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AI Claim Categorization as a Global Good

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Gumzo ya Mwezi Montly Meeting

04 April 2022

Content

- Claim Adjudication
- AI-based Claim Adjudication
- Framing questions

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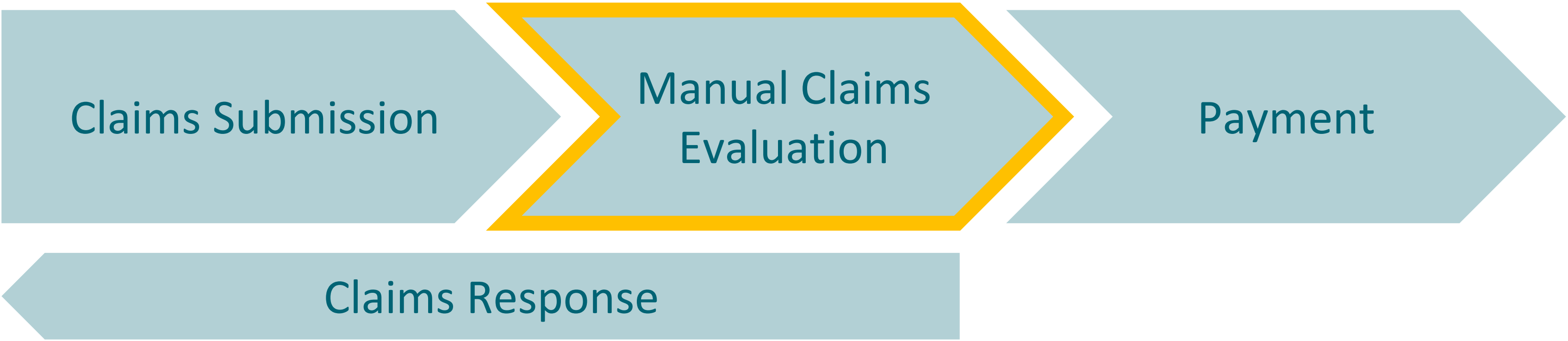
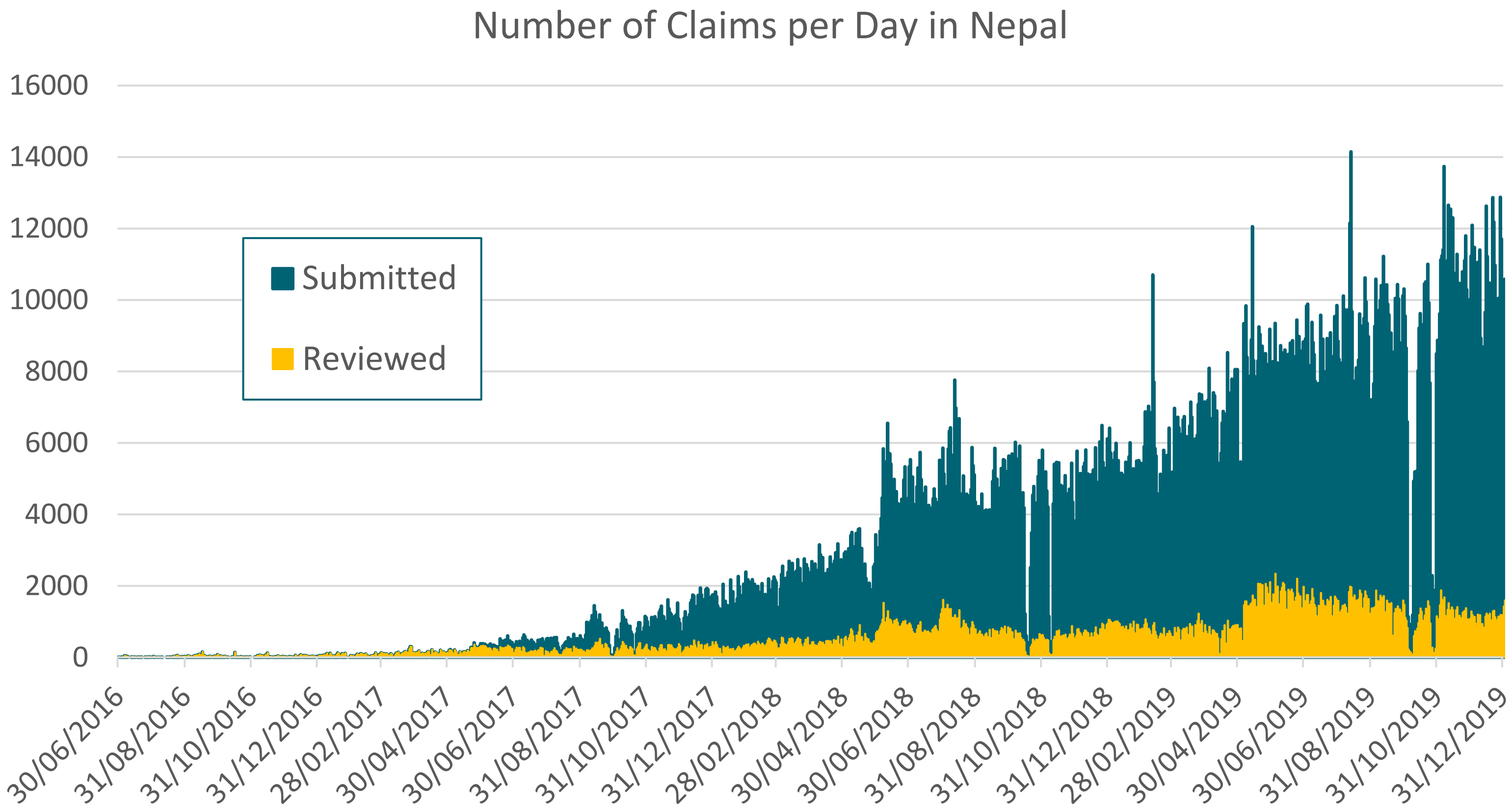
Claims Adjudication

