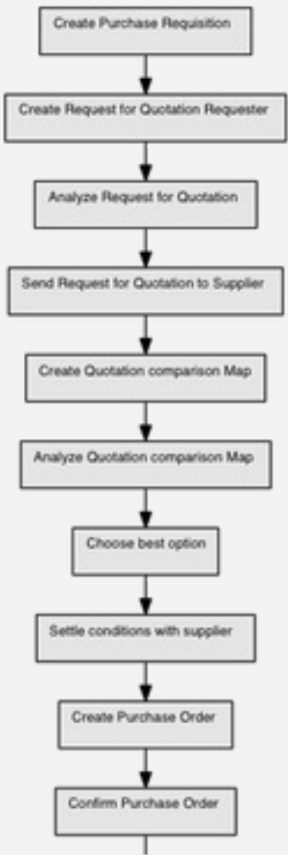
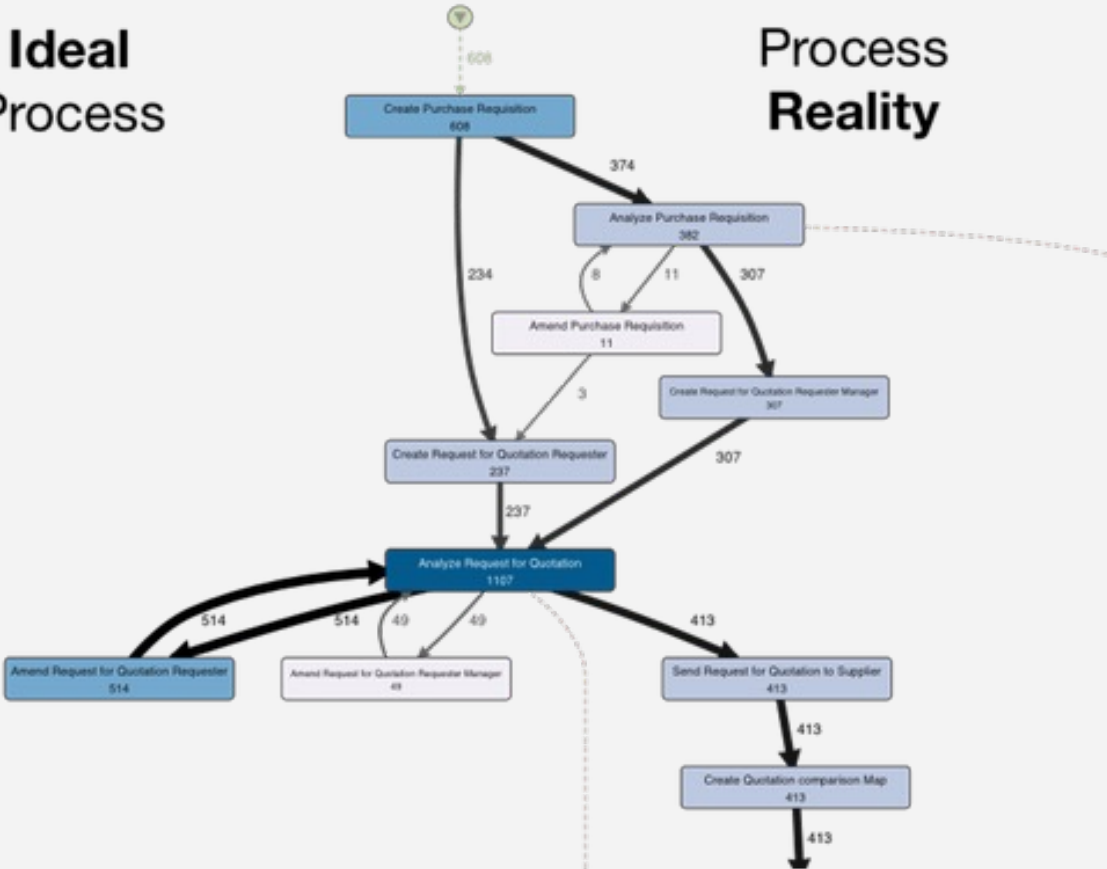




PROCESS MINING



Ideal Process



Process Reality

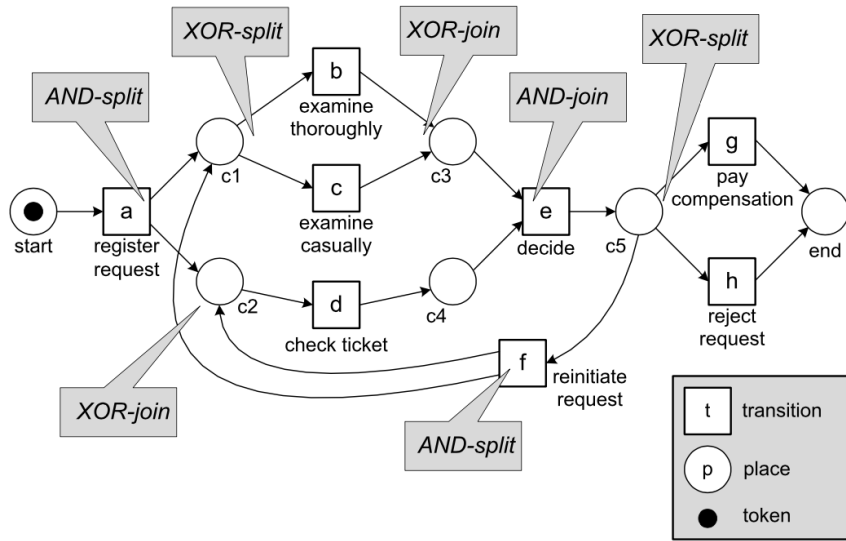


Fig. 3.2 A marked Petri net

6.2.2 Algorithm

After showing the basic idea and some examples, we describe the α -algorithm [157].

Definition 6.4 (α -algorithm) Let L be an event log over $T \subseteq \mathcal{A}$. $\alpha(L)$ is defined as follows:

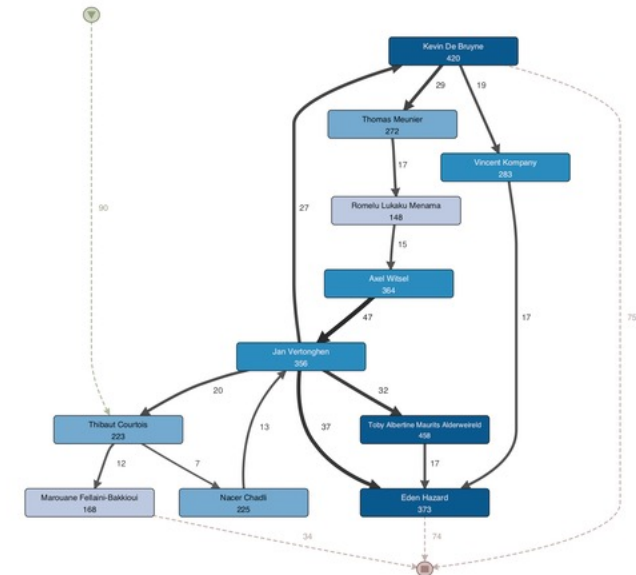
1. $T_L = \{t \in T \mid \exists \sigma \in L \ t \in \sigma\}$,
2. $T_I = \{t \in T \mid \exists \sigma \in L \ t = \text{first}(\sigma)\}$,
3. $T_O = \{t \in T \mid \exists \sigma \in L \ t = \text{last}(\sigma)\}$,
4. $X_L = \{(A, B) \mid A \subseteq T_L \wedge A \neq \emptyset \wedge B \subseteq T_L \wedge B \neq \emptyset \wedge \forall a \in A \forall b \in B \ a \rightarrow_L b \wedge \forall a_1, a_2 \in A \ a_1 \#_L a_2 \wedge \forall b_1, b_2 \in B \ b_1 \#_L b_2\}$,
5. $Y_L = \{(A, B) \in X_L \mid \forall (A', B') \in X_L \ A \subseteq A' \wedge B \subseteq B' \implies (A, B) = (A', B')\}$,
6. $P_L = \{p_{(A, B)} \mid (A, B) \in Y_L\} \cup \{i_L, o_L\}$,
7. $F_L = \{(a, p_{(A, B)}) \mid (A, B) \in Y_L \wedge a \in A\} \cup \{(p_{(A, B)}, b) \mid (A, B) \in Y_L \wedge b \in B\} \cup \{(i_L, t) \mid t \in T_I\} \cup \{(t, o_L) \mid t \in T_O\}$, and
8. $\alpha(L) = (P_L, T_L, F_L)$.

