



# Sequence 6: movement



**Fiche de synthèse mobilisée** (collection en français) :

- Fiche n°6 : mouvement, position, vitesse, accélération



**Sommaire des activités ETLV :**

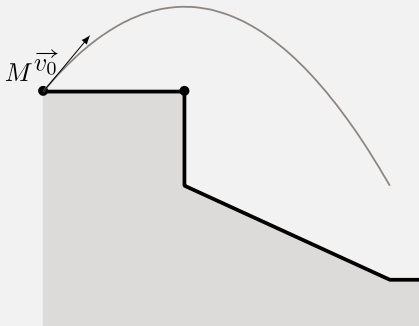
- ACTIVITY 1: Trajectory of a pinguin jumping off a cliff
- ACTIVITY 2: Speed of the pinguin

## ACTIVITY 1: Trajectory of a pinguin jumping off a cliff

**Objective:** understanding how to plot a trajectory

### DOCUMENT 1: Movement of the pinguin

A pinguin jumps off a cliff to dive into the ocean with an initial speed. His movement is observed, and his position is referenced versus time.



Source: wikimedia commons

### DOCUMENT 2: Position and time

His position, of coordinates x and y, is entered using the code Python:

```

1 | x = [0. , 0.28 , 0.56 , 0.85 , 1.13 , 1.41 , 1.70 , 1.98 ,
   |   2.26 , 2.54]
2 | y = [10.0 , 10.22 , 10.32 , 10.30 , 10.16 , 9.90 , 9.51 ,
   |   9.01 , 8.39 , 7.64]

```

Time is also coded as a list:

```

3 | t = [0. , 0.11 , 0.22 , 0.33 , 0.44 , 0.55 , 0.67 ,
   |   0.78 , 0.89 , 1. ]

```

N = len(x) #number of values

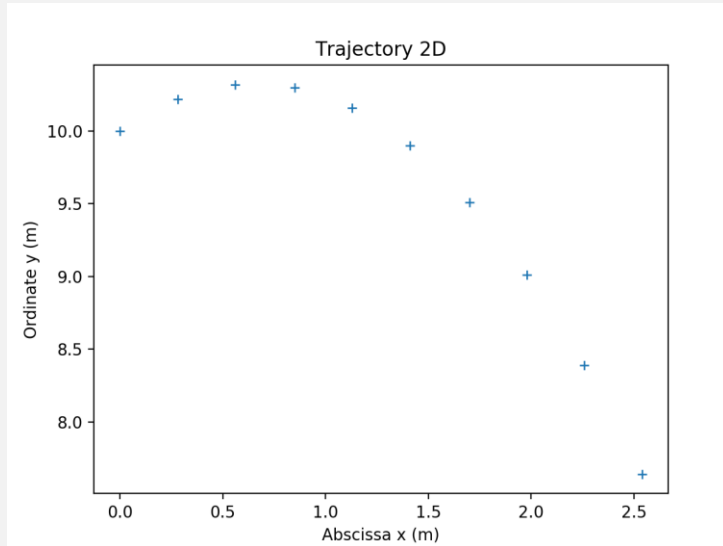


### DOCUMENT 3: Plotting the trajectory

Instructions are then entered in order to plot the trajectory:

```
plt.plot(x,y,'+')#plotting using crosses
```

```
plt.show()
```



#### ■ Acquiring vocabulary:

Using the previous documents, find a translation for the following expressions:

English	French
trajectory	
to plot	
	abscisse
	ordonnées
	le langage (informatique)
	des valeurs

#### ■ Understanding:

In order to plot the trajectory of the penguin, which variable needs to be plotted against which other variable?

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What is the initial position of the penguin?

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## ACTIVITY 2: Speed of the penguin

**Objective:** computing speed at a given position

### DOCUMENT 1: Computing speed

Each position can be referred to using indexes: for example,  $x[i]$  and  $y[i]$  at index  $i$  and  $x[i+1]$  and  $y[i+1]$  at index  $i+1$ .

Speed at index  $i$  can be computed using:

$$v_x[i] = \frac{x[i+1] - x[i]}{t[i+1] - t[i]} \quad \text{and} \quad v_y[i] = \frac{y[i+1] - y[i]}{t[i+1] - t[i]}$$

Careful:  $v_x[N-1]$  and  $v_y[N-1]$  cannot be computed as  $x[N]$  and  $y[N]$  do not exist. Indeed, indexes stop at  $N-1$ .

