Etude de la régularité des trains entre 2015 et 2020 (SNCF)

Projet - Pipeline de traitements de données pour le cloud

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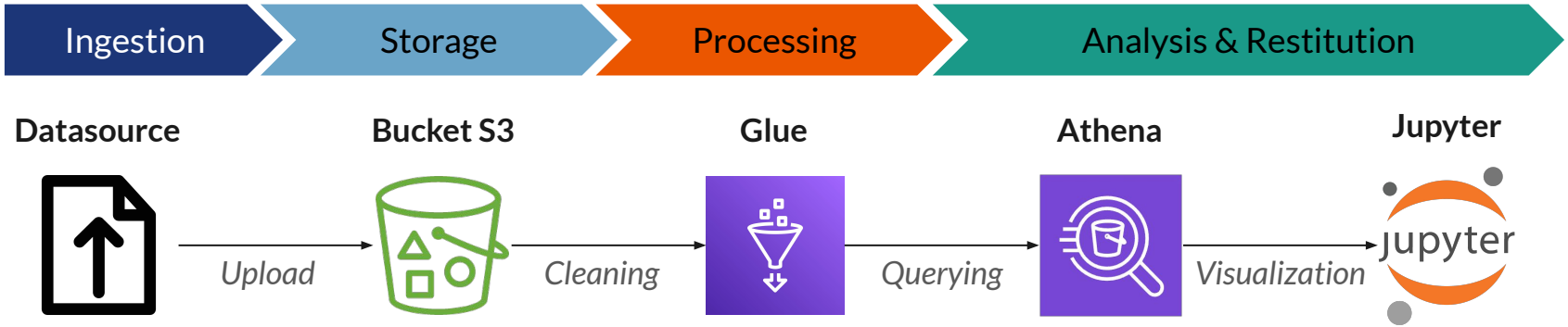
Les 5 V

- **Volume :** Historique complet de 2015 à 2020 (cumul par mois sur les trajets communiqués par la SNCF). *7806 lignes soit 7806/(12*6) = 108 trajets en moyenne par mois*
- **Vélocité :** Données mensuelles. Le pipeline est conçu en mode "Batch" (traitement par lots à l'arrivée de nouveaux fichiers mensuels).
- **Variété :** Données structurées (CSV) avec schéma mixte (texte, numériques, pourcentages).
- **Véracité :** Données issues de l'Open Data SNCF (source officielle et fiable).
- **Valeur :** Prédiction des risques de retard selon la durée, transparence pour les usagers.

Diagramme d'architecture



Format des Données → Raw Data


```
{
  "Year": 2019,
  "Month": 7.0,
  "Departure station": "ANGOULEME",
  "Arrival station": "PARIS MONTPARNASSE",
  "Average travel time (min)": 131.914979757,
  "Number of expected circulations": 247.0,
  "Number of cancelled trains": 0.0,
  "Number of late trains at departure": 191.0,
  "Average delay of late departing trains (min)":
3.5763525305400004,
  "Average delay of all departing trains (min)":
2.67827260459,
  "Comment (optional) delays at departure": null,
  "Number of trains late on arrival": 41.0,
  "Average delay of late arriving trains (min)":
22.924796748000002,
  "Average delay of all arriving trains (min)":
5.23333333333,
  "Comment (optional) delays on arrival": null,
  "% trains late due to external causes (weather,
obstacles, suspicious packages, malevolence, social
movements, etc.)": 0.25,
…
```

```
…
"% trains late due to railway infrastructure (maintenance,
works)": 0.15,
  "% trains late due to traffic management (rail line traffic,
network interactions)": 0.275,
  "% trains late due to rolling stock": 0.125,
  "% trains late due to station management and reuse of
material": 0.025,
  "% trains late due to passenger traffic (affluence, PSH
management, connections)": 0.175,
  "Number of late trains > 15min": 21.0,
  "Average train delay > 15min": 32.9658730159,
  "Number of late trains > 30min": 7.0,
  "Number of late trains > 60min": 2.0,
  "Period": "2019-07",
  "Delay due to external causes": 25.0,
  "Delay due to railway infrastructure": 15.0,
  "Delay due to traffic management": 27.500000000000004,
  "Delay due to rolling stock": 12.5,
  "Delay due to station management and reuse of material": 2.5,
  "Delay due to travellers taken into account": 17.5
}
```