Process Mining Meets Football! How Does a Football Team Possess The Ball On The Pitch? Rudi 23 Oct '19



The players as activities

We can also have another perspective on the process by taking the *players* as *activities* and see the way they interact on the pitch, see Figure 5.





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INTERNACIONAL

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Quiénes somos

Noticias

Contacto



Inicio

Alumnos UC

Alumnos internacionales

Internacionalización en casa

Investigadores

Académicos y Staff

Postulación en línea

Pregrado y Magíster

Ruta de postulación Intercambio UC

1. Calendario de Postulación Primer semestre
(Estudiante UC)

2. Calendario de Postulación Segundo
semestre (Estudiante UC)

3. Requisitos de postulación

4. Proceso de asignación de cupos

5. Validación del certificado de Idiomas

6. Extensión del Intercambio

7. Convalidación de asignaturas

8. Vía Equidad de Vacantes

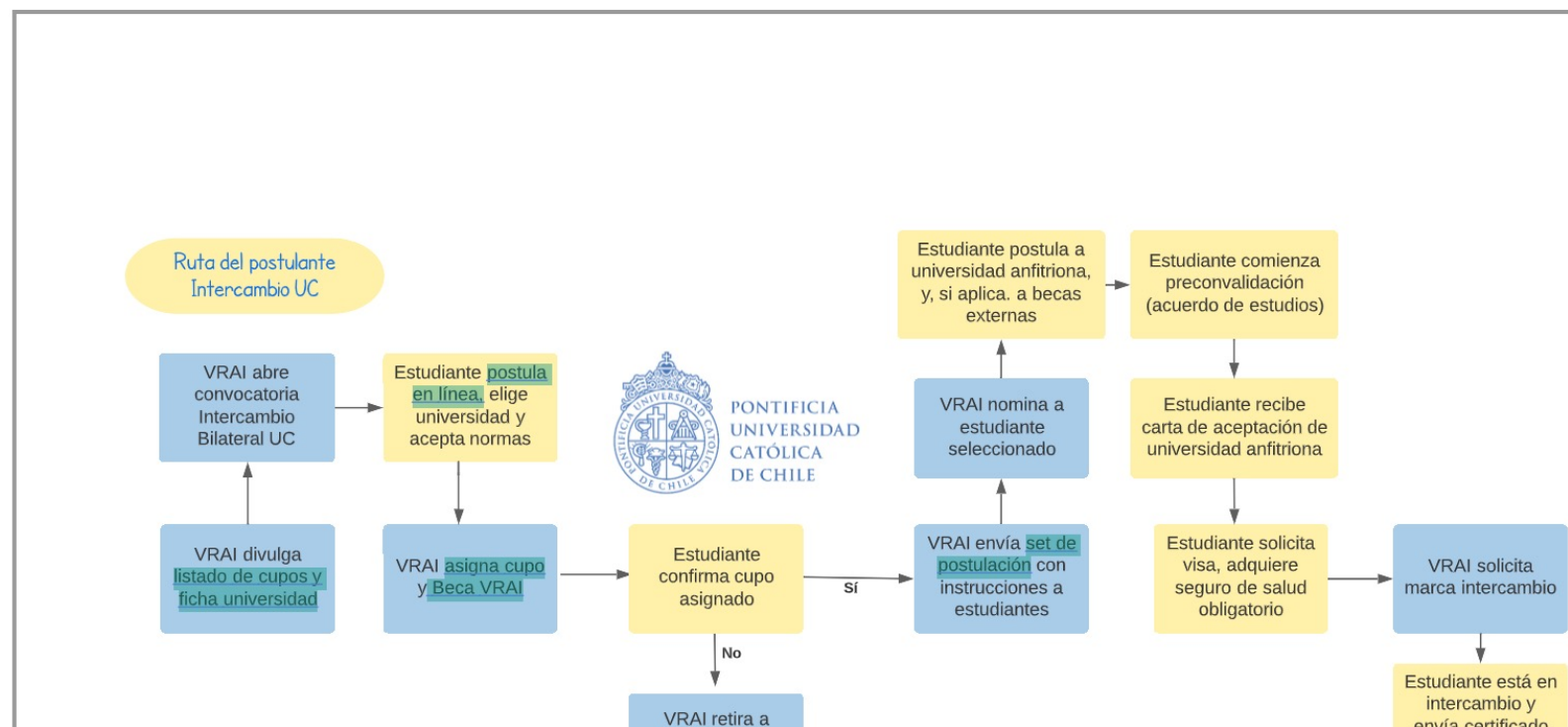
9. Testimonios de intercambio

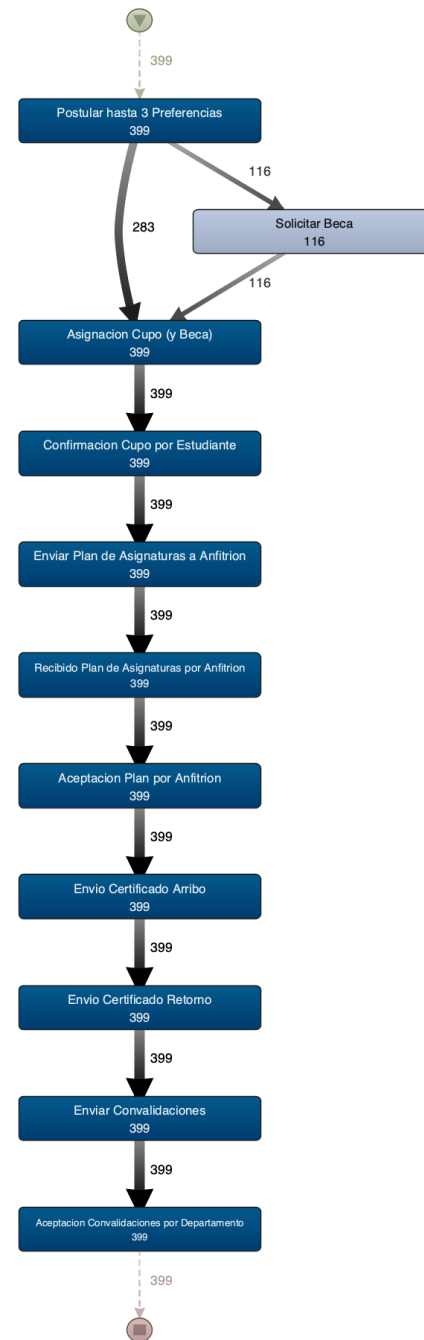
Postulación en línea

Becas

Doble grado/Titulación

Inicio / Alumnos UC / Pregrado y Magíster / Ruta de postulación Intercambio UC





The Process Perspective

Motivating Process Mining

Jorge Munoz-Gama
INF3803 – Process Mining

This course is **not** about techniques, algorithms, or tools, ... is about a **new way to address** problems.

The Process Perspective

A Motivational Example

NotCo

- NotCo

AI to create plant-based products
notco.com



~~TRANSGÉNICOS~~
~~LACTOSA~~
~~GLUTEN~~
~~COLESTEROL~~
~~HUEVO~~
~~SOYA~~

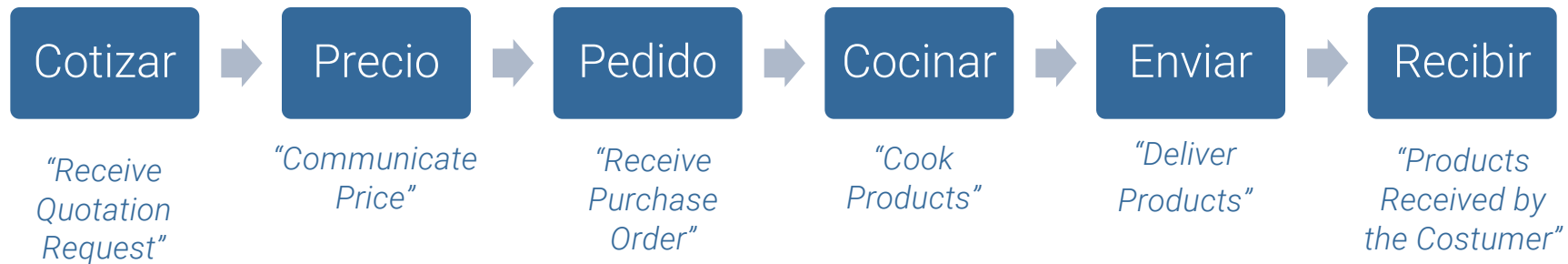


A Key-Value Analysis

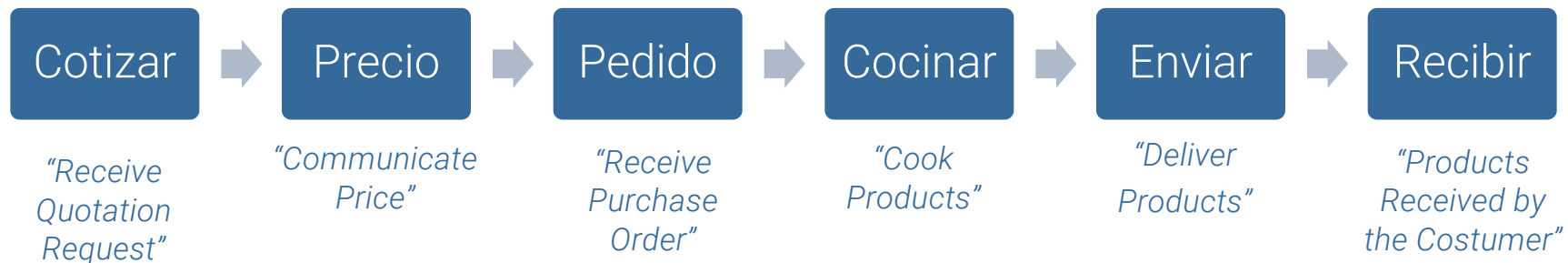
NotCo

Seems like a straightforward process
but they are having problems.

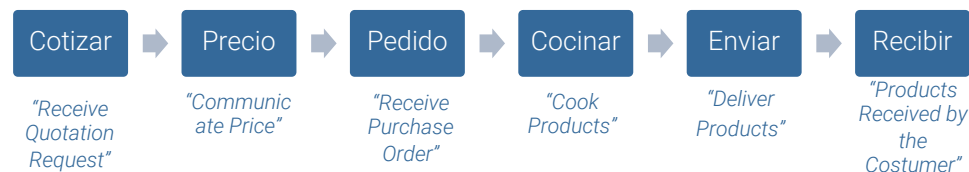
Decide to use a
more traditional key-value analysis.



<i>"Order"</i>	<i>"Store"</i>	<i>"Product"</i>	<i>"Quantity"</i>	<i>"Price"</i>	<i>"Employee"</i>	<i>"Delivery Company"</i>	<i>* time unit (timestamp)</i>					
Pedido	Empresa	Producto	Cantidad	Precio	Ejecutivo	Delivery	Cotizar	Precio	Pedido	Cocinar	Enviar	Recibir
1	Lyder	Not Mayo	100	200	Alice	TransMove	0	10	20	30	40	50
2	Lyder	Not Milk	200	200	Alice	TransMove	60	70	80	90	100	110
3	Jimbo	Not Mayo	200	380	Bob	FastBBB	100	110	120	130	140	150
4	Jimbo	Not Burguer	500	850	Alice	FastBBB	150	170	180	190	200	300
5	Jimbo	Not Milk	1000	2000	Bob	TransMove	300	400	410	420	430	440
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8	Badulaque	Not IceCream	100	500	Bob	FastBBB	500	510	520	530	650	660
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10	MegaStore	Not Milk	15000	30000	Charlie	FastBBB	700	710	720	730	760	770
11	Lyder	Not IceCream	300	23000	Bob	-	690	750	700	710	-	-
12	Jimbo	Not Milk	500	1000	Alice	TransMove	700	710	720	950	960	965
13	Lyder	Not Milk	500	1000	Charlie	TransMove	710	715	725	950	970	980



<i>"Order"</i>	<i>"Store"</i>	<i>"Product"</i>	<i>"Quantity"</i>	<i>"Price"</i>	<i>"Employee"</i>	<i>"Delivery Company"</i>						
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12	Jimbo	Not Milk	500	1000	Alice	TransMove	700	710	720	950	960	965
13	Lyder	Not Milk	500	1000	Charlie	TransMove	710	715	725	950	970	980



¿How often do we receive a new quotation request?

- Statistics, ..

Mean, distribution, ...

¿How does the delivery company hired depends on the employee selling?

- Statistics, Data Mining, IA, ...

Decision trees, ...

¿Could you categorize the purchases in 3 types depending on the quantity of the product?

- Data Mining, ...

Clustering, K-means, ...

¿But what about ..?

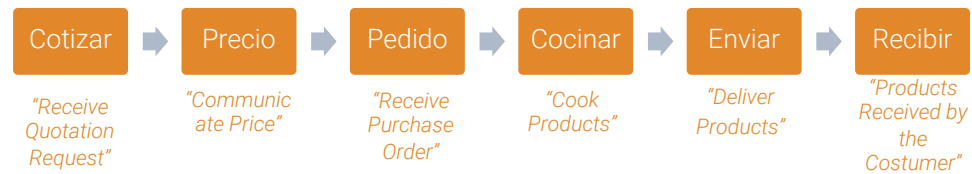
<i>"Order"</i>	<i>"Store"</i>	<i>"Product"</i>	<i>"Quantity"</i>	<i>"Price"</i>	<i>"Employee"</i>	<i>"Delivery Company"</i>						
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¿How many cases do not end as expected?

- ¿...?

¿How many different ways of handling purchases are there?

- ¿...?



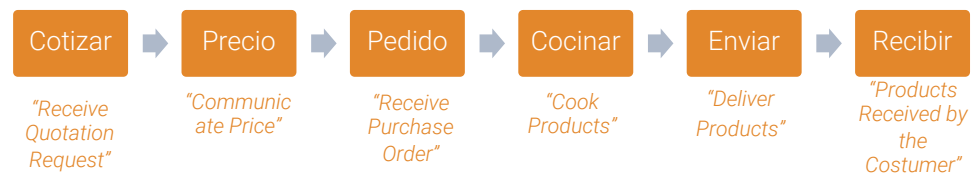
<i>"Order"</i>	<i>"Store"</i>	<i>"Product"</i>	<i>"Quantity"</i>	<i>"Price"</i>	<i>"Employee"</i>	<i>"Delivery Company"</i>						
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13	Lyder	Not Milk	500	1000	Charlie	TransMove	710	715	725	950	970	980

¿How many cases do not end as expected?

- 8

¿How many different ways of handling purchases are there?

- 9



A Process-Oriented Analysis *NotCo*

Shift to process-oriented perspective

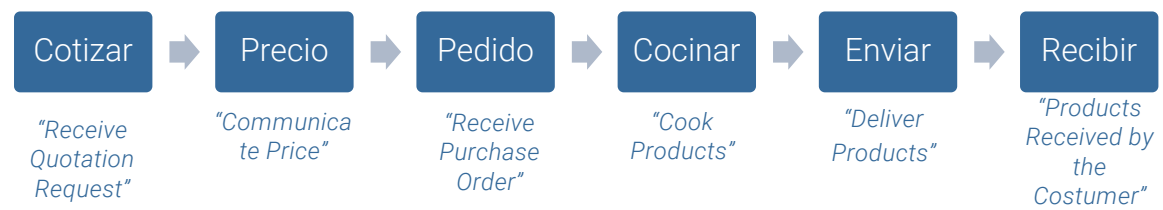
Go to the raw data

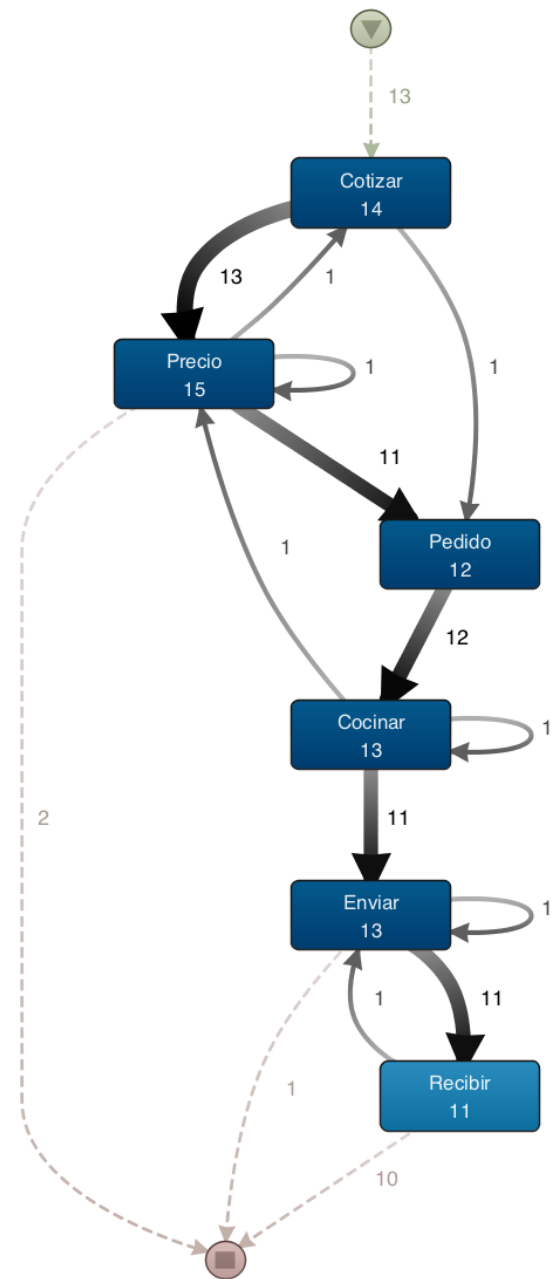
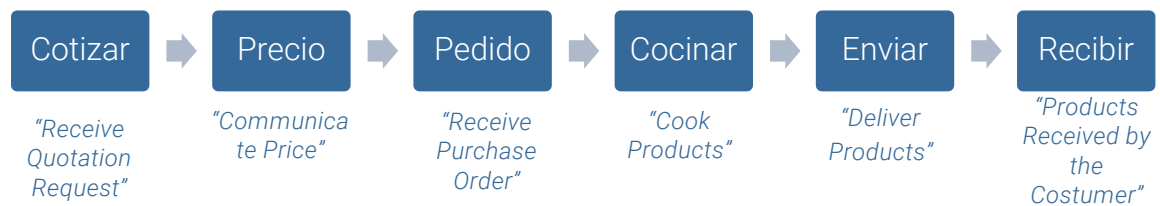
Process-oriented extraction from the databases


























Pedido	Empresa	Producto	Cantidad	Precio	Ejecutivo	Delivery	Cotizar	Precio	Pedido	Cocinar	Enviar	Recibir
1	Lyder	Not Mayo	100	200	Alice	TransMove	0	10	20	30	40	50
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13	Lyder	Not Milk	500	1000	Charlie	TransMove	710	715	725	950	970	980


EMPRESA	NPED	ACCION	TIEMPO	PRODUCTO	CANTIDAD	PRECIO	DELIVERY	EJECUTIVO
Lyder	1	Cocinar	30					
Lyder	2	Cocinar	90					
Jimbo	3	Cocinar	130					
Jimbo	4	Cocinar	190					
Jimbo	5	Cocinar	420					
Jimbo	6	Cocinar	420					
Jimbo	6	Cocinar	600					
Badulaque	8	Cocinar	530					
Italiany	9	Cocinar	730					
MegaStore	10	Cocinar	730					
Lyder	11	Cocinar	710					
Jimbo	12	Cocinar	950					
Lyder	13	Cocinar	950					
Lyder	1	Cotizar	0	Not Mayo	100			Alice
Lyder	2	Cotizar	60	Not Milk	200			Alice
Jimbo	3	Cotizar	100	Not Mayo	200			Bob
Jimbo	4	Cotizar	150	Not Burguer	500			Charlie
Jimbo	5	Cotizar	200	Not Milk	2000			Bob
Jimbo	5	Cotizar	300	Not Milk	1000			Bob
Jimbo	6	Cotizar	400	Not Milk	100			Alice
Lyder	7	Cotizar	500	Not Mayo	50			Bob
Badulaque	8	Cotizar	500	Not IceCream	100			Bob
Italiany	9	Cotizar	700	Not Milk	300			Alice
MegaStore	10	Cotizar	700	Not Milk	15000			Charlie
Lyder	11	Cotizar	690	Not IceCream	300			Bob
Jimbo	12	Cotizar	700	Not Milk	500			Alice
Lyder	13	Cotizar	710	Not Milk	500			Charlie
Lyder	1	Enviar	40				TransMove	
Lyder	2	Enviar	100				TransMove	
Jimbo	3	Enviar	140				FastBBB	

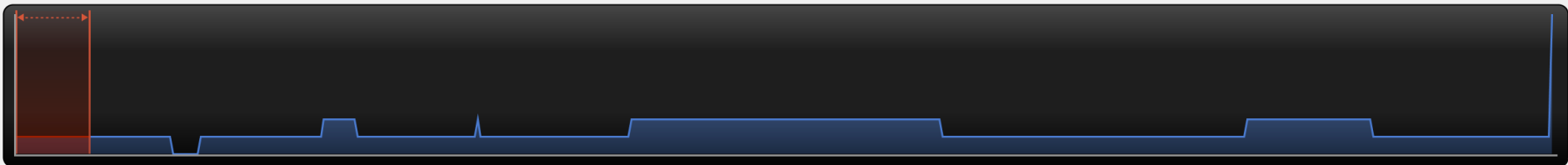




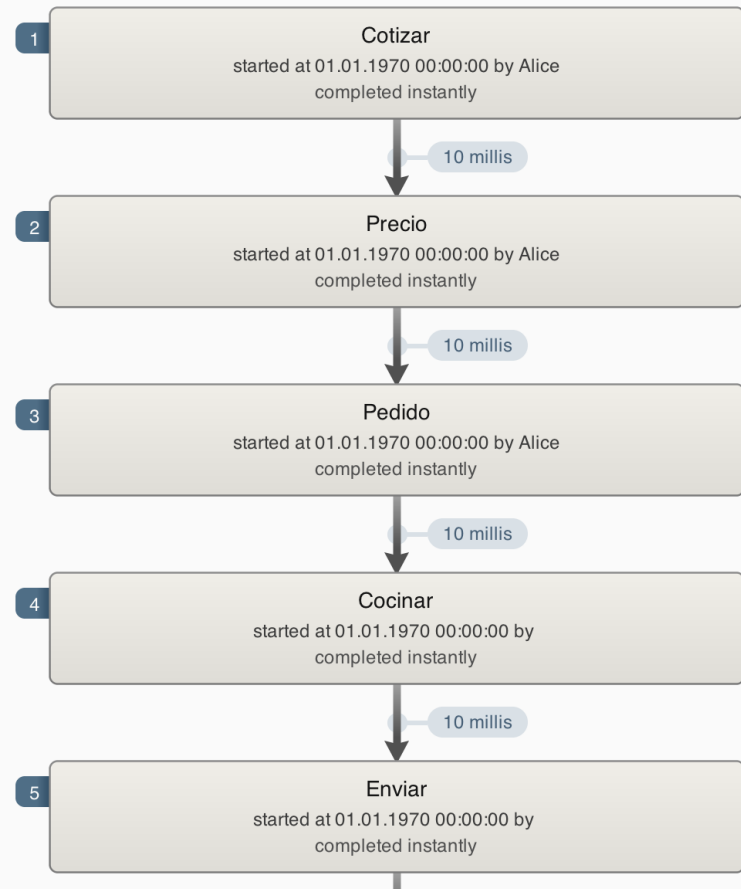
Variants (9)		Cases (13)	
 Complete log	All cases (13)	 1	6 events
 Variant 1	5 cases (38.46%)	 2	6 events
 Variant 2	1 case (7.69%)	 3	6 events
 Variant 3	1 case (7.69%)	 4	7 events
 Variant 4	1 case (7.69%)	 5	8 events
 Variant 5	1 case (7.69%)	 6	7 events
 Variant 6	1 case (7.69%)	 7	2 events
 Variant 7	1 case (7.69%)	 8	7 events
 Variant 8	1 case (7.69%)	 9	5 events
 Variant 9	1 case (7.69%)	 10	8 events
		 11	4 events
		 12	6 events
		 13	6 events
			

9 different ways to handle the 13 orders!

