

Data Mining Project 1

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Implement Apriori Algorithm

min_support=0.01, min_conf=0.3

```
{frozenset({'961'}), frozenset({'325'}), frozenset({'491'}), frozenset({'274'}), frozenset({'607'}), frozenset({'123'}), frozenset({'455'}), frozenset({'772'}), frozenset({'992'}), frozenset({'418'}), frozenset({'500'}), frozenset({'546'}), frozenset({'51'}), frozenset({'544'}), frozenset({'150'}), frozenset({'116'}), frozenset({'459'}), frozenset({'377'}), frozenset({'509'}), frozenset({'799'}), frozenset({'631'}), frozenset({'21'}), frozenset({'993'}), frozenset({'238'}), frozenset({'93'}), frozenset({'907'}), frozenset({'216'}), frozenset({'767'}), frozenset({'667'}), frozenset({'28'}), frozenset({'140'}), frozenset({'783'}), frozenset({'628'}), frozenset({'912'}), frozenset({'575'}), frozenset({'148'}), frozenset({'171'}), frozenset({'416'}), frozenset({'514'}), frozenset({'368'}), frozenset({'85'}), frozenset({'538'}), frozenset({'529'}), frozenset({'675'}), frozenset({'111'}), frozenset({'687'}), frozenset({'938'}), frozenset({'219'}), frozenset({'652'}), frozenset({'832'}), frozenset({'981'}), frozenset({'281'}), frozenset({'732'}), frozenset({'395'}), frozenset({'925'}), frozenset({'348'}), frozenset({'307'}), frozenset({'3'}), frozenset({'193'}), frozenset({'142'}), frozenset({'69'}), frozenset({'743'}), frozenset({'490'}), frozenset({'277'}), frozenset({'248'}), frozenset({'682'}), frozenset({'668'}), frozenset({'364'}), frozenset({'8'}), frozenset({'170'}), frozenset({'527'}), frozenset({'870'}), frozenset({'331'}), frozenset({'904'}), frozenset({'662'}) 0.020943472956486377
frozenset({'259'}) 0.026297953097465094
frozenset({'68'}) 0.013487867696895757
frozenset({'481'}) 0.011318964348651213
frozenset({'570'}) 0.01708011386742578
frozenset({'87'}) 0.03829469974244273
frozenset({'974'}) 0.010437847363426867
frozenset({'959'}) 0.022637928697302426
frozenset({'399'}) 0.029009082282770774
frozenset({'733'}) 0.01870679137860919
frozenset({'622'}) 0.015385658126609733
frozenset({'132'}) 0.042632506438931815
frozenset({'915'}) 0.014707875830283313
frozenset({'778'}) 0.020875694726853734
frozenset({'807'}) 0.028399078216076998
frozenset({'532'}) 0.011047851430120645
frozenset({'926'}) 0.010980073200488003
frozenset({'707'}) 0.04527585739460485
frozenset({'721'}) 0.025552392571506034
frozenset({'722'}) 0.027246848312322082
```

IBM Data

1. Number of transactions in database
2. Average transaction length
3. Number of items

拿4種不同組合參數生成資料

1. $ntrans=0.1$, $tlen=20$, $nitems=0.1$
2. $ntrans=0.1$, $tlen=20$, $nitems=0.5$
3. $ntrans=0.5$, $tlen=20$, $nitems=0.1$
4. $ntrans=0.5$, $tlen=40$, $nitems=0.1$

IBM Data (Cont.)

