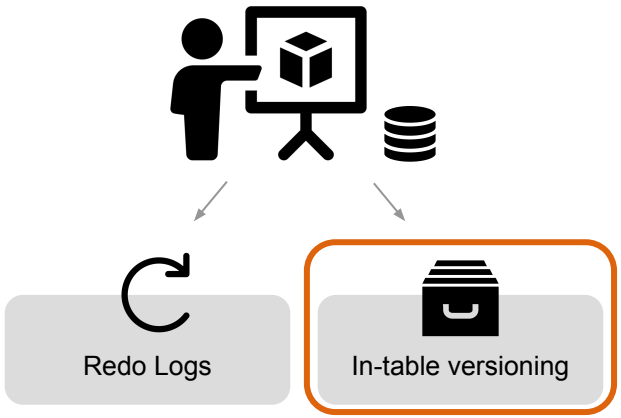
Multiple Case Notion in Log Extraction

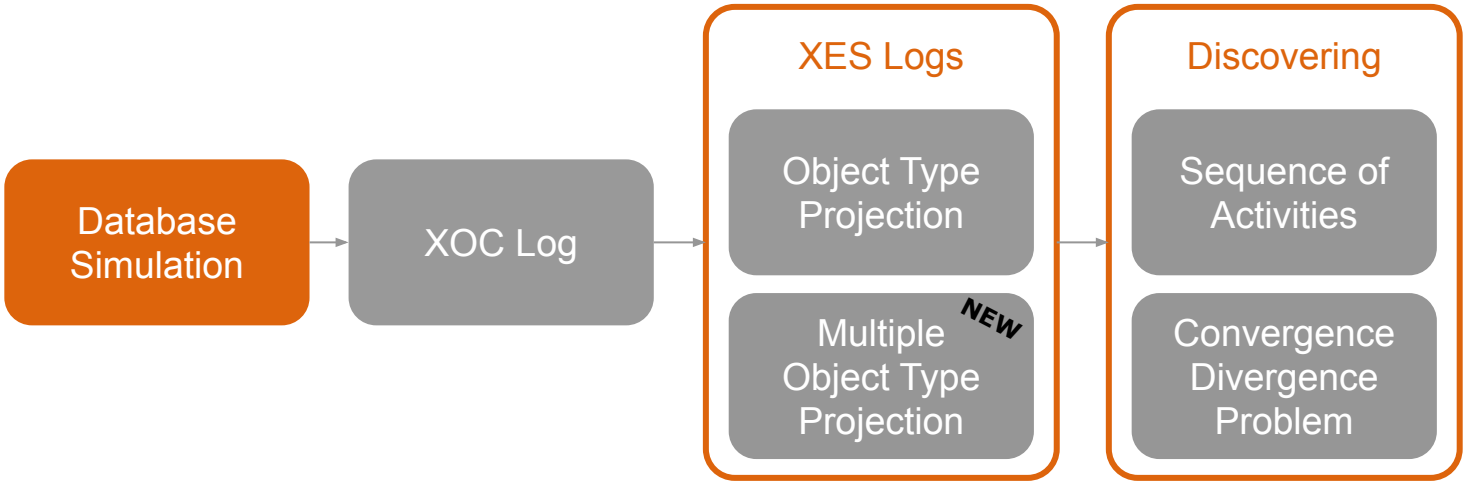
Rachel Brabender and Oliver Clasen

Recap: Event Log Extraction from Databases [1]