 1
Case with 6 events

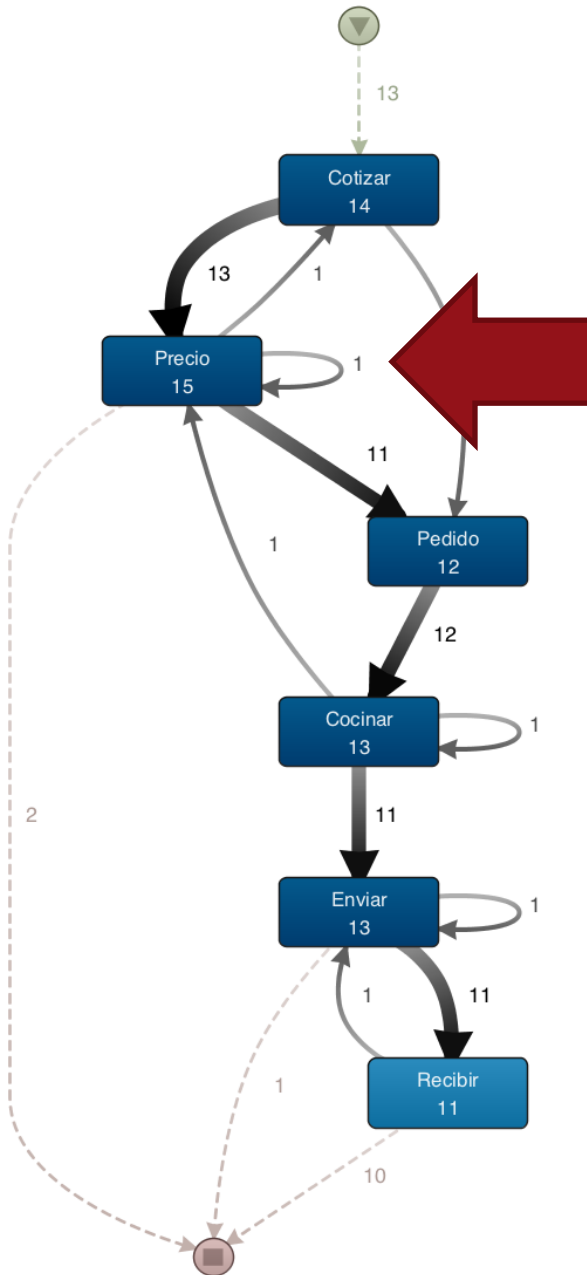


Graph Table

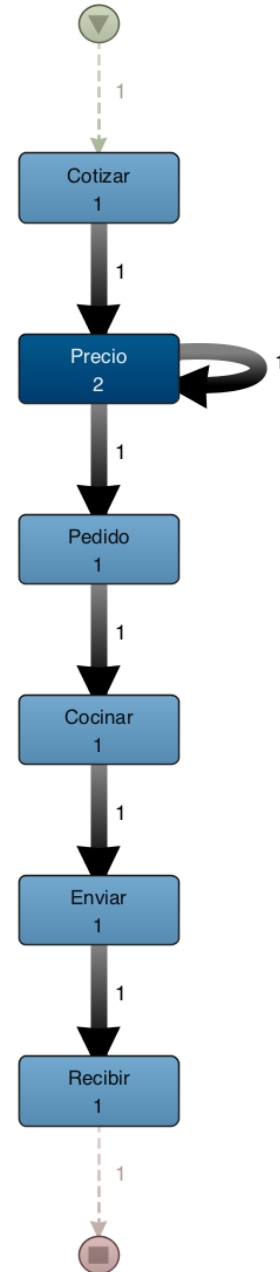


What is going on with ...
double price communication?

All orders



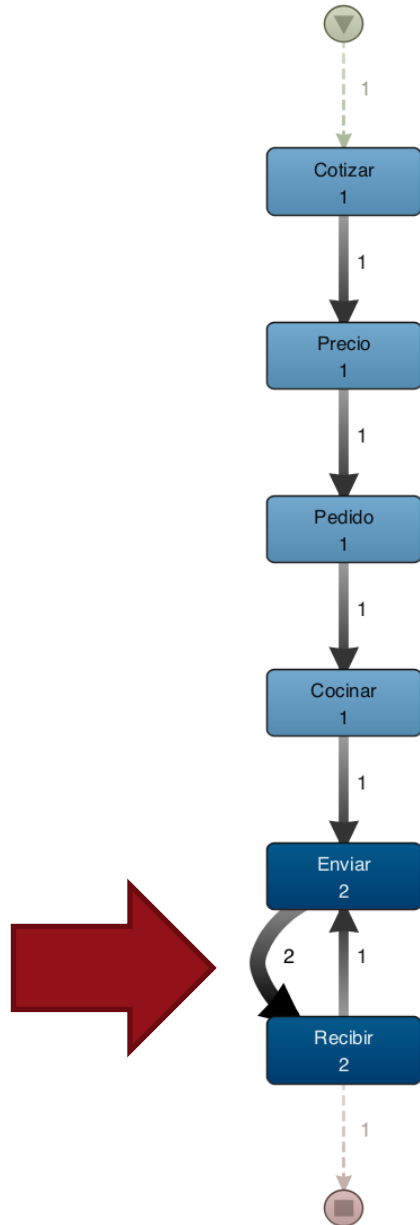
*Order with prices
communication problems*



- We detect there is one case where prices is communicated **twice**
- Further investigation reveals that a client received an **irregular price reduction** from an employee (Bob)

What is going on with ...
the products being received twice?

Order with delivery problems



Follower
Filters by subsequences

Filter by: **Activity**

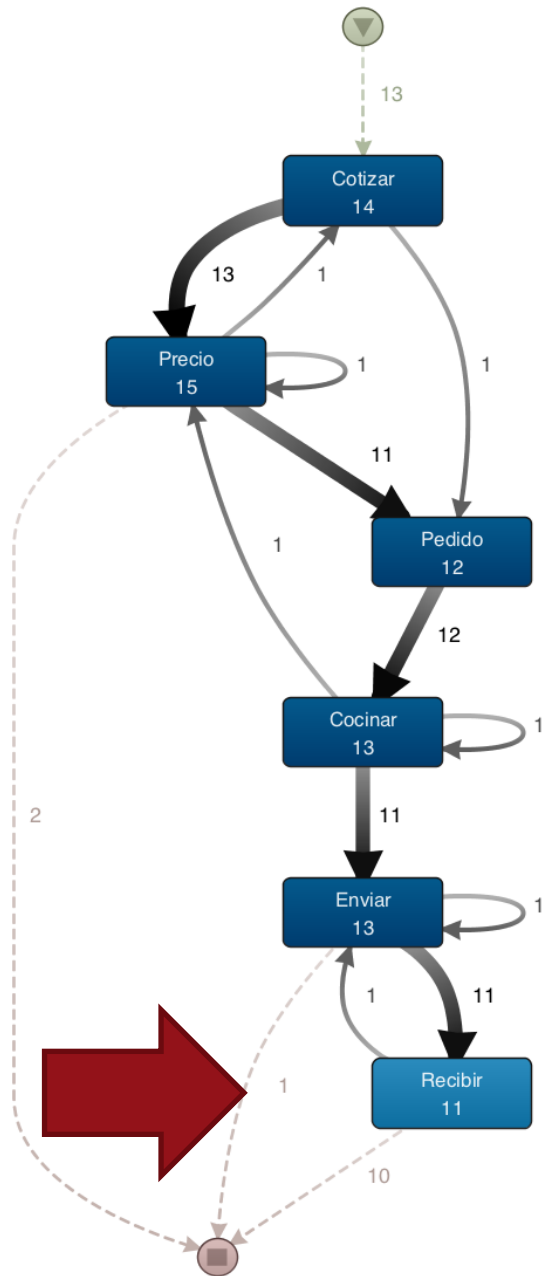
Reference event must be **eventually followed** by a follower event.

Reference event values: (1 of 6 selected)	Follower event values: (1 of 6 selected)
<input type="checkbox"/> Cocinar	<input type="checkbox"/> Cocinar
<input type="checkbox"/> Cotizar	<input type="checkbox"/> Cotizar
<input type="checkbox"/> Enviar	<input type="checkbox"/> Enviar
<input type="checkbox"/> Pedido	<input type="checkbox"/> Pedido
<input type="checkbox"/> Precio	<input type="checkbox"/> Precio
<input checked="" type="checkbox"/> Recibir	<input checked="" type="checkbox"/> Recibir