Format des Données → Cleaned Data

Données Supprimées


```
{
  "Year": 2019,
  "Month": 7.0,
  "Departure station": "ANGOULEME",
  "Arrival station": "PARIS MONTPARNASSE",
  "Average travel time (min)": 131.914979757,
  "Number of expected circulations": 247.0,
  "Number of cancelled trains": 0.0,
  "Number of late trains at departure": 191.0,
  "Average delay of late departing trains (min)":
3.5763525305400004,
  "Average delay of all departing trains (min)":
2.67827260459,
  "Comment (optional) delays at departure": null,
  "Number of trains late on arrival": 41.0,
  "Average delay of late arriving trains (min)":
22.924796748000002,
  "Average delay of all arriving trains (min)":
5.23333333333,
  "Comment (optional) delays on arrival": null,
  "% trains late due to external causes (weather,
obstacles, suspicious packages, malevolence, social
movements, etc.)": 0.25,
…
…
"% trains late due to railway infrastructure (maintenance,
works)": 0.15,
  "% trains late due to traffic management (rail line traffic,
network interactions)": 0.275,
  "% trains late due to rolling stock": 0.125,
  "% trains late due to station management and reuse of
material": 0.025,
  "% trains late due to passenger traffic (affluence, PSH
management, connections)": 0.175,
  "Number of late trains > 15min": 21.0,
  "Average train delay > 15min": 32.9658730159,
  "Number of late trains > 30min": 7.0,
  "Number of late trains > 60min": 2.0,
  "Period": "2019-07",
  "Delay due to external causes": 25.0,
  "Delay due to railway infrastructure": 15.0,
  "Delay due to traffic management": 27.500000000000004,
  "Delay due to rolling stock": 12.5,
  "Delay due to station management and reuse of material": 2.5,
  "Delay due to travellers taken into account": 17.5
}
```

