

## Dataset description

The event log of a “Road traffic fine management” process (managing fines punishing road traffic infractions, i.e., speeding) contains real data of an Italian regional agency for traffic management.

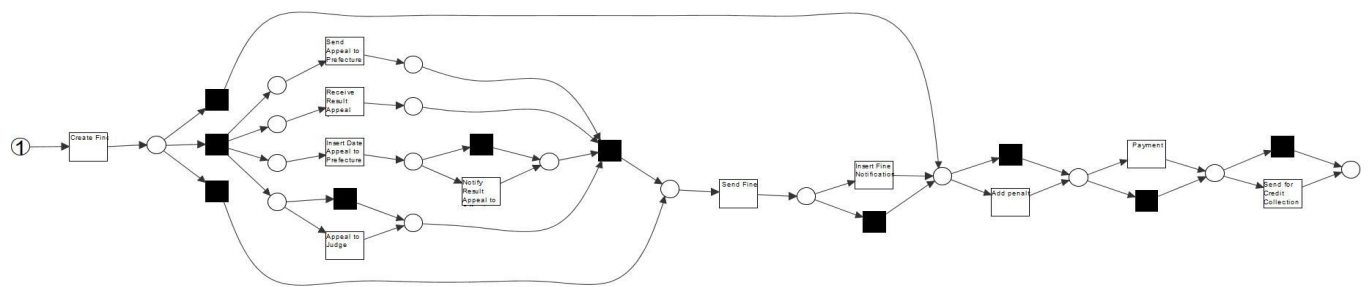
According to domain experts, the process normally operates as follows:

- A fine is created (*Create Fine*).
- The fine is sent to the offender’s place of residence (*Send Fine*).
- When the offender receives the fine, the date of reception of such notification is also registered (*Insert Fine Notification*).
- The offender has 60 days to either pay the fine (Payment) or appeal against it. After this period, a penalty is added to the fine amount (*Add Penalty*).
- If an appeal is initiated within 60 days, it is sent to the corresponding prefecture (*Send Appeal to Prefecture*), and registered when it is received (*Insert Date Appeal to Prefecture*). The results of the appeal are sent back to the municipality (*Receive Result Appeal from Prefecture*) and notified to the offender (*Notify Result Appeal to Offender*), which can appeal against the result (*Appeal to Judge*). If the offender does not pay (possibly after a denied appeal), the case is sent to an external credit collection agency that will contact the offender to collect the payment (*Send for Credit Collection*). The part of the process after the fine is sent out for credit collection is not captured in the event log.
- Exception: parking tickets can be paid immediately, after the ticket creation (in which case the paperwork is bypassed and unnecessary administration costs are avoided).

## Dataset preprocessing

The dataset includes 150370 cases with the name “Data” in the notebook . After removing the columns recording NaN on more than two thirds of the values, the dataset retained the following named “df “ in the notebook :

- Must-have configuration information for a process mining analysis
  - ‘Case’ – the id of the fine
  - ‘Event’ – the status of the fine, one of 11 distinct values (‘Create Fine’, ‘Send Fine’, ‘Insert Fine Notification’, ‘Add penalty’, ‘Send for Credit Collection’, ‘Payment’, ‘Insert Date Appeal to Prefecture’, ‘Send Appeal to Prefecture’, ‘Receive Result Appeal from Prefecture’, ‘Notify Result Appeal to Offender’, ‘Appeal to Judge’)
  - ‘startTime’, ‘completeTime’ – the timestamp associated with the event
- Columns that may be used for filtering purposes: ‘Amount’, ‘article’, ‘points’, ‘org:resource’, ‘vehicleClass’, ‘totalPaymentAmount’, ‘notificationType’, ‘expense’.
- New columns “Dates , Year , Month” have been added to the data to ease the filtering process
- NAN values for the same case ID have been replaced with the same values in “Points , Vehicle Class “
- NAN values for events that don’t require payment have been replaced with 0 .