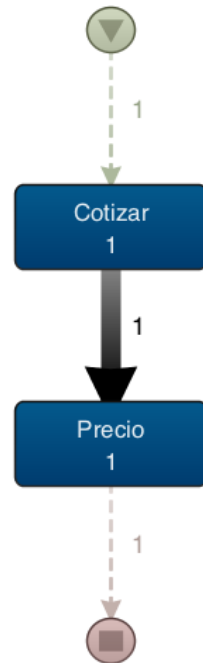
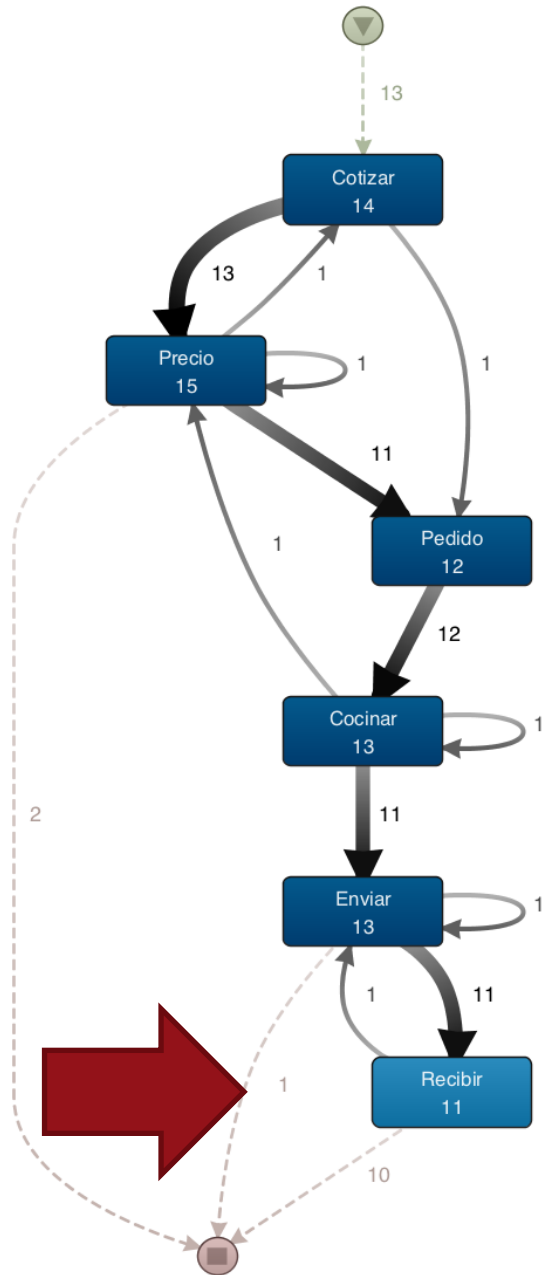
- We detect the pattern “send, received, send, received”.
- Further investigation reveals that the delivery company irregularly split large deliveries into small ones.

What is going on with ...
the orders ending up not being received?

All orders

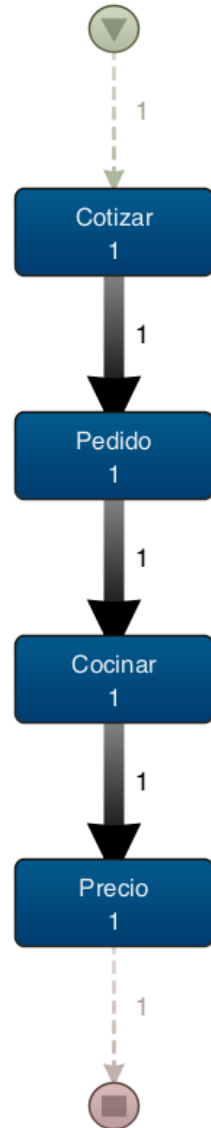
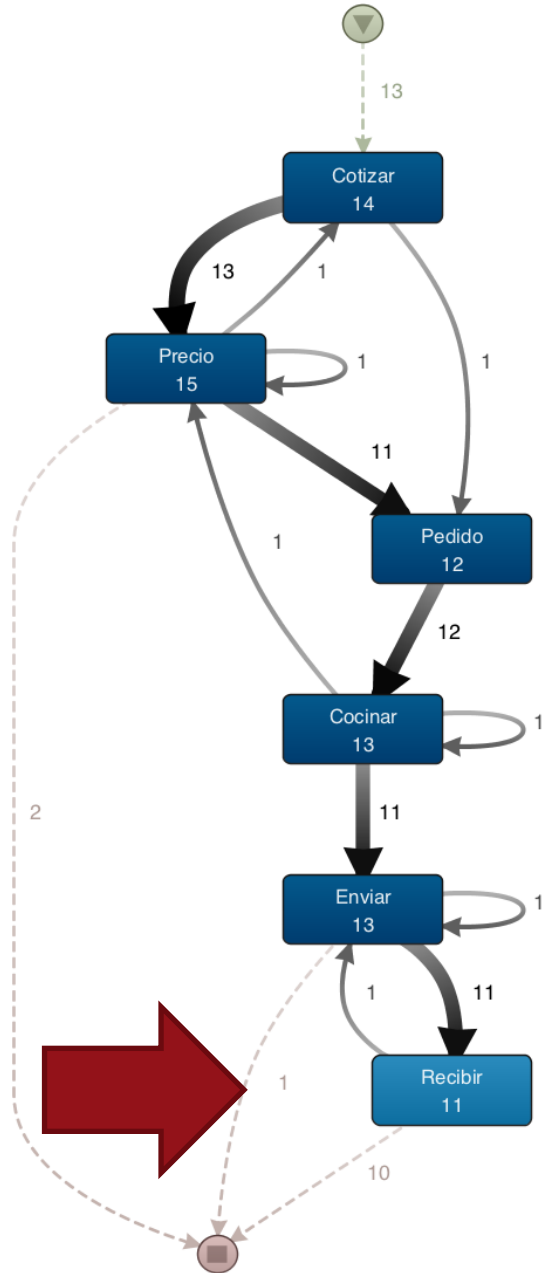


All orders



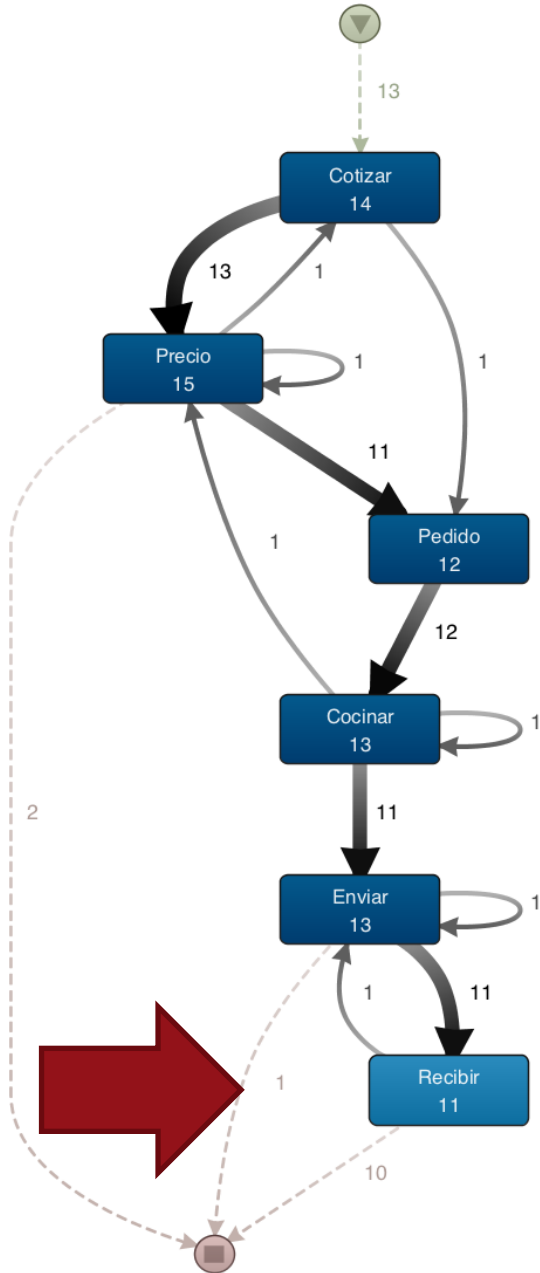
- The costumer did **not like the price**
- Could be a normal behavior but further investigation reveals that the client received an **out-of-market price** from an employee (Bob)

