Analyse des données LIDAR issues de la base nuScenes : qualification (semi-) automatique de l'analyse des interactions entre véhicules

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Soutenance TFE/Master – 03/09/21 – Tiffany DARINI

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Partie 1 : Contexte, enjeux et problématique

Les véhicules autonomes et le trafic

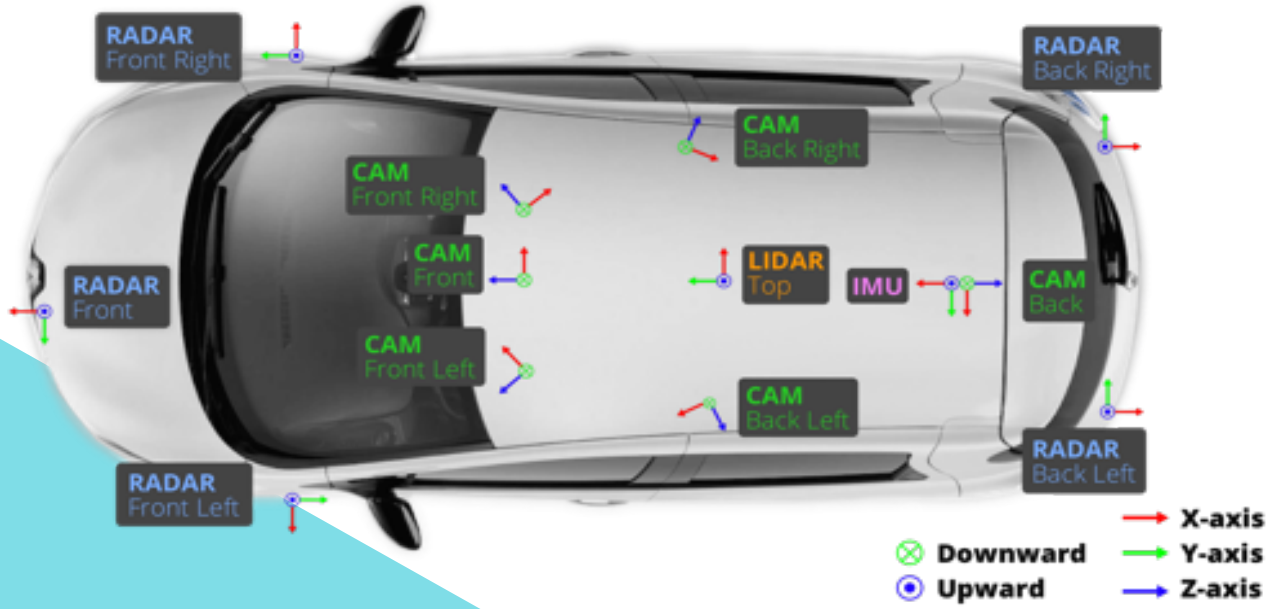
Bases de données

- KITTI (2013)
- Argoverse (2019)
- Waymo Open Dataset (2020)

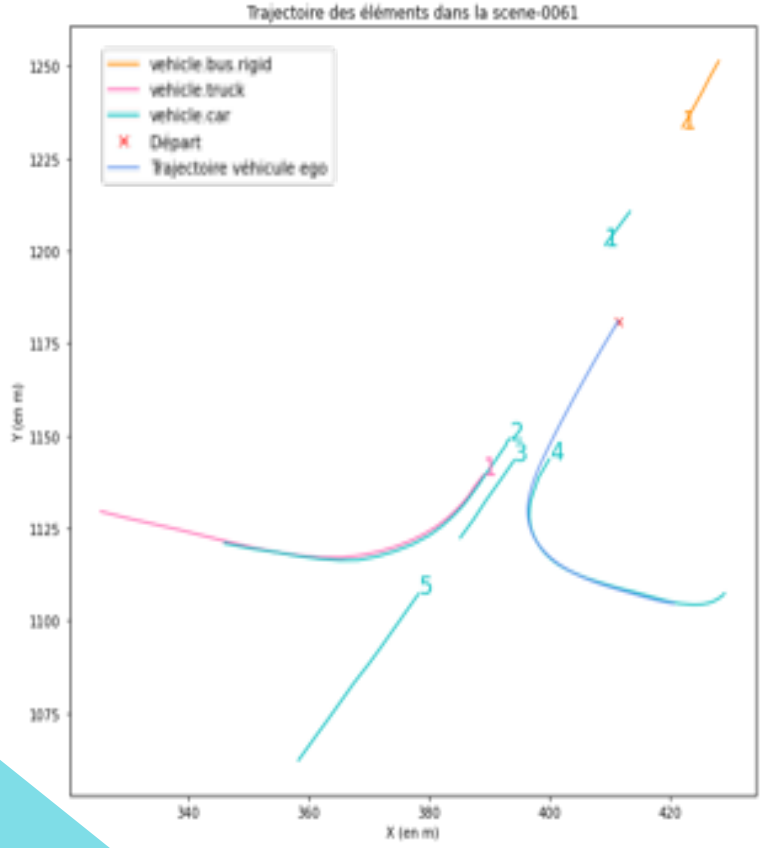
Peut-on utiliser les données issues de capteurs embarqués pour affiner la compréhension et la modélisation du trafic ?