Format des Données → Standardized Data

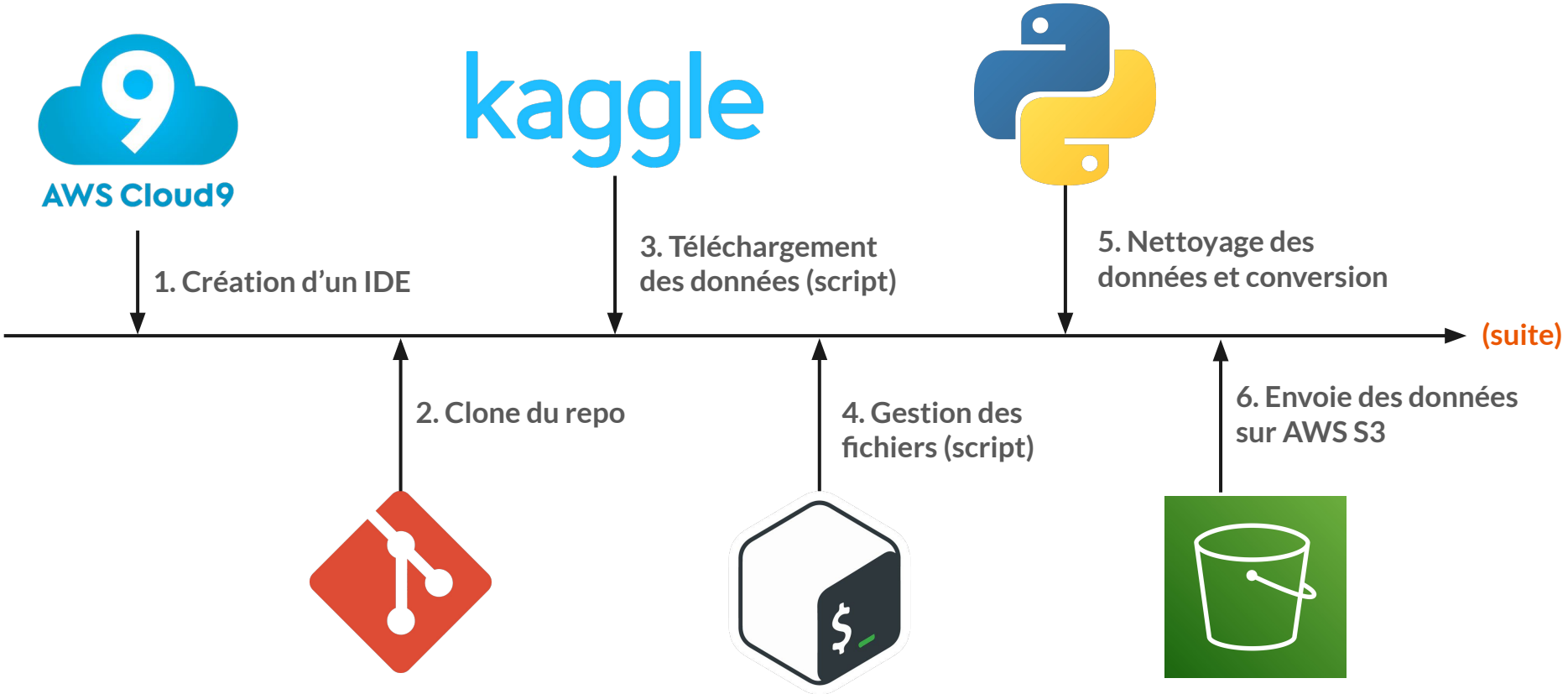
Ancien nom colonne
Nouveau nom colonne
Nouvelle colonne


```
{
  "Year": 2019,
  "Month": 7.0,
  "Departure station": "ANGOULEME",
  "Arrival station": "PARIS MONTPARNASSE",
  "Average travel time (min)": 131.914979757,
  "Number of expected circulations": 247.0,
  "Number of late trains at departure": 191.0,
  "Number of trains late on arrival": 41.0,
  "Number of late trains > 15min": 21.0,
  "Number of late trains > 30min": 7.0,
  "Number of late trains > 60min": 2.0,
  "Period": "2019-07",
  "Delay due to external causes": 25.0,
  "Delay due to railway infrastructure": 15.0,
  "Delay due to traffic management":
27.500000000000004,
  "Delay due to rolling stock": 12.5,
  "Delay due to station management and reuse of
material": 2.5,
  "Delay due to travellers taken into account": 17.5
}
```



```
{
  "year": 2019,
  "month": 7.0,
  "departure_station": "ANGOULEME",
  "arrival_station": "PARIS MONTPARNASSE",
  "avg_travel_time_min": 131.915,
  "nb_expected": 247.0, // this - nb_cancelled
  "nb_late_dep": 191.0,
  "nb_late_arr": 41.0,
  "nb_late_over_15": 21.0,
  "nb_late_over_30": 7.0,
  "nb_late_over_60": 2.0,
  "period": "2019-07",
  "delay_cause_external": 25.0,
  "delay_cause_infra": 15.0,
  "delay_cause_traffic": 27.5,
  "delay_cause_rolling_stock": 12.5,
  "delay_cause_station": 2.5,
  "delay_cause_travelers": 17.5,
  "nb_late_before_15": 20.0 //nb_late_arr - nb_late_over_15
}
```