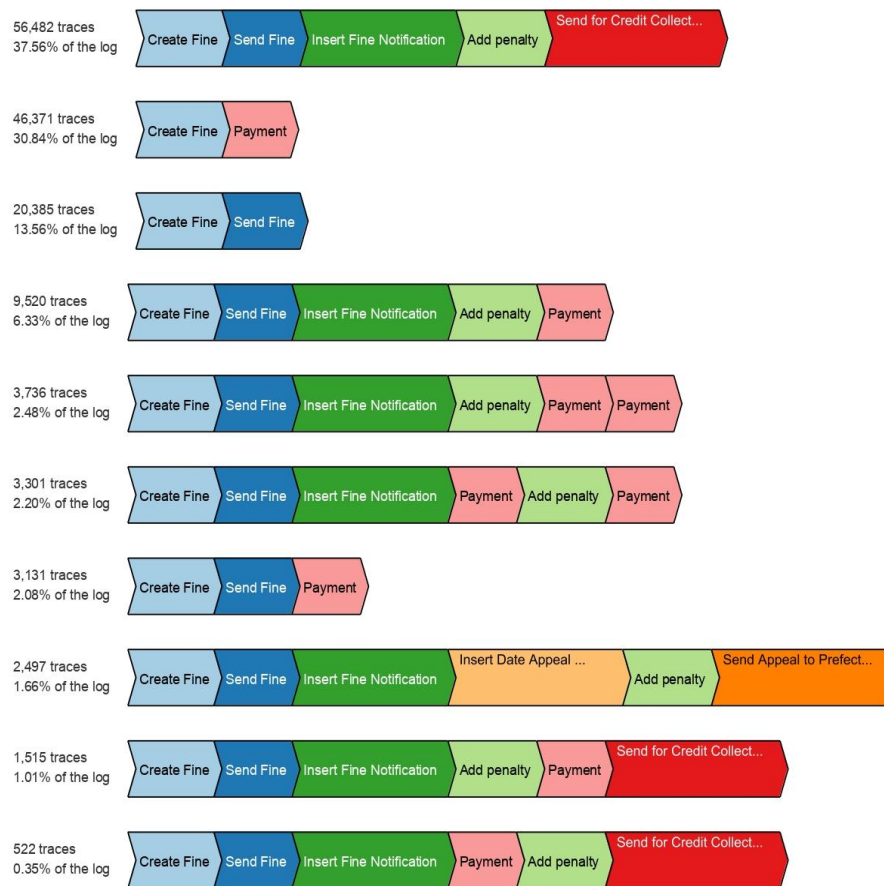
**Unfiltered process flow using Inductive miner**

## Analysis

### De-noising

7.3% of the cases represent unusual cases (based on very small group sizes, e.g. of 1-80), and are not indicative of overall systemic behaviour. While interesting, they are irrelevant for the purpose of understanding a birdview of the flow, and for global optimization purposes. They were ignored in the analysis stage.

13.6% of all cases are represented by incomplete “Create Fine → Send Fine” journeys (i.e. which start, but do not conclude within the total time frame of the data). They were simply left out in the analysis stage.



## Trace Variant Discovery using ProM

### Process discovery

Let's uncover the actual behaviour of the people when it comes to receiving and (not) paying a fine.

### Desired behaviour

39.2 % of the journeys are represented by desired behaviour (Payment observed).

- 30.6% of the cases (the second most frequent pathway) represent tickets paid on the spot: Create Fine → Payment .
- In 6% of the cases, offenders pay the fine after receiving an additional penalty, and the story ends with this Payment.
- In 2.1 % of the journeys, the ticket is created and sent to the place of residence of the offender, and a Payment is made eventually (an average end-to-end waiting time of ~ 4 months )

Atypical behaviour in this category includes:

- Payment observed as repetitive behaviour
- Payment observed, but (surprisingly) followed by added penalties / action initiated by the external credit collector agency (which probably should have been notified to not trigger an unnecessary bureaucratic chain). It might be that this shows a possible lack of synchronization between the accounting department and the external credit collection agency (which was not announced in time that the case was resolved once a Payment was made)

## Undesired behaviour

39.9% of the journeys represent undesired behaviour (no Payment observed at any point in the path).

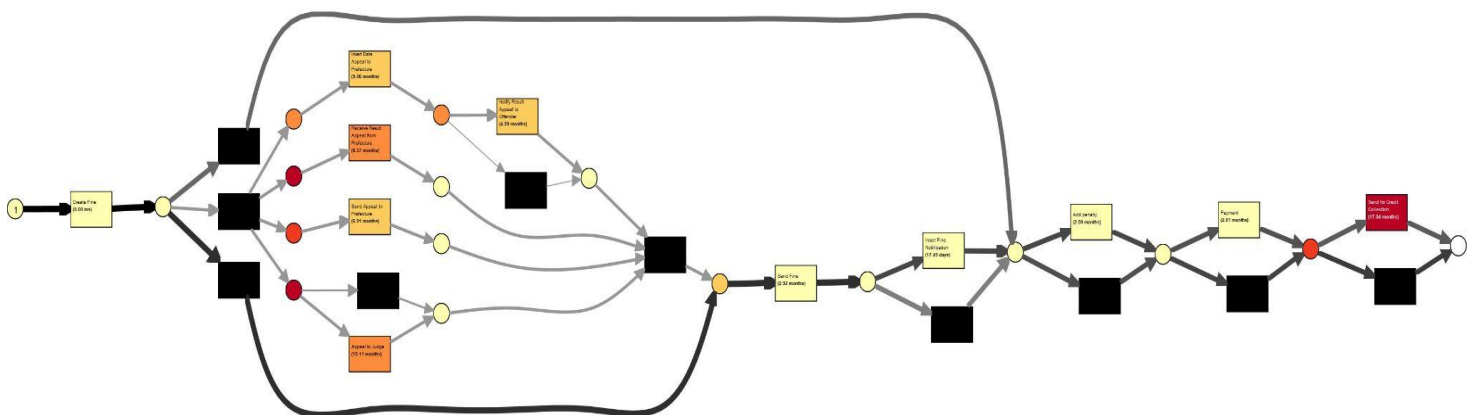
- 37.6% of all journeys ( the largest group of all journeys) impose an average end-to-end waiting time of approx. ~2 years. These are people who officially receive the fine along with penalties for not paying it in time, and eventually end up being addressed by the external collection agency.

Atypical behaviour in this category includes:

- a penalty is still added officially despite the unexpected initiation of an appeal by the offender (1.7% of all cases).

## Define Bottleneck of process

- Using simple bar chart we noticed that 2013 has significantly lower amount of total actual payments
- This may be related to the day the data was collected and sent to us to analyse
- But after further investigation we noticed that most events found in 2013 were actually credit collection events that have not been completed for processes started over 2 or 3 years before
- This might be related to slow notification of the offenders or slow payment processing in collection department
- This insight was confirmed using ProM performance analysis when we found the average wait time for credit collection is 17.54 months
- Same goes for “recieving the result for appealing” with average wait time of 8.37 months and “appeal to judge with average wait time of 10.11 months



Model performance analysis using ProM

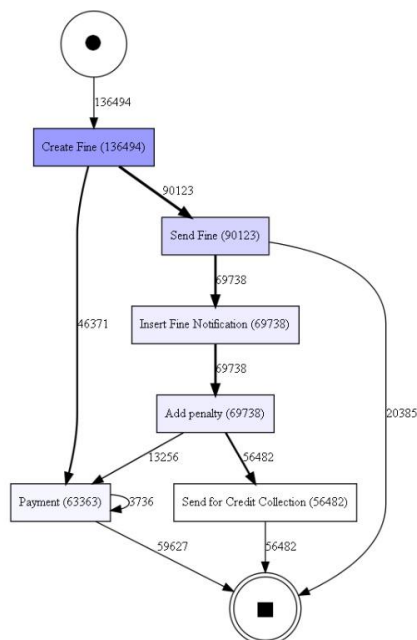
## Optimization checkpoints

- What is the story behind unwanted performance indicator values (e.g. outstandingly long end-to-end waiting times | loops | successions of steps)? Is there anything that could be done to decrease them?
  - Almost 40% of the fines received do not get resolved in the timeframe considered for analysis, and end up being taken over by the external credit collector agency. One solution would be to officially decrease the unnecessarily long waiting time (of approx. 2 years) before transferring an issue to a third party.

- Unwanted successions of steps uncovered revealed a possible lack of synchronization between the sub-departments in charge with accounting / all other paperwork. One solution would be digital transformation: to ensure that once payments are made, updates are automatically sent to the other subsystems.

## Recommendation :

- Huge improvement can be done on the process if the initiation of appeal was excluded or done after the payment has completed , this is confirmed using the K variant filtering of the data and visualizing it using Directly-Follows Graph .



- Are there unnecessary repetitive steps that contribute to increasing delays in the system?
  - Payment is unexpectedly executed twice in 2.5% of the cases, most probably because people omit to pay the penalty received the first time. This issue could be easily tackled by not allowing payments that do not match the total amount of the fine, and displaying a message to inform on the spot about the reason for payment denial.

