

資料分析

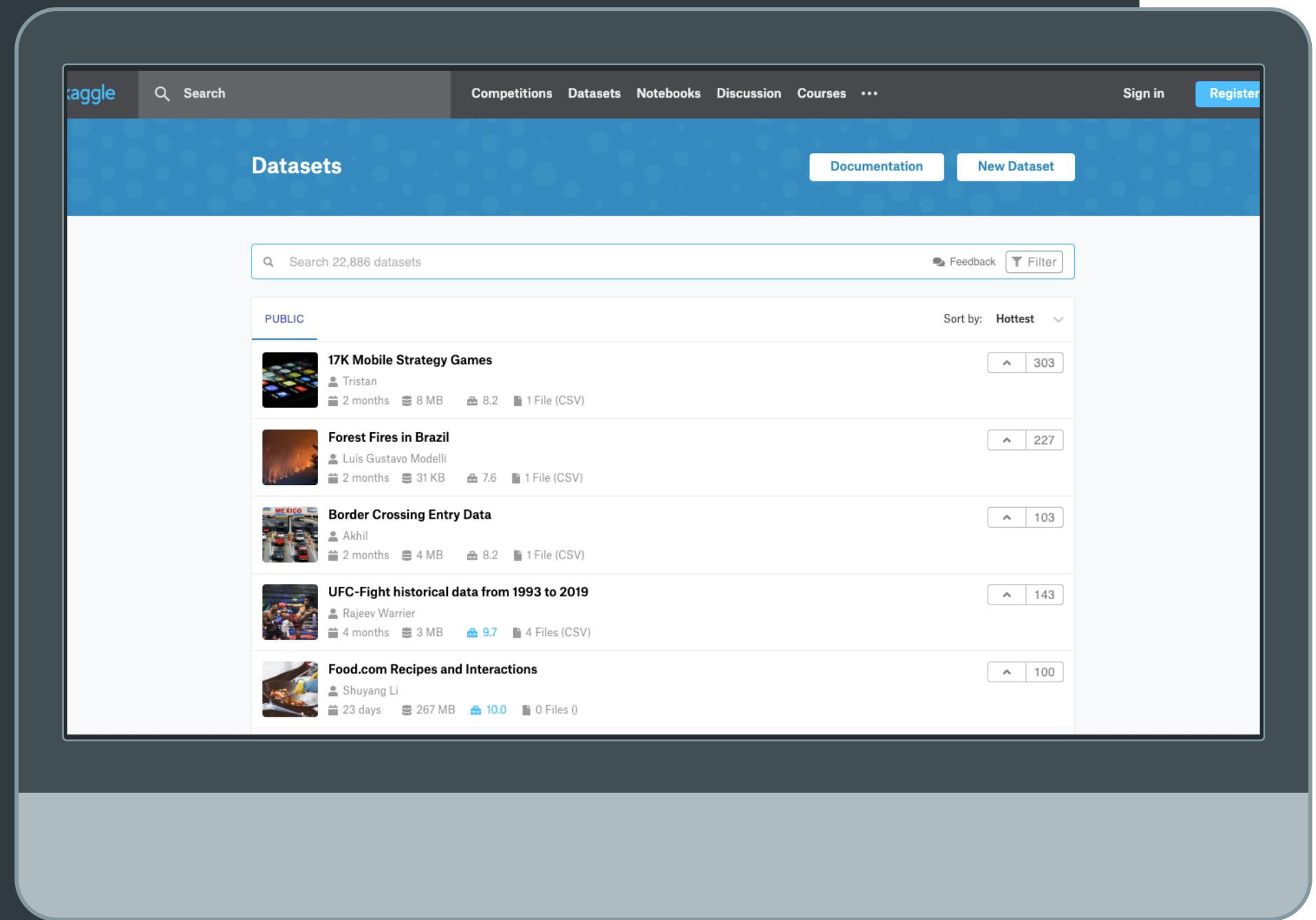
Gender Recognition by Voice

組員：

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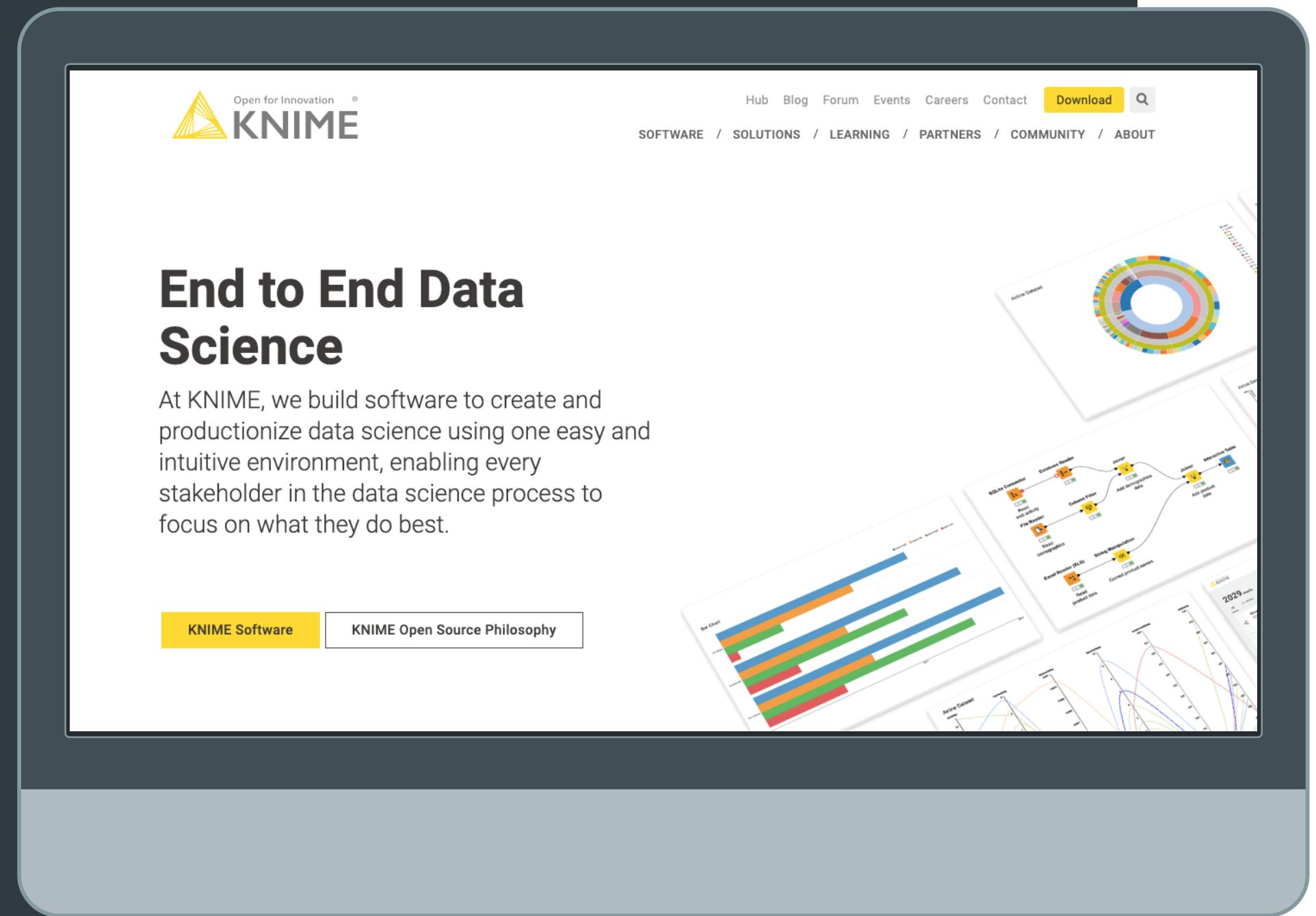
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Use the dataset By Kaggle

<https://www.kaggle.com/primaryobjects/voicegender>



Analyze the dataset By KNIME

<https://www.knime.com/>

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SECTION 1

What's your data mining problem?

