# exoNote2TP9-gr1B_sujet

March 8, 2023

## 1 Exercice noté

### 1.1 groupe 1B – jeudi 16 mars

### 1.2 NOM :

### 1.3 Prénom :

On a fait un certain nombre de mesures successives. On a 30 valeurs comprises entre -2 et -1 dans un tableau nommé tabx. Les différentes mesures sont ensuite effectuées pour ces valeurs là.

Ces mesures sont mises dans un second tableau qui se compose de 40 séries de 30 valeurs qui correspondent donc à 40 séries de mesures correspondants aux valeurs de tabx.

[1]:
```
import numpy as np
import matplotlib.pyplot as plt

tabx=np.array([-2.   , -1.966, -1.931, -1.897, -1.862, -1.828, -1.793, -1.759,
       -1.724, -1.69 , -1.655, -1.621, -1.586, -1.552, -1.517, -1.483,
       -1.448, -1.414, -1.379, -1.345, -1.31 , -1.276, -1.241, -1.207,
       -1.172, -1.138, -1.103, -1.069, -1.034, -1.   ])

mesures=np.array([[-0.528, -0.43 , -0.125, -0.077, -0.092, -0.23 , -0.42 , -0.
 ↪396,
        -0.268, -0.22 , -0.519, -0.234, -0.096, -0.468, -0.1  , -0.067,
        -0.021, -0.48 , -0.282, -0.157, -0.012, -0.023, -0.222, -0.361,
         0.006, -0.403, -0.416, -0.449, -0.043, -0.34 ],
       [-0.364, -0.132, -0.407, -0.289, -0.146, -0.49 , -0.236, -0.338,
        -0.108, -0.214, -0.435, -0.158, -0.03 , -0.058, -0.404, -0.337,
        -0.333, -0.052, -0.04 , -0.105, -0.152, -0.263, -0.378, -0.295,
        -0.476, -0.445, -0.182, -0.143,  0.023, -0.336],
       [-0.194, -0.352, -0.313, -0.467, -0.428, -0.316, -0.322, -0.288,
        -0.394, -0.186, -0.337, -0.208, -0.218, -0.218, -0.228, -0.487,
        -0.267, -0.432, -0.266, -0.013, -0.224, -0.347, -0.008, -0.007,
        -0.102, -0.117, -0.246, -0.009, -0.101, -0.224],
       [-0.102, -0.19 , -0.221, -0.387, -0.424, -0.518, -0.496, -0.046,
        -0.3  , -0.492, -0.459, -0.376, -0.092, -0.218, -0.334, -0.079,
        -0.473, -0.05 , -0.354, -0.317, -0.438, -0.121, -0.11 , -0.159,
        -0.472, -0.173, -0.218, -0.377, -0.243, -0.282],
       [-0.42 , -0.35 , -0.561, -0.217, -0.538, -0.084, -0.082, -0.518,
```

```
 -0.3  , -0.114, -0.283, -0.446, -0.122, -0.446, -0.27 , -0.475,
 -0.185, -0.324, -0.062, -0.081, -0.34 , -0.393, -0.266, -0.287,
 -0.168, -0.211, -0.014, -0.359, -0.031, -0.206],
[-0.382, -0.344, -0.399, -0.403, -0.092, -0.242, -0.538, -0.074,
 -0.244, -0.494, -0.527, -0.178, -0.158, -0.188, -0.264, -0.101,
 -0.149, -0.304, -0.446, -0.025, -0.41 , -0.259, -0.342, -0.003,
 -0.21 , -0.345, -0.324, -0.023, -0.141, -0.44 ],
[-0.57 , -0.556, -0.127, -0.453, -0.166, -0.292, -0.272, -0.274,
 -0.136, -0.452, -0.395, -0.178, -0.502, -0.446, -0.16 , -0.239,
 -0.105, -0.42 , -0.48 , -0.027, -0.264, -0.115, -0.138, -0.257,
 -0.166,  0.011, -0.376, -0.201, -0.341, -0.234],
[-0.276, -0.42 , -0.343, -0.383, -0.432, -0.53 , -0.056, -0.348,
 -0.31 , -0.308, -0.503, -0.256, -0.314, -0.43 , -0.248, -0.365,
 -0.375, -0.152, -0.446, -0.121, -0.11 , -0.195, -0.004, -0.057,