Étapes de construction et exécution de la pipeline



Zoom : Nettoyage des données et conversion

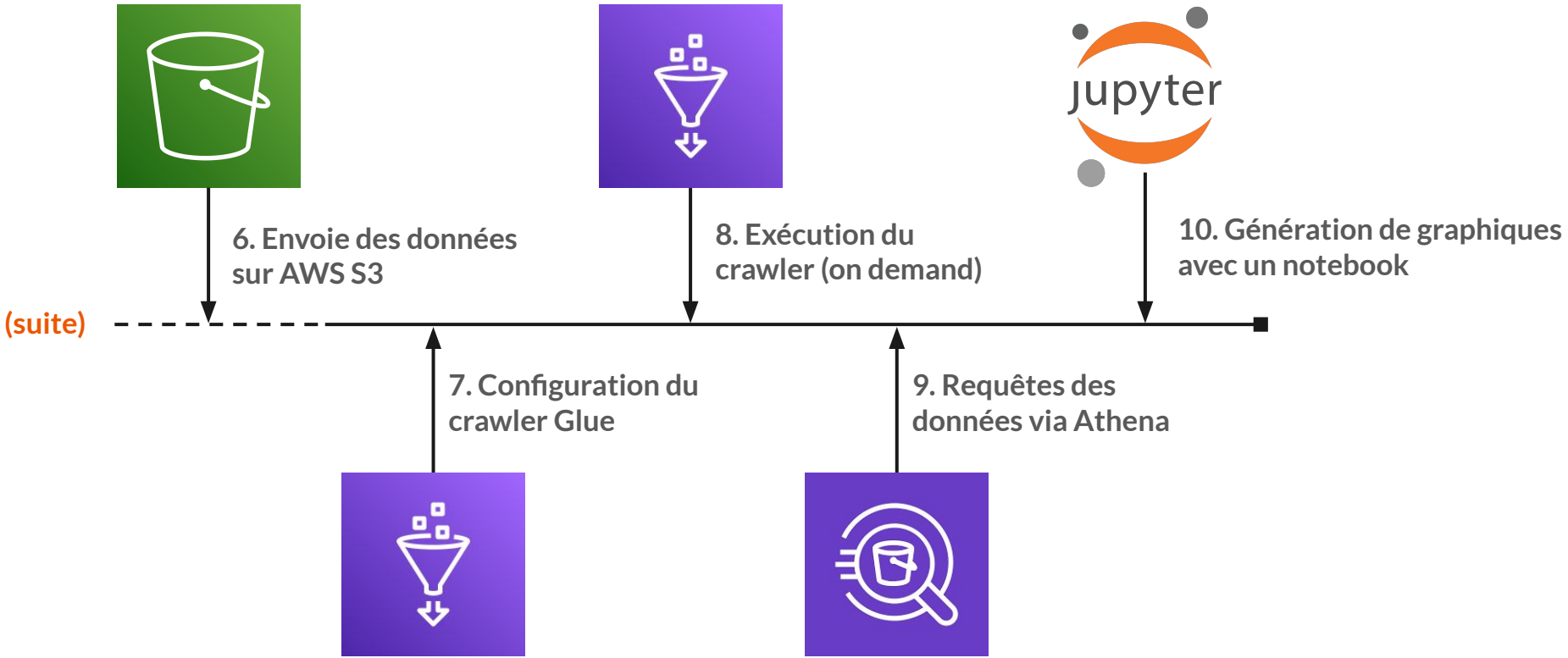
CSV
+ Suppression de 45% des données
+ conversion en PARQUET
→ 92% plus léger

```
org_size = os.path.getsize(file_path)
cleaned_size = os.path.getsize(output_filename)
pct_gain = round((1-cleaned_size/org_size)*100,2)

print(f"Cleaned files saved as: {output_filename}")
print(f"Original size: {org_size} bytes")
print(f"Cleaned file size: {cleaned_size} bytes")
print(f"Gain: {pct_gain}% lighter")
```

```
voclabs:~/environment/pip-aws-sncf-regularities (main) $ python3 3-python-clean-script.py
Cleaned files saved as: trains_france_clean.parquet
Original size: 3230102 bytes
Cleaned file size: 243213 bytes
Gain: 92.47% lighter
```

