1. 資料夾組成

├── report.pdf: Written report

├── sql_final_code: 資料夾內包含所有的程式碼

　　├── crawl_data.ipynb: 用來爬取 NBA 官網的數據資料

　　├── NBA.csv: 爬下來的數據(2022-2023 例行賽球員數據)

　　├── total_and_avg_list.py: Zn-SNARK 計算總和與平均

　　├── var.py: Zn-SNARK 計算變異數與標準差

　　├── pr.py: Zn-SNARK 計算陣列 pr 值

　　├── sql_final.ipynb: 最後用來 demo 的 code

├── requirements.txt: 使用到的套件

2. 執行方式

(1) 執行 crawl_data.ipynb 將 NBA 球員數據資料爬下來，在同個資料夾下儲存 NBA.csv(若 NBA.csv 已存在則可略過此步驟)

(2) 將 sql_final_code 整個資料夾上傳 google 雲端

(3) 點開 Google Colab 網頁，上傳 sql_final.ipynb 並執行

--以下步驟均在 sql_final.ipynb 中執行

(4) mount 到自己的雲端，成功 mount 後，每個 cell 均點選並執行

```
1 from google.colab import drive
2 drive.mount('/content/drive')
```

```
Drive already mounted at /content/drive; to attempt to forcibly remount, call drive
```

(5) Example 1: Total, average, variance and standard deviation 3pt FG of one team

使用者輸入球隊名稱代號(代號可於 NBA.csv 中的 Tm 欄位中得知)，可透過 Zn-SNARK 得到該球隊中所有球員於 2022-2023 賽季的三分球總進球數、每位球員的平均進球數、以及進球數的變異數與標準差。

```
from total_and_avg_list import sum_zk
from var import var_zk
from pr import pr_zk

def team_average_3p_over_all_season(team):
    print(f'{team} players total, average, variance and standard deviation 3pt FG')
    cursor.execute('select G, Three_pt from player where Tm=?', [team])
    values = cursor.fetchall()
    data = [round(i[0] * i[1]) for i in values]
    print('-----sum and average-----')
    sum_zk(data)
    print('-----variance and standard deviation-----')
    var_zk(data)
    return
team = input('Please input the team which you want to look up : ')

team_average_3p_over_all_season(team)
```

```
Please input the team which you want to look up : MIA
```

輸入欲查詢的球隊名稱代號(例如：邁阿密熱火為 MIA)

```
from total_and_avg_list import sum_zk
from var import var_zk
from pr import pr_zk

def team_average_3p_over_all_season(team):
    print(f'{team} players total, average, variance and standard deviation 3pt FG')
    cursor.execute('select G, Three_pt from player where Tm=?', [team])
    values = cursor.fetchall()
    data = [round(i[0] * i[1]) for i in values]
    print('-----sum and average-----')
    sum_zk(data)
    print('-----variance and standard deviation-----')
    var_zk(data)
    return
team = input('Please input the team which you want to look up : ')

team_average_3p_over_all_season(team)
```

```
Please input the team which you want to look up : MIA
MIA players total, average, variance and standard deviation 3pt FG
-----sum and average-----
*** Trying to read key
*** No key or computation changed, generating keys...
*** Generating proof (sat=True, #io=143, #witness=0, #constraint=119)
*** Sum: 981
*** Average: 49
*** Verification status: True
-----variance and standard deviation-----
*** Trying to read key
*** No key or computation changed, generating keys...
*** Generating proof (sat=True, #io=7925, #witness=0, #constraint=7877)
*** Var: 3839
*** Std: 61
*** Verification status: True
```

Zn-SNARK 的執行結果：邁阿密熱火隊在 2022-23 賽季例行賽中，總共投進 981 顆三分球，平均每人這賽季投進 49 顆三分球，進球數的變異數 3839，標準差為 61，Verified 的結果為 True。

(6) Example 2: PR value of PPG in one team

使用者輸入球隊名稱代號與欲查詢的 PR 值，透過 Zn-SNARK 得到該球隊於 2022-2023 賽季中對於所有球員，位於第 PR 百分位數下的平均得分為多少。

```
def pr_ppg_over_all_season(team, pr_value):
    print(f'PPG of PR {pr_value} player with game played > 50 in {team}')
    cursor.execute('select PTS from player where Tm = ? and G>"50"', [team])
    values = cursor.fetchall()
    data = [round(i[0]) for i in values]
    pr_zk(int(pr_value), data)
    return
team = input('Please input the team which you want to look up : ')
pr_value = input('Please input the percentage which you want to look up : ')
pr_ppg_over_all_season(team, pr_value)
```

```
Please input the team which you want to look up : GSW
```

輸入欲查詢的球隊名稱代號(例如：金州勇士 GSW)

```
def pr_ppg_over_all_season(team, pr_value):
    print(f'PPG of PR {pr_value} player with game played > 50 in {team}')
    cursor.execute('select PTS from player where Tm = ? and G>"50"', [team])
    values = cursor.fetchall()
    data = [round(i[0]) for i in values]
    pr_zk(int(pr_value), data)
    return
team = input('Please input the team which you want to look up : ')
pr_value = input('Please input the percentage which you want to look up : ')
pr_ppg_over_all_season(team, pr_value)
```

```
Please input the team which you want to look up : GSW
Please input the percentage which you want to look up : 60
```

輸入欲查詢的 PR 值(數值需在 0~100 之間)

```
def pr_ppg_over_all_season(team, pr_value):
    print(f'PPG of PR {pr_value} player with game played > 50 in {team}')
    cursor.execute('select PTS from player where Tm = ? and G>"50"', [team])
    values = cursor.fetchall()
    data = [round(i[0]) for i in values]
    pr_zk(int(pr_value), data)
    return
team = input('Please input the team which you want to look up : ')
pr_value = input('Please input the percentage which you want to look up : ')
pr_ppg_over_all_season(team, pr_value)
```

```
Please input the team which you want to look up : GSW
Please input the percentage which you want to look up : 60
PPG of PR 60 player with game played > 50 in GSW
*** Trying to read key
*** No key or computation changed, generating keys...
*** Generating proof (sat=True, #io=12, #witness=0, #constraint=5)
*** pr: 9
*** Verification status: True
```

Zn-SNARK 的執行結果：金州勇士隊在 2022-23 賽季例行賽中，隊中 PR60 的球員的平均得分為 9 分，Verified 的結果為 True。