 -0.41 , -0.377, -0.212, -0.025, -0.203, -0.38 ],
[-0.32 , -0.33 , -0.161, -0.539, -0.27 , -0.094, -0.31 , -0.172,
 -0.52 , -0.506, -0.033, -0.358, -0.204, -0.412, -0.372, -0.221,
 -0.185, -0.314, -0.2  , -0.321, -0.484, -0.475, -0.328, -0.371,
 -0.42 , -0.399, -0.418, -0.413, -0.131, -0.334],
[-0.216, -0.266, -0.295, -0.093, -0.46 , -0.424, -0.11 , -0.108,
 -0.046, -0.514, -0.315, -0.406, -0.298, -0.126, -0.204, -0.345,
 -0.451, -0.086, -0.146, -0.393, -0.174, -0.473, -0.132, -0.089,
 -0.224, -0.065, -0.386, -0.053, -0.239, -0.088],
[-0.456, -0.32 , -0.327, -0.401, -0.218, -0.152, -0.388, -0.196,
 -0.384, -0.342, -0.369, -0.286, -0.428, -0.19 , -0.288, -0.167,
 -0.365, -0.434, -0.114, -0.023, -0.162, -0.109,  0.006, -0.395,
 -0.16 , -0.067, -0.242, -0.059, -0.171, -0.234],
[-0.484, -0.152, -0.353, -0.467, -0.19 , -0.492, -0.136, -0.468,
 -0.462, -0.384, -0.099, -0.378, -0.058, -0.368, -0.312, -0.383,
 -0.427, -0.066, -0.258, -0.261, -0.438, -0.045, -0.284, -0.289,
 -0.06 , -0.197, -0.27 , -0.181, -0.355, -0.13 ],
[-0.496, -0.356, -0.103, -0.339, -0.178, -0.184, -0.466, -0.176,
 -0.366, -0.428, -0.079, -0.212, -0.51 , -0.292, -0.348, -0.217,
 -0.115, -0.384, -0.448, -0.087, -0.484, -0.129, -0.352, -0.139,
 -0.4  , -0.411, -0.362, -0.193, -0.371, -0.184],
[-0.194, -0.352, -0.273, -0.523, -0.184, -0.142, -0.544, -0.156,
 -0.452, -0.516, -0.175, -0.256, -0.052, -0.36 , -0.362, -0.227,
 -0.227, -0.144, -0.312, -0.205, -0.14 , -0.109, -0.124, -0.033,
 -0.188, -0.185, -0.446, -0.187, -0.137, -0.08 ],
[-0.188, -0.268, -0.515, -0.555, -0.346, -0.38 , -0.47 , -0.06 ,
 -0.262, -0.35 , -0.409, -0.44 , -0.104, -0.288, -0.084, -0.209,
 -0.449, -0.336, -0.408, -0.263, -0.366, -0.317, -0.082, -0.223,
 -0.056, -0.175, -0.158, -0.157, -0.031, -0.186],
[-0.36 , -0.284, -0.329, -0.535, -0.33 , -0.484, -0.426, -0.348,
 -0.286, -0.452, -0.363, -0.448, -0.184, -0.218, -0.362, -0.433,
 -0.381, -0.196, -0.316, -0.407, -0.15 , -0.049, -0.172, -0.157,
 -0.27 , -0.215, -0.378, -0.131, -0.035, -0.128],
```

```
      [-0.448, -0.418, -0.291, -0.513, -0.552, -0.328, -0.08 , -0.424,
       -0.314, -0.046, -0.311, -0.154, -0.086, -0.03 , -0.104, -0.089,
       -0.321, -0.38 , -0.34 , -0.111, -0.146, -0.051, -0.02 , -0.099,
       -0.106, -0.193, -0.142, -0.229, -0.135, -0.458],
      [-0.342, -0.284, -0.257, -0.231, -0.172, -0.232, -0.082, -0.402,
       -0.154, -0.374, -0.257, -0.188, -0.096, -0.25 , -0.454, -0.445,
       -0.341, -0.286, -0.112, -0.127, -0.158, -0.421, -0.12 , -0.159,
       -0.078, -0.335, -0.046, -0.147, -0.345,  0.028],
      [-0.322, -0.174, -0.217, -0.125, -0.34 , -0.236, -0.284, -0.156,
       -0.47 , -0.35 , -0.219, -0.504, -0.046, -0.246, -0.438, -0.219,
       -0.423, -0.454, -0.264, -0.295, -0.058, -0.293, -0.266, -0.059,
       -0.102, -0.219, -0.422, -0.445, -0.043, -0.066],
      [-0.514, -0.192, -0.387, -0.085, -0.4  , -0.2  , -0.302, -0.518,
