Question 1

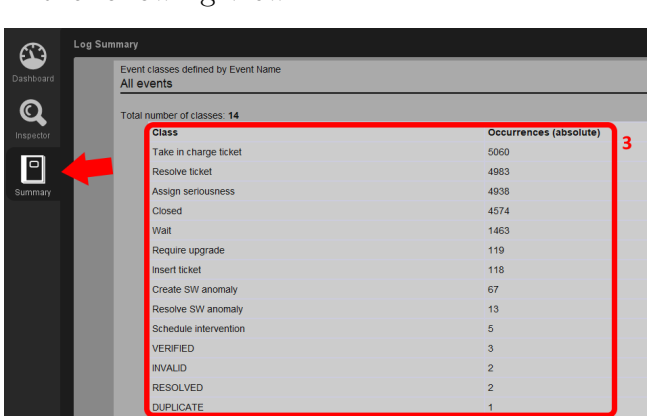
(a)

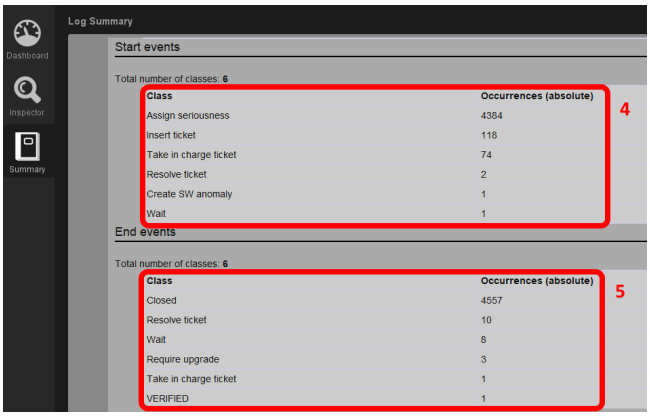
Import *log-flat.xes* to ProM. Click the eye symbol to view resource.
This results in the following view:

From it we can read

- the time period (1) covered by the event log, which is from 13.01.2010 to 03.01.2014
- the number of cases, events and activities of the log (2), being 4580, 21348 and 14 respectively (note that activities appear in ProM as event classes)

To gain more information on the activities we click the summary tab in the left which results in the following view:



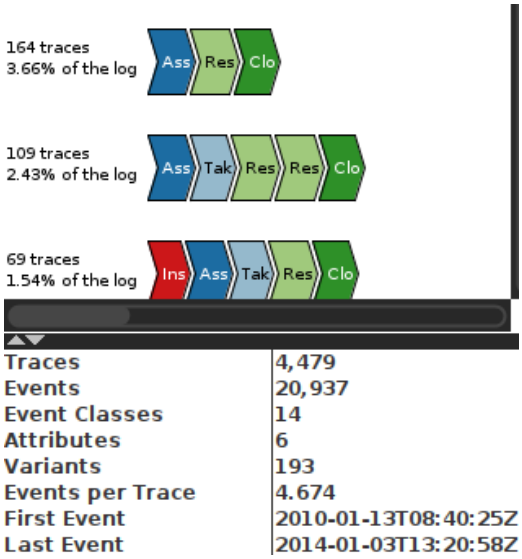


From (3) we get a table of occurence frequencies for each activity. From (4) we get a table of occurence frequencies for each start activity. From (5) we get a table of occurence frequencies for each end activity.
To determine the number of unique trace variants we click on 'Select visualization' and select 'Explore Event Log'
Under this view all trace variants are listed and some further information is given. From this we learn that there are 226 unique variants in the event log.

98% of tickets taken in charge are also resolved ($\frac{4983}{5060}$). The variants seem to be quite diverse ($\tilde{1}$:20 ratio of cases to variants, although distributed very unevenly).
From (4) we also observe that a quite high number of cases start with "illegal" activities (so not 'Assign seriousness' or 'Insert ticket'). It strikes out, that people managed in 74 cases to start their tickets with the "illegal" activity 'Take in charge ticket', while in comparison only 118 cases begin with the activity 'Insert ticket'.

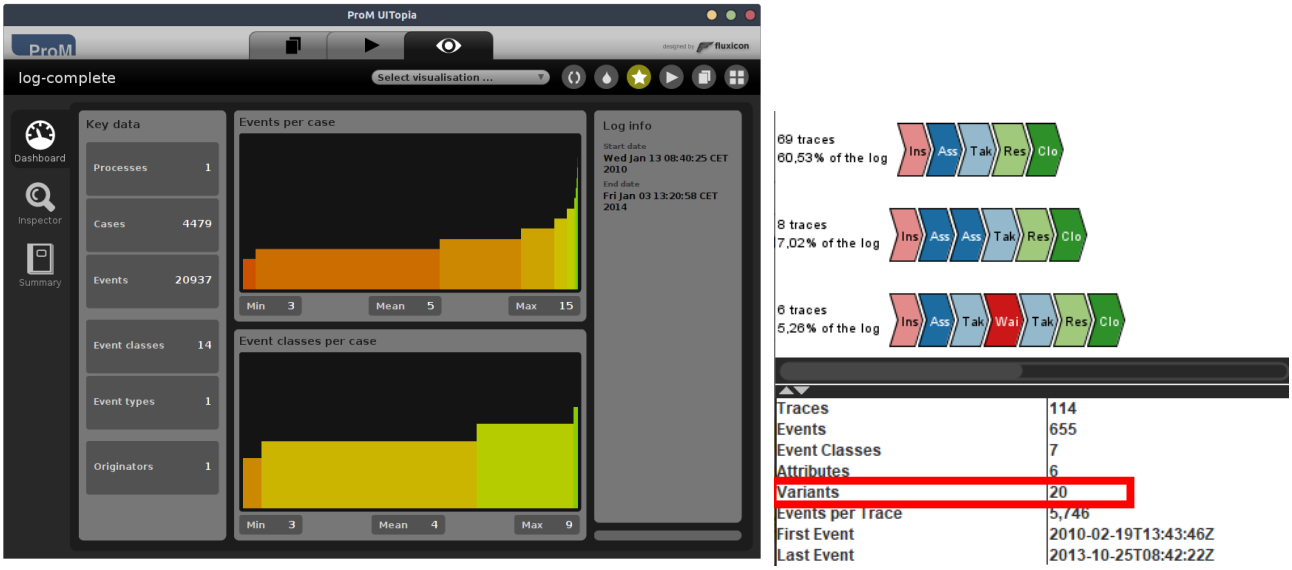
(b)

From the introduction we learned that every trace has to start with 'Insert ticket' or 'Assign seriousness' and ends with 'Closed'. Therefore every trace that does not begin/end with these events must have started/ended outside of our observed time period, making it incomplete.
To filter out incomplete traces we go on the 'Actions' tab, select 'Filter Log using Simple Heuristics' and press 'Start'. In the first dialogue we just click 'Next'. In the next dialogue window we select 'Insert ticket' and 'Assign seriousness' as start events and click 'Next'. For the end events we only select 'Closed' and click 'Next'.
Since we do not want to filter out any other events we select 100% of events in Event Filter and click 'Finish'. We now get the following log:

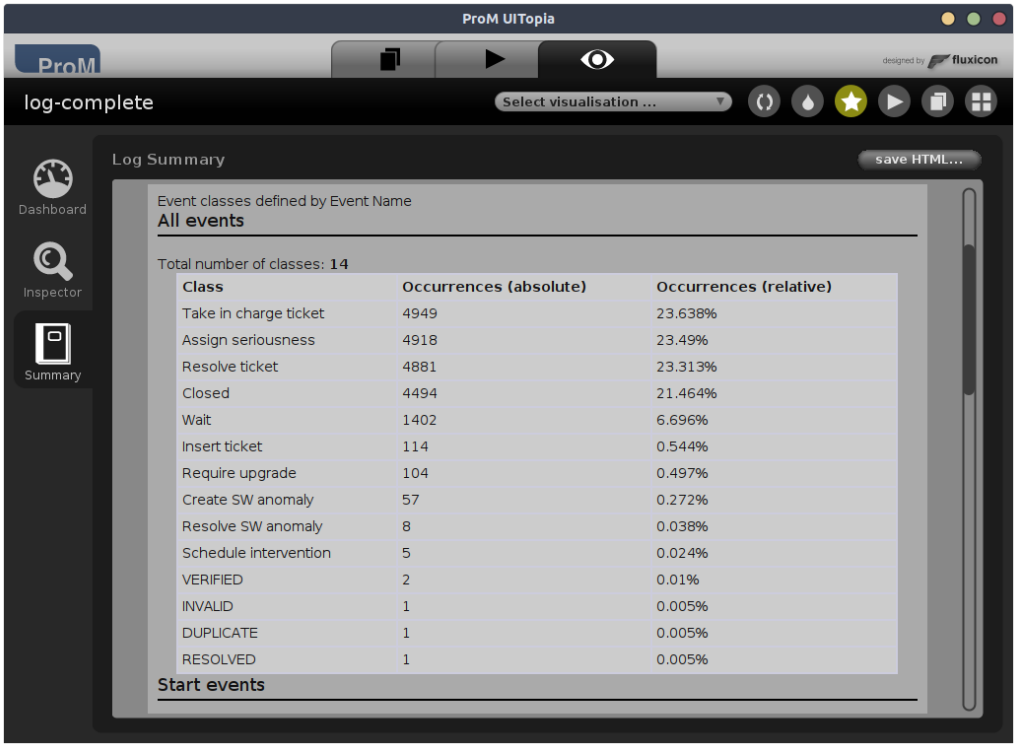


(c)

1. As in (a) we inspect the overview of *log-complete* to find 114 cases, 655 events and 7 activities. Also just like in (a) we select the visualization 'Explore Event Log' to find out there are 20 unique trace variants.