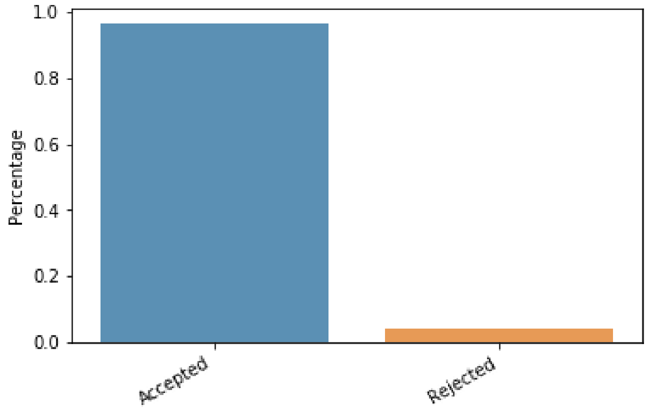
Manual Claims Adjudication



Problem: Number of Claims



- 5 953 640 Claims:
  - 12 371 992 Medical Items
  - 16 655 364 Medical Services
- 3 790 789 Insurees
- 780 Health Facilities



Bottelneck: Human Adjudicators

- Estimation (openIMIS Nepal):
  - 1 officer = 100 claims per day max
- Currently employed:
  - 16 officers = 1,600 claims per day
- Needed:
  - 300 officer = 30,000 claims per day

