TP1 - Exploration et transformation des données

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In [141…
```
import pandas as pd
import numpy as np
import seaborn as sns
from scipy.stats import chi2_contingency
import matplotlib.pyplot as plt
import time
```

Étape 1 : On considère le fichier train_users_2.csv

- Indiquer les points marquants l'exploration.
- Pour chaque observation, indiquer l'opération à effectuer qui serait la plus appropriée.

In [141…
```
df = pd.read_csv('train_users_2.csv', index_col=0)
```

In [141…
```
print('\nAffichage du dataset\n')
display(df.head(10))
```

```
Affichage du dataset
```

id	date_account_created	timestamp_first_active	date_first_booking	gender	age	signup_method	signup_flow	langu
gxn3p5htnn	2010-06-28	20090319043255	NaN	-unknown-	NaN	facebook	0	
820tgsjxq7	2011-05-25	20090523174809	NaN	MALE	38.0	facebook	0	
4ft3gnwmtx	2010-09-28	20090609231247	2010-08-02	FEMALE	56.0	basic	3	
bjjt8pjhuk	2011-12-05	20091031060129	2012-09-08	FEMALE	42.0	facebook	0	
87mebub9p4	2010-09-14	20091208061105	2010-02-18	-unknown-	41.0	basic	0	
osr2jwljor	2010-01-01	20100101215619	2010-01-02	-unknown-	NaN	basic	0	
lsw9q7uk0j	2010-01-02	20100102012558	2010-01-05	FEMALE	46.0	basic	0	
0d01nltbrs	2010-01-03	20100103191905	2010-01-13	FEMALE	47.0	basic	0	
a1vcnhxeij	2010-01-04	20100104004211	2010-07-29	FEMALE	50.0	basic	0	
6uh8zyj2gn	2010-01-04	20100104023758	2010-01-04	-unknown-	46.0	basic	0	

1.1. Quels sont les descripteurs (colonnes) du dataset?

In [141…

```
print("Les descripteurs du dataset:")
print(df.columns.tolist())
```

```
Les descripteurs du dataset:
['date_account_created', 'timestamp_first_active', 'date_first_booking', 'gender', 'age', 'signup_method', 's
ignup_flow', 'language', 'affiliate_channel', 'affiliate_provider', 'first_affiliate_tracked', 'signup_app',
'first_device_type', 'first_browser', 'country_destination']
```

1.2. Combien d'enregistrements (lignes) ont été fournis ?

In [141…

```
nombre_enregistrements = df.shape[0]
print("Le nombre d'enregistrements:",nombre_enregistrements)
```

```
Le nombre d'enregistrements: 213451
```

1.3. Quel est le format des données. Par exemple, dans quel format les dates sont fournies, existe-t-il des valeurs numériques, à quoi ressemblent les différentes valeurs catégorielles ?

In [141…
```
print(df.info())
```

```
<class 'pandas.core.frame.DataFrame'>
Index: 213451 entries, gxn3p5htnn to nw9fwlyb5f
Data columns (total 15 columns):
 #   Column                   Non-Null Count   Dtype
---  ------                   --------------   -----
 0   date_account_created     213451 non-null  object
 1   timestamp_first_active   213451 non-null  int64
 2   date_first_booking       88908 non-null   object
 3   gender                   213451 non-null  object
 4   age                      125461 non-null  float64
 5   signup_method            213451 non-null  object
 6   signup_flow              213451 non-null  int64
 7   language                 213451 non-null  object
 8   affiliate_channel        213451 non-null  object
 9   affiliate_provider       213451 non-null  object
 10  first_affiliate_tracked  207386 non-null  object
 11  signup_app               213451 non-null  object
 12  first_device_type        213451 non-null  object
 13  first_browser            213451 non-null  object
 14  country_destination      213451 non-null  object
dtypes: float64(1), int64(2), object(12)
memory usage: 26.1+ MB
None
```

Les données de types date: 'date_account_created', 'timestamp_first_active', 'date_first_booking'</br> Les données numériques: 'age', 'signup_flow'</br> Les données categorielles: 'gender', 'signup_method', 'language', 'affiliate_channel', 'affiliate_provider', 'first_affiliate_tracked', 'signup_app', 'first_device_type', 'first_browser', 'country_destination'</br></br>

Les dates sont de types objet et int. elles seront converties en type datetime (format ci-dessous) pour en extraire proprement les champs</br> 'date_account_created' utilise le format 'YYYY-MM-DD'</br> 'timestamp_first_active' utilise le format 'YYYYMMDDhhmmss'</br> 'date_first_booking' utilise le format 'YYYY-MM-DD'</br></br>

In [142…
```
cols = ['gender', 'signup_method', 'signup_flow', 'language', 'affiliate_channel', 'affiliate_provider', 'fir

print('Ci-dessous les valeurs catégorielles:\n')
for col in cols:
```

```
    print(col,':', df[col].unique(), '\n')
```

```
Ci-dessous les valeurs catégorielles:

gender : ['-unknown-' 'MALE' 'FEMALE' 'OTHER']

signup_method : ['facebook' 'basic' 'google']

signup_flow : [ 0  3  2  1 24  8  6  5 10 25 12  4 16 15 20 21 23]

language : ['en' 'fr' 'de' 'es' 'it' 'pt' 'zh' 'ko' 'ja' 'ru' 'pl' 'el' 'sv' 'nl'
 'hu' 'da' 'id' 'fi' 'no' 'tr' 'th' 'cs' 'hr' 'ca' 'is']

affiliate_channel : ['direct' 'seo' 'other' 'sem-non-brand' 'content' 'sem-brand'
 'remarketing' 'api']

affiliate_provider : ['direct' 'google' 'other' 'craigslist' 'facebook' 'vast' 'bing' 'meetup'
 'facebook-open-graph' 'email-marketing' 'yahoo' 'padmapper' 'gsp' 'wayn'
 'naver' 'baidu' 'yandex' 'daum']

first_affiliate_tracked : ['untracked' 'omg' nan 'linked' 'tracked-other' 'product' 'marketing'
 'local ops']

signup_app : ['Web' 'Moweb' 'iOS' 'Android']

first_device_type : ['Mac Desktop' 'Windows Desktop' 'iPhone' 'Other/Unknown'
 'Desktop (Other)' 'Android Tablet' 'iPad' 'Android Phone'
 'SmartPhone (Other)']

first_browser : ['Chrome' 'IE' 'Firefox' 'Safari' '-unknown-' 'Mobile Safari'
 'Chrome Mobile' 'RockMelt' 'Chromium' 'Android Browser' 'AOL Explorer'
 'Palm Pre web browser' 'Mobile Firefox' 'Opera' 'TenFourFox' 'IE Mobile'
 'Apple Mail' 'Silk' 'Camino' 'Arora' 'BlackBerry Browser' 'SeaMonkey'
 'Iron' 'Sogou Explorer' 'IceWeasel' 'Opera Mini' 'SiteKiosk' 'Maxthon'
 'Kindle Browser' 'CoolNovo' 'Conkeror' 'wOSBrowser' 'Google Earth'
 'Crazy Browser' 'Mozilla' 'OmniWeb' 'PS Vita browser' 'NetNewsWire'
 'CometBird' 'Comodo Dragon' 'Flock' 'Pale Moon' 'Avant Browser'
 'Opera Mobile' 'Yandex.Browser' 'TheWorld Browser' 'SlimBrowser' 'Epic'
 'Stainless' 'Googlebot' 'Outlook 2007' 'IceDragon']

country_destination : ['NDF' 'US' 'other' 'FR' 'CA' 'GB' 'ES' 'IT' 'PT' 'NL' 'DE' 'AU']
```

1.4. Y a-t-il des valeurs manquantes?

In [142…
```
print("Valeurs manquantes par colonne:\n")
print(df.isnull().sum())
```

```
Valeurs manquantes par colonne:

date_account_created            0
timestamp_first_active          0
date_first_booking         124543
gender                          0
age                         87990
signup_method                   0
signup_flow                     0
language                        0
affiliate_channel               0
affiliate_provider              0
first_affiliate_tracked      6065
signup_app                      0
first_device_type               0
first_browser                   0
country_destination             0
dtype: int64
date_account_created            0
timestamp_first_active          0
date_first_booking         124543
gender                          0
age                         87990
signup_method                   0
signup_flow                     0
language                        0
affiliate_channel               0
affiliate_provider              0
first_affiliate_tracked      6065
signup_app                      0
first_device_type               0
first_browser                   0
country_destination             0
dtype: int64
```

1.5. Est-ce qu'il y'a des dépendances évidentes au niveau des descripteurs?

Oui, il peut exister des dépendances entre certains descripteurs. Par exemple, entre:</br>

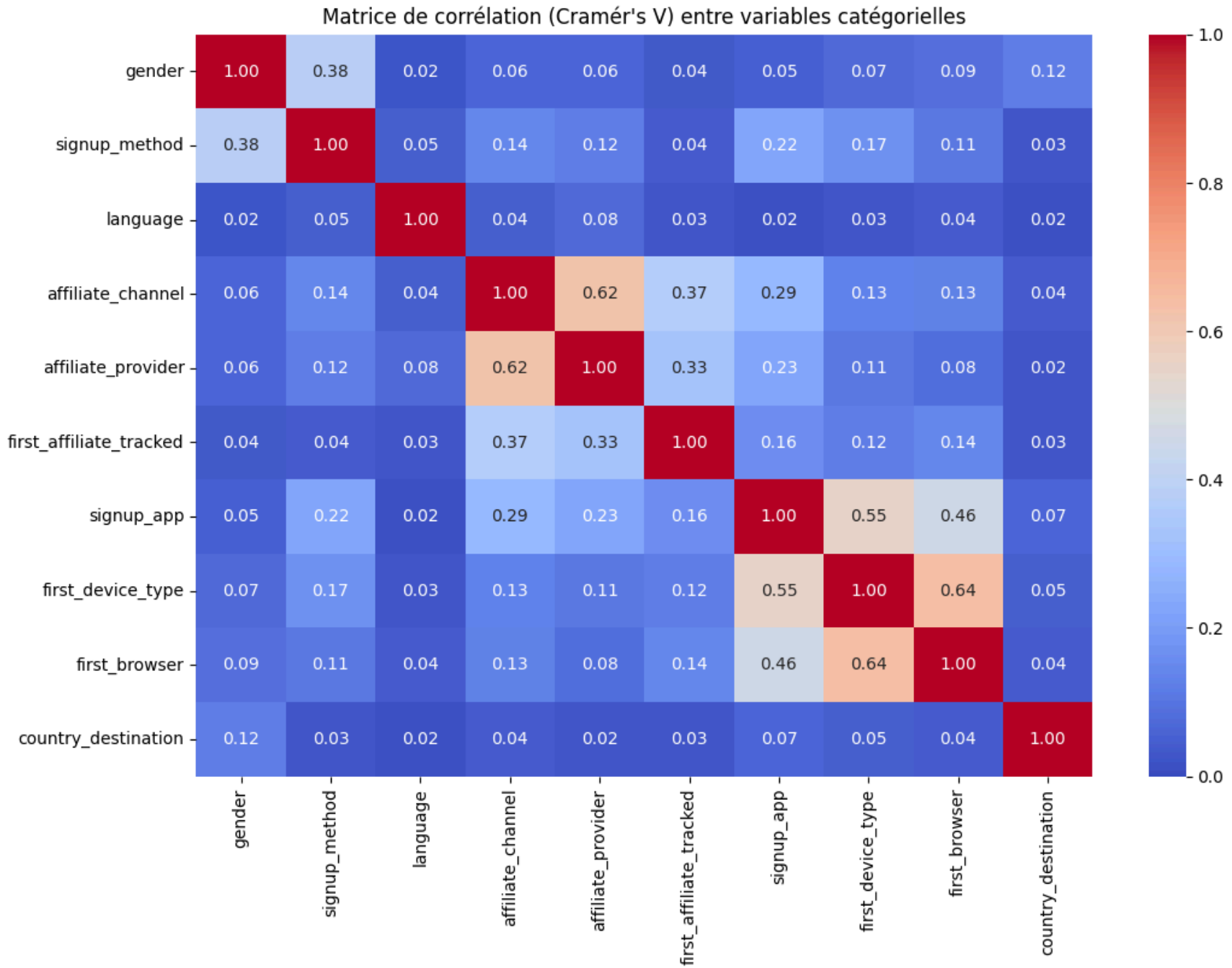
- ('language', 'country_destination'): Un utilisateur qui s'inscrit avec la langue française a plus de chances de reserver en France
- ('date_account_created', 'timestamp_first_active', 'date_first_booking'): 'date_account_created' est toujours antérieure à 'timestamp_first_active' et 'date_first_booking' est toujours postérieure aux deux premières dates.
- ('first_device_type', 'first_browser'): certains types d'appareils influencent fortement le navigateur utilisé
- ('affiliate_provider', 'affiliate_channel'): certains providers peuvent privilégier certains canaux.
  Nous allons validé ces dépendances à l'aide ds matrices de corrélations ci-dessous

Corrélations entre variables qualitatives

In [142…

```
categorical_columns = [
    'gender', 'signup_method', 'language', 'affiliate_channel','affiliate_provider', 'first_affiliate_tracked
]

# Fonction pour calculer le coefficient de Cramér
def cramers_v(x, y):
    confusion_matrix = pd.crosstab(x, y)
    chi2 = chi2_contingency(confusion_matrix)[0]
    n = confusion_matrix.sum().sum()
    phi2 = chi2 / n
    r, k = confusion_matrix.shape
    phi2corr = max(0, phi2 - ((k-1)*(r-1))/(n-1))
    rcorr = r - ((r-1)**2)/(n-1)
    kcorr = k - ((k-1)**2)/(n-1)
    return np.sqrt(phi2corr / min((kcorr-1), (rcorr-1)))

# Créer une matrice de corrélation
correlation_matrix = pd.DataFrame(index=categorical_columns, columns=categorical_columns)

# Remplir la matrice avec les coefficients de Cramér
for col1 in categorical_columns:
    for col2 in categorical_columns:
        correlation_matrix.loc[col1, col2] = cramers_v(df[col1], df[col2])

# Convertir la matrice en valeurs numériques
correlation_matrix = correlation_matrix.astype(float)

# Afficher la matrice de corrélation avec une heatmap
plt.figure(figsize=(12, 8))
sns.heatmap(correlation_matrix, annot=True, cmap='coolwarm', fmt=".2f", vmin=0, vmax=1)
```

```
plt.title("Matrice de corrélation (Cramér's V) entre variables catégorielles")
plt.show()
```