左圖每行分別代表CustID, TransID, Item

右圖為DAT格式，將同一個Transaction的Item放在同一列

1	1	0
1	1	6
1	1	8
1	1	8
1	1	34
1	1	36
1	1	38
1	1	42
1	1	45
1	1	47
1	1	49
1	1	50
1	1	51
1	1	52
1	1	53
1	1	55
1	1	61
1	1	62
1	1	63
1	1	67
1	1	69
1	1	71
1	1	74
1	1	78
1	1	83
1	1	94
2	2	4

1	0,6,8,34,36,38,42,45,47,49,50,51,52,53,55,61,62,63,67,69,71,74,78,83,94,
2	4,8,9,11,14,17,18,35,36,38,39,40,41,42,43,59,63,69,73,80,81,85,87,93,97,
3	8,9,10,14,17,21,25,36,38,40,43,45,57,60,62,63,69,83,85,93,
4	0,4,7,11,12,13,14,20,23,26,29,38,42,46,61,62,63,72,73,85,86,91,96,
5	3,6,11,12,14,17,18,19,21,25,33,38,48,61,62,63,68,71,75,80,81,83,84,87,89,
6	0,11,13,38,40,60,63,74,80,
7	3,5,7,17,23,28,32,38,39,40,43,47,52,57,61,67,69,70,79,85,87,93,
8	3,29,43,45,69,72,74,78,89,93,95,97,
9	0,3,4,12,15,28,33,38,39,40,47,48,61,65,71,72,74,80,86,87,89,96,98,
10	17,21,33,36,43,45,47,48,61,69,73,78,81,83,87,
11	3,5,6,28,35,36,38,40,43,48,51,52,61,62,63,74,77,85,86,
12	3,5,8,11,14,17,20,21,28,33,36,40,51,52,57,59,63,66,81,83,85,89,90,
13	5,8,14,21,29,31,35,38,39,41,42,59,62,63,70,86,95,
14	1,3,5,7,11,14,28,31,33,35,36,43,48,61,63,69,80,82,86,91,
15	12,21,26,28,29,31,43,45,57,61,62,63,67,69,77,80,81,83,86,87,88,89,93,96,
16	3,8,11,12,17,20,23,28,29,35,38,40,43,47,48,50,62,63,66,71,72,73,81,83,92,97,
17	13,23,25,31,35,36,38,50,62,66,67,70,71,74,81,85,
18	21,36,43,51,59,62,63,69,70,87,89,97,
19	5,13,23,29,36,42,46,48,51,57,63,68,69,72,74,81,83,85,87,95,
20	3,8,9,17,21,27,28,36,38,40,43,45,48,49,57,66,67,69,71,74,78,81,84,85,86,87,89,91,93,95,
21	7,13,21,34,35,38,47,49,52,63,66,68,71,80,89,
22	3,8,10,13,25,26,28,36,38,39,48,51,62,63,69,72,73,81,83,85,93,
23	3,8,12,14,17,23,35,38,41,48,51,57,61,63,69,73,76,85,86,87,89,90,97,

Kaggle data

New Zealand Migration

Migration numbers to and from New Zealand from 1979 to 2016

每行feature分別是：

1. **Measure**: The signal type given in this row, one of: "Arrivals", "Departures", "Net"
2. **Country**: Country from where people arrived into to New Zealand (for Measure = "Arrivals") or to where they left (for Measure = "Departures"). Contains special values "Not Stated" and "All countries" (grand total)
3. **Citizenship**: Citizenship of the migrants, one of: "New Zealand Citizen", "Australian Citizen", "Total All Citizenships"
4. **Year**: Year of the measurement
5. **Value**: Number of migrants

Kaggle data (Cont.)

將公民身份別為紐西蘭，以及移民人數大於1000的資料抓出來，以同年份代表同一 Transaction ID，希望算出紐西蘭至別的國家移民的關聯

```
123 1989 Hong-Kong
124 1989 Japan
125 1989 Malaysia
126 1989 Singapore
127 1989 Taiwan
128 1989 Europe
129 1989 UK
130 1989 Americas
131 1989 USA
132 1989 Not-stated
133 1990 Oceania
134 1990 Australia
135 1990 Fiji
136 1990 New-Zealand
137 1990 Samoa
138 1990 Asia
```

```
Oceania,Australia,Fiji,Asia,Hong-Kong,Japan,Malaysia,Taiwan,Europe,UK,USSR
Oceania,Australia,Fiji,Asia,Hong-Kong,Japan,South-Korea,Malaysia,Taiwan,Eu
ica-and-the-Middle-East,South-Africa,Not-stated,
Oceania,Australia,Fiji,Samoa,Asia,China,Hong-Kong,India,Japan,South-Korea,M
K,Americas,USA,Africa-and-the-Middle-East,South-Africa,Not-stated,
Oceania,Australia,Fiji,Samoa,Asia,China,Hong-Kong,India,Japan,South-Korea,M
K,Americas,Canada,USA,Africa-and-the-Middle-East,South-Africa,Not-stated,
```