All orders



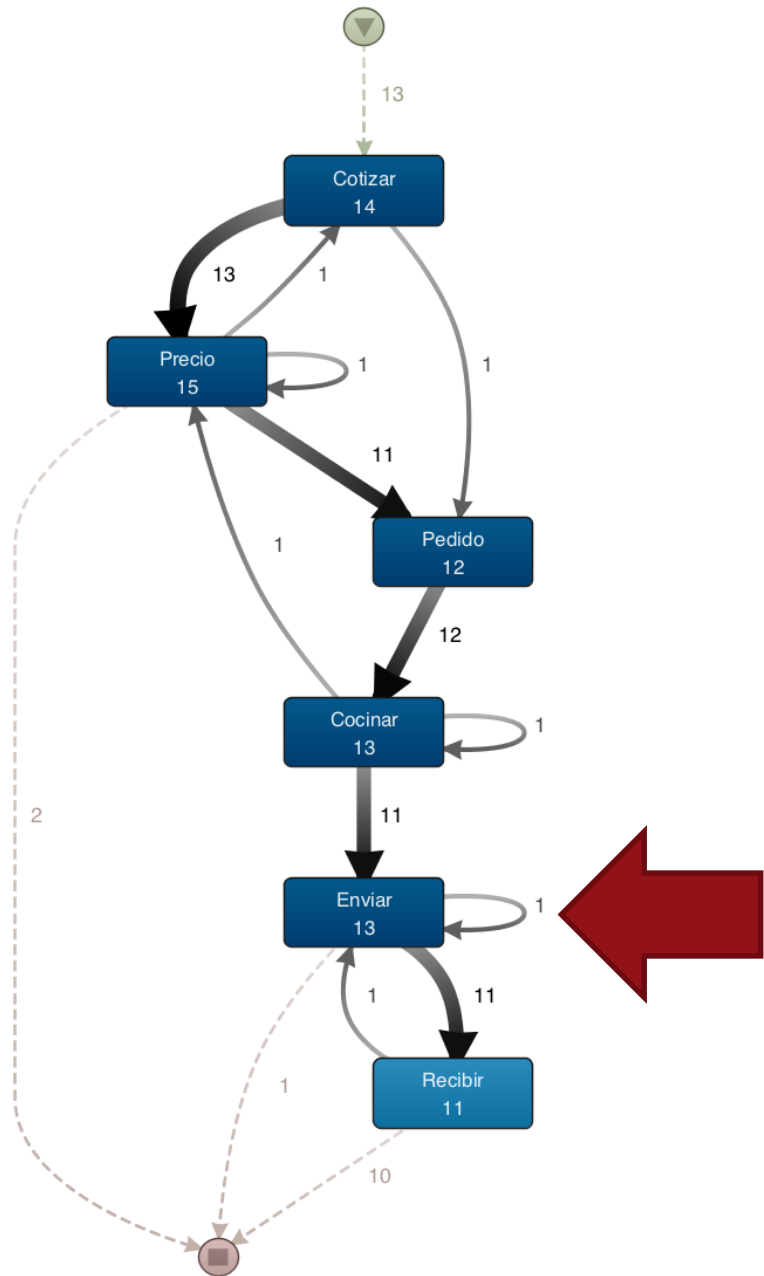
- The employee (Bob) went forward with the **purchase** without communicating the **price** to client.
- When the client received the price, he **didn't like it**.
- All the cooked product batch had to be **discarded**.

All orders



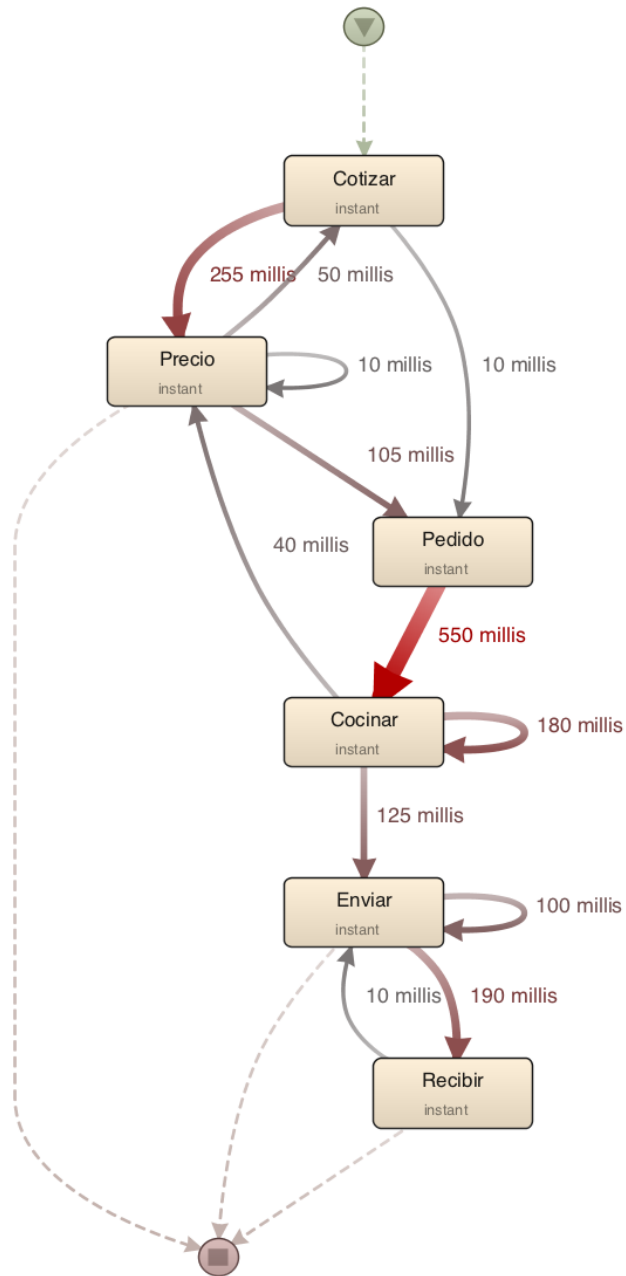
- The delivery was never received but was not sent again.
- All the product batch that stayed in the warehouse went bad and had to be discarded.

What is going on with ...
delivery immediately followed by another delivery?



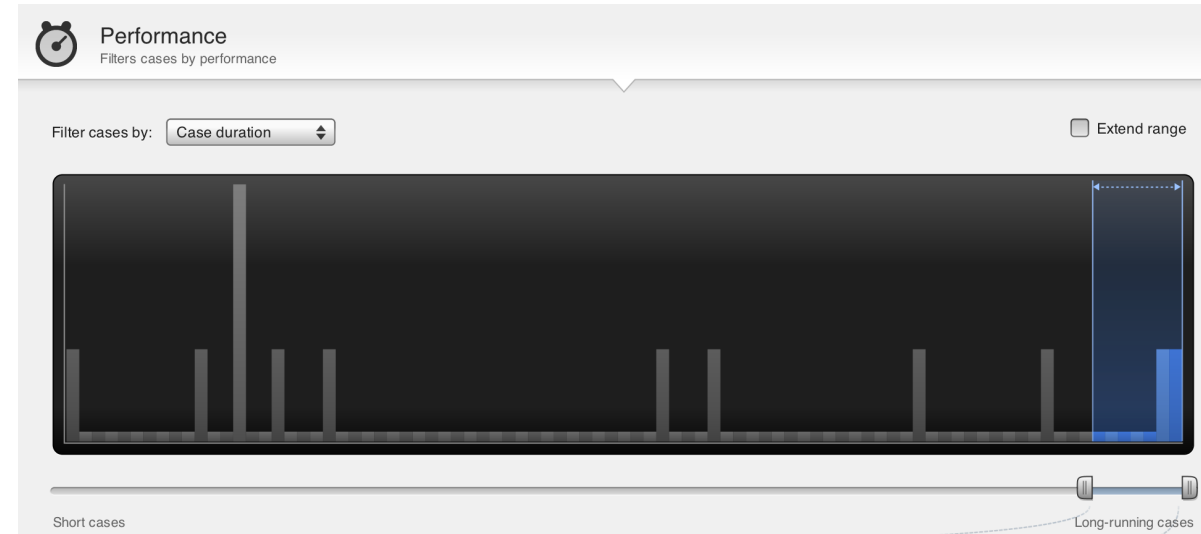
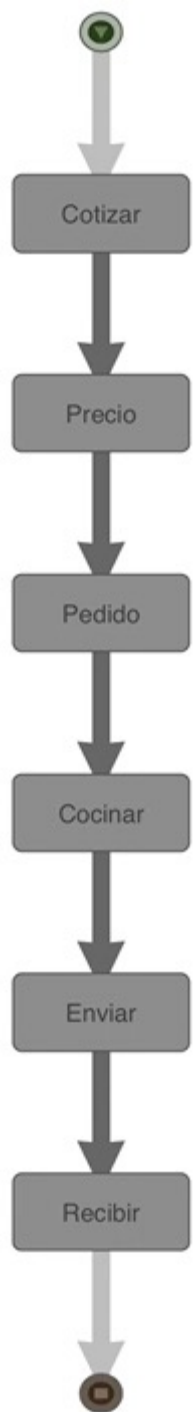
- The delivery company wrote the wrong address.

Where are we **wasting** time?



- Between formalizing the purchase and start cooking
(normal)
- Between sending the delivery and receiving it
(normal)
- Between asking for a quotation and receiving the price
(NOT normal. That step should be almost automatic)

Why some orders are taking so much time?



- Two almost **simultaneous** orders.
- The kitchen was **collapsed**.
- The second delivery waited for the first to be received

Further investigation reveals that the delivery company had **only one ban** that day.

Wrap Up
NotCo

One could claim everything could be analyzed
with a key-value software like Excel

... and its true because Excel is Turing Complete
(i.e., could solve any computational problem)

It's not about what we can do
but to consider the process perspective as
a First-Class Citizen



PONTIFICIA
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CATÓLICA
DE CHILE

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Buscar...