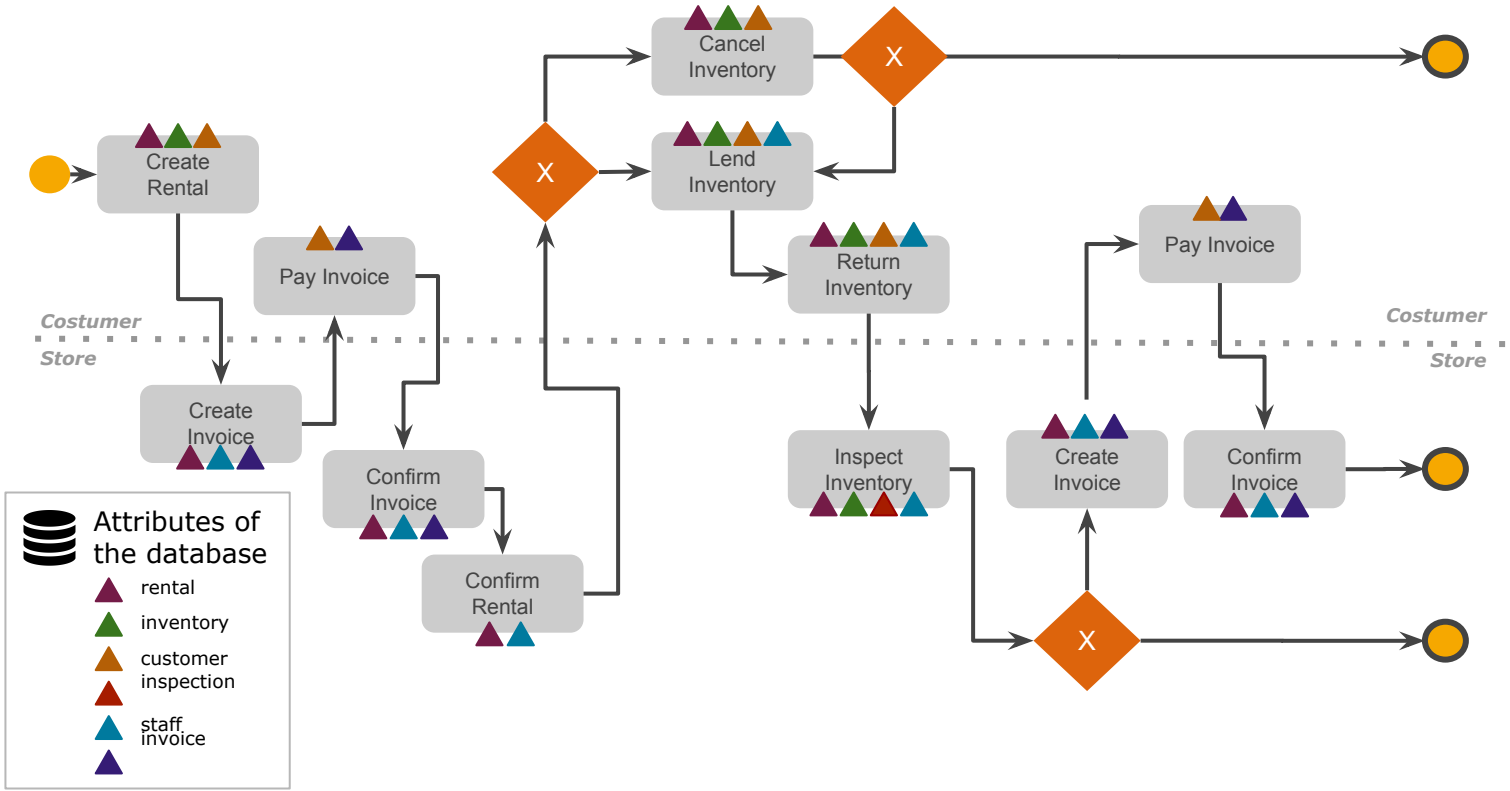


- XES notation as the current standard to visualize a certain perspective
- object-centric information systems are builded on top of relational database technology
- XOC notation used to describe the complex process flow within a database

Milestones


Database Simulation
XOC Log
XES Logs
Object Type Projection
Multiple Object Type Projection
NEW
Discovering
Sequence of Activities
Convergence Divergence Problem

Model of our Process in an Online Rental Shop



icons from thenounproject.com

Simulation

for each **interval** in **simulation**:
for each **interval** in **simulation**:
while not (all **rentals are finished** and all **invoices are confirmed**):

Each **customer** decides for one action to take:
with a probability of

- 10% -> **create_rental**, if simulation time isn't exceeded
- 25% -> **pay_invoices**
- 30% -> **cancel_inventory**
- 35% -> **return_inventory** *and* **lend_inventory**

Each **store** decides for one action to take:
with a probability of

- 30% -> **create_invoice**
- 20% -> **confirm_invoice**
- 20% -> **confirm_rental**
- 30% -> **inspect_inventory** *and* ***create_invoice***

Milestones

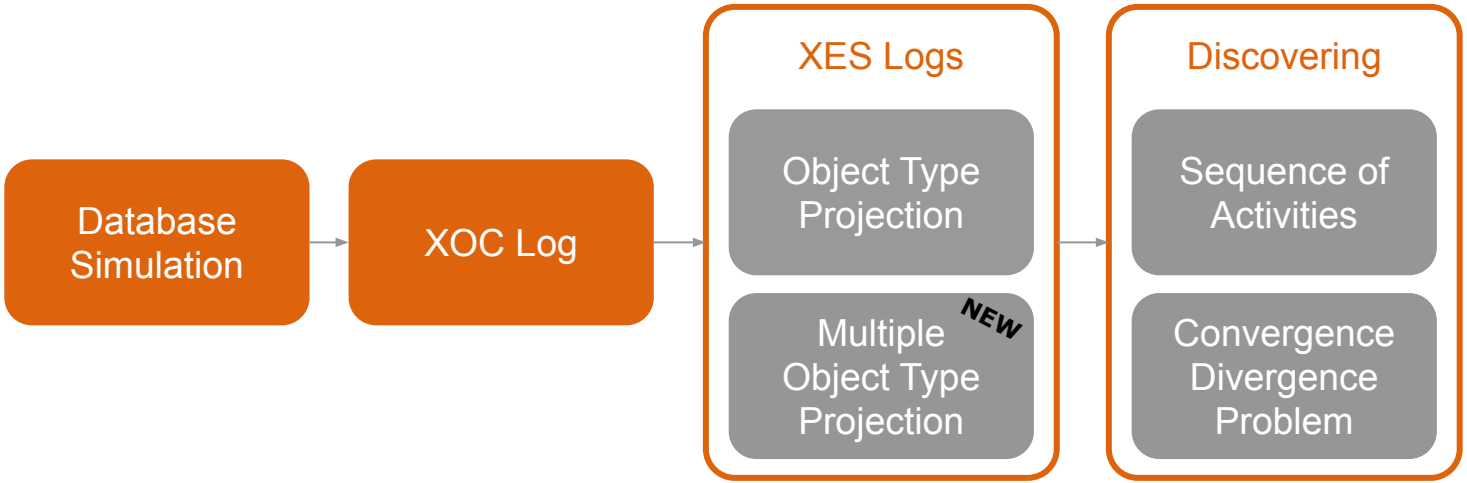
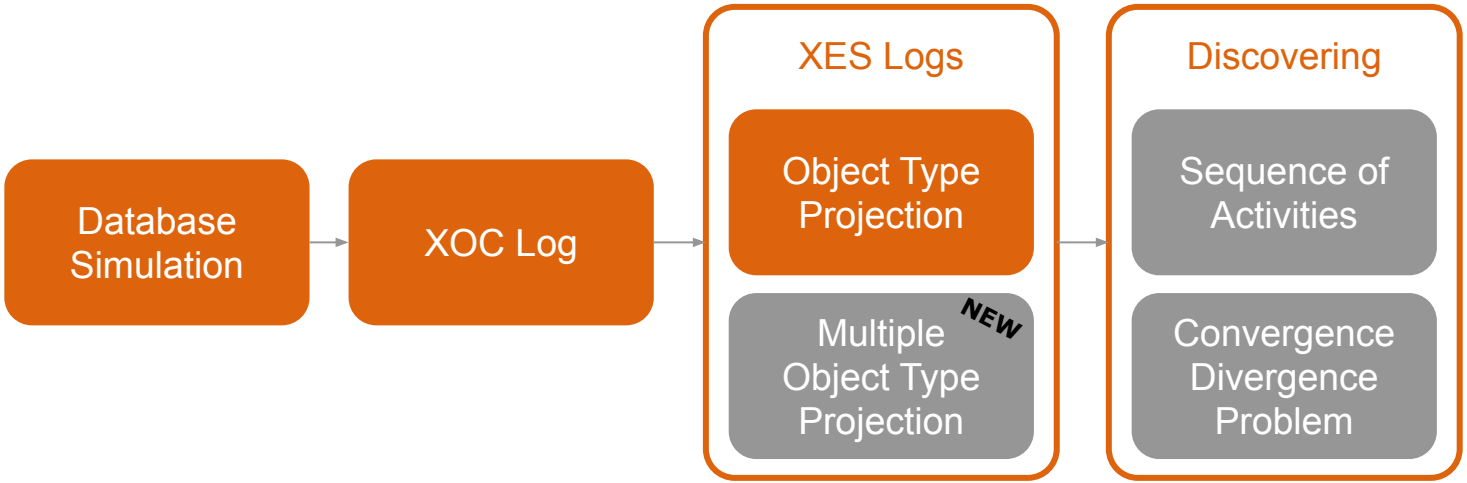