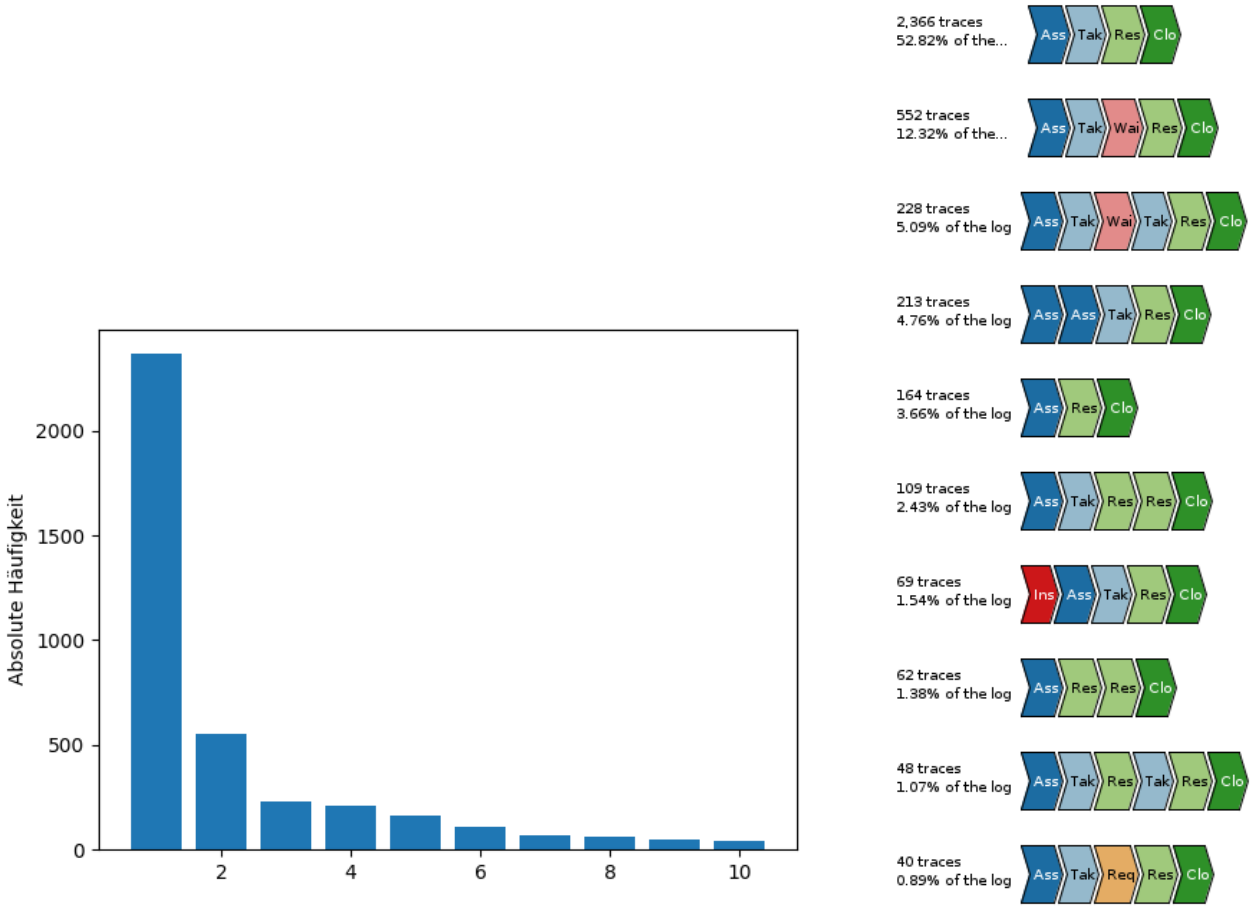


2. Just like in (a) we look at 'Summary' to find a table of activities along with their frequency of occurrence:



Class	Occurrences (absolute)	Occurrences (relative)
Take in charge ticket	4949	23.638%
Assign seriousness	4918	23.49%
Resolve ticket	4881	23.313%
Closed	4494	21.464%
Wait	1402	6.696%
Insert ticket	114	0.544%
Require upgrade	104	0.497%
Create SW anomaly	57	0.272%
Resolve SW anomaly	8	0.038%
Schedule intervention	5	0.024%
VERIFIED	2	0.01%
INVALID	1	0.005%
DUPLICATE	1	0.005%
RESOLVED	1	0.005%

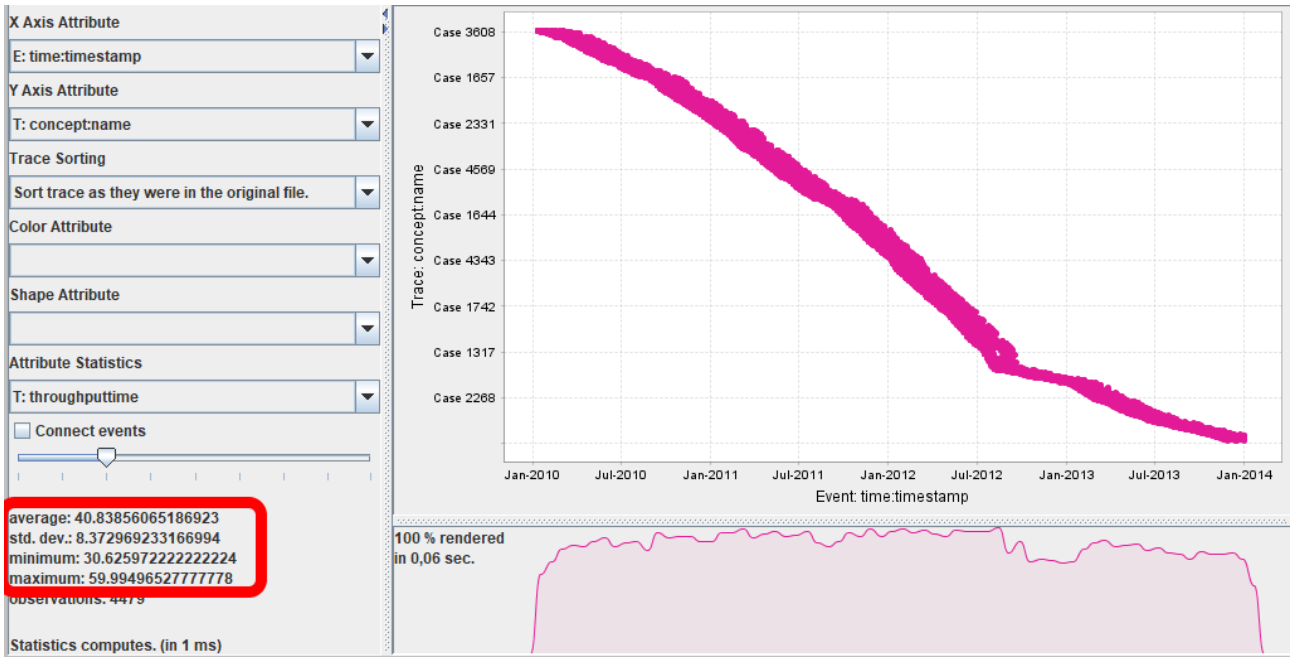
3. We read the counts of the top 10 traces from the Event Log Explorer in RapidMiner, and the plugged those values into a short python script to create the following bar chart.



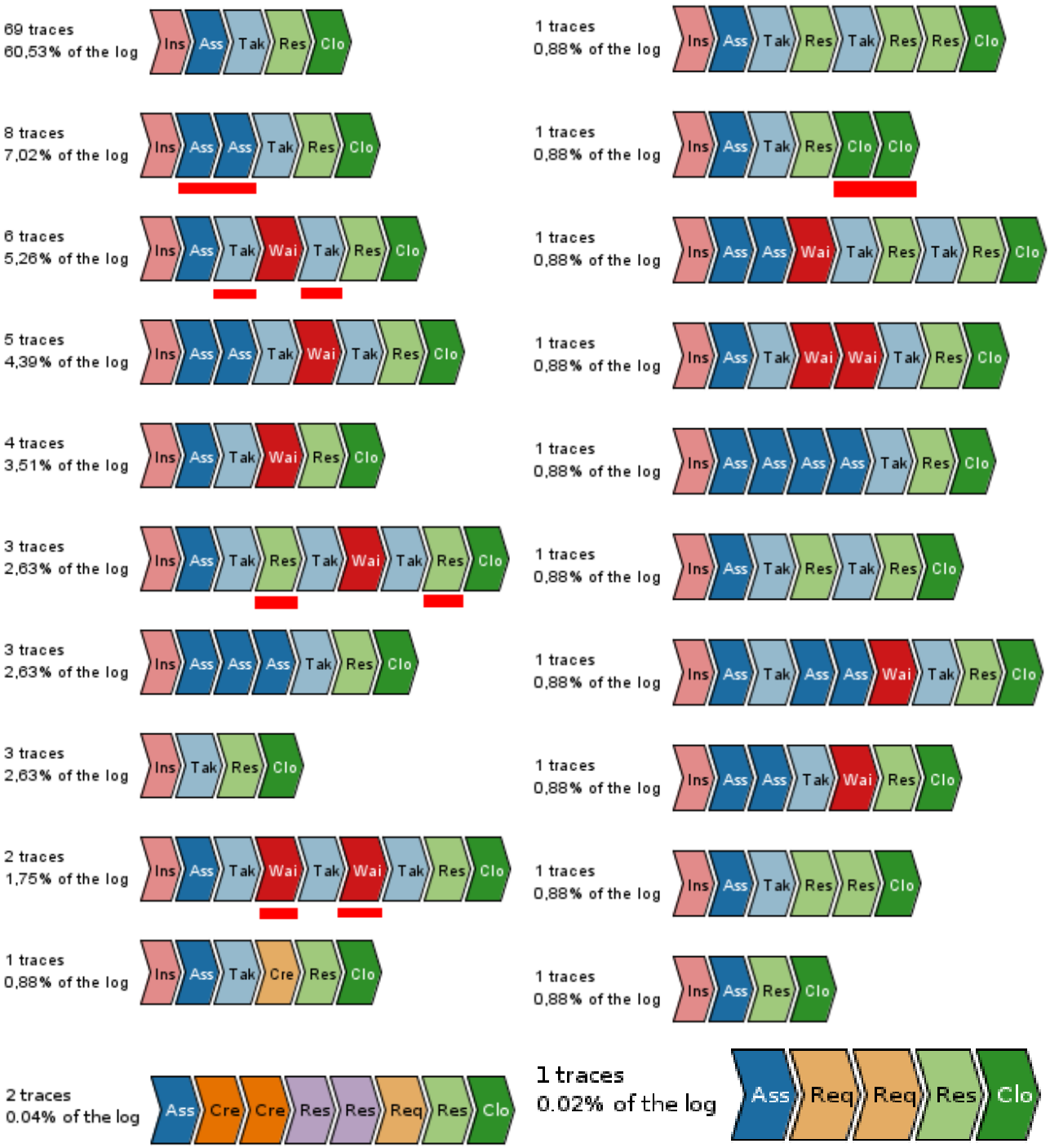
4. We apply the 'Add Throughput Time as Trace Attribute (In place)' plugin to *log-complete* and select 'DAYS' as the resolution to be used for the elapsed time. We then select the visualization 'Dotted Chart' on the result. To retrieve minimum, maximum and average trace durations we select 'T: throughputtime' as Attribute Statistics and get the following rounded

result:

- minimum trace duration: 31 days
- maximum trace duration: 60 days
- average trace duration: 41 days



5. To find out which activities appear more than once in at least one trace we again take a look at the 'Explore Event Log' visualization:



The tasks that appear more than once (as marked in the visualization) are

- Ass: Assign seriousness
- Tak: Take in charge ticket
- Res: Resolve ticket
- Wai: Wait
- Clo: Closed
- Cre: Create SW Anomaly
- Req: Require Update

(d)

1. We choose Pie Charts for these visualization. For *Ticket type* distribution we choose `TICKET TYPE` as dimension:

```
"case_table_csv"."TICKET TYPE"
```

and `COUNT(TICKET TYPE)` as KPI:

```
COUNT("case_table_csv"."TICKET TYPE")
```

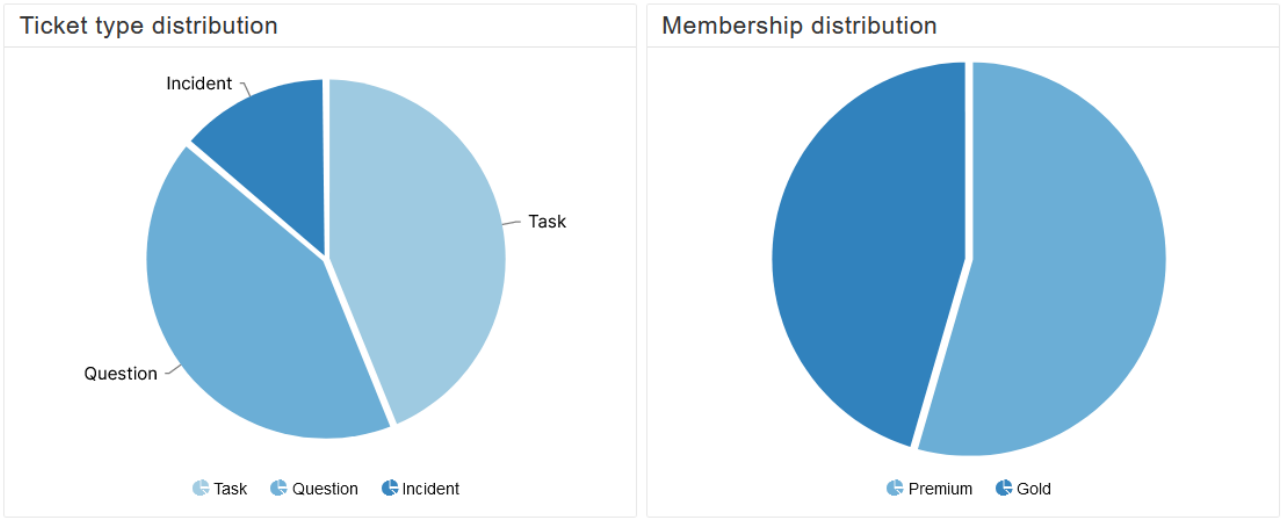
For *Membership* distribution we choose `MEMBERSHIP` as dimension:

```
"case_table_csv"."MEMBERSHIP"
```

and `COUNT(MEMBERSHIP)` as KPI:

```
COUNT("case_table_csv"."MEMBERSHIP")
```

The resulting distribution visualization can be seen below.