Étapes de construction et exécution de la pipeline



Les KPIs

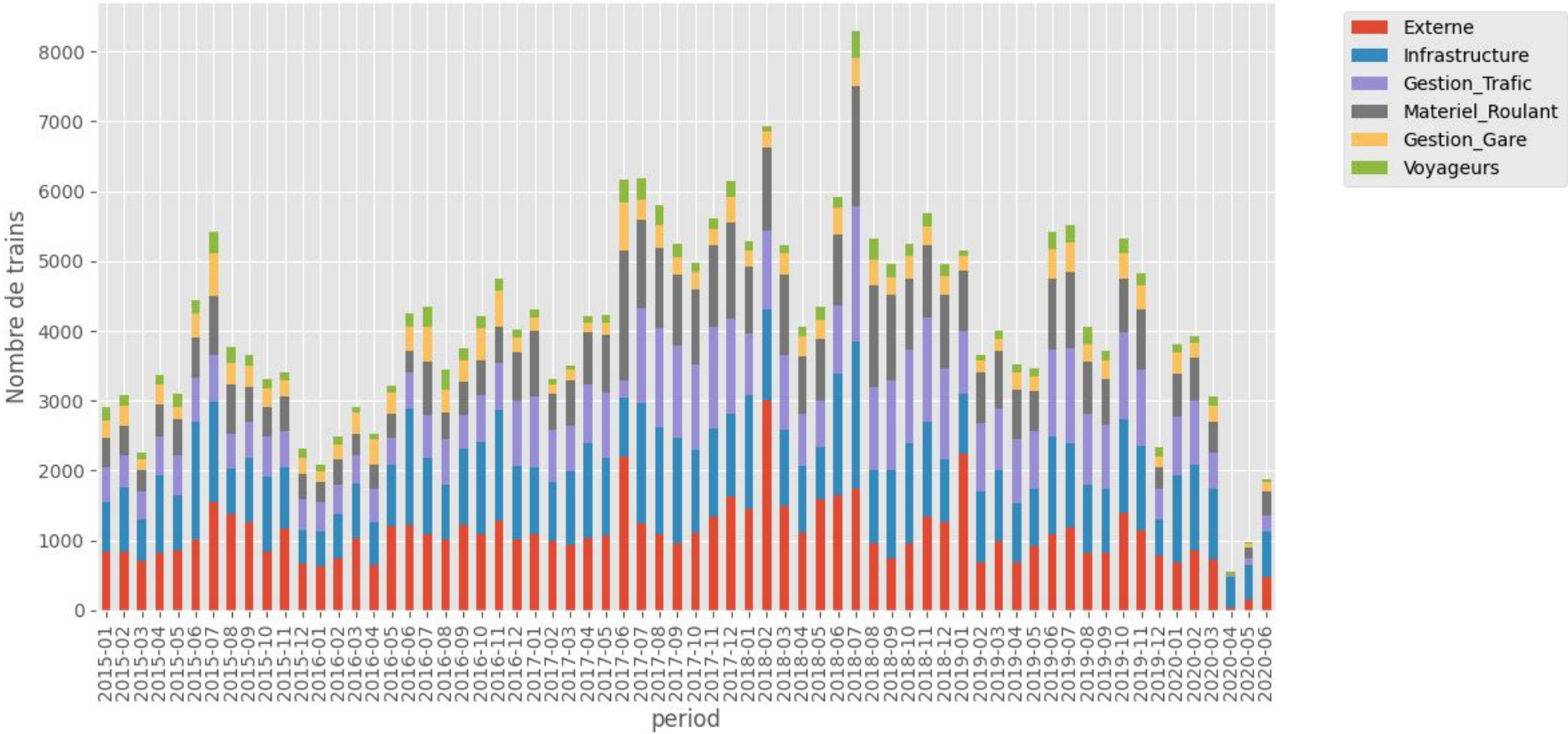
1. Distribution des raisons de délais (retards) en fonction du nombre totale de retards à l'arrivée, groupé par période
2. Distribution des horaires de retards en fonction du nombre totale de retards à l'arrivée, groupé par période
3. Comparaison du nombre de train en retard par rapport au nombre de train prévus
4. Comparaison des lignes ayant le plus de retard (cumul)