Database Simulation
XOC Log
XES Logs
Object Type Projection
Multiple Object Type Projection
NEW
Discovering
Sequence of Activities
Convergence Divergence Problem

Table Representation of a XOC Log File

XOC Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174, 95}	{47}	{}	{}	{}
17	create_invoice	2020-01-01 10:06	{0, 1}	{}	{}	{20}	{}	{2, 3, 4}
275	pay_invoice	2020-01-02 03:27	{}	{}	{47}	{}	{}	{2, 11, 63, 88, 91}
314	confirrm_invoice	2020-01-02 05:36	{}	{}	{}	20	{}	[2, 11, 63, 87, 88, 91, 93, 94]
377	confirm_rental	2020-01-02 08:51	{0, 1, 15, 40, 50, 55, 64, 68, 70, 74, 82, 89, 95, 98, 100, 109}	{}	{}	20	{}	{}

Milestones


Database Simulation
XOC Log
XES Logs
Object Type Projection
Multiple Object Type Projection
NEW
Discovering
Sequence of Activities
Convergence Divergence Problem

Object Type Projection [2]

Case Notion

XOC Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174, 95}	{47}	{}	{}	{}
17	create_invoice	2020-01-01 10:06	{0, 1, 7}	{}	{}	{20}	{}	{2, 3, 4}
..	...	...	...	..	...	...	...	...

```
Decide for an object type
Foreach id from the object type:
     Create trace with the id
     Select all events where object instance is involved
     Foreach event:
          Include other involved objects as attributes
```

Object Type Projection [2]

Case Notion

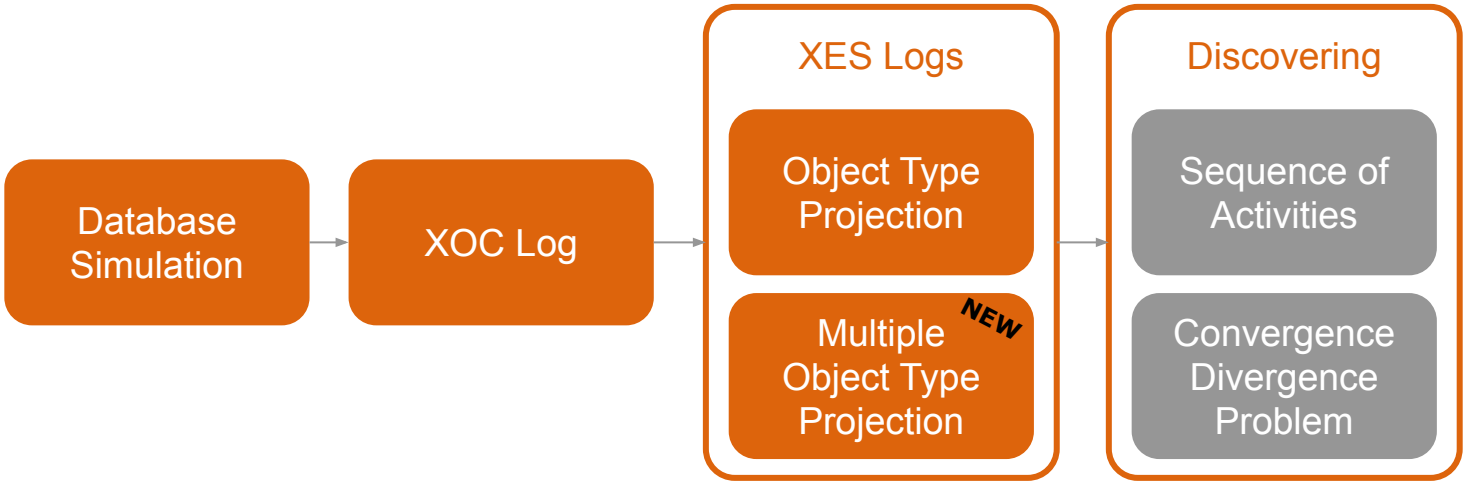
XOC Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174, 95}	{47}	{}	{}	{}
17	create_invoice	2020-01-01 10:06	{0, 1}	{}	{}	{20}	{}	{2, 3, 4}
..	...	...	...	..	...	...	...	...