FP Growth Algorithm - IBM Data

min_support=0.01

	946	frozenset: {'222'}
	947	frozenset: {'238'}
['42', '397', '471', '510', '553', '629', '644', '656', '716', '772', '790', '838'],	948	frozenset: {'127'}
['56', '293', '521', '729'], ['321', '459', '524', '543', '578', '592', '599', '622'],	949	frozenset: {'444'}
['29', '39', '46', '152', '306', '336', '412', '429', '432', '543', '547', '553', '766',	950	frozenset: {'827'}
'794', '819', '870', '894', '902', '981'], ['80', '108', '304', '388', '625', '962', '96	951	frozenset: {'132'}
4', '994'], ['62', '107', '129', '163', '437', '629', '705', '815', '904'], ['137', '18	952	frozenset: {'874'}
8', '214', '405', '418', '420', '443', '447', '566', '813', '837', '858'], ['51', '63',	953	frozenset: {'38'}
'86', '146', '325', '374', '395', '444', '571', '628', '684', '970'], ['38', '60', '85,	954	frozenset: {'707'}
'371', '387', '456', '764', '840'], ['8', '50', '60', '117', '360', '557', '578', '592',	955	frozenset: {'63'}
'624', '753', '868', '870', '877', '954'], ['7', '35', '99', '102', '127', '172', '194',	956	frozenset: {'800'}
'221', '266', '462', '607'], ['106', '351', '432', '599'], ['124', '740', '988', '989',	957	frozenset: {'221'}
'990'], ['39', '155', '167', '169', '214', '287', '374', '497', '593', '733', '778', '80	958	frozenset: {'432'}
6', '848', '850'], ['25', '106', '107', '123', '135', '167', '179', '182', '374', '414',	959	frozenset: {'416'}
'571', '589', '601', '612', '673', '729', '820', '847', '911', '934'], ['3', '105', '11	960	frozenset: {'571'}
6', '123', '773', '806'], ['36', '201', '404', '416', '559', '668', '682', '719', '803',	961	frozenset: {'592', '571'}
'916'], ['12', '47', '148', '238', '278', '368', '446', '471', '544', '584'], ['47', '32	962	frozenset: {'553'}
8', '737', '772', '855', '970'], ['21', '255', '447', '456', '692', '803', '934', '981',	963	frozenset: {'709'}
'994'], ['150', '371', '425', '477', '773', '966', '994'], ['7', '245', '412', '644', '7	964	frozenset: {'592'}
32', '733', '744', '813', '874', '903', '946', '991'], ['15', '29', '119', '274', '283',		
'472', '490', '571', '682', '776', '835', '884', '909'], ['182', '441', '442', '456', '4		
73', '487', '506', '682', '756', '801', '820', '832', '845'], ['17', '144', '280', '33		