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Adding AI

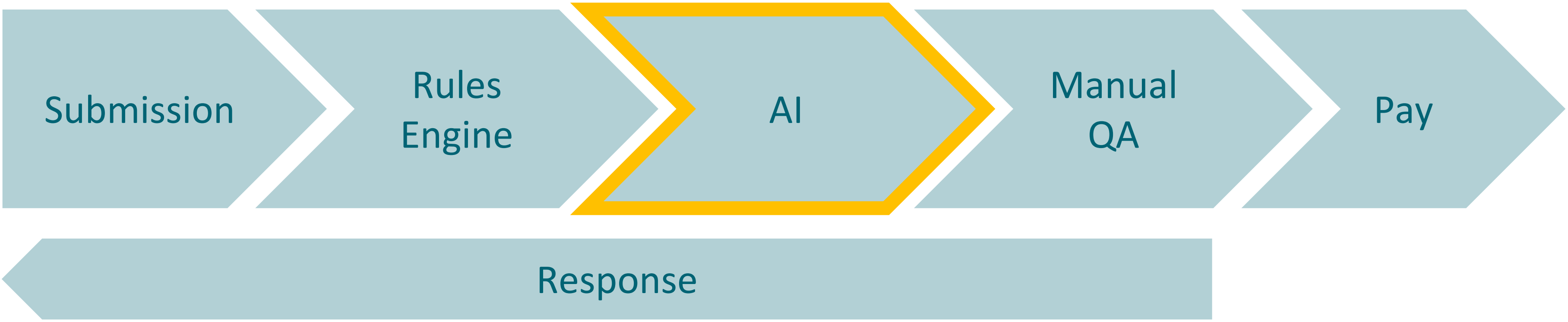
Rule Based Automation

Aim:
- Reduce workload

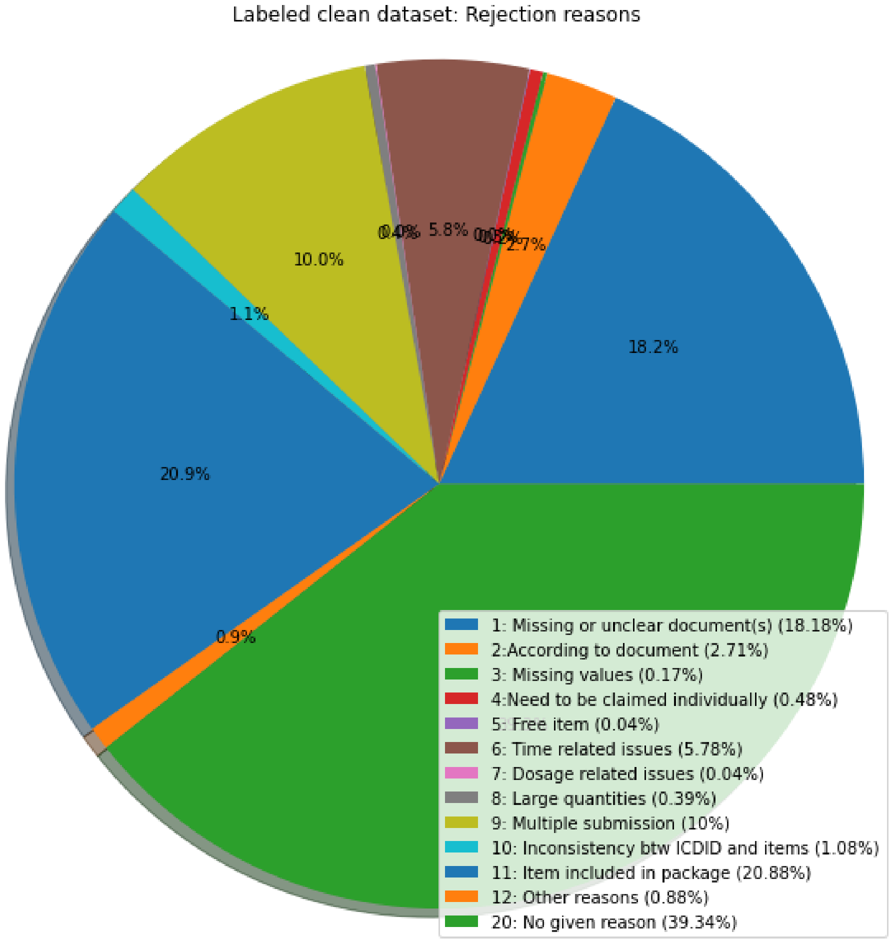
Method:
- Automatically reject formally incorrect claims
- No manual verification of rejected claims

Formally this is already Artificial Intelligence (but not Machine Learning and not the hype thing)

AI Supported Automation



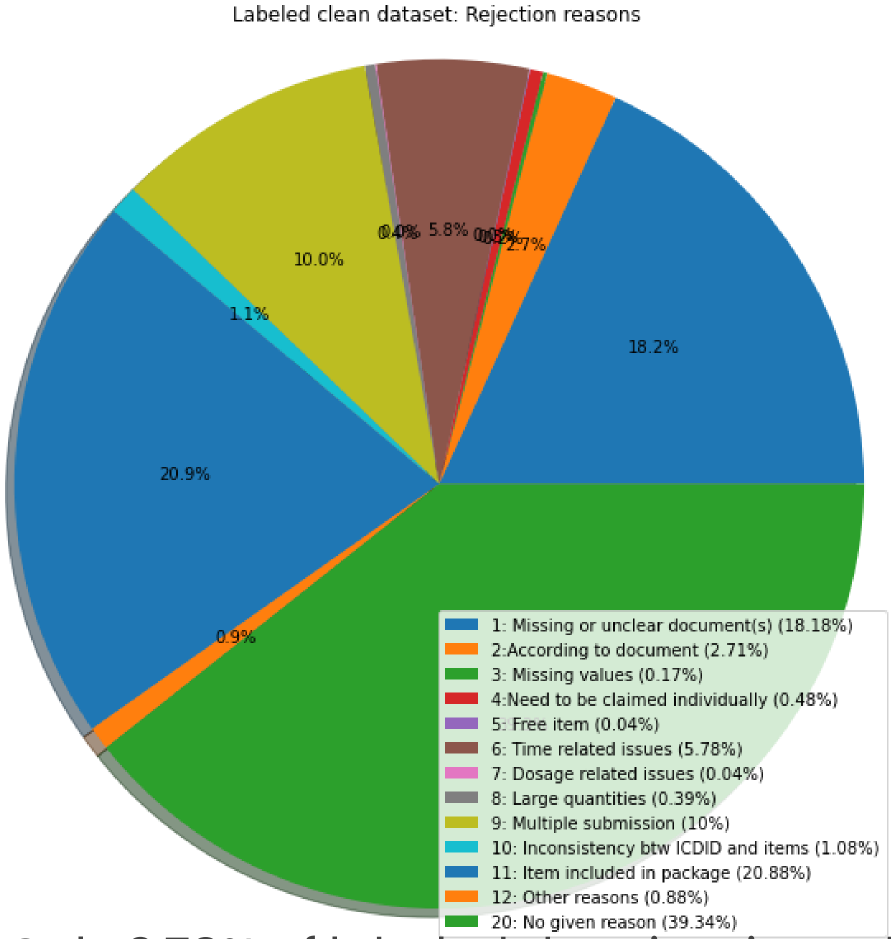
Challenges on data analysis



- Only 3.78% of labeled data is rejected, while only 2.29% has an associated rejection reason
    - Rejection justifications are free non standardized text fields ⇨ need to **process this information** in order to extract rejection reasons and standardize the Justification/Adjustment field
    - ⇨ dealing with **highly imbalanced dataset**
- Most of the features are categorical