XES Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
17	create_invoice	2020-01-01 10:06	{0}	{}	{}	{20}	{}	{2, 3, 4}
17	create_invoice	2020-01-01 10:06	{1}	{}	{}	{20}	{}	{2, 3, 4}
...	...	...	...	...	...	...	...	...

Milestones


Database Simulation
XOC Log
XES Logs
Object Type Projection
Multiple Object Type Projection
NEW
Discovering
Sequence of Activities
Convergence Divergence Problem

Multiple Object Type Projection

Case Notion **XOC Log**

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174, 95}	{47}	{}	{}	{}
17	create_invoice	2020-01-01 10:06	{0, 1}	{}	{}	{20}	{}	{2, 3, 4}
..	...	...	...	..	...	...	...	...

```
Decide for two object types
Derive unique combinations of ids from both object types and assign a new_id
Foreach new_id:
     Create trace
     Select all events where both object instances are involved
     Foreach event:
          Include other involved objects as attributes
```

Multiple Object Type Projection

Case Notion

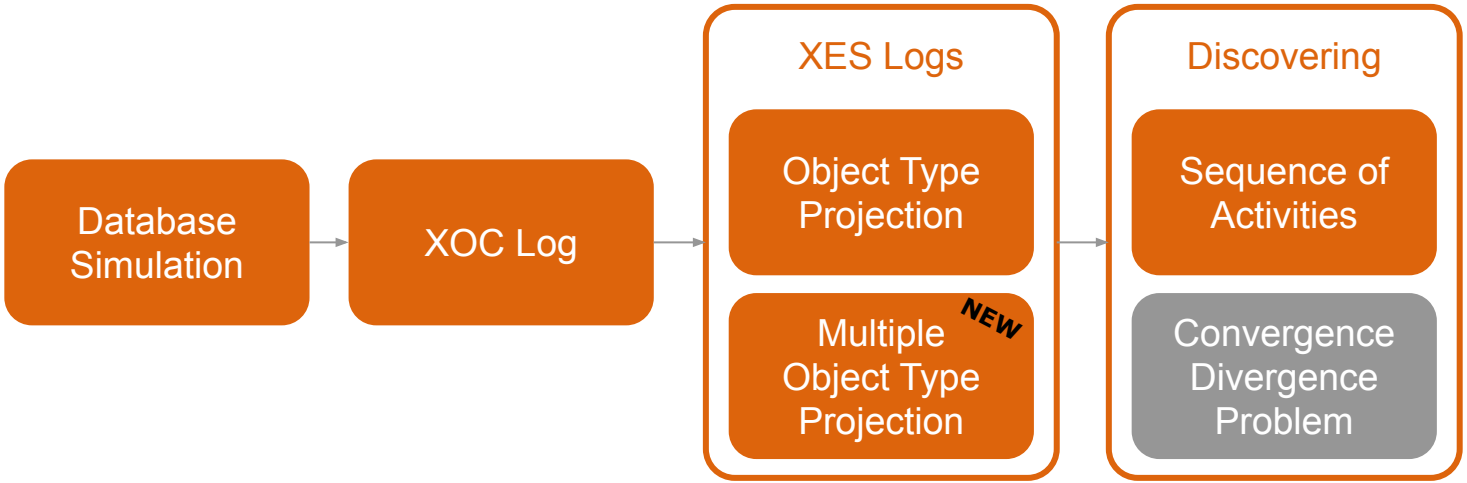
XOC Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174, 95}	{47}	{}	{}	{}
..	...	...	...	..	...	...	...	...

