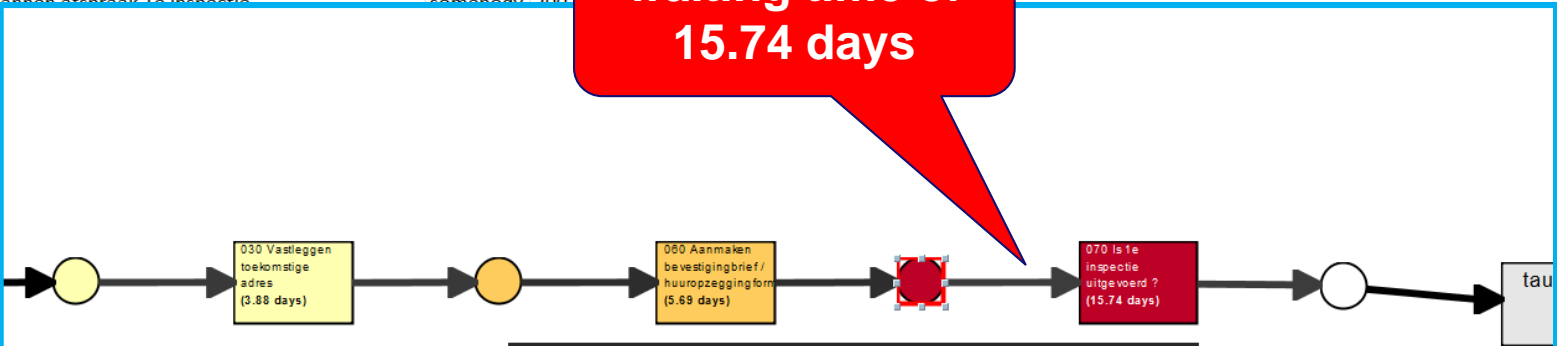
185783	240 Registreren voorl. huurovereenkomst +afdrucken	somebody	2007/11/28 12:34:23.000
185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/12/12 11:19:41.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/12/12 11:19:41.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/12/12 11:19:41.000
5	185783	060 Aankomen	somebody	2007/12/12 11:19:41.000
6	185783	070 Is te inspectie uitgevoerd?	somebody	2007/12/12 11:19:41.000
7	185783	100 Gereguleerd	somebody	2007/12/12 11:19:41.000
8	185783	120 Plichtvolden	somebody	2007/12/12 11:19:41.000
9	185783	400 Is te inspectie uitgevoerd?	somebody	2007/12/12 11:19:41.000
10	185783	440 Zakenlijst	somebody	2007/12/12 11:19:41.000
11	185783	450 Kanton	somebody	2007/12/12 11:19:41.000
12	185783	500 Bepalen	somebody	2007/12/12 11:19:41.000
13	185783	110 Bepalen	somebody	2007/12/12 11:19:41.000
14	185783	510 Is te inspectie uitgevoerd?	somebody	2007/12/12 11:19:41.000
15	185783	130 Is te inspectie uitgevoerd?	somebody	2007/12/12 11:19:41.000
16	185783	140 Aankomen	somebody	2007/12/12 11:19:41.000
17	185783	150 Is te inspectie uitgevoerd?	somebody	2007/12/12 11:19:41.000
18	185783	180 Aankomen	somebody	2007/12/12 11:19:41.000
19	185783	190 Hulp	somebody	2007/12/12 11:19:41.000
20	185783	205 Bepalen	somebody	2007/12/12 11:19:41.000
21	185783	170 Aankomen	somebody	2007/12/12 11:19:41.000
22	185783	520 Aankomen	somebody	2007/12/12 11:19:41.000
23	185783	530 Aankomen	somebody	2007/12/12 11:19:41.000
24	185783	540 Wachten	somebody	2007/12/12 11:19:41.000
25	185783	550 Vastleggen	somebody	2007/12/12 11:19:41.000
26	185783	240 Registreren	somebody	2007/12/12 11:19:41.000
27	185783	260 Is te inspectie uitgevoerd?	somebody	2007/12/12 11:19:41.000
28	185783	300 Wachten	somebody	2007/12/12 11:19:41.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

performance analysis

waiting time of 15.74 days



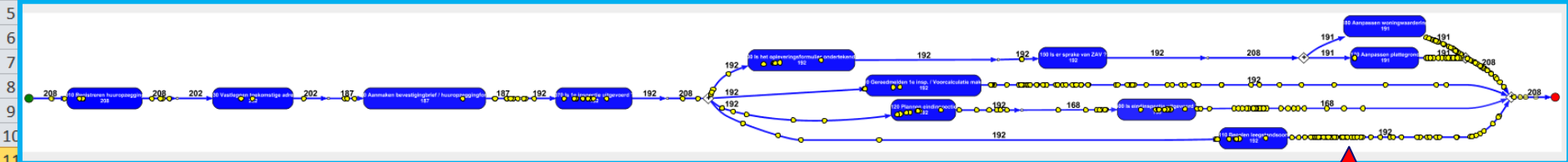
NO modeling needed!

Inspector						
Info Display Filter Export						
Legend						
View						
Element Statistics						
Selected elements* sink 5						
Property	Min.	Max.	Avg.	Std. Dev	Freq.	
Waiting time	6.00 seconds	9.10 months	15.74 days	24.52 days	192	
Synchroniza...	0.00 ms	0.00 ms	0.00 ms	0.00 ms	192	
Sojourn time	6.00 seconds	9.10 months	15.74 days	24.52 days	192	

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Complete Timestamp
2	185783	010 Registreren huuropzegging	somebody	2007/09/11 13:21:27.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/11 13:26:29.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/11 13:29:34.000

animating reality



12	185783	500 Beoordelen/wijzigen leegstandsoort	somebody	2007/09/24 10:57:02.000
13	185783	110 Bepalen leegstandsoort	somebody	2007/09/24 10:57:42.000
14	185783	510 Is opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:08.000
15	185783	130 Is het opleveringsformulier ondertekend ?	somebody	2007/09/24 10:58:19.000
16	185783	140 Aanmaken 1e in gebreke stelling	somebody	2007/09/24 11:01:58.000
17	185783	150 Is er sprake van ZAV ?	somebody	2007/09/24 11:37:33.000
18	185783	180 Aanpassen woningwaardering	somebody	2007/09/24 11:37:44.000
19	185783	190 Harmoniseren huurprijs	somebody	2007/09/24 11:40:01.000
20	185783	205 Bepalen kandidaat huurder	somebody	2007/09/24 11:47:42.000
21	185783	170 Aanpassen plattegrond	somebody	2007/09/24 12:10:58.000
22	185783	520 Aanmaken 2e in gebreke stelling	somebody	2007/10/30 11:45:53.000
23	185783	530 Aanmaken werkopdracht	somebody	2007/10/30 11:46:09.000
24	185783	540 Worden er bonussen/ kosten toegekend ?	somebody	2007/10/30 11:46:36.000
25	185783	550 Vastleggen bonussen / kosten	somebody	2007/10/30 11:53:00.000
26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	somebody	2007/11/28 12:34:23.000
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

real cases

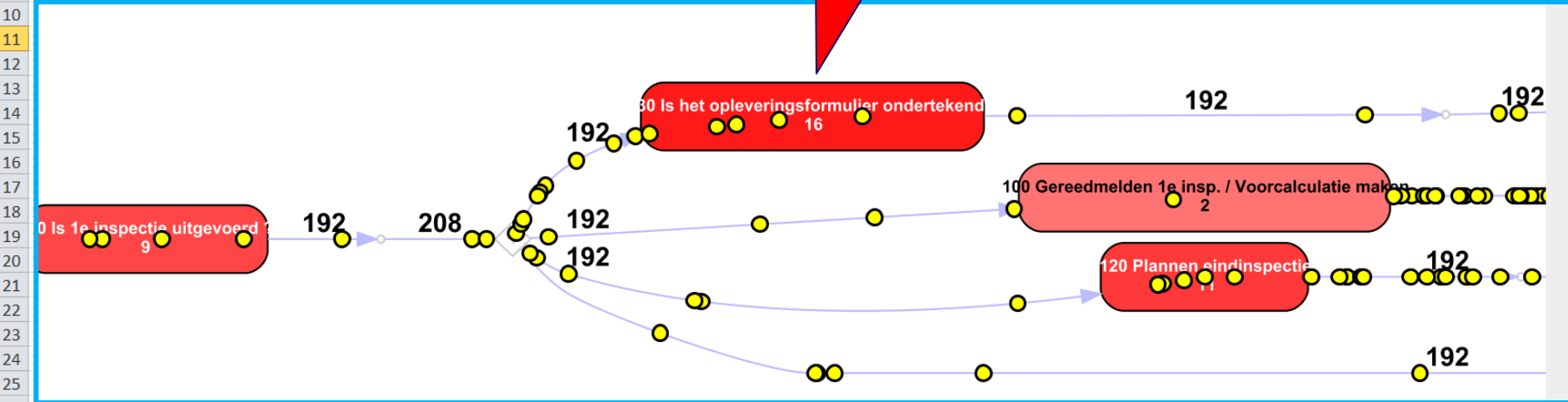
NO modeling needed!

Process Mining: Spreadsheet for behavior

	A	B	C	D
1	Case ID	Activity	Resource	Completed
2	185783	010 Registreren huuropzegging	somebody	2007/09/24 08:41:26.000
3	185783	030 Vastleggen toekomstige adres	somebody	2007/09/24 08:51:00.000
4	185783	050 Plannen afspraak 1e inspectie	somebody	2007/09/24 10:55:56.000
5	185783	060 Aanmaken bevestigingsbrief / huuropzeggingform.	somebody	
6	185783	070 Is 1e inspectie uitgevoerd ?	somebody	
7	185783	100 Gereedmelden 1e insp. / Voorcalculatie maken	somebody	2007/09/24 08:41:26.000
8	185783	120 Plannen eindinspectie	somebody	2007/09/24 08:51:00.000
9	185783	400 Is eindinspectie uitgevoerd ?	somebody	2007/09/24 10:55:56.000

animating reality

16 cases are queueing



26	185783	240 Registreren voorl. huurovereenkomst +afdrukken	somebody	2007/11/28 12:34:23.000
27	185783	260 Is contract getekend en geld ontvangen ?	somebody	2007/12/10 10:44:06.000
28	185783	300 Wijzigen status WMS (definitief geaccepteerd)	somebody	2007/12/11 16:26:14.000
29	185783	560 Opstellen eindnota	somebody	2007/12/12 11:19:41.000

Event data

Event data may come from ...

Event data may come from ...

- **a database system (e.g., patient data in a hospital),**

Event data may come from ...

- a database system (e.g., patient data in a hospital),
- a comma-separated values (CSV) file or spreadsheet,

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

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

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

Minimal requirements in terms of a CSV file

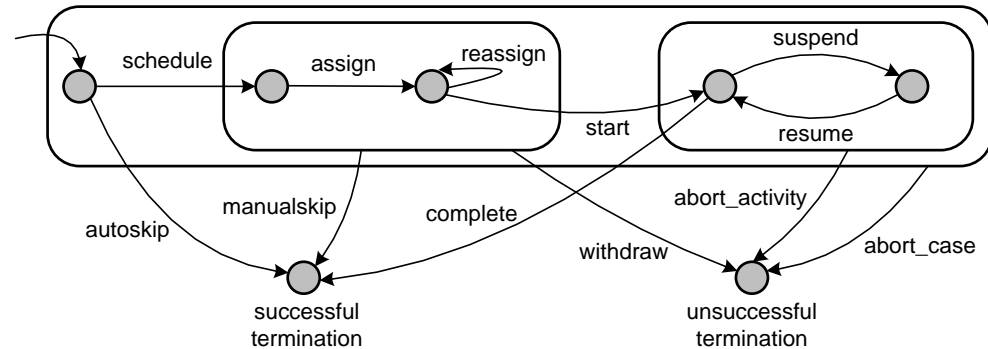
- Each row corresponds to an event.
- There are at least three columns:
 - Case id (patient id, order number, claim number, ...)
 - Activity name (approve, reject, request, send, ...)
 - Timestamp (2015-08-18T06:36:40, ...)
- There may be many other (optional) columns: resource, transaction type, age, costs, etc.

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

Extensions

- **Transactional information** on activity instances:

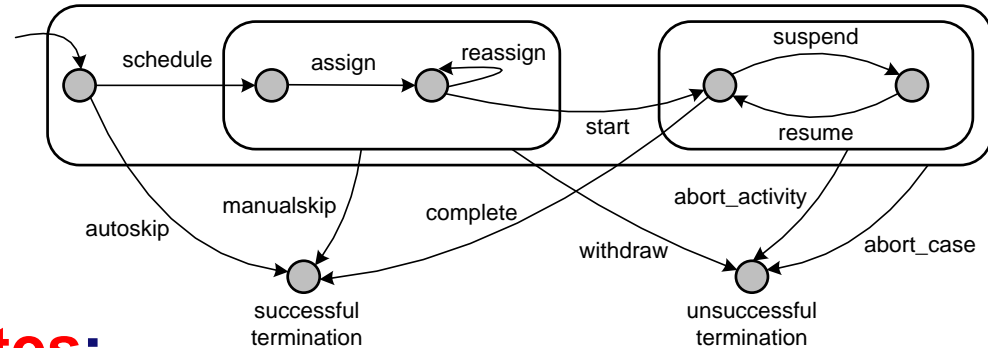
An event can represent a **start, complete, suspend, resume, abort, etc.**



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.