⇨ only **specific AI models** are capable to consider this

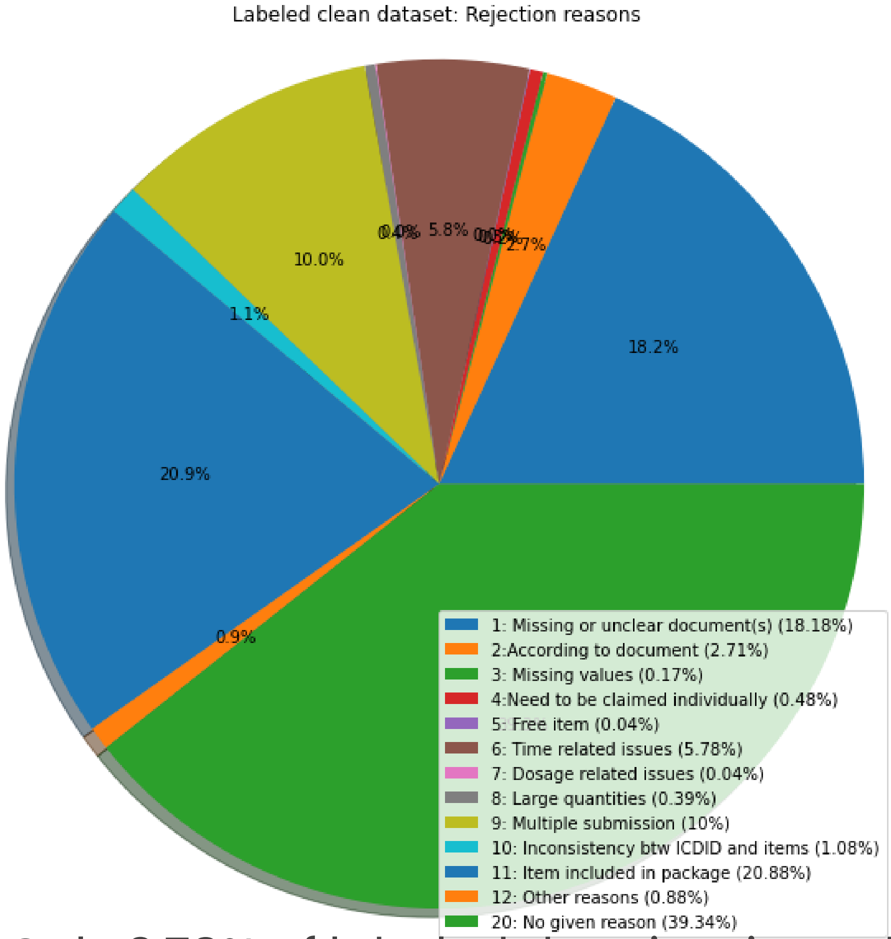
Challenges on data analysis



Only 3.78% of labeled data is rejected, while only 2.29% has an associated rejection reason

- Most of the features are categorical
  - Numerical: QuantityProvided, PriceAsked, ItemPrice
  - Categorical:
    - Date: DateFrom, DateTo, DateClaimed, DOB
    - Related to categories: ItemFrequency, ItemPatCat, ItemLevel, VisitType, HFLevel, HFCareType, Gender, ItemServiceType, PovertyStatus
    - ID related: ItemID, ClaimID, ClaimAdminID, HFID, LocationID, HFLocationID, InsureeID, FamilyID, ICDID, ICDID1