### DOCUMENT 3: Computing speed using Python

```
#Computing speed
vx=[]
vy=[]
for i in range(0,N-1):
    vx.append((x[i+1]-x[i])/(t[i+1]-t[i]))
    vy.append((y[i+1]-y[i])/(t[i+1]-t[i]))
```

### DOCUMENT 3: Plotting speed using Python

```
#Plotting speed
plt.figure('Traj')
plt.plot(x,y,'+-')
for i in range(0,N-1):
    plt.arrow(x[i],y[i],vx[i]*0.2,vy[i]*0.2,head_width=0.05)
plt.title("Trajectory et speed vectors")
plt.xlabel("Abscissa x (m)")
plt.ylabel("Ordinate y (m)")
plt.savefig("Traj_v")
plt.show()
```

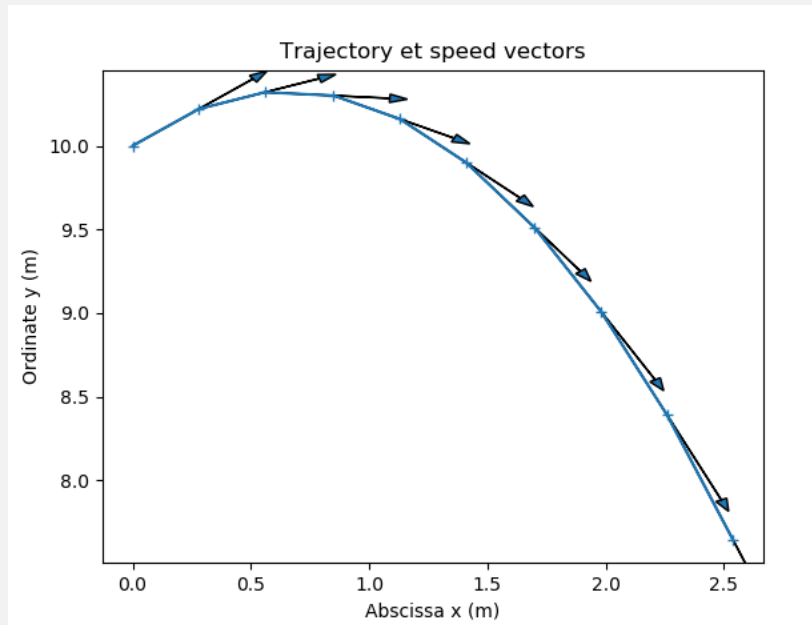
#### ■ Understanding and applying:

Which mathematical expressions are used in order to compute speed coordinates  $v_x$  and  $v_y$  (using  $x$  and  $y$ )?

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### DOCUMENT 4: Plotting speed vectors



#### ■ Reinvesting, going further:

In the above graph, speed vectors  $\vec{v}$  are plotted in blue at each position of the penguin. What can be said with regards to speed vectors and trajectory?

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In your opinion, why is the vector not plotted at the last position of the penguin?

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# Activity summary

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What you must remember:

- **speed**
- **plotting**
- **abscissa**
- **ordinates**

Skills linked to the curriculum:

Compétences	Capacités à maîtriser	Où dans cette séquence ?
APP	<ul style="list-style-type: none"><li>• Utiliser du vocabulaire spécifique</li><li>• Faire le lien entre la vitesse moyenne obtenue à partir des mesures de positions et la vitesse associée au nombre dérivé.</li><li>• Citer et exploiter la relation entre les coordonnées de la position et celles du vecteur vitesse.</li></ul>	Activités 1 et 2
	Lire et comprendre des documents scientifiques	Activités 1 et 2
ANA	Mettre en lien des documents pour émettre des hypothèses en réponse à une question scientifique	Activité 2
COM	S'exprimer à l'écrit en utilisant le vocabulaire adapté	Activités 1 et 2
REA	<ul style="list-style-type: none"><li>• Utiliser un modèle</li><li>• Capacité numérique : représenter graphiquement l'évolution temporelle des coordonnées de position et la trajectoire à partir d'un tableau de valeurs de positions ;</li><li>• Capacité numérique : calculer les coordonnées du vecteur vitesse à partir d'un tableau de valeurs de positions ;</li></ul>	Activité 2