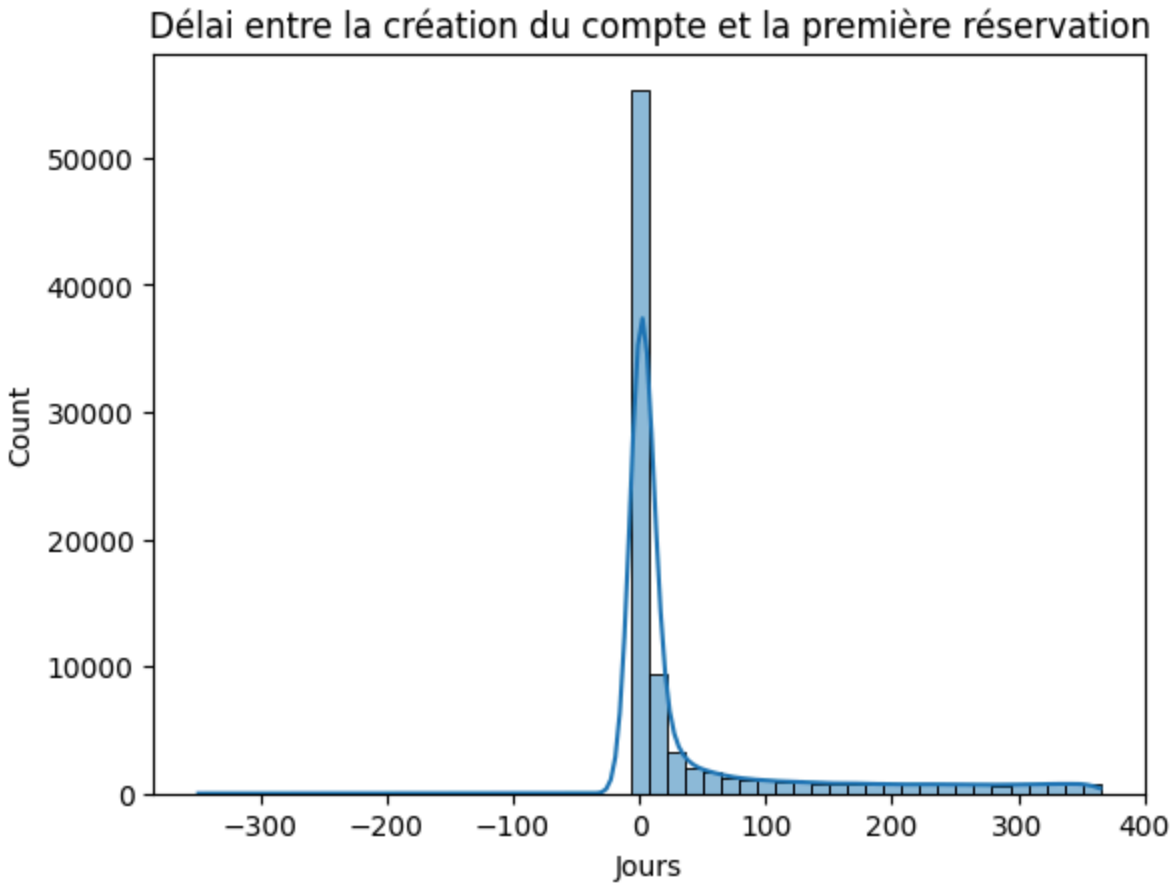
La matrice de corrélation met en lumière les dépendances mentionnées précédemment

Corrélations entre variables numériques

In [142…

```
df_original = df.copy()
# Vérifier les dépendances temporelles
# Vérifier que les timestamps sont bien ordonnés
df["date_account_created"] = pd.to_datetime(df["date_account_created"]) #Convesion de la colonne "date_accoun

# Conversion de la colonne 'date_account_created' en datetime si ce n'est pas déjà fait
df["timestamp_first_active"] = pd.to_datetime(df["timestamp_first_active"], format='%Y%m%d%H%M%S')
df["date_first_booking"] = pd.to_datetime(df["date_first_booking"])

# Vérifier si `timestamp_first_active` est toujours avant ou égal à `date_account_created`
df["timestamp_issue"] = df["timestamp_first_active"] > df["date_account_created"]
print("Nombre de cas où `timestamp_first_active` est postérieur à `date_account_created` :", df["timestamp_is

# Visualiser l'écart entre `date_account_created` et `date_first_booking`
df["booking_delay"] = (df["date_first_booking"] - df["date_account_created"]).dt.days
sns.histplot(df["booking_delay"].dropna(), bins=50, kde=True)
plt.title("Délai entre la création du compte et la première réservation")
plt.xlabel("Jours")
plt.show()

print('Dataset avec dates converties:\n')
display(df)
```

```
Nombre de cas où `timestamp_first_active` est postérieur à `date_account_created` : 213273
```



Dataset avec dates converties:

id	date_account_created	timestamp_first_active	date_first_booking	gender	age	signup_method	signup_flow	langu
gxn3p5htnn	2010-06-28	2009-03-19 04:32:55	NaT	-unknown-	NaN	facebook	0	
820tgsjxq7	2011-05-25	2009-05-23 17:48:09	NaT	MALE	38.0	facebook	0	
4ft3gnwmtx	2010-09-28	2009-06-09 23:12:47	2010-08-02	FEMALE	56.0	basic	3	
bjjt8pjhuk	2011-12-05	2009-10-31 06:01:29	2012-09-08	FEMALE	42.0	facebook	0	
87mebub9p4	2010-09-14	2009-12-08 06:11:05	2010-02-18	-unknown-	41.0	basic	0	
...	...	...	...	...	...	...	...	
zxodksqpep	2014-06-30	2014-06-30 23:56:36	NaT	MALE	32.0	basic	0	
mhewnxesx9	2014-06-30	2014-06-30 23:57:19	NaT	-unknown-	NaN	basic	0	
6o3arsjbb4	2014-06-30	2014-06-30 23:57:54	NaT	-unknown-	32.0	basic	0	
jh95kwisub	2014-06-30	2014-06-30 23:58:22	NaT	-unknown-	NaN	basic	25	
nw9fwlyb5f	2014-06-30	2014-06-30 23:58:24	NaT	-unknown-	NaN	basic	25	

213451 rows × 17 columns

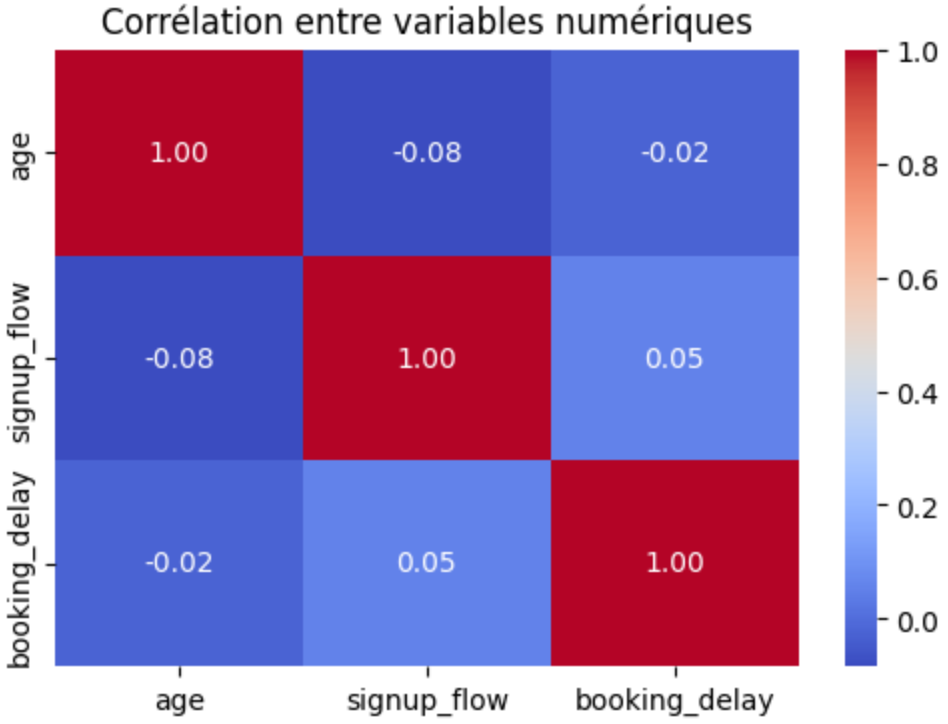
Si timestamp_first_active est après date_account_created, il y a un problème dans les données.</br> La distribution des délais de réservation permet de voir combien de temps les utilisateurs attendent avant leur première réservation.

In [142…

```
# Convertir l'âge en numérique et traiter les valeurs aberrantes
df["age"] = pd.to_numeric(df["age"], errors="coerce")
df_FilteredAge = df[(df["age"] > 17) & (df["age"] <= 120)]  # Filtrer des âges aberrants
display(df_FilteredAge['age'])

# Matrice de corrélation
num_vars = ["age", "signup_flow", "booking_delay"]
corr_matrix = df_FilteredAge[num_vars].corr()

# Affichage
```

```
plt.figure(figsize=(6, 4))
sns.heatmap(corr_matrix, annot=True, cmap="coolwarm", fmt=".2f")
plt.title("Corrélation entre variables numériques")
plt.show()
```

```
id
820tgsjxq7    38.0
4ft3gnwmtx    56.0
bjjt8pjhuk    42.0
87mebub9p4    41.0
lsw9q7uk0j    46.0
              ...
omlc9iku7t    34.0
0k26r3mir0    36.0
qbxza0xojf    23.0
zxodksqpep    32.0
6o3arsjbb4    32.0
Name: age, Length: 124522, dtype: float64
```



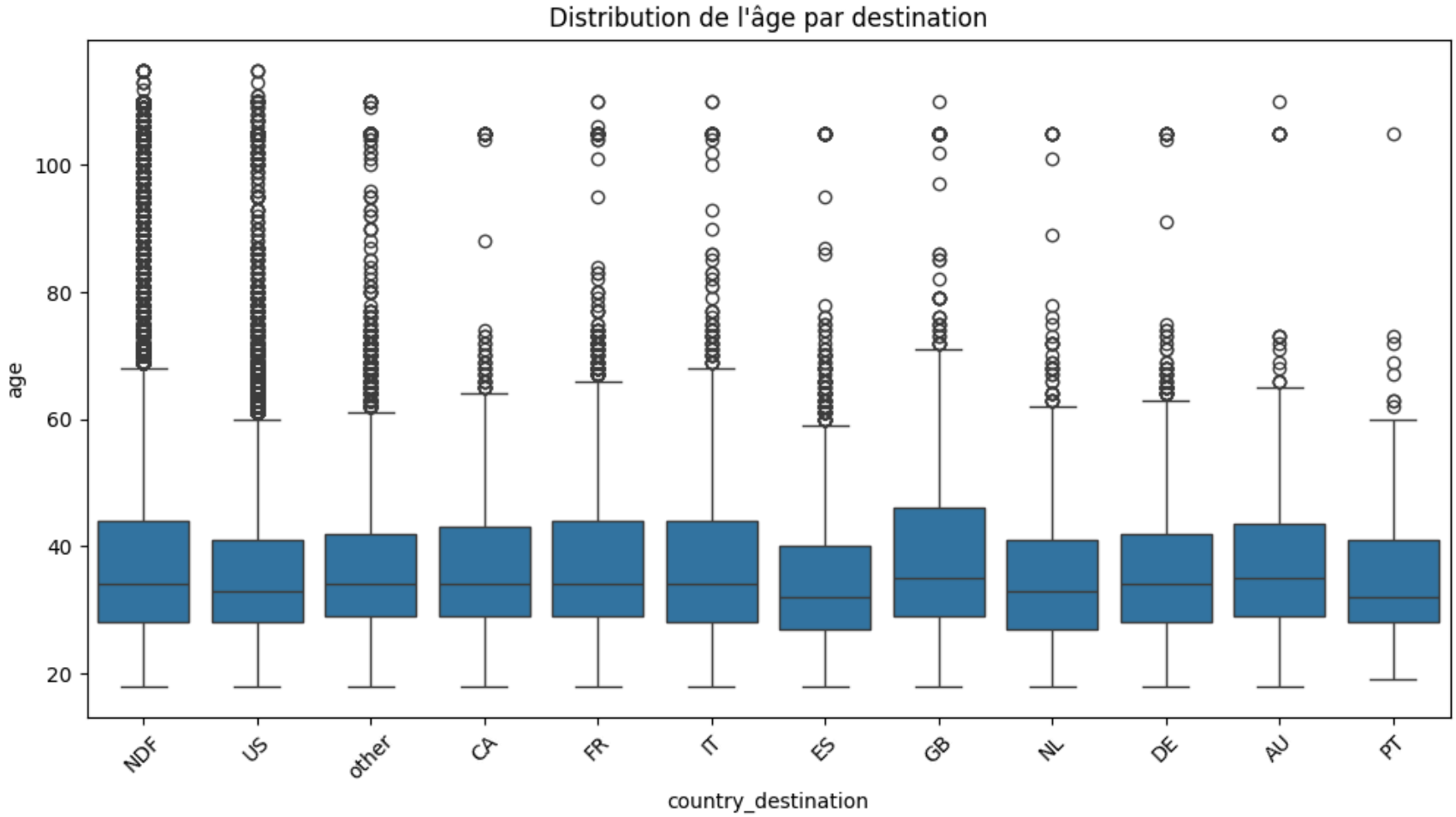
La matrice de corrélation montre qu'il n'y a pas de dépendances entre les variables quantitatives

1.6. D'autres observations sur le dataset qui pourraient être pertinentes ?

Boxplot de l'âge en fonction du pays de destination

In [142…

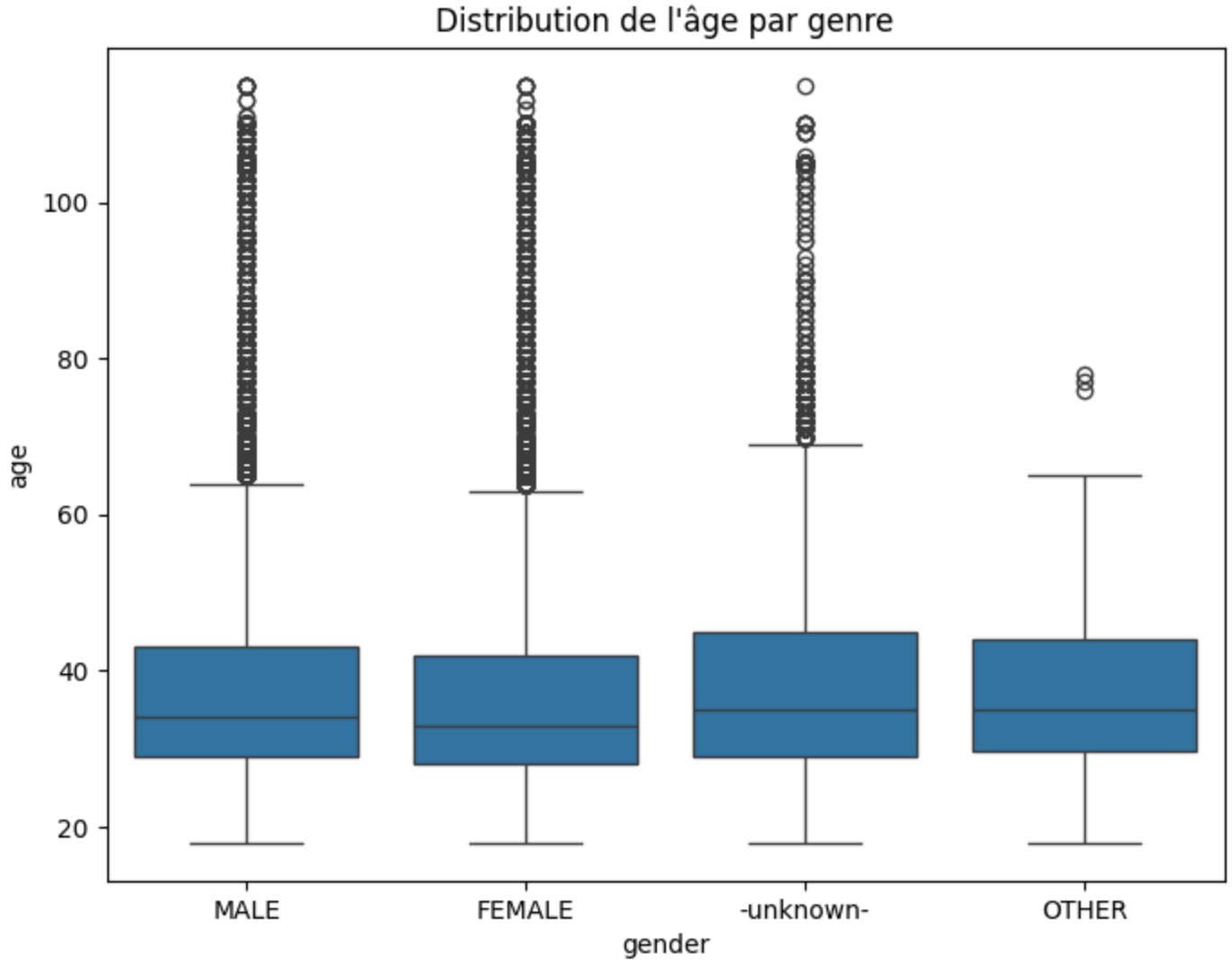
```
#L'âge semble être la seule variable continue intéressante pour un boxplot.
plt.figure(figsize=(12, 6))
sns.boxplot(x="country_destination", y="age", data=df_FilteredAge)
plt.xticks(rotation=45)
plt.title("Distribution de l'âge par destination")
plt.show()
```



Boxplot de l'âge selon le sexe :

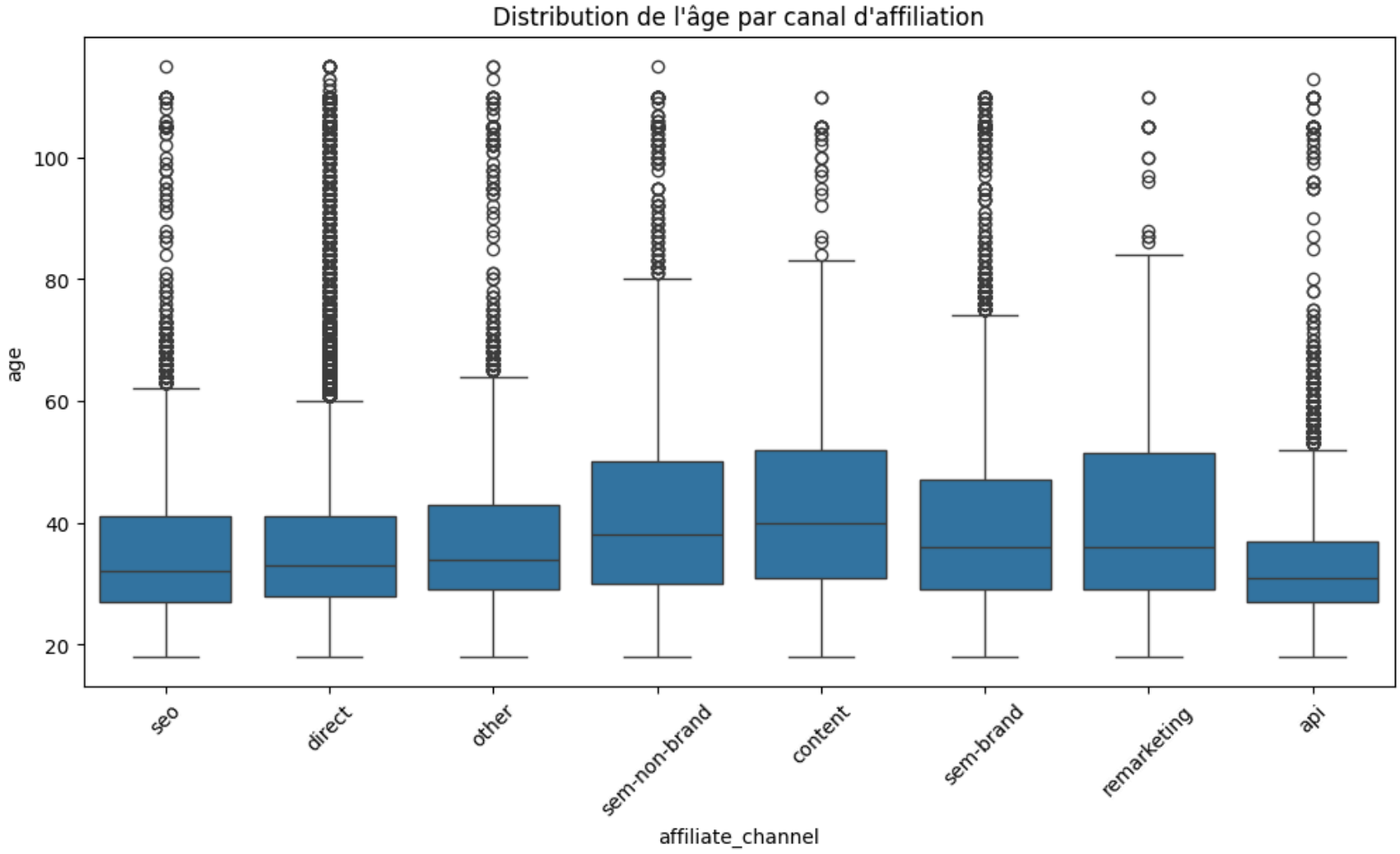
In [142…

```
plt.figure(figsize=(8, 6))
sns.boxplot(x="gender", y="age", data=df_FilteredAge)
plt.title("Distribution de l'âge par genre")
plt.show()
```



Boxplot de l'âge selon le canal d'affiliation :

In [142…
```
plt.figure(figsize=(12, 6))
sns.boxplot(x="affiliate_channel", y="age", data=df_FilteredAge)
plt.xticks(rotation=45)
plt.title("Distribution de l'âge par canal d'affiliation")
plt.show()
```



Détection des valeurs aberrantes de l'âge (outliers)

In [142…
```
Q1 = df['age'].quantile(0.25)
Q3 = df['age'].quantile(0.75)
```

```
IQR = Q3 - Q1

outliers = df[(df['age'] < (Q1 - 1.5 * IQR)) | (df['age'] > (Q3 + 1.5 * IQR))]
display(outliers[['age']])  # Liste des outliers
```

id	age
dgatsm5ocq	69.0
3qsa4lo7eg	5.0
47wdhtdini	72.0
uhbkw5exeg	70.0
kw7qyvlhsq	70.0
...	...
pw9nfo1ulb	95.0
y37l7vzjpa	66.0
jl5f10hu4t	69.0
gfend4omwv	105.0
l8tltghomx	69.0

5594 rows × 1 columns

In [142…

```
print(df['age'].describe())
```

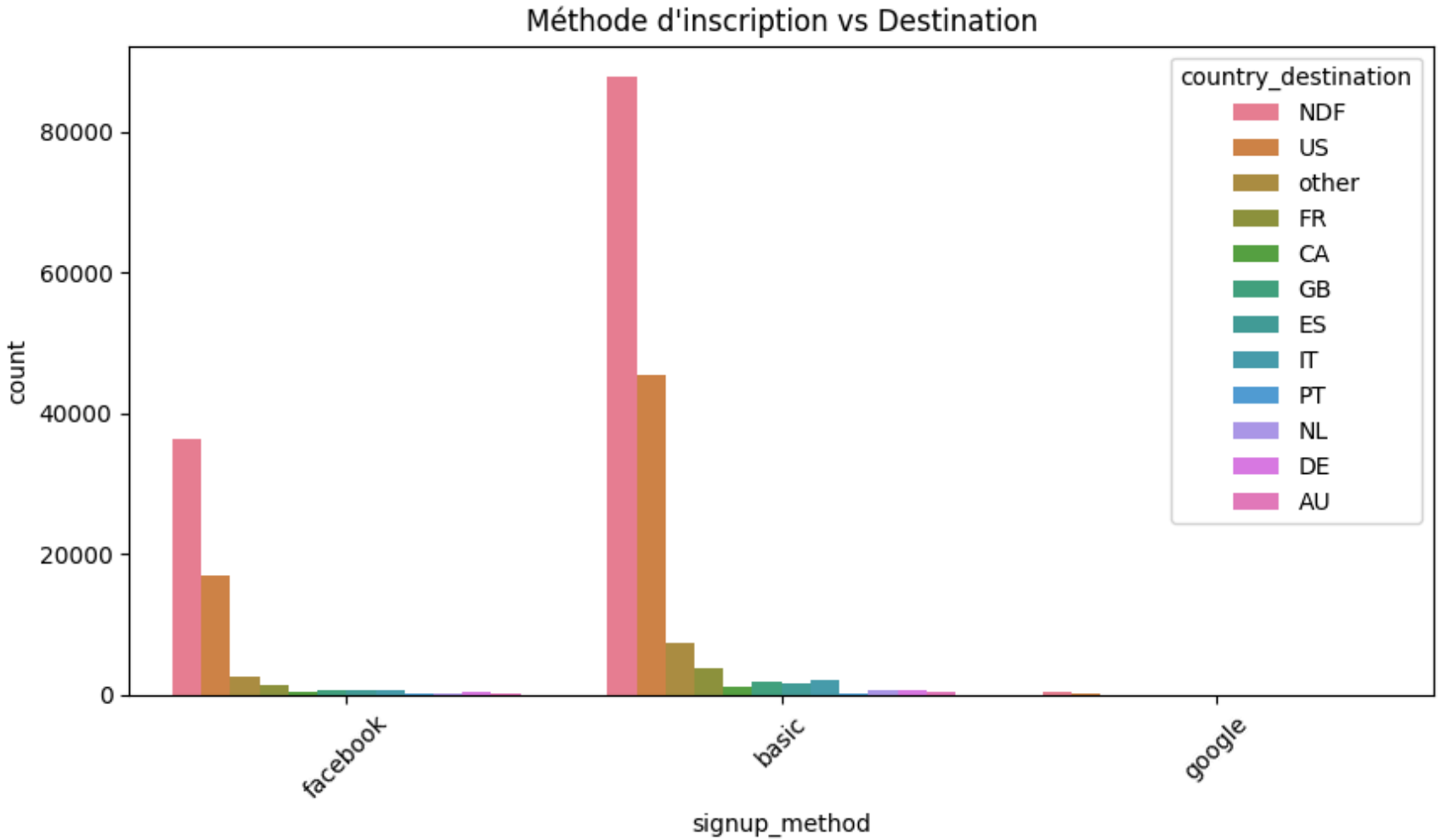
```
count    125461.000000
mean         49.668335
std         155.666612
min           1.000000
25%          28.000000
50%          34.000000
75%          43.000000
max        2014.000000
Name: age, dtype: float64
```

On constate que la colonne 'age' contient des données abbérantes. Nous ferons un filtrage á l'étape 2.

Relations entre variables catégorielles

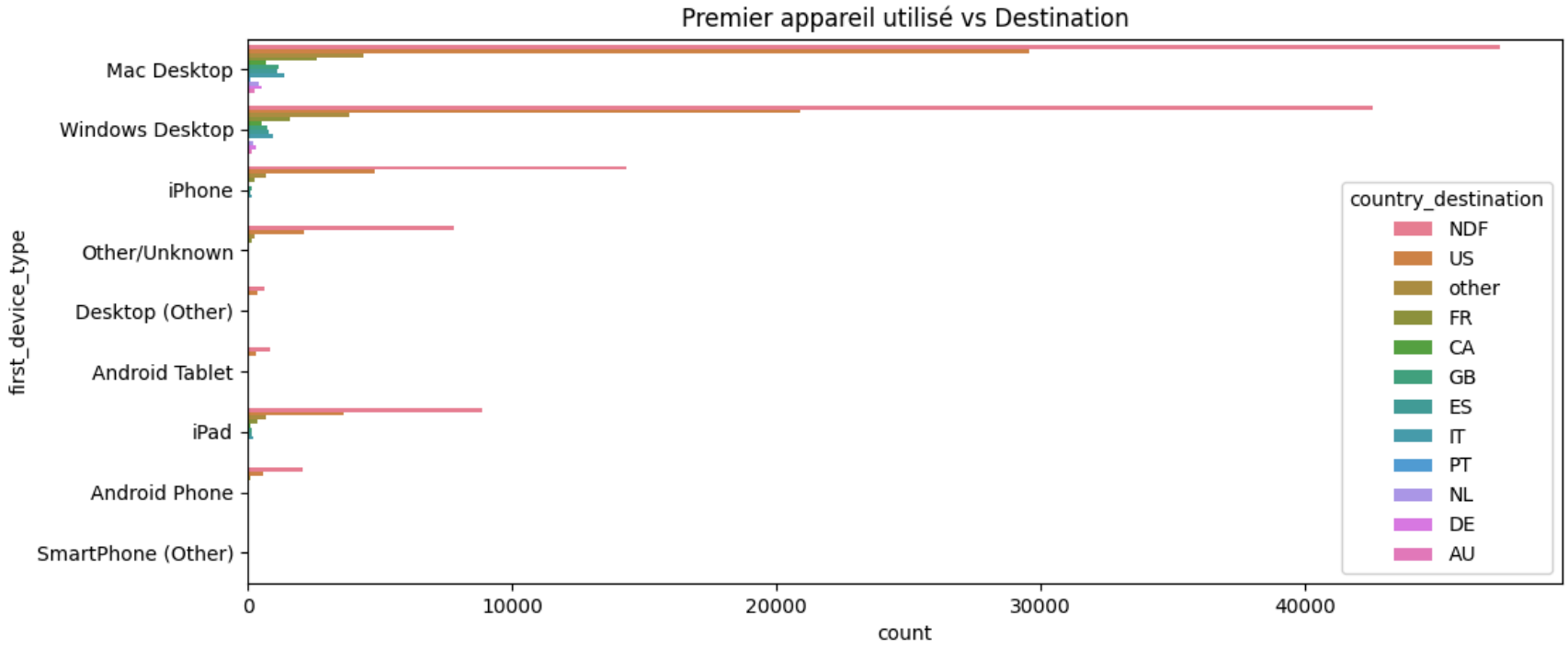
In [143…

```
#Impact de signup_method sur country_destination
plt.figure(figsize=(10, 5))
sns.countplot(data=df, x="signup_method", hue="country_destination")
plt.title("Méthode d'inscription vs Destination")
plt.xticks(rotation=45)
plt.show()
```



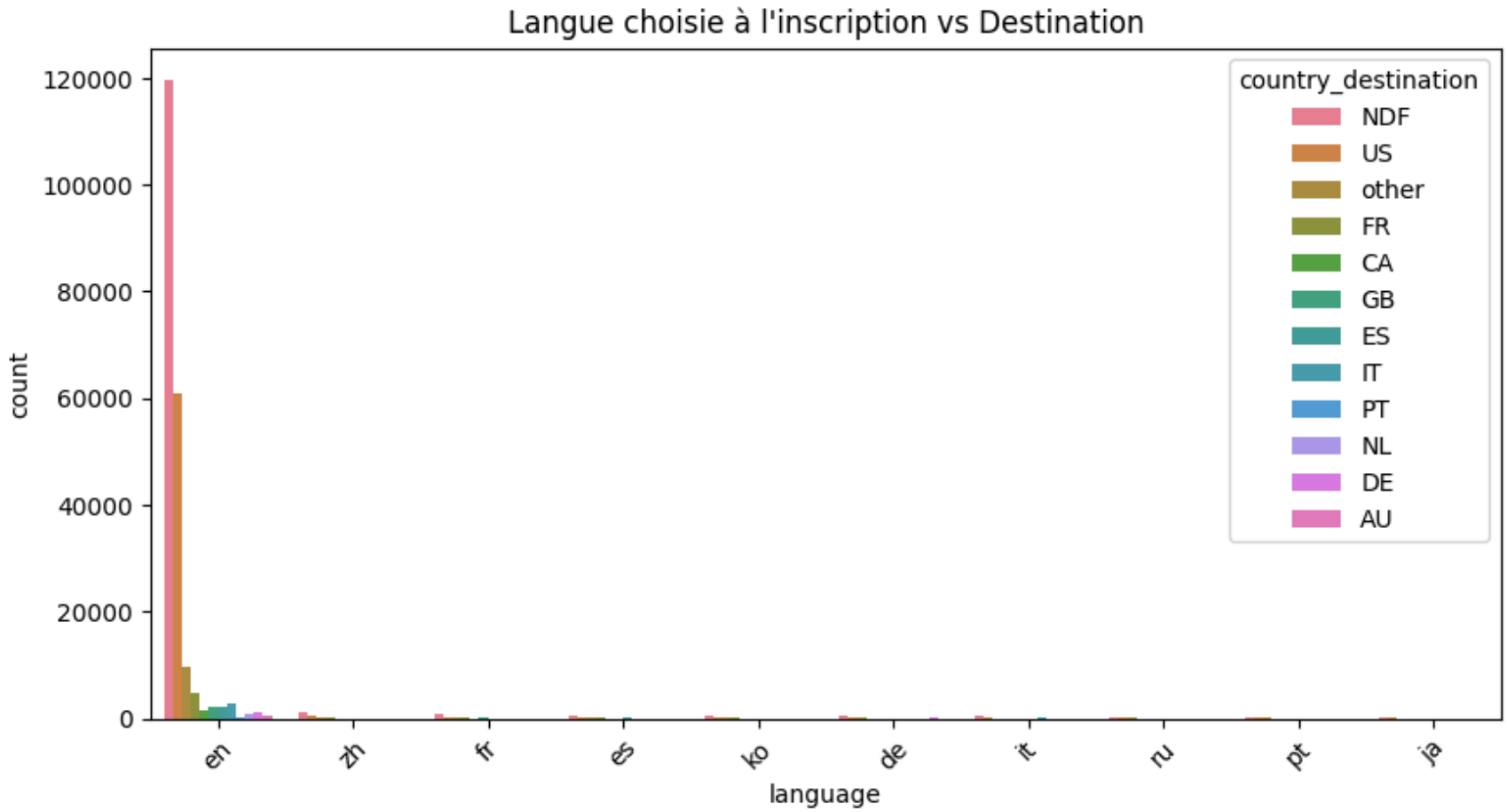
Certains modes d'inscription sont peut-être plus populaires pour certaines destinations. Par exemple, les utilisateurs inscrits via Google ou Facebook peuvent être différents de ceux inscrits par email.

In [143…
```
#Influence de first_device_type sur country_destination
plt.figure(figsize=(12, 5))
sns.countplot(data=df, y="first_device_type", hue="country_destination")
plt.title("Premier appareil utilisé vs Destination")
plt.show()
```



On constate que les utilisateurs mobiles (iPhone, Android) réservent plus rapidement que ceux sur ordinateur

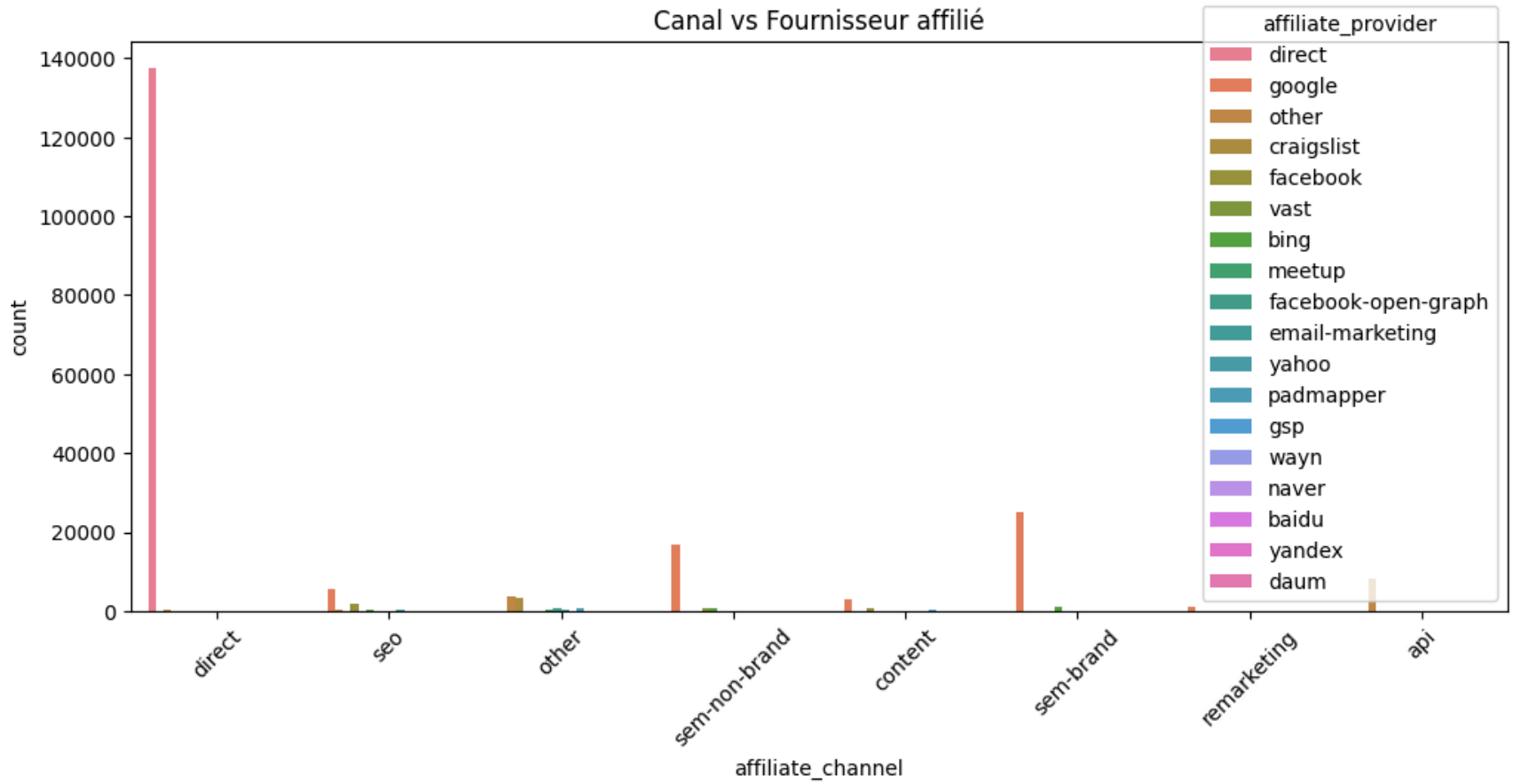
In [143…
```
#Langue (language) et destination
plt.figure(figsize=(10, 5))
sns.countplot(data=df, x="language", hue="country_destination", order=df["language"].value_counts().index[:10
plt.title("Langue choisie à l'inscription vs Destination")
plt.xticks(rotation=45)
plt.show()
```



On confirme que La langue d'inscription influence la destination finale

In [143…

```
# Vérifier les relations entre affiliés
plt.figure(figsize=(12, 5))
sns.countplot(data=df, x="affiliate_channel", hue="affiliate_provider")
plt.title("Canal vs Fournisseur affilié")
plt.xticks(rotation=45)
plt.show()
```



Le diagramme ci-dessus confirme que certains fournisseurs affiliés sont spécialisés dans certains canaux de conversion

Étape 2 : On considère le fichier train_users_2.csv et test_users.csv

- Implémenter les correctifs soulignés dans l'étape 1.

In [143…

```
import pandas as pd
import numpy as np
from sklearn.ensemble import RandomForestRegressor
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split


df = df_original.copy()
```

```
df_test = pd.read_csv('test_users.csv', index_col=0)

print("Données de Train:")
display(df)

print("Données de Test:")
display(df_test)
```

```
Données de Train:
```

id	date_account_created	timestamp_first_active	date_first_booking	gender	age	signup_method	signup_flow	langu
gxn3p5htnn	2010-06-28	20090319043255	NaN	-unknown-	NaN	facebook	0	
820tgsjxq7	2011-05-25	20090523174809	NaN	MALE	38.0	facebook	0	
4ft3gnwmtx	2010-09-28	20090609231247	2010-08-02	FEMALE	56.0	basic	3	
bjjt8pjhuk	2011-12-05	20091031060129	2012-09-08	FEMALE	42.0	facebook	0	
87mebub9p4	2010-09-14	20091208061105	2010-02-18	-unknown-	41.0	basic	0	
...	...	...	...	...	...	...	...	
zxodksqpep	2014-06-30	20140630235636	NaN	MALE	32.0	basic	0	
mhewnxesx9	2014-06-30	20140630235719	NaN	-unknown-	NaN	basic	0	
6o3arsjbb4	2014-06-30	20140630235754	NaN	-unknown-	32.0	basic	0	
jh95kwisub	2014-06-30	20140630235822	NaN	-unknown-	NaN	basic	25	
nw9fwlyb5f	2014-06-30	20140630235824	NaN	-unknown-	NaN	basic	25	

213451 rows × 15 columns

```
Données de Test:
```

id	date_account_created	timestamp_first_active	date_first_booking	gender	age	signup_method	signup_flow	langua
5uwns89zht	2014-07-01	20140701000006	NaN	FEMALE	35.0	facebook	0	
jtl0dijy2j	2014-07-01	20140701000051	NaN	-unknown-	NaN	basic	0	
xx0ulgorjt	2014-07-01	20140701000148	NaN	-unknown-	NaN	basic	0	
6c6puo6ix0	2014-07-01	20140701000215	NaN	-unknown-	NaN	basic	0	
czqhjk3yfe	2014-07-01	20140701000305	NaN	-unknown-	NaN	basic	0	
...	...	...	...	...	...	...	...	
cv0na2lf5a	2014-09-30	20140930235232	NaN	-unknown-	31.0	basic	0	
zp8xfonng8	2014-09-30	20140930235306	NaN	-unknown-	NaN	basic	23	
fa6260ziny	2014-09-30	20140930235408	NaN	-unknown-	NaN	basic	0	
87k0fy4ugm	2014-09-30	20140930235430	NaN	-unknown-	NaN	basic	0	
9uqfg8txu3	2014-09-30	20140930235901	NaN	FEMALE	49.0	basic	0	

62096 rows × 14 columns

* Existance les doublons

In [143…
```
print("Doublons dans les doneées de train:", df.duplicated().unique())
print("Doublons dans les doneées de test:", df_test.duplicated().unique())
```

```
Doublons dans les doneées de train: [False]
Doublons dans les doneées de test: [False]
```

2.1. Conversion de type/format (les dates)

* Dataset de Training

In [143…
```
df['date_account_created'] = pd.to_datetime(df['date_account_created'])
df['timestamp_first_active'] = pd.to_datetime(df['timestamp_first_active'], format='%Y%m%d%H%M%S')

df.drop(['date_first_booking'], axis=1, inplace=True) # Supprimer la colonne 'date_first_booking' car elle es

display(df)
```

id	date_account_created	timestamp_first_active	gender	age	signup_method	signup_flow	language	affiliate_channe
gxn3p5htnn	2010-06-28	2009-03-19 04:32:55	-unknown-	NaN	facebook	0	en	direc
820tgsjxq7	2011-05-25	2009-05-23 17:48:09	MALE	38.0	facebook	0	en	se
4ft3gnwmtx	2010-09-28	2009-06-09 23:12:47	FEMALE	56.0	basic	3	en	direc
bjjt8pjhuk	2011-12-05	2009-10-31 06:01:29	FEMALE	42.0	facebook	0	en	direc
87mebub9p4	2010-09-14	2009-12-08 06:11:05	-unknown-	41.0	basic	0	en	direc
...	...	...	...	...	...	...	...	.
zxodksqpep	2014-06-30	2014-06-30 23:56:36	MALE	32.0	basic	0	en	sem-bran
mhewnxesx9	2014-06-30	2014-06-30 23:57:19	-unknown-	NaN	basic	0	en	direc
6o3arsjbb4	2014-06-30	2014-06-30 23:57:54	-unknown-	32.0	basic	0	en	direc
jh95kwisub	2014-06-30	2014-06-30 23:58:22	-unknown-	NaN	basic	25	en	othe
nw9fwlyb5f	2014-06-30	2014-06-30 23:58:24	-unknown-	NaN	basic	25	en	direc

213451 rows × 14 columns

* Dataset de Test

In [143…
```
df_test['date_account_created'] = pd.to_datetime(df_test['date_account_created'])
df_test.drop(['date_first_booking'], axis=1, inplace=True)
```

```
df_test['timestamp_first_active'] = pd.to_datetime(df_test['timestamp_first_active'], format='%Y%m%d%H%M%S')

display(df_test)
```

id	date_account_created	timestamp_first_active	gender	age	signup_method	signup_flow	language	affiliate_channe
5uwns89zht	2014-07-01	2014-07-01 00:00:06	FEMALE	35.0	facebook	0	en	direct
jtl0dijy2j	2014-07-01	2014-07-01 00:00:51	-unknown-	NaN	basic	0	en	direct
xx0ulgorjt	2014-07-01	2014-07-01 00:01:48	-unknown-	NaN	basic	0	en	direct
6c6puo6ix0	2014-07-01	2014-07-01 00:02:15	-unknown-	NaN	basic	0	en	direct
czqhjk3yfe	2014-07-01	2014-07-01 00:03:05	-unknown-	NaN	basic	0	en	direct
...	...	...	...	...	...	...	...	..
cv0na2lf5a	2014-09-30	2014-09-30 23:52:32	-unknown-	31.0	basic	0	en	direct
zp8xfonng8	2014-09-30	2014-09-30 23:53:06	-unknown-	NaN	basic	23	ko	direct
fa6260ziny	2014-09-30	2014-09-30 23:54:08	-unknown-	NaN	basic	0	de	direct
87k0fy4ugm	2014-09-30	2014-09-30 23:54:30	-unknown-	NaN	basic	0	en	sem-branc
9uqfg8txu3	2014-09-30	2014-09-30 23:59:01	FEMALE	49.0	basic	0	en	other

62096 rows × 13 columns

2.2. Remplacement de valeurs manquantes

* Dataset de Train

La colonne 'age', présentant un nombre considérable (87990) de valeurs manquantes, nous utiliser une méthode de prédiction (RandomForest) au lieu d'un Immputer pour remplacer les données manquantes et évite d'aplatir la distribution des âges. C'est

une méthode plus réaliste, surtout si l'âge a un impact sur la destination

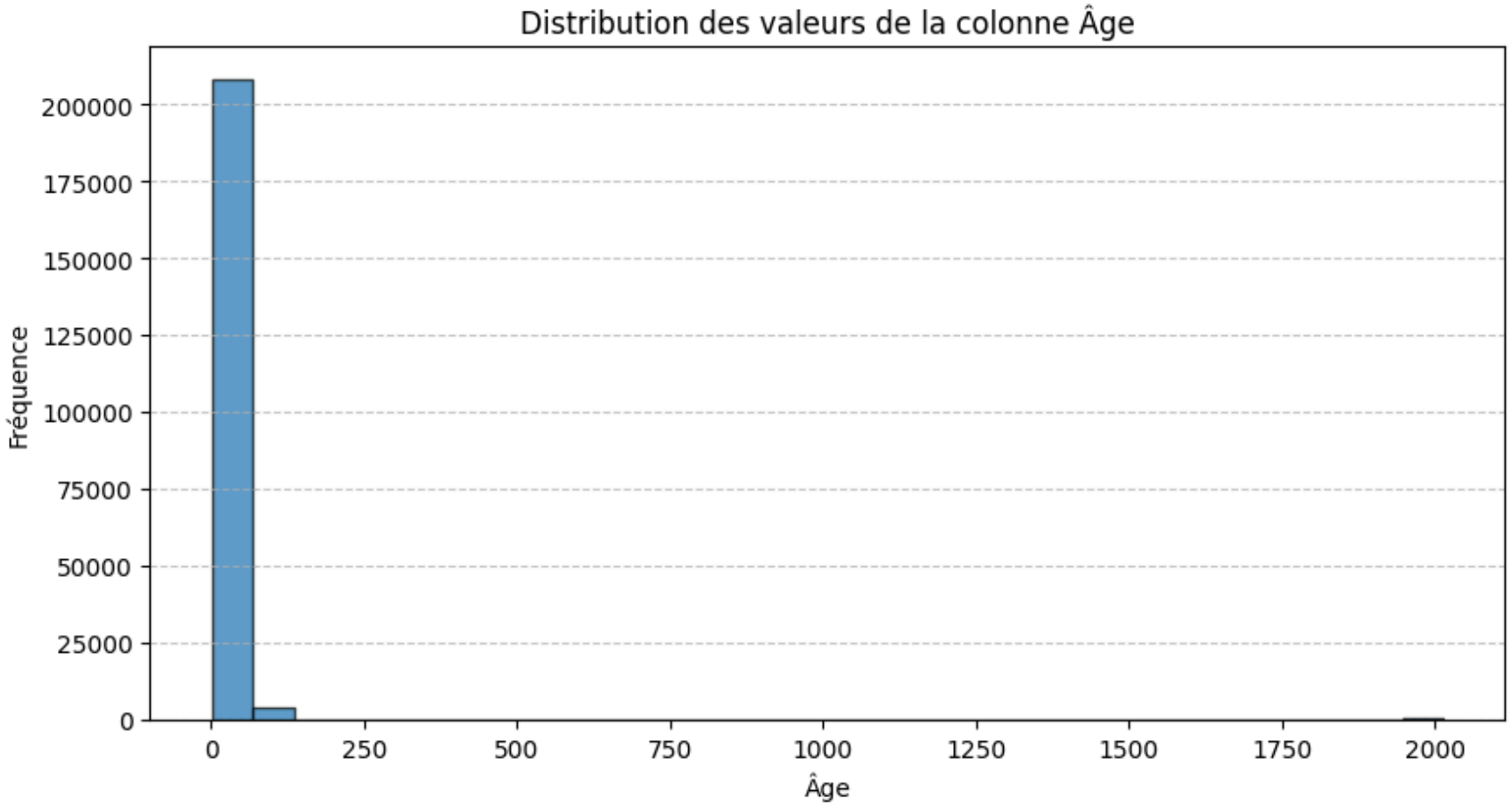
In [143…
```
age_data = df[df['age'].notnull()]
age_target = age_data['age']
age_features = age_data.drop(['age'], axis=1).select_dtypes(include=[np.number])

age_model = RandomForestRegressor()
age_model.fit(age_features, age_target)

# Prédire les valeurs manquantes dans 'age'
missing_age_data = df[df['age'].isnull()]
predicted_ages = age_model.predict(missing_age_data.drop(['age'], axis=1).select_dtypes(include=[np.number]))
df.loc[df['age'].isnull(), 'age'] = predicted_ages
```

Remplacement des valeurs manquantes de 'first_affiliate_tracked' par sa valeur médiane

In [143…
```
# c. Remplacement de first_affiliate_tracked avec la médiane
df['first_affiliate_tracked'].fillna(df['first_affiliate_tracked'].mode()[0], inplace=True)
```

```
/var/folders/dz/dt7pkrls1kxg9y931v65tmz40000gn/T/ipykernel_13424/4188757126.py:2: FutureWarning: A value is t
rying to be set on a copy of a DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object o
n which we are setting values always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=Tru
e)' or df[col] = df[col].method(value) instead, to perform the operation inplace on the original object.


  df['first_affiliate_tracked'].fillna(df['first_affiliate_tracked'].mode()[0], inplace=True)
```

In [144…
```
# Afficher la distribution des valeurs de la colonne 'age'
plt.figure(figsize=(10, 5))
plt.hist(df['age'].dropna(), bins=30, edgecolor='black', alpha=0.7)
plt.xlabel('Âge')
plt.ylabel('Fréquence')
plt.title('Distribution des valeurs de la colonne Âge')
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()
```

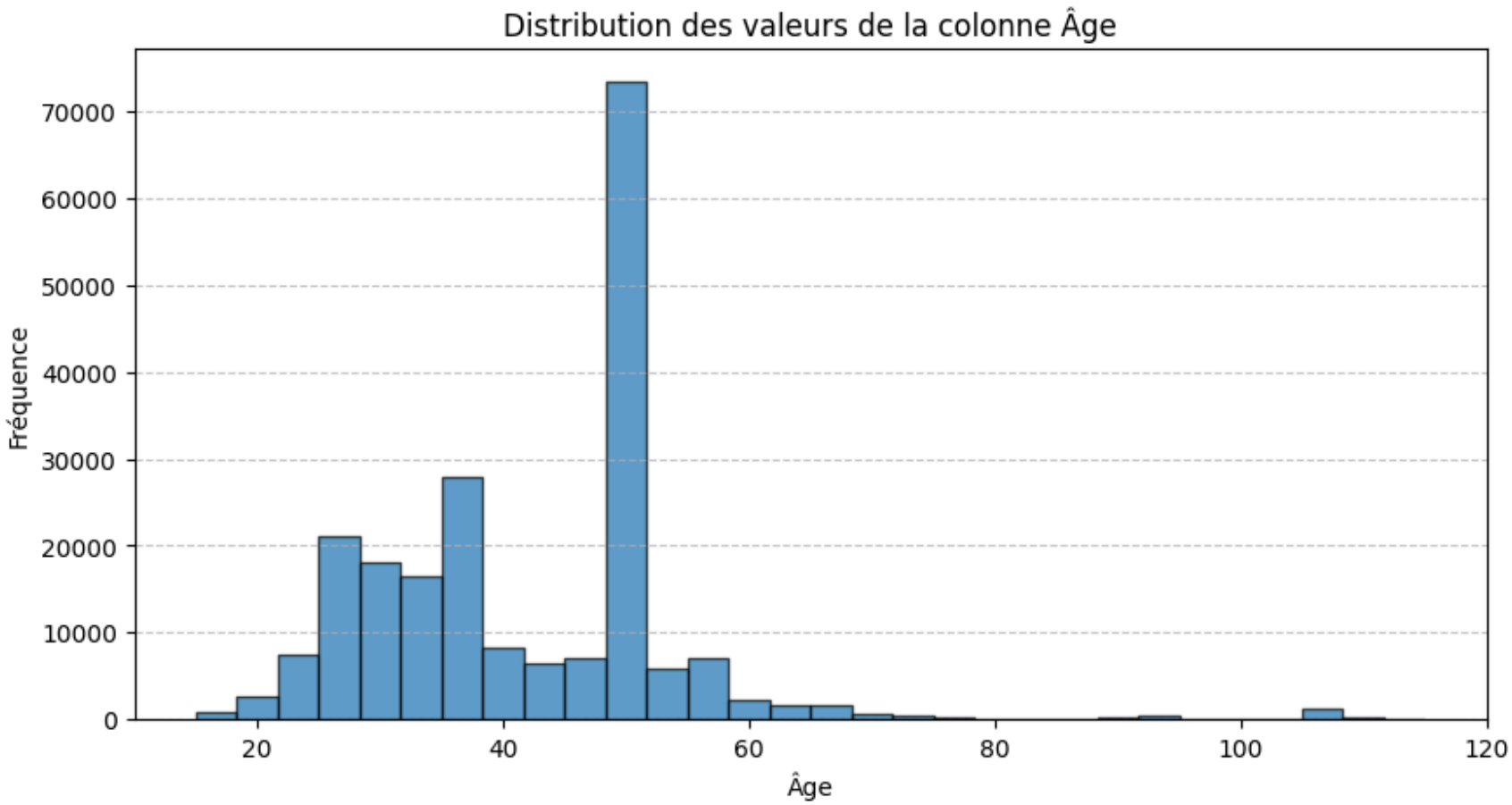


On constate la présence de valeurs aberrantes dans la colonne 'age'. Pour y remédier, nous supprimons les enregistrements où l'âge est inférieur à 15 ou supérieur à 120.

In [144…
```
# 3. Correction/Suppression de valeurs aberrantes/erronées
df = df[(df['age'] >= 15) & (df['age'] <= 120)]  # Suppression des âges aberrants
df['age'] = df['age'].astype(int)
```

In [144…
```
# Afficher la distribution des valeurs de la colonne 'age'
plt.figure(figsize=(10, 5))
plt.hist(df['age'].dropna(), bins=30, edgecolor='black', alpha=0.7)
plt.xlabel('Âge')
plt.ylabel('Fréquence')
plt.title('Distribution des valeurs de la colonne Âge')
```

```
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()
```



In [144…

```
display(df)
```

id	date_account_created	timestamp_first_active	gender	age	signup_method	signup_flow	language	affiliate_channe
gxn3p5htnn	2010-06-28	2009-03-19 04:32:55	-unknown-	50	facebook	0	en	direc
820tgsjxq7	2011-05-25	2009-05-23 17:48:09	MALE	38	facebook	0	en	sec
4ft3gnwmtx	2010-09-28	2009-06-09 23:12:47	FEMALE	56	basic	3	en	direc
bjjt8pjhuk	2011-12-05	2009-10-31 06:01:29	FEMALE	42	facebook	0	en	direc
87mebub9p4	2010-09-14	2009-12-08 06:11:05	-unknown-	41	basic	0	en	direc
...	...	...	...	...	...	...	...	..
zxodksqpep	2014-06-30	2014-06-30 23:56:36	MALE	32	basic	0	en	sem-branc
mhewnxesx9	2014-06-30	2014-06-30 23:57:19	-unknown-	50	basic	0	en	direc
6o3arsjbb4	2014-06-30	2014-06-30 23:57:54	-unknown-	32	basic	0	en	direc
jh95kwisub	2014-06-30	2014-06-30 23:58:22	-unknown-	38	basic	25	en	othe
nw9fwlyb5f	2014-06-30	2014-06-30 23:58:24	-unknown-	38	basic	25	en	direc

212613 rows × 14 columns

* Dataset de Test

Les commentaires du dataset de train s'appliquent aussi pour le test.

In [144…
```
print(df_test.describe())
print("Valeurs manquantes par colonne:\n")
print(df_test.isnull().sum())  # Compte les valeurs manquantes par colonne
```

```
                date_account_created         timestamp_first_active  \
count                          62096                          62096
mean   2014-08-14 19:24:31.631022848  2014-08-15 07:57:04.415598080
min              2014-07-01 00:00:00           2014-07-01 00:00:06
25%              2014-07-24 00:00:00    2014-07-24 00:04:38.500000
50%              2014-08-14 00:00:00           2014-08-14 02:36:11
75%              2014-09-05 00:00:00           2014-09-05 22:39:30
max              2014-09-30 00:00:00           2014-09-30 23:59:01
std                              NaN                           NaN

                age   signup_flow
count  33220.000000  62096.000000
mean      37.616677      7.813885
min        1.000000      0.000000
25%       26.000000      0.000000
50%       31.000000      0.000000
75%       40.000000     23.000000
max     2002.000000     25.000000
std       74.440647     11.254291
Valeurs manquantes par colonne:

date_account_created           0
timestamp_first_active         0
gender                         0
age                        28876
signup_method                  0
signup_flow                    0
language                       0
affiliate_channel              0
affiliate_provider             0
first_affiliate_tracked       20
signup_app                     0
first_device_type              0
first_browser                  0
dtype: int64
```

In [144…

```python
age_data = df_test[df_test['age'].notnull()]
age_target = age_data['age']
age_features = age_data.drop(['age'], axis=1).select_dtypes(include=[np.number])

age_model = RandomForestRegressor()
age_model.fit(age_features, age_target)

# Prédire les valeurs manquantes dans 'age'
missing_age_data = df_test[df_test['age'].isnull()]
```

```
predicted_ages = age_model.predict(missing_age_data.drop(['age'], axis=1).select_dtypes(include=[np.number]))
df_test.loc[df_test['age'].isnull(), 'age'] = predicted_ages
```

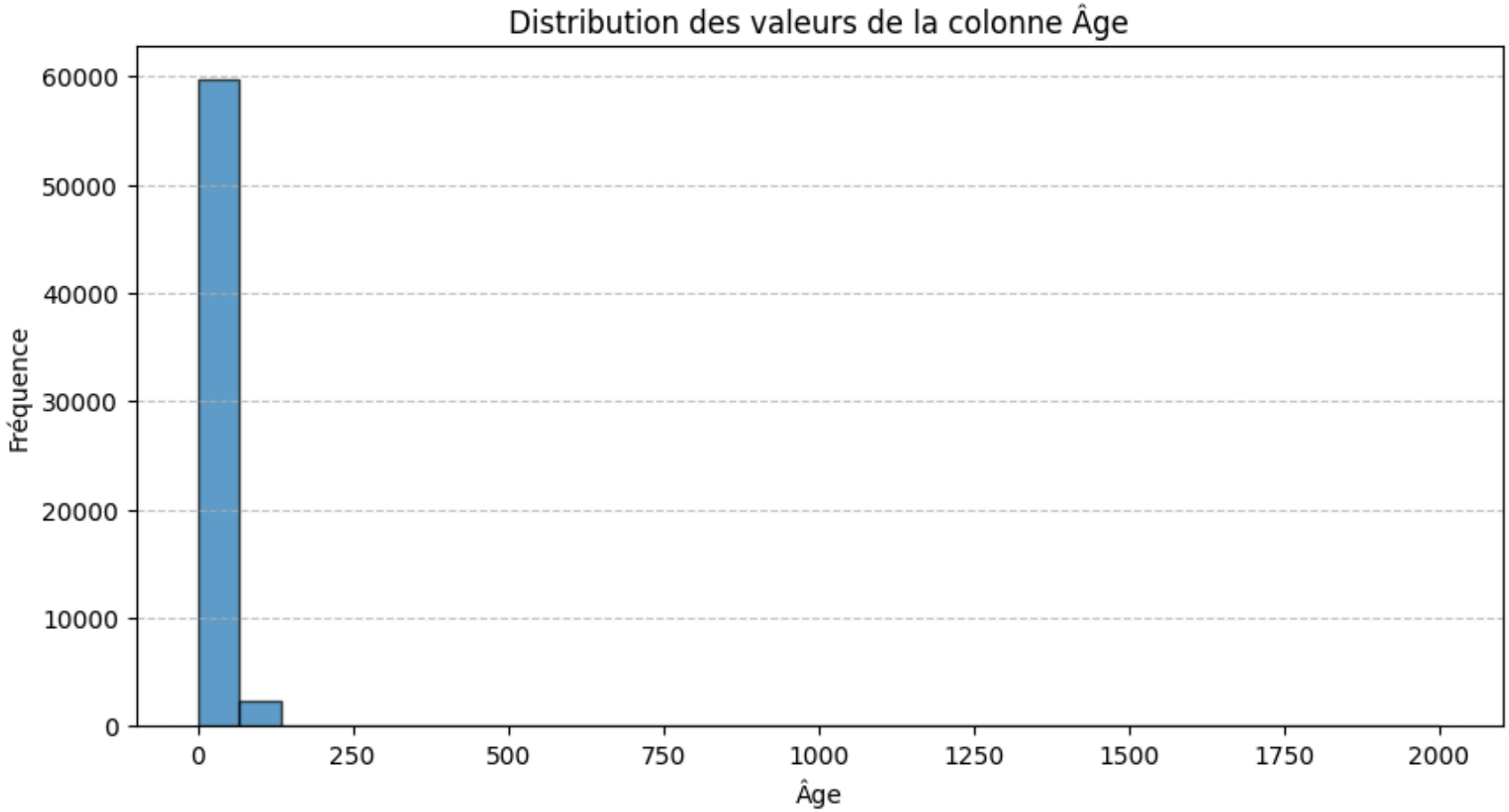
In [144…

```
# c. Remplacement de first_affiliate_tracked avec la médiane

df_test['first_affiliate_tracked'].fillna(df_test['first_affiliate_tracked'].mode()[0], inplace=True)
```

```
/var/folders/dz/dt7pkrls1kxg9y931v65tmz40000gn/T/ipykernel_13424/961816202.py:3: FutureWarning: A value is tr
ying to be set on a copy of a DataFrame or Series through chained assignment using an inplace method.
The behavior will change in pandas 3.0. This inplace method will never work because the intermediate object o
n which we are setting values always behaves as a copy.

For example, when doing 'df[col].method(value, inplace=True)', try using 'df.method({col: value}, inplace=Tru
e)' or df[col] = df[col].method(value) instead, to perform the operation inplace on the original object.


  df_test['first_affiliate_tracked'].fillna(df_test['first_affiliate_tracked'].mode()[0], inplace=True)
```

In [144…

```
# Afficher la distribution des valeurs de la colonne 'age'
plt.figure(figsize=(10, 5))
plt.hist(df_test['age'].dropna(), bins=30, edgecolor='black', alpha=0.7)
plt.xlabel('Âge')
plt.ylabel('Fréquence')
plt.title('Distribution des valeurs de la colonne Âge')
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()
```



In [144…
```
# 3. Correction/Suppression de valeurs aberrantes/erronées
df_test = df_test[(df_test['age'] >= 15) & (df_test['age'] <= 120)]  # Suppression des âges aberrants
df_test['age'] = df_test['age'].astype(int)
```

In [144…
```
# Afficher la distribution des valeurs de la colonne 'age'
plt.figure(figsize=(10, 5))
plt.hist(df_test['age'].dropna(), bins=30, edgecolor='black', alpha=0.7)
plt.xlabel('Âge')
plt.ylabel('Fréquence')
plt.title('Distribution des valeurs de la colonne Âge')
plt.grid(axis='y', linestyle='--', alpha=0.7)
plt.show()
```

In [145…
```
display(df_test)
```

id	date_account_created	timestamp_first_active	gender	age	signup_method	signup_flow	language	affiliate_channel
5uwns89zht	2014-07-01	2014-07-01 00:00:06	FEMALE	35	facebook	0	en	direct
jtl0dijy2j	2014-07-01	2014-07-01 00:00:51	-unknown-	36	basic	0	en	direct
xx0ulgorjt	2014-07-01	2014-07-01 00:01:48	-unknown-	36	basic	0	en	direct
6c6puo6ix0	2014-07-01	2014-07-01 00:02:15	-unknown-	36	basic	0	en	direct
czqhjk3yfe	2014-07-01	2014-07-01 00:03:05	-unknown-	36	basic	0	en	direct
...	...	...	...	...	...	...	...	...
cv0na2lf5a	2014-09-30	2014-09-30 23:52:32	-unknown-	31	basic	0	en	direct
zp8xfonng8	2014-09-30	2014-09-30 23:53:06	-unknown-	61	basic	23	ko	direct
fa6260ziny	2014-09-30	2014-09-30 23:54:08	-unknown-	36	basic	0	de	direct
87k0fy4ugm	2014-09-30	2014-09-30 23:54:30	-unknown-	36	basic	0	en	sem-brand
9uqfg8txu3	2014-09-30	2014-09-30 23:59:01	FEMALE	49	basic	0	en	other

62045 rows × 13 columns

2.3. Standardisation de la dataset train

In [145…

```
import pandas as pd

df_qualitatives = df.select_dtypes(include=['object'])
df_quantitatives = df.select_dtypes(include=[np.number])
df_dates = df.select_dtypes(include=['datetime64'])
df_target = df['country_destination']

display(df_qualitatives)
display(df_quantitatives)
```

```
display(df_dates)
display(df_target)
```

id	gender	signup_method	language	affiliate_channel	affiliate_provider	first_affiliate_tracked	signup_app	first_devic
gxn3p5htnn	-unknown-	facebook	en	direct	direct	untracked	Web	Mac D
820tgsjxq7	MALE	facebook	en	seo	google	untracked	Web	Mac D
4ft3gnwmtx	FEMALE	basic	en	direct	direct	untracked	Web	Windows D
bjjt8pjhuk	FEMALE	facebook	en	direct	direct	untracked	Web	Mac D
87mebub9p4	-unknown-	basic	en	direct	direct	untracked	Web	Mac D
...	...	...	...	...	...	...	...	
zxodksqpep	MALE	basic	en	sem-brand	google	omg	Web	Mac D
mhewnxesx9	-unknown-	basic	en	direct	direct	linked	Web	Windows D
6o3arsjbb4	-unknown-	basic	en	direct	direct	untracked	Web	Mac D
jh95kwisub	-unknown-	basic	en	other	other	tracked-other	iOS	
nw9fwlyb5f	-unknown-	basic	en	direct	direct	untracked	iOS	

212613 rows × 10 columns

id	age	signup_flow
gxn3p5htnn	50	0
820tgsjxq7	38	0
4ft3gnwmtx	56	3
bjjt8pjhuk	42	0
87mebub9p4	41	0
...	...	...
zxodksqpep	32	0
mhewnxesx9	50	0
6o3arsjbb4	32	0
jh95kwisub	38	25
nw9fwlyb5f	38	25

212613 rows × 2 columns

id	date_account_created	timestamp_first_active
gxn3p5htnn	2010-06-28	2009-03-19 04:32:55
820tgsjxq7	2011-05-25	2009-05-23 17:48:09
4ft3gnwmtx	2010-09-28	2009-06-09 23:12:47
bjjt8pjhuk	2011-12-05	2009-10-31 06:01:29
87mebub9p4	2010-09-14	2009-12-08 06:11:05
...	...	...
zxodksqpep	2014-06-30	2014-06-30 23:56:36
mhewnxesx9	2014-06-30	2014-06-30 23:57:19
6o3arsjbb4	2014-06-30	2014-06-30 23:57:54
jh95kwisub	2014-06-30	2014-06-30 23:58:22
nw9fwlyb5f	2014-06-30	2014-06-30 23:58:24

212613 rows × 2 columns

```
id
gxn3p5htnn      NDF
820tgsjxq7      NDF
4ft3gnwmtx       US
bjjt8pjhuk    other
87mebub9p4       US
              ...
zxodksqpep      NDF
mhewnxesx9      NDF
6o3arsjbb4      NDF
jh95kwisub      NDF
nw9fwlyb5f      NDF
Name: country_destination, Length: 212613, dtype: object
```

Encodage des variables catégorielles de la dataset train

Dans cette étape, nous appliquons le OneHotEncoder afin de convertir les données catégorielles en format numérique. Cette transformation crée des indicateurs binaires pour chaque modalité.

In [145…

```
from sklearn.preprocessing import OneHotEncoder

df_qualitatives = df_qualitatives.drop(['country_destination'], axis=1)
colonnes_qualitatives = df_qualitatives.select_dtypes(include=['object']).columns


encoder = OneHotEncoder()
encoded_data = encoder.fit_transform(df_qualitatives[colonnes_qualitatives]).toarray()

df_encoded = pd.DataFrame(encoded_data, columns=encoder.get_feature_names_out(colonnes_qualitatives))
print(df_encoded)

p_k = np.mean(df_encoded.values,axis=0)
print(p_k)

ZD = df_encoded.values/np.sqrt(p_k)
display(ZD.round(3))

df_encoded = pd.DataFrame(ZD, columns=encoder.get_feature_names_out(colonnes_qualitatives), index=df.index)
print(df_encoded)
```

	gender_-unknown-	gender_FEMALE	gender_MALE	gender_OTHER	\
0	1.0	0.0	0.0	0.0	
1	0.0	0.0	1.0	0.0	
2	0.0	1.0	0.0	0.0	
3	0.0	1.0	0.0	0.0	
4	1.0	0.0	0.0	0.0	
...	...	...	...	...	
212608	0.0	0.0	1.0	0.0	
212609	1.0	0.0	0.0	0.0	
212610	1.0	0.0	0.0	0.0	
212611	1.0	0.0	0.0	0.0	
212612	1.0	0.0	0.0	0.0	

	signup_method_basic	signup_method_facebook	signup_method_google	\
0	0.0	1.0	0.0	
1	0.0	1.0	0.0	
2	1.0	0.0	0.0	
3	0.0	1.0	0.0	
4	1.0	0.0	0.0	
...	...	...	...	
212608	1.0	0.0	0.0	
212609	1.0	0.0	0.0	
212610	1.0	0.0	0.0	
212611	1.0	0.0	0.0	
212612	1.0	0.0	0.0	

	language_ca	language_cs	language_da	...	first_browser_SeaMonkey	\
0	0.0	0.0	0.0	...	0.0	
1	0.0	0.0	0.0	...	0.0	
2	0.0	0.0	0.0	...	0.0	
3	0.0	0.0	0.0	...	0.0	
4	0.0	0.0	0.0	...	0.0	
...	...	...	...	...	...	
212608	0.0	0.0	0.0	...	0.0	
212609	0.0	0.0	0.0	...	0.0	
212610	0.0	0.0	0.0	...	0.0	
212611	0.0	0.0	0.0	...	0.0	
212612	0.0	0.0	0.0	...	0.0	

	first_browser_Silk	first_browser_SiteKiosk	\
0	0.0	0.0	
1	0.0	0.0	
2	0.0	0.0	
3	0.0	0.0	
4	0.0	0.0	

```
...                   ...                     ...
212608                0.0                     0.0
212609                0.0                     0.0
212610                0.0                     0.0
212611                0.0                     0.0
212612                0.0                     0.0

        first_browser_SlimBrowser  first_browser_Sogou Explorer  \
0                             0.0                           0.0
1                             0.0                           0.0
2                             0.0                           0.0
3                             0.0                           0.0
4                             0.0                           0.0
...                           ...                           ...
212608                        0.0                           0.0
212609                        0.0                           0.0
212610                        0.0                           0.0
212611                        0.0                           0.0
212612                        0.0                           0.0

        first_browser_Stainless  first_browser_TenFourFox  \
0                           0.0                       0.0
1                           0.0                       0.0
2                           0.0                       0.0
3                           0.0                       0.0
4                           0.0                       0.0
...                         ...                       ...
212608                      0.0                       0.0
212609                      0.0                       0.0
212610                      0.0                       0.0
212611                      0.0                       0.0
212612                      0.0                       0.0

        first_browser_TheWorld Browser  first_browser_Yandex.Browser  \
0                                  0.0                           0.0
1                                  0.0                           0.0
2                                  0.0                           0.0
3                                  0.0                           0.0
4                                  0.0                           0.0
...                                ...                           ...
212608                             0.0                           0.0
212609                             0.0                           0.0
212610                             0.0                           0.0
212611                             0.0                           0.0
212612                             0.0                           0.0
```

```
        first_browser_wOSBrowser
0                            0.0
1                            0.0
2                            0.0
3                            0.0
4                            0.0
...                          ...
212608                       0.0
212609                       0.0
212610                       0.0
212611                       0.0
212612                       0.0

[212613 rows x 130 columns]
[4.49694986e-01 2.94196498e-01 2.54796273e-01 1.31224337e-03
 7.15878145e-01 2.81553809e-01 2.56804617e-03 2.35169063e-05
 1.45804819e-04 2.72796113e-04 3.44287508e-03 1.12881150e-04
 9.66493112e-01 4.28948371e-03 6.58473377e-05 5.50295608e-03
 9.40676252e-06 7.99574814e-05 1.03474388e-04 2.35169063e-05
 2.41283459e-03 1.05826078e-03 3.50401904e-03 4.51524601e-04
 1.41101438e-04 2.53982588e-04 1.12410812e-03 1.82491193e-03
 5.73812514e-04 1.12881150e-04 3.01016401e-04 7.67591822e-03
 3.83513708e-02 1.85266188e-02 6.45350943e-01 4.18742034e-02
 5.12668557e-03 1.21986896e-01 8.82260257e-02 4.05572566e-02
 1.36398057e-04 1.09118445e-02 1.61655214e-02 4.70338126e-06
 6.43954039e-01 7.80761289e-04 1.06672687e-02 2.56334279e-03
 2.42078330e-01 2.12592833e-03 1.63207330e-03 2.44575826e-04
 5.88110793e-02 3.60279005e-03 3.87558616e-03 3.76270501e-05
 2.32817372e-03 7.99574814e-05 2.16755325e-01 1.59914963e-04
 6.53769995e-04 2.06163311e-01 7.26672405e-03 2.87988035e-02
 5.40202151e-01 2.56099110e-02 2.93443957e-02 8.55676746e-01
 8.93689473e-02 1.31130270e-02 6.04384492e-03 5.62524399e-03
 4.19809701e-01 4.98699515e-02 3.52753595e-04 3.40595354e-01
 6.71689878e-02 9.74211361e-02 1.27833199e-01 1.12881150e-03
 3.96965378e-03 1.69321725e-04 4.70338126e-06 1.88135250e-05
 2.44575826e-04 4.23304313e-05 2.99233819e-01 5.91685363e-03
 3.43346832e-04 5.17371939e-05 9.40676252e-06 4.70338126e-06
 2.82202876e-05 9.40676252e-06 4.70338126e-06 1.57629120e-01
 9.40676252e-06 4.70338126e-06 4.70338126e-06 9.86487186e-02
 1.69321725e-04 4.70338126e-06 6.11439564e-05 7.99574814e-05
 4.70338126e-06 2.16355538e-04 1.41101438e-04 9.02814033e-02
 1.41101438e-05 4.70338126e-06 9.40676252e-06 8.79532296e-04
 1.88135250e-05 9.40676252e-06 4.70338126e-06 4.70338126e-06
 5.64405751e-05 4.70338126e-06 1.12881150e-04 2.11567496e-01
```

```
 5.17371939e-05 5.83219276e-04 1.12881150e-04 9.40676252e-06
 1.55211582e-04 4.70338126e-06 3.76270501e-05 9.40676252e-06
 5.17371939e-05 2.82202876e-05]
array([[1.491, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       [0.   , 0.   , 1.981, ..., 0.   , 0.   , 0.   ],
       [0.   , 1.844, 0.   , ..., 0.   , 0.   , 0.   ],
       ...,
       [1.491, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       [1.491, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       [1.491, 0.   , 0.   , ..., 0.   , 0.   , 0.   ]])
```

id	gender_-unknown-	gender_FEMALE	gender_MALE	gender_OTHER	\
gxn3p5htnn	1.491217	0.000000	0.000000	0.0	
820tgsjxq7	0.000000	0.000000	1.981087	0.0	
4ft3gnwmtx	0.000000	1.843662	0.000000	0.0	
bjjt8pjhuk	0.000000	1.843662	0.000000	0.0	
87mebub9p4	1.491217	0.000000	0.000000	0.0	
...	...	...	...	...	
zxodksqpep	0.000000	0.000000	1.981087	0.0	
mhewnxesx9	1.491217	0.000000	0.000000	0.0	
6o3arsjbb4	1.491217	0.000000	0.000000	0.0	
jh95kwisub	1.491217	0.000000	0.000000	0.0	
nw9fwlyb5f	1.491217	0.000000	0.000000	0.0	

id	signup_method_basic	signup_method_facebook	signup_method_google	\
gxn3p5htnn	0.000000	1.8846	0.0	
820tgsjxq7	0.000000	1.8846	0.0	
4ft3gnwmtx	1.181899	0.0000	0.0	
bjjt8pjhuk	0.000000	1.8846	0.0	
87mebub9p4	1.181899	0.0000	0.0	
...	...	...	...	
zxodksqpep	1.181899	0.0000	0.0	
mhewnxesx9	1.181899	0.0000	0.0	
6o3arsjbb4	1.181899	0.0000	0.0	
jh95kwisub	1.181899	0.0000	0.0	
nw9fwlyb5f	1.181899	0.0000	0.0	

id	language_ca	language_cs	language_da	...	\
gxn3p5htnn	0.0	0.0	0.0	...	
820tgsjxq7	0.0	0.0	0.0	...	
4ft3gnwmtx	0.0	0.0	0.0	...	
bjjt8pjhuk	0.0	0.0	0.0	...	
87mebub9p4	0.0	0.0	0.0	...	
...	...	...	...	...	
zxodksqpep	0.0	0.0	0.0	...	
mhewnxesx9	0.0	0.0	0.0	...	
6o3arsjbb4	0.0	0.0	0.0	...	
jh95kwisub	0.0	0.0	0.0	...	
nw9fwlyb5f	0.0	0.0	0.0	...	

id	first_browser_SeaMonkey	first_browser_Silk	\
gxn3p5htnn	0.0	0.0	

```
820tgsjxq7                    0.0                 0.0
4ft3gnwmtx                    0.0                 0.0
bjjt8pjhuk                    0.0                 0.0
87mebub9p4                    0.0                 0.0
...                           ...                 ...
zxodksqpep                    0.0                 0.0
mhewnxesx9                    0.0                 0.0
6o3arsjbb4                    0.0                 0.0
jh95kwisub                    0.0                 0.0
nw9fwlyb5f                    0.0                 0.0

            first_browser_SiteKiosk  first_browser_SlimBrowser  \
id
gxn3p5htnn                    0.0                       0.0
820tgsjxq7                    0.0                       0.0
4ft3gnwmtx                    0.0                       0.0
bjjt8pjhuk                    0.0                       0.0
87mebub9p4                    0.0                       0.0
...                           ...                       ...
zxodksqpep                    0.0                       0.0
mhewnxesx9                    0.0                       0.0
6o3arsjbb4                    0.0                       0.0
jh95kwisub                    0.0                       0.0
nw9fwlyb5f                    0.0                       0.0

            first_browser_Sogou Explorer  first_browser_Stainless  \
id
gxn3p5htnn                           0.0                      0.0
820tgsjxq7                           0.0                      0.0
4ft3gnwmtx                           0.0                      0.0
bjjt8pjhuk                           0.0                      0.0
87mebub9p4                           0.0                      0.0
...                                  ...                      ...
zxodksqpep                           0.0                      0.0
mhewnxesx9                           0.0                      0.0
6o3arsjbb4                           0.0                      0.0
jh95kwisub                           0.0                      0.0
nw9fwlyb5f                           0.0                      0.0

            first_browser_TenFourFox  first_browser_TheWorld Browser  \
id
gxn3p5htnn                       0.0                             0.0
820tgsjxq7                       0.0                             0.0
4ft3gnwmtx                       0.0                             0.0
bjjt8pjhuk                       0.0                             0.0
```

```
87mebub9p4                        0.0                                0.0
...                               ...                                ...
zxodksqpep                        0.0                                0.0
mhewnxesx9                        0.0                                0.0
6o3arsjbb4                        0.0                                0.0
jh95kwisub                        0.0                                0.0
nw9fwlyb5f                        0.0                                0.0

            first_browser_Yandex.Browser  first_browser_wOSBrowser
id
gxn3p5htnn                           0.0                       0.0
820tgsjxq7                           0.0                       0.0
4ft3gnwmtx                           0.0                       0.0
bjjt8pjhuk                           0.0                       0.0
87mebub9p4                           0.0                       0.0
...                                  ...                       ...
zxodksqpep                           0.0                       0.0
mhewnxesx9                           0.0                       0.0
6o3arsjbb4                           0.0                       0.0
jh95kwisub                           0.0                       0.0
nw9fwlyb5f                           0.0                       0.0

[212613 rows x 130 columns]
```

Normalisation des variables quantitatives : centrage et réduction

Ici, nous appliquons une standardisation afin de centrer (soustraire la moyenne) et réduire (diviser par l'écart-type) nos données numériques pour garantir une échelle uniforme lors de leur utilisation dans les modèles.

In [145…

```
df_scaled = (df_quantitatives.values-np.mean(df_quantitatives.values,axis=0))/np.std(df_quantitatives.values,
df_scaled = pd.DataFrame(df_scaled, columns=df_quantitatives.columns, index=df.index)
display(df_scaled)
```

id	age	signup_flow
gxn3p5htnn	0.616295	-0.428185
820tgsjxq7	-0.331967	-0.428185
4ft3gnwmtx	1.090426	-0.035788
bjjt8pjhuk	-0.015879	-0.428185
87mebub9p4	-0.094901	-0.428185
...	...	...
zxodksqpep	-0.806097	-0.428185
mhewnxesx9	0.616295	-0.428185
6o3arsjbb4	-0.806097	-0.428185
jh95kwisub	-0.331967	2.841790
nw9fwlyb5f	-0.331967	2.841790

212613 rows × 2 columns

In [145…
```
train = pd.concat([df_dates, df_scaled, df_encoded], axis=1)
```

Standardisation de la dataset Test

In [145…
```
df_qualitatives = df_test.select_dtypes(include=['object'])
df_quantitatives = df_test.select_dtypes(include=[np.number])
df_dates = df_test.select_dtypes(include=['datetime64'])

display(df_qualitatives)
display(df_quantitatives)
display(df_dates)
```

id	gender	signup_method	language	affiliate_channel	affiliate_provider	first_affiliate_tracked	signup_app	first_devic
5uwns89zht	FEMALE	facebook	en	direct	direct	untracked	Moweb	
jtl0dijy2j	-unknown-	basic	en	direct	direct	untracked	Moweb	
xx0ulgorjt	-unknown-	basic	en	direct	direct	linked	Web	Windows D
6c6puo6ix0	-unknown-	basic	en	direct	direct	linked	Web	Windows D
czqhjk3yfe	-unknown-	basic	en	direct	direct	untracked	Web	Mac D
...	...	...	...	...	...	...	...	
cv0na2lf5a	-unknown-	basic	en	direct	direct	untracked	Web	Windows D
zp8xfonng8	-unknown-	basic	ko	direct	direct	untracked	Android	Android
fa6260ziny	-unknown-	basic	de	direct	direct	linked	Web	Windows D
87k0fy4ugm	-unknown-	basic	en	sem-brand	google	omg	Web	Mac D
9uqfg8txu3	FEMALE	basic	en	other	other	tracked-other	Web	Windows D

62045 rows × 9 columns

id	age	signup_flow
5uwns89zht	35	0
jtl0dijy2j	36	0
xx0ulgorjt	36	0
6c6puo6ix0	36	0
czqhjk3yfe	36	0
...	...	...
cv0na2lf5a	31	0
zp8xfonng8	61	23
fa6260ziny	36	0
87k0fy4ugm	36	0
9uqfg8txu3	49	0

62045 rows × 2 columns

id	date_account_created	timestamp_first_active
5uwns89zht	2014-07-01	2014-07-01 00:00:06
jtl0dijy2j	2014-07-01	2014-07-01 00:00:51
xx0ulgorjt	2014-07-01	2014-07-01 00:01:48
6c6puo6ix0	2014-07-01	2014-07-01 00:02:15
czqhjk3yfe	2014-07-01	2014-07-01 00:03:05
...	...	...
cv0na2lf5a	2014-09-30	2014-09-30 23:52:32
zp8xfonng8	2014-09-30	2014-09-30 23:53:06
fa6260ziny	2014-09-30	2014-09-30 23:54:08
87k0fy4ugm	2014-09-30	2014-09-30 23:54:30
9uqfg8txu3	2014-09-30	2014-09-30 23:59:01

62045 rows × 2 columns

Encodage des variables catégorielles de la dataset test

Dans cette étape, nous appliquons le OneHotEncoder afin de convertir les données catégorielles en format numérique. Cette transformation crée des indicateurs binaires pour chaque modalité, rendant ainsi les variables compatibles avec les algorithmes d'apprentissage automatique.

In [145…

```
colonnes_qualitatives = df_qualitatives.select_dtypes(include=['object']).columns


encoder = OneHotEncoder()
encoded_data = encoder.fit_transform(df_qualitatives[colonnes_qualitatives]).toarray()

df_encoded = pd.DataFrame(encoded_data, columns=encoder.get_feature_names_out(colonnes_qualitatives))
print(df_encoded)

p_k = np.mean(df_encoded.values,axis=0)
print(p_k)
```

```
ZD = df_encoded.values/np.sqrt(p_k)
display(ZD.round(3))

df_encoded = pd.DataFrame(ZD, columns=encoder.get_feature_names_out(colonnes_qualitatives), index=df_test.ind
print(df_encoded)
```

```
       gender_-unknown-  gender_FEMALE  gender_MALE  gender_OTHER  \
0                   0.0            1.0          0.0           0.0
1                   1.0            0.0          0.0           0.0
2                   1.0            0.0          0.0           0.0
3                   1.0            0.0          0.0           0.0
4                   1.0            0.0          0.0           0.0
...                 ...            ...          ...           ...
62040               1.0            0.0          0.0           0.0
62041               1.0            0.0          0.0           0.0
62042               1.0            0.0          0.0           0.0
62043               1.0            0.0          0.0           0.0
62044               0.0            1.0          0.0           0.0

       signup_method_basic  signup_method_facebook  signup_method_google  \
0                      0.0                     1.0                   0.0
1                      1.0                     0.0                   0.0
2                      1.0                     0.0                   0.0
3                      1.0                     0.0                   0.0
4                      1.0                     0.0                   0.0
...                    ...                     ...                   ...
62040                  1.0                     0.0                   0.0
62041                  1.0                     0.0                   0.0
62042                  1.0                     0.0                   0.0
62043                  1.0                     0.0                   0.0
62044                  1.0                     0.0                   0.0

       signup_method_weibo  language_-unknown-  language_ca  ...  \
0                      0.0                 0.0          0.0  ...
1                      0.0                 0.0          0.0  ...
2                      0.0                 0.0          0.0  ...
3                      0.0                 0.0          0.0  ...
4                      0.0                 0.0          0.0  ...
...                    ...                 ...          ...  ...
62040                  0.0                 0.0          0.0  ...
62041                  0.0                 0.0          0.0  ...
62042                  0.0                 0.0          0.0  ...
62043                  0.0                 0.0          0.0  ...
62044                  0.0                 0.0          0.0  ...

       first_browser_Opera Mobile  first_browser_Pale Moon  \
0                             0.0                      0.0
1                             0.0                      0.0
2                             0.0                      0.0
3                             0.0                      0.0
4                             0.0                      0.0
```

```
...                          ...                    ...
62040                        0.0                    0.0
62041                        0.0                    0.0
62042                        0.0                    0.0
62043                        0.0                    0.0
62044                        0.0                    0.0

       first_browser_Safari  first_browser_SeaMonkey  first_browser_Silk  \
0                       0.0                      0.0                 0.0
1                       0.0                      0.0                 0.0
2                       0.0                      0.0                 0.0
3                       0.0                      0.0                 0.0
4                       1.0                      0.0                 0.0
...                     ...                      ...                 ...
62040                   0.0                      0.0                 0.0
62041                   0.0                      0.0                 0.0
62042                   0.0                      0.0                 0.0
62043                   1.0                      0.0                 0.0
62044                   0.0                      0.0                 0.0

       first_browser_SiteKiosk  first_browser_Sogou Explorer  \
0                          0.0                           0.0
1                          0.0                           0.0
2                          0.0                           0.0
3                          0.0                           0.0
4                          0.0                           0.0
...                        ...                           ...
62040                      0.0                           0.0
62041                      0.0                           0.0
62042                      0.0                           0.0
62043                      0.0                           0.0
62044                      0.0                           0.0

       first_browser_UC Browser  first_browser_Yandex.Browser  \
0                           0.0                           0.0
1                           0.0                           0.0
2                           0.0                           0.0
3                           0.0                           0.0
4                           0.0                           0.0
...                         ...                           ...
62040                       0.0                           0.0
62041                       0.0                           0.0
62042                       0.0                           0.0
62043                       0.0                           0.0
62044                       0.0                           0.0
```

```
       first_browser_w0SBrowser
0                           0.0
1                           0.0
2                           0.0
3                           0.0
4                           0.0
...                         ...
62040                       0.0
62041                       0.0
62042                       0.0
62043                       0.0
62044                       0.0

[62045 rows x 107 columns]
[5.44588605e-01 2.33056652e-01 2.21516641e-01 8.38101378e-04
 7.29937948e-01 2.39422999e-01 3.02683536e-02 3.70698686e-04
 1.61173342e-05 1.61173342e-05 2.73994681e-04 2.73994681e-04
 3.94874688e-03 9.67040052e-05 9.53743251e-01 4.17438956e-03
 9.67040052e-05 5.41542429e-03 1.12821339e-04 1.61173342e-05
 1.91796277e-03 1.93408010e-03 5.91506165e-03 5.96341365e-04
 3.38464018e-04 3.38464018e-04 1.32162140e-03 1.91796277e-03
 8.70336046e-04 6.44693368e-05 4.51285357e-04 1.61495689e-02
 2.73994681e-03 7.05890886e-01 9.42864050e-03 2.77218148e-03
 1.67507454e-01 1.98243211e-02 9.18365702e-02 4.83520026e-05
 2.24192119e-02 6.44693368e-05 3.22346684e-05 7.05890886e-01
 1.67620276e-03 2.77701668e-02 3.38464018e-04 2.29833186e-01
 3.22346684e-05 1.77290676e-04 2.25642679e-04 7.84914175e-03
 1.07986139e-03 1.61173342e-05 2.53042147e-03 1.61173342e-05
 2.54234830e-01 5.64106697e-04 2.28866146e-03 1.75276009e-01
 1.28455154e-02 8.02643243e-03 5.46764445e-01 8.10057217e-02
 6.85953743e-02 5.99419776e-01 2.50979128e-01 1.06583931e-01
 1.29905714e-02 4.96413893e-03 2.69610766e-01 8.02643243e-03
 1.85349343e-03 2.29301314e-01 5.95857845e-02 3.07083568e-01
 2.75445241e-01 1.45056008e-04 1.16850673e-02 1.45056008e-04
 5.80224031e-04 2.38875010e-01 3.08002256e-02 1.61173342e-04
 1.61173342e-05 8.07478443e-02 1.61173342e-05 5.92312032e-02
 1.32162140e-03 1.61173342e-05 1.12821339e-04 2.25642679e-04
 5.47989363e-04 1.66991700e-01 1.61173342e-05 6.44693368e-04
 6.44693368e-05 3.22346684e-05 1.61173342e-05 1.31082279e-01
 1.61173342e-05 7.73632041e-04 4.83520026e-05 1.61173342e-04
 1.61173342e-05 4.83520026e-05 1.61173342e-05]
```

```
array([[0.   , 2.071, 0.   , ..., 0.   , 0.   , 0.   ],
       [1.355, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       [1.355, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       ...,
       [1.355, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       [1.355, 0.   , 0.   , ..., 0.   , 0.   , 0.   ],
       [0.   , 2.071, 0.   , ..., 0.   , 0.   , 0.   ]])
```

```
            gender_-unknown-  gender_FEMALE  gender_MALE  gender_OTHER  \
id
5uwns89zht          0.000000       2.071425          0.0           0.0
jtl0dijy2j          1.355082       0.000000          0.0           0.0
xx0ulgorjt          1.355082       0.000000          0.0           0.0
6c6puo6ix0          1.355082       0.000000          0.0           0.0
czqhjk3yfe          1.355082       0.000000          0.0           0.0
...                      ...            ...          ...           ...
cv0na2lf5a          1.355082       0.000000          0.0           0.0
zp8xfonng8          1.355082       0.000000          0.0           0.0
fa6260ziny          1.355082       0.000000          0.0           0.0
87k0fy4ugm          1.355082       0.000000          0.0           0.0
9uqfg8txu3          0.000000       2.071425          0.0           0.0

            signup_method_basic  signup_method_facebook  signup_method_google  \
id
5uwns89zht             0.000000                  2.0437                   0.0
jtl0dijy2j             1.170461                  0.0000                   0.0
xx0ulgorjt             1.170461                  0.0000                   0.0
6c6puo6ix0             1.170461                  0.0000                   0.0
czqhjk3yfe             1.170461                  0.0000                   0.0
...                         ...                     ...                   ...
cv0na2lf5a             1.170461                  0.0000                   0.0
zp8xfonng8             1.170461                  0.0000                   0.0
fa6260ziny             1.170461                  0.0000                   0.0
87k0fy4ugm             1.170461                  0.0000                   0.0
9uqfg8txu3             1.170461                  0.0000                   0.0

            signup_method_weibo  language_-unknown-  language_ca  ...  \
id                                                                ...
5uwns89zht                  0.0                 0.0          0.0  ...
jtl0dijy2j                  0.0                 0.0          0.0  ...
xx0ulgorjt                  0.0                 0.0          0.0  ...
6c6puo6ix0                  0.0                 0.0          0.0  ...
czqhjk3yfe                  0.0                 0.0          0.0  ...
...                         ...                 ...          ...  ...
cv0na2lf5a                  0.0                 0.0          0.0  ...
zp8xfonng8                  0.0                 0.0          0.0  ...
fa6260ziny                  0.0                 0.0          0.0  ...
87k0fy4ugm                  0.0                 0.0          0.0  ...
9uqfg8txu3                  0.0                 0.0          0.0  ...

            first_browser_Opera Mobile  first_browser_Pale Moon  \
id
5uwns89zht                         0.0                      0.0
```

```
jtl0dijy2j                       0.0                     0.0
xx0ulgorjt                       0.0                     0.0
6c6puo6ix0                       0.0                     0.0
czqhjk3yfe                       0.0                     0.0
...                              ...                     ...
cv0na2lf5a                       0.0                     0.0
zp8xfonng8                       0.0                     0.0
fa6260ziny                       0.0                     0.0
87k0fy4ugm                       0.0                     0.0
9uqfg8txu3                       0.0                     0.0

            first_browser_Safari  first_browser_SeaMonkey  first_browser_Silk  \
id
5uwns89zht              0.000000                      0.0                 0.0
jtl0dijy2j              0.000000                      0.0                 0.0
xx0ulgorjt              0.000000                      0.0                 0.0
6c6puo6ix0              0.000000                      0.0                 0.0
czqhjk3yfe              2.762028                      0.0                 0.0
...                          ...                      ...                 ...
cv0na2lf5a              0.000000                      0.0                 0.0
zp8xfonng8              0.000000                      0.0                 0.0
fa6260ziny              0.000000                      0.0                 0.0
87k0fy4ugm              2.762028                      0.0                 0.0
9uqfg8txu3              0.000000                      0.0                 0.0

            first_browser_SiteKiosk  first_browser_Sogou Explorer  \
id
5uwns89zht                      0.0                           0.0
jtl0dijy2j                      0.0                           0.0
xx0ulgorjt                      0.0                           0.0
6c6puo6ix0                      0.0                           0.0
czqhjk3yfe                      0.0                           0.0
...                             ...                           ...
cv0na2lf5a                      0.0                           0.0
zp8xfonng8                      0.0                           0.0
fa6260ziny                      0.0                           0.0
87k0fy4ugm                      0.0                           0.0
9uqfg8txu3                      0.0                           0.0

            first_browser_UC Browser  first_browser_Yandex.Browser  \
id
5uwns89zht                       0.0                           0.0
jtl0dijy2j                       0.0                           0.0
xx0ulgorjt                       0.0                           0.0
6c6puo6ix0                       0.0                           0.0
```

```
czqhjk3yfe                      0.0                                0.0
...                             ...                                ...
cv0na2lf5a                      0.0                                0.0
zp8xfonng8                      0.0                                0.0
fa6260ziny                      0.0                                0.0
87k0fy4ugm                      0.0                                0.0
9uqfg8txu3                      0.0                                0.0

            first_browser_wOSBrowser
id
5uwns89zht                      0.0
jtl0dijy2j                      0.0
xx0ulgorjt                      0.0
6c6puo6ix0                      0.0
czqhjk3yfe                      0.0
...                             ...
cv0na2lf5a                      0.0
zp8xfonng8                      0.0
fa6260ziny                      0.0
87k0fy4ugm                      0.0
9uqfg8txu3                      0.0

[62045 rows x 107 columns]
```

Normalisation des variables quantitatives : centrage et réduction

Ici, nous appliquons une standardisation afin de centrer (soustraire la moyenne) et réduire (diviser par l'écart-type) nos données numériques pour garantir une échelle uniforme lors de leur utilisation dans les modèles.

In [145…

```
df_scaled = (df_quantitatives.values-np.mean(df_quantitatives.values,axis=0))/np.std(df_quantitatives.values,
df_scaled = pd.DataFrame(df_scaled, columns=df_quantitatives.columns, index=df_test.index)
display(df_scaled)
```

id	age	signup_flow
5uwns89zht	-0.150289	-0.693777
jtl0dijy2j	-0.082872	-0.693777
xx0ulgorjt	-0.082872	-0.693777
6c6puo6ix0	-0.082872	-0.693777
czqhjk3yfe	-0.082872	-0.693777
...	...	...
cv0na2lf5a	-0.419955	-0.693777
zp8xfonng8	1.602543	1.350003
fa6260ziny	-0.082872	-0.693777
87k0fy4ugm	-0.082872	-0.693777
9uqfg8txu3	0.793544	-0.693777

62045 rows × 2 columns

In [145…
```
test = pd.concat([df_dates, df_scaled, df_encoded], axis=1)
```

In [145…
```
print("Data de training:")
display(train)
```

```
Data de training:
```

id	date_account_created	timestamp_first_active	age	signup_flow	gender_-unknown-	gender_FEMALE	gender_MALE	gen
gxn3p5htnn	2010-06-28	2009-03-19 04:32:55	0.616295	-0.428185	1.491217	0.000000	0.000000	
820tgsjxq7	2011-05-25	2009-05-23 17:48:09	-0.331967	-0.428185	0.000000	0.000000	1.981087	
4ft3gnwmtx	2010-09-28	2009-06-09 23:12:47	1.090426	-0.035788	0.000000	1.843662	0.000000	
bjjt8pjhuk	2011-12-05	2009-10-31 06:01:29	-0.015879	-0.428185	0.000000	1.843662	0.000000	
87mebub9p4	2010-09-14	2009-12-08 06:11:05	-0.094901	-0.428185	1.491217	0.000000	0.000000	
...	...	...	...	...	...	...	...	
zxodksqpep	2014-06-30	2014-06-30 23:56:36	-0.806097	-0.428185	0.000000	0.000000	1.981087	
mhewnxesx9	2014-06-30	2014-06-30 23:57:19	0.616295	-0.428185	1.491217	0.000000	0.000000	
6o3arsjbb4	2014-06-30	2014-06-30 23:57:54	-0.806097	-0.428185	1.491217	0.000000	0.000000	
jh95kwisub	2014-06-30	2014-06-30 23:58:22	-0.331967	2.841790	1.491217	0.000000	0.000000	
nw9fwlyb5f	2014-06-30	2014-06-30 23:58:24	-0.331967	2.841790	1.491217	0.000000	0.000000	

212613 rows × 134 columns

In [146…

```
print("Dataset Target:")
display(df_target)
```

```
Dataset Target:
id
gxn3p5htnn      NDF
820tgsjxq7      NDF
4ft3gnwmtx       US
bjjt8pjhuk    other
87mebub9p4       US
              ...
zxodksqpep      NDF
mhewnxesx9      NDF
6o3arsjbb4      NDF
jh95kwisub      NDF
nw9fwlyb5f      NDF
Name: country_destination, Length: 212613, dtype: object
```

In [146…
```
print("Dataset de test:")
display(test)
```

```
Dataset de test:
```

id	date_account_created	timestamp_first_active	age	signup_flow	gender_-unknown-	gender_FEMALE	gender_MALE	genc
5uwns89zht	2014-07-01	2014-07-01 00:00:06	-0.150289	-0.693777	0.000000	2.071425	0.0	
jtl0dijy2j	2014-07-01	2014-07-01 00:00:51	-0.082872	-0.693777	1.355082	0.000000	0.0	
xx0ulgorjt	2014-07-01	2014-07-01 00:01:48	-0.082872	-0.693777	1.355082	0.000000	0.0	
6c6puo6ix0	2014-07-01	2014-07-01 00:02:15	-0.082872	-0.693777	1.355082	0.000000	0.0	
czqhjk3yfe	2014-07-01	2014-07-01 00:03:05	-0.082872	-0.693777	1.355082	0.000000	0.0	
...	...	...	...	...	...	...	...	
cv0na2lf5a	2014-09-30	2014-09-30 23:52:32	-0.419955	-0.693777	1.355082	0.000000	0.0	
zp8xfonng8	2014-09-30	2014-09-30 23:53:06	1.602543	1.350003	1.355082	0.000000	0.0	
fa6260ziny	2014-09-30	2014-09-30 23:54:08	-0.082872	-0.693777	1.355082	0.000000	0.0	
87k0fy4ugm	2014-09-30	2014-09-30 23:54:30	-0.082872	-0.693777	1.355082	0.000000	0.0	
9uqfg8txu3	2014-09-30	2014-09-30 23:59:01	0.793544	-0.693777	0.000000	2.071425	0.0	

62045 rows × 111 columns