# Data Mining Project 2


## P76061425 林聖軒


# Environment

- DISTRIB_ID=Ubuntu
- DISTRIB_RELEASE=18.04
- DISTRIB_CODENAME=bionic
- DISTRIB_DESCRIPTION=Ubuntu 18.04.1 LTS

# Usage

## Classifier

```
$ python3 classifier.py [-h]
```

| optional Options | Description |
| --- | --- |
| -h --help | show this help message and exit |
| -m METHOD | Classification method, dct=(Decision Tree),svm=(Support Vector Machine), default = dct |
| -train, TRAIN_PATH | Input training data file, default = ./data/train_data.txt |
| -test TEST_PATH | Input testing data file, default = ./data/test_data.txt |
| -k KERNEL | SVM kernel,default=rbf |
| -c PENALTY_C | SVM penalty parameter C of the error term,default=1 |
| -cv CV | SVM cross_validate,default=10 |

- 用-m 來指定分類器，dct=(Decision Tree),svm=(Support Vector Machine)
- Decision Tree:

  用 Training Data 訓練 Decision Tree，並將訓練出的 decisionTree 結果 output 至當前目錄的 tree.pdf 中。
- SVM:

  用 Training Data 訓練 Support Vector Machine，並將 cross_validate 的結果及 Testing 的 Accuracy、Precision、Recall 輸出。
- 需要安裝 graphviz:

```
$ apt-get install graphviz
```

## Data Generator

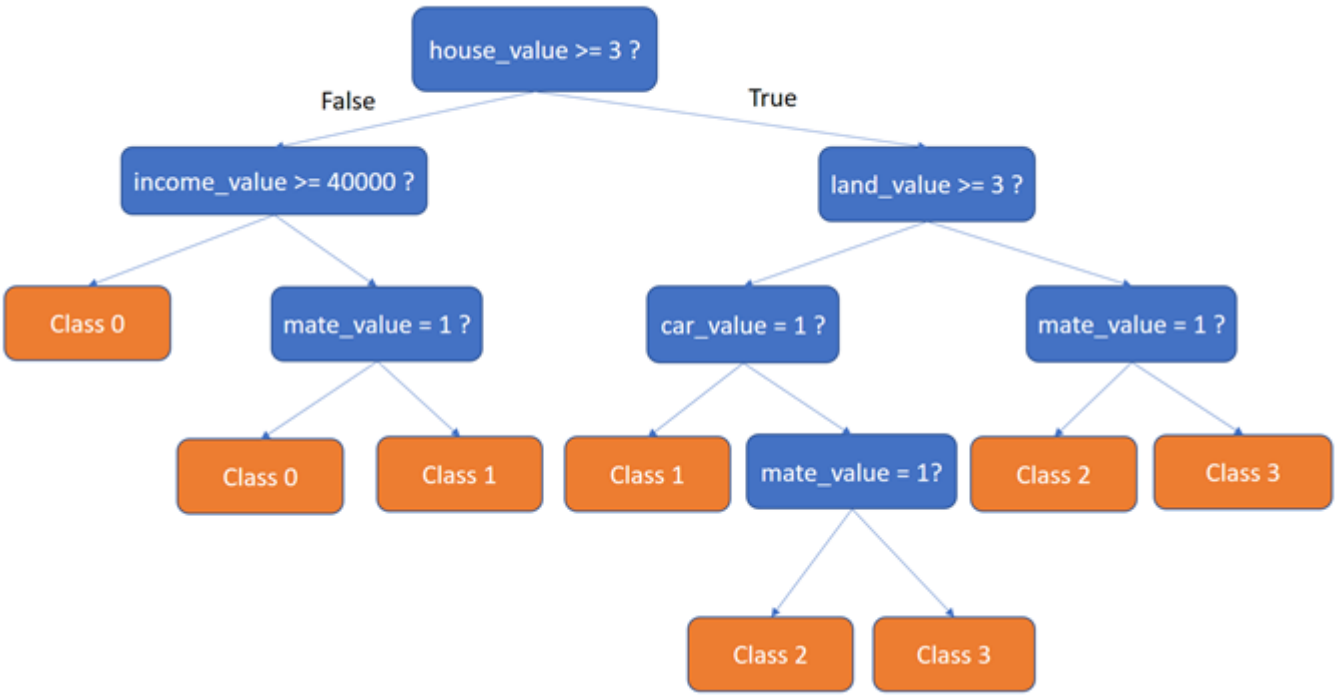
```
$ python3 data_generator.py [-h]
```

| optional Options | Description |
| --- | --- |
| -h, --help | show this help message and exit |
| -train, TRAIN_SIZE | The number of training data you want to generate, default = 10000 |
| –test, TEST_SIZE | The number of testing data you want to generate, default = 10000 |

- 執行後會在 data 資料夾內生成 10000 筆 training data(train_data.txt)及 testing data(test_data.txt)。