2. We obtained the column chart titeled 'Total workload per ressource' by using

```
"event_table_csv"."RESOURCE"
```

as dimension and

```
COUNT("event_table_csv"."ACTIVITY")
```

as KPI. The x-Axis shows the resources 1-8 in ascending order, the y-Axis shows the summed number of activities handeled by the given resource.

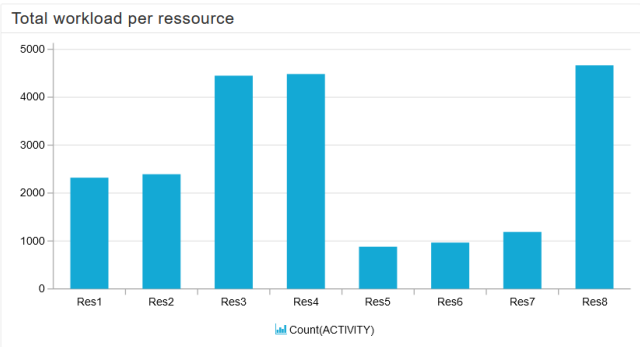
3. We created the column chart named 'Throughput times distribution' by selecting the total throughput time in days as our dimension:

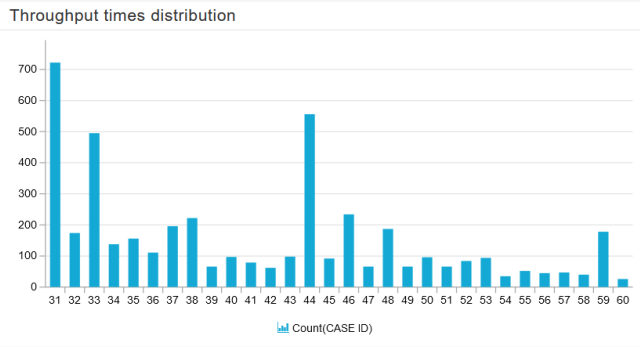
```
CALC_THROUGHPUT(ALL_OCCURRENCE['Process Start'] TO ALL_OCCURRENCE['Process End'], REMAP_
```

and selecting

```
COUNT("case_table_csv"."CASE ID")
```

as our KPI. The x-Axis shows the throughput time in days and the y-Axis shows the number of cases with a given throughput time.

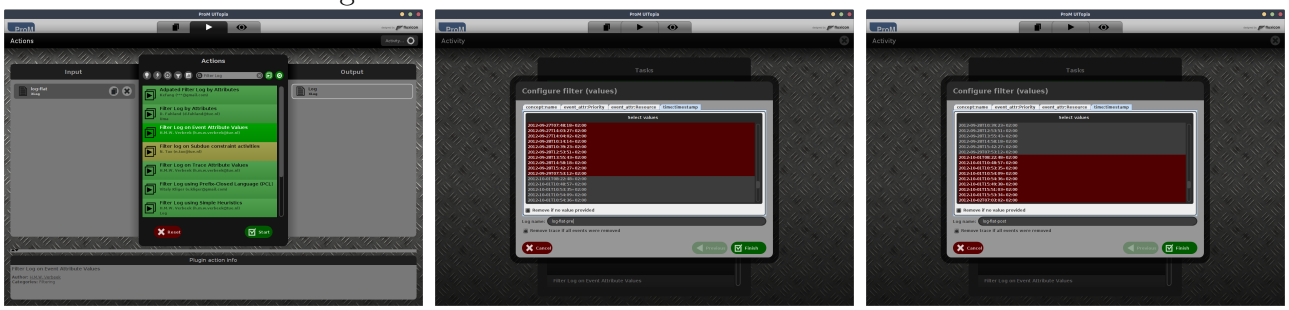




Question 2

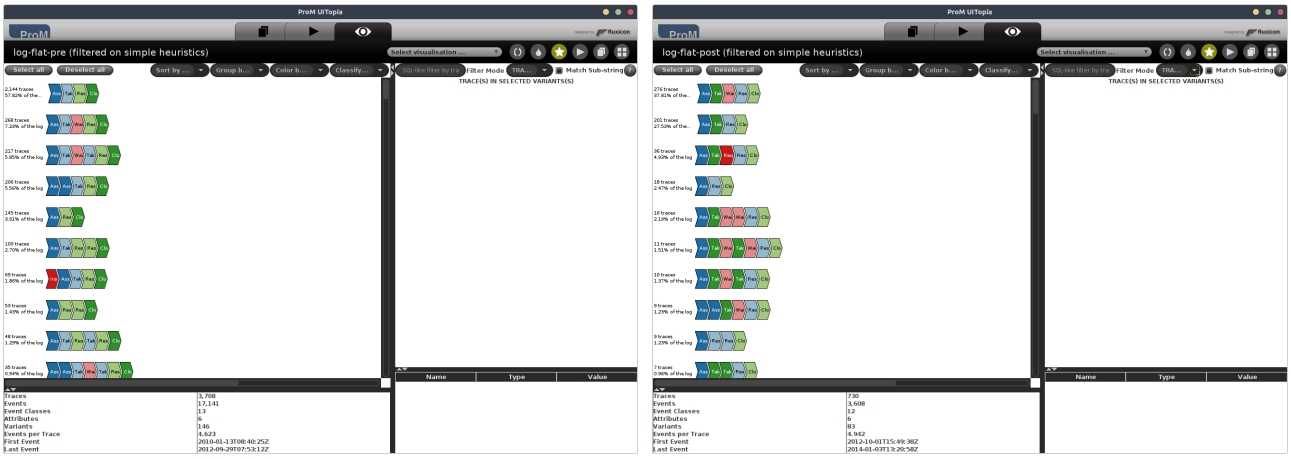
(a)

We can split the event log into two event logs using the plugin 'Filter Log on Event Attribute Values' with the following selections:



Afterwards, we can apply our filtering to only allow valid traces, as seen before.

For the event log pre 01.10.2012 we get 13 unique activities across 3708 cases, as a whole consisting of 6 variants.
For the event log post (including) 01.10.2012 we get 12 unique activities across 730 cases, as a whole consisting of 6 variants.



(b)

1. We apply the following workflow both for *log-pre-complete* and *log-post-complete*:

1. Apply plugin 'Interactive Data-aware Heuristic Miner (iDHM)'

2. Set 'Options & Thresholds' to: (info about resulting precision and fitness included)
   All tasks connected: True

	i) (*pre-complete*)	ii) (*pre-complete*)	iii) (*post-complete*)	iv) (*post-complete*)
Frequency	0.1	0	0.1	0
Dependency	0.9	0.9	0.9	0.9
Bindings	0.1	0.1	0.1	0.1
Conditions	0.5	0.5	0.5	0.5
Precision	93%	83,6%	84,6%	79,6%
Fitness	95,8%	99,5%	90,3%	92,5%

3. Select 'Petri net' as 'Output: Process Model' and click 'Export model'
4. Use the log and the newly created Petri net as input for the 'Multi-perspective Process Miner' plugin

This results in the models that can be found in the appendix (Precision and Fitness are underlined)
As we can see all these models exceed our fitness threshold of 90% and contain all activities occuring in their respective logs (*log-pre-complete* doesn't contain the activity DUPLICATE and *log-post.complete* doesn't contain the activities INVALID and RESOLVED).

2. —
3. We apply the following workflow both for *log-pre-complete* and *log-post-complete*:

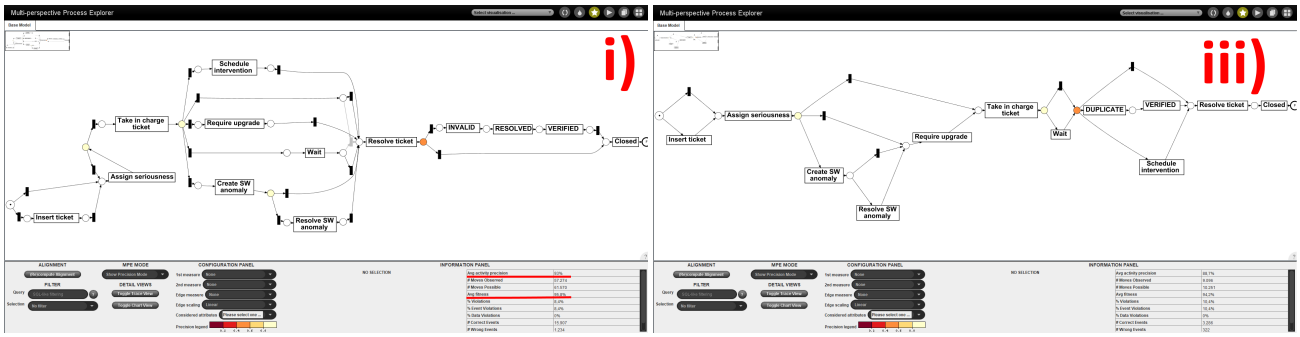
1. Use plugin 'Mine Petri net with Inductive Miner' with Variant set to 'Inductive Miner - infrequent (IMf)' and the following settings for the noise threshold: (info about resulting precision and fitness included)

	i) (*pre-complete*)	ii) (*pre-complete*)	iii) (*post-complete*)	iv) (*post-complete*)
Noise threshold	0.2	0	0.2	0
Precision	89,4%	70,5%	88,7%	35,1%
Fitness	94,5%	100%	94,2%	100%

2. Next we use the corresponding log together with its created Petri net as input for the 'Multi-perspective Process Explorer' plugin and select 'Show Precision Mode' as MPE Mode.

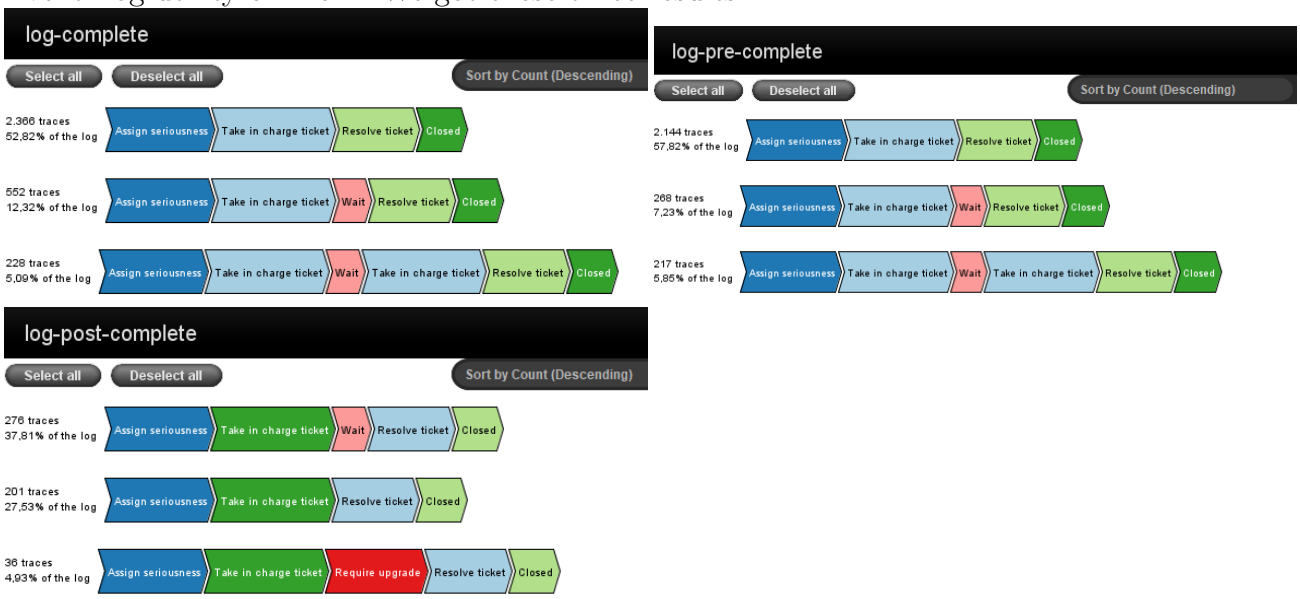
This results in the models that can be found in the appendix.
As we can see all these models exceed our fitness threshold of 90% and contain all activities occuring in their respective logs (*log-pre-complete* doesn't contain the activity DUPLICATE and *log-post.complete* doesn't contain the activities INVALID and RESOLVED).