Gender Recognition by Voice and Speech Analysis

Identify a voice as male or female

- This database was created to identify a voice as male or female, based upon **acoustic properties** of the voice and speech.
- The dataset consists of **3,168** recorded voice samples, collected from male and female speakers.
- The voice samples are pre-processed by acoustic analysis in R using the seewave and tuneR packages, with an analyzed frequency range of 0hz-280hz

Question

■ 主要

1. 男性和女性聲音之間還有哪些其他特徵？
2. 可以發現男性和女性聲音在共鳴(resonance)上有區別嗎？

■ 次要

1. 可以從正常聲音中識別假音(falsetto)嗎？（為此可能需要單獨的數據集）
2. 數據中還有其他有趣的功能嗎？

“以人耳看來，用聲音決定性別能否依靠簡單的頻率來決策呢？”



SECTION 2

Data understanding

Dataset

data categories

- Dataset: 3618*21
- Filename: voice.csv
- Data based on acoustic properties of the voice and speech (frequency:kHz)
 - meanfreq、sd、median、Q25、Q75、IQR、skew、kurt、sp.ent、sfm、mode、centroid、meanfun、minfun、maxfun、meandom、mindom、maxdom、dfrange、modindx、class

Data Attribute-acoustic properties

//頻率以kHz為單位

- meanfreq:平均頻率
- sd:頻率標準差
- median:中位數頻率
- Q25、Q75:第1、3四分位數
- IQR:四分位距(Q75-Q25)
- skew:偏斜
- kurt:峰度
- sp.ent:頻譜熵
- sfm:頻譜平坦度
- mode: 頻率眾數

- centroid:頻率重心
- meanfun:跨聲學信號測得的**基本頻率**的平均值
- minfun:跨聲學信號測得的最小基頻
- maxfun:跨聲學信號測得的最大基頻
- meandom:整個聲信號測得的主頻的平均值
- mindom:跨聲學信號測得的最小主頻
- maxdom:跨聲信號測得的主頻率最大值
- dfrange:跨聲信號測得的主頻範圍
- modindx:調製指數。計算為相鄰基頻測量之間的累計絕對差除以頻率範圍
- class:男性或女性

Meandom(average dominant frequency)

- 口語中的頻率變化很大，更不用說整個句子了。頻率隨著語調而上升和下降，通常是在單詞和語音中傳達某些情感。這可能使查明準確的頻率變得困難。
- 可以通過使用每個語音樣本中測得的平均主導頻率。
- 關於性別，平均主導頻率的確具有統計學意義。因為皆是正值，因此這支持了基本假設，即頻率的增加與女性的語音分類相對應。

Fundamental frequency(基本頻率)

- males ranges from 100 to 150 Hz
- females ranges from 180 to 250 Hz

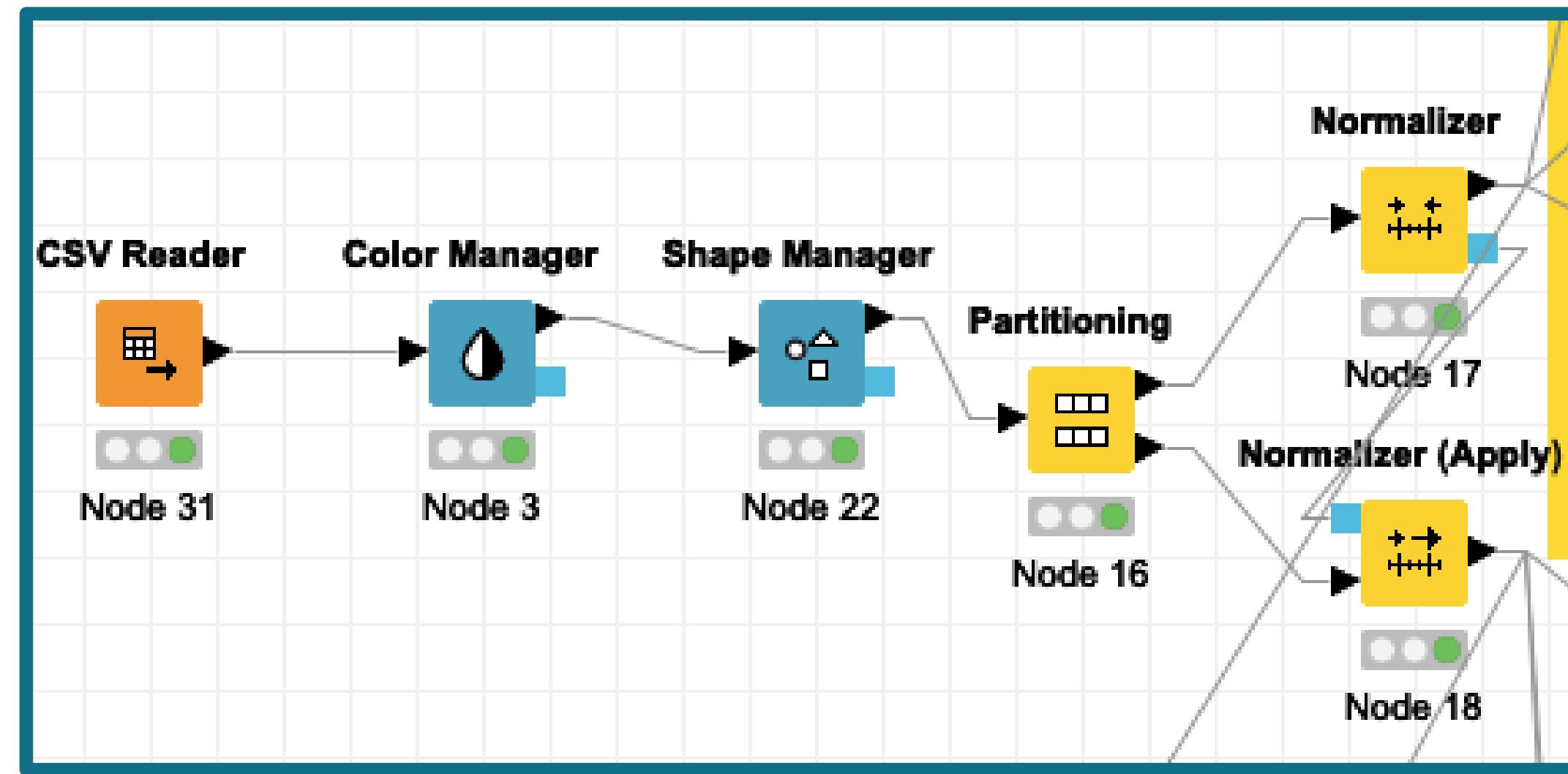
SECTION 3

Data preparation

Analysis

Use different algorithm

- 找到適合的演算法，達到精準的分析
- 用不同的演算法進行分析，例如
 - a. Logistic Regression
 - b. Random forest
 - c. SVM
- 對dataset進行feature selection以及降維(using PCA)