Ressources

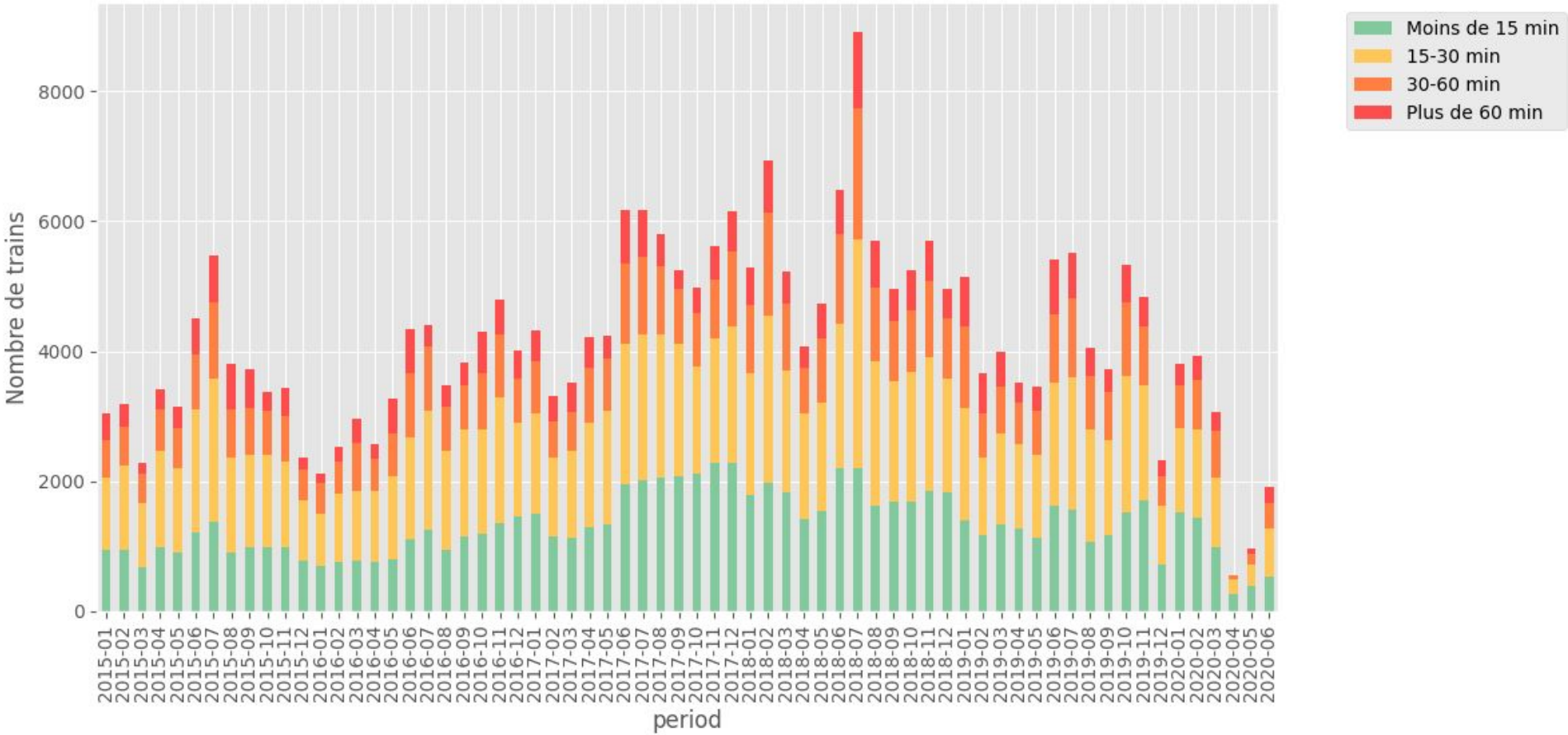
Repo GitHub :
https://github.com/BlooSkyd/pip-aws-sncf-regularities

Dataset :
https://www.kaggle.com/datasets/gatandubuc/public-transport-traffic-data-in-france