We choose M_{pre} to be the Heuristic Mining net i) and M_{post} to be the Inductive Mining net iii):



(c)

1. We visualized the three most frequent trace variant and their frequencies with the Explore Event Log utility of ProM. We got these three results:



   The first similarity observed between the three most frequent trace variants of all three event logs is, that they all start with the Assign seriousness and Take in charge ticket activities and finish with Resolve ticket and Closed. The second observation is the equality of the three most frequent trace variants of the *log-complete* and *log-pre-complete* event logs. This makes sense since most of the events of *log-complete* are in *log-pre-complete* and not in *log-post-complete*. This also explains the difference in absolute frequency of the most common trace variant between *log-complete* and *log-pre-complete* and the most frequent one of *log-post-complete* which differ by one order of magnitude. Another important difference is that in *log-complete* and *log-pre-complete* the most common trace variant has a relative frequency of over 50% whilst in *log-post-complete* the most common trace variants are more equally diveded between the two most frequent traces with 38% and 28%. Finally the activity Require upgrade is only present in the three most common trace variants in the *log-post-complete* event log.

2. All trace variants are replayable on both models:

	σ_{compl}	σ_{pre}	σ_{post}
M_{pre}	⟨Assign seriousness, Take in charge ticket, Resolve ticket, Closed⟩	⟨Assign seriousness, Take in charge ticket, Resolve ticket, Closed⟩	⟨Assign seriousness, Take in charge ticket, Wait Resolve ticket, Closed⟩
M_{post}	⟨Assign seriousness, Take in charge ticket, Resolve ticket, Closed⟩	⟨Assign seriousness, Take in charge ticket, Resolve ticket, Closed⟩	⟨Assign seriousness, Take in charge ticket, Wait Resolve ticket, Closed⟩

(d)

1. In M_{pre} tickets are inserted first (optional) and then the seriousness is assigned at least once. After that the ticket is taken in charge and set on 1 of 5 possible paths before the ticket is resolved:

- an intervention is scheduled
- upgrade is required
- ticket is put on wait
- an SW anomaly is created and potentially resolved

After being resolved the ticket is either immediatly closed or set to INVALID, then RESOLVED and then VERIFIED before being closed.
2. In M_{post} tickets are also optionally inserted first. After that the seriousness is assigned. Before the ticket is taken in charge an upgrade can be required, and before an upgrade is required it is possible an SW anomaly is created and potentially fixed. After the ticket has been taken in charge it might be set on wait before it is resolved and closed. **3.** Both models start with the option 'Insert ticket', however in M_{post} the activity 'Assign seriousness' can only be done once.
With M_{post} the activity 'Take in charge ticket' can be preceeded by the activities 'Create SW anomaly', 'Resolve SW anomaly' and 'Require upgrade'. For M_{pre} these activities can only succeed 'Take in charge Ticket'.
Both models end with the activities 'Resolve ticket' and 'Closed', however with M_{pre} it is possible to perform the activities INVALID, RESOLVED, VERIFIED in between.

Question 3

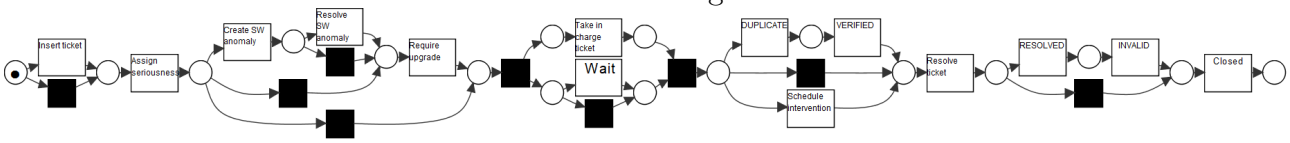
(a)

We use the Plugin 'Filter Log on Trace Attribute Values' to only select Tickets of type 'Task'. As visualization, we then choose 'Explore Event Log'. This gives us the table below:

Traces	2.018
Events	10.283
Event Classes	14
Attributes	6
Variants	201
Events per Trace	5,096
First Event	2010-01-13T12:30:37Z
Last Event	2014-01-03T13:20:58Z

From it, we can take that there are 2018 traces, 201 trace variants and 10283 events. We then

apply the plugin 'Mine Petri net with Inductive Miner' on this filtered log and make sure we choose 'Inductive Miner - Infrequent (IMf)' as our variant and set it to 20% by assigning the Noise threshold to 0.20. This results in the following Model:



(b)

We use the plugin 'Multi-perspective Process Explorer' on our Petri net from (a). This gives us the following information on fitness and precision:

Avg fitness	92,3%
% Violations	14,2%
% Event Violations	14,2%
% Data Violations	0%
# Correct Events	8.966
# Wrong Events	1.317
# Missing Events	166

Avg activity precision	82,9%
# Moves Observed	33.237
# Moves Possible	40.096
Avg fitness	92,3%
% Violations	14,2%
% Event Violations	14,2%
% Data Violations	0%
# Correct Events	8.966
# Wrong Events	1.317
# Missing Events	166

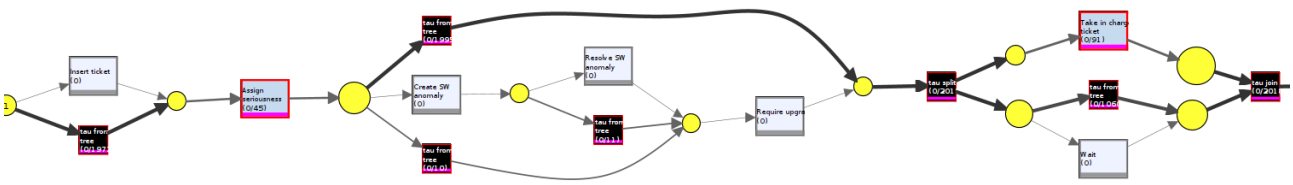
We obtain the percentage of fitting traces by calculating 100% minus the percentage of violations (100% - 14.2%), resulting in 85,8% fitting traces. Alignment-based fitness (92.3%) and precision (82.9%) can be read from the tables above.
By using the inductive miner again and adjusting the infrequency parameter to 10% we obtain a process model with better fitness, precision and more perfectly fitting traces than before. The stats of the new model can be seen below:

Avg activity precision	83,6%
# Moves Observed	35.324
# Moves Possible	42.242
Avg fitness	92,4%
% Violations	14%
% Event Violations	14%
% Data Violations	0%
# Correct Events	8.985
# Wrong Events	1.298
# Missing Events	169

(c)

We used the plugin 'Align Log and Model for Repair (global costs)' for this subtask. We used the default values.

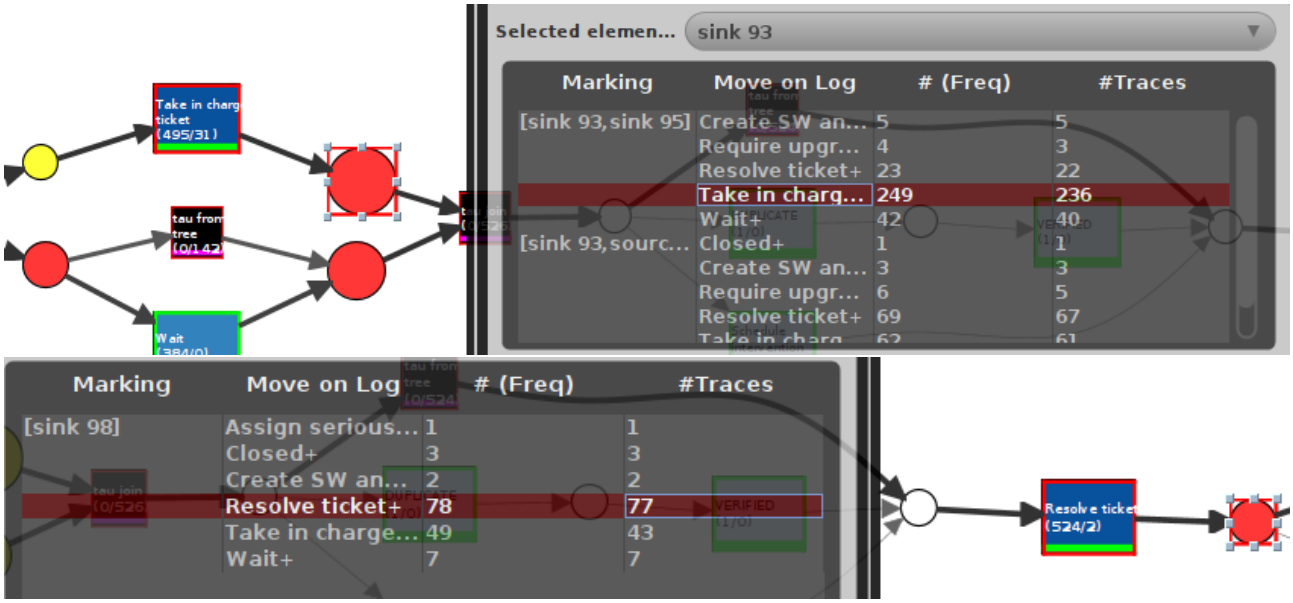
Move on Model



Moves on Model occur obviously at every hidden transition (since they aren't in the log) and the activities of 'Assign seriousness', 'Take in charge ticket', 'Resolve ticket', 'Closed'. The later two just have fairly few moves on logs and are acceptable in the model, since there are cases with tickets still in progress in the log.

The first two activities are important for improving the model or even the ticketing system. We see that not every case executes Assign seriousness. Perhaps this transition should be skipable by a tau-transition. However, the assignment introduction states that either 'Insert ticket' or 'Assign seriousness' should be executed first. Therefore, the model could also have an option between both in the beginning, instead of putting one behind the other.
That 'Take in charge ticket' was moved on the model 91 times should also be noted. That the model set this action in parallel with 'Wait' seems problematic. It should be possible to wait any time in the ticketing process in order to execute some activity later on.

Move on Log



We can analyze Moves on Logs by clicking on the big places in the visualization. As one can see, the transitions 'Take in charge ticket' and 'Resolve ticket' experience the most moves on log in the model. We used the Movement Container Filter to only allow traces with moves on logs in these transitions.