La base de données d'étude : nuScenes

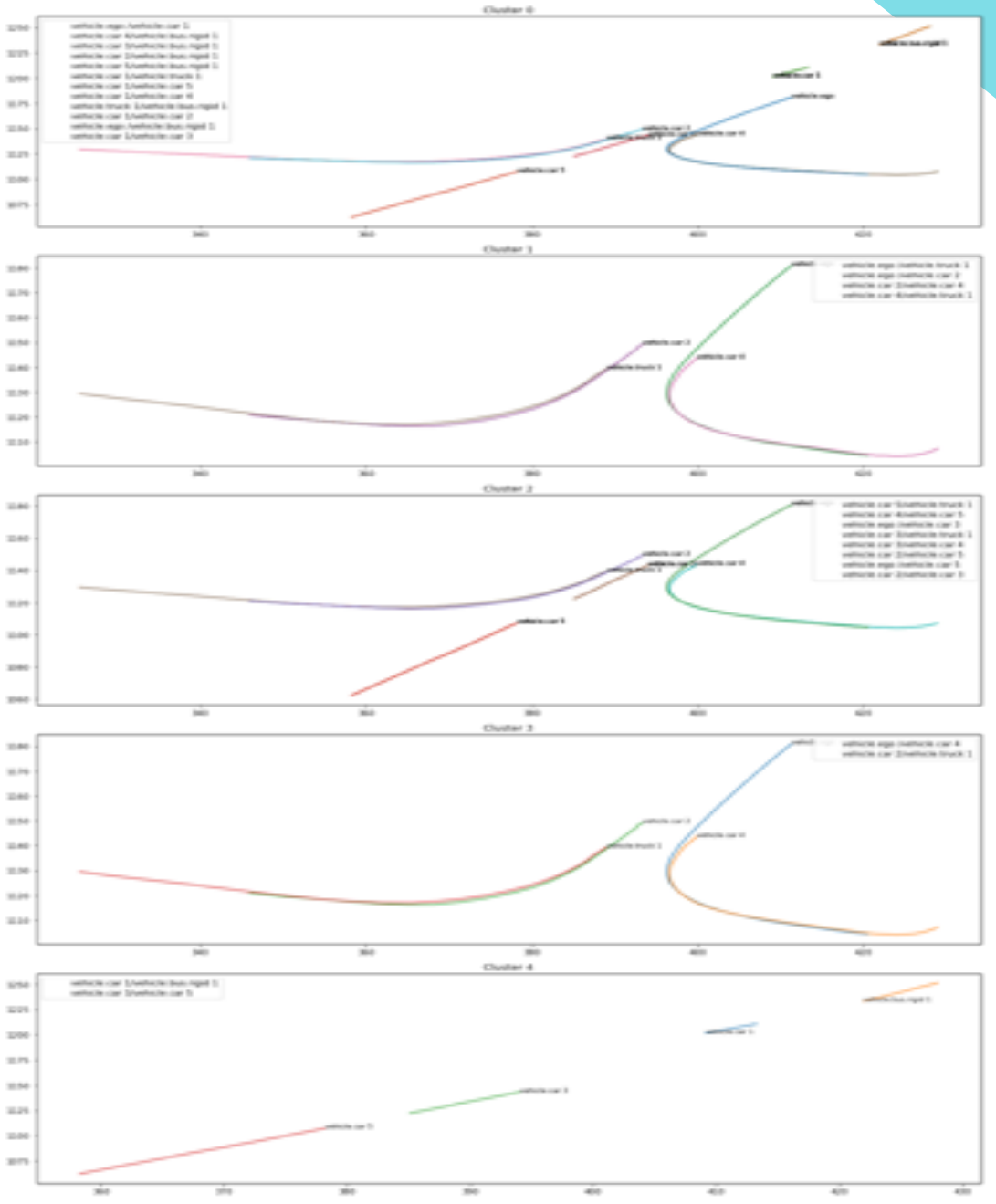
- 1000 scènes réalisées à Singapour et Boston
- 20s / scène