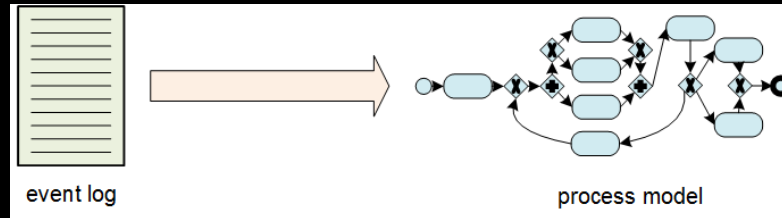
XES (eXtensible Event Stream)

- 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**.



Extensible Event Stream

Process discovery algorithms





THIS WAY

THAT WAY

ANOTHER WAY



THIS WAY

THAT WAY

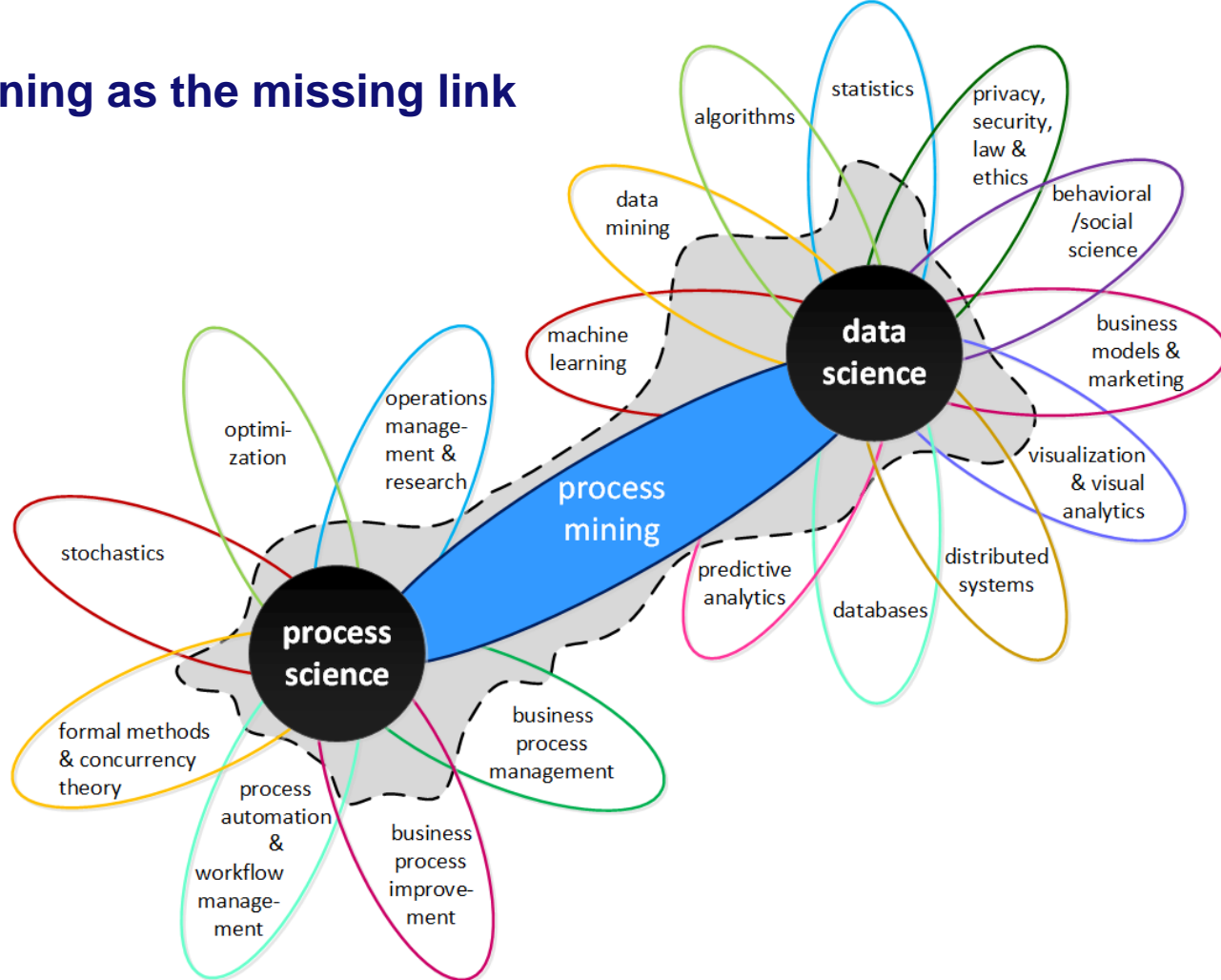
ANOTHER WAY

Characteristics

- 1. Representational bias (class of target models)**
- 2. Ability to deal with noise/infrequent/incomplete behavior**
- 3. Formal guarantees (in the limit, rediscoverability)**
- 4. Scalability**
- 5. Approach used:**
 - Direct algorithmic (alpha-family, heuristic/fuzzy miner)**
 - Region-based (language/state-based)**
 - Generic/evolutionary**
 - Inductive**

How process mining compares to data mining

process mining as the missing link



Connecting things: Process mining as super glue

- **Data – Process**
- **Business – IT**
- **Business Intelligence – Business Process Management**
- **Performance – Compliance**
- **Runtime – Design time**
- ...



Process Mining Versus Data Mining

- Both start from **data**.
- Data mining techniques are typically **not process-centric**.
- Topics such as **process discovery, conformance checking, and bottleneck analysis** are **not** addressed by traditional data mining techniques.

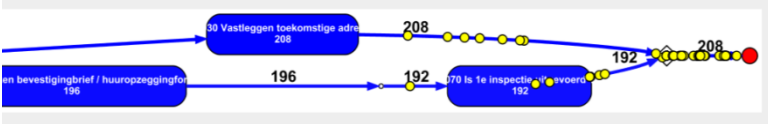
Process Mining Versus Data Mining

- **End-to-end** process models and **concurrency** are essential for process mining.
- Process mining assumes event logs where events have **timestamps** and refer to **cases** (process instances).
- Process mining and data mining need to be **combined** for more advanced questions.

Tooling and industry collaboration

Process Mining Software

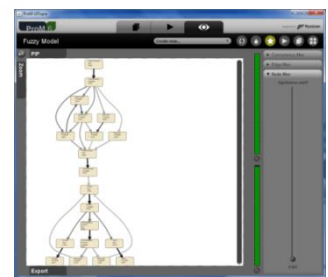




1500+ plug-ins available covering the whole process mining spectrum



100% FREE



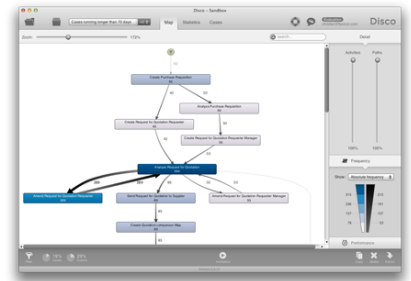
>130k downloads





Disco

perceptive software
a Lexmark company



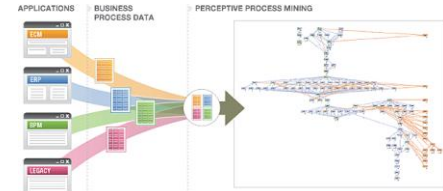
minit



celonis
process mining



Software AG
Process Performance Manager
Discover, analyze and monitor:
the road to process improvement



my i nvenio

FUJITSU

SNP The Transformation Company

TU/e

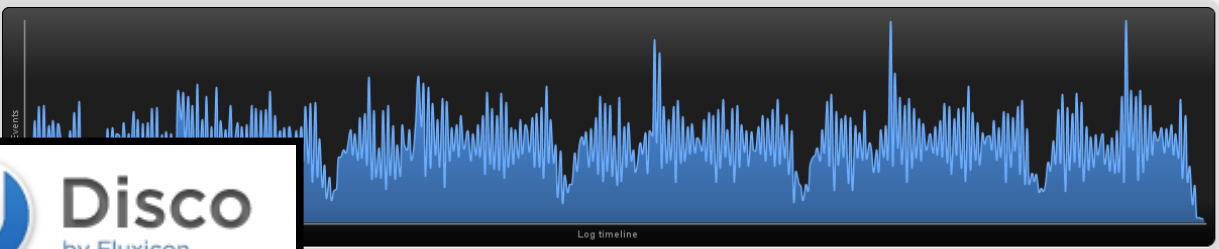
Links to some tools

Short name	Full name of tool	Version	Vendor	Webpage
Celonis	Celonis Process Mining	4	Celonis GmbH	www.celonis.de
Disco	Disc	1.9.5	Fluxicon	www.fluxicon.com
EDS	Enterprise Discovery Suite	4	StereoLOGIC Ltd	www.stereologic.com
Fujitsu	Interstage Business Process Manager Analytics	12.2	Fujitsu Ltd	www.fujitsu.com
Icaro	Icaro EVERFlow	1	Icaro Tech	www.icarotech.com
Icris	Icris Process Mining Factory	1	Icris	www.processminingfactory.com
LANA	LANA Process Mining	1	Lana Labs	www.lana-labs.com
Minit	Minit	1	Gradient ECM	www.minitlabs.com
myInvenio	myInvenio	1	Cognitive Technology	www.my-invenio.com
Perceptive	Perceptive Process Mining	2.7	Lexmark	www.lexmark.com
ProcessGold	ProcessGold Enterprise Platform	8	Processgold International B.V.	www.processgold.com
ProM	ProM	6.6	Open Source hosted at TU/e	www.promtools.org
ProM Lite	ProM Lite	1.1	Open Source hosted at TU/e	www.promtools.org
QPR	QPR ProcessAnalyzer	2015.5	QPR	www.qpr.com
RapidProM	RapidProM	4.0.0	Open Source hosted at TU/e	www.rapidprom.org
Rialto	Rialto Process	1.5	Exeura	www.exeura.eu
SNP	SNP Business Process Analysis	15.27	SNP Schneider-Neureither & Partner AG	www.snp-bpa.com
PPM	webMethods Process Performance Manager	9.9	Software AG	www.softwareag.com

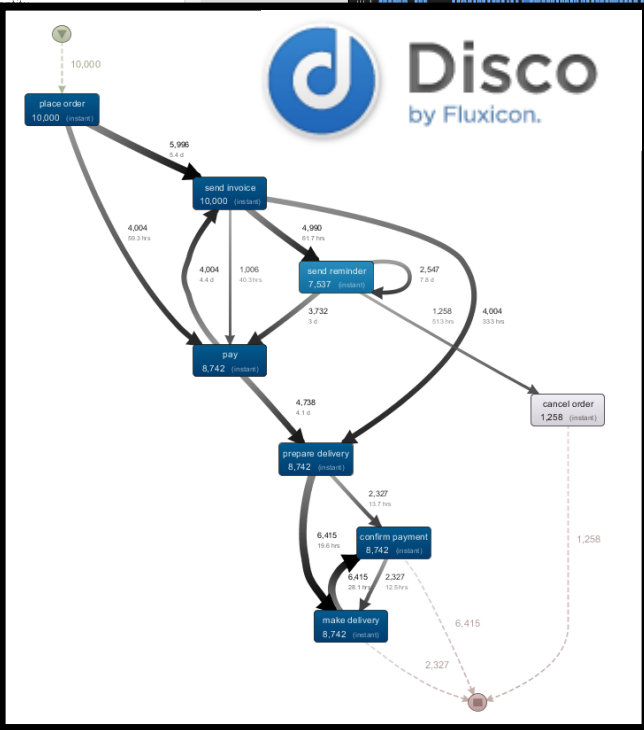
- Statistics views
 - Overview
 - Global statistics
- Activity
 - Activity classes
- product
 - Other attribute
- prod-price
 - Other attribute

Overview
Global statistics

- Events over time
- Active cases over time
- Case variants
- Events per case
- Case duration

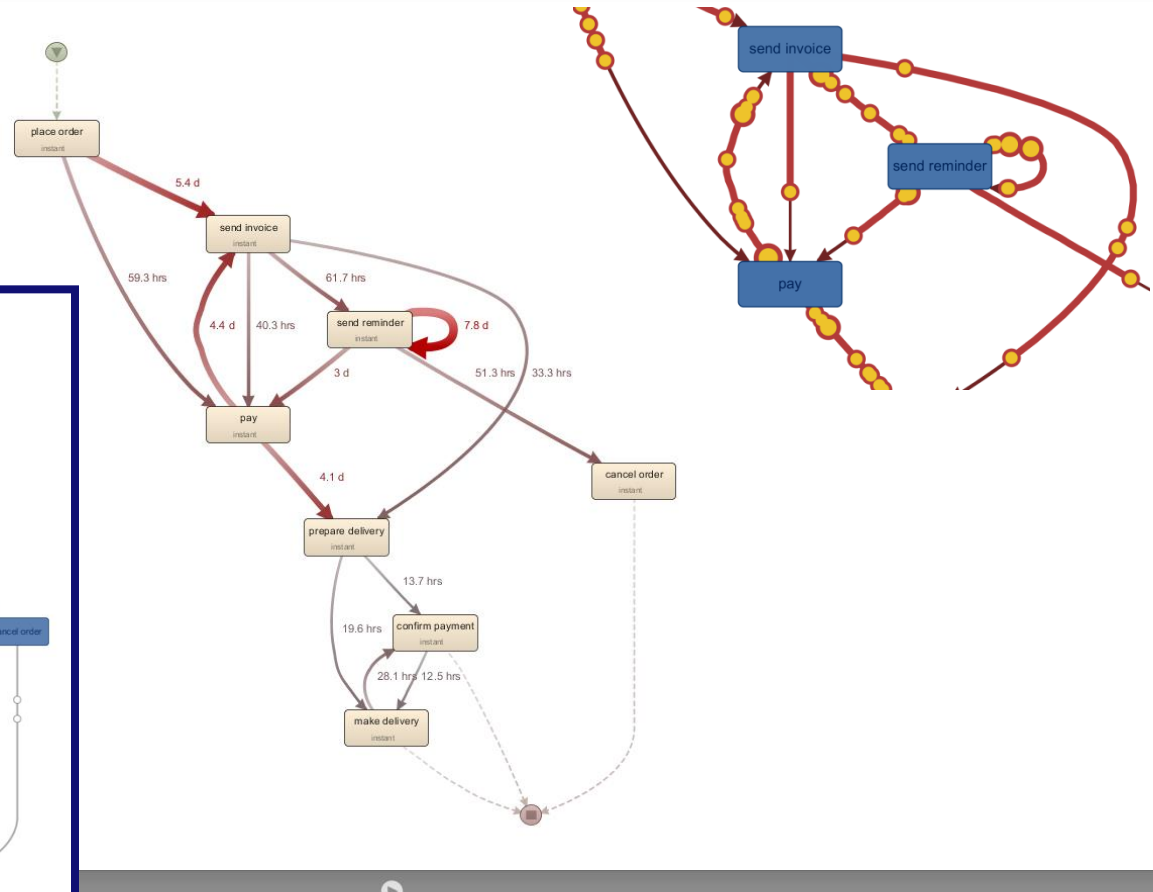
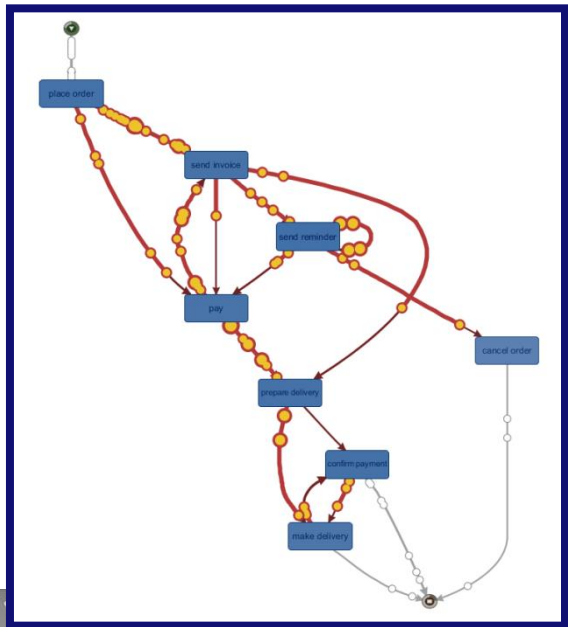


Events	63,763
Cases	10,000
Activities	8
Median case duration	13.9 d
Mean case duration	14.9 d
Start	05.01.2015 09:00:07
End	31.12.2019 14:46:02



Cases (10000) Variants (9)

Variant	Started	Finished	Duration
7	05.01.2015 09:00:07	26.01.2015 16:42:28	21 days, 7 hours
1	05.01.2015 10:18:21	15.01.2015 15:52:30	10 days, 5 hours
4	05.01.2015 11:54:49	09.01.2015 18:38:58	4 days, 6 hours
3	05.01.2015 14:07:45	22.01.2015 13:18:30	16 days, 23 hours
1	05.01.2015 15:33:38	12.01.2015 17:27:36	7 days, 1 hour
5	05.01.2015 17:25:23	02.02.2015 12:31:09	27 days, 19 hours
4	05.01.2015 19:08:53	15.01.2015 14:56:54	9 days, 19 hours
9	05.01.2015 21:54:00	13.01.2015 15:49:53	7 days, 17 hours
4	06.01.2015 07:25:13	15.01.2015 11:27:50	9 days, 4 hours
1	06.01.2015 10:09:51	15.01.2015 19:15:18	9 days, 9 hours
1	06.01.2015 11:37:49	14.01.2015 09:14:28	7 days, 21 hours
4	06.01.2015 13:33:45	14.01.2015 11:30:05	7 days, 21 hours
4	06.01.2015 15:25:38	13.01.2015 12:25:34	6 days, 20 hours
2	06.01.2015 17:09:23	22.01.2015 18:59:10	16 days, 1 hour
3	06.01.2015 18:36:53	22.01.2015 14:39:39	15 days, 20 hours
8	06.01.2015 21:26:54	26.01.2015 17:16:02	19 days, 19 hours
1	07.01.2015 04:42:36	16.01.2015 10:17:14	9 days, 5 hours
3	07.01.2015 10:10:58	21.01.2015 17:31:29	14 days, 7 hours
8	07.01.2015 11:40:04	28.01.2015 10:27:12	20 days, 22 hours
9	07.01.2015 13:38:15	13.01.2015 13:22:15	5 days, 23 hours
1	07.01.2015 15:34:37	19.01.2015 09:11:23	11 days, 17 hours
1	07.01.2015 17:27:21	16.01.2015 09:09:25	8 days, 15 hours
5	07.01.2015 19:12:50	03.02.2015 14:34:33	26 days, 19 hours
6	07.01.2015 22:01:54	19.01.2015 13:15:02	11 days, 15 hours
8	08.01.2015 07:12:36	28.01.2015 10:41:14	20 days, 3 hours
3	08.01.2015 09:55:59	26.01.2015 15:52:42	18 days, 5 hours
6	08.01.2015 12:10:05	15.01.2015 13:54:59	7 days, 1 hour
1	08.01.2015 13:38:17	14.01.2015 12:30:26	5 days, 22 hours
5	08.01.2015 15:34:42	02.02.2015 14:10:36	24 days, 22 hours
2	08.01.2015 17:27:31	29.01.2015 11:26:06	20 days, 17 hours
3	08.01.2015 19:13:09	26.01.2015 14:16:02	17 days, 19 hours
4	08.01.2015 22:02:32	20.01.2015 10:35:40	11 days, 12 hours



Detail

Activities 100% Paths 100%

Frequency

Performance

Show: Mean duration

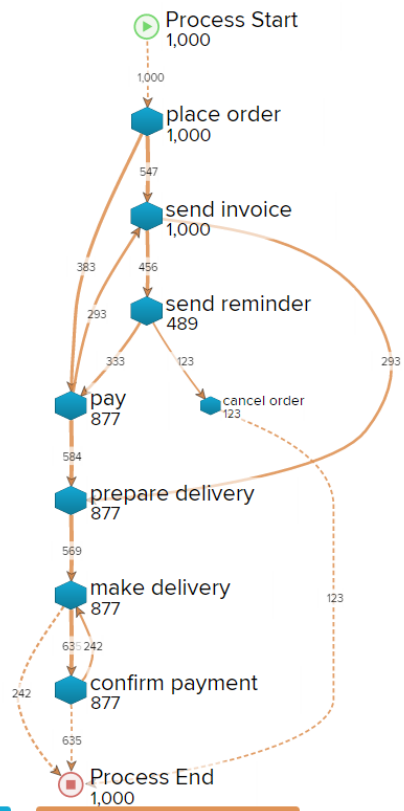
instant	6.3 d
instant	4.7 d
instant	3.1 d
instant	37.6 hrs

Add secondary metrics

123

▶

🔍

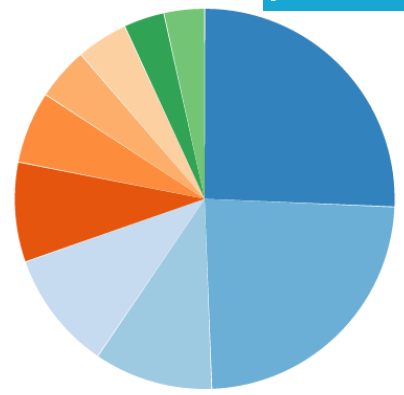


[-] [Home] [+]

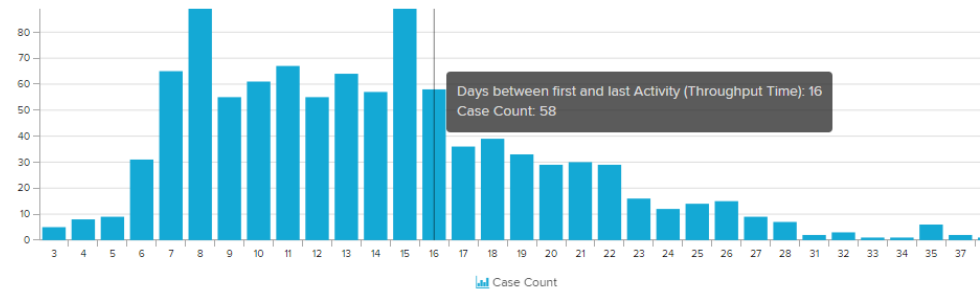
Vertical zoom slider

Activities 100%

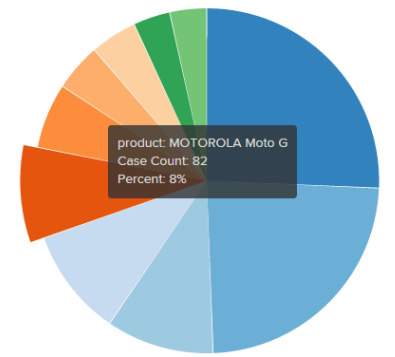
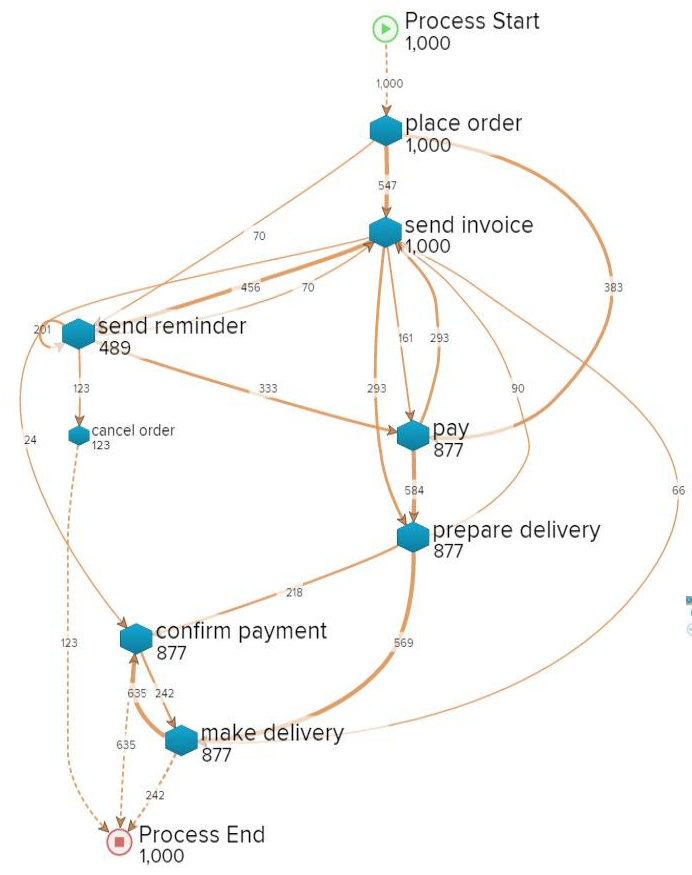
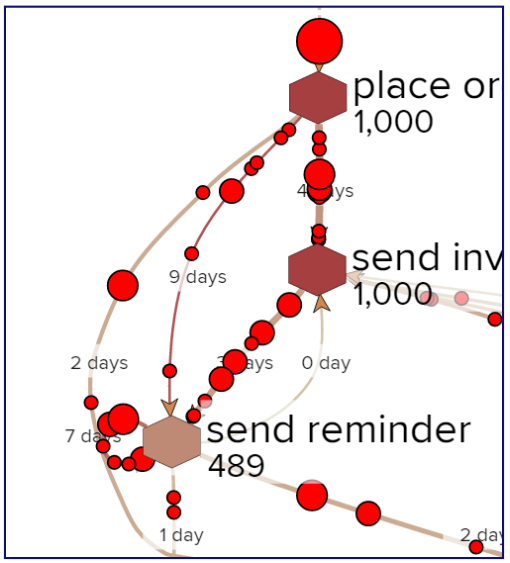
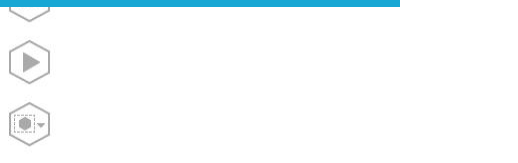
Connections 87.8%



- APPLE iPhone 6 16 GB
- SAMSUNG Galaxy S4
- APPLE iPhone 6s 64 GB
- APPLE iPhone 5s 16 GB
- MOTOROLA Moto G
- SAMSUNG Core Prime
- MOTOROLA Moto E 4G
- HUAWEI P8 Lite
- SAMSUNG Galaxy J5
- SAMSUNG Galaxy S6 32 GB



modelguidedabstraction.tex updated
"modelguidedabstraction.tex" was updated to the latest version (click to view).