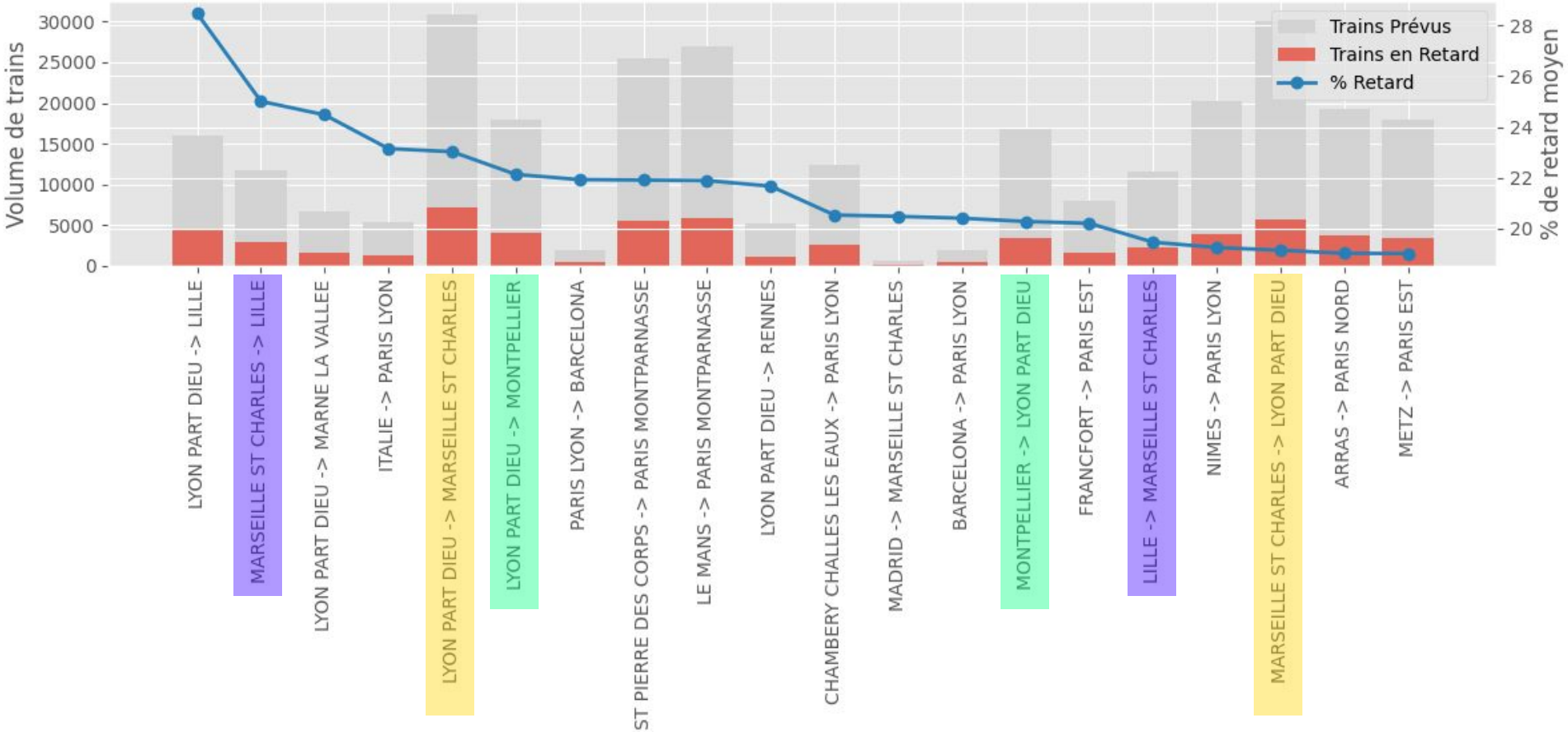
Distribution des causes de retards par période



Sévérité des retards par période



Comparaison Volume vs. Taux de retard (top 20)



Lignes les plus problématiques (en volume, top 20)