       -0.468, -0.512, -0.159, -0.394, -0.436, -0.332, -0.116, -0.369,
       -0.337, -0.312, -0.076, -0.271, -0.366, -0.209, -0.23 , -0.043,
       -0.022, -0.353,  0.002, -0.367, -0.099, -0.186],
      [-0.252, -0.258, -0.137, -0.267, -0.532, -0.262, -0.208, -0.426,
       -0.082, -0.294, -0.497, -0.368, -0.084, -0.294, -0.47 , -0.321,
       -0.021, -0.482, -0.348, -0.437, -0.16 , -0.115, -0.246, -0.425,
       -0.108, -0.439, -0.354, -0.409, -0.361, -0.406],
      [-0.468, -0.136, -0.185, -0.539, -0.502, -0.406, -0.096, -0.408,
       -0.198, -0.26 , -0.481, -0.206, -0.058, -0.204, -0.256, -0.351,
       -0.503, -0.356, -0.038, -0.331, -0.046, -0.135, -0.222, -0.241,
       -0.454, -0.121, -0.396, -0.063, -0.125, -0.434],
      [-0.11 , -0.482, -0.117, -0.435, -0.43 , -0.378, -0.088, -0.478,
       -0.06 , -0.182, -0.305, -0.034, -0.092, -0.036, -0.194, -0.477,
       -0.333, -0.052, -0.044, -0.157, -0.324, -0.009, -0.274, -0.225,
       -0.21 , -0.023, -0.082, -0.211, -0.333, -0.05 ],
      [-0.482, -0.284, -0.439, -0.443, -0.126, -0.296, -0.208, -0.39 ,
       -0.394, -0.124, -0.411, -0.128, -0.142, -0.508, -0.144, -0.459,
       -0.387, -0.42 , -0.368, -0.325, -0.43 , -0.245, -0.438, -0.275,
       -0.32 , -0.021, -0.048, -0.093, -0.061, -0.2  ],
      [-0.176, -0.528, -0.305, -0.299, -0.414, -0.396, -0.478, -0.4  ,
       -0.216, -0.27 , -0.517, -0.498, -0.21 , -0.306, -0.084, -0.373,
       -0.301, -0.068, -0.134, -0.051, -0.376, -0.313, -0.114, -0.401,
       -0.152, -0.065, -0.464, -0.297, -0.357, -0.378],
      [-0.48 , -0.288, -0.225, -0.397, -0.236, -0.368, -0.07 , -0.042,
       -0.132, -0.314, -0.363, -0.344, -0.314, -0.344, -0.056, -0.485,
       -0.223, -0.176, -0.306, -0.271, -0.458, -0.313, -0.314, -0.153,
       -0.04 , -0.467, -0.204, -0.177, -0.465, -0.106],
      [-0.202, -0.158, -0.169, -0.243, -0.302, -0.474, -0.46 , -0.416,
       -0.38 , -0.504, -0.267, -0.222, -0.374, -0.206, -0.258, -0.165,
       -0.419, -0.026, -0.342, -0.045, -0.458, -0.471, -0.276, -0.263,
       -0.34 , -0.411, -0.21 , -0.385, -0.101, -0.414],
      [-0.458, -0.362, -0.277, -0.323, -0.454, -0.488, -0.292, -0.052,
       -0.408, -0.348, -0.515, -0.236, -0.42 , -0.462, -0.476, -0.173,
       -0.151, -0.026, -0.398, -0.147, -0.246, -0.177, -0.17 , -0.207,
```

```
       -0.46 , -0.439, -0.38 , -0.035, -0.407, -0.188],
      [-0.126, -0.292, -0.391, -0.241, -0.396, -0.408, -0.25 , -0.396,
       -0.392, -0.134, -0.265, -0.346, -0.408, -0.254, -0.104, -0.497,
       -0.055, -0.118, -0.14 , -0.089, -0.146, -0.477, -0.154, -0.299,
       -0.06 , -0.159, -0.06 , -0.147, -0.305, -0.018],
      [-0.214, -0.356, -0.155, -0.287, -0.488, -0.524, -0.176, -0.088,
       -0.26 , -0.06 , -0.359, -0.508, -0.17 , -0.448, -0.5  , -0.165,
       -0.263, -0.38 , -0.324, -0.355, -0.124, -0.387, -0.318, -0.101,
       -0.13 , -0.169, -0.284, -0.321, -0.043,  0.004]])
```