Challenges on data analysis

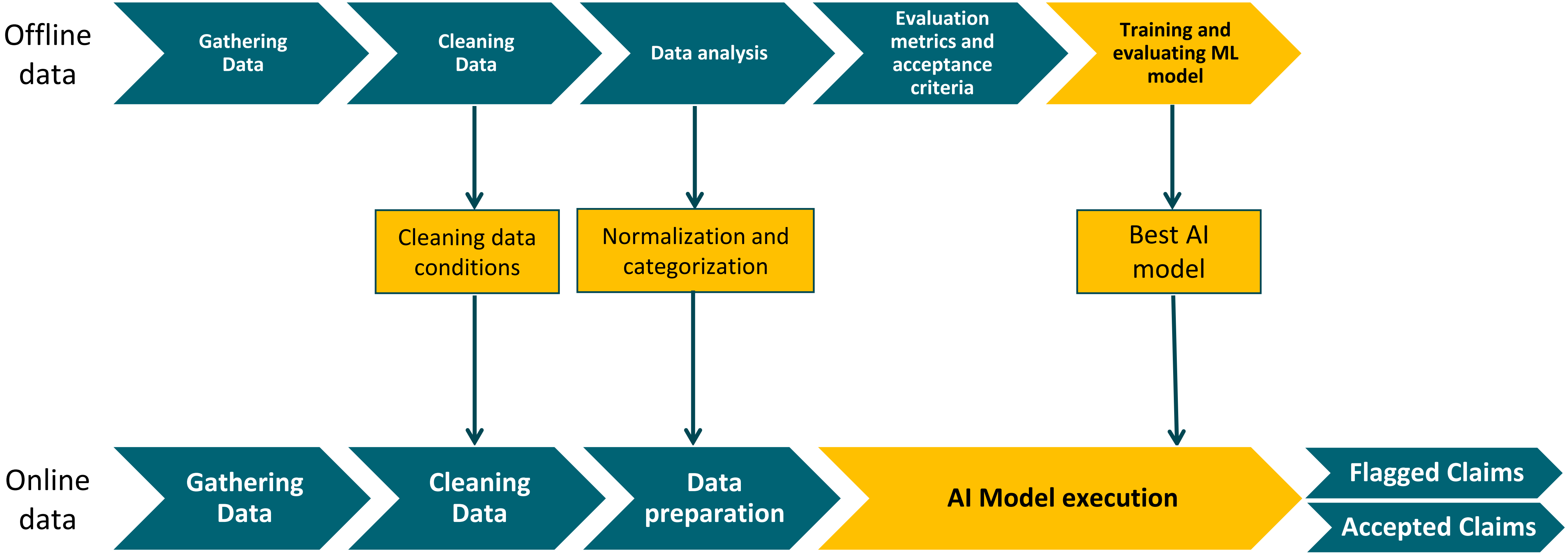


Only 3.78% of labeled data is rejected, while only 2.29% has an associated rejection reason

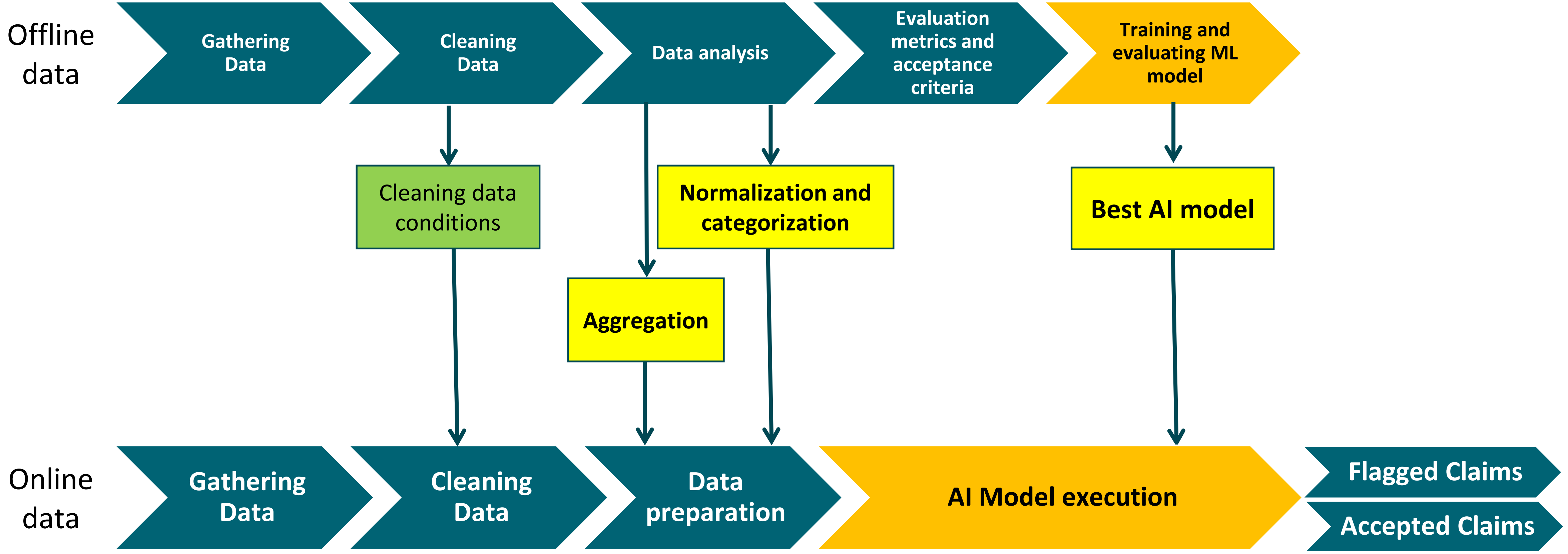
- Most of the features are categorical
  - Numerical: QuantityProvided, PriceAsked, ItemPrice Duration, DurationClaimed, Age
  - Categorical:
    - Date: ~~DateFrom, DateTo, DateClaimed, DOB~~
    - Related to categories: ItemFrequency, ItemPatCat, ItemLevel, VisitType, HFLevel, HFCareType, Gender, ~~ItemServiceType~~, Poverty
    - ID related: ItemID, ClaimID, ClaimAdminID, HFID, LocationID, HFLocationID, InsureeID, FamilyID, ICDID, ICDID1