Data preparation

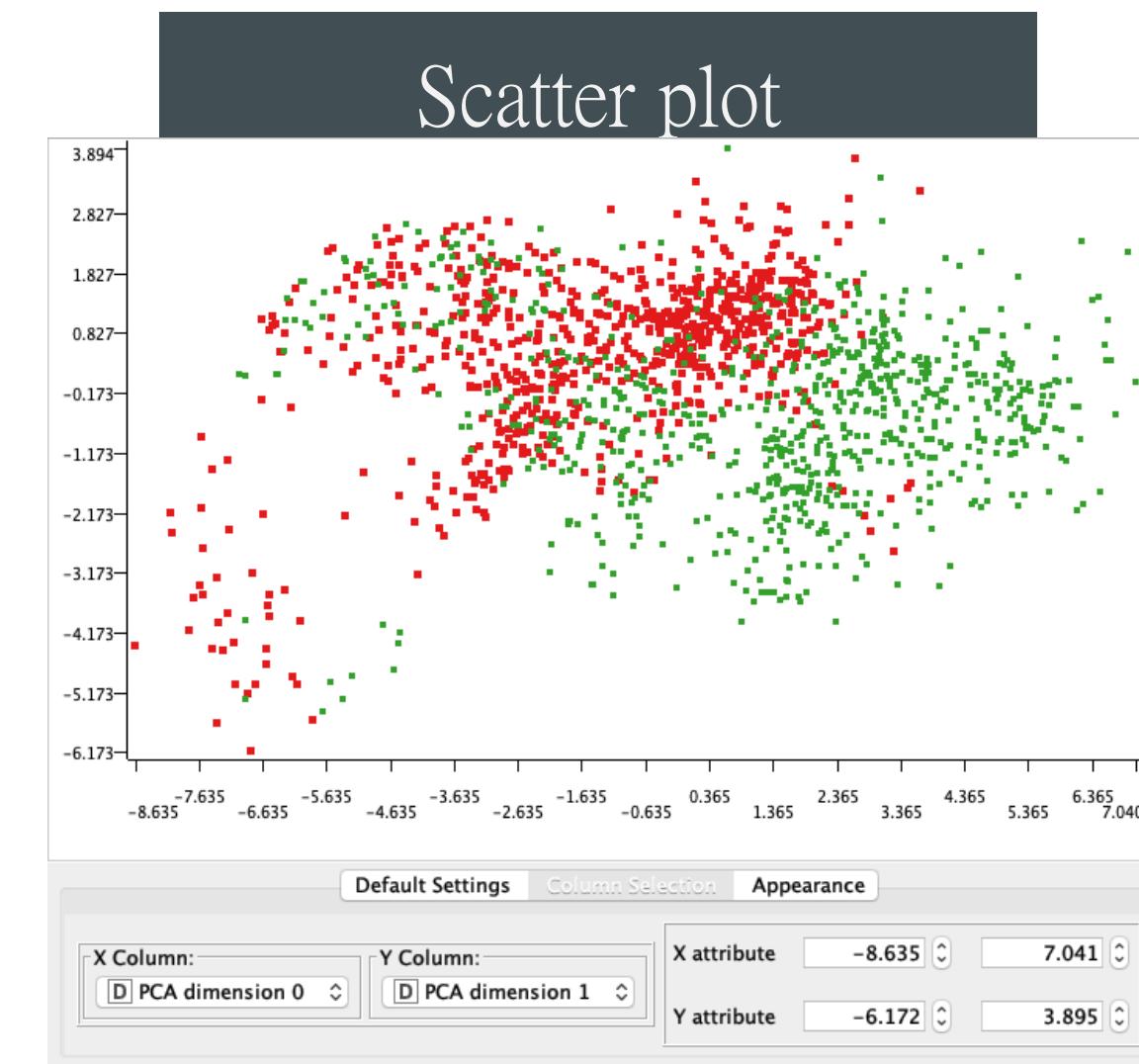
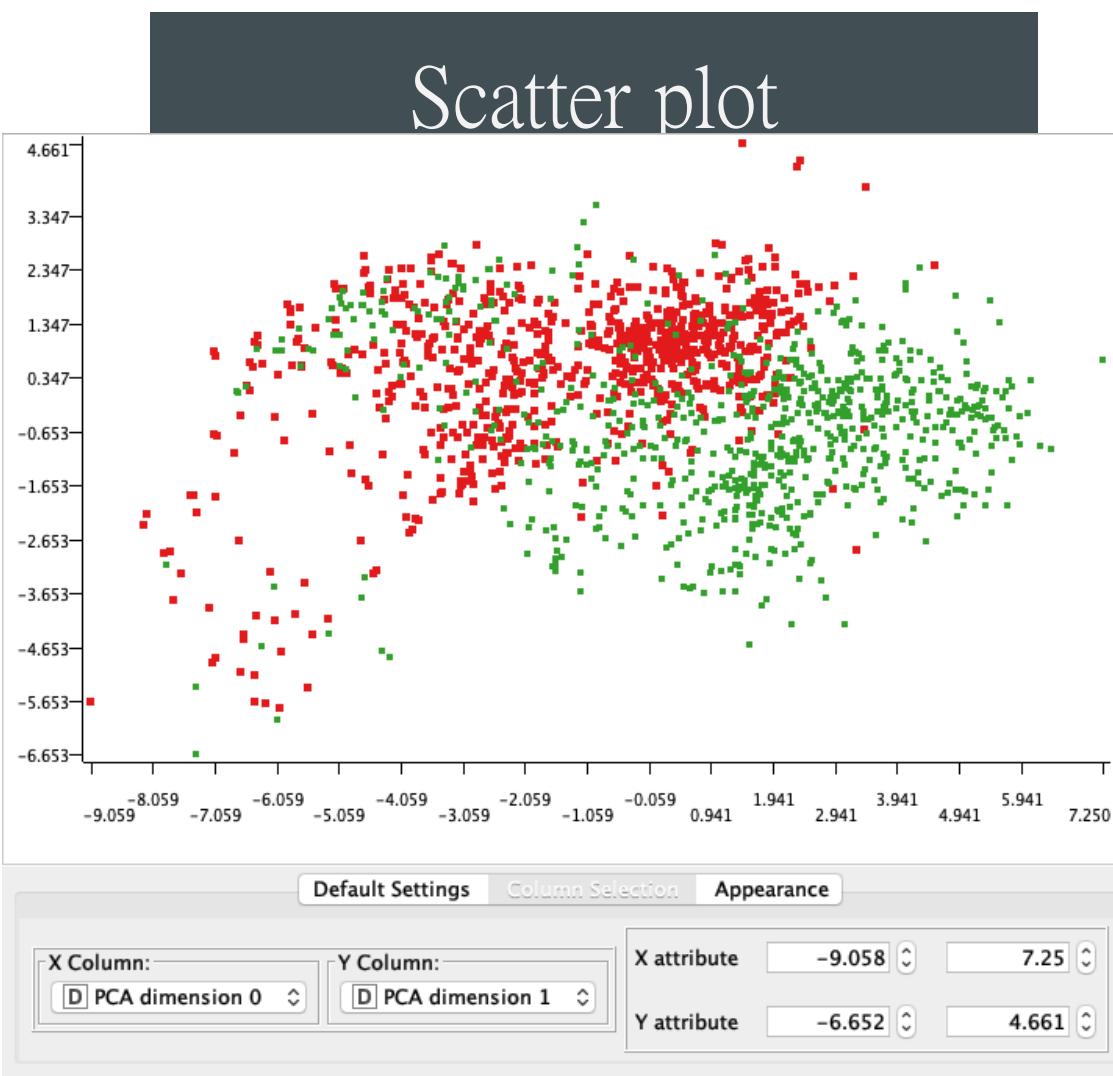
Import 資料庫檔案(voice.csv) → 進行 color/shape manager
 → partitioning(relative 50%) → Normallizer(using z-score)



SECTION 4

Result and Discussion

PCA Dimension Reduction to 2dim.



- PCA training

X:PCA0

Y:PCA1

- PCA testing

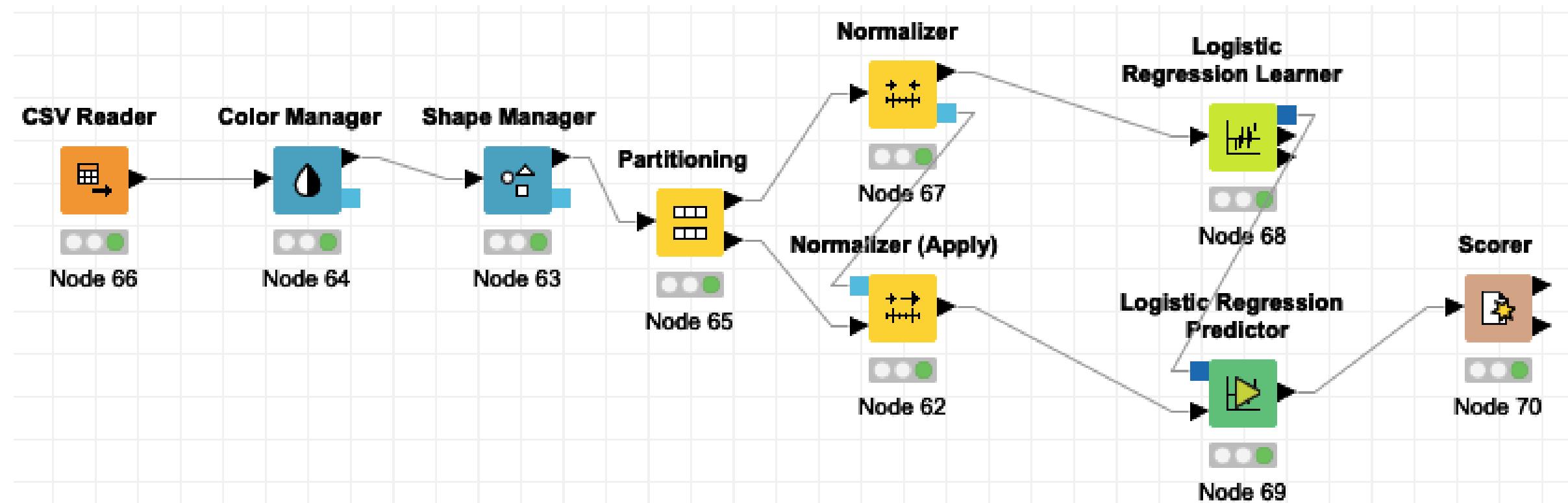
X:PCA0

Y:PCA1

Use Only meandom

- 另外，我們對於單一頻率，只使用meandom，用邏輯回歸模型透過訓練，在測試上的準確性為56.313%。準確度達到一半左右，但仍遠不能準確檢測男性/女性聲音。

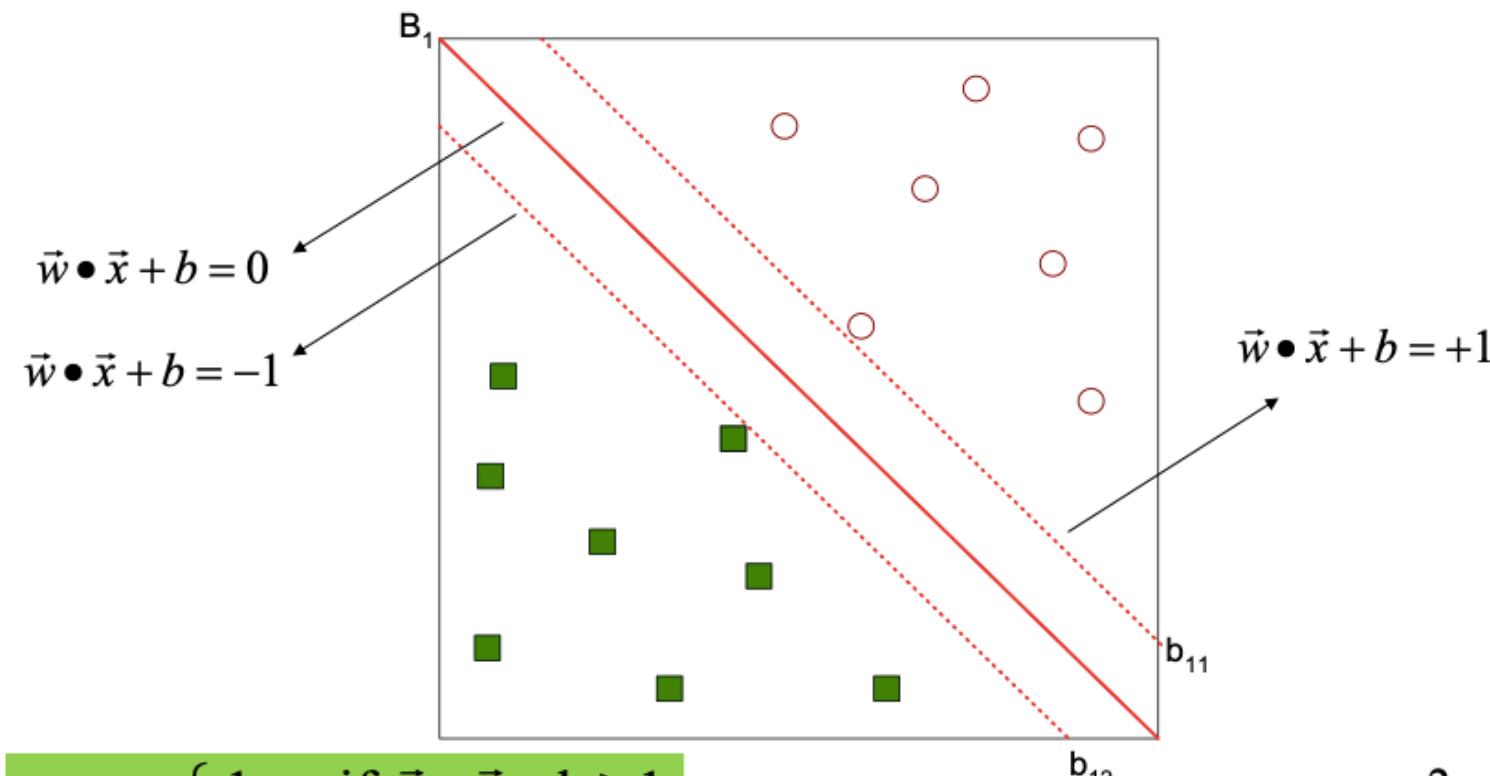
Correct classified: 892	Wrong classified: 692
Accuracy: 56.313 %	Error: 43.687 %
Cohen's kappa (κ) 0.126	



SVM

- SVM是一種監督式的學習(Supervised learning)方法，其概念非常簡單，就是找到一個決策邊界(decision boundary)讓兩類之間的邊界(margins)最大化，使其可以完美區隔開來。

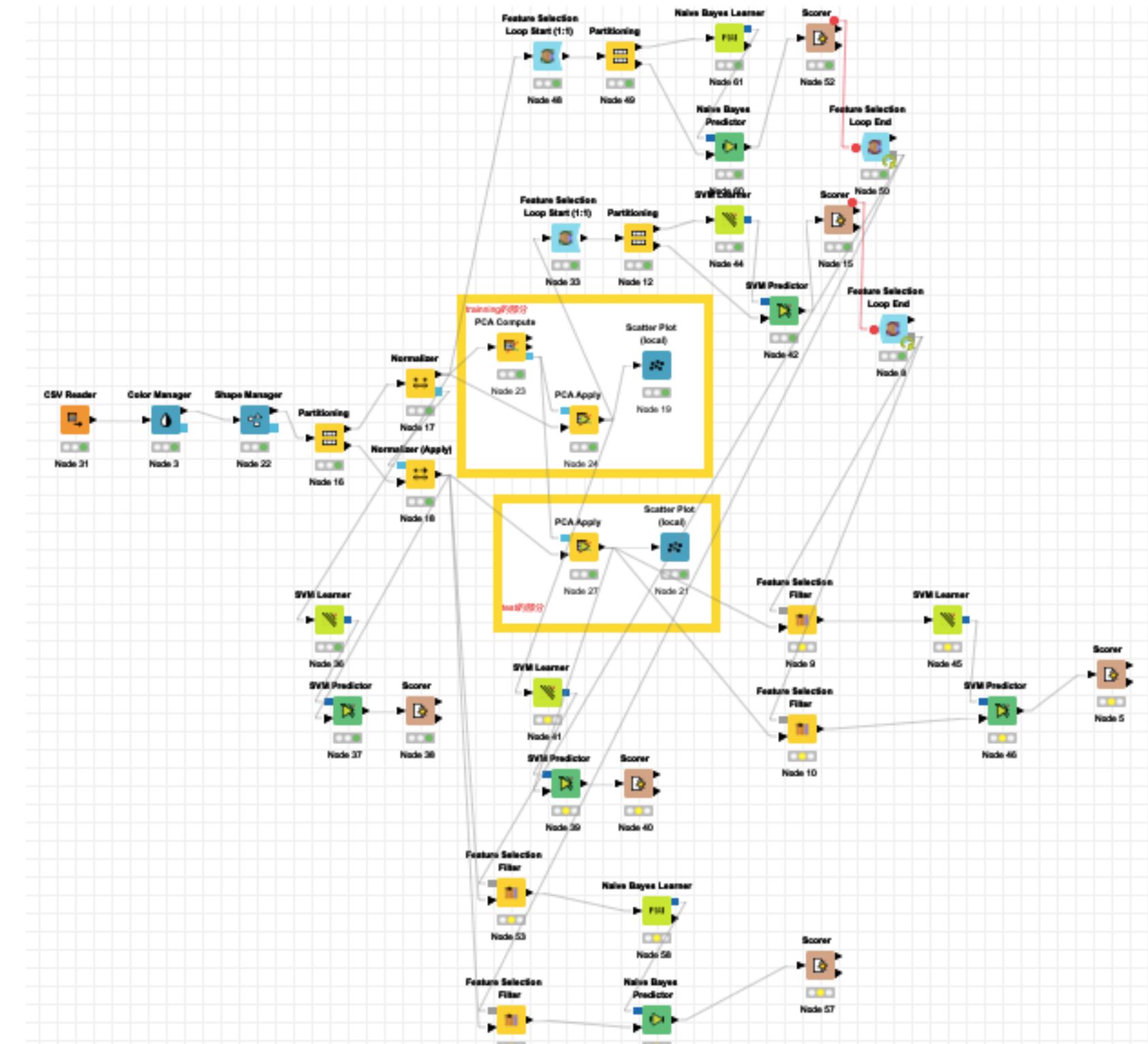
Support Vector Machines



$$f(\vec{x}) = \begin{cases} 1 & \text{if } \vec{w} \cdot \vec{x} + b \geq 1 \\ -1 & \text{if } \vec{w} \cdot \vec{x} + b \leq -1 \end{cases}$$

PCA	Feature selection	Accuracy(%) by SVM
✗	✗	97.475
✗	✓	97.727
✓	✗	97.475
✓	✓	97.033

SVM workflows



Feature selection for SVM

Feature selection

Dialog - 0:53 - Feature Selection Filter

Include static columns
 Select features manually
 Select features automatically by score threshold
Prediction score threshold

Accuracy	Nr. of features	
0.986	17	D meanfreq
0.981	15	D sd
0.98	18	D median
0.98	16	D Q25
0.98	11	D Q75
0.98	9	D IQR
0.979	14	D skew
0.977	6	D kurt
0.976	10	D sp.ent
0.976	7	D sfm
0.975	8	D mode
0.975	4	D centroid
0.973	13	D meanfun
0.972	5	D minfun
0.971	12	D maxfun
0.971	20	D meandom
0.97	19	D mindom
0.968	3	D maxdom
0.967	2	D dfrange
0.963	2	D modindx
0.948	1	S class

OK Apply Cancel ?

Feature selection + PCA

Dialog - 0:9 - Feature Selection Filter

Include static columns
 Select features manually
 Select features automatically by score threshold
Prediction score threshold

Accuracy	Nr. of features	
0.981	6	D meanfreq
0.98	6	D sd
0.98	9	D median
0.98	8	D Q25
0.979	19	D Q75
0.979	14	D IQR
0.979	12	D skew
0.979	11	D kurt
0.977	5	D sp.ent
0.975	18	D sfm
0.975	10	D mode
0.975	7	D centroid
0.973	16	D meanfun
0.973	4	D minfun
0.972	17	D maxfun
0.972	15	D meandom
0.972	13	D mindom
0.971	20	D maxdom
0.971	3	D dfrange
0.971	2	D modindx
0.968	22	S class
0.968	21	D PCA dimension 0
0.952	1	D PCA dimension 1

OK Apply Cancel ?

SVM Confusion matrix

None and PCA

class \ Pre...	male	female
male	768	24
female	16	776

Correct classified: 1,544
Accuracy: 97.475 %
Cohen's kappa (κ) 0.949

Wrong classified: 40
Error: 2.525 %

Feature selection

class \ Pre...	male	female
male	773	19
female	17	775

Correct classified: 1,548
Accuracy: 97.727 %
Cohen's kappa (κ) 0.955

Feature selection + PCA

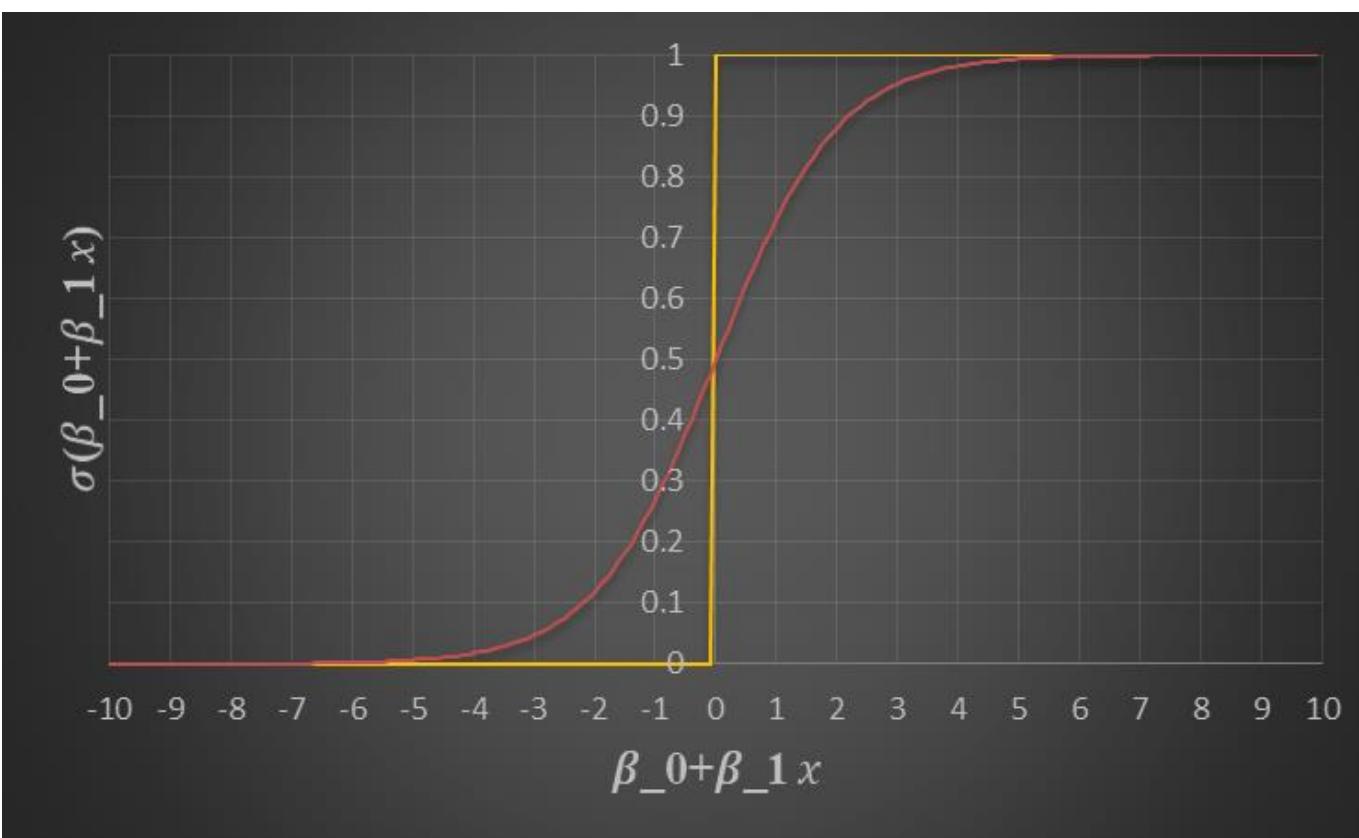
class \ Pre...	male	female
male	769	23
female	24	768

Correct classified: 1,537
Accuracy: 97.033 %
Cohen's kappa (κ) 0.941

Wrong classified: 47
Error: 2.967 %

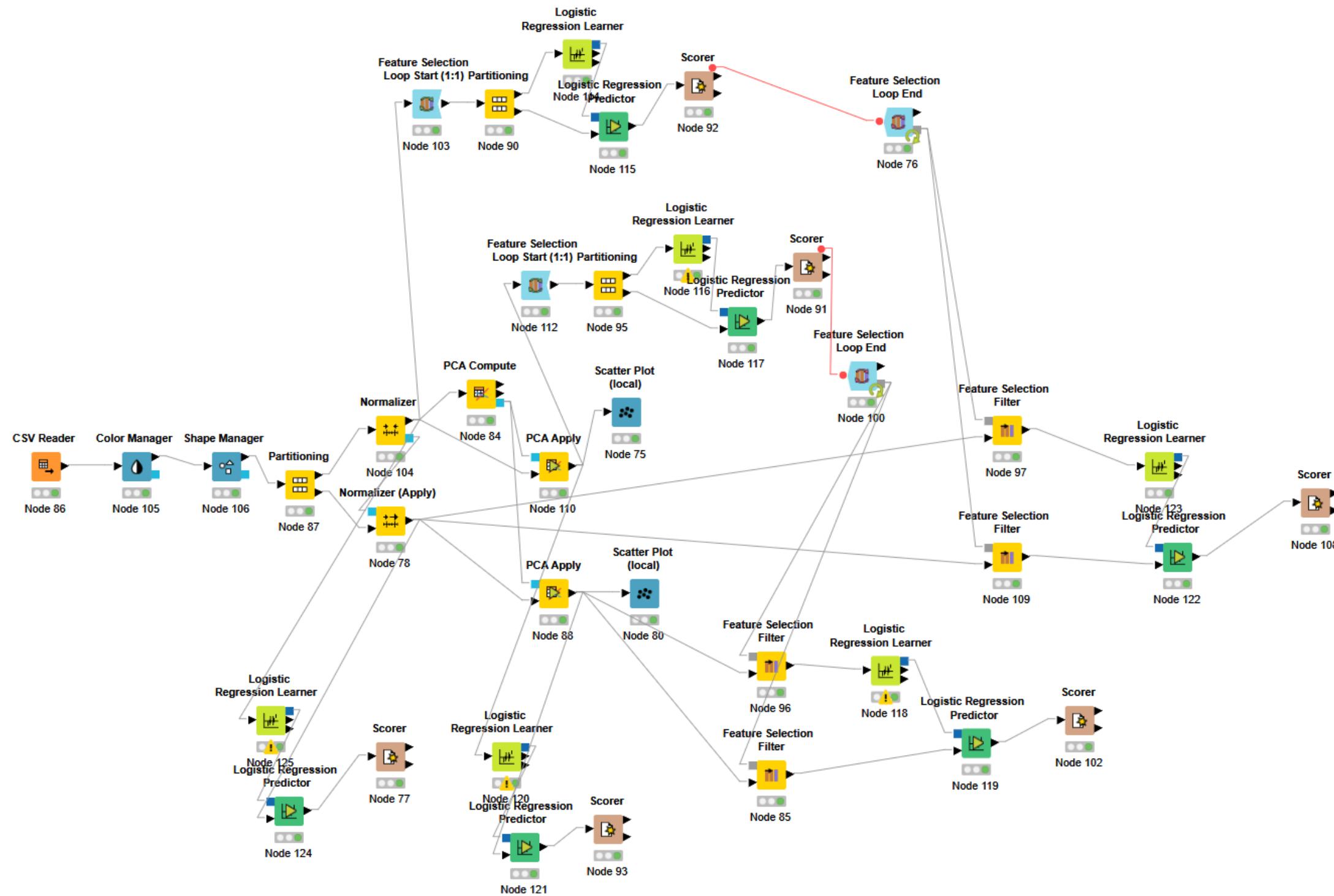
Logistic Regression

- 一種統計模型，其基本形式是使用logistic函數對二進制因變量進行建模，儘管存在許多更複雜的擴展。在回歸分析中，邏輯回歸是在評估邏輯模型的參數



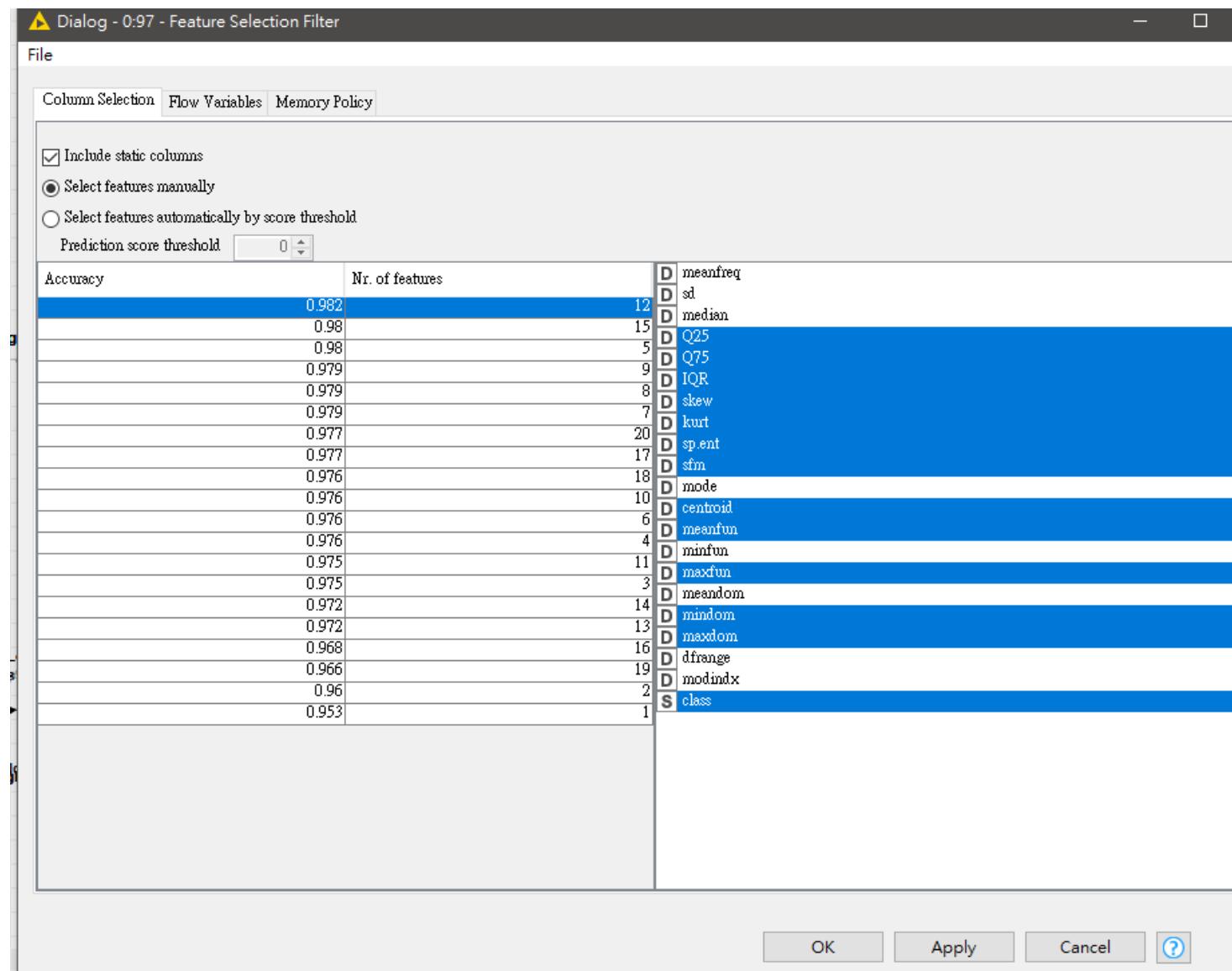
PCA	Feature selection	Accuracy(%) by Logistic Regression
✗	✗	96.465
✗	✓	96.402
✓	✗	96.843
✓	✓	97.412

Logistic Regression workflows

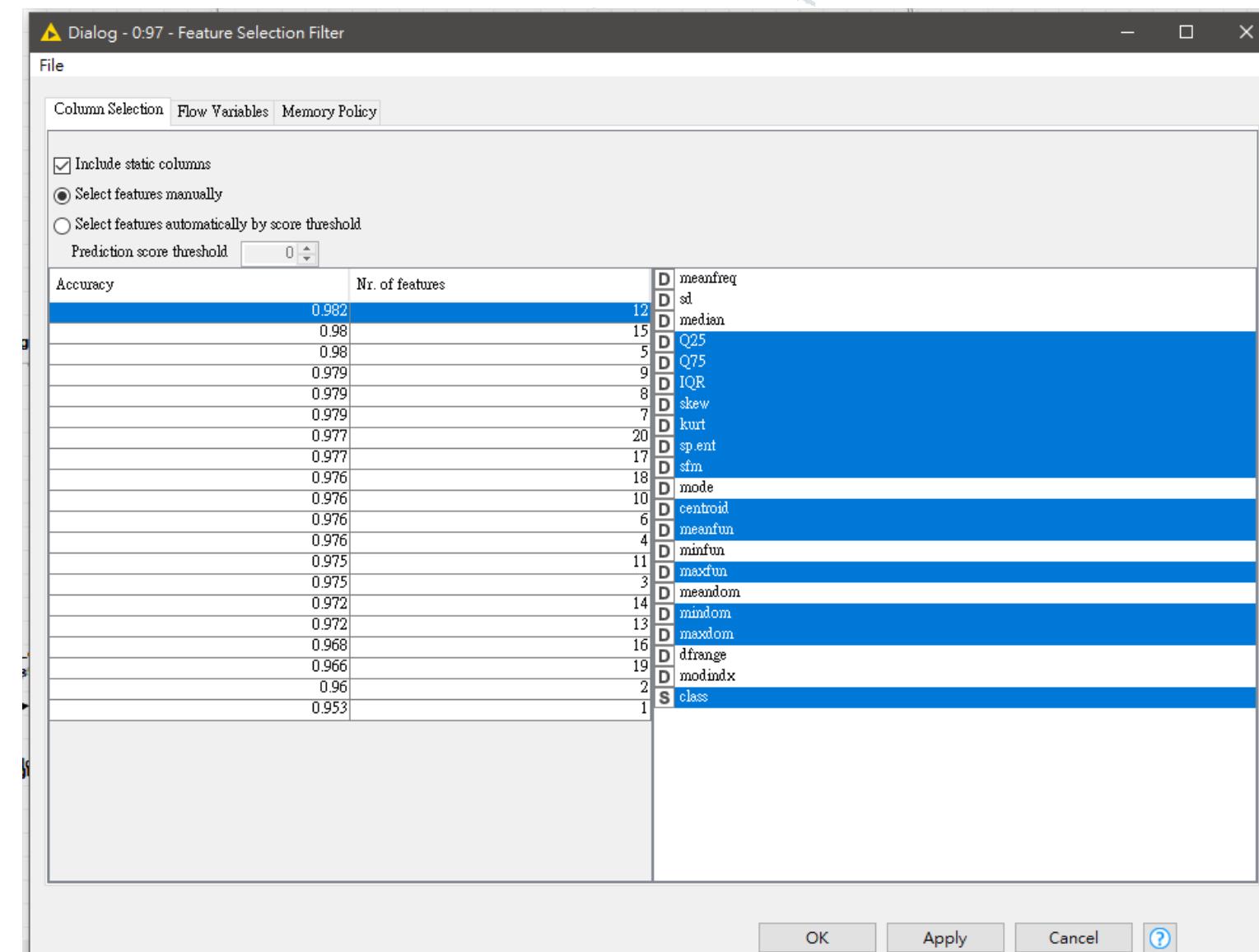


Feature selection for Logistic Regression

Feature selection



Feature selection + PCA



Logistic Regression Confusion matrix

None

PCA

Feature selection

Feature selection + PCA

class \ Predi...	male	female
male	773	19
female	37	755

Correct classified: 1,528
Accuracy: 96.465 %
Cohen's kappa (K) 0.929

class \ Predi...	male	female
male	774	18
female	39	753

Correct classified: 1,527
Accuracy: 96.402 %
Cohen's kappa (K) 0.928

class \ Predi...	male	female
male	773	19
female	31	761

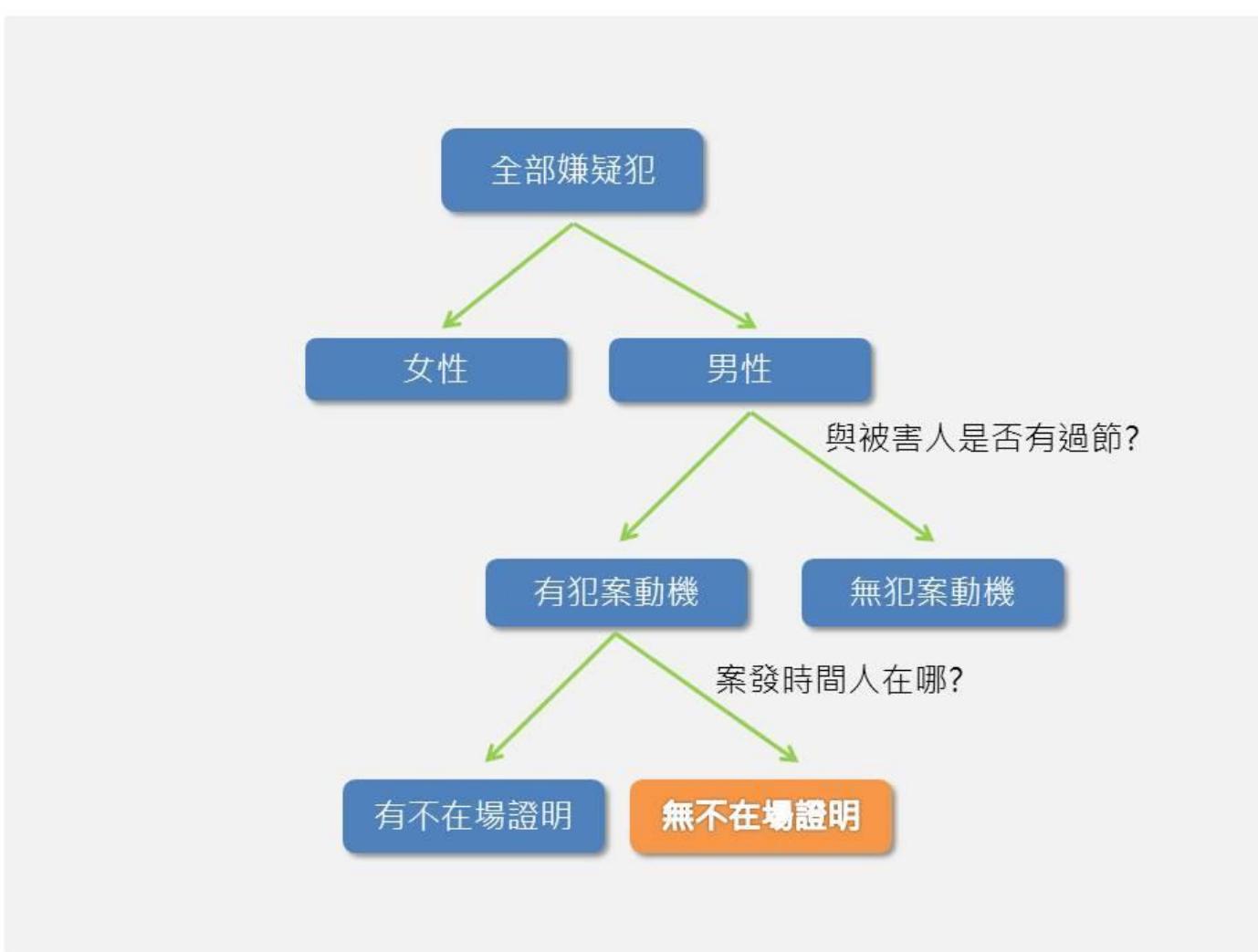
Correct classified: 1,534
Accuracy: 96.843 %
Cohen's kappa (K) 0.937

class \ Predi...	male	female
male	775	17
female	24	768

Correct classified: 1,543
Accuracy: 97.412 %
Cohen's kappa (K) 0.948

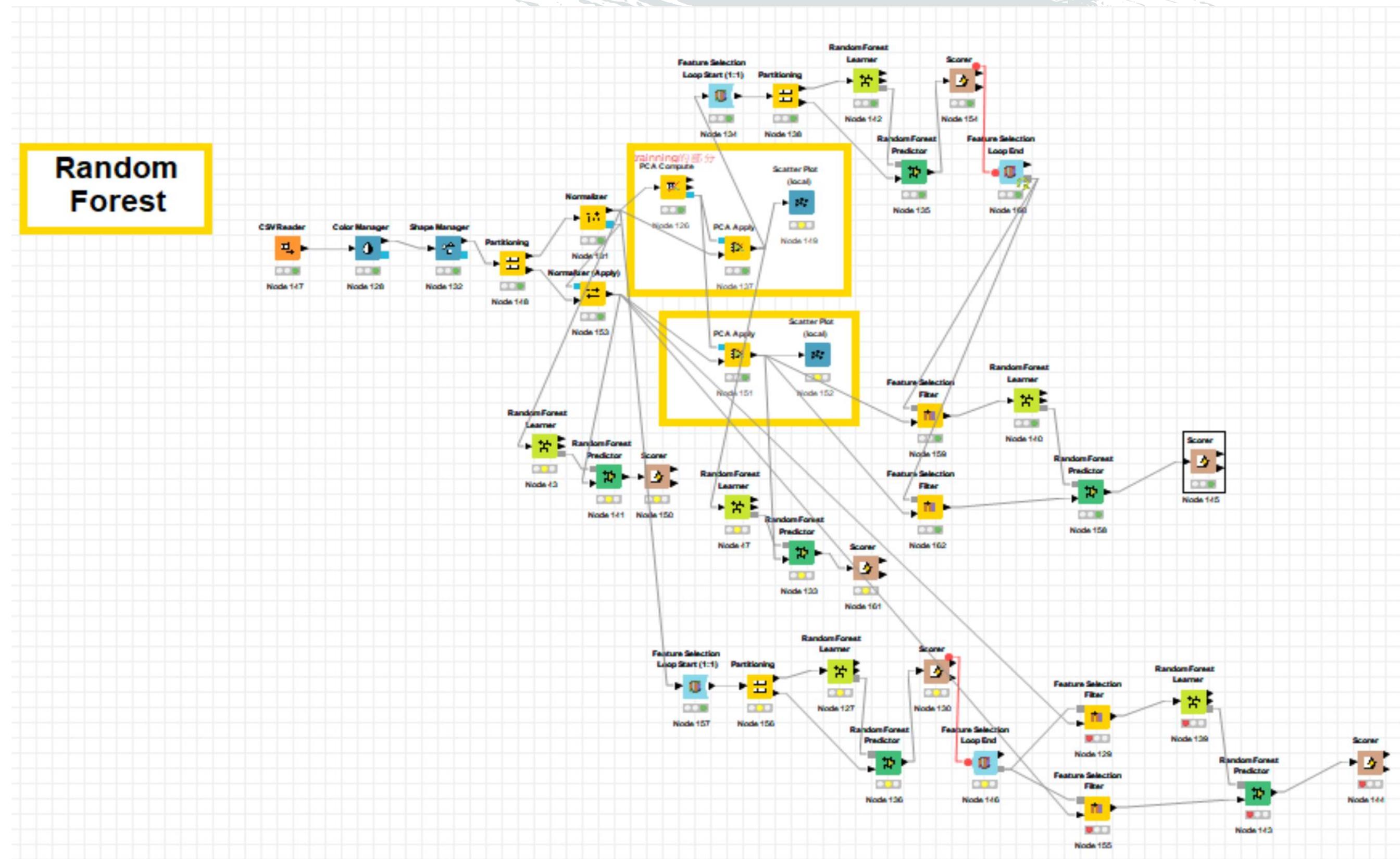
Random Forest

- 隨機森林其實就是進階版的決策樹，這句話簡單說明，就是很多顆樹加起來可以變成一座森林。



PCA	Feature selection	Accuracy(%) by Random Forest
✗	✗	97.917
✗	✓	100
✓	✗	97.917
✓	✓	100

Random Forest workflows



Feature selection for Random Forest

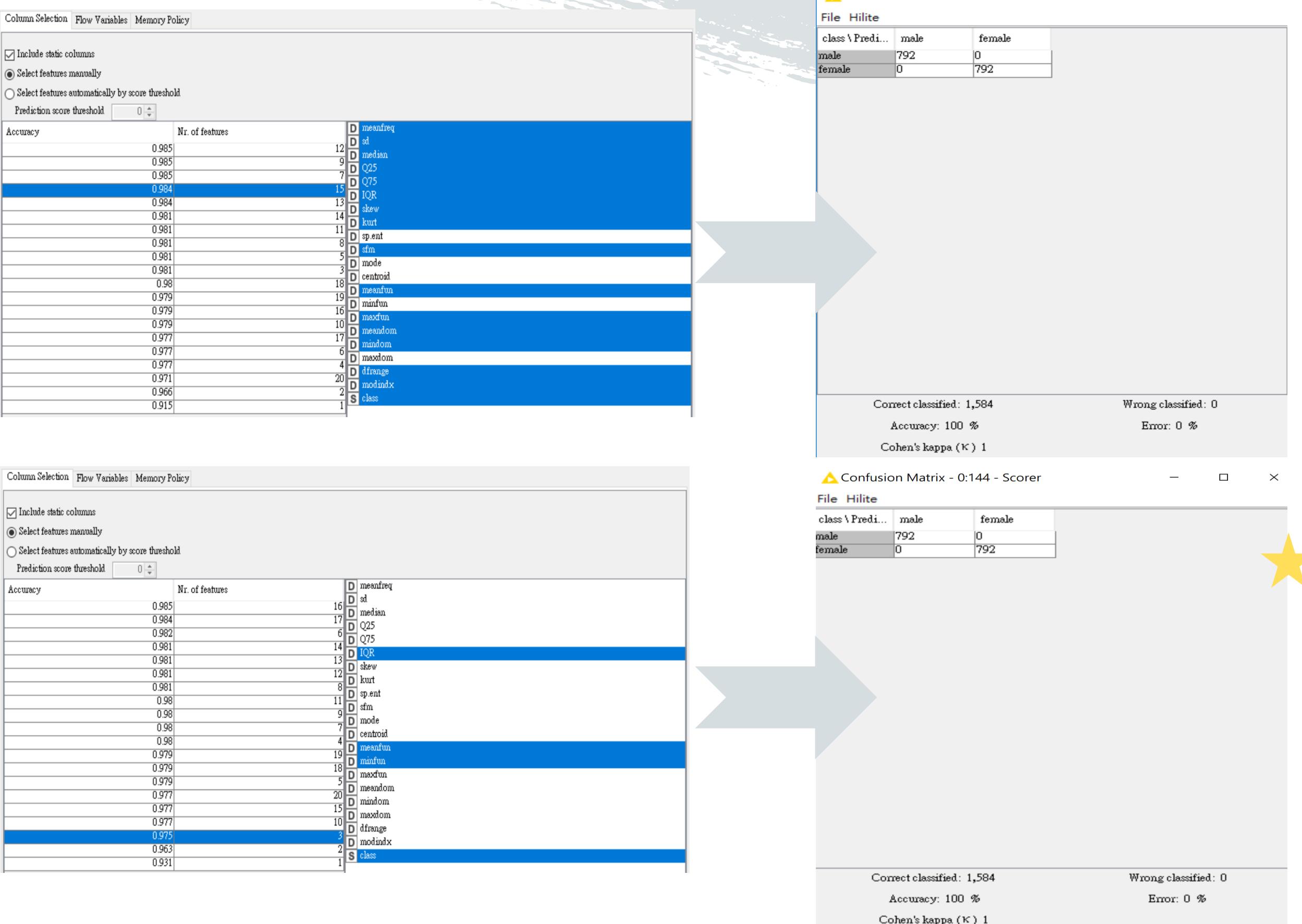
Feature selection

Column Selection		
Flow Variables		
Memory Policy		
<input checked="" type="checkbox"/> Include static columns		
<input checked="" type="radio"/> Select features manually		
<input type="radio"/> Select features automatically by score threshold		
Prediction score threshold	0	▲ ▼
Accuracy	Nr. of features	
0.986	14	D meanfreq
0.985	21	D sd
0.985	20	D median
0.985	16	D Q25
0.985	16	D Q75
0.985	15	D IQR
0.985	15	D skew
0.985	10	D kurt
0.985	3	D sp.ent
0.984	13	D sfm
0.984	12	D mode
0.984	9	D centroid
0.984	4	D meanfun
0.982	18	D minfun
0.981	11	D maxfun
0.981	7	D meandom
0.981	6	D mindom
0.981	5	D maxdom
0.98	19	D dfrange
0.979	17	D modindx
0.979	8	S class
0.977	22	D PCA dimension 0
0.968	2	D PCA dimension 1
0.929	1	

Feature selection + PCA

Column Selection		
Flow Variables		
Memory Policy		
<input checked="" type="checkbox"/> Include static columns		
<input checked="" type="radio"/> Select features manually		
<input type="radio"/> Select features automatically by score threshold		
Prediction score threshold	0	▲ ▼
Accuracy	Nr. of features	
0.985	16	D meanfreq
0.984	17	D sd
0.982	6	D median
0.981	14	D Q25
0.981	13	D Q75
0.981	14	D IQR
0.981	13	D skew
0.981	12	D kurt
0.981	8	D sp.ent
0.98	11	D sfm
0.98	9	D mode
0.98	7	D centroid
0.98	4	D meanfun
0.979	19	D minfun
0.979	18	D maxfun
0.979	5	D meandom
0.977	20	D mindom
0.977	15	D maxdom
0.977	10	D dfrange
0.975	3	D modindx
0.963	2	S class
0.931	1	

Feature selection for Random Forest



★ 在Random Forest 中使用Feature Selection以及Feature Selection +PCA，不論有幾個Feature，都不會影響到最後算出來的精準度，結果都為100%

Random Forest Confusion matrix

None

PCA

Feature selection

Feature selection + PCA

Confusion Matrix - 3:150 - Scorer			Confusion Matrix - 3:161 - Scorer			Confusion Matrix - 3:145 - Scorer			Confusion Matrix - 3:145 - Scorer		
File Hilite		File Hilite		File Hilite		File Hilite		File Hilite		File Hilite	
class \ Predi...	male	female	class \ Predi...	male	female	class \ Predi...	male	female	class \ Predi...	male	female
male	773	19	male	774	18	male	792	0	male	792	0
female	14	778	female	15	777	female	0	792	female	0	792
Correct classified: 1,551		Wrong classified: 33		Correct classified: 1,551		Wrong classified: 33		Correct classified: 1,584		Wrong classified: 0	
Accuracy: 97.917 %		Error: 2.083 %		Accuracy: 97.917 %		Error: 2.083 %		Accuracy: 100 %		Error: 0 %	
Cohen's kappa (K) 0.958		Cohen's kappa (K) 0.958		Cohen's kappa (K) 1		Cohen's kappa (K) 1		Cohen's kappa (K) 1		Cohen's kappa (K) 1	

Result and Discussion

- 不管是透過PCA,feature selection，其準確度相差不遠
- 不管是透過SVM,random forest,logistic regression，其準確度相差不遠，若使用random forest精準度可以高達100%
- 在Random Forest 中使用Feature Selection或是Feature Selection +PCA，不論有幾個Feature，都不會影響到最後算出來的精準度
- 對於男性如果發出較高頻率的聲音(假音)，有可能造成誤判
- Partitioning多少與結果並無影響，我們有嘗試過使用不同的partitioning，重新execute了10多次，進行分析後與relative 50%的準確度相差不遠
- 本次使用的dataset僅僅是世界77億人口中的一小部分，如果可以加大資料集，那訓練結果也會更好，但也只是接近100%，仍還是需要其他的features來準確辨別性別

SECTION 5 Reflection



Reflection

https://github.com/king87515/knime_voice_project

- 透過這次project，對於KNIME的操作更熟悉
 - Ex: CSV reader,PCA,color/shape manager,plot,feature selection,etc.
- Kaggle裡面的資料集很多，也有很多問題在討論區得到解答，裡面的reference也很用幫助
- 對一些machine learning的演算法更加了解，以及如何使用與操作
- 原本對於一些統計方面的東西不夠了解，藉由這次機會了解了更多
- 一直對於資料處理、分析這塊很有興趣，是一門學問很大、很淵博、實用的工具
- 了解到一些聲學性質與名詞

References

- <https://www.kaggle.com/primaryobjects/voicegender>
- <http://www.primaryobjects.com/2016/06/22/identifying-the-gender-of-a-voice-using-machine-learning/>
- <https://github.com/primaryobjects/voice-gender>
- <http://notebookpage1005.blogspot.com/2018/03/random-forest.html>

THANK YOU!