1. Calculer la mesure maximale.

[2]:
```
# à compléter
```

```
maximum  0.028
```

2. Calculer le tableau moyennes qui contient les 30 valeurs moyennes des 30 séries.

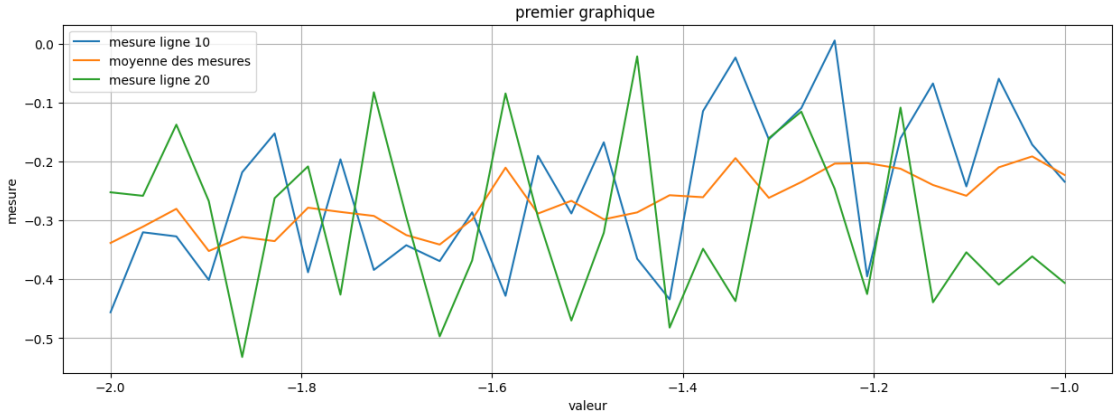
[3]:
```
# à compléter
```

```
tableau des moyennes  [-0.33813333 -0.31046667 -0.28013333 -0.35186667
-0.32793333 -0.335
 -0.2782     -0.2854     -0.2922     -0.3248     -0.34086667 -0.29826667
 -0.2102     -0.2882     -0.26646667 -0.298      -0.2862     -0.257
 -0.2604     -0.19393333 -0.26146667 -0.2346     -0.20326667 -0.2024
 -0.21193333 -0.2396     -0.25793333 -0.20953333 -0.191      -0.2226    ]
```

3. Faire un graphique comme sur la figure ci-dessous: on représentera

- le tableau des moyennes
- le tableau de la ligne 10
- le tableau de la ligne 20

[4]:
```
# à compléter
```



4. Cette “courbe” ressemble à une courbe polynomiale. On souhaite donc trouver les paramètres $a,b,c,d $ de la fonction $f(t) = ax**5 + bx**3 + c*x + d$ qui passe au mieux par les points du tableau moyennes.

Utilisez la fonction `scipy.optimize.curve_fit` pour déterminer les paramètres a,b,c,d de cette fonction.

[5]:
```
import scipy.optimize

# à compléter
```

```
a= -0.017785246609251997 b= 0.13863329732356056 c= -0.3142247636685328 d=
-0.40690813435401824
```

5. On affichera le ‘résidu moyen’ (écart entre modèle et données) au moyen de $r = \frac{\sqrt{\sum (f(t)-t_i)^2}}{N}$.

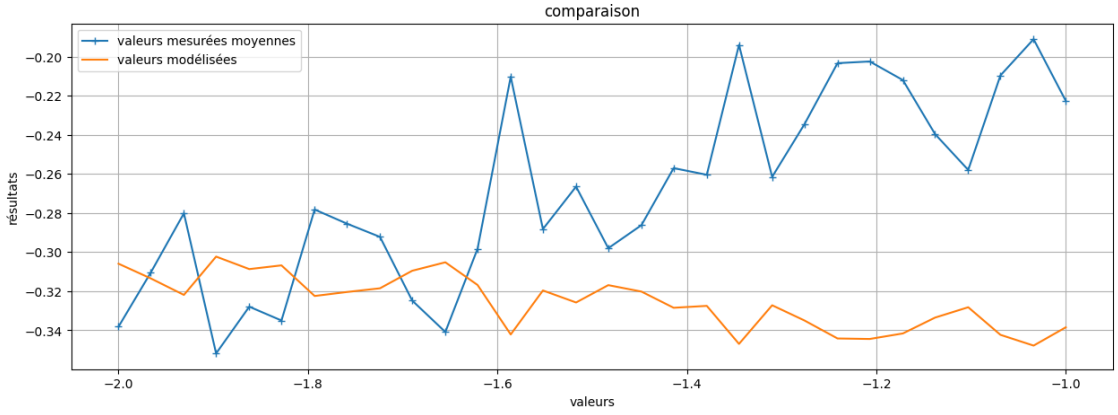
Il s’agit de la moyenne des écarts au carré entre le modèle et les données, où $N$ est le nombre de points.