⇨ replace ID related fields with aggregated fields

From research to production



From research to production



Excluding conditions

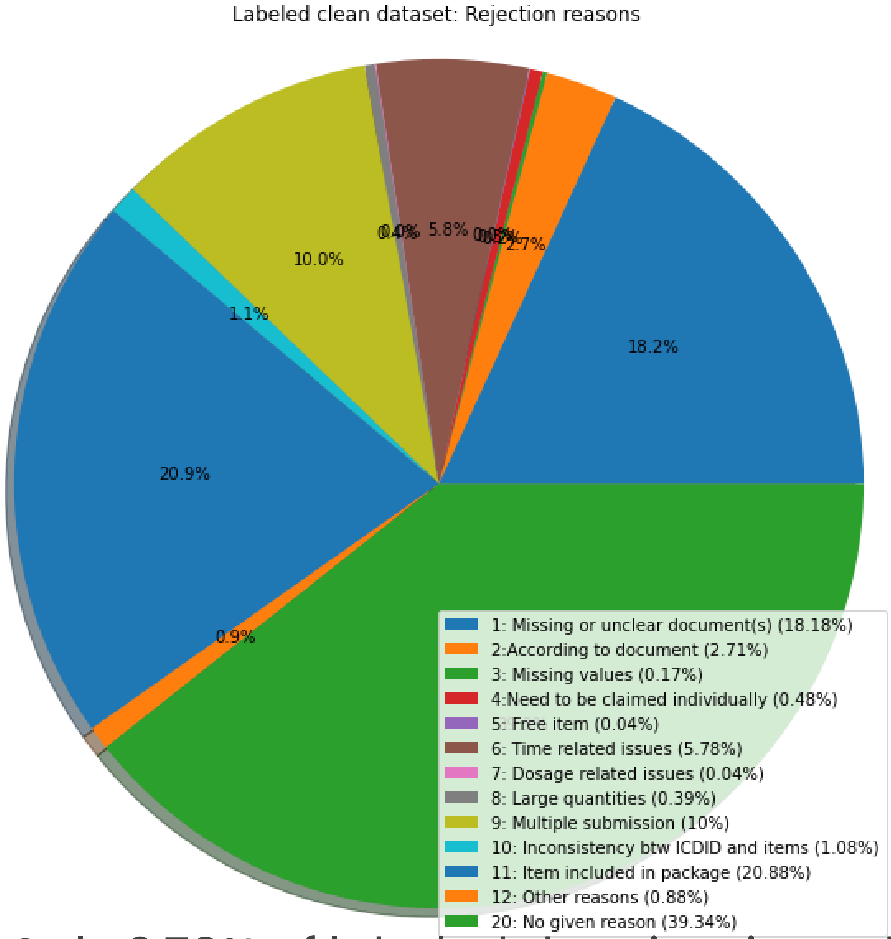
<table>
<tr><th>Condition</th><th>Description</th></tr>
<tr><td>1. df[‘ClaimStatus’] == CS_Entered</td><td>The items that are submitted, but not yet in checked by the Rule Engile are excluded</td></tr>
<tr><td>2. df['RejectionReason']>RR_Accepted</td><td>Items rejected by the Rule Engine are excluded</td></tr>
<tr><td>3.(df['RejectionReason']==RR_RbyMO)&(df['PriceValuated']>0)</td><td>Incoherence between status and valuated price</td></tr>
<tr><td>4. ((df['ClaimItemStatus']==CIS_Rejected)&\
(df['RejectionReason']==RR_Accepted))|\
((df['ClaimStatus']==CS_Rejected)&(df['RejectionReason']==RR_Accepted))|((df['ClaimItemStatus']==CIS_Accepted)&(df['RejectionReason']==RR_RbyMO))</td><td>Incoherence in the status fields are excluded</td></tr>
<tr><td>5. df['ClaimAdminId'].isnull())|(df['VisitType'].isnull())</td><td>Missing values in the ClaimAdminId, VisiType fields</td></tr>
<tr><td>6. (df ['DateFrom']<datetime.datetime(2016, 5, 15))|\
(df ['DOB']>df_items['DateFrom'])|\
(df ['DateClaimed']<datetime.datetime(2016, 5, 15))|\
(df ['DateClaimed']<df['DateFrom'])</td><td>Incoherence in the date related fields</td></tr>
<tr><td>7. df['HFID']!=df['HFId']</td><td>Check if ClaimAdminID has the same HFID as the ClaimHFID</td></tr>
</table>

Aggregation

Field name	Description
LastSameItem	Number of days since last submitted (and accepted) item (same ItemID)
SameItemPerDay/Claim	Count of items having the same ItemID, submitted same day/claim
ItemPerClaim AmountPerClaim/Day	Count of items having the same ItemID, submitted within the claim Amount related to the claim/day (ItemPrice or PriceAsked?)
ItemsPerWeek/Month/ Quarter/Year	Count of items for same Insuree over a period of 7 days (1 week), 30 days (1 month) or 90 days prior to the current submission
AmountPerWeek/Month/ Quarter/Year	Total ItemPrice/PriceAsked for the items submitted over a period of 7, 30 or 90 days prior to the current submission
AverageClaimOverMonth	Average amount of a claim over a 30 days period until the current submission AmountPerMonth/ClaimsPerMonth
AverageOverQuarter	Average amount / week related to claims submitted over past 90 days AmountPerQuarter/12
AverageDailyOverMonth	Average amount/day related to claims submitted over past 30 days AmountPerMonth/30
IsPackage	Check is a package was submitted within the associated claim

!Infinite possibilities of aggregation with respect to other Features and Time periods.