Selected Process Mining

Process Start

place order

send invoice

send reminder

pay

prepare delivery

make delivery

confirm payment

Process End

product: MOTOROLA Moto G

Case Count: 82

Percent: 8%

Bar chart showing activity distribution

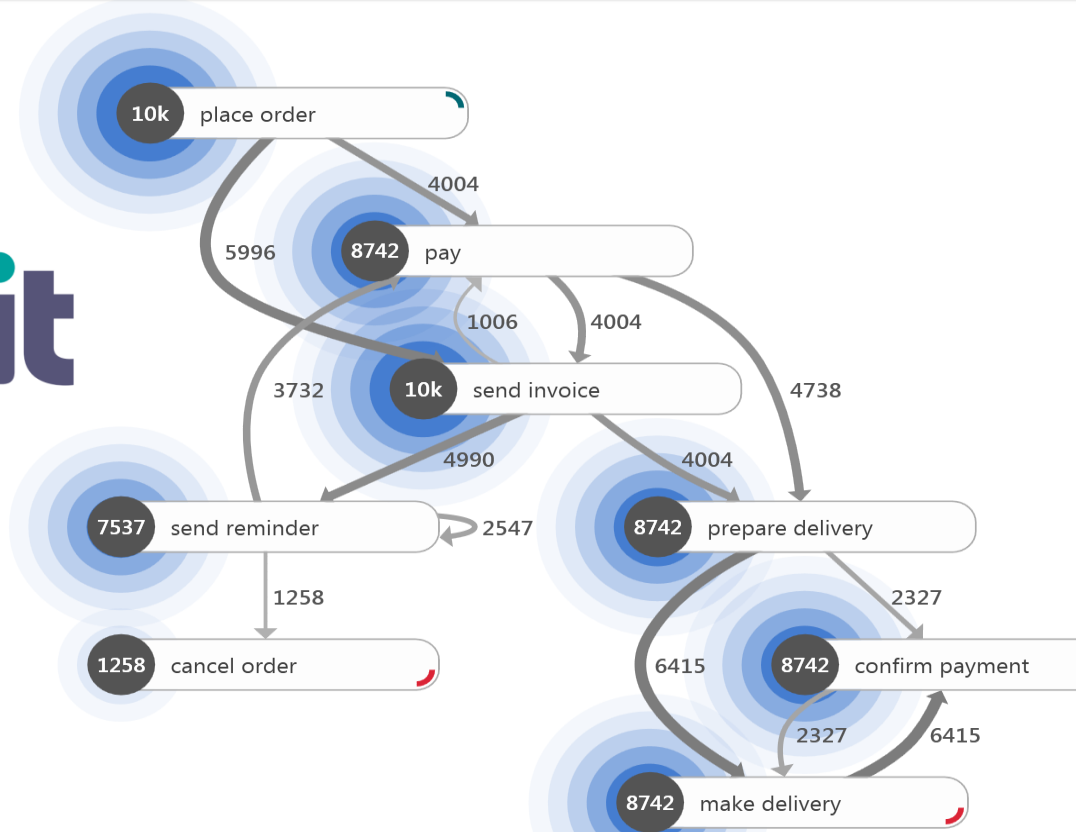


Process map

event log 10000 ▾



vanderAalstWil
Trial ▾



Customize

Process view

Social view

Missing attribute of type Resource.

Show terminal nodes

Snap to backbone

Left to right

Highlight predecessor/successor activities

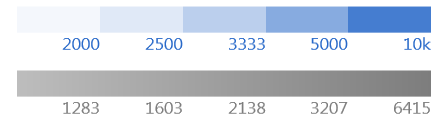
Activities 100 %

Paths 100 %

Frequency

Performance

Event count ▾



Visualize



cases 100%

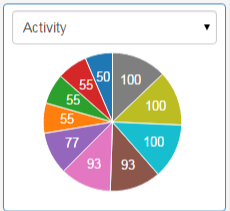
events 100%

reviewing

Navigation icons: list, search, refresh, zoom in, zoom out, right arrow

100% 100%
100 cases 2278 events

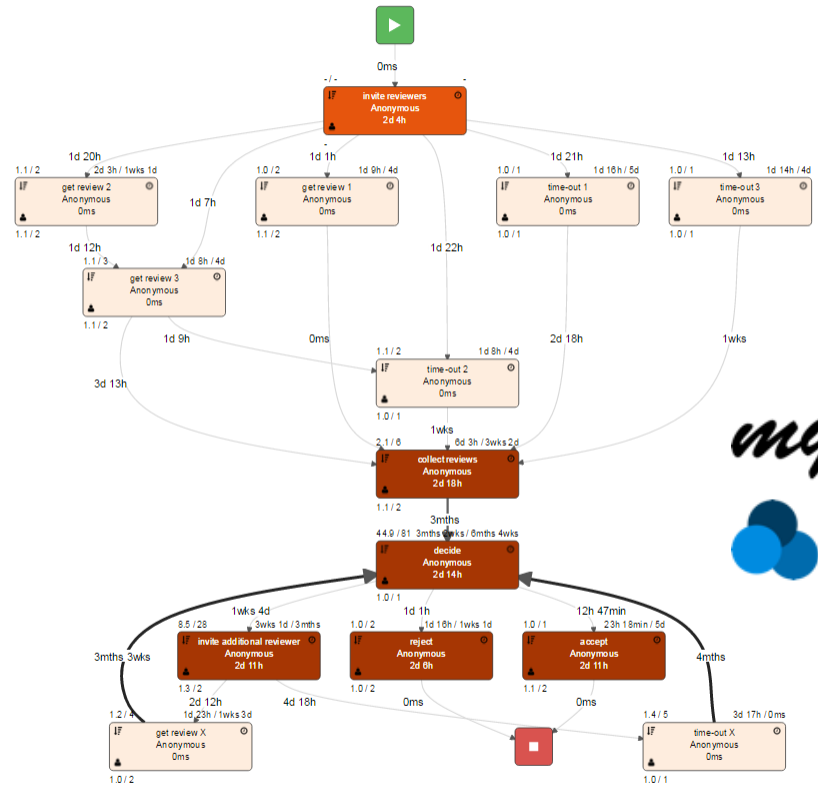
Resolution Tokens
Sat Dec 31, 2005 23:00:00



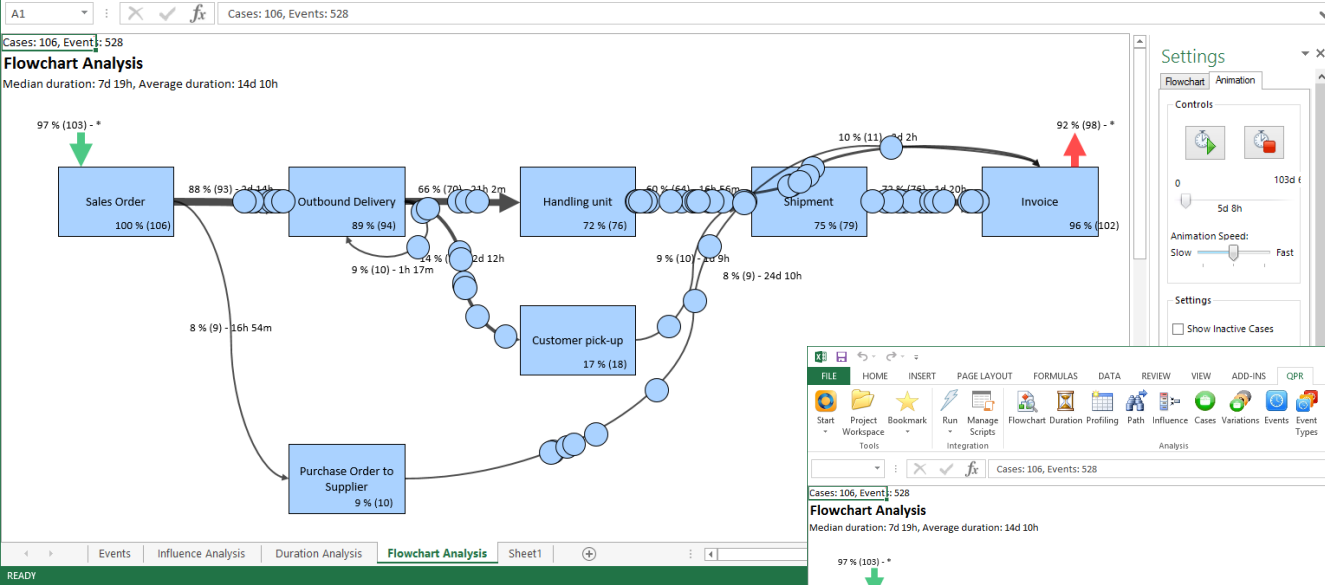
Model's details
Activities
Relations

Resource focus

Portrait Landscape



Legend for activity durations: 0ms, 13h 20min, 1d 2h, 1d 16h



Settings

Flowchart Animation

Controls

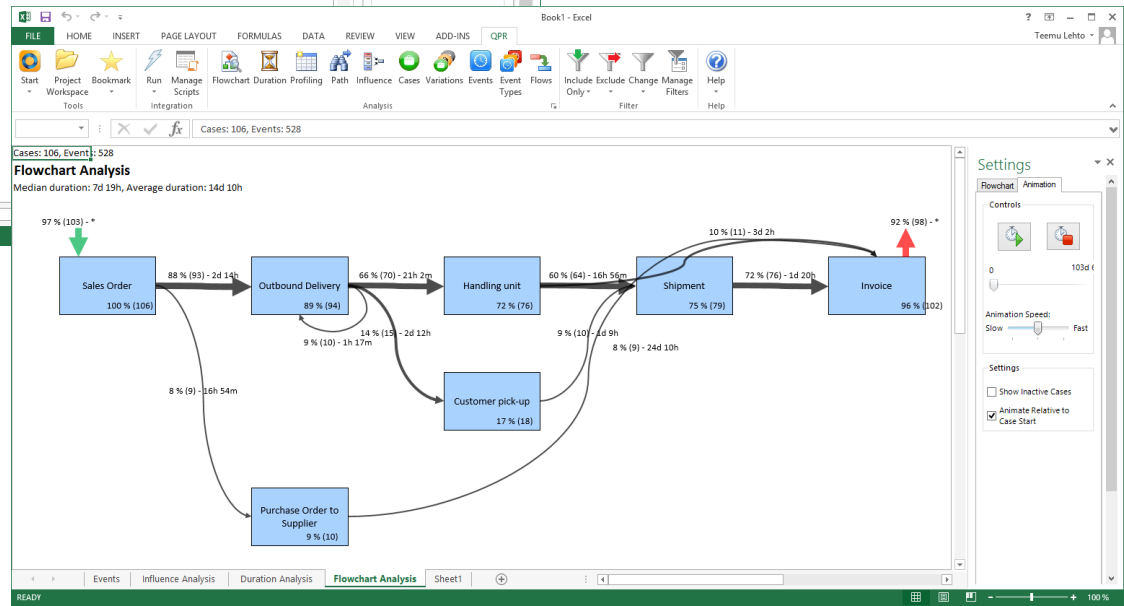
0 103d f

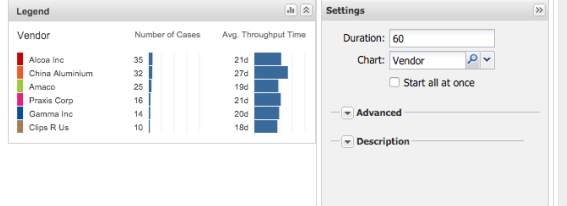
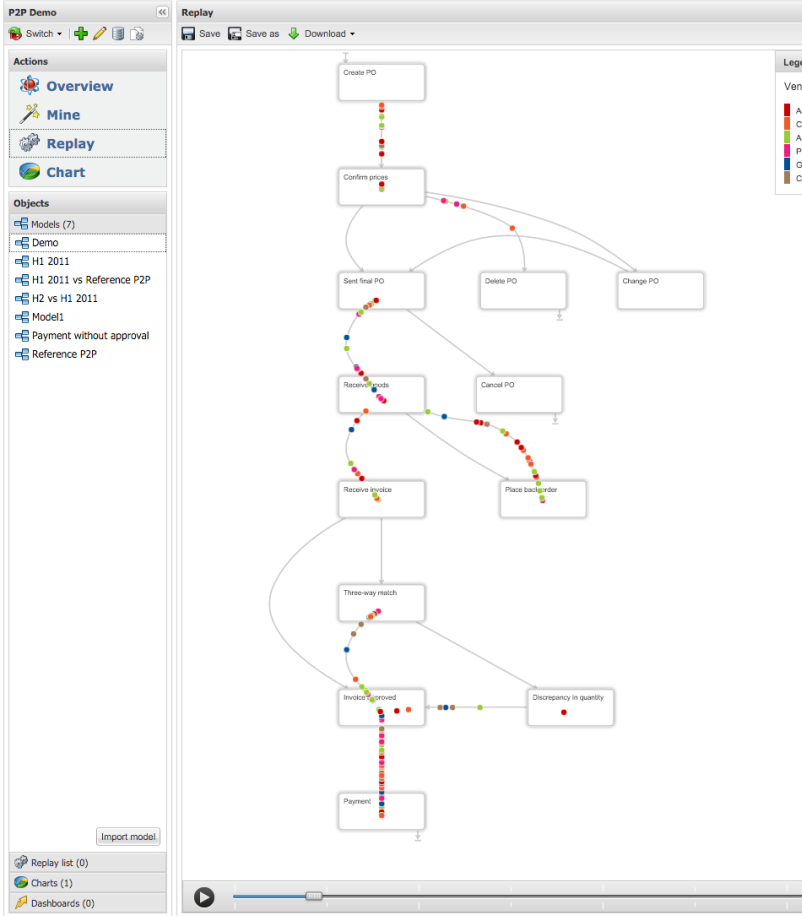
5d 8h