Apriori Algorithm - IBM Data

min_support=0.001, min_conf=0.3

```
frozenset({'253'}) => frozenset({'807'}) conf: 0.45652173913043476
frozenset({'650'}) => frozenset({'656'}) conf: 0.7619047619047619
frozenset({'363'}) => frozenset({'624'}) conf: 0.3269230769230769
frozenset({'835'}) => frozenset({'325'}) conf: 0.45652173913043476
frozenset({'274'}) => frozenset({'653'}) conf: 0.45652173913043476
frozenset({'607'}) => frozenset({'123'}) conf: 0.45652173913043476
frozenset({'611'}) => frozenset({'27'}) conf: 0.45652173913043476
frozenset({'483'}) => frozenset({'1'}) conf: 0.45652173913043476
frozenset({'747'}) => frozenset({'772'}) conf: 0.45652173913043476
frozenset({'992'}) => frozenset({'282'}) conf: 0.45652173913043476
frozenset({'987'}) => frozenset({'309'}) conf: 0.45652173913043476
frozenset({'976'}) => frozenset({'970'}) conf: 0.45652173913043476
frozenset({'650'}) => frozenset({'86'}) conf: 0.45652173913043476
frozenset({'429'}) => frozenset({'116'}) conf: 0.45652173913043476
frozenset({'665'}) => frozenset({'347'}) conf: 0.45652173913043476
frozenset({'621'}) => frozenset({'26'}) conf: 0.45652173913043476
frozenset({'681'}) => frozenset({'715'}) conf: 0.45652173913043476
frozenset({'771'}) => frozenset({'377'}) conf: 0.45652173913043476
frozenset({'965'}) => frozenset({'79'}) conf: 0.45652173913043476
frozenset({'799'}) => frozenset({'956'}) conf: 0.45652173913043476
frozenset({'11'}) => frozenset({'431'}) conf: 0.45652173913043476
frozenset({'714'}) => frozenset({'714'}) conf: 0.45652173913043476
frozenset({'430'}) => frozenset({'993'}) conf: 0.45652173913043476
frozenset({'710'}) => frozenset({'199'}) conf: 0.45652173913043476
frozenset({'700'}) => frozenset({'206'}) conf: 0.45652173913043476
frozenset({'499'}) => frozenset({'814'}) conf: 0.45652173913043476
frozenset({'907'}) => frozenset({'216'}) conf: 0.45652173913043476
frozenset({'767'}) => frozenset({'667'}) conf: 0.45652173913043476
frozenset({'43'}) => frozenset({'906'}) conf: 0.45652173913043476
frozenset({'359'}) => frozenset({'806'}) conf: 0.45652173913043476
frozenset({'140'}) => frozenset({'783'}) conf: 0.45652173913043476
frozenset({'352'}) => frozenset({'637'}) conf: 0.45652173913043476
frozenset({'854'}) => frozenset({'298'}) conf: 0.45652173913043476
frozenset({'642'}) => frozenset({'171'}) conf: 0.45652173913043476
frozenset({'416'}) => frozenset({'453'}) conf: 0.45652173913043476
frozenset({'83'}) => frozenset({'960'}) conf: 0.45652173913043476
frozenset({'77'}) => frozenset({'865'}) conf: 0.45652173913043476
frozenset({'466'}) => frozenset({'368'}) conf: 0.45652173913043476
frozenset({'98'}) => frozenset({'62'}) conf: 0.45652173913043476
frozenset({'686'}) => frozenset({'633'}) conf: 0.45652173913043476
frozenset({'522'}) => frozenset({'85'}) conf: 0.45652173913043476
frozenset({'867'}) => frozenset({'658'}) conf: 0.45652173913043476
frozenset({'529'}) => frozenset({'278'}) conf: 0.45652173913043476
frozenset({'67'}) => frozenset({'554'}) conf: 0.45652173913043476
frozenset({'45'}) => frozenset({'704'}) conf: 0.45652173913043476
frozenset({'839'}) => frozenset({'474'}) conf: 0.45652173913043476
frozenset({'716'}) => frozenset({'297'}) conf: 0.45652173913043476
frozenset({'215'}) => frozenset({'200'}) conf: 0.45652173913043476
frozenset({'494'}) => frozenset({'657'}) conf: 0.45652173913043476
frozenset({'513'}) => frozenset({'219'}) conf: 0.45652173913043476
frozenset({'65'}) => frozenset({'367'}) conf: 0.45652173913043476
frozenset({'194'}) => frozenset({'462'}) conf: 0.5476190476190477
frozenset({'297'}) => frozenset({'687'}) conf: 0.4084507042253521
frozenset({'207'}) => frozenset({'697'}) conf: 0.32727272727272727
frozenset({'650'}) => frozenset({'132'}) conf: 0.8095238095238095
frozenset({'650'}) => frozenset({'132'}) conf: 0.8095238095238095
frozenset({'621'}) => frozenset({'26'}) conf: 0.5789473684210527
frozenset({'431'}) => frozenset({'404'}) conf: 0.36708860759493667
frozenset({'714'}) => frozenset({'753'}) conf: 0.4722222222222222
frozenset({'906'}) => frozenset({'545'}) conf: 0.7142857142857142
frozenset({'757'}) => frozenset({'289'}) conf: 0.4772727272727273
frozenset({'22'}) => frozenset({'628'}) conf: 0.323943661971831
frozenset({'960'}) => frozenset({'52'}) conf: 0.46341463414634143
frozenset({'98'}) => frozenset({'62'}) conf: 0.3333333333333333
frozenset({'180'}) => frozenset({'891'}) conf: 0.39999999999999997
frozenset({'554'}) => frozenset({'217'}) conf: 0.31506849315068497
frozenset({'208'}) => frozenset({'49'}) conf: 0.3125
frozenset({'367'}) => frozenset({'293'}) conf: 0.35555555555555555
```