Question 4

(a)

We created the following OLAP Table:

CASE ID	TICKET TYPE	MEMBERSHIP	PRIORITY	RESOURCE OF STARTING ...	NUMBER OF ACTIVE CASE...	Decision
Case 1	Question	Gold	Normal	Res4	18	False/No-Wait
Case 10	Task	Premium	Normal	Res4	18	False/No-Wait
Case 100	Task	Premium	Normal	Res3	18	False/No-Wait
Case 1000	Incident	Gold	Urgent	Res8	18	False/No-Wait
Case 1001	Task	Premium	Normal	Res4	18	False/No-Wait
Case 1002	Task	Gold	High	Res3	18	False/No-Wait
Case 1003	Task	Premium	Normal	Res4	18	False/No-Wait
Case 1004	Incident	Premium	Normal	Res4	18	False/No-Wait
Case 1005	Task	Premium	Normal	Res3	18	False/No-Wait
Case 1006	Question	Gold	High	Res4	18	False/No-Wait
Case 1007	Task	Premium	Normal	Res3	18	False/No-Wait
Case 1008	Task	Gold	High	Res8	18	False/No-Wait
Case 1009	Task	Premium	High	Res8	18	True/Wait

For this, we used the following PQL Queries in the order of columns in the image left to right:

```
"case_table_csv"."CASE ID"
```

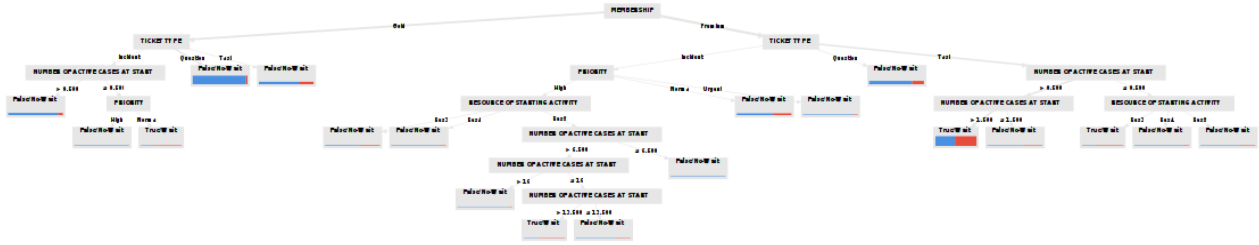
```
"case_table_csv"."MEMBERSHIP"
```

```
"case_table_csv"."TICKET TYPE"
```

```
"event_table_csv"."PRIORITY"

PU_FIRST ( "case_table_csv", "event_table_csv"."RESOURCE")

RUNNING_SUM (
  CASE WHEN MATCH_PROCESS_REGEX("event_table_csv"."ACTIVITY", 'Closed'$) = 1 THEN 0
  ELSE 1
  END
)

CASE WHEN
MATCH_PROCESS_REGEX ( "event_table_csv"."ACTIVITY", 'Wait' ) = 1 THEN 'True/Wait'
ELSE 'False/No-Wait'
END
```

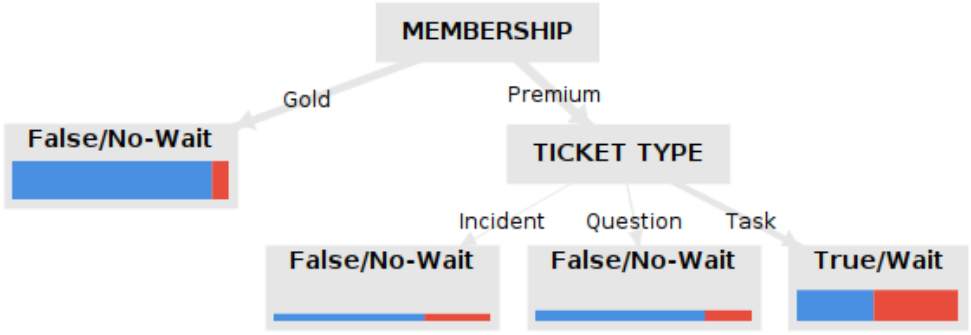
(b)

First, we export the OLAP Table and import it into RapidMiner as described in Instruction 2. The resulting decision tree is evidently too large to fit into a PDF, thus we have added the description in the Appendix:



We found that some tasks using Resource 3 would wait, even if they were the only task running at creation. From the tree we can also observe that some high priority incidents (using Resource 3 or 8) would have to wait depending on the number of active cases at start, although there does not seem to be any connection to the prior predictor variables.

After removing the attribute 'number of active cases at start', we get a much more simplified, but comprehensible Decision Tree:



Here we see that about half the Premium Tasks will have to wait, while for all other tickets waiting is less likely.

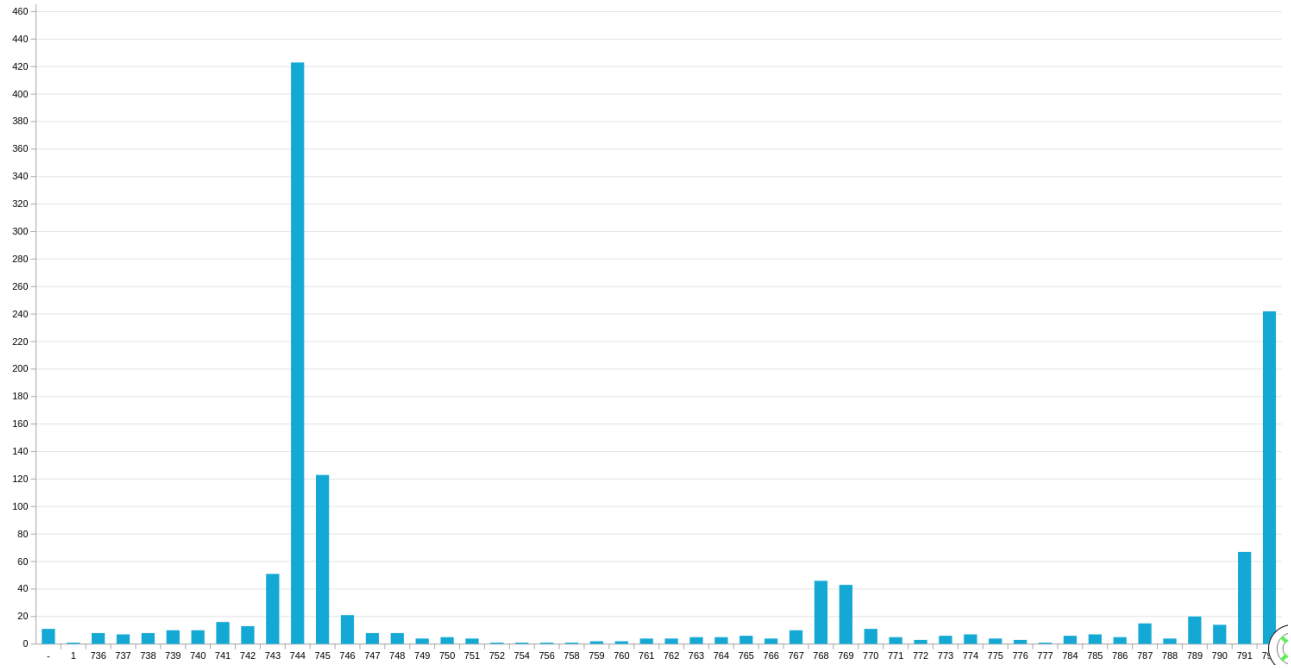
Question 5

(a)

Similarly to 1d), we created a new column chart. Here, we used the following Dimension:

```
CASE WHEN MATCH_PROCESS_REGEX("event_table_csv"."ACTIVITY", 'Closed'$) = 1
THEN CALC_THROUGHPUT(
CASE_START TO CASE_END,
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
ELSE CALC_THROUGHPUT(
CASE_START TO LAST_OCCURRENCE['Resolve ticket'],
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
END
```

Using the Case Count as a Dimension, we got the following chart. Note that this is just a tiny section of the entire chart. There are cases with throughput times up to 1440h:



(b)

We applied the `Quantile` function on the real throughput times (see above) for 0.3 and 0.7, respectively (here for 0.3):

```
QUANTILE(CASE WHEN MATCH_PROCESS_REGEX("event_table_csv"."ACTIVITY", 'Closed'$) = 1
THEN CALC_THROUGHPUT(
CASE_START TO CASE_END,
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
ELSE CALC_THROUGHPUT(
CASE_START TO LAST_OCCURRENCE['Resolve ticket'],
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
END, 0.3)
```

For the 0.3-quantile we got 795h, for the 0.7-quantile 1079h.

(c)

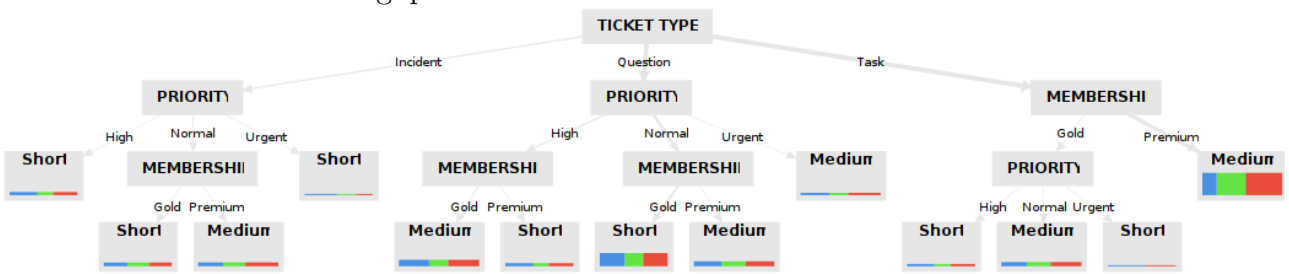
Approach equivalent to Question 4a). We used the following PQL queries:

```
"case_table_csv"."CASE ID"

"case_table_csv"."TICKET TYPE"

"case_table_csv"."MEMBERSHIP"

"event_table_csv"."PRIORITY"

CASE

WHEN (CASE WHEN MATCH_PROCESS_REGEX("event_table_csv"."ACTIVITY", 'Closed'$) = 1
THEN CALC_THROUGHPUT(
CASE_START TO CASE_END,
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
ELSE CALC_THROUGHPUT(
CASE_START TO LAST_OCCURRENCE['Resolve ticket'],
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
END) < 795 THEN 'Short'

WHEN (CASE WHEN MATCH_PROCESS_REGEX("event_table_csv"."ACTIVITY", 'Closed'$) = 1
THEN CALC_THROUGHPUT(
CASE_START TO CASE_END,
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
ELSE CALC_THROUGHPUT(
CASE_START TO LAST_OCCURRENCE['Resolve ticket'],
REMAP_TIMESTAMPS("event_table_csv"."TIMESTAMP",HOURS)
)
END) < 1079 THEN 'Medium'

ELSE 'Long'

END
```

CASE ID	TICKET TYPE	MEMBERSHIP	PRIORITY	Performance class
Case 1	Question	Gold	Normal	Short
Case 10	Task	Premium	Normal	Long
Case 100	Task	Premium	Normal	Long
Case 1000	Incident	Gold	Urgent	Medium
Case 1001	Task	Premium	Normal	Medium
Case 1002	Task	Gold	High	Short
Case 1003	Task	Premium	Normal	Medium
Case 1004	Incident	Premium	Normal	Short
Case 1005	Task	Premium	Normal	Long
Case 1006	Question	Gold	High	Long
Case 1007	Task	Premium	Normal	Long
Case 1008	Task	Gold	High	Medium
Case 1009	Task	Premium	High	Medium
Case 101	Question	Premium	Normal	Long
Case 1010	Task	Premium	Normal	Medium
Case 1011	Question	Gold	Normal	Long
Case 1012	Incident	Premium	Normal	Short
Case 1013	Question	Premium	Normal	Medium

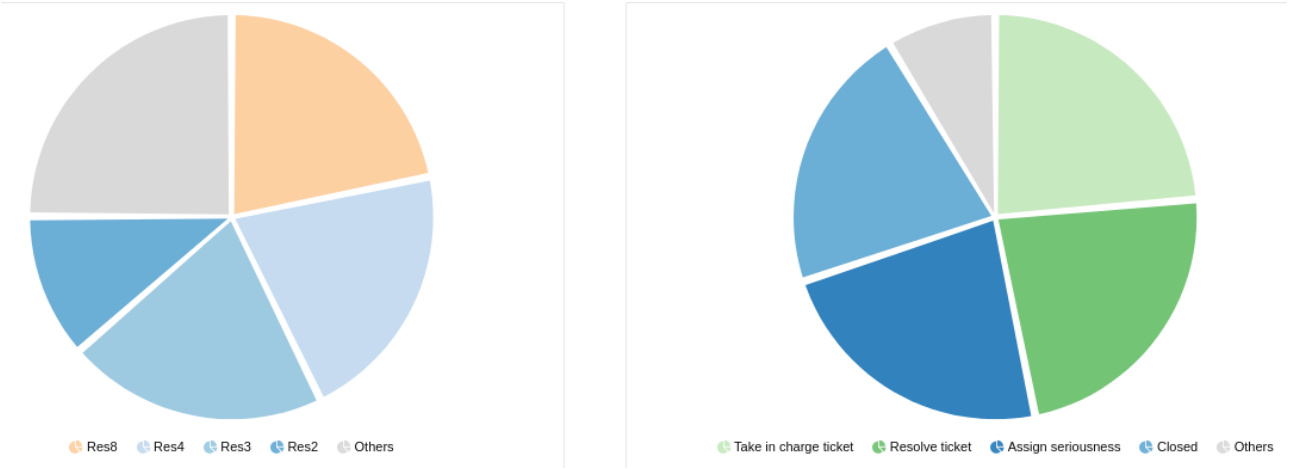
(d)

First, we export the OLAP Table and import it into RapidMiner as described in Instruction 2. Even after setting the parameters of the Decision Tree algorithm to extreme values (minimal gain at 1.0E-6), we could not find any clear variable that predicts the outcome of the performance class in any way. Thus, we conclude that the performance class (and thus the real throughput time) has no strong correlation with neither Priority nor Ticket Type. The only thing noticeable was, that close to half the Tasks stemming from Premium Memberships were Medium rated in real throughput time.



Question 6

(a)



For the left Pie Chart we used `"event_table_csv"."RESOURCE"` as the Dimension and `COUNT("event_table_csv"."ACTIVITY")` as the KPI.
For the right Pie Chart we used `"event_table_csv"."ACTIVITY"` as the Dimension and `COUNT("event_table_csv"."RESOURCE")` as the KPI.

(b)

RESOURCE	Assign seri...	Wait	Insert ticket	Resolve tic...	Create SW...	Take in ch...	Resolve S...	Closed	Require U...	RESOLVED	VERIFIED	Schedule i...	INVALID	DUPLICATE
Res1	0	0	0	0.00043668...	0	0	0	0.00196506...	0.01310043...	0.00021834...	0	0.00043668...	0.00021834...	0
Res2	0	0	0	0.00109170...	0	0	0	0.00174672...	0.01222707...	0.00021834...	0.00043668...	0.00065502...	0.00021834...	0.000218...
Res3	0.34388646...	0.04825327...	0.01026200...	0.35262008...	0.00174672...	0.21310043...	0.00109170...	0	0	0	0	0	0	0
Res4	0.35807860...	0.05087336...	0.00829694...	0.34126637...	0.00065502...	0.21834061...	0.00043668...	0	0	0	0	0	0	0
Res5	0.00371179...	0.05262008...	0	0.00349344...	0.00240174...	0.12969432...	0	0	0	0	0	0	0	0
Res6	0.00371179...	0.05611353...	0	0.00305676...	0.00436681...	0.14323144...	0	0	0	0	0	0	0	0
Res7	0.00240174...	0.05873362...	0	0.00545851...	0.00327510...	0.18930131...	0	0	0	0	0	0	0	0
Res8	0.36637554...	0.05109170...	0.00720524...	0.37838427...	0.00218340...	0.21091703...	0.00131004...	0	0	0	0	0	0	0

`SOURCE("event_table_csv"."RESOURCE")`

```
1  SUM(CASE WHEN SOURCE ( "event_table_csv"."ACTIVITY" ) = '[ACTIVITY]' THEN
     1 ELSE 0 END) / 4580
```

Replace `[ACTIVITY]` with each of the 14 Activities for the corresponding Dimensions. 4580 is the number of cases obtained by `COUNT_TABLE("case_table_csv")`.

(c)

Attribute	cluster_0	cluster_1	cluster_2
Assign seriousness	0.003	0.356	0
Wait	0.056	0.050	0
Insert ticket	0	0.009	0
Resolve ticket	0.004	0.357	0.001
Create SW anomaly	0.003	0.002	0
Take in charge ticket	0.154	0.214	0
Resolve SW anomaly	0	0.001	0
Closed	0	0	0.002
Require Upgrade	0	0	0.013
RESOLVED	0	0	0.000
VERIFIED	0	0	0.000
Schedule intervention	0	0	0.001
INVALID	0	0	0.000
DUPLICATE	0	0	0.000

id	label
1	cluster_2
2	cluster_2
3	cluster_1
4	cluster_1
5	cluster_0
6	cluster_0
7	cluster_0
8	cluster_1

We observed that Resources 3,4,8 were the only ones that executed 'Insert Ticket' and 'Resolve SW anomaly', thus forming cluster 1, which's centroid also reflects this. Resources 1,2 were the only ones to close any tickets (amongst other Activities), forming cluster 2. Resources 5,6,7 did none of these Activities, but also called Activities that Resources in cluster 1 called.

(d)

RESOURCE_FROM	RESOURCE_TO	Handover
Res1	Res1	0.0032751091703056767
Res1	Res2	0.002183406113537118
Res1	Res3	0.00240174672489083
Res1	Res4	0.0034934497816593887
Res1	Res5	0.0002183406113537118
Res1	Res6	0.0006550218340611354
Res1	Res7	0.0006550218340611354
Res1	Res8	0.0034934497816593887
Res2	Res1	0.0017467248908296944
Res2	Res2	0.004366812227074236
Res2	Res3	0.0028384279475982535
Res2	Res4	0.0028384279475982535
Res2	Res5	0.0002183406113537118
Res2	Res7	0.0008733624454148472
Res2	Res8	0.003930131004366812
Res3	Res1	0.15807860262008733
Res3	Res2	0.16179039301310044
Res3	Res3	0.1665938864628821

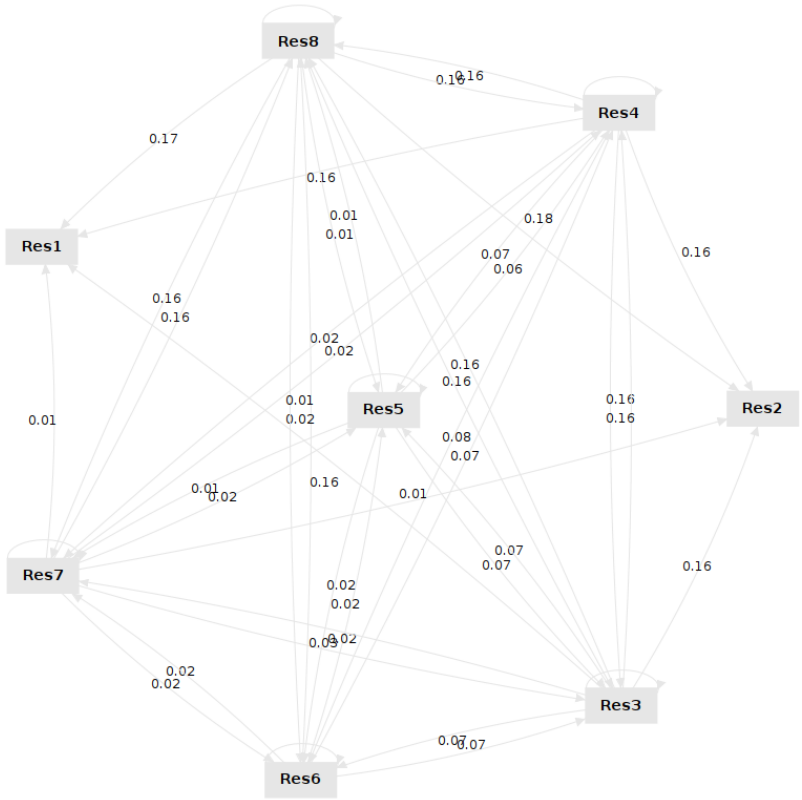
`SOURCE("event_table_csv"."RESOURCE")`

`TARGET("event_table_csv"."RESOURCE")`

```
1  COUNT(SOURCE("event_table_csv"."ACTIVITY")) / 4580
```

4580 is the number of cases obtained by `COUNT_TABLE("case_table_csv")`.

(e)



(f)

CLUSTER_FROM	CLUSTER_TO	Handoff
cluster_0	cluster_0	0.15152838427947599
cluster_0	cluster_1	0.4836244541484716
cluster_0	cluster_2	0.026419213973799125
cluster_1	cluster_0	0.5089519650655022
cluster_1	cluster_1	1.4661572052401746
cluster_1	cluster_2	0.9912663755458515
cluster_2	cluster_0	0.0026200873362445414
cluster_2	cluster_1	0.018995633187772927
cluster_2	cluster_2	0.011572052401746726

We took the clusters from c) and plugged them into Celonis using PQL:

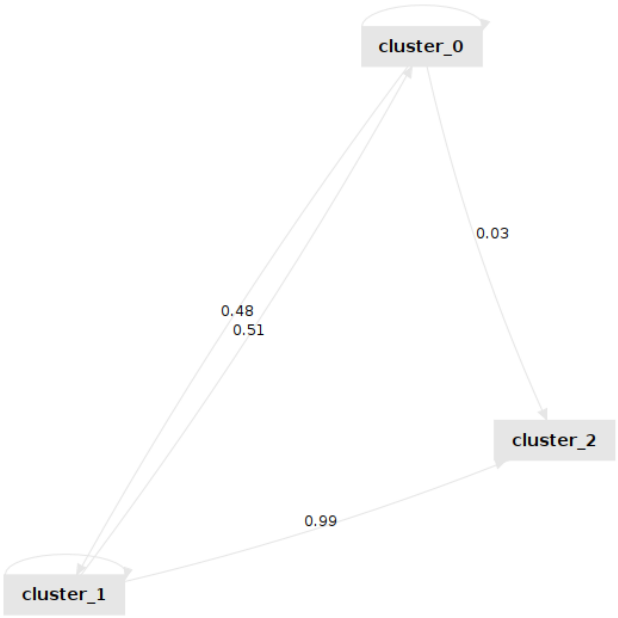
```
CASE WHEN SOURCE("event_table_csv"."RESOURCE") IN ('Res5', 'Res6', 'Res7') THEN
    'cluster_0'
WHEN SOURCE("event_table_csv"."RESOURCE") IN ('Res3', 'Res4', 'Res8') THEN '
    cluster_1'
ELSE 'cluster_2'
END
```

```
CASE WHEN SOURCE("event_table_csv"."RESOURCE") IN ('Res5', 'Res6', 'Res7') THEN
    'cluster_0'
WHEN SOURCE("event_table_csv"."RESOURCE") IN ('Res3', 'Res4', 'Res8') THEN '
    cluster_1'
ELSE 'cluster_2'
END
```

```
COUNT(SOURCE("event_table_csv"."ACTIVITY")) / 4580
```

4580 is the number of cases obtained by `COUNT_TABLE("case_table_csv")`.

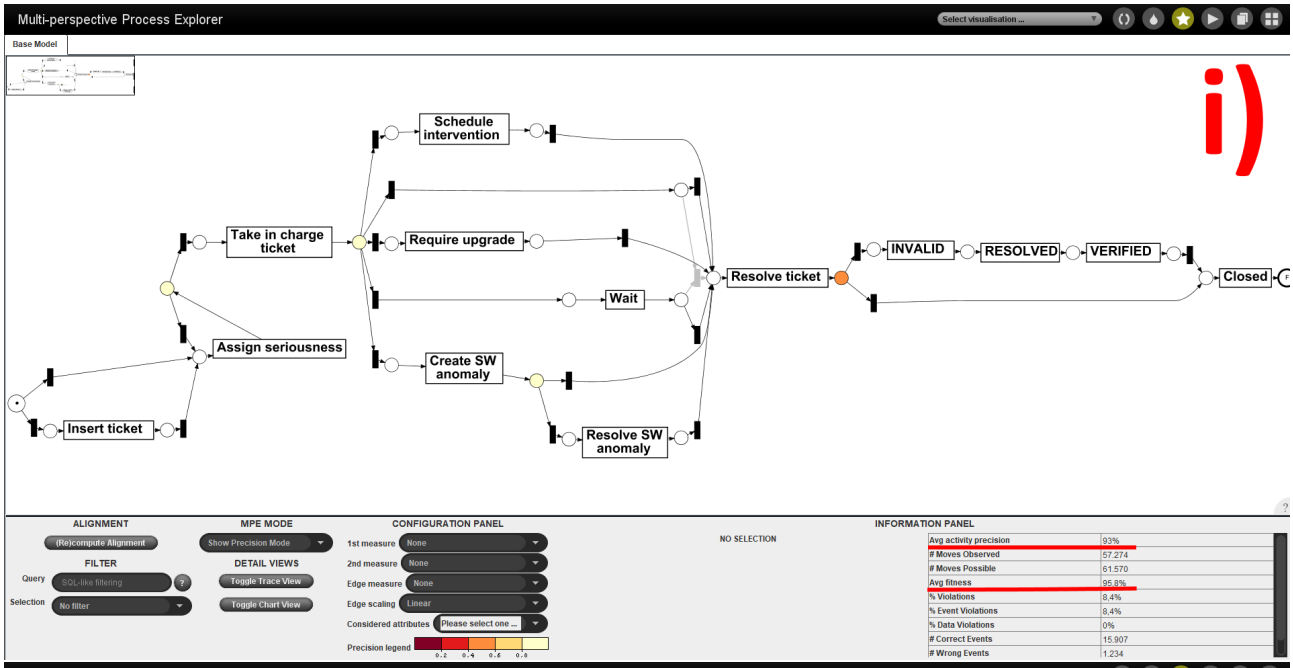
(g)

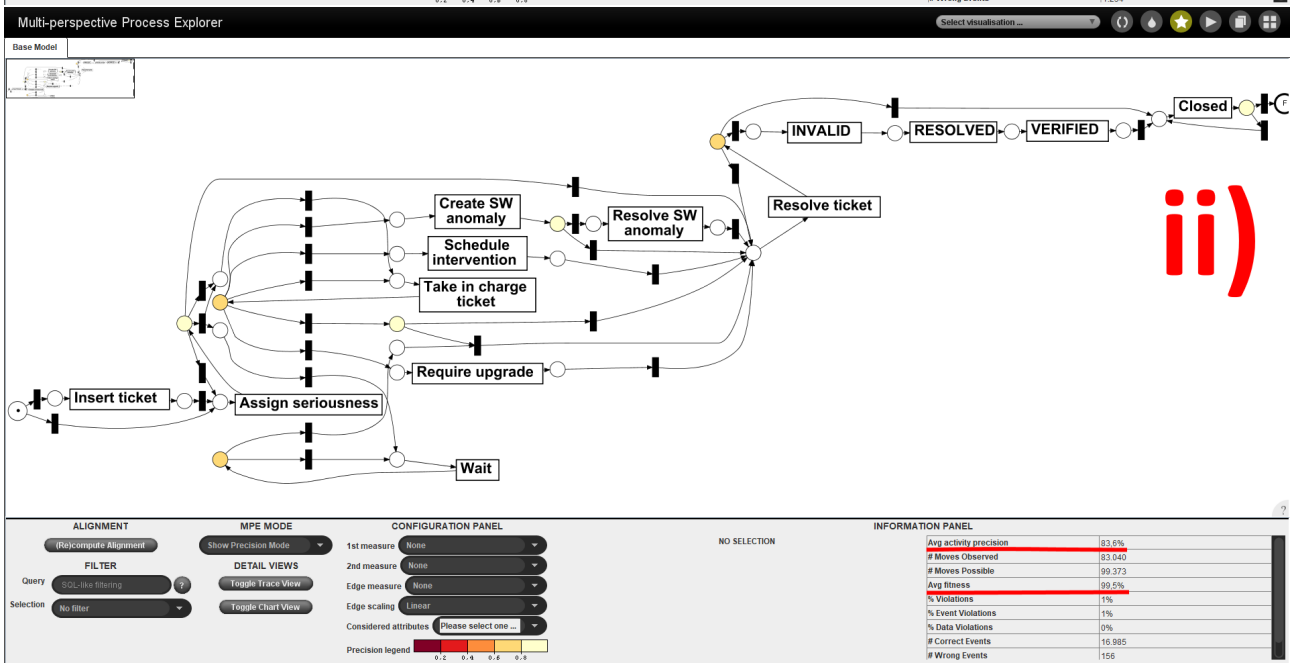


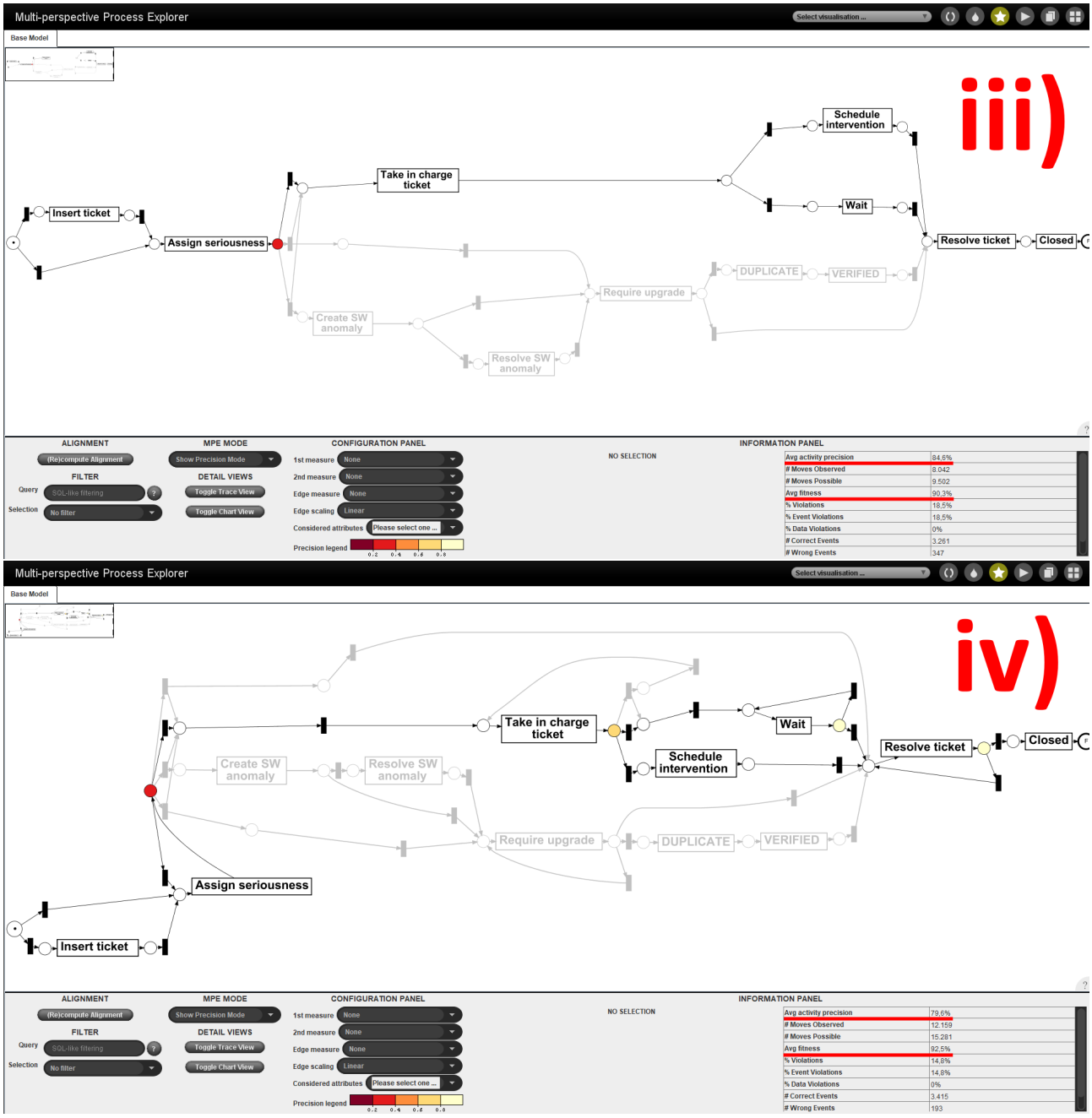
Since the ressources in cluster_2 are responsible for closing the tickets, there are no transitions leaving it. Since the ressources in cluster_0 and cluster_1 perform very similar activities tickets frequently change between these clusters. Most Transitions into cluster_2 originate in cluster_1.

Appendix

Question 2(b)1

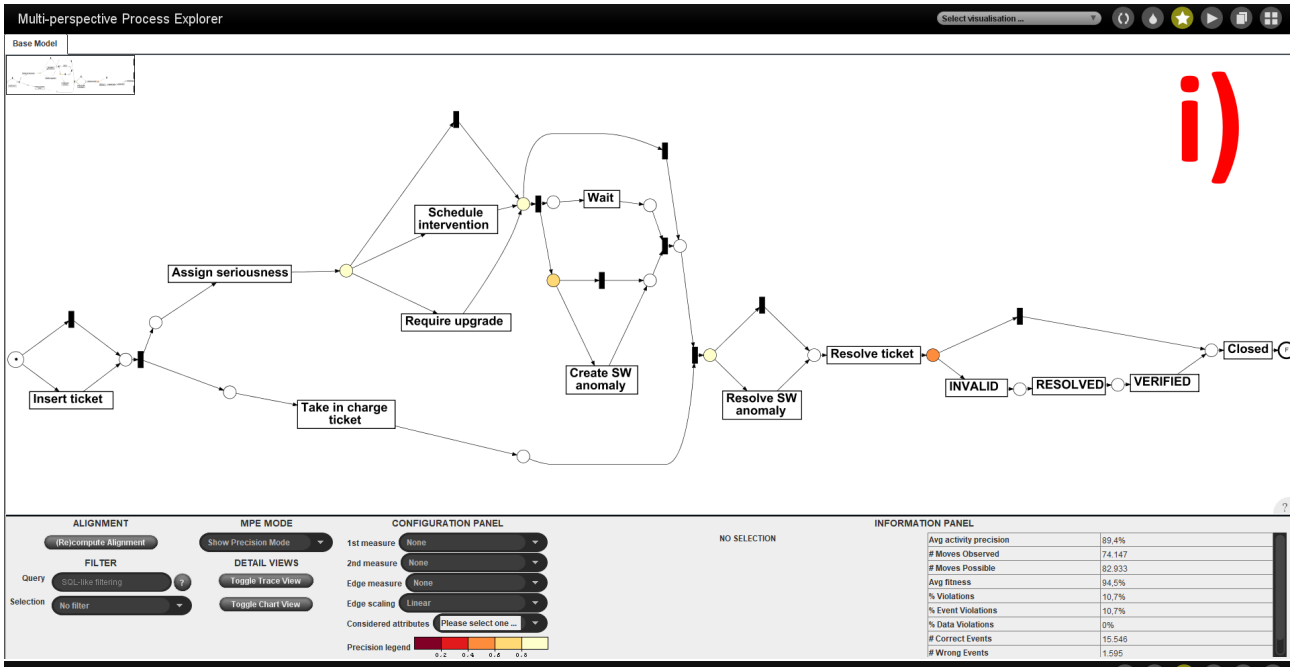


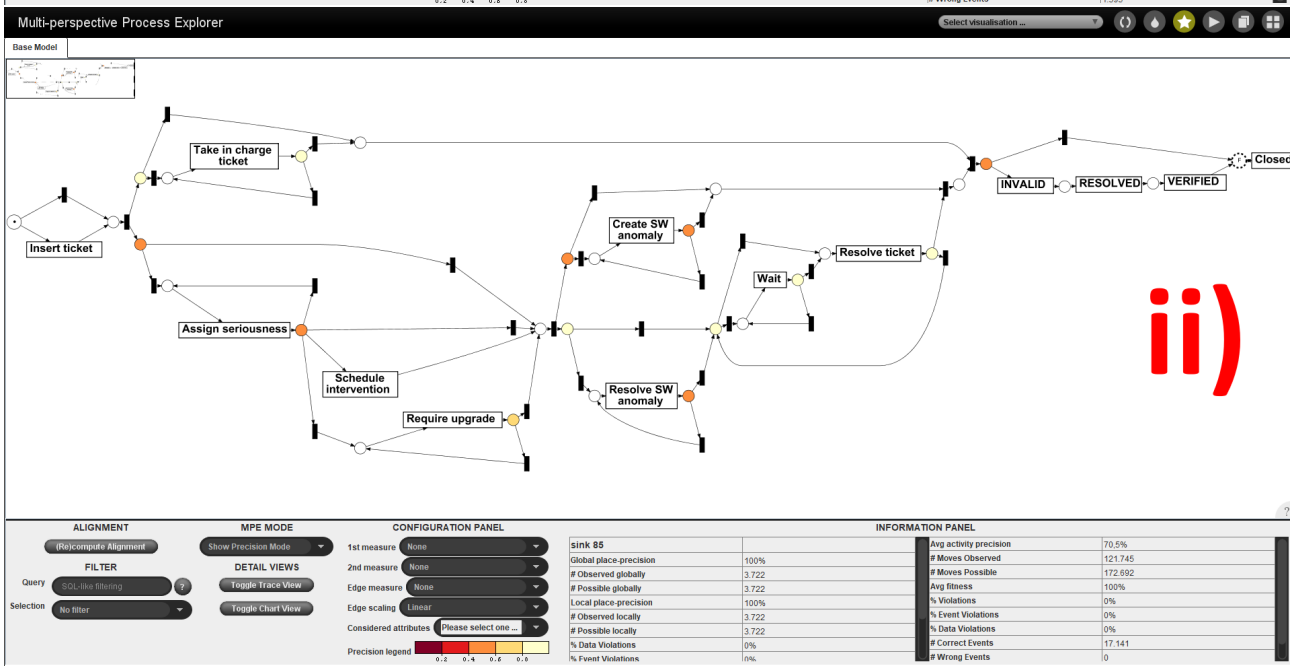


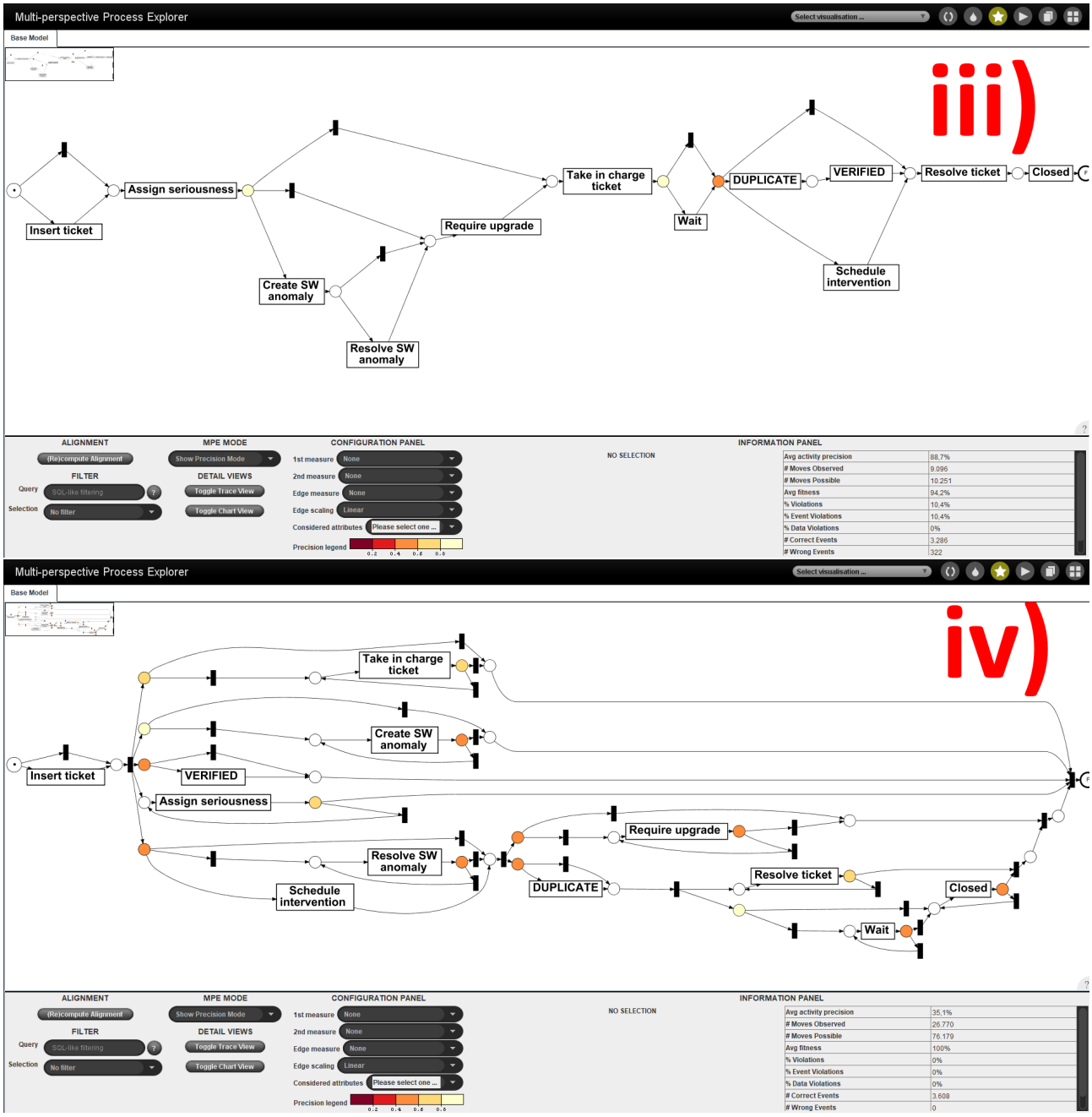

Multi-perspective Process Explorer
Base Model
iii)
Insert ticket
Assign seriousness
Take in charge ticket
Schedule intervention
Wait
Resolve ticket
Closed
Create SW anomaly
Resolve SW anomaly
Require upgrade
DUPLICATE
VERIFIED
ALIGNMENT
(Re)compute Alignment
FILTER
Query
SQL-like filtering
Selection
No filter
MPE MODE
Show Precision Mode
DETAIL VIEWS
Toggle Trace View
Toggle Chart View
CONFIGURATION PANEL
1st measure
2nd measure
Edge measure
Edge scaling
Considered attributes
Precision legend
None
Linear
Please select one ...
NO SELECTION
INFORMATION PANEL
Avg activity precision 84.6%
Moves Observed 8.042
Moves Possible 9.502
Avg fitness 90.3%
% Violations 18.5%
% Event Violations 18.5%
% Data Violations 0%
# Correct Events 3.261
# Wrong Events 347

Multi-perspective Process Explorer
Base Model
iv)
Take in charge ticket
Wait
Schedule intervention
Resolve ticket
Closed
Create SW anomaly
Resolve SW anomaly
Require upgrade
DUPLICATE
VERIFIED
Assign seriousness
Insert ticket
ALIGNMENT
(Re)compute Alignment
FILTER
Query
SQL-like filtering
Selection
No filter
MPE MODE
Show Precision Mode
DETAIL VIEWS
Toggle Trace View
Toggle Chart View
CONFIGURATION PANEL
1st measure
2nd measure
Edge measure
Edge scaling
Considered attributes
Precision legend
None
Linear
Please select one ...
NO SELECTION
INFORMATION PANEL
Avg activity precision 79.6%
Moves Observed 12.159
Moves Possible 15.281
Avg fitness 92.5%
% Violations 14.8%
% Event Violations 14.8%
% Data Violations 0%
# Correct Events 3.415
# Wrong Events 193

Question 2(b)3







Question 4(b) Decision Tree description:

```
MEMBERSHIP = Gold
|   TICKET TYPE = Incident
|   |   NUMBER OF ACTIVE CASES AT START > 0.500: False/No-Wait {False/No-Wait=266, True/Wait=27}
|   |   NUMBER OF ACTIVE CASES AT START <= 0.500
|   |   |   PRIORITY = High: False/No-Wait {False/No-Wait=2, True/Wait=0}
|   |   |   PRIORITY = Normal: True/Wait {False/No-Wait=1, True/Wait=2}
|   TICKET TYPE = Question: False/No-Wait {False/No-Wait=1391, True/Wait=41}
|   TICKET TYPE = Task: False/No-Wait {False/No-Wait=262, True/Wait=89}
MEMBERSHIP = Premium
|   TICKET TYPE = Incident
|   |   PRIORITY = High
```

```
|   |   RESOURCE OF STARTING ACTIVITY = Res3: False/No-Wait {False/No-Wait=19, True/Wait=11}
|   |   RESOURCE OF STARTING ACTIVITY = Res4: False/No-Wait {False/No-Wait=22, True/Wait=4}
|   |   RESOURCE OF STARTING ACTIVITY = Res8
|   |   |   NUMBER OF ACTIVE CASES AT START > 6.500
|   |   |   |   NUMBER OF ACTIVE CASES AT START > 16: False/No-Wait {False/No-Wait=11, True/Wait=1}
|   |   |   |   NUMBER OF ACTIVE CASES AT START <= 16
|   |   |   |   |   NUMBER OF ACTIVE CASES AT START > 13.500: True/Wait {False/No-Wait=1, True/Wait=2}
|   |   |   |   |   NUMBER OF ACTIVE CASES AT START <= 13.500: False/No-Wait {False/No-Wait=8, True/Wait=3}
|   |   |   NUMBER OF ACTIVE CASES AT START <= 6.500: False/No-Wait {False/No-Wait=3, True/Wait=0}
|   |   PRIORITY = Normal: False/No-Wait {False/No-Wait=147, True/Wait=75}
|   |   PRIORITY = Urgent: False/No-Wait {False/No-Wait=13, True/Wait=1}
|   TICKET TYPE = Question: False/No-Wait {False/No-Wait=401, True/Wait=110}
|   TICKET TYPE = Task
|   |   NUMBER OF ACTIVE CASES AT START > 0.500
|   |   |   NUMBER OF ACTIVE CASES AT START > 1.500: True/Wait {False/No-Wait=777, True/Wait=861}
|   |   |   NUMBER OF ACTIVE CASES AT START <= 1.500: False/No-Wait {False/No-Wait=4, True/Wait=2}
|   |   NUMBER OF ACTIVE CASES AT START <= 0.500
|   |   |   RESOURCE OF STARTING ACTIVITY = Res3: True/Wait {False/No-Wait=2, True/Wait=4}
|   |   |   RESOURCE OF STARTING ACTIVITY = Res4: False/No-Wait {False/No-Wait=9, True/Wait=1}
|   |   |   RESOURCE OF STARTING ACTIVITY = Res8: False/No-Wait {False/No-Wait=5, True/Wait=2}
```