Animation Speed: Slow Fast

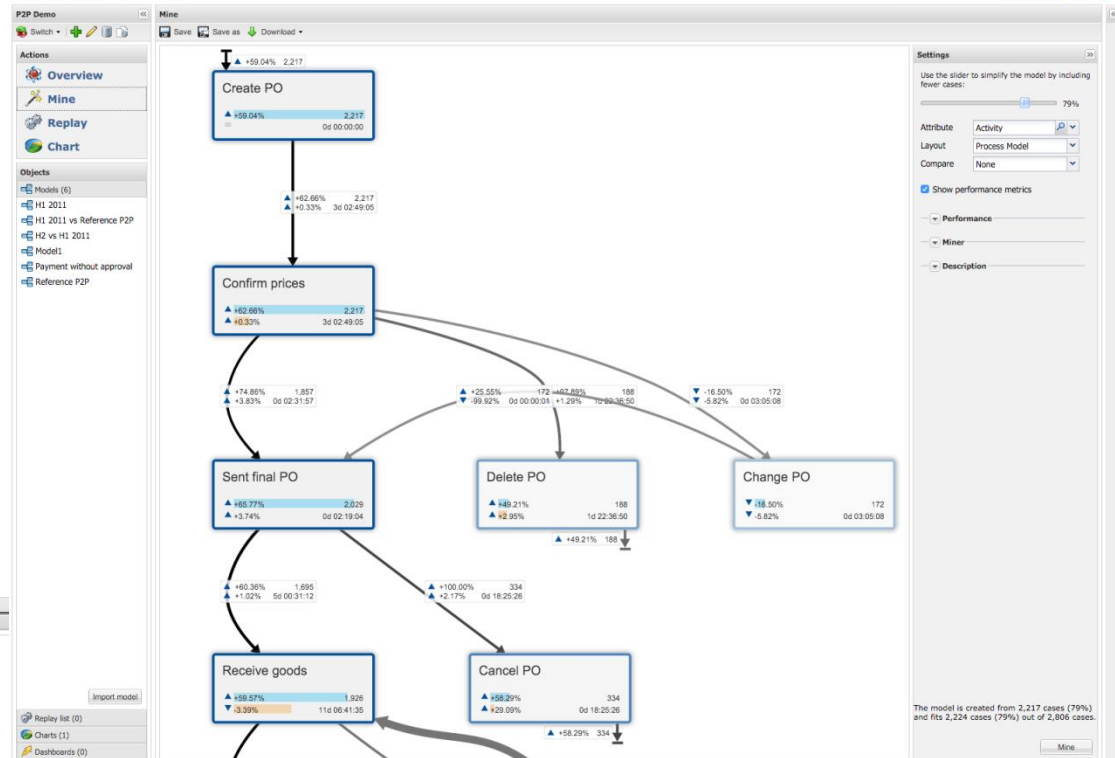
Settings

Show Inactive Cases



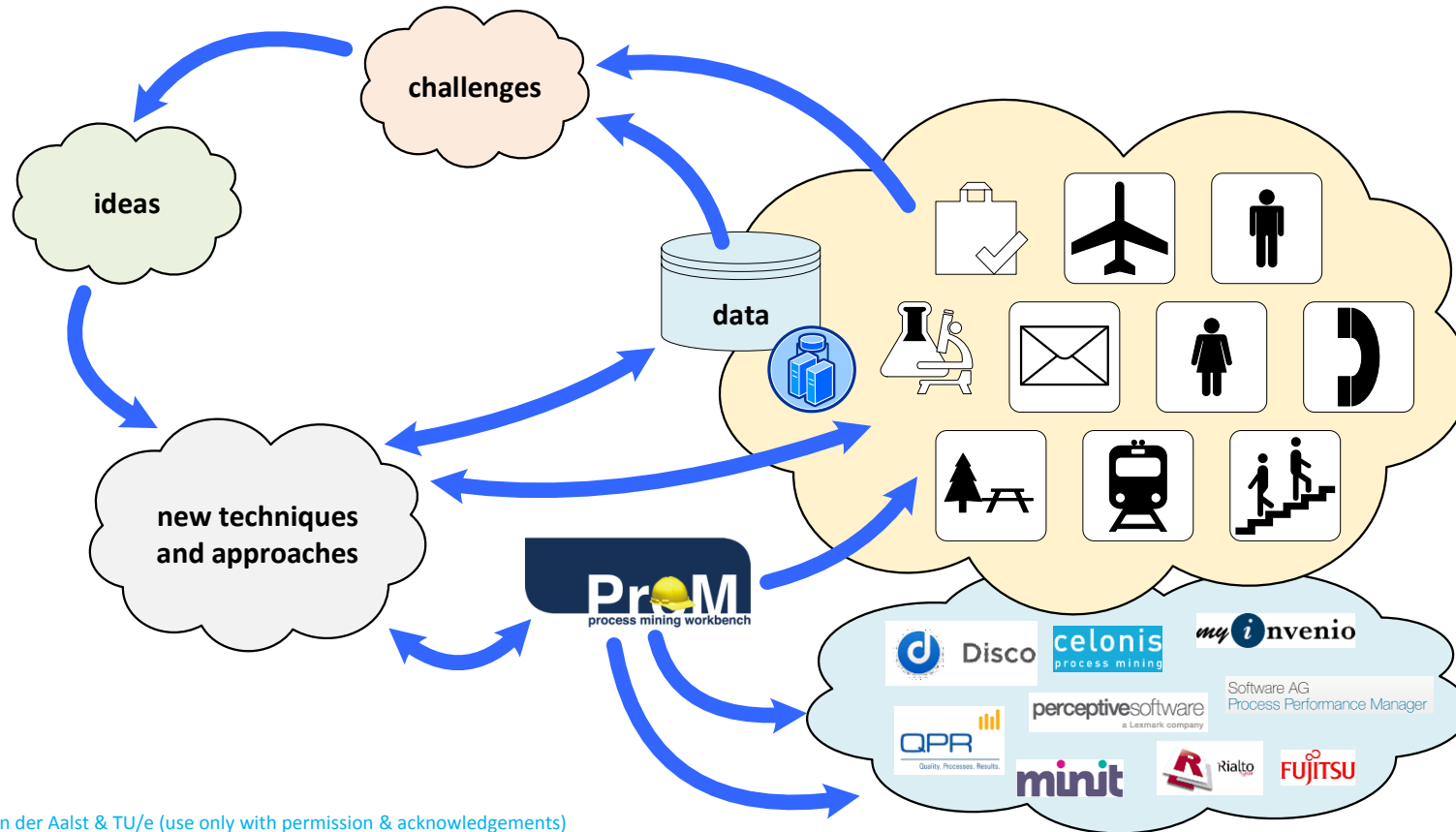


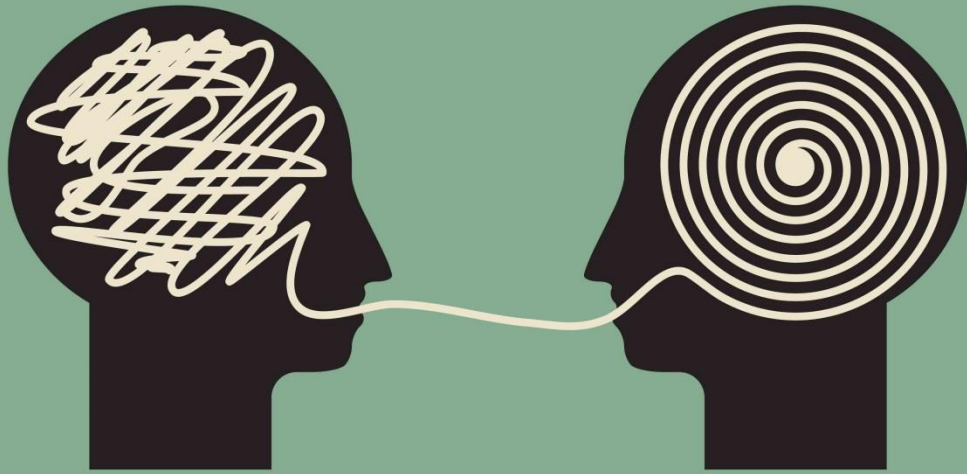
perceptive process mining



The model is created from 2,217 cases (79%) and fits 2,224 cases (79%) out of 2,800 cases.

Interaction with industry





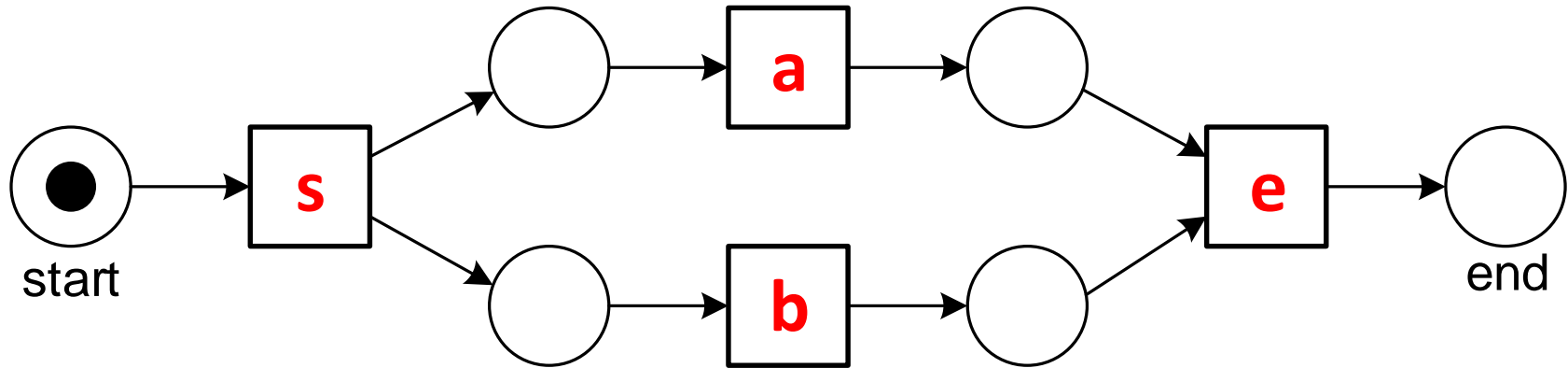
- **Can I trust the results of process mining?**
- **How to interpret the results correctly?**
- **Alignments are a key technology!**

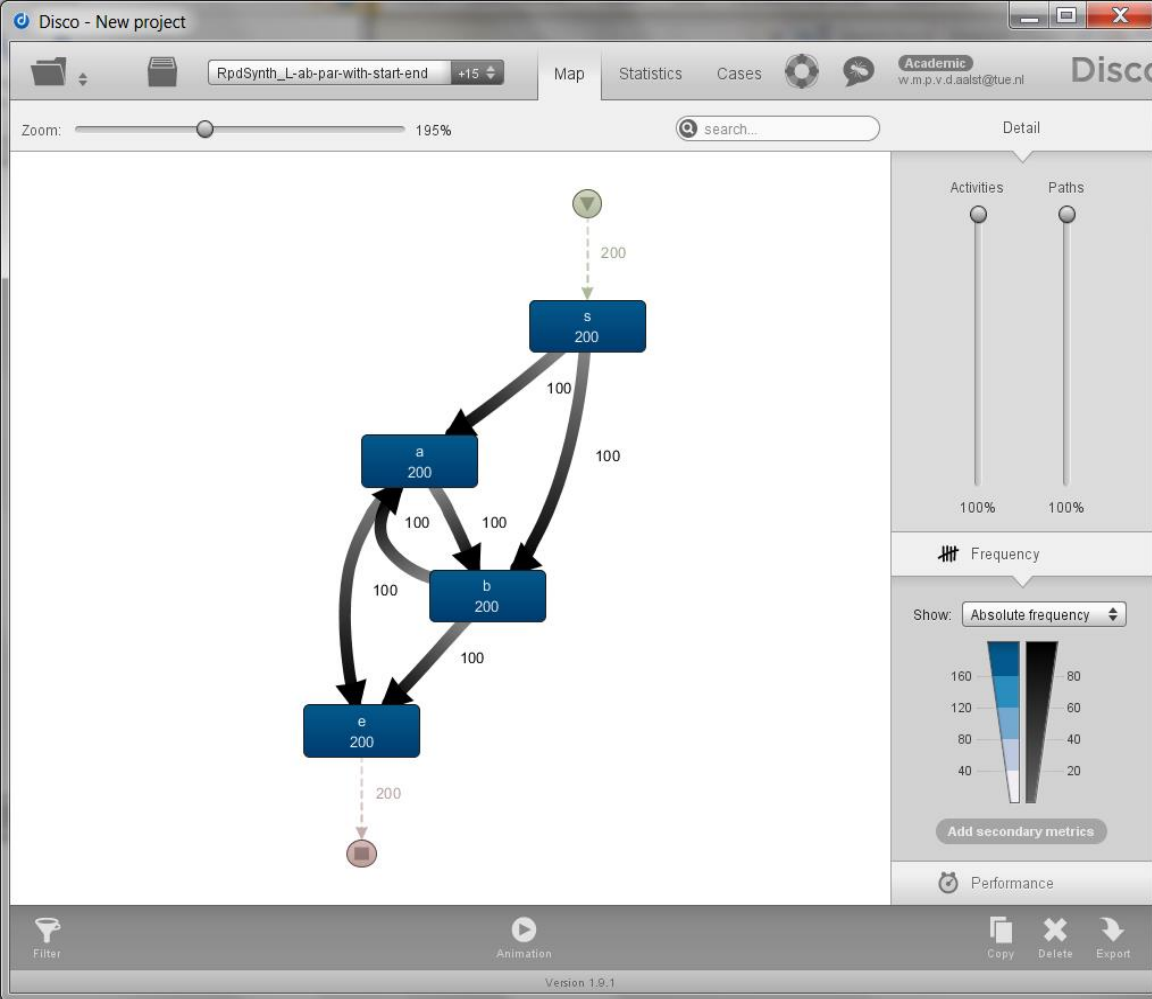
Simple process model: starts with **s**, ends with **e**, **a** and **b** are executed once, **no** loops.

Event log:

100x **sabe**

100x **sbae**

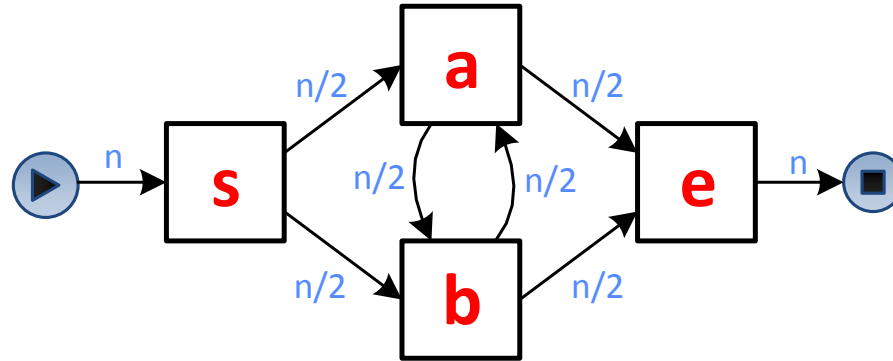
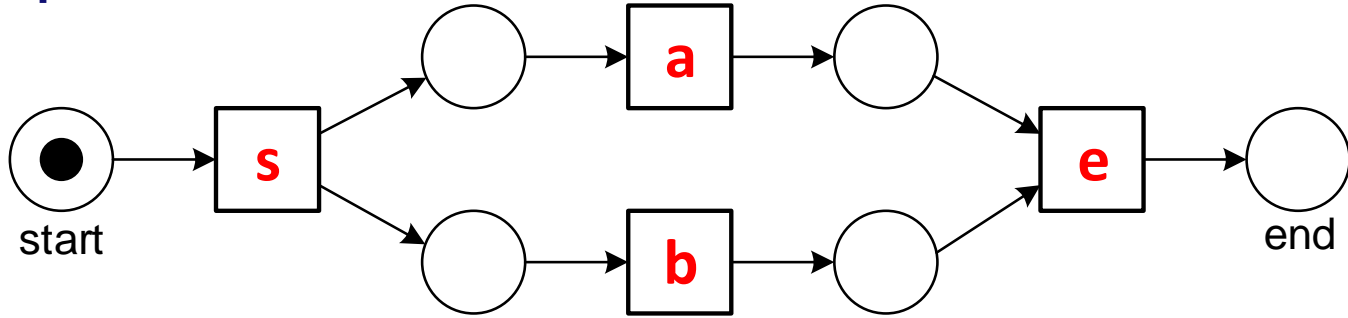




100x **sabe**
 100x **sbae**

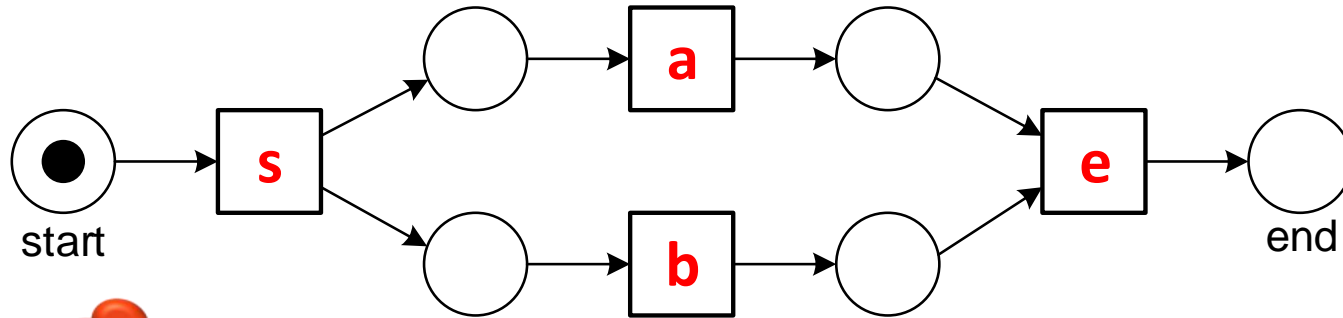
Is the model describing reality well?

Simple process model: starts with **s**, ends with **e**, **a** and **b** are executed once, **no** loops.



See the problem?

Alignments are a key technology!



Not (well)
supported
by
commercial
tools

Trace 1: **sabe** (OK)

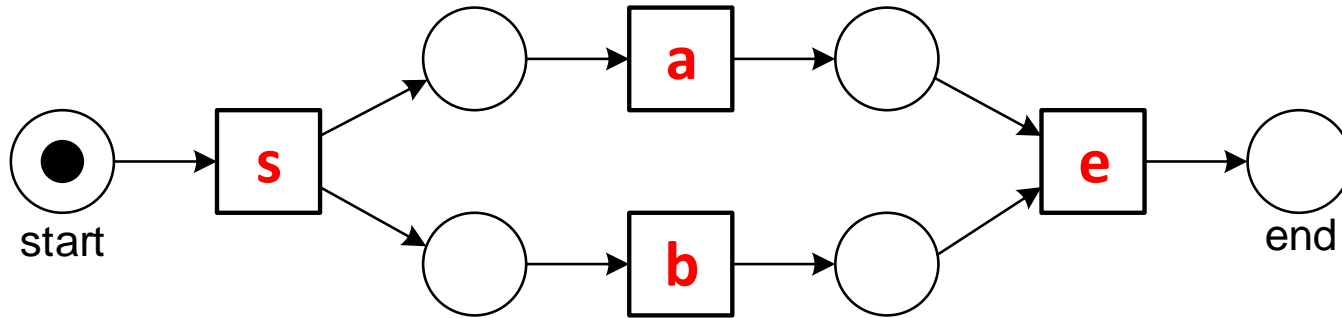
Trace 2: **sbae** (OK)

Trace 3: **sae** (b is missing)

Trace 4: **sabae** (two a's)

Trace 5: **saae** (2 problems)

Alignment for Trace 1: sabe



Reality:

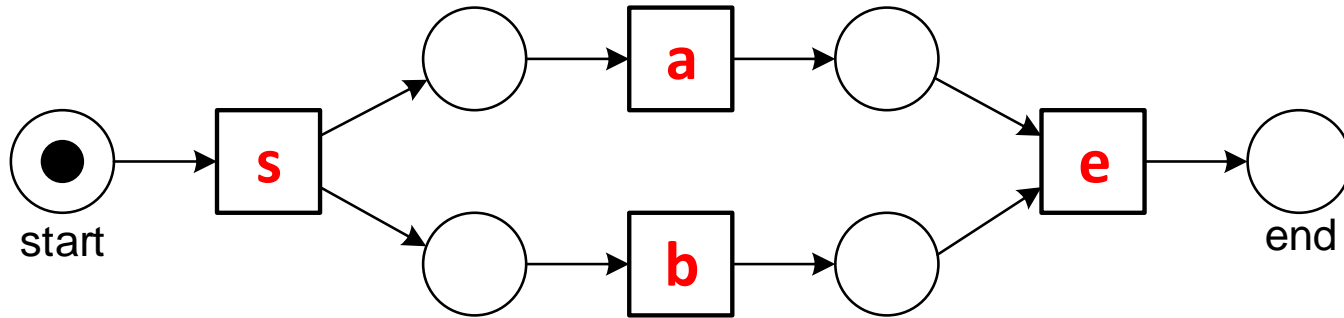
s	a	b	e
----------	----------	----------	----------

Model:

s	a	b	e
----------	----------	----------	----------



Alignment for Trace 2: sbae



Reality:

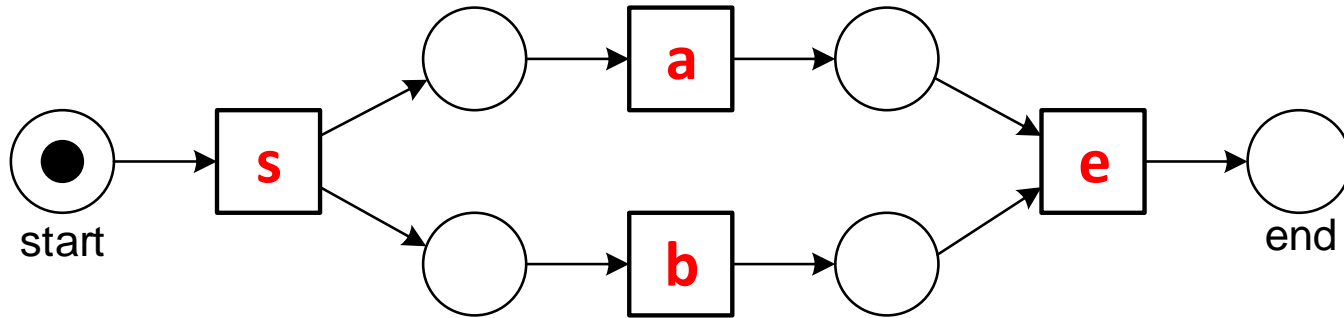
s	b	a	e
----------	----------	----------	----------

Model:

s	b	a	e
----------	----------	----------	----------



Alignment for Trace 3: sae



Reality:

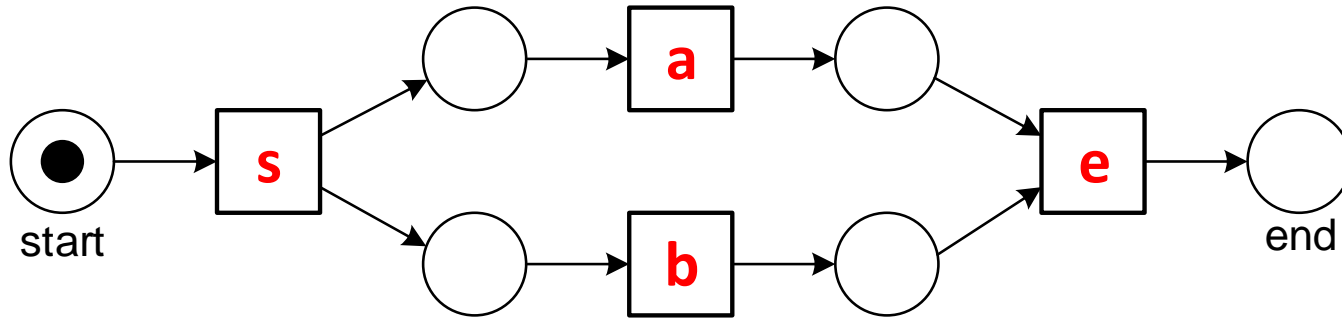
s	a	X	e
---	---	---	---

Model:

s	a	b	e
---	---	---	---

b was
skipped

Alignment for Trace 4: sabae



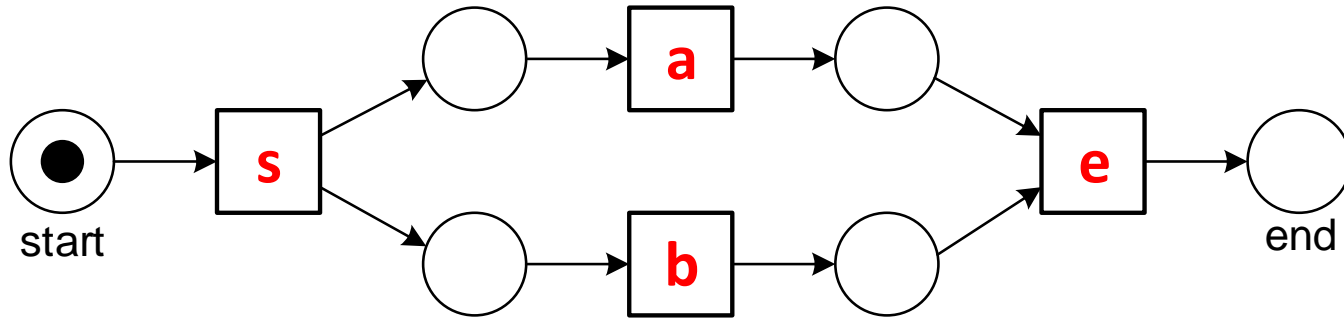
Reality:

s	a	b	a	e
s	a	b	X	e

Model:

Second **a** should not be there

Alignment for Trace 5: saae

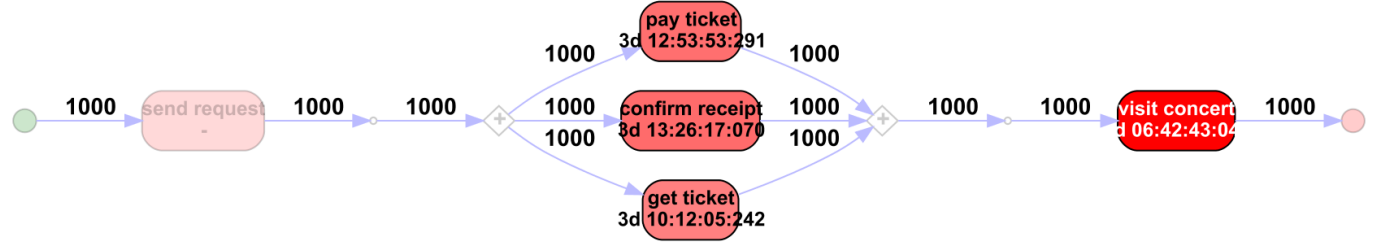
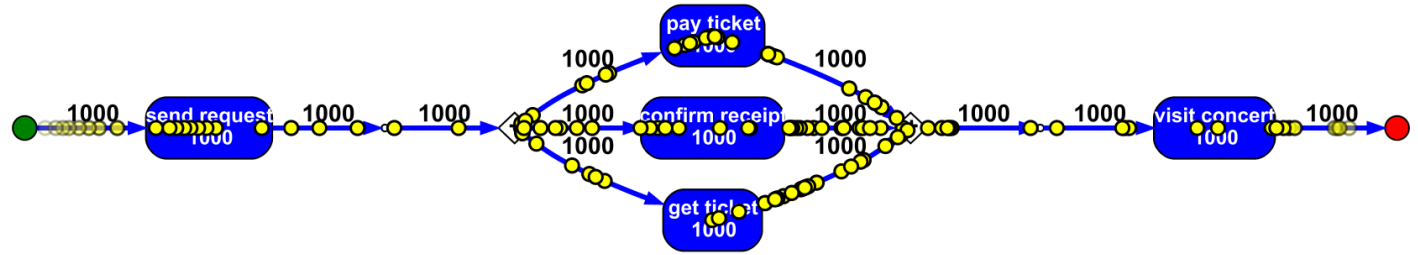


Reality:

s	a	a	X	e
s	a	X	b	e

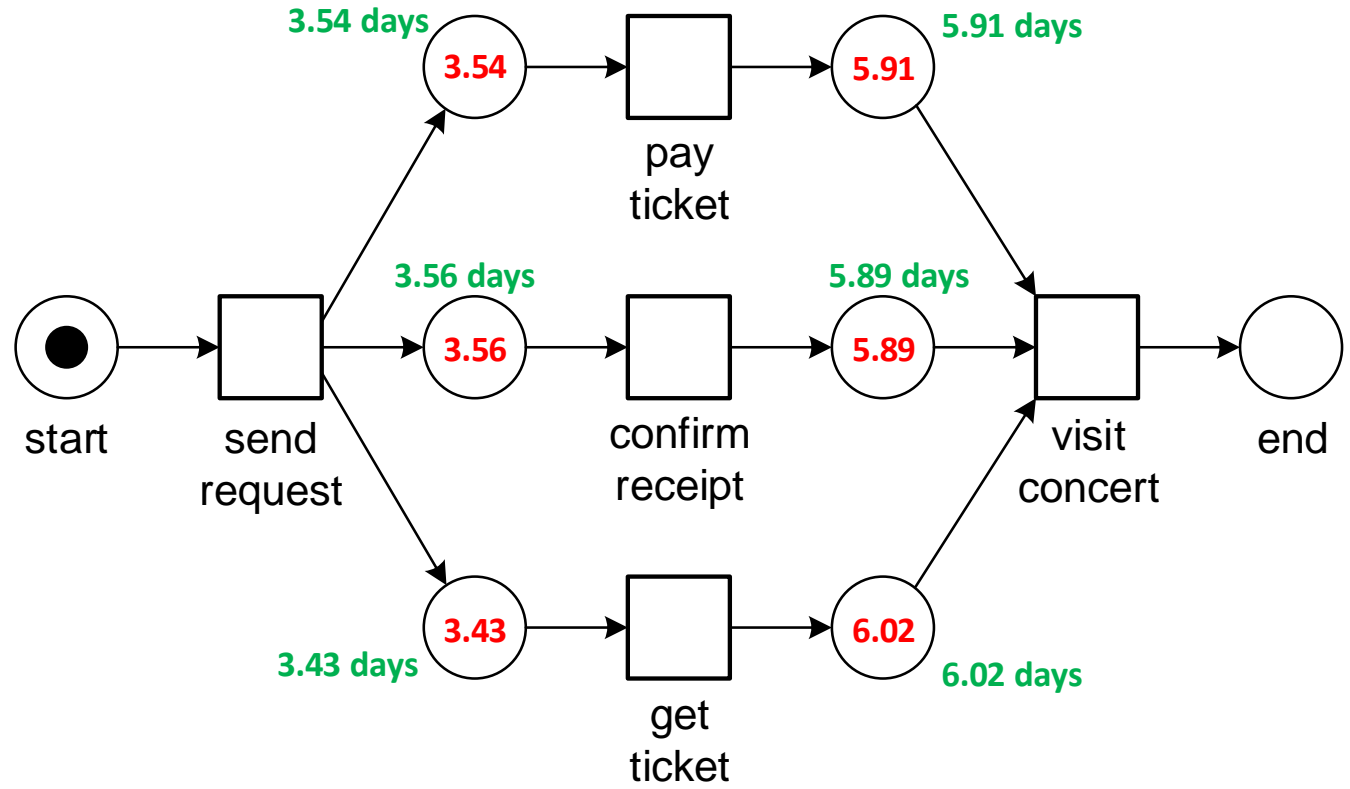
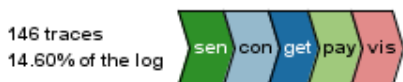
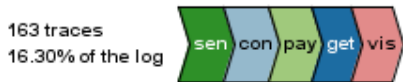
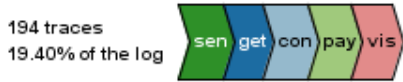
Model:

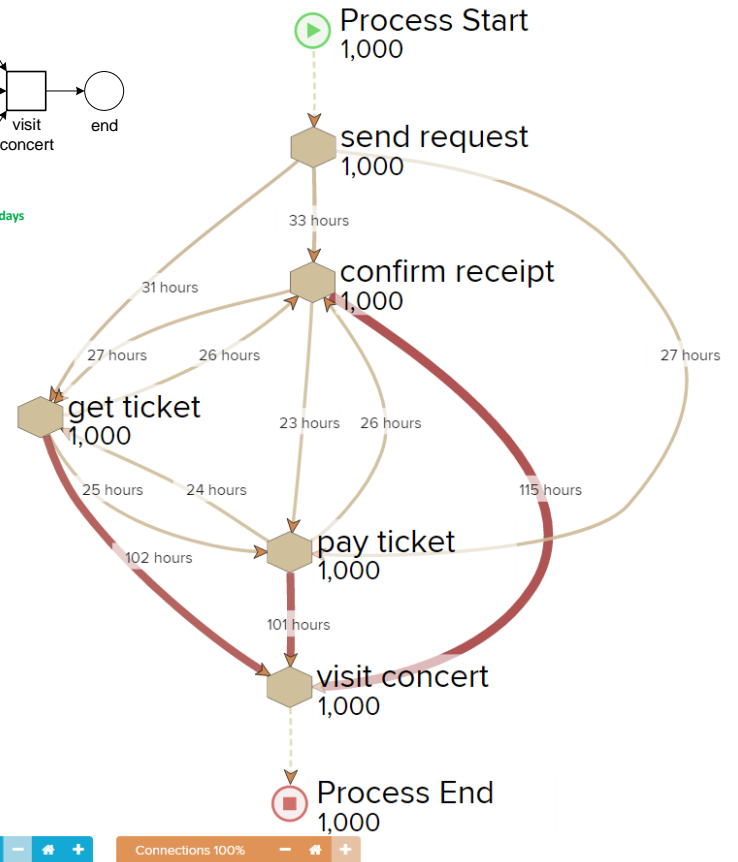
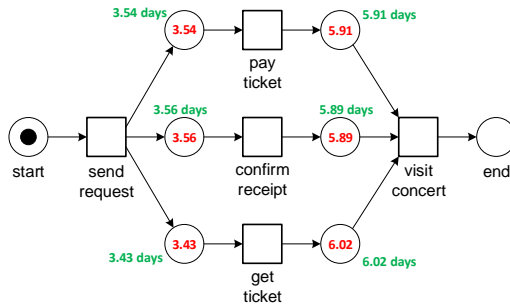
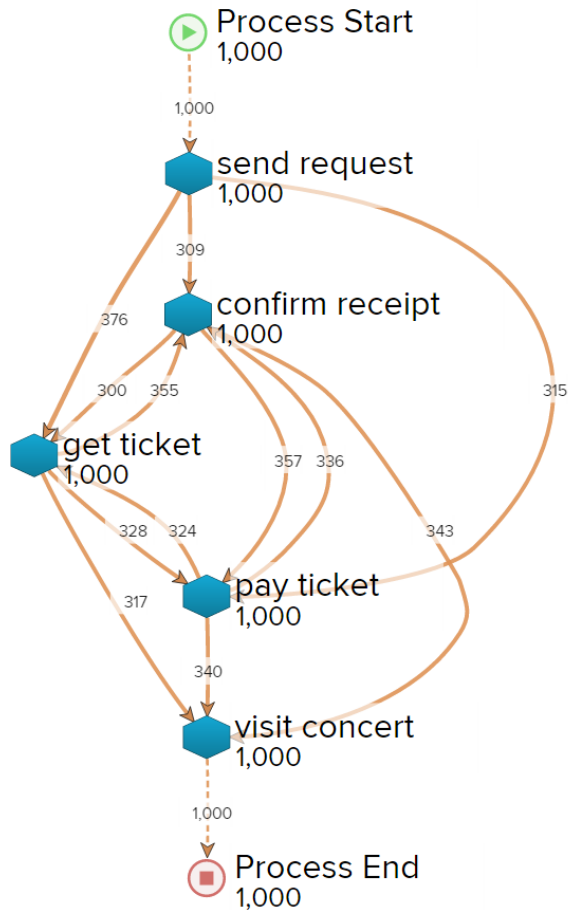
Second
a
instead
of b

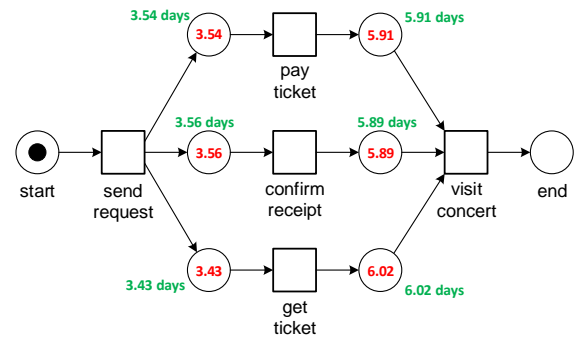
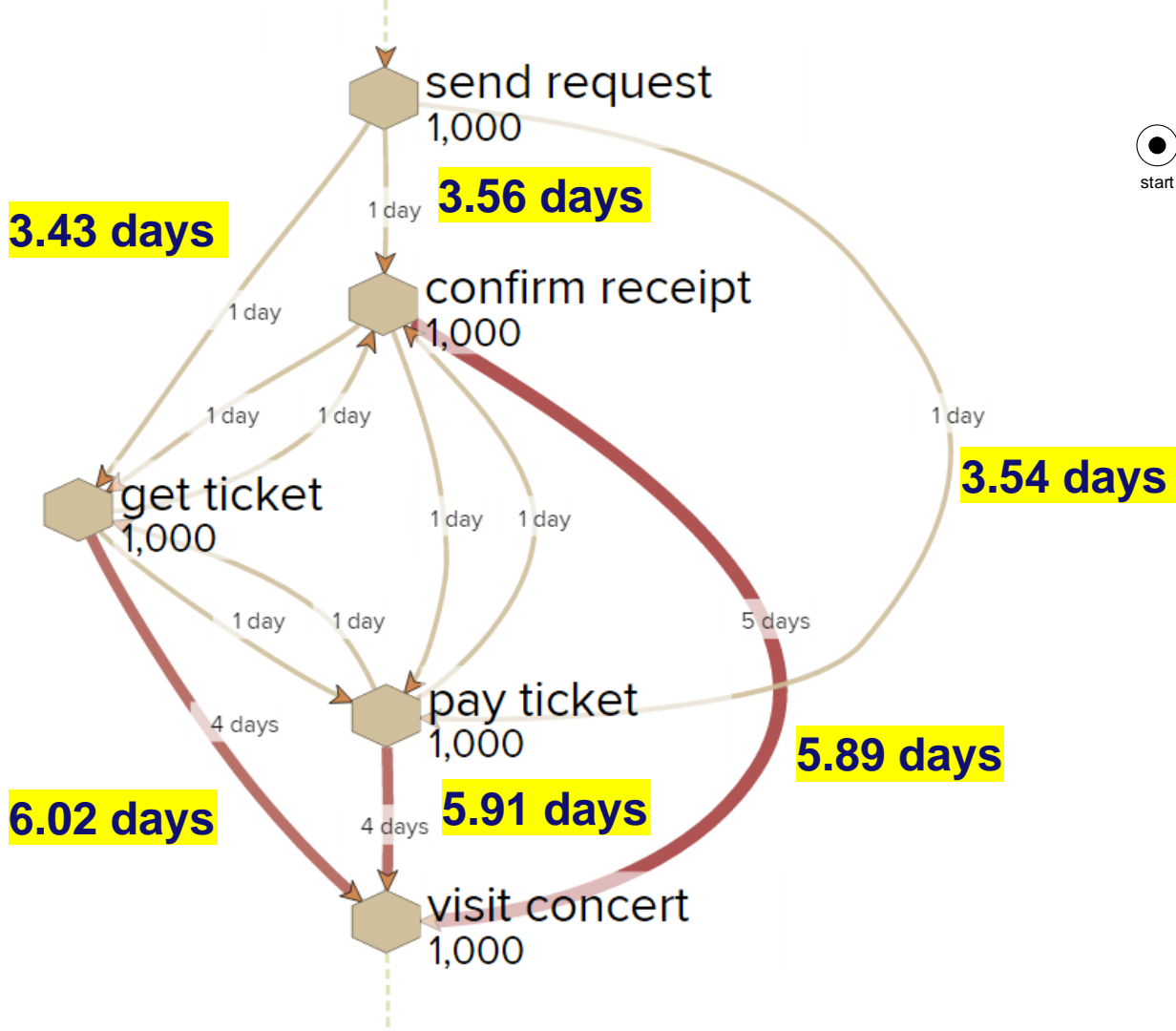


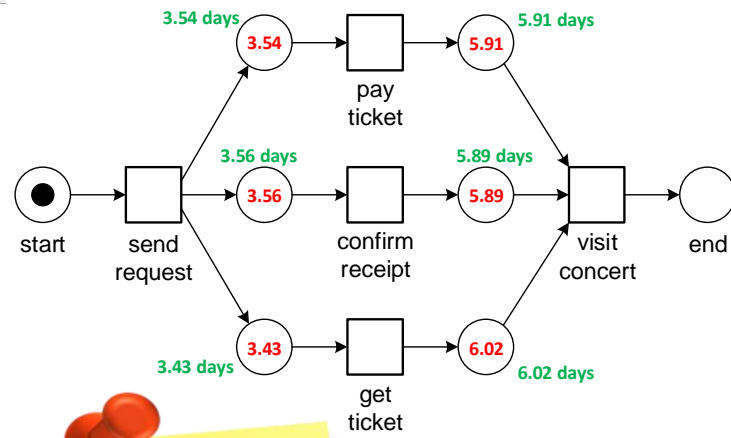
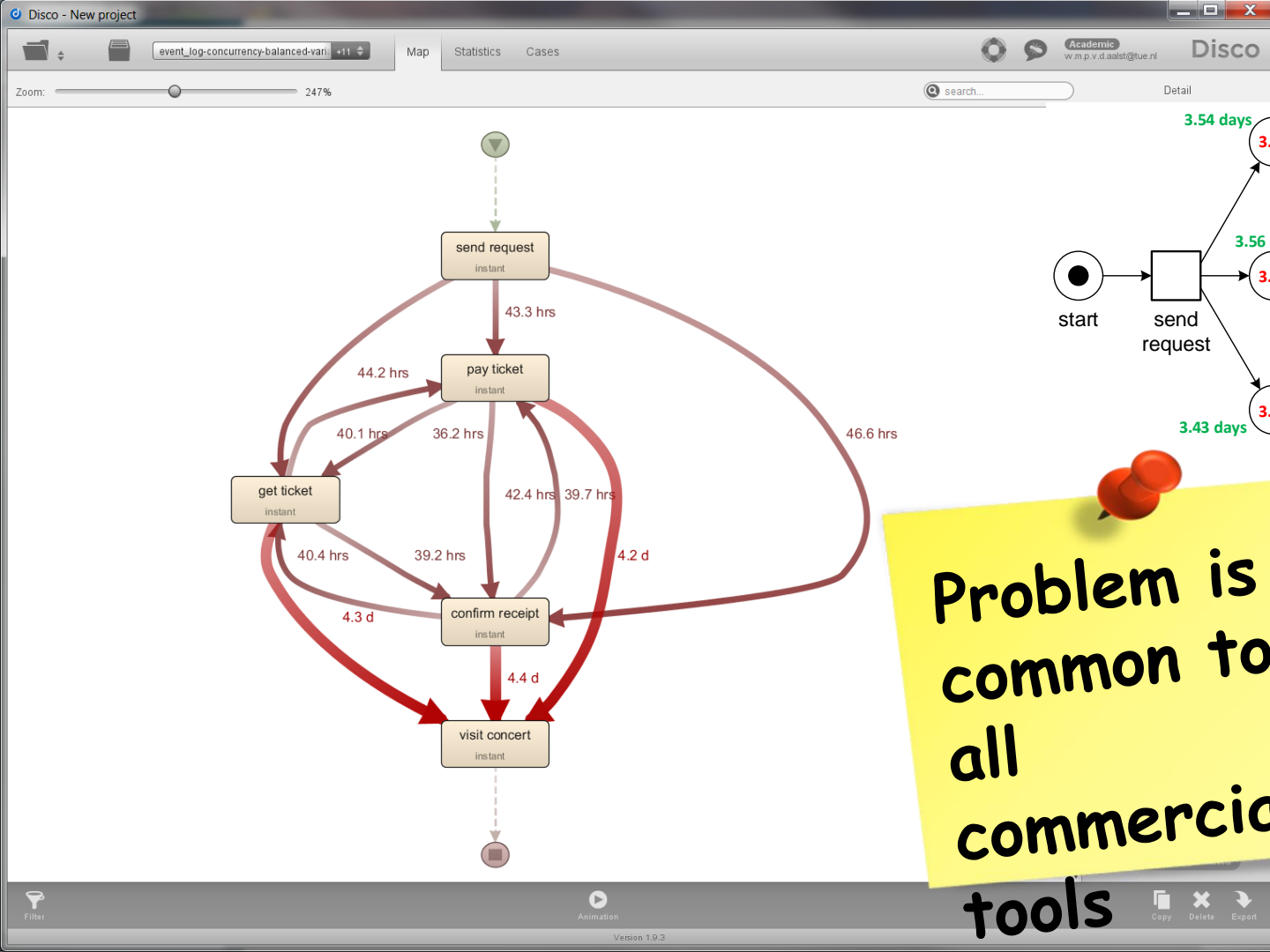
No alignments
and/or
concurrency:
Performance
diagnostics
may be very
misleading

Anonymous log imported from event_log-concurrency-balanced-variable.xes







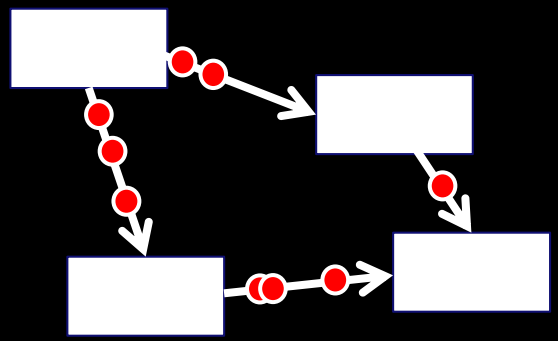


Problem is common to all commercial tools

A	B	C	D
ITEM	NO.	UNIT	COST
----	----	----	----
MUCK RAKE	43	12.95	556.85
BUZZ CUT	155	6.75	1036.25
TOE TONER	250	49.95	12487.50
EYE SNUFF	2	4.95	9.90

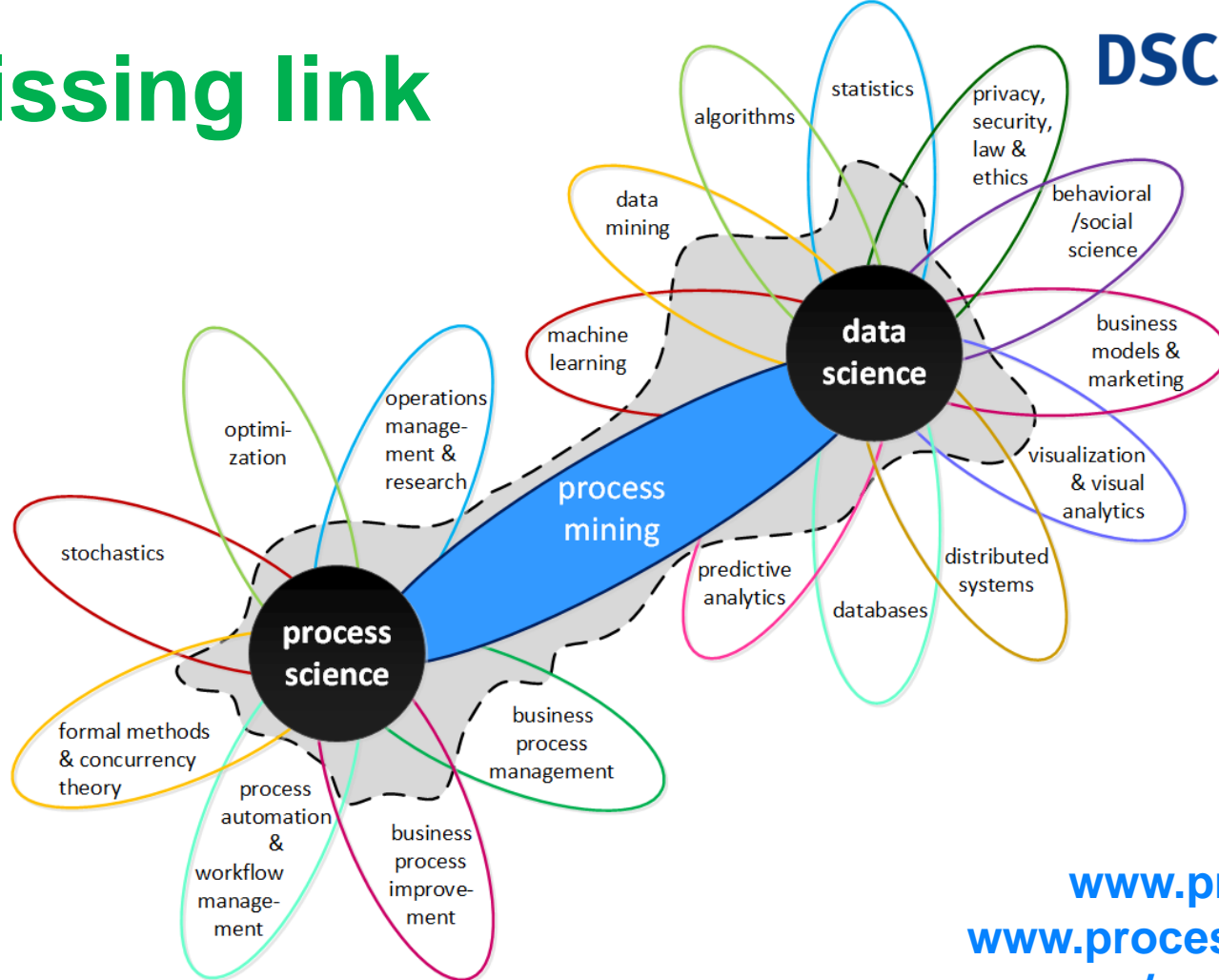
		SUBTOTAL	13155.50
		9.75% TAX	1282.66

		TOTAL	14438.16



Summary

The missing link



www.promtools.org
www.processmining.org
www.coursera.org/course/procmin



Process Mining Data Science in Action

**Starts
every
4
weeks**

Info MOOC: www.coursera.org/course/procmin

Wil van der Aalst
Process Mining
Data Science in Action, *Second Edition*

This is the second edition of Wil van der Aalst's seminal book on process mining, which now discusses the field also in the broader context of data science and big data approaches. It includes several additions and updates, e.g. on inductive mining techniques, the notion of alignments, a considerably expanded section on software tools and a completely new chapter on process mining in the large. It is self-contained, while at the same time covering the entire process-mining spectrum from process discovery to predictive analytics.

After a general introduction to data science and process mining in Part I, Part II provides the basics of business process modeling and data mining necessary to understand the remainder of the book. Next, Part III focuses on process discovery as the most important process mining task, while Part IV moves beyond discovering the control flow of processes, highlighting conformance checking, and organizational and time perspectives. Part V offers a guide to successfully applying process mining in practice, including an introduction to the widely used open-source tool ProM and several commercial products. Lastly, Part VI takes a step back, reflecting on the material presented and the key open challenges.

Overall, this book provides a comprehensive overview of the state of the art in process mining. It is intended for business process analysts, business consultants, process managers, graduate students, and BPM researchers.

Features and Benefits:

- First book on process mining bridging the gap between business process modeling and business process mining
- Comprehensive coverage of process mining within the context of data science and big data
- Includes material, e.g. on data quality, conformance checking, and the notion of alignments
- Written for business process analysts and computer scientists and for a broad audience in academia
- Includes software tools and the exploitation of process mining

Data science
Big data
Alignments
Data quality
Inductive mining
Tooling

vander Aalst



Process Mining

Wil van der Aalst

Process Mining

Data Science in Action

Second Edition

<http://www.springer.com/9783662498507>

2nd Ed.