Challenges on data analysis



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- Most of the features are categorical
  - Numerical: QuantityProvided, PriceAsked, ItemPrice Duration, DurationClaimed, Age, LastSameItem, SameItemPerClaim, SameItemPerDay, ItemsPerDay/Week/Month/Quarter/Year, AmountPerDay/Week/Month/Quarter/Year
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    - Related to categories: ItemFrequency, ItemPatCat, ItemLevel, VisitType, HFLevel, HFCareType, Gender, ~~ItemServiceType~~, Poverty
    - ID related: ItemID, ~~ClaimID, ClaimAdminID, HFID, LocationID, HFLocationID, InsureeID, FamilyID~~, ICDID, ICDID1

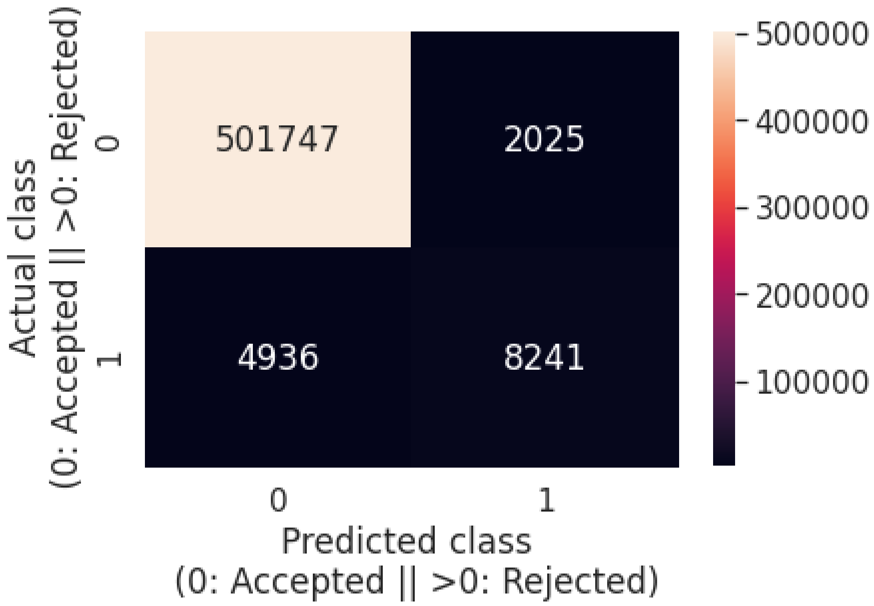
      or UUID/Code related: ItemUUID, ~~ClaimUUID, ClaimAdminUUID, HFUUID, LocationID, HFLocationID, InsureeUUID, FamilyUUID~~, ICDCode, ICD1Code