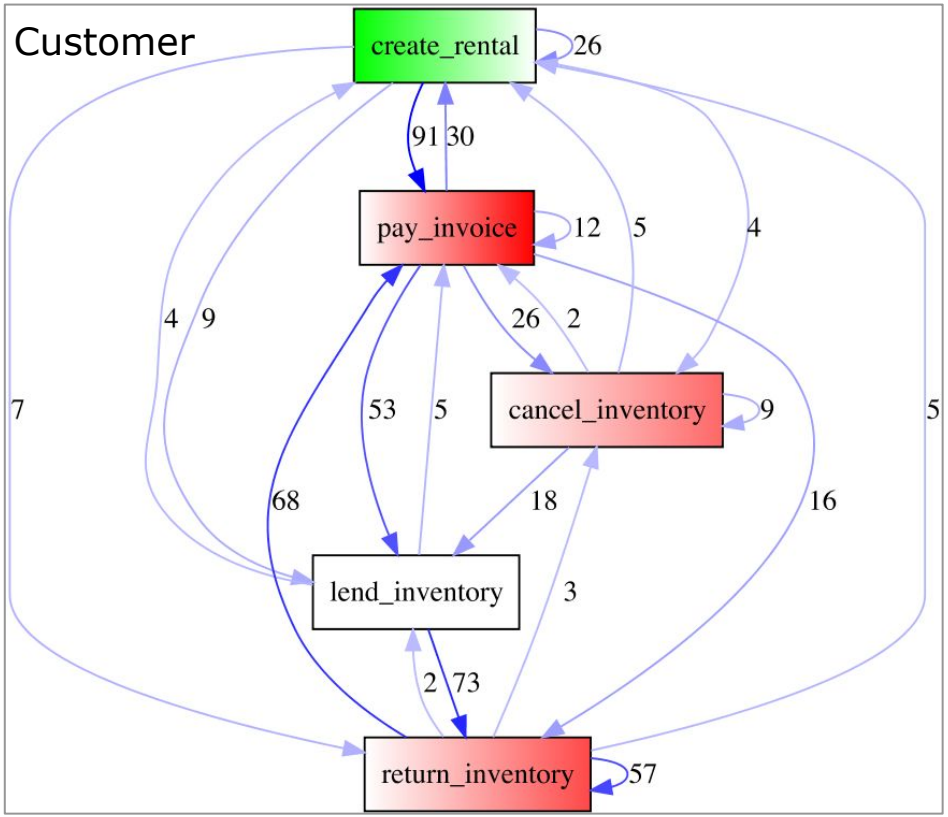
XES Log

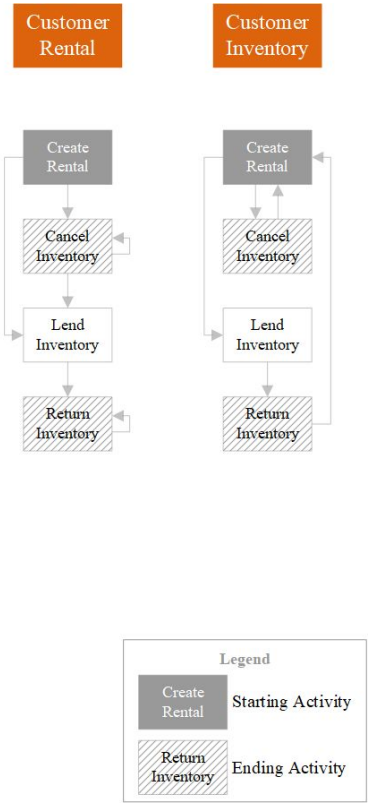
event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice	case_ id
0	create_rental	2020-01-01 08:00	{0}	{174}	{47}	{}	{}	{}	1
0	create_rental	2020-01-01 08:00	{0}	{95}	{47}	{}	{}	{}	2
..	...	...	...	..	...	...	...	...	

Milestones

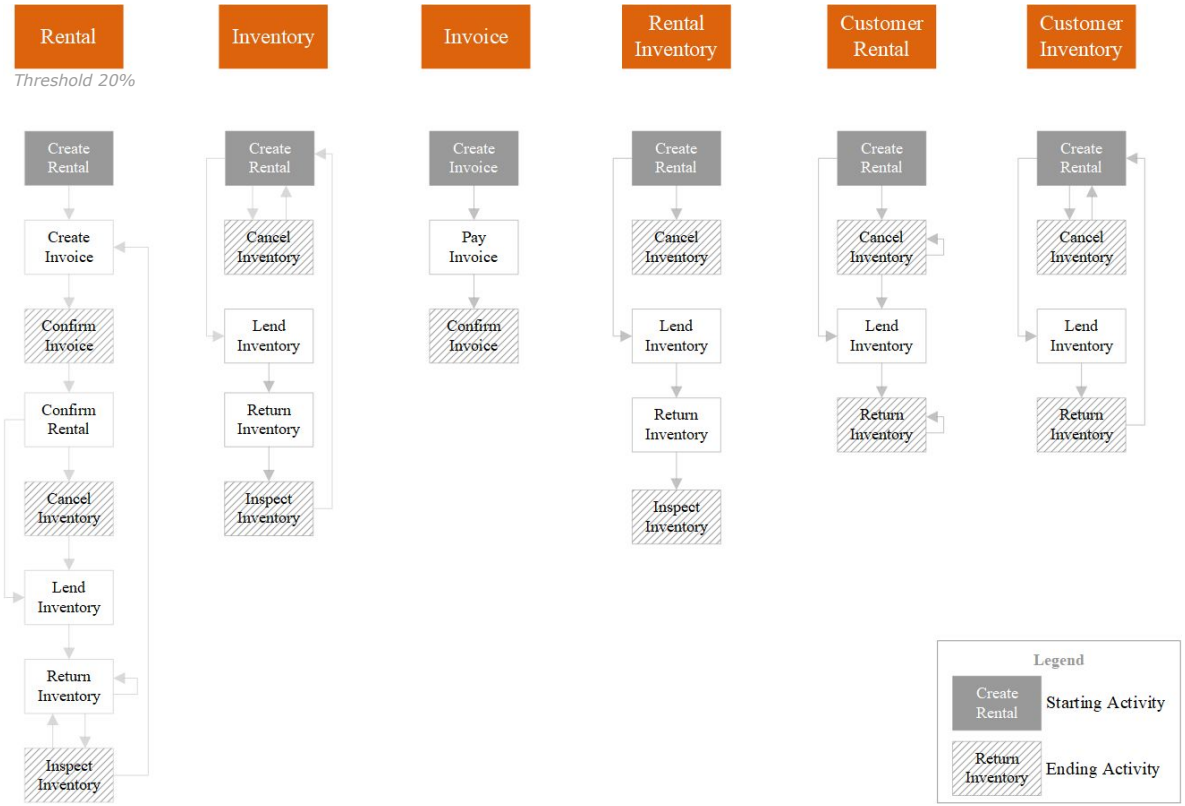

Database Simulation
XOC Log
XES Logs
Object Type Projection
Multiple Object Type Projection
NEW
Discovering
Sequence of Activities
Convergence Divergence Problem

Directly Follows Graph

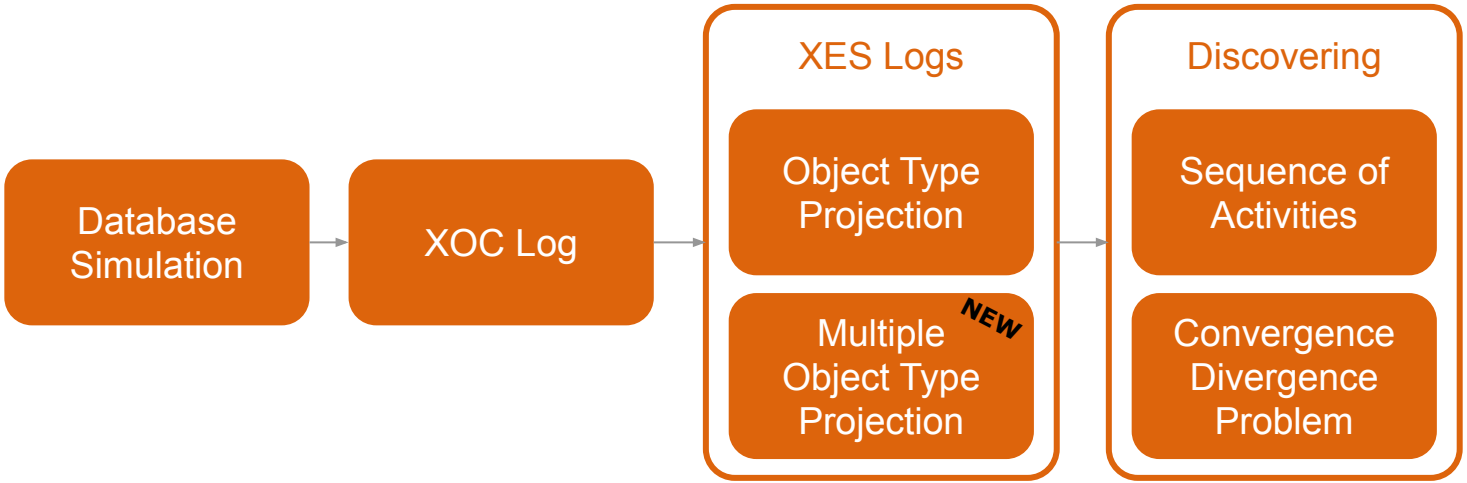




Directly Follows Graph



Milestones


Database Simulation
XOC Log
XES Logs
Object Type Projection
Multiple Object Type Projection
NEW
Discovering
Sequence of Activities
Convergence Divergence Problem

The Convergence and Divergence Problem [2][3]

Convergence = one event may be related to different cases

Case Notion

XOC Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174, 95}	{47}	{}	{}	{}

XES Log

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
0	create_rental	2020-01-01 08:00	{0}	{174}	{47}	{}	{}	{}
0	create_rental	2020-01-01 08:00	{0}	{95}	{47}	{}	{}	{}

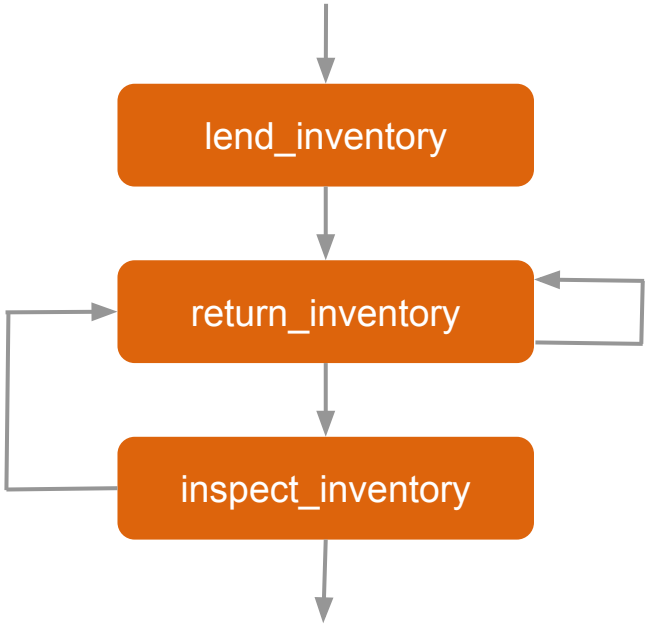
The Convergence and Divergence Problem [2][3]

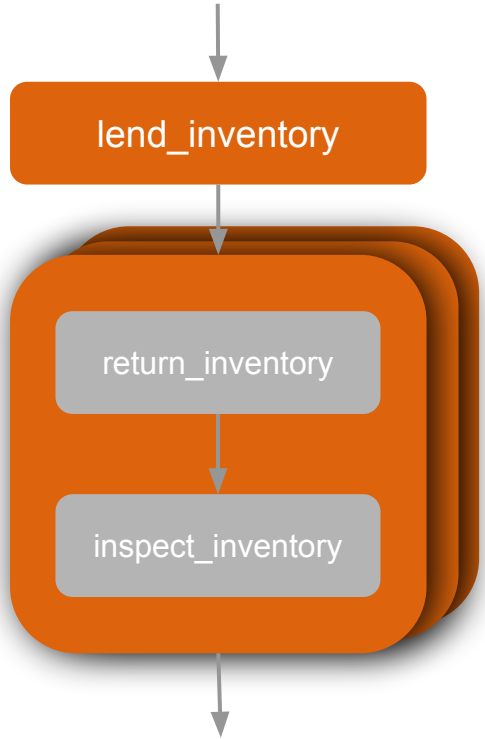
Divergence = for a given case, there may be multiple instances of the same activity within a case

Case Notion **XES Log**

event_id	activity	timestamp	rental	inventory	customer	staff	inspection	invoice
...	...	...	...	...	...	...	...	...
23	lend_inventory	2020-01-01 08:00	{0}	{174, 95,180}	{47}	{}	{}	{}
37	return_inventory	2020-01-02 09:30	{0}	{95}	{47}	{2}	{}	{}
54	return_inventory	2020-01-03 14:00	{0}	{174}	{47}	{5}	{}	{}
60	inspect_inventory	2020-01-03 17:00	{0}	{95}	{}	{3}	{13}	{}
65	return_inventory	2020-01-03 17:00	{0}	{180}	{47}	{2}	{}	{}
...	...	...	...	...	...	...	...	...

The Convergence and Divergence Problem [2][3]

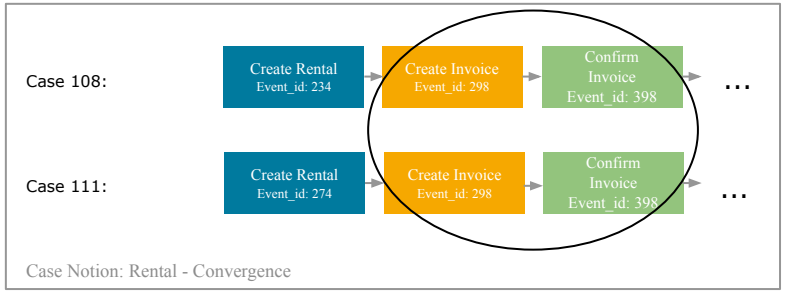


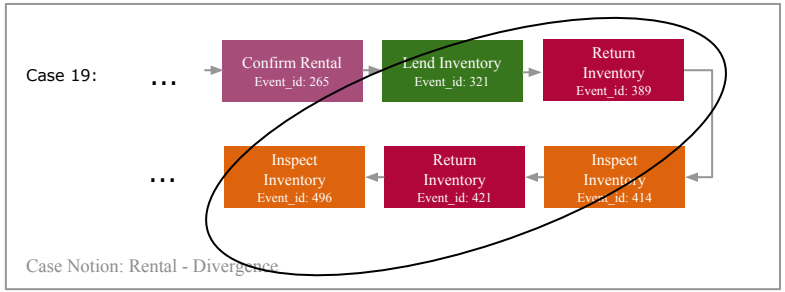


Examples from our Simulation

Rental

- Convergence Problem occurs when e.g. **an invoice is created for multiple rentals** (such as Rental 108 and 111)
- Divergence Problem occurs when **multiple inventories of one rental are returned** (e.g. rental 19) **one by one.**

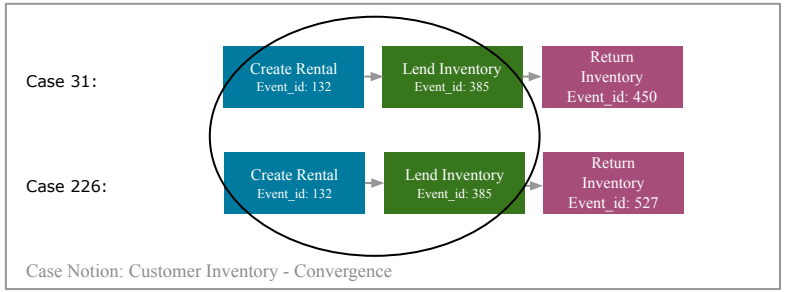


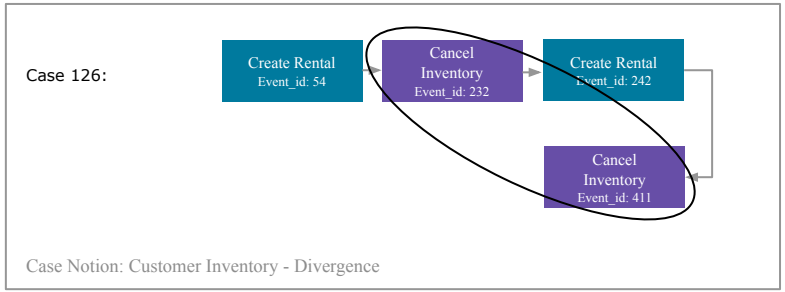


Examples from our Simulation

Customer Inventory

- Convergence Problem occurs when e.g. **a customer creates a rental with multiple inventories**
- Divergence Problem occurs when **one customer creates multiple rentals with the same inventory**

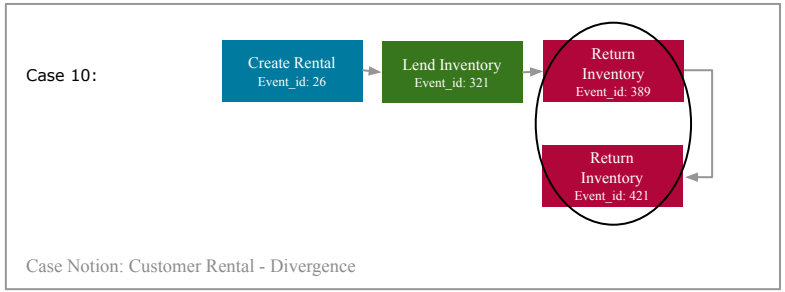




Examples from our Simulation

Customer Rental

- Divergence Problem occurs when **the same customer requests an inventory for multiple times**

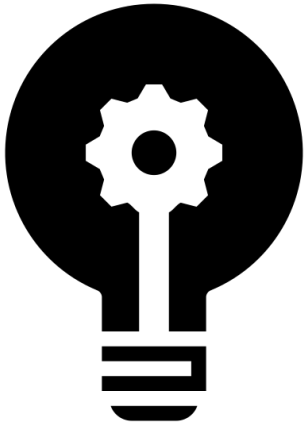


Retrospective: What have we done?

1) **Compared XES and XOC**
2) Tested some **OCBC tools**
   -> *missing documentation*
3) **Simulating** Process
4) Modelling **XOC Log**
5) **Extracting XES Log** using:
   a) **Object Type Projection** of [2]
   b) Adapted for **Multiple Object Types**
6) **Investigation** of:
   a) Sequence of activities
   b) Convergence & Divergence Problem

Take away

- **XOC notation** for visualization of the behavior within object-centric information-systems
- **Multiple Object Type Projection** enables a specific view on the process flow
- **XES log extraction** causes **Convergence Problems** and **Divergence Problem**
- **Future Work:**
  - Test Multiple Object Type Projection on a larger process/database
  - Involve more than two object types into the projection
  - Create a *weak* Multiple Object Types Projection



Multiple Case Notion in Log Extraction

Rachel Brabender and Oliver Clasen

Bibliography

[1] Li G., de Murillas E.G.L., de Carvalho R.M., van der Aalst W.M.P. (2018) Extracting Object-Centric Event Logs to Support Process Mining on Databases. In: Mendling J., Mouratidis H. (eds) Information Systems in the Big Data Era. CAiSE 2018. Lecture Notes in Business Information Processing, vol 317. Springer, Cham

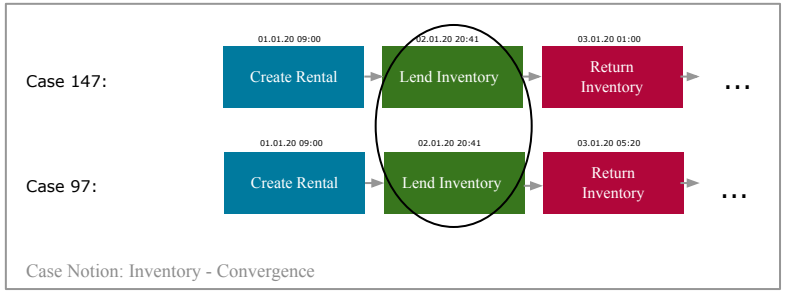
[2] van der Aalst W.M.P. (2019) Object-Centric Process Mining: Dealing with Divergence and Convergence in Event Data. In: Ölveczky P., Salaün G. (eds) Software Engineering and Formal Methods. SEFM 2019. Lecture Notes in Computer Science, vol 11724. Springer, Cham

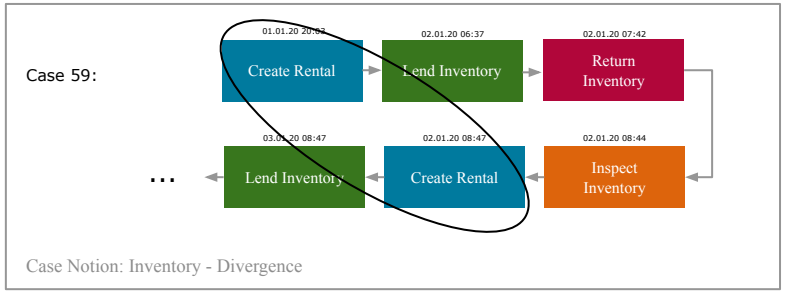
[3] van der Aalst W.M.P. Process Mining Camp 2020 — Day 8: Object-Centric Process Mining https://www.youtube.com/watch?v=mq405gY1x4g

Examples from our Simulation

Inventory

- Convergence Problem occurs when **two inventories** (such as Inventory 147 and 97) **are lended together**
- Divergence Problem occurs when **one inventory gets rented multiple times**, therefore it same activities are repeated.

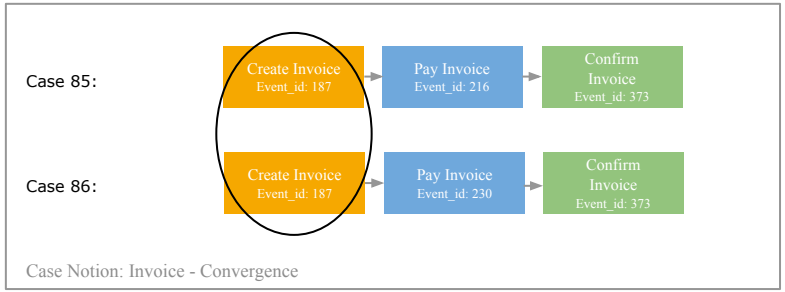




Examples from our Simulation

Invoice

- Convergence Problem occurs when **multiple invoices** (Invoice 85 and 86) **are created at the same time.**



Directly Follows Graph