Les résultats attendus

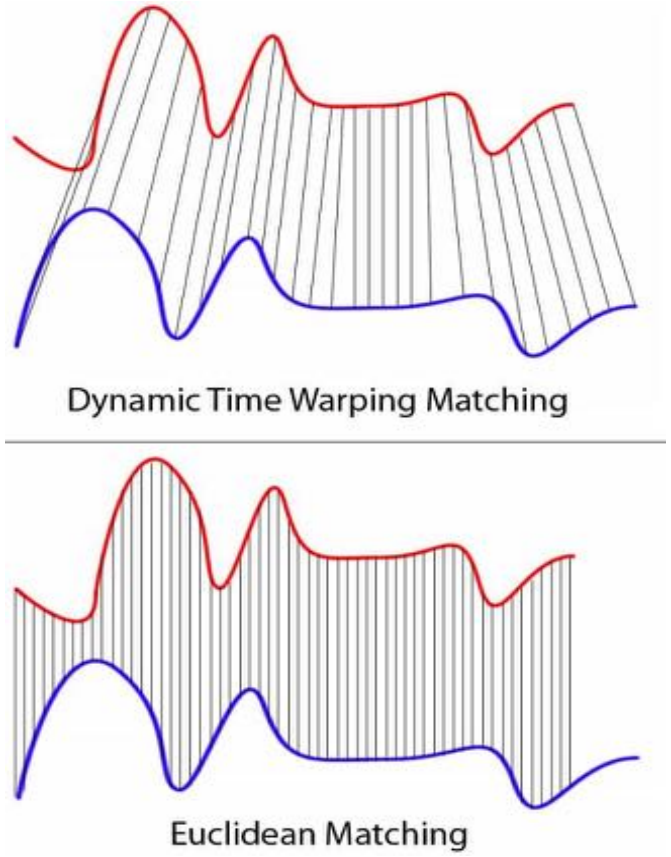


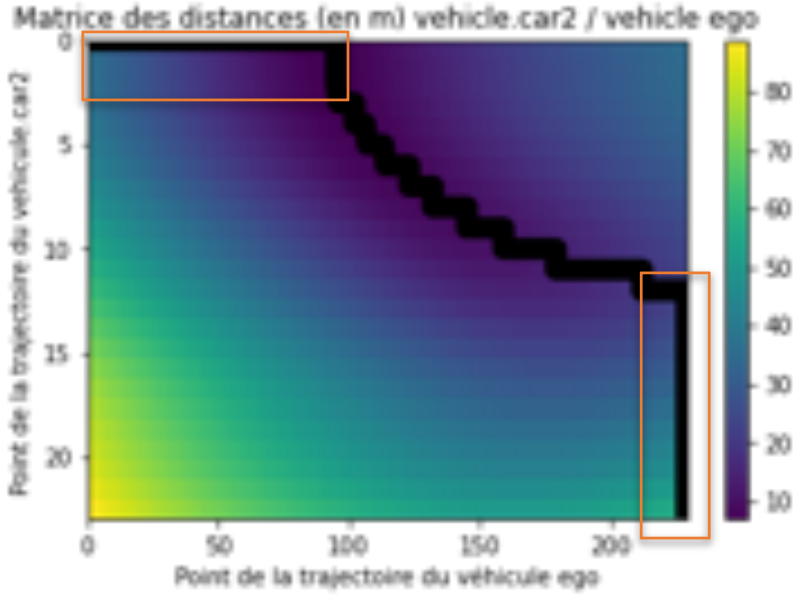
Classification des interactions

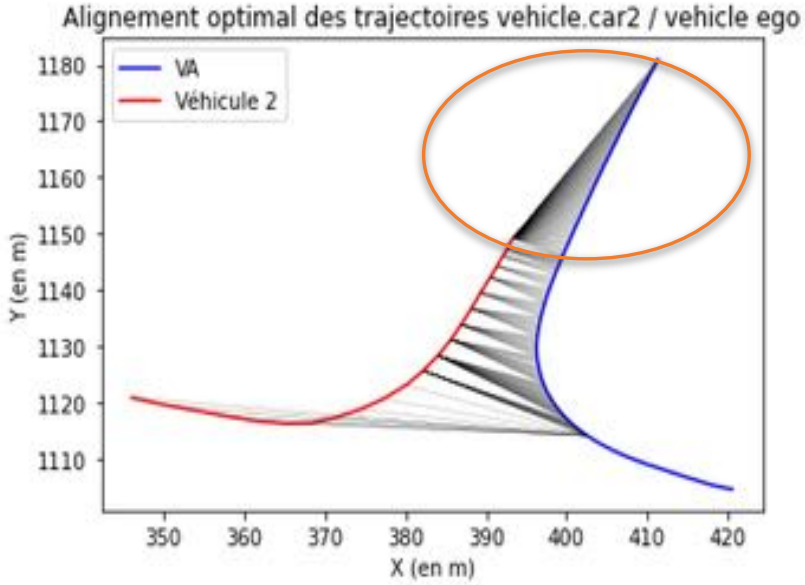


Partie 2 : Caractérisation des Interactions

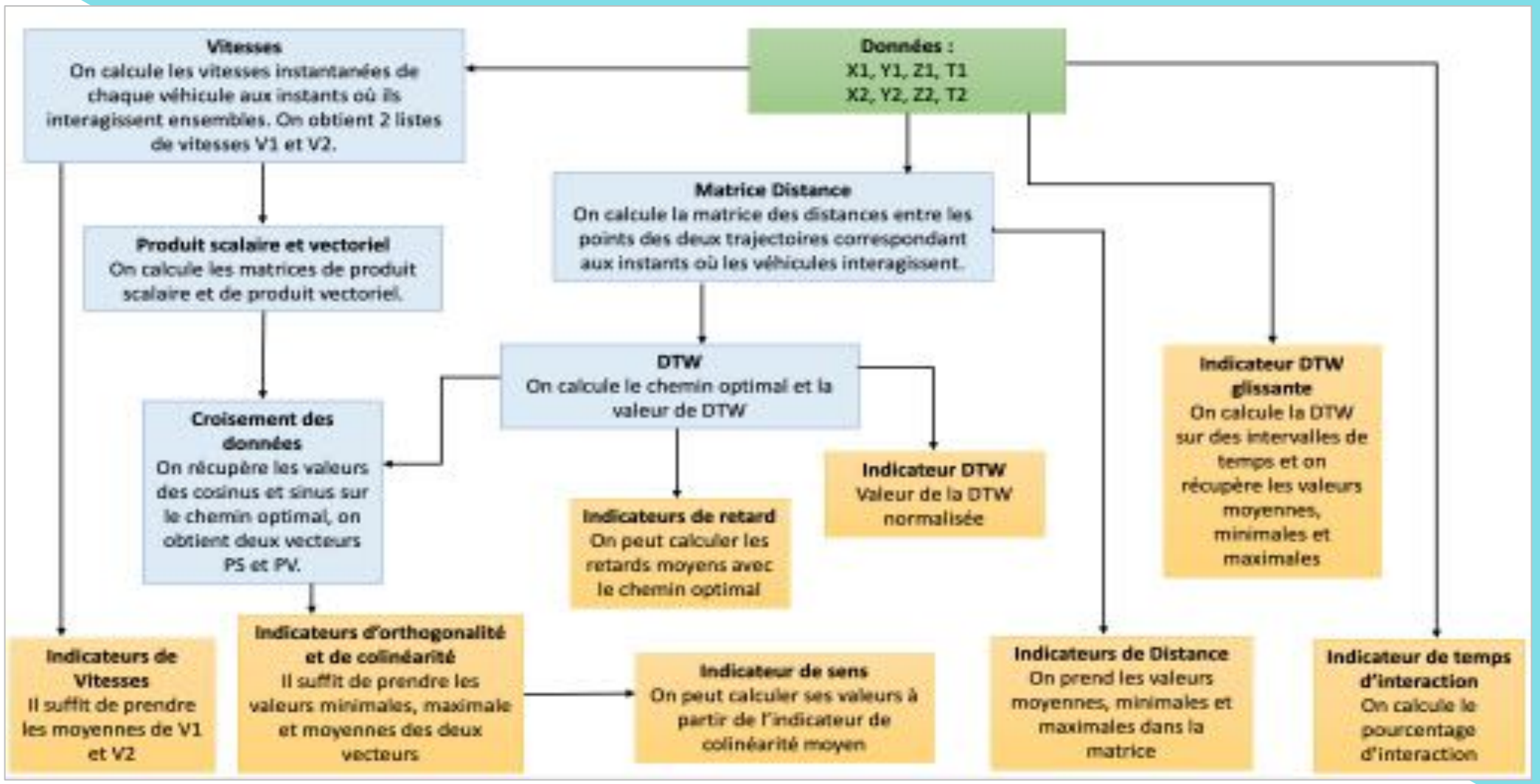
Similarité des trajectoires







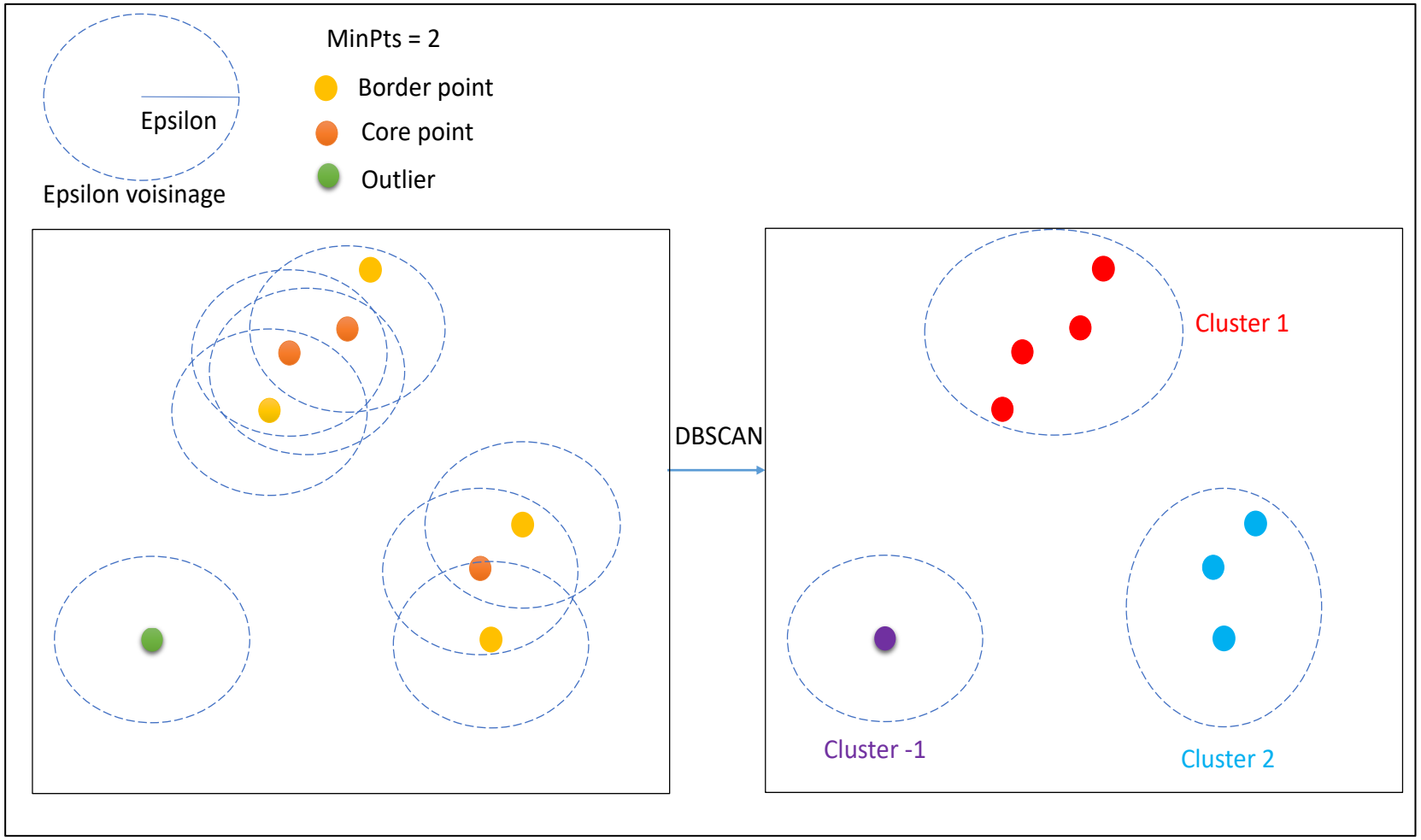
Les autres indicateurs



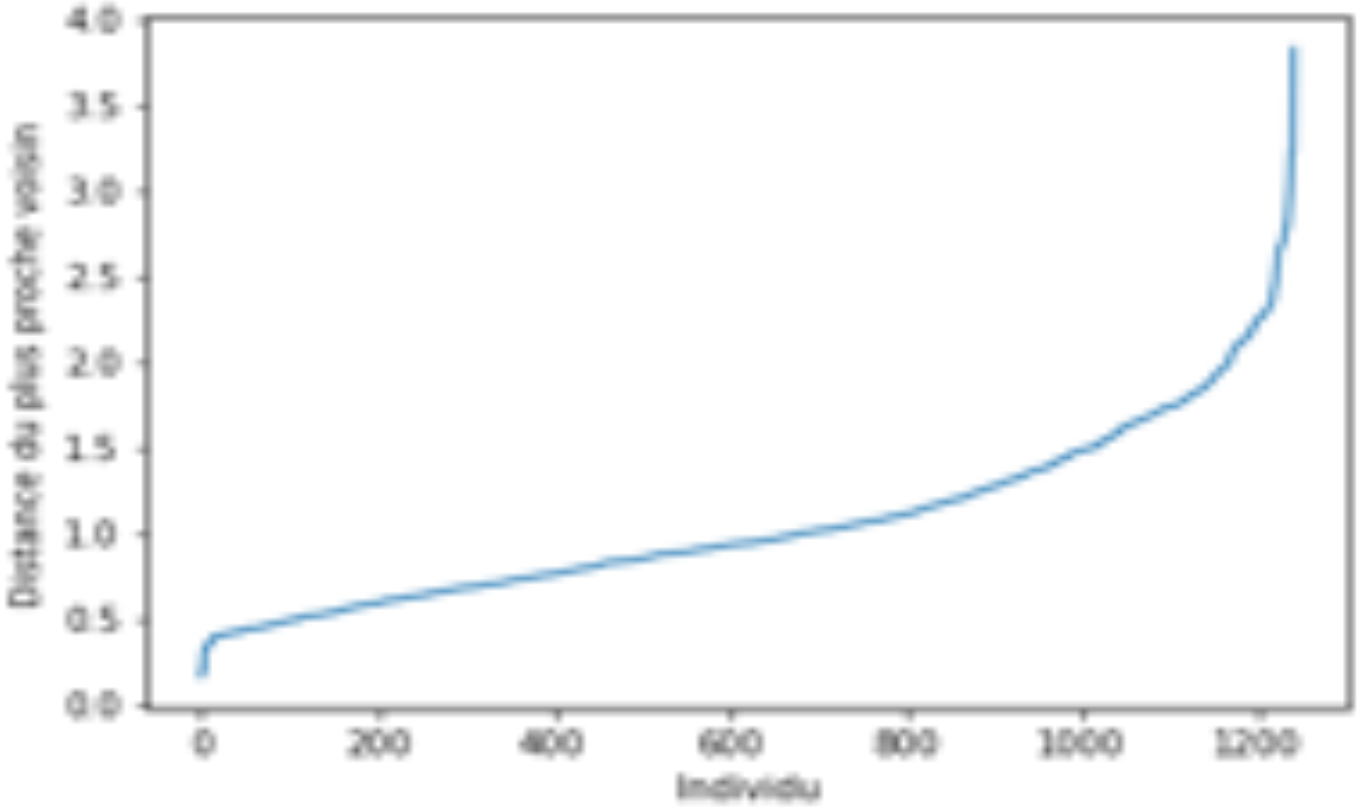
Partie 3 : Classification des Interactions

DBSCAN

- 2 paramètres :
  - Epsilon
  - MinPts
- 3 types de points
  - Core point
  - Border point
  - Outlier



Paramètres optimaux de DBSCAN

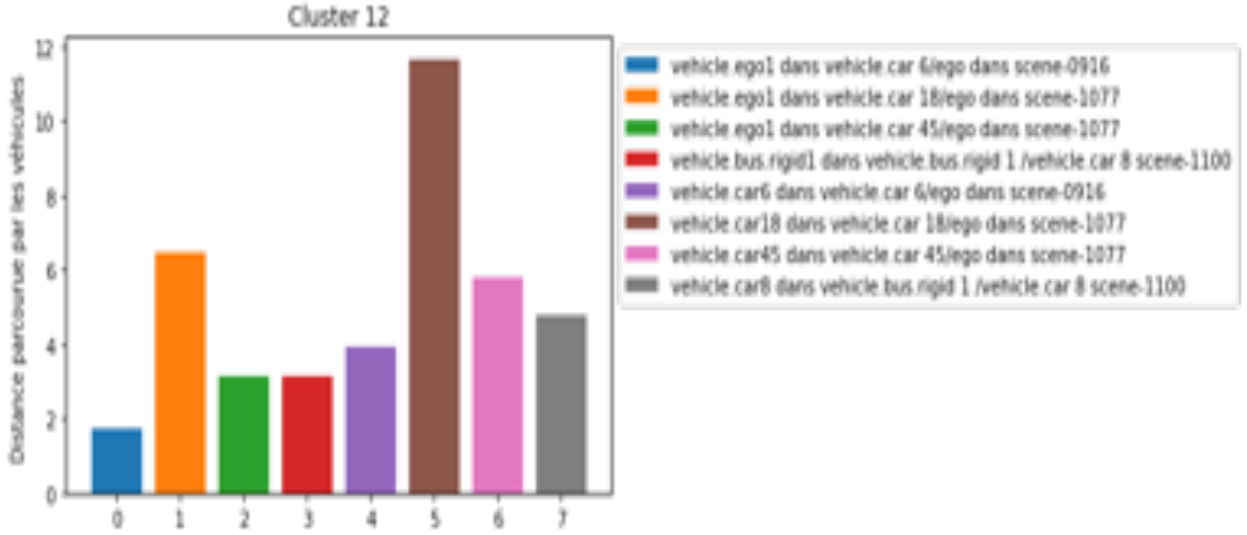


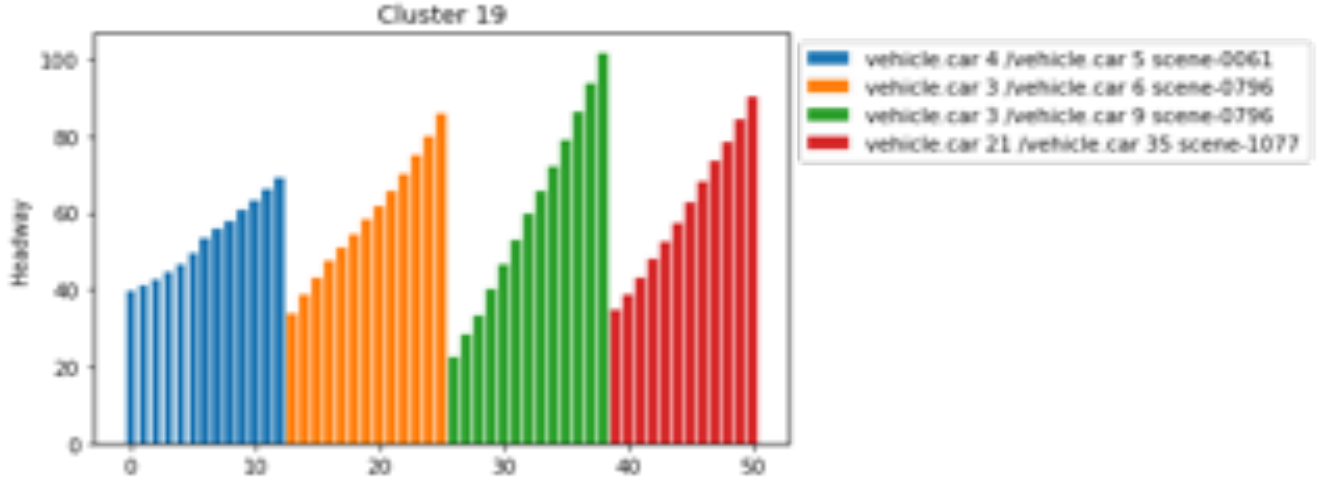
- Epsilon = 1.5
- MinPts = 2

68 clusters

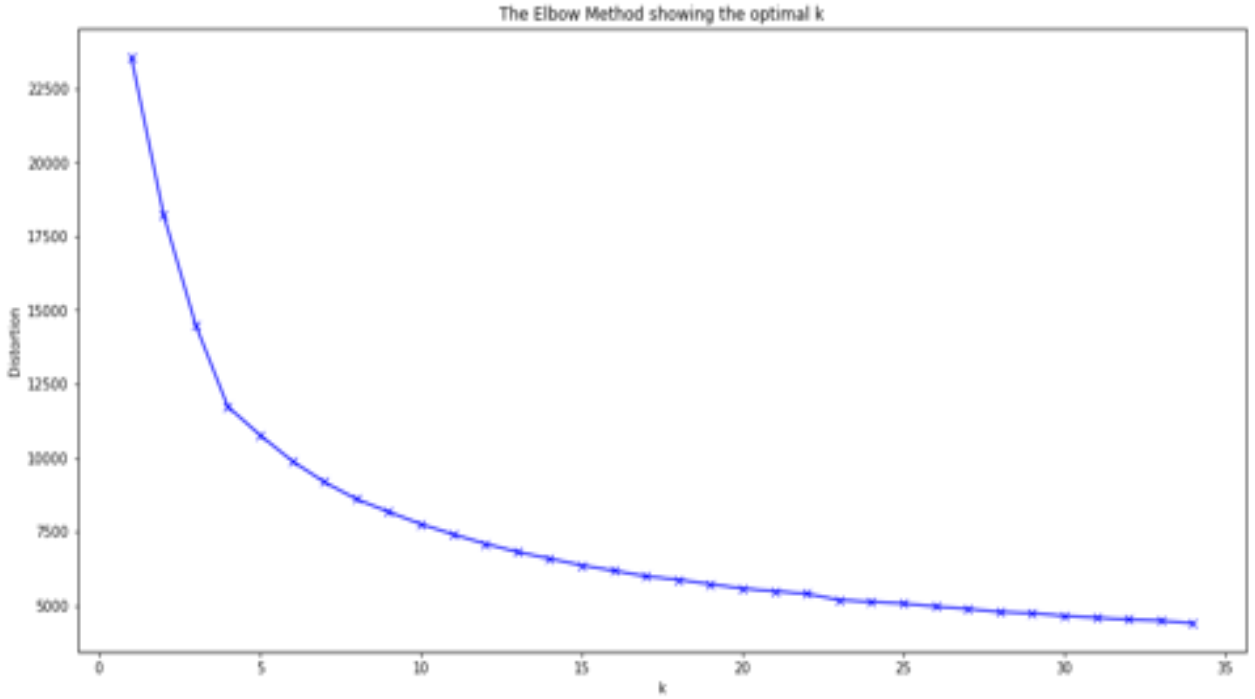
Analyse des clusters DBSCAN

	Distance intra-cluster moyenne	Variance
count	68.000000	6.800000e+01
mean	0.834821	1.030795e-01
std	0.636222	3.015279e-01
min	0.219973	0.000000e+00
25%	0.558568	7.318534e-32
50%	0.697944	3.081488e-31
75%	0.883214	8.086898e-02
max	4.523113	1.757898e+00

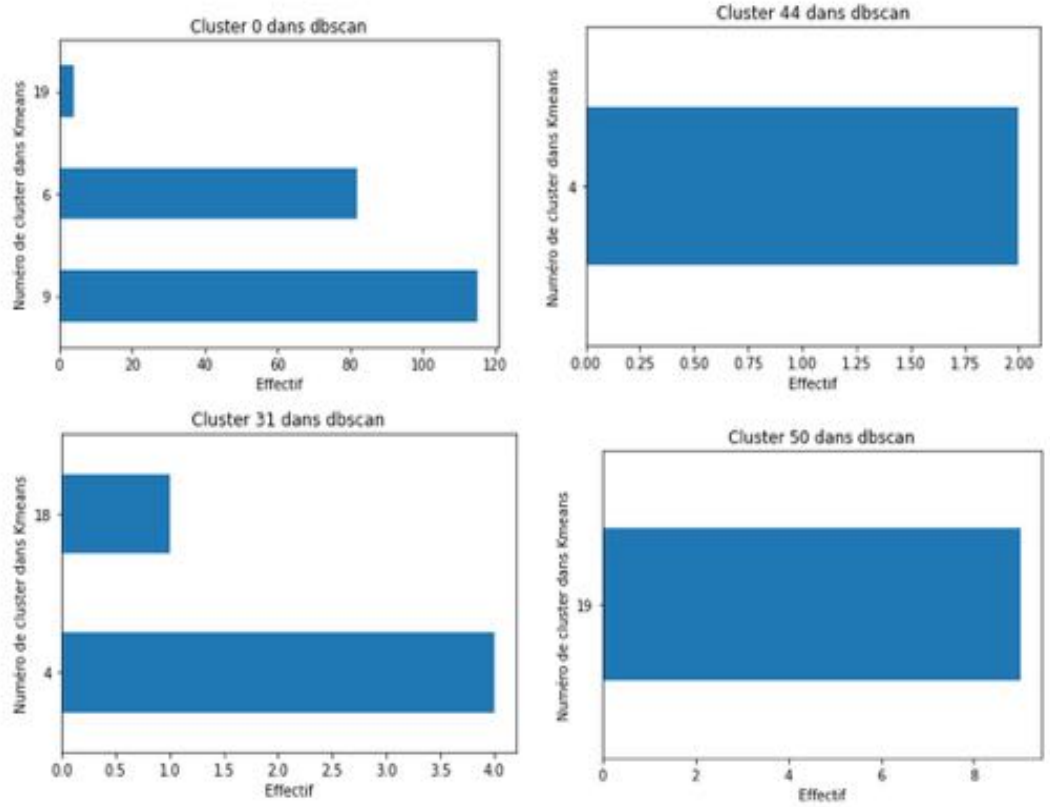




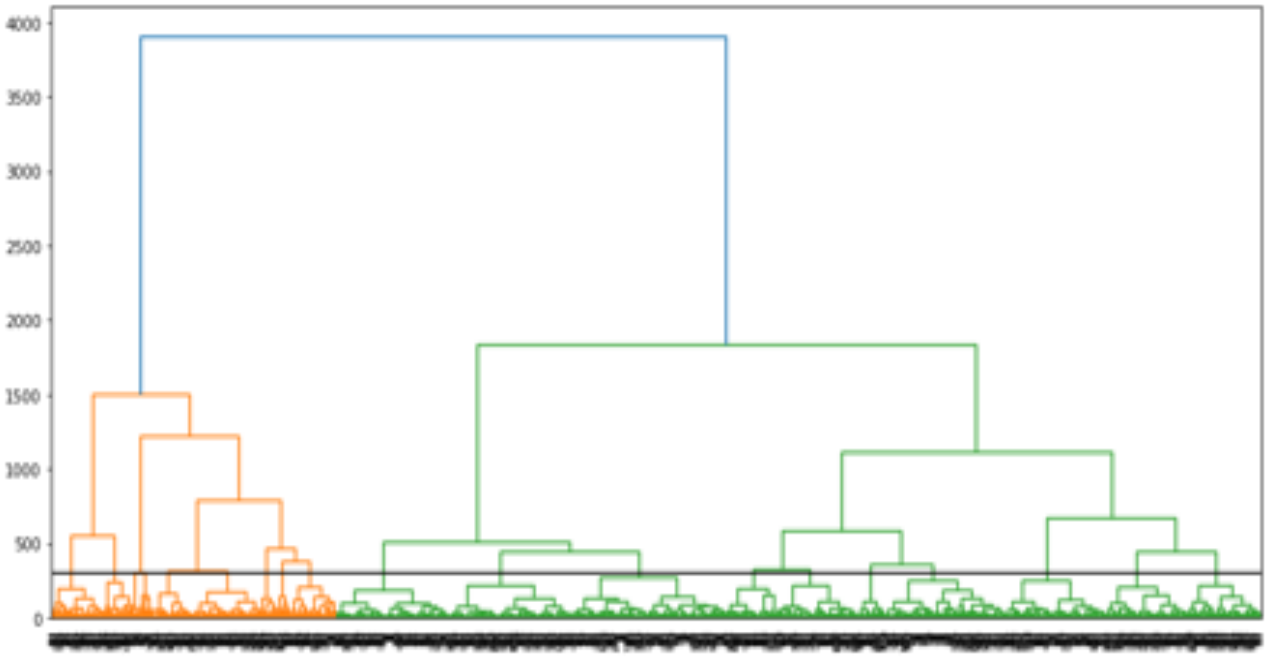
Classification des interactions : Kmeans



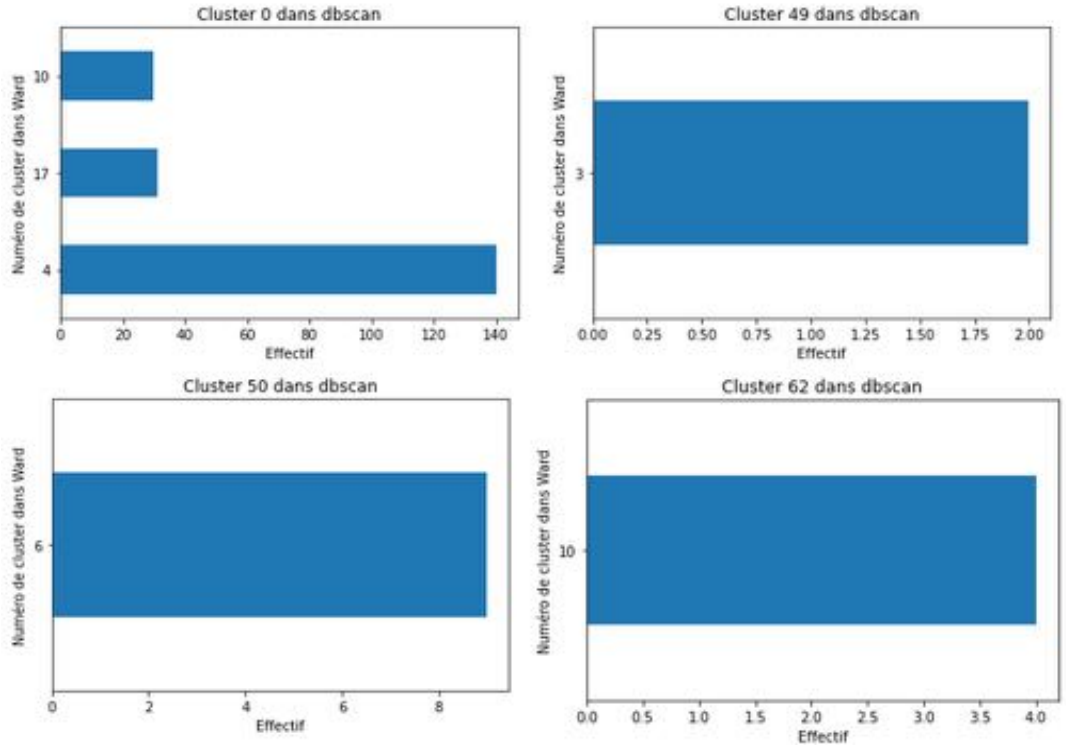
- K = 20



Classification des interactions : Ward

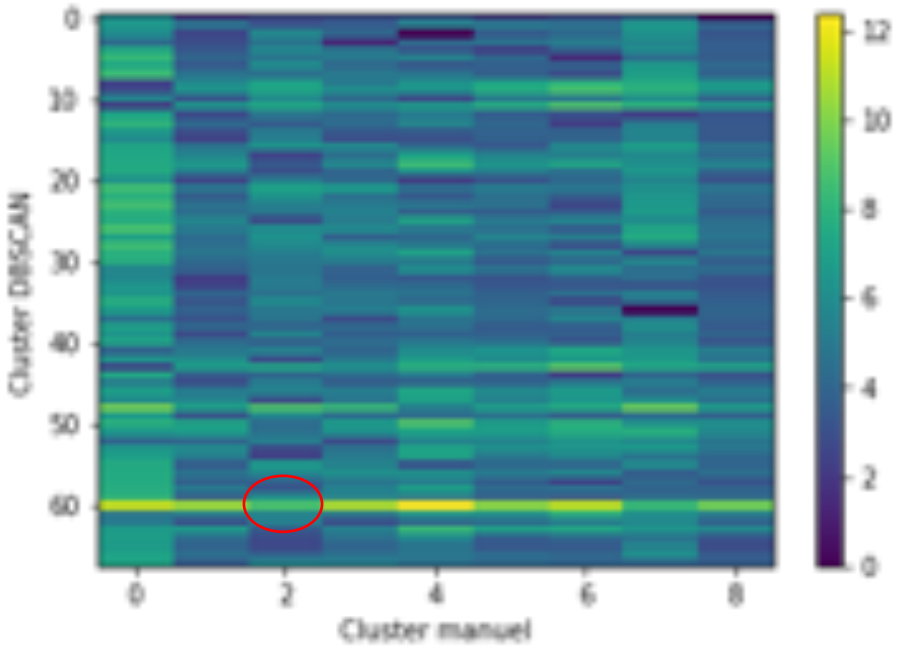


- K = 18



Classification manuelle des interactions

Type d'interaction	Clusters DBSCAN concernés	Numéro de cluster manuel
Car following	7, 8, 10, 40, 42, 60	0
Même sens sans car following	9, 13, 14, 19, 30, 31, 32, 34, 36, 38, 44, 45, 47, 51, 55, 61, 66	1
Véhicules en sens inverse	12, 15, 16, 17, 18, 24, 25, 37, 39, 41, 43, 46, 49, 50, 52, 53, 57, 62, 64, 65	2
Beaucoup de couple dans le cluster	0, 2, 11	3
Trajectoires qui se ressemblent, dans le même sens	1	4
Véhicule à l'arrêt	3, 59, 63	5
Trajectoires orthogonales	4, 5, 6, 20, 21, 22, 23, 27, 29, 56	6
Routes qui vont se croiser	35	7
Non classable	26, 28, 33, 48, 54, 58, -1	8



Classification semi-automatique des interactions

- **4 indicateurs** :
  - Orthogonalité
  - Sens
  - Distance
  - Retard

→ 54 clusters

	Cluster Dbscan	Cluster semi-automatique le plus proche	Classe correspondante (Orthogonalité, Sens, DTW, Retard)
0	-1	Cluster 17	Variable Variable Moyenne Grand
1	0	Cluster 0	Colinéaire Sens inverse Moyenne Moyen
2	1	Cluster 2	Variable Même sens Petite Grand
3	2	Cluster 7	Colinéaire Même sens Moyenne Petit
4	3	Cluster 20	Orthogonale Même sens Petite Grand
5	4	Cluster 9	Orthogonale Orthogonale Moyenne Petit
6	5	Cluster 2	Variable Même sens Petite Grand
7	6	Cluster 10	Variable Variable Petite Moyen
8	7	Cluster 4	Colinéaire Même sens Petite Grand
9	8	Cluster 5	Colinéaire Même sens Moyenne Grand
10	9	Cluster 35	Variable Même sens Petite Petit
11	10	Cluster 4	Colinéaire Même sens Petite Grand

Piste d'exploration : la méthode Latent Dirichlet Allocation (LDA)

"Arts"	"Budgets"	"Children"	"Education"
NEW	MILLION	CHILDREN	SCHOOL
FILM	TAX	WOMEN	STUDENTS
SHOW	PROGRAM	PEOPLE	SCHOOLS
MUSIC	BUDGET	CHILD	EDUCATION
MOVIE	BILLION	YEARS	TEACHERS
PLAY	FEDERAL	FAMILIES	HIGH
MUSICAL	YEAR	WORK	PUBLIC
BEST	SPENDING	PARENTS	TEACHER
ACTOR	NEW	SAYS	BENNETT
FIRST	STATE	FAMILY	MANIGAT
YORK	PLAN	WELFARE	NAMPHY
OPERA	MONEY	MEN	STATE
THEATER	PROGRAMS	PERCENT	PRESIDENT
ACTRESS	GOVERNMENT	CARE	ELEMENTARY
LOVE	CONGRESS	LIFE	HAITI

The William Randolph Hearst Foundation will give $1.25 million to Lincoln Center, Metropolitan Opera Co., New York Philharmonic and Juilliard School. "Our board felt that we had a real opportunity to make a mark on the future of the performing arts with these grants an act every bit as important as our traditional areas of support in health, medical research, education and the social services," Hearst Foundation President Randolph A. Hearst said Monday in announcing the grants. Lincoln Center's share will be $200,000 for its new building, which will house young artists and provide new public facilities. The Metropolitan Opera Co. and New York Philharmonic will receive $400,000 each. The Juilliard School, where music and the performing arts are taught, will get $250,000. The Hearst Foundation, a leading supporter of the Lincoln Center Consolidated Corporate Fund, will make its usual annual $100,000 donation, too.

Piste d'exploration : la méthode Latent Dirichlet Allocation (LDA)

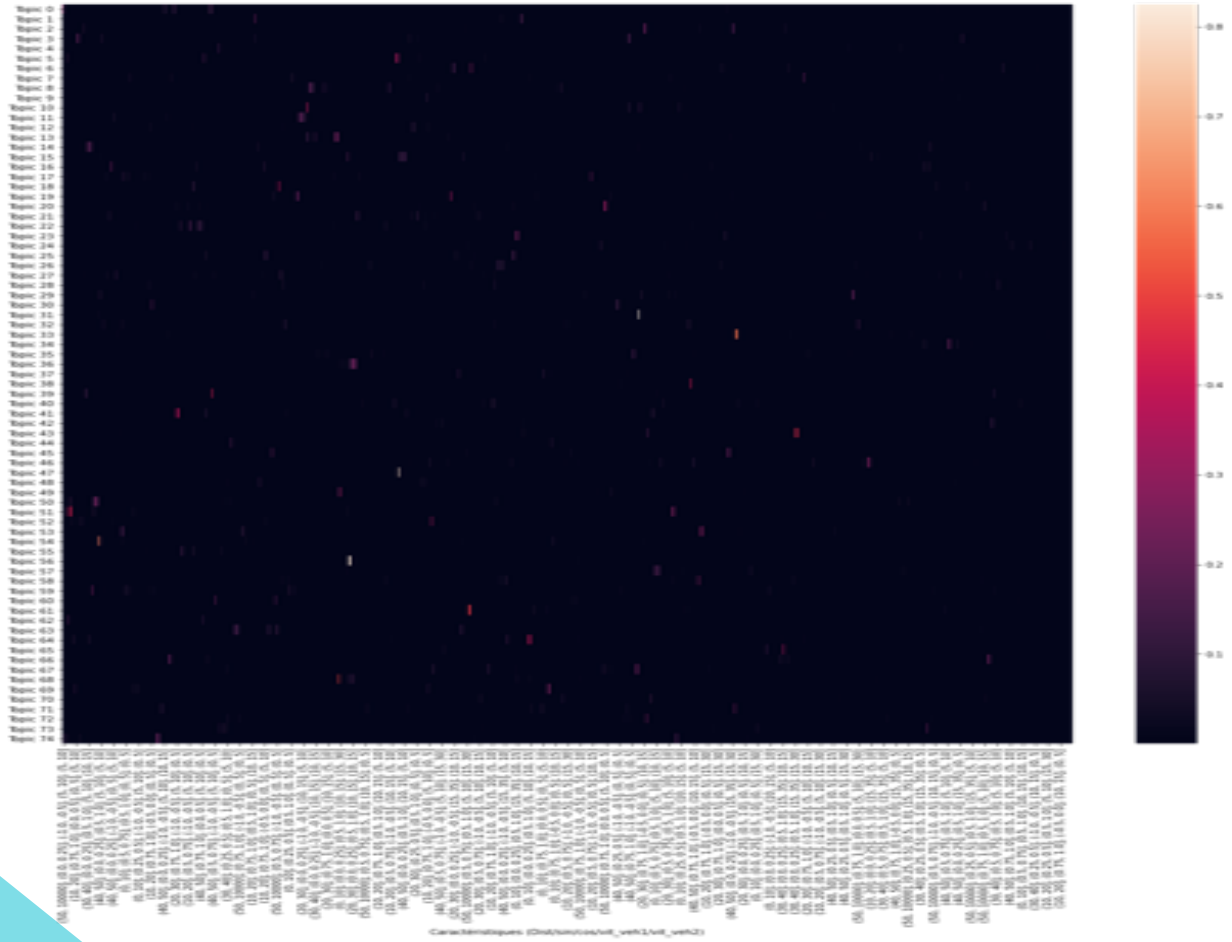
- 5 indicateurs :
  - Distance
  - Sinus
  - Cosinus
  - Vitesse Véhicule 1
  - Vitesse Véhicule 2

MOTS

DOCUMENTS

tout	([50, 10000]; [0.0, 0.25]; [-1.0, -0.5]; [5, 10]; [5, 10]]	([20, 30]; [0.0, 0.25]; [-1.0, -0.5]; [5, 10]; [5, 10]]	([0, 10]; [0.0, 0.25]; [0.5, 1.0]; [5, 10]; [0, 5]]	([10, 20]; [0.0, 0.25]; [0.5, 1.0]; [5, 10]; [0, 5]]	([20, 30]; [0.0, 0.25]; [0.5, 1.0]; [5, 10]; [0, 5]]	([0, 10]; [0.0, 0.25]; [0.5, 1.0]; [5, 10]; [5, 10]]	([10, 20]; [0.5, 0.75]; [0.5, 1.0]; [0, 5]; [5, 10]]	([0, 10]; [0.25, 0.5]; [0.5, 1.0]; [5, 10]; [5, 10]]	([10, 20]; [0.75, 1.0]; [0.0, 0.5]; [0, 5]; [5, 10]]	([10, 20]; [0.75, 1.0]; [0.5, 1.0]; [0, 5]; [5, 10]]	...	([0, 10]; [0.75, 1.0]; [0.5, 1.0]; [10, 15]; [5, 10]]	([0, 10]; [0.75, 1.0]; [0.0, 0.5]; [10, 15]; [0, 5]]	([10, 20]; [0.75, 1.0]; [-0.5, 0.0]; [10, 15]; [0, 5]]	([10, 20]; [0.75, 1.0]; [-0.5, 0.0]; [15, 35]; [0, 5]]	([10, 20]; [0.5, 0.75]; [-1.0, -0.5]; [10, 15]; [0, 5]]
vehicle.bus.rigid 1/ego dans scene-0061	1.0	0.0	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0
vehicle.car 1/ego dans scene-0061	0.0	1.0	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0
vehicle.car 2/ego dans scene-0061	0.0	0.0	0.197479	0.12605	0.105042	0.084034	0.084034	0.079832	0.071429	0.071429	...	0.0	0.0	0.0	0.0	0.0
vehicle.car 3/ego dans scene-0061	0.0	0.0	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0
vehicle.car 4/ego dans scene-0061	0.0	0.0	0.125984	0.00000	0.000000	0.089239	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
vehicle.car 11 /vehicle.motorcycle 1 scene-1100	0.0	0.0	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0
vehicle.car 11 /vehicle.motorcycle 2 scene-1100	0.0	0.0	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0
vehicle.car 12 /vehicle.motorcycle 1 scene-1100	0.0	0.0	0.000000	0.00000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	...	0.0	0.0	0.0	0.0	0.0

Piste d'exploration : la méthode Latent Dirichlet Allocation (LDA)



Résultats pour une classe de 30 couples en car following

Topic dominant	
49	5
59	5
50	4
68	4
51	2
19	1
22	1
43	1
71	1

dtype: int64

	Catégorie dominante				
	Distance	**Sinus**	**Cosinus**	**Vitesse véh 1**	**Vitesse véh 2**
Topic 49	[0 ; 10]	[0 ; 0.25]	[0.5 ; 1]	[10 ; 15]	[15 ; 30]
Topic 59	[0 ; 10]	[0 ; 0.25]	[0.5 ; 1]	[0 ; 5]	[0 ; 5]
Topic 50	[20 ; 30]	[0 ; 0.25]	[0.5 ; 1]	[5 ; 10]	[5 ; 10]
Topic 68	[0 ; 10]	[0 ; 0.25]	[0.5 ; 1]	[10 ; 15]	[10 ; 15]
Topic 51	[0 ; 10]	[0 ; 0.25]	[0.5 ; 1]	[5 ; 10]	[5 ; 10]
Topic 19	[50 ; 10000]	[0 ; 0.25]	[-1 ; -0.05]	[15 ; 35]	[10 ; 15]
Topic 22	[20 ; 30]	[0.75 ; 1]	[0 ; 0.5]	[5 ; 10]	[0 ; 5]
Topic 43	[50 ; 10000]	[0 ; 0.25]	[0.5 ; 1]	[15 ; 35]	[5 ; 10]
Topic 71	[50 ; 10000]	[0.25 ; 0.5]	[0.5 ; 1]	[10 ; 15]	[5 ; 10]

Partie 4 : Conclusion et perspectives

Peut-on utiliser les données issues de capteurs embarqués pour affiner la compréhension et la modélisation du trafic ?

Avantages :

- Données riches et exploitables
- Possibilité de calculer de nombreux indicateurs de trafic

Inconvénients :

- Difficultés à trouver une méthode donnant de bons résultats
- Difficultés d'interprétation

Merci pour votre attention !