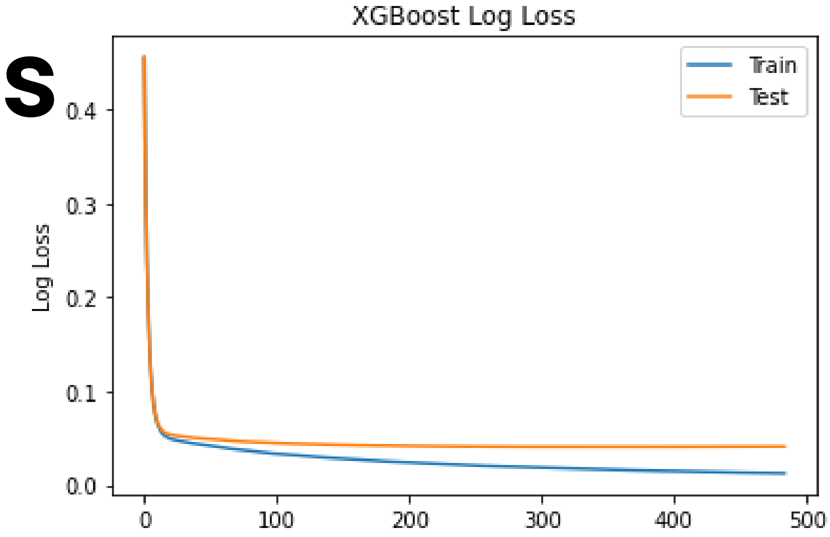
Aggregation – in practice

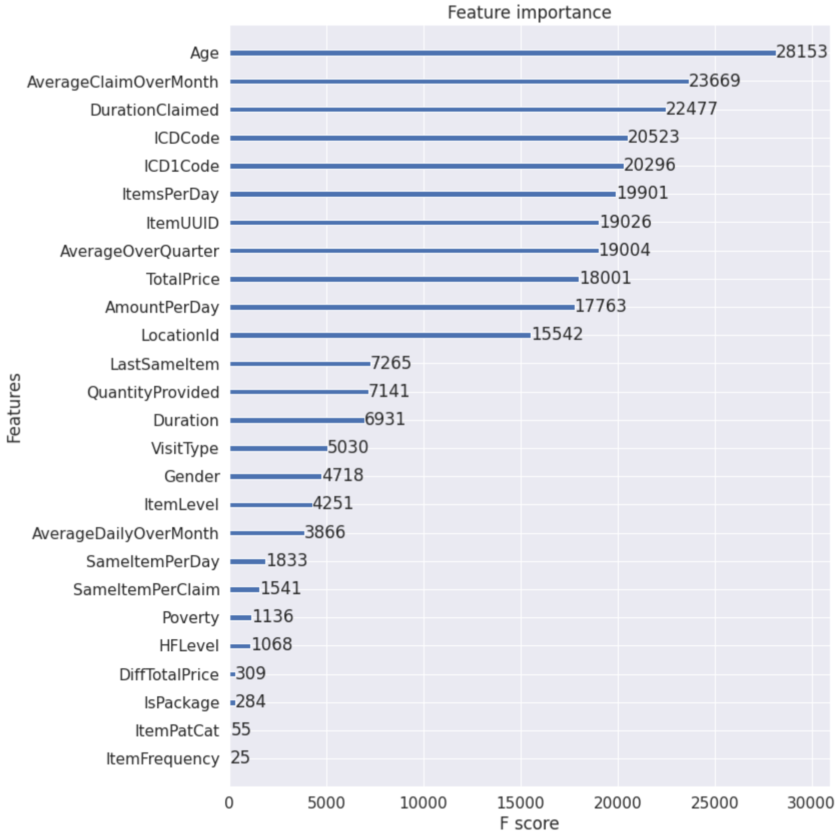
- In order to create the aggregated features, access to historical dataset is necessary

- For new submitted claims, in order to create the aggregated features for these claims, we need to retrieve the historical claims related to the InsureeIDs

AI model performances







$$\text{Accuracy} = \frac{TN+TP}{TN+FP+FN+TP} = \frac{501747+8241}{501747+2025+4936+8241} = \frac{509988}{516949} = 0.9865$$

$$\text{Precision} = \frac{TP}{TP+FP} = \frac{8241}{2025+8241} = \frac{8241}{10266} = 0.8027$$

$$\text{Recall} = \frac{TP}{TP+FN} = \frac{8241}{8241+4936} = \frac{8241}{13177} = 0.6254$$

$$\text{F1} - \text{score} = 2\,\frac{Precision * Recall}{Precision + Recall} = 2\,\frac{0.8027 * 0.6254}{0.8027+0.6254} = 0.7031$$

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AI model performances

Dataset	Accuracy	Precision	Recall	F1-Score
Training set	0.9955	0.9600	0.8612	0.9079
Test set	0.9865	0.8027	0.6254	0.7031
Production: 1 weeks	0.9854	0.6424	0.4763	0.5471
Production: 1 month	0.9839	0.6340	0.4358	0.5166
Production: 2 months	0.9832	0.6156	0.4143	0.4953
Production: 3 months	0.9831	0.6028	0.4027	0.4828
Production: >1year	0.9853	0.3876	0.3167	0.3486

Fairness indices

- We can check the fairness of the AI model with respect to several feature values:
  Gender, Poverty, Age, Location, Race, Education, Religion, …

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Top view of developments/tests

Classification based algorithms: **Decision Trees**, **Random Forests,** Isolation Forest, Bayesian Networks, ...

Nearest-Neighbor based algorithms: **k-NN**, Local Outlier Factor (LOF), Connectivity-based Outlier Factor (COF), ...

Clustering based algorithms: K-means, Cluster based Local Outlier Factor (CBLOF), Local Density Cluster based Outlier Factor (LDCOF), ...

Statistics based techniques: Parametric techniques, Non-parametric techniques, ...

Neural Networks related techniques: Artificial Neural Networks, Autoencoders, Long Short Term Memory (LSTM), ...

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ML algorithm dependencies and variations:

- **Dataset variations**:
    - Binary class
    - Multiclass

    - Imbalanced case
    - Balanced case: Undersampling/Oversampling techniques (only on the training set)

    - Feature aggregation

- **Splitting of the dataset** in several sets: train/dev/test set, train/test set, ... (depending on the ML algorithm, validation method)

- **Hyperparameters** of the ML algorithm to be tuned

- **Evaluation metrics**: precision, recall, f1 score, accuracy, ...

- **Validation step:** holdout method, cross-validation, ...

Now what?

- Creation of a synthetic dataset that can be used for a DemoServer
- Create a video presenting the model?
- How to increase acceptance of the openIMIS AI module?
- How to improve the AI model?

Now what?

- Creation of a synthetic dataset that can be used for a DemoServer
- Create a video presenting the model?
- How to improve acceptance of the openIMIS AI module?
- How to improve the AI model?
  - Still needs to be improved?

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Thank you

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More information on openIMIS

Website: www.openIMIS.org

Wiki: wiki.openIMIS.org

Source code: github.com/openimis

Documentation: docs.openIMIS.org

Demo: demo.openIMIS.org

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Confédération suisse
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Confederaziun svizra

Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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DEVAIS

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