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Internacionalización en casa ▼

Investigadores ▼

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➤ Postulación en línea

Pregrado y Magíster ▼

Ruta de postulación Intercambio UC ▼

1. Calendario de Postulación Primer semestre
(Estudiante UC)

2. Calendario de Postulación Segundo
semestre (Estudiante UC)

3. Requisitos de postulación

4. Proceso de asignación de cupos

5. Validación del certificado de Idiomas

6. Extensión del Intercambio

7. Convalidación de asignaturas

8. Vía Equidad de Vacantes

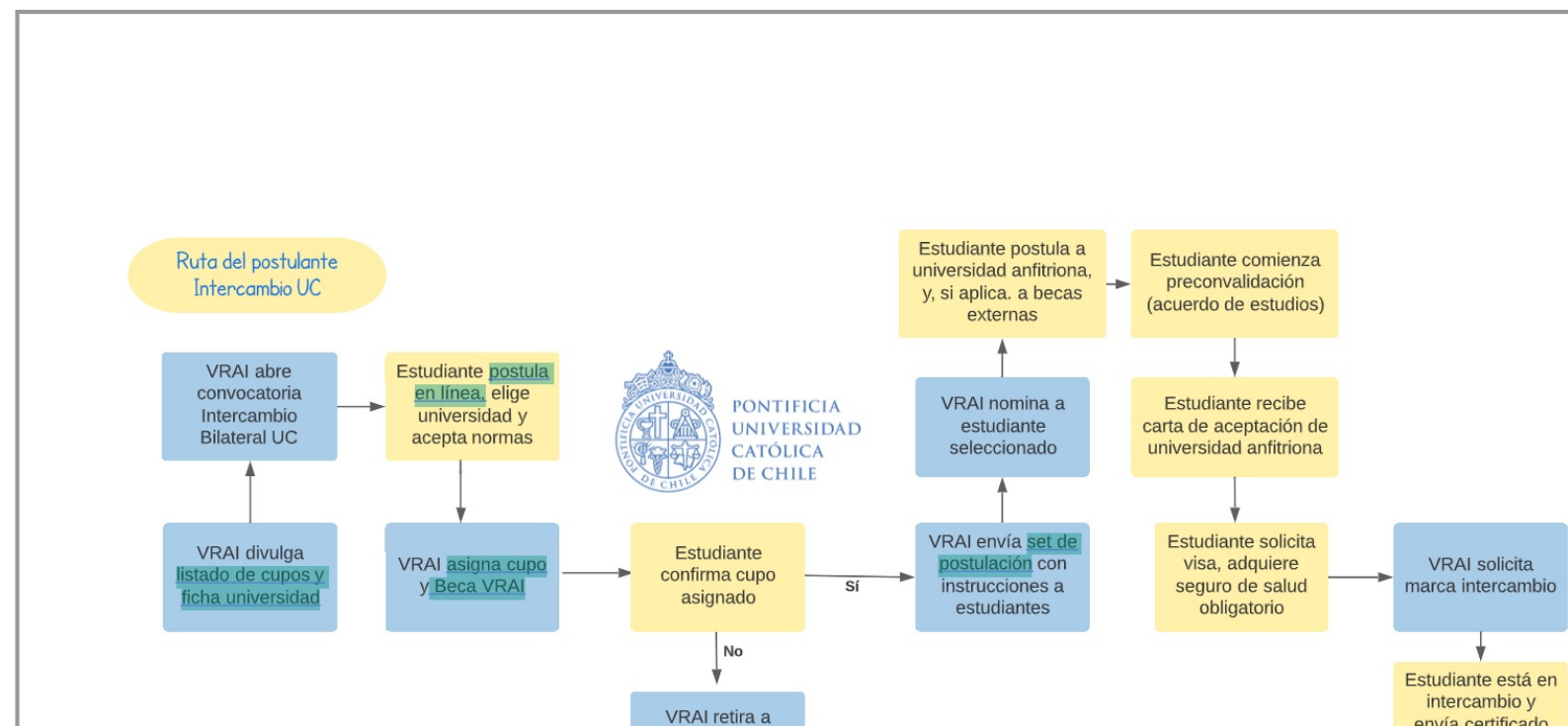
9. Testimonios de intercambio

Postulación en línea ➤

Becas ➤

Doble grado/Titulación

Inicio / Alumnos UC / Pregrado y Magíster / Ruta de postulación Intercambio UC



intercambios.csv

Case ID;Activity;Timestamp;Beca;Preferencia;Pais;Universidad; Rechazo Plan;Rechazo Convalidacion
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est0;Asignacion Cupo (y Beca);2021-04-30 00:00:00;NO;2;Austria;University 2 of Austria;;
est0;Confirmacion Cupo por Estudiante;2021-05-16 00:00:00;;;;;
est0;Enviar Plan de Asignaturas a Anfitrion;2021-05-26 00:00:00;;;;;
est0;Recibido Plan de Asignaturas por Anfitrion;2021-05-27 00:00:00;;;;;
est0;Aceptacion Plan por Anfitrion;2021-05-30 00:00:00;;;;;
est0;Envio Certificado Arribo;2021-06-17 00:00:00;;;;;
est0;Envio Certificado Retorno;2021-12-05 00:00:00;;;;;
est0;Enviar Convalidaciones;2021-12-13 00:00:00;;;;;
est0;Rechazado Convalidaciones por Departamento;2021-12-18 00:00:00;;;;;Programas muy diferentes
est0;Re-Enviar Convalidaciones;2021-12-20 00:00:00;;;;;
est0;Aceptacion Convalidaciones por Departamento;2021-12-24 00:00:00;;;;;
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est2;Enviar Plan de Asignaturas a Anfitrion;2021-06-07 00:00:00;;;;;
est2;Recibido Plan de Asignaturas por Anfitrion;2021-06-08 00:00:00;;;;;
est2;Aceptacion Plan por Anfitrion;2021-06-11 00:00:00;;;;;
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est2;Envio Certificado Retorno;2021-11-13 00:00:00;;;;;
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est3;Aceptacion Plan por Anfitrion;2021-06-10 00:00:00;;;;;
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est3;Envio Certificado Retorno;2021-12-10 00:00:00;;;;;
est3;Enviar Convalidaciones;2021-12-23 00:00:00;;;;;
est3;Aceptacion Convalidaciones por Departamento;2021-12-26 00:00:00;;;;;
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est4;Recibido Plan de Asignaturas por Anfitrion;2021-06-12 00:00:00;;;;;

intercambios								
Case ID	Activity	Timestamp	Beca	Preferencia	Pais	Universidad	Rechazo Plan	Rechazo Convalidacion
est0	Postular hasta 3 Preferencias	2021-04-09 00:00:00						
est0	Asignacion Cupo (y Beca)	2021-04-30 00:00:00	NO	2	Austria	University 2 of Austria		
est0	Confirmacion Cupo por Estudiante	2021-05-16 00:00:00						
est0	Enviar Plan de Asignaturas a Anfitrion	2021-05-26 00:00:00						
est0	Recibido Plan de Asignaturas por Anfitrion	2021-05-27 00:00:00						
est0	Aceptacion Plan por Anfitrion	2021-05-30 00:00:00						
est0	Envio Certificado Arribo	2021-06-17 00:00:00						
est0	Envio Certificado Retorno	2021-12-05 00:00:00						
est0	Enviar Convalidaciones	2021-12-13 00:00:00						
est0	Rechazado Convalidaciones por Departamento	2021-12-18 00:00:00						Programas muy diferentes
est0	Re-Enviar Convalidaciones	2021-12-20 00:00:00						
est0	Aceptacion Convalidaciones por Departamento	2021-12-24 00:00:00						
est1	Postular hasta 3 Preferencias	2021-04-11 00:00:00						
est1	Asignacion Cupo (y Beca)	2021-04-30 00:00:00	NO	3	Portugal	University 2 of Portugal		
est2	Postular hasta 3 Preferencias	2021-03-29 00:00:00						
est2	Asignacion Cupo (y Beca)	2021-04-30 00:00:00	NO	1	Austria	University 3 of Austria		
est2	Confirmacion Cupo por Estudiante	2021-05-27 00:00:00						
est2	Enviar Plan de Asignaturas a Anfitrion	2021-06-07 00:00:00						
est2	Recibido Plan de Asignaturas por Anfitrion	2021-06-08 00:00:00						
est2	Aceptacion Plan por Anfitrion	2021-06-11 00:00:00						
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est2	Envio Certificado Retorno	2021-11-13 00:00:00						
est2	Enviar Convalidaciones	2021-11-21 00:00:00						
est2	Aceptacion Convalidaciones por Departamento	2021-11-24 00:00:00						
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est4	Postular hasta 3 Preferencias	2021-03-23 00:00:00						