FP Growth Algorithm - IBM Data

min_support=0.001

	946	frozenset: {'222'}	
	947	frozenset: {'238'}	
	948	frozenset: {'127'}	
	949	frozenset: {'444'}	
	950	frozenset: {'827'}	
	951	frozenset: {'132'}	
	952	frozenset: {'874'}	
	953	frozenset: {'38'}	
	954	frozenset: {'707'}	
	955	frozenset: {'63'}	
	956	frozenset: {'800'}	
	957	frozenset: {'221'}	
	958	frozenset: {'432'}	
	959	frozenset: {'416'}	
	960	frozenset: {'571'}	
	961	frozenset: {'592', '571'}	
	962	frozenset: {'553'}	
	963	frozenset: {'709'}	
	964	frozenset: {'592'}	

Performance Comparison - **IBM Data**

	Apriori	FP Growth
minSup=0.01, min_conf=0.3	3117.908341	33.07
minSup=0.001, min_conf=0.3	2810.978982	38.62

Discussion - IBM Data

Apriori的時間複雜度為FP-Growth的100倍左右，比較特別的是將minSupport 值調低，Apriori的時間花費減少了，而FP-Growth時間增加

FP Growth Algorithm - Kaggle Data

user@user-System-Product-Name: /media/user/67a2dc9c-17dd-44b5-969d-d7ac6dcfcc

檔案(F) 編輯(E) 檢視(V) 搜尋(S) 終端機(T) 求助(H)

```
(Australia Europe Oceania USA) ==> (Not-stated ) confidence=
(Not-stated) ==> (Australia Europe UK ) confidence= 1.00
(Australia) ==> (Not-stated Europe UK ) confidence= 0.97
(Europe) ==> (Not-stated Australia UK ) confidence= 0.97
(UK) ==> (Not-stated Australia Europe ) confidence= 0.97
(Not-stated Australia) ==> (Europe UK ) confidence= 1.00
(Not-stated Europe) ==> (Australia UK ) confidence= 1.00
(Not-stated UK) ==> (Australia Europe ) confidence= 1.00
(Australia Europe) ==> (Not-stated UK ) confidence= 0.97
(Australia UK) ==> (Not-stated Europe ) confidence= 0.97
(Europe UK) ==> (Not-stated Australia ) confidence= 0.97
(Not-stated Australia Europe) ==> (UK ) confidence= 1.00
(Not-stated Australia UK) ==> (Europe ) confidence= 1.00
(Not-stated Europe UK) ==> (Australia ) confidence= 1.00
(Australia Europe UK) ==> (Not-stated ) confidence= 0.97
(Not-stated) ==> (Australia Europe UK USA ) confidence= 1.00
(Australia) ==> (Not-stated Europe UK USA ) confidence= 0.97
(Europe) ==> (Not-stated Australia UK USA ) confidence= 0.97
(UK) ==> (Not-stated Australia Europe USA ) confidence= 0.97
(USA) ==> (Not-stated Australia Europe UK ) confidence= 0.97
```

minsupport =1000

FP Growth Algorithm - Kaggle Data

user@user-System-Product-Name: /media/user/67a2dc9c-17dd-44b5-969d-d7ac6dcfcc

檔案(F) 編輯(E) 檢視(V) 搜尋(S) 終端機(T) 求助(H)

```
(Australia Europe Oceania USA) ==> (Not-stated ) confidence=
(Not-stated) ==> (Australia Europe UK ) confidence= 1.00
(Australia) ==> (Not-stated Europe UK ) confidence= 0.97
(Europe) ==> (Not-stated Australia UK ) confidence= 0.97
(UK) ==> (Not-stated Australia Europe ) confidence= 0.97
(Not-stated Australia) ==> (Europe UK ) confidence= 1.00
(Not-stated Europe) ==> (Australia UK ) confidence= 1.00
(Not-stated UK) ==> (Australia Europe ) confidence= 1.00
(Australia Europe) ==> (Not-stated UK ) confidence= 0.97
(Australia UK) ==> (Not-stated Europe ) confidence= 0.97
(Europe UK) ==> (Not-stated Australia ) confidence= 0.97
(Not-stated Australia Europe) ==> (UK ) confidence= 1.00
(Not-stated Australia UK) ==> (Europe ) confidence= 1.00
(Not-stated Europe UK) ==> (Australia ) confidence= 1.00
(Australia Europe UK) ==> (Not-stated ) confidence= 0.97
(Not-stated) ==> (Australia Europe UK USA ) confidence= 1.00
(Australia) ==> (Not-stated Europe UK USA ) confidence= 0.97
(Europe) ==> (Not-stated Australia UK USA ) confidence= 0.97
(UK) ==> (Not-stated Australia Europe USA ) confidence= 0.97
(USA) ==> (Not-stated Australia Europe UK ) confidence= 0.97
```

minsupport =0.001

Time = 0.05745s

Apriori Algorithm - Kaggle Data

min_support=0.001, min_conf=0.3, Time=0.121113s

```
(UK, Australia, Asia, Americas, USA, Oceania, Not-stated) ==> (Europe) confidence = 1.0
(UK, Australia, Europe, Americas, USA, Oceania, Not-stated) ==> (Asia) confidence = 1.0
(UK, Australia, Europe, Asia, USA, Oceania, Not-stated) ==> (Americas) confidence = 1.0
(UK, Australia, Europe, Asia, Americas, Oceania, Not-stated) ==> (USA) confidence = 1.0
(UK, Australia, Europe, Asia, Americas, USA, Not-stated) ==> (Oceania) confidence = 1.0
(UK, Australia, Europe, Asia, Americas, USA, Oceania) ==> (Not-stated) confidence = 0.974
(Australia, Asia, Americas, USA, Oceania, Europe) ==> (UK) confidence = 0.974
(UK, Asia, Americas, USA, Oceania, Europe) ==> (Australia) confidence = 0.974
(UK, Australia, Asia, Americas, USA, Oceania) ==> (Europe) confidence = 0.974
(UK, Australia, Americas, USA, Oceania, Europe) ==> (Asia) confidence = 0.974
(UK, Australia, Asia, USA, Oceania, Europe) ==> (Americas) confidence = 0.974
(UK, Australia, Asia, Americas, Oceania, Europe) ==> (USA) confidence = 0.974
(UK, Australia, Asia, Americas, USA, Europe) ==> (Oceania) confidence = 0.974
```

Discussion - Kaggle Data

每年都會有固定的移民從紐西蘭去別的城市，沒有因為不同年代而有太大的改變，應該是資料前處理時，移民數設大於1000人就取出來的關係，會導致取出來的資料沒什麼代表性，數字要再取大一點，Frequent itemset才不會這麼多。