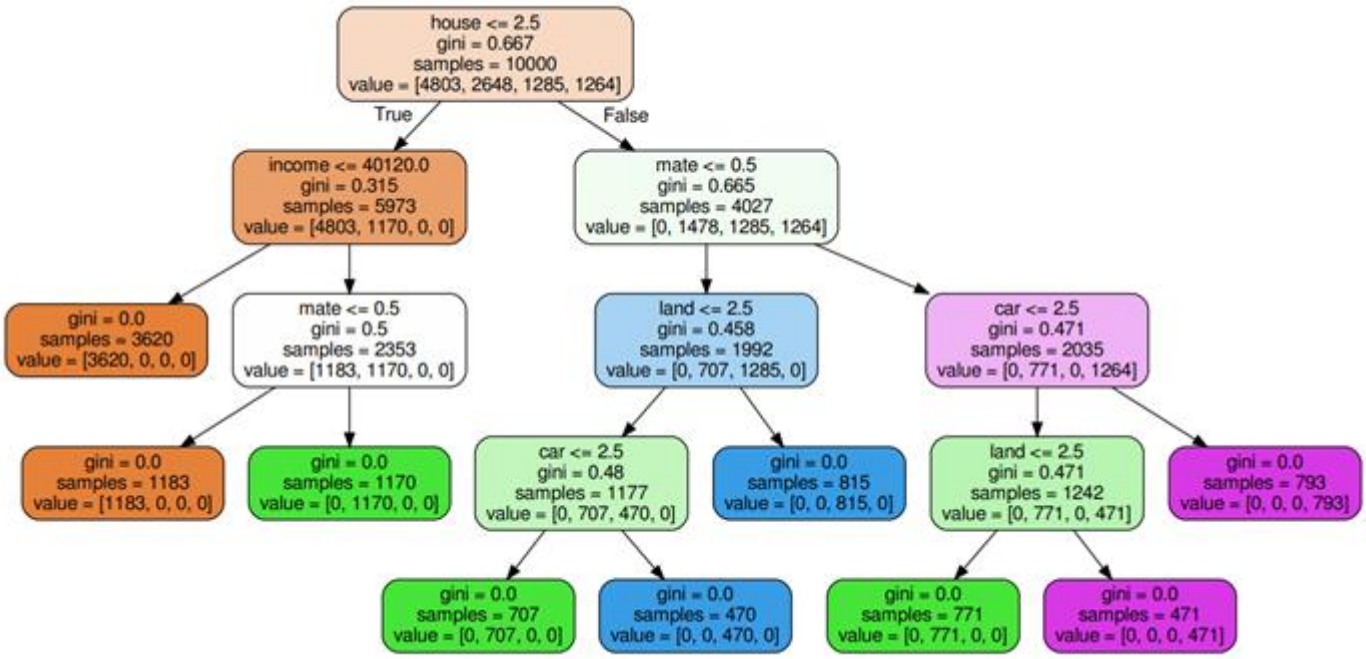
# Absolutely Right Rules

- Attributes_list = house, car, land, income, mate, class
- house_value = [0, 5]
- car_value = [0, 5]
- land_value = [0, 5]
- income_value = [-50000, 100000]
- mate_value = [0, 1]
- class_vlaue = {0, 1, 2, 3}




# Decision Tree

- Training size = 10000
- Testing size = 10000
- Criterion = Gini



## Result metrics

- Accuracy = 0.9997
- Precision = 0.9999826689774697
- Recall = 0.9999677377726158

---

- 從結果圖可以得知，與 Absolutely Right Rules 相比，Decision tree 所建立出的 model 和實際的 rules 並非完全相同，但有很高的相似度，由於 Absolutely Right Rules 的規則很簡單，因此結果的 Accuracy, Precision, Recall 均有相當好的表現。

# Support Vector Machine

- Penalty C: 1.0
- Cross Validate: 10

## Kernel : rbf

### Cross Validation Result:

| CV No. | Accuracy | Percision | Recall | Accuracy | Percision | Recall |
|---|---|---|---|---|---|---|
| Type | Train | Train | Train | Test | Test | Test |
| cv0 | 0.9971 | 0.9979 | 0.9979 | 0.9940 | 0.9961 | 0.9953 |
| cv1 | 0.9970 | 0.9978 | 0.9979 | 0.9980 | 0.9982 | 0.9990 |
| cv2 | 0.9974 | 0.9980 | 0.9983 | 0.9940 | 0.9949 | 0.9965 |
| cv3 | 0.9969 | 0.9977 | 0.9978 | 0.9970 | 0.9976 | 0.9980 |
| cv4 | 0.9966 | 0.9974 | 0.9976 | 0.9970 | 0.9984 | 0.9972 |

| CV No. | Accuracy | Percision | Recall | Accuracy | Percision | Recall |
|---|---|---|---|---|---|---|
| cv5 | 0.9961 | 0.9971 | 0.9973 | 0.9970 | 0.9976 | 0.9980 |
| cv6 | 0.9968 | 0.9976 | 0.9977 | 0.9980 | 0.9990 | 0.9981 |
| cv7 | 0.9974 | 0.9981 | 0.9982 | 0.9940 | 0.9953 | 0.9960 |
| cv8 | 0.9970 | 0.9977 | 0.9979 | 0.9950 | 0.9966 | 0.9962 |
| cv9 | 0.9972 | 0.9978 | 0.9981 | 0.9970 | 0.9980 | 0.9976 |
| avg | 0.9970 | 0.9977 | 0.9979 | 0.9961 | 0.9972 | 0.9972 |

### Testing Result:

- Accuracy: 0.9969
- Precision: 0.9976627899295014
- Recall: 0.9977905324777975

---

## Kernel: sigmoid

### Cross Validation Result:

| CV No. | Accuracy | Percision | Recall | Accuracy | Percision | Recall |
|---|---|---|---|---|---|---|
| Type | Train | Train | Train | Test | Test | Test |
| cv0 | 0.6478 | 0.6150 | 0.6020 | 0.6507 | 0.6169 | 0.6125 |
| cv1 | 0.6443 | 0.6152 | 0.5984 | 0.6687 | 0.6406 | 0.6432 |

| CV No. | Accuracy | Percision | Recall | Accuracy | Percision | Recall |
|---|---|---|---|---|---|---|
| cv2 | 0.6568 | 0.6282 | 0.6147 | 0.6687 | 0.6398 | 0.6319 |
| cv3 | 0.6545 | 0.6308 | 0.6137 | 0.6194 | 0.5878 | 0.5671 |
| cv4 | 0.6461 | 0.6201 | 0.5991 | 0.6670 | 0.6313 | 0.6152 |
| cv5 | 0.6463 | 0.6214 | 0.6007 | 0.6396 | 0.6195 | 0.5945 |
| cv6 | 0.6519 | 0.6267 | 0.6085 | 0.6176 | 0.5853 | 0.5553 |
| cv7 | 0.6549 | 0.6289 | 0.6112 | 0.6767 | 0.6457 | 0.6284 |
| cv8 | 0.6490 | 0.6207 | 0.6061 | 0.6423 | 0.6170 | 0.6011 |
| cv9 | 0.6603 | 0.6299 | 0.6098 | 0.6513 | 0.6296 | 0.6088 |
| avg | 0.6512 | 0.6237 | 0.6064 | 0.6502 | 0.6214 | 0.6058 |

## Testing Result:

- Accuracy: 0.6435
- Precision: 0.6204495628355513
- Recall: 0.6003172025937911

---

## Kernel: poly

### Cross Validation Result:

| CV No. | Accuracy | Percision | Recall | Accuracy | Percision | Recall |
|---|---|---|---|---|---|---|
| Type | Train | Train | Train | Test | Test | Test |
| cv0 | 0.9617 | 0.9786 | 0.9653 | 0.9731 | 0.9850 | 0.9758 |
| cv1 | 0.9631 | 0.9799 | 0.9663 | 0.9611 | 0.9776 | 0.9636 |
| cv2 | 0.9615 | 0.9783 | 0.9651 | 0.9701 | 0.9826 | 0.9725 |
| cv3 | 0.9627 | 0.9791 | 0.9662 | 0.9411 | 0.9694 | 0.9452 |
| cv4 | 0.9617 | 0.9781 | 0.9653 | 0.9680 | 0.9844 | 0.9698 |
| cv5 | 0.9627 | 0.9787 | 0.9661 | 0.9650 | 0.9805 | 0.9687 |
| cv6 | 0.9637 | 0.9796 | 0.9670 | 0.9580 | 0.9785 | 0.9612 |
| cv7 | 0.9597 | 0.9775 | 0.9633 | 0.9530 | 0.9733 | 0.9574 |
| cv8 | 0.9619 | 0.9786 | 0.9653 | 0.9599 | 0.9743 | 0.9655 |
| cv9 | 0.9622 | 0.9789 | 0.9656 | 0.9679 | 0.9799 | 0.9718 |
| avg | 0.9621 | 0.9787 | 0.9655 | 0.9617 | 0.9786 | 0.9652 |

## Testing Result:

- Accuracy: 0.9607
- Precision: 0.978488520596513
- Recall: 0.9643157193348397

- 從結果可以看到，Support Vector Machine 在 Kernel 用 rbf 時效果最好，有最高的 Accuracy、Precision 及 Recall，Kernel 用 poly 時次之，而 Kernel 用 sigmoid 時則結果較差，但在簡單的規則下所定義出的 data，用 Decision Tree 這種簡單的 model 反而效果還要比用 SVM 來得更好，因此要視問題來決定 model，而不是一昧的使用特定的 model 來解決問題。