[6]:
```
# à compléter
```

```
résidu moyen avec les moyennes: 0.0050309278336533
```

6. Tracer sur la même courbe la moyenne des données relevées et la courbe obtenue avec la fonction d’estimation (calculées ci-dessus).

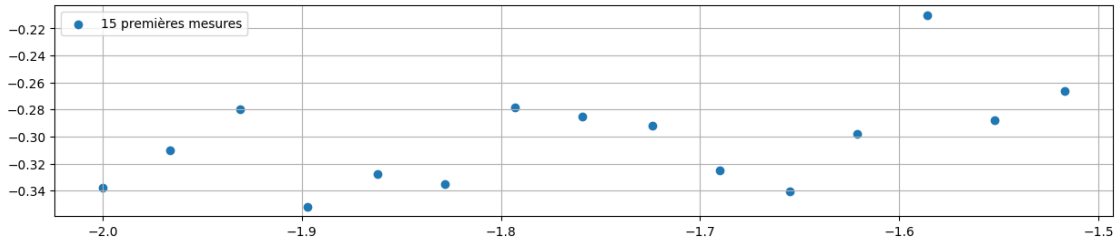
[7]:
```
# à compléter
```




7. Interpolation

Dans cette partie, on va s’interesser aux 15 premières valeurs de tref (et aux résultats associées dans mesures). Représenter les 10 points correspondants sur un graphique.

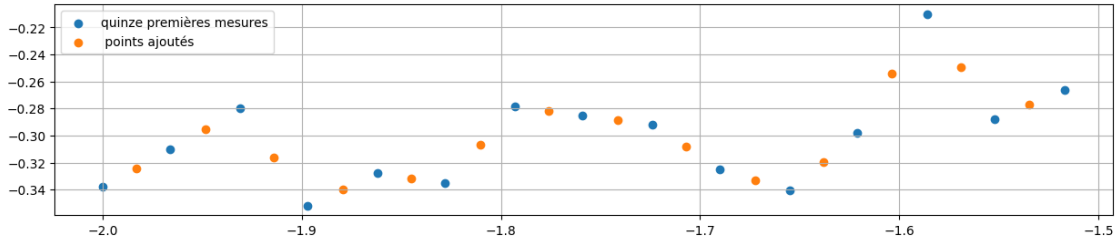
[8]:
```
# à compléter
```




8. Pour mieux visualiser la courbe ajouter sur le dessin les points “milieux” (en utilisant numpy).

[9]:
```
# à compléter
```

[9]:
```
<matplotlib.legend.Legend at 0x7f8e413cc520>
```



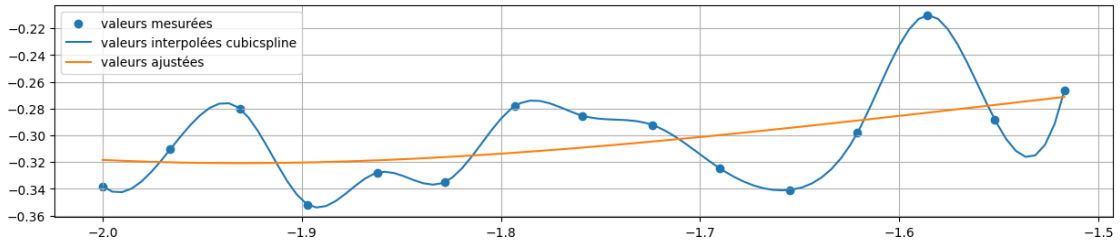

9. On cherche à interpoler entre les points pour estimer les valeurs entre ces points.

- Interpoler au moyen de `scipy.interpolate.CubicSpline`
- Tracer la courbes interpolée et les points sur le même graphique.
- Tracer également la courbe obtenue avec la méthode d’ajustement de la première partie.

[10]:
```
import scipy.interpolate

cs = scipy.interpolate.CubicSpline(val,etud)
```

[11]:
```
# à compléter
```


valeurs mesurées
valeurs interpolées cubicspline
valeurs ajustées
−0.22
−0.24
−0.26
−0.28
−0.30
−0.32
−0.34
−0.36
−2.0
−1.9
−1.8
−1.7
−1.6
−1.5

[ ]: