

SAVVY2 W GROUP BUSINESS REPORT

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1 Introduction

- Market basket analysis (MBA) is an analytics technique to understand customer purchase behaviours. It is used to determine what items are frequently bought together or placed in the same basket by customers.
- Task: Comparing traditional market basket analysis techniques with network science techniques.
- Key aims: Model customer transactions as a network and extract groups of commonly bought together products as well as important products using Network Science metrics.

2 Dataset description

There are four datasets in the whole report, namely UK, France, rest of the world and key accounts. For key accounts group, it indicates the top 50 customers who have the highest expenditure. For each dataset, it has been divided into quarter of 2018 from April.

The following table describes the variable that are used in the dataset.

Variable	Description
Item/ Product Code	Product identification
Customer Name	Each customer has been given a number. UK customers: Customer 1 - Customer 96; rest of the world customers: Customer 97 - Customer 202; French customers: Customer 203 - Customer 310; key accounts customers: Customer 311 - Customer 384
Season	Information about when the product was introduced in the business to be sold (e.g. SS19 = Spring Summer 2019, AW18 = Autumn Winter 2018 etc.)
Category	Type of category (e.g. home) that product fits in
Product type	Type of product sold
Collection	Trend names within the design world (look of the design)
Colour	Colour for the design
Icon	Icon within the design
Rank	Ranking as per quarter expenditure
Invoice number	A 6-digit integral number uniquely assigned to each transaction
Invoice date	the day when each invoice was generated There are four periods in each dataset. Q1: April - June 2018, Q2: July - September 2018, Q3: October - December2018 and Q4: January - March2019

3 Network science model

To find out products with the highest record of purchase and related products that bought together, Network Science Model is used to simplify the process. Through creating two-mode network, products that bought at the same time will be linked and list of paired products will

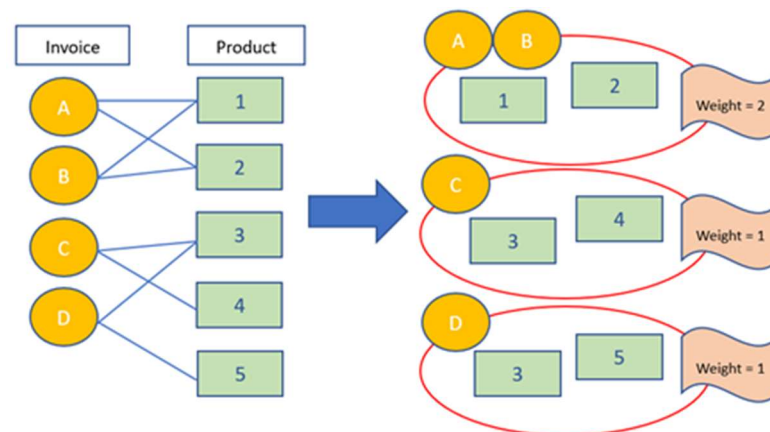
be concluded. To compare results with association rule mode, top 10 of paired nodes are listed out and assumption can be made.

Implementation:

Step 1: In order to analyse with complete dataset, data with missing values (NaN) will be ignored.

Step 2: Creating a 2-mode network by setting top nodes as invoice number and bottom nodes as product code. A bipartite network, shown below on the left-hand side, can then be formed.

Step 3: When 2-mode network is created, it will then be transferred into a one-mode network in order to find out weighted nodes (products).



4 Association rule model

In order to formulate corresponding marketing strategies and conduct bundling sales to increase sales, we use association rule to analyse the combination of goods that customers often buy at the same time from retail records. Apriori algorithm is one of the classical algorithms of "association rule learning" or "Associative Analysis". The purpose of this algorithm is to find out the relationship between different product, mainly use Confidence and Support level to measure whether the rule is good enough.

The degree of support reveals how often product A and B appear in the same invoice. If the frequency of A and B appearing together is very small, then the relationship between A and B is not significant. But if they occur in the same invoice very often, then A and B can be realized that they are associated. The confidence indicates how credible this rule is and reveals whether A must appear when B appears and how likely it is if it does.

Implementation:

Step 1: To make sure the completeness of dataset, data with any missing value in features will be ignored.

Step 2: Use invoice number and invoice date in the dataset to create transaction data. The table below gives an example of this. Each row shows the products bought together in one transaction.

Invoice date	Invoice number	Product
2018/5/23	174366	94Prod, 325Prod, 234Prod
2018/6/29	179000	1719Prod, 1049Prod, 864Prod, 790Prod

Step 3: Use transaction data to mine the rules based on the Apriori algorithm.

- To correspond with the result of the network science model, set there are only 2 items in a basket.
- To determine the minimum support level and the minimum confidence level, compare the number of rules found through the network science model, and set the support level and the confidence level to the value which can generate a similar number of rules in the network science model. The table below shows the number of rules found in both models and the minimum support and minimum confidence selected.

Region	Period	Number of rules found in the network model	Number of rules found in the association rule model	minimum support level	minimum confidence level
Key account	Q1	21872	25233	0.001	0.5
	Q2	64986	72647	0.001	0.5
	Q3	75364	83482	0.001	0.5
	Q4	8531	7100	0.001	0.55
UK	Q1	49065	49828	0.001	0.15
	Q2	58310	58278	0.001	0.25
	Q3	94371	95345	0.001	0.2
	Q4	59145	61588	0.001	0.2
France	Q1	66422	72709	0.002	0.25
	Q2	41251	49061	0.002	0.25
	Q3	61756	60606	0.002	0.3
	Q4	61756	65931	0.002	0.3
Rest of the world	Q1	76312	76540	0.0025	0.22
	Q2	89526	87585	0.0025	0.25
	Q3	130748	144334	0.0025	0.25
	Q4	52206	49149	0.0025	0.245

- The figure below shows the result of the association rules. For instance, the first row indicates that customers who bought product 1174 also bought product 1501 together, and the support level, confidence level, lift and count of this rule.

lhs	rhs	support	confidence	lift	count
{1174Prod}	=> {1501Prod}	0.002427184	1.0	412.0	1
{1501Prod}	=> {1174Prod}	0.002427184	1.0	412.0	1
{531Prod}	=> {969Prod}	0.002427184	1.0	51.5	1
{2173Prod}	=> {1825Prod}	0.002427184	1.0	206.0	1
{1825Prod}	=> {2173Prod}	0.002427184	0.5	206.0	1
{3135Prod}	=> {3134Prod}	0.002427184	1.0	412.0	1

Step 4: Sort the rules by confidence level and support level in descending order. Then choose the top 10 rules to make comparison with the rules found by the network science model.

	lhs	rhs	support	confidence	lift	count
11765	1646Prod	542Prod	0.082524	1.0	8.956522	34
11790	296Prod	2297Prod	0.067961	1.0	13.733333	28
25224	1016Prod	257Prod	0.024272	1.0	29.428571	10
11634	873Prod	571Prod	0.016990	1.0	51.500000	7
25098	513Prod	210Prod	0.016990	1.0	29.428571	7
10964	11Prod	6Prod	0.014563	1.0	68.666667	6
10965	6Prod	11Prod	0.014563	1.0	68.666667	6
10966	11Prod	835Prod	0.014563	1.0	68.666667	6
10967	835Prod	11Prod	0.014563	1.0	68.666667	6
10969	11Prod	168Prod	0.014563	1.0	58.857143	6

5 Analysis

a. Key accounts

Q1:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count	lhs	rhs	support	confidence	lift	count	
12881	346Prod	542Prod	36	11765	1646Prod	542Prod	0.082524	1.0	8.956522	34
18089	542Prod	1646Prod	34	11790	296Prod	2297Prod	0.067961	1.0	13.733333	28
12879	346Prod	1646Prod	31	25224	1016Prod	257Prod	0.024272	1.0	29.428571	10
13077	296Prod	2297Prod	28	11634	873Prod	571Prod	0.016990	1.0	51.500000	7
19696	159Prod	2297Prod	27	25098	513Prod	210Prod	0.016990	1.0	29.428571	7
13073	296Prod	840Prod	26	10964	11Prod	6Prod	0.014563	1.0	68.666667	6
13079	296Prod	159Prod	26	10965	6Prod	11Prod	0.014563	1.0	68.666667	6
16814	840Prod	2297Prod	26	10966	11Prod	835Prod	0.014563	1.0	68.666667	6
16794	840Prod	159Prod	26	10967	835Prod	11Prod	0.014563	1.0	68.666667	6
1873	210Prod	286Prod	11	10969	11Prod	168Prod	0.014563	1.0	58.857143	6

- **Luggage tags and shopping bags are bought together.**
In network model, it shows that customers bought 2 of the products between 542Prod, 346Prod and 1646Prod. These 3 products are also the 3 most frequently bought items in Q1. But in the association model, it only shows that customers who bought 1646Prod bought 542Prod together. Since product set {1646Prod, 542Prod} is recognised by both models, we conclude that luggage tags and shopping bags are frequently bought together.
- **Trinket dishes with different collections and colours are bought together.**
In network model, customers bought 2 of the products between 2297Prod, 159Prod, 296Prod and 840Prod as well. But in the association model, customers who bought

296Prod bought 2297Prod together. Since product set {296Prod, 2297Prod} is recognised by both models, we find out that these 2 products are trinket dishes with different collections and colours.

- **Mugs with different collections may be complementary items and are bought together.** In association model, it shows that 11Prod and 6Prod, 11Prod and 835Prod bought together. Also, who bought 11Prod has opportunity to bought 168 Prod as well. These products are all mugs with different collections. These 4 products may be complementary goods since they have similar features.

Q2:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count	lhs	rhs	support	confidence	lift	count	
55633	325Prod	55Prod	43	18431	74Prod	111Prod	0.056140	1.0	17.272727	32
7675	1671Prod	1201Prod	32	45065	168Prod	6Prod	0.015789	1.0	47.500000	9
4942	74Prod	111Prod	32	72475	2283Prod	1170Prod	0.014035	1.0	57.000000	8
7721	1671Prod	325Prod	32	12382	822Prod	2374Prod	0.012281	1.0	43.846154	7
51779	1201Prod	111Prod	31	52551	210Prod	286Prod	0.012281	1.0	71.250000	7
4952	74Prod	325Prod	31	72372	2282Prod	1170Prod	0.012281	1.0	57.000000	7
4943	74Prod	1671Prod	31	5440	2437Prod	144Prod	0.010526	1.0	51.818182	6
4945	74Prod	55Prod	31	5505	999Prod	1005Prod	0.010526	1.0	47.500000	6
4947	74Prod	1201Prod	31	5507	999Prod	822Prod	0.010526	1.0	81.428571	6
7904	1671Prod	111Prod	31	5509	999Prod	2374Prod	0.010526	1.0	43.846154	6

- **Keyrings, trinket dishes, flasks or mugs are likely to be bought together.**
 - In the network model, we found that 74Prod appears frequently in item sets, and is bought together with 111Prod, 325Prod, 1671Prod, 55Prod or 1201Prod. In association rule model, we also recognise that 74Prod brought with 111Prod together. These 6 products are key rings, trinket dishes, flasks and mugs, meaning that customers who bought key rings (74Prod) may bought this kind of items together. Moreover, for item set {74Prod, 111Prod} recognised in both models, these two products are key rings introduced in the same season (2018SS) but with different collections and colours.
 - In the network model, 1671Prod appears frequently in item sets as well and is bought together with 74Prod, 325Prod, 111Prod or 1201Prod. However, these item sets do not appear in the association rule model. These items are flasks (1671Prod) and key rings, trinket dishes and mugs.
- **Christmas products with a wood texture or reindeer icons are bought together.** In association rule model, the most frequently appeared rules is that customers who bought 999Prod also bought 1005Prod, 822Prod and 2374Prod. It is interesting to notice these items are all Christmas products. 999Prod is a wood suitcase with reindeer icon while others are coasters, milk bottle and decoration, and most of them are wood with brown colour or reindeer icon.

Q3:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
26007	99Prod	370Prod	17	81512	1170Prod	11Prod	0.017518	1.0	36.052632	12
19584	6Prod	11Prod	17	36877	1163Prod	105Prod	0.014599	1.0	48.928571	10
448	168Prod	6Prod	16	36895	1163Prod	2282Prod	0.014599	1.0	57.083333	10
473	168Prod	11Prod	15	36897	1163Prod	6Prod	0.014599	1.0	32.619048	10
57556	8Prod	11Prod	14	36898	1163Prod	168Prod	0.014599	1.0	28.541667	10
19514	6Prod	8Prod	14	36899	1163Prod	1170Prod	0.014599	1.0	57.083333	10
16863	553Prod	448Prod	13	36903	1163Prod	11Prod	0.014599	1.0	36.052632	10
26094	173Prod	8Prod	13	4919	976Prod	448Prod	0.013139	1.0	48.928571	9
19570	6Prod	248Prod	13	4921	976Prod	553Prod	0.013139	1.0	45.666667	9
26186	173Prod	11Prod	12	13812	1688Prod	1642Prod	0.013139	1.0	68.500000	9

- **Mugs with different collections may be complementary items and are bought together.**
 - In the network model, we found that 6Prod appears frequently in item sets, and is bought together with 11Prod, 168Prod, 8Prod or 248Prod. However, in the association rule model, we do not recognise these rules. These products are all mugs and 3 of these 5 items have a collection of “Kawaii Friends” and are introduced in 2016AW.
 - In the network model, 11Prod also appears frequently in item sets and is bought together with 6Prod, 168Prod, 8Prod or 173Prod. Among these items, we also found that 8Prod is bought with 173Prod together. These products are all mugs and 3 of these 5 items have a collection of “Kawaii Friends”. However, we found that 8Prod and 173Prod are the 2 products with different collections.
- **Christmas decoration bought together with plant plots or trinket dishes with the collection of “MANDALA ELEPHANT”.**

In the association model, 976Prod is bought together with 448Prod or 553Prod. Furthermore, it is recognised that 553Prod and 448Prod bought together in the network model. It is interesting to notice that 976Prod is a standing Christmas decoration, while 448Prod and 553Prod are plant plots and trinket dishes with the same collection of “MANDALA ELEPHANT”, meaning that 448Prod and 553Prod may be complementary items of each other. Also, since 553Prod bought together with 448Prod, it indicates that plant plots are bought with trinket dishes.

Q4:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
3429	103Prod	1Prod	38	7077	206Prod	1Prod	0.078390	1.0	11.800000	37
6597	1Prod	206Prod	37	7021	295Prod	281Prod	0.076271	1.0	13.111111	36
5833	277Prod	302Prod	36	7022	281Prod	295Prod	0.076271	1.0	13.111111	36
6588	1Prod	295Prod	36	7023	295Prod	232Prod	0.076271	1.0	13.111111	36
2786	281Prod	103Prod	36	7024	232Prod	295Prod	0.076271	1.0	13.111111	36
8206	109Prod	295Prod	36	7025	295Prod	109Prod	0.076271	1.0	13.111111	36
4158	232Prod	1Prod	36	7026	109Prod	295Prod	0.076271	1.0	13.111111	36
4161	232Prod	206Prod	36	7027	295Prod	206Prod	0.076271	1.0	12.756757	36
4162	232Prod	109Prod	36	7029	295Prod	277Prod	0.076271	1.0	12.102564	36
4163	232Prod	295Prod	36	7031	295Prod	103Prod	0.076271	1.0	10.976744	36

- **Bowls are bought together with bamboo sets, cushions, cutlery sets or plates with similar colours (white, grey, cream, silver).**

In network model, we found that 232Prod appears frequently in item sets, and is bought together with 1Prod, 206Prod, 109Prod or 295Prod. These 5 items are all kitchen/home-related products with similar colours (white, grey, cream, silver). 232Prod are bowls, other 4 products are bamboo sets, cushions, cutlery sets and plates, meaning these sorts of kitchen/home accessories are likely to be bought together with bowls.

- **Cutlery sets are bought with plates or bowls in the same collection “Sweet Dreams” and white and grey colour.**

295Prod is the most frequently bought item recognised in both models. In the network model, it is bought with 1Prod, 109Prod or 232Prod. In the association rule model, customers who bought 295Prod also bought 281Prod, 232Prod, 109Prod, 206Prod, 277Prod or 103Prod. It is noticeable that 109Prod or 232Prod appear in both models, showing that cutlery sets are bought with plates or bowls in the same collection “Sweet Dreams” and white and grey colour.

b. UK

Q1:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
47003	303Prod	81Prod	32	44314	572Prod	88Prod	0.015504	1.0	12.285714	8
13571	15Prod	81Prod	15	11796	903Prod	766Prod	0.013566	1.0	64.500000	7
11932	18Prod	15Prod	15	17346	1890Prod	1573Prod	0.011628	1.0	73.714286	6
2077	2327Prod	2138Prod	15	42662	1130Prod	1171Prod	0.011628	1.0	73.714286	6
45938	27Prod	88Prod	15	42703	1130Prod	1499Prod	0.011628	1.0	23.454545	6
38294	119Prod	30Prod	15	1093	647Prod	327Prod	0.009690	1.0	23.454545	5
13352	15Prod	119Prod	15	35987	806Prod	834Prod	0.009690	1.0	86.000000	5
30454	56Prod	317Prod	15	3248	226Prod	696Prod	0.007752	1.0	51.600000	4
31479	2142Prod	119Prod	14	17212	852Prod	136Prod	0.007752	1.0	73.714286	4
31510	2142Prod	88Prod	14	17220	852Prod	1805Prod	0.007752	1.0	57.333333	4

- **Money box in different collection is popular in Q1. Money box in different collection maybe alternative products and usually are bought together.**

In network model, it shows that 119Prod and 15Prod have the higher probability to be purchased with other product by customers. These two products are also the most frequently bought items in Q1. These two products are Money box in different collection. It shows that 119Prod bought together with 30Prod(money box in same collection), 15Prod(money box in different collection) and 2142Prod(letter rack). As for 15Prod, it usually was purchased with 81Prod(passport holder), 18Prod(glasses case) and 119Prod(money box in different collection). We can infer that 119Prod and 15Prod is alternative product.

Also, 2142Prod, 81Prod and 88Prod are a little bit less popular than 119Prod and 15Prod. But in association model, it shows that 1130Prod and 852Prod are popular.

- **88Prod(suitcase) is more likely to bought in pair by customers in Q1. Suitcases are bought with letter rack, lunch box and suitcase in different colour and collection.**

Since 88Prod shows both in network and association model, we speculate that it is more credible that this product is more likely to be bought in pair by customers in Q1. In

network model, customers bought 88Prod with 27Prod or 2142Prod. But in association model, customers who bought 88Prod bought 572Prod together. From that, we can see that customers usually bought suitcase(88Prod) with letter rack, lunch box and suitcase in different colour and collection.

- **Mugs in different collection are substitute goods and are bought together.**

In association model, it shows that 1130Prod bought together with 1171Prod and 1499Prod.

These products are all mugs. Two of them have the collection of “Gold” but one (1499Prod) have the collection of “Monochrome”. The 1499Prod and 1171Prod may be substitute goods since they have similar features(in similar colour).

- **Coaster in home accessories is bought with some kitchen accessories like Trinket Dish and Mug.**

In association model, It is noticeable that who bought 852Prod also bought 136Prod and 1805Prod. 852Prod is Coaster(Home Accessories), purchasing with Trinket Dish and Mug(two item of Kitchen Accessories). It is more reasonable customers usually buy coaster and mug together, and sometime they would like to add some trinket dish. So we can suggest buddle sale strategies, such as a set of coaster and mug or a set of these three product, which may motivate customer to buy more.

Q2:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
42695	28Prod	175Prod	23	56163	380Prod	192Prod	0.013769	1.0	44.692308	8
16049	18Prod	66Prod	18	57457	1293Prod	1065Prod	0.012048	1.0	58.100000	7
36727	13Prod	2Prod	17	57852	1191Prod	1065Prod	0.012048	1.0	58.100000	7
37199	56Prod	66Prod	16	58090	749Prod	1065Prod	0.012048	1.0	58.100000	7
42676	28Prod	66Prod	16	56829	2389Prod	1507Prod	0.010327	1.0	44.692308	6
56285	303Prod	81Prod	16	57705	1489Prod	534Prod	0.010327	1.0	72.625000	6
48564	52Prod	127Prod	16	19614	903Prod	766Prod	0.008606	1.0	116.200000	5
54742	254Prod	66Prod	16	19615	766Prod	903Prod	0.008606	1.0	116.200000	5
27591	1008Prod	28Prod	15	19621	903Prod	358Prod	0.008606	1.0	72.625000	5
37124	56Prod	52Prod	14	19629	766Prod	358Prod	0.008606	1.0	72.625000	5

- **Lunch bags are bought with glasses case, rug and lunch bags of different collection and colour.**

In network model, we found that 66Prod appears frequently in item sets, and is bought together with 18Prod, 56Prod, 28Prod, 254Prod. These 5 products are lunch bag in different collection and colour, glasses case and rug, meaning that customers who bought lunch bag (66Prod) may bought this kind of items together.

- **Drawer Knob in different collection and colour maybe substitute goods and customers usually bought 2 between 3 Drawer Knob items(766Prod,903Prod,358Prod).**
 - In association rule model, we find that customers are likely to buy 2 products between 766Prod, 903Prod and 358Prod. These products and 1064Prod are the most frequently bought items in Q1.
 - These 3 products are all Drawer Knob introduced at the same time(2017 MMS), but in different collection and colour. They may be substitute goods.

- **Rug are bought with lunch bag, bookend and rug with different colour and collection.**
In network model, 28Prod appears frequently in item sets as well, and is bought together with 175Prod, 66Prod, 1008Prod. However, these item sets do not appear in association rule model.
 - These items are rug and lunch bag, bookend. Like above analysis, we can know that customers who bought lunch bag may bought this kind of items together.
- **Christmas products(hanging decorations and Standing Xmas Decoration) from same collection("Wonderland") in different colour are usually purchased together.**
In association rule model, the most frequently appeared rules is that customers who bought 1065Prod also bought 1191Prod, 749 Prod and 1293Prod. It is interesting to notice these items are all Christmas products from one collection in different colour. 1065Prod,1293Prod, 749Prod are hanging decorations while 1191Prod is Standing Xmas Decoration.
- **There is no rule set show both in two model in Q2.**

Q3:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
18985	13Prod	2Prod	18	69868	465Prod	480Prod	0.018916	1.0	41.736842	15
37888	81Prod	303Prod	16	41046	2064Prod	1956Prod	0.011349	1.0	44.055556	9
29843	290Prod	1008Prod	16	57625	266Prod	26Prod	0.011349	1.0	31.720000	9
88972	480Prod	465Prod	15	44984	126Prod	266Prod	0.010088	1.0	88.111111	8
44118	23Prod	313Prod	14	44986	126Prod	77Prod	0.010088	1.0	66.083333	8
84880	1184Prod	1049Prod	14	44988	126Prod	105Prod	0.010088	1.0	56.642857	8
44158	23Prod	206Prod	14	44990	126Prod	702Prod	0.010088	1.0	61.000000	8
37793	81Prod	18Prod	14	44992	126Prod	465Prod	0.010088	1.0	52.866667	8
79905	1170Prod	1163Prod	14	44994	126Prod	186Prod	0.010088	1.0	56.642857	8
46683	18Prod	315Prod	13	44996	126Prod	146Prod	0.010088	1.0	41.736842	8

- **Toy are bought with plant pot in diverse collection and colour, clothing accessories, mug and money box.**
 - In association rule model, we found that 126Prod appears most frequently in item sets, and is bought together with 266Prod, 77Prod, 105Prod, 186Prod, 146Prod or 465Prod.
 - These products are toy(126Prod), plant pots in diverse collection and colour, clothing accessories, mug and money box. Like above analysis, we can know that customers who bought toy may bought this kind of items together.
- **Passport holder is bought together with luggage tag and glasses case.**
- **Cushion with "Sweet Dreamsare" or "Stars" collection and in Silver, White, Beige colour bought together.**
 - Also, in network model, it shows that 81Prod, 23Prod and 18Prod were popular than others. 81Prod is a passport holder which is usually bought together with 303Prod(luggage tag) and 18Prod(glasses case). These three products may be complementary product.
 - 23Prod was bought with 313Prod or 206Prod. They are all cushions. 313Prod and 206Prod are in same collection and same colour but differ from 23Prod. So these two items may be alternative to each other.

- 18Prod is glasses case and is convincing that customers like buying glasses case with passport holder(81Prod) which have been shown on above analysis. So it may be a useful strategy to put them in a bundle sale to attract consumers.
- **Similar plant pots are bought together (from “SCANDI BOHO” collection and in black, cream colour) and this item set shows both in network model and association rule model.**

Item set {99Prod, 370Prod} is shown both in network model and association rule model. They are all plant pots from the same collection(“SCANDI BOHO”) and in same colour(Black, Cream), introduced at the same time(2018AW). Since this item set is recognized in both model, we conclude that customers like buying similar plant pots together.

Q4:

- Top 10 rules:

Network model				Association rule model					
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift count
56690	303Prod	81Prod	28	43430	2024Prod	2111Prod	0.011952	1.0	31.375000 6
55177	27Prod	88Prod	22	43440	2024Prod	1573Prod	0.011952	1.0	27.888889 6
55155	27Prod	19Prod	17	32365	495Prod	1014Prod	0.009960	1.0	45.636364 5
36217	13Prod	40Prod	16	52203	1776Prod	1601Prod	0.009960	1.0	33.466667 5
46665	119Prod	30Prod	16	53282	1351Prod	1028Prod	0.009960	1.0	71.714286 5
47428	130Prod	66Prod	15	20377	2064Prod	2111Prod	0.007968	1.0	31.375000 4
28586	1008Prod	2142Prod	15	30367	417Prod	272Prod	0.007968	1.0	100.400000 4
17901	15Prod	119Prod	15	41999	1387Prod	748Prod	0.007968	1.0	20.080000 4
16674	18Prod	13Prod	15	45893	879Prod	1499Prod	0.007968	1.0	33.466667 4
3320	821Prod	15Prod	15	47633	1285Prod	1601Prod	0.007968	1.0	33.466667 4

- **Home accessories are more popular than other categories in Q4.**
- **Suitcases are bought with rug and suitcase in different collection and colour.**
- **money boxes in “Gold” or “Vintage Map” collection and in clear, gold, black or blue brown colour are bought together.**
- **Led lights are bought with money box and glasses case.**
 - In network model, we found that 27Prod, 13Prod, 119Prod, 15Prod appears frequently in item sets.
 - 13Prod, 119Prod and 15Prod are all home accessories related products. 13Prod is Led light and the other two are money box meaning that customers purchased home accessories than other categories in Q4.
 - 27Prod which is a suitcase bought with 88Pord(suitcase in different collection and colour) or 19Prod(rug).
 - 119 Prod bought with 30Prod or 15Prod. They are all money box. 119Prod and 30Prod are from same collection “Gold” and in same colour(Clear, Gold, Black). However, 15Prod is from collection “Vintage Map” and in Blue, Brown colour. We can conclude that 30Prod and 15Prod may be alternative product to each other.
 - 13Prod bought with 40Prod or 18Prod, meaning that customers who bought led light usually bought money box and glasses case as well.
- **Kitchen accessories are usually purchased together. Similar mugs of “Bohemian” collection and in multi-colour are likely to be bought together.**

- In association rule model, we found that 2024Prod, 1601Prod, 2111Prod appears frequently in item sets.
- 2024Prod, 2111Prod, 2064 and 1573Prod are all kitchen related products. They are all mug from same collection “Bohemian” and all in multi-colour. 2024Prod bought with 2111Prod or 1573Prod, and 2111Prod bought with 2024Prod and 2064Prod, meaning similar mugs are likely to be purchased at the same time.
- **Home accessories are usually purchased together as well. Bookend in “CATICORN”, “Roarsome Dinosaurs” collection is bought together.**
- **Hook is a complementary product to bookend and they are bought together.**
 - 1285Prod, 1776Prod and 1601Prod are all home accessories related products. 1776Prod and 1601Prod are bookend from different collection (“CATICORN”, “Roarsome Dinosaurs” respectively) and colour. 1285Prod is a hook from the same collection with 1601Prod. Hook is a complementary product to bookend so it is reasonable that they are bought together. And 1601Prod and 1285Prod usually are purchased together, meaning people like buying bookend in different style at the same time.
- **There is no rule set show both in two model in Q4.**

c. France

Q1:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
2278	44Prod	32Prod	43	66885	732Prod	195Prod	0.031579	1.0	28.500000	9
18382	49Prod	32Prod	38	42264	605Prod	661Prod	0.024561	1.0	35.625000	7
2251	44Prod	21Prod	37	61639	150Prod	245Prod	0.024561	1.0	35.625000	7
2316	44Prod	49Prod	37	66731	164Prod	245Prod	0.024561	1.0	35.625000	7
37016	193Prod	113Prod	36	67107	191Prod	245Prod	0.024561	1.0	35.625000	7
8319	41Prod	21Prod	36	33847	391Prod	267Prod	0.021053	1.0	40.714286	6
2235	44Prod	41Prod	36	35831	1031Prod	127Prod	0.021053	1.0	19.000000	6
10625	21Prod	32Prod	36	48286	1297Prod	732Prod	0.021053	1.0	31.666667	6
62592	60Prod	2Prod	35	48295	1297Prod	195Prod	0.021053	1.0	28.500000	6
8609	41Prod	16Prod	35	63098	377Prod	376Prod	0.021053	1.0	40.714286	6

- **Cutlery set were often bought with one of the following items, 49Prod(mug), 32Prod (bowl), 21Prod(plates).**
As the network model shows, 44Prod(cutlery set), 32Prod(bowl), 49Prod(mug), 21Prod(plates), 41Prod(water bottle), 16Prod(lunch bag) are all products from the same collection. It can be seen from the network analysis that customers often buy two of them at the same time, so it is recommended to bundle them.
- **Put substitutes together will be a probability to increase the sales of bundle.**
41 and 60 are same products with different collection, they are substitutes for customers to have more choice, can be placed in the same area.
- **There may be two areas dedicated to different products of these two series : Bear camp and Rainbow Unicorn.**

There may be a combination of different products within same collection for sales, or additional discounts for the same series of products.

- **Fruit & Veg is one of the popular collections.**

In association model, it shows customers often bought 245Prod(mug) with 150Prod(plate), 164Prod(cutlery set), 191Prod(Bowl). These are all products from the collection Fruit & Veg.

- To sum up, **products of Kitchen Accessories are quite popular in this season.**

To combine these products such as bowls, plates, mugs and cutlery set together and put them in the form of different collections of combinations on the shelves for customers to choose.

Q2:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
958	44Prod	32Prod	54	42371	525Prod	485Prod	0.109023	1.0	8.580645	29
940	44Prod	21Prod	51	42381	525Prod	394Prod	0.109023	1.0	7.388889	29
5715	21Prod	32Prod	47	42387	525Prod	57Prod	0.109023	1.0	6.650000	29
982	44Prod	49Prod	44	42393	525Prod	123Prod	0.109023	1.0	6.820513	29
11387	49Prod	32Prod	41	42395	525Prod	34Prod	0.109023	1.0	7.388889	29
23948	4Prod	3Prod	40	42399	525Prod	72Prod	0.109023	1.0	6.045455	29
5742	21Prod	49Prod	39	39766	118Prod	111Prod	0.037594	1.0	16.625000	10
32077	166Prod	57Prod	33	41029	42Prod	36Prod	0.037594	1.0	20.461538	10
1030	44Prod	16Prod	33	38598	83Prod	58Prod	0.033835	1.0	13.300000	9
32029	166Prod	72Prod	32	39178	164Prod	245Prod	0.033835	1.0	24.181818	9

- In network model, people who buy 44Prod(cutlery set) will often buy 16Prod(lunch bag), 32Prod(bowl), 21Prod(plates), 49Prod(mug) at the same time.

It can be found that they are all from collection Bear Camp. Therefore, different categories of products of this collection can be displayed together or bundle these complementary products together.

- **Customers may buy same product with different features.**

All these products: 49Prod,166Prod,72Prod are different colours and different collections of mugs. They can be put together to make customers have more choices.

- **More different kinds of lights can be sold as a combination.**

4Prod and 3Prod are LED LIGHT with different collection and icon.

- In association model, it shows customers often bought 525Prod(Hook) with 485Prod(Bowl), 394Prod(Vase), 57Prod(Plant Pot), 123Prod(lunch bag), 34Prod(Suitcase). However these items did not have same features, even they are not in the same category or collection. We can take this as a necessity of life. No matter what the customer's goal is, they are likely to buy this product when they see it. Therefore, it is suggested to put it in each category.

- In particular, **Easter limited goods 72Prod(mug) appear in both network analysis**, it was also one of the most frequently purchase items of the season. It indicates that customers may be very interested in Easter or bunny products and this collection can be placed in a prominent place to increase the likelihood of being purchased.

- As in the first quarter, the bear camp collection was still very popular.

Q3:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count	lhs	rhs	support	confidence	lift	count	
1694	44Prod	32Prod	43	58648	318Prod	396Prod	0.101156	1.0	9.351351	35
1555	44Prod	21Prod	42	60135	288Prod	52Prod	0.072254	1.0	8.871795	25
9413	21Prod	32Prod	39	59952	562Prod	52Prod	0.066474	1.0	8.871795	23
7478	41Prod	29Prod	37	59966	562Prod	110Prod	0.066474	1.0	8.238095	23
28304	396Prod	115Prod	36	59362	340Prod	52Prod	0.046243	1.0	8.871795	16
28348	396Prod	318Prod	35	59323	611Prod	110Prod	0.040462	1.0	8.238095	14
60784	318Prod	157Prod	34	57727	509Prod	208Prod	0.031792	1.0	11.533333	11
28310	396Prod	157Prod	34	57735	509Prod	23Prod	0.031792	1.0	10.484848	11
30989	115Prod	157Prod	34	57737	509Prod	52Prod	0.031792	1.0	8.871795	11
30995	115Prod	158Prod	34	51708	144Prod	209Prod	0.026012	1.0	24.714286	9

- In network model, **Bear camp collection includes the items which appears most frequently in item sets.** So 44 Prod(Cutlery Set), 32Prod(Bowl), 21Prod(Plate), 41Prod(water bottle) can be bundled.
- Products of collection PUPPY DOG PLAYTIME can be suggested to sold as the flagship products.**
396Prod(Water bottle), 115Prod(Bamboo set), 318Prod(Lunch Box) which were all from the new season 2018 AW collection PUPPY DOG PLAYTIME often appear together in this quarter.
- Lunch box was purchased with other Home accessories products frequently.**
In association model, customers always bought 52Prod(Lunch Bag) with 562Prod(Photo Frame), 340Prod(Home accessories), 509Prod(Sippy Cup).Therefore not only put Lunch Bag in the Bag collection, but also put in the Home accessories collection to let customers can find it easily.
- There is a strong rule appear in both of the two modes, which is 396(Prod) and 318(Lunch box).**

Q4:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count	lhs	rhs	support	confidence	lift	count	
1694	44Prod	32Prod	43	63125	294Prod	298Prod	0.140426	1.0	6.714286	33
1555	44Prod	21Prod	42	65492	557Prod	323Prod	0.140426	1.0	5.595238	33
9413	21Prod	32Prod	39	65584	361Prod	323Prod	0.140426	1.0	5.595238	33
7478	41Prod	29Prod	37	65409	604Prod	289Prod	0.136170	1.0	5.222222	32
28304	396Prod	115Prod	36	65417	604Prod	260Prod	0.136170	1.0	4.700000	32
28348	396Prod	318Prod	35	65192	495Prod	404Prod	0.123404	1.0	7.343750	29
60784	318Prod	157Prod	34	65194	495Prod	604Prod	0.123404	1.0	7.343750	29
28310	396Prod	157Prod	34	65198	495Prod	557Prod	0.123404	1.0	7.121212	29
30989	115Prod	157Prod	34	65200	495Prod	444Prod	0.123404	1.0	6.714286	29
30995	115Prod	158Prod	34	65202	495Prod	361Prod	0.123404	1.0	7.121212	29

- In the network · **44Prod(Cutlery Set), 32Prod(Bowl), 21Prod(Plate)** were still the 3 products that customers would like to purchase together frequently.
- **Water bottle is one of the high-volume products.**
41(water bottle) and 29(Water bottle) are the same product but different category, from the frequency plot, it was obviously are the most popular products in this season, so they can be put in the same place or bundle with the products of same category.
- **Products of Kitchen accessories are particularly likely to be purchased.**
Customers were likely to buy two of the following items in the same basket: 115Prod(bamboo set), 318(Lunch box), 157Prod(Travel mug), 158Prod(Lunch box), 44Prod(Cutlery set), 32Prod(Bowl) were always appeared in the same basket with home accessories such as 21Prod(Plate).
- **In the association rules, products of stationary were hot sale in this season.**
Customers often bought 495Prod(luggage tag) with sticky notes (404Prod, 604prod, 557Prod, 444Prod) and 361Prod(Pen). Customers are likely to buy sticky notes when buying other stationery, so they can put more sticky notes with different collections for customers to choose from.

d. Rest of the World:

Q1:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count	lhs	rhs	support	confidence	lift	count	
31628	40Prod	15Prod	44	32291	961Prod	652Prod	0.156863	1.0	5.666667	40
41433	262Prod	15Prod	44	34993	468Prod	262Prod	0.129412	1.0	4.322034	33
31562	40Prod	262Prod	42	35131	1295Prod	1182Prod	0.062745	1.0	15.000000	16
31588	40Prod	730Prod	42	34549	886Prod	1295Prod	0.058824	1.0	15.937500	15
19392	587Prod	664Prod	41	34551	886Prod	1182Prod	0.058824	1.0	15.000000	15
31467	40Prod	119Prod	41	29305	1940Prod	886Prod	0.039216	1.0	17.000000	10
63718	119Prod	15Prod	41	29315	1940Prod	1295Prod	0.039216	1.0	15.937500	10
41370	262Prod	730Prod	41	29317	1940Prod	1182Prod	0.039216	1.0	15.000000	10
51792	664Prod	105Prod	41	29319	1940Prod	696Prod	0.039216	1.0	6.375000	10
56984	652Prod	961Prod	40	29324	1940Prod	441Prod	0.039216	1.0	11.590909	10

- In network model, 40Prod is the most popular product that had been bought together with other products, which are 15Prod, 262Prod, 730Prod and 119 Prod respectively. **Except from 262Prod, the other 4 products are all money boxes as product type, either with different colours, blue brown or others, or different collections (vintage map or paint splash).**
- Another popular item would be 15Prod, which was bought together with 40Prod, 262Prod and 119Prod individually. This shares the same reason as 40Prod as most results are the same.
- Interesting finding is that 2 cycle of products can be spotted, which is 262Prod, 15Prod, 40Prod and 119Prod, 15Prod and 40Prod. We may conclude that **water bottle (paint**

splash, 262Prod) will always be included when purchasing money boxes (40Prod and 15Prod) or same product with different collection and colour will be picked when consumer purchasing.

- In association rules, 1940Prod are connected to 5 other products (886Prod, 1295Prod, 1182Prod, 696Prod, 441Prod), where all of them are in paint splash collection.
- 886Prod, 1940Prod and 1295Prod resulted in common purchased products. **It is noticeable that for 1295Prod and 886Prod, which are stationaries, are frequently bought together.** Also, As mentioned, 1940Prod, which is a photo frame, are suggested to be bought together when purchasing stationary goods.

Q2:

- Top 10 rules:

Network model				Association rule model					
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift count
30116	2Prod	7Prod	13	41161	1065Prod	805Prod	0.040816	1.0	21.777778 8
70334	354Prod	284Prod	13	44575	722Prod	1251Prod	0.040816	1.0	17.818182 8
29971	2Prod	13Prod	13	31746	252Prod	97Prod	0.035714	1.0	14.000000 7
38865	6Prod	7Prod	13	45131	196Prod	175Prod	0.035714	1.0	9.333333 7
47605	11Prod	7Prod	12	34646	73Prod	343Prod	0.030612	1.0	12.250000 6
30229	2Prod	5Prod	12	38956	806Prod	669Prod	0.030612	1.0	32.666667 6
30192	2Prod	213Prod	11	38957	669Prod	806Prod	0.030612	1.0	32.666667 6
33367	327Prod	452Prod	11	40302	554Prod	100Prod	0.030612	1.0	14.000000 6
74012	13Prod	175Prod	11	42318	708Prod	135Prod	0.030612	1.0	21.777778 6
38599	6Prod	11Prod	11	43633	849Prod	956Prod	0.030612	1.0	28.000000 6

- In network science result, 2Prod were purchased with 7Prod, 5Prod, 213Prod, 13Prod respectively. **2Prod, 7Prod and 13Prod are LED Light with similar colours, white. Other products are mostly home accessories as 2Prod (5Prod,13Prod, 5Prod) and 213Prod is a fashion accessory, which doesn't really have common.**
- 7Prod is frequently bought together with 2Prod, 6Prod, 11Prod. **Except from 2Prod, three of the products are mugs with kawaii friends as collection but in different colours.** These three products also created a cycle where people tended to purchase together.
- There is no specific product that was purchased over and over again with different products. However, an interesting finding for the result is consumer behaviour in this period of time. **decorations (1065Prod and 805Prod) for Christmas, storage bags (97Prod and 252Prod) and suitcases (554Prod, 100Prod...) for Christmas holiday.** Company can offer discount or deal for consumer to increase profit.

Q3:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count		lhs	rhs	support	confidence	lift	count
55191	366Prod	143Prod	60	71378	576Prod	207Prod	0.028571	1.0	13.333333	8
55172	366Prod	747Prod	60	74467	44Prod	49Prod	0.028571	1.0	28.000000	8
55078	366Prod	20Prod	59	70887	1857Prod	1591Prod	0.021429	1.0	23.333333	6
78139	143Prod	747Prod	57	72041	1327Prod	1884Prod	0.021429	1.0	31.111111	6
93080	747Prod	20Prod	57	72716	21Prod	49Prod	0.021429	1.0	28.000000	6
124586	20Prod	996Prod	56	44742	121Prod	29Prod	0.017857	1.0	25.454545	5
55198	366Prod	15Prod	56	71996	772Prod	646Prod	0.017857	1.0	17.500000	5
120907	15Prod	20Prod	55	72356	2231Prod	2382Prod	0.017857	1.0	40.000000	5
78164	143Prod	15Prod	55	72451	1833Prod	2382Prod	0.017857	1.0	40.000000	5
78053	143Prod	20Prod	55	72464	1833Prod	974Prod	0.017857	1.0	28.000000	5

- In network result of Q3, top 10 results are only formed simply by 6 products and one of them are connected to all others, which is 20Prod. It was purchased with 366Prod, 747Prod, 15Prod, 996Prod and 143Prod. **Two of the outcomes (366Prod and 747Prod) share same product type (Lunch box) and the other two products, 143Prod and 996Prod, belongs to Bags as category.**
- For 366Prod, it was purchased with 143Prod, 747Prod, 20Prod and 15Prod individually for each pair. 366Prod and 747Prod are same product type, Lunch box, and 15Prod and 20Prod share same category, home accessories. **A brief assumption that can be drawn is consumer purchase kitchen accessories tend to purchase home accessories at the same time.** For 143Prod, as it is lunch bag, 366Prod, as it is a lunch box, worked as a supplementary good.
- In association rule results, 1833Prod was purchased with 2382Prod and 974Prod. All of these share same categories with same collections but only different colours. **As it is shaped bauble, it is reasonable that consumer purchase in variety colours.**
- A second finding is 49Prod was purchased with 44Prod and 21Prod respectively. **A common feature among all these products are bear camp as their collection.**
- Unlike results from network science, most of the results are not by repeating purchased. **Most product that bought together, i.e. 1327Prod and 1884Prod, 1833Prod and 2383Prod... etc., are Christmas related product.** As mentioned, time period may reflect to consumer preference on consuming products, therefore, deal and offers may be included in the upcoming year.

Q4:

- Top 10 rules:

Network model				Association rule model						
	Prod1	Prod2	count	lhs	rhs	support	confidence	lift	count	
37276	515Prod	369Prod	64	23273	938Prod	1163Prod	0.162651	1.0	6.036364	54
25281	987Prod	369Prod	57	23649	652Prod	417Prod	0.162651	1.0	5.928571	54
44535	1014Prod	369Prod	57	23661	652Prod	515Prod	0.162651	1.0	4.811594	54
12594	1497Prod	81Prod	56	23169	546Prod	938Prod	0.159639	1.0	6.148148	53
9971	218Prod	81Prod	56	23173	546Prod	1163Prod	0.159639	1.0	6.036364	53
51911	15Prod	81Prod	55	23130	2183Prod	479Prod	0.156627	1.0	5.724138	52
9970	218Prod	961Prod	55	23132	2183Prod	1497Prod	0.156627	1.0	5.442623	52
25359	987Prod	515Prod	55	23134	2183Prod	218Prod	0.156627	1.0	5.533333	52
35410	479Prod	81Prod	55	23136	2183Prod	81Prod	0.156627	1.0	5.269841	52
4426	130Prod	81Prod	55	23144	2183Prod	961Prod	0.156627	1.0	3.018182	52

- In network science result, 369Prod was purchased along with 515Prod, 987Prod and 1014Prod dispersedly. **Where 369Prod and 515Prod have the same collection (Caticorn), 987Prod and 1014Prod own same collection and colour.**
- Another finding is that 81Prod was purchased with 15Prod, 1497Prod, 479Prod, 218Prod and 130Prod. **We can see products that mostly bought together with 81Prod share a same or even similar collection, vintage map.** For 130Prod, which is a lunch bag, are bought together for 81Prod.
- In association rule, 2183Prod was mostly bought together. It was purchased with 479Prod, 1497Prod, 218Prod, 81Prod and 961Prod. 478Prod, 1497Prod and 218Prod are mugs with different collection and colours. Furthermore, **2183Prod is home accessory where consumer tend to buy with kitchen accessories.**
- 652Prod was purchased with 417Prod and 515Prod. 417Prod and 515Prod are kitchen accessories.
- 218Prod and 81Prod are in both models however they do not have the same combinations.

e. Analysis among different regions

Q1:

In quarter 1, we found that different area has different purchasing behaviour.

For the customer of UK and Key account, they like buying mugs in different collection and colour at the same time. For the customers in UK, they also buy mugs with coaster which is a product from home accessories. However, the people in France purchase mug with cutley set together.

Money box is a popular item in quarter 1. In the UK area, people bought money box in different collection and colour. For the rest of world area, people purchase money box in different collection and colour or with water bottle.

People who bought Trinket dishes usually bought other item at the same time. For Key account customers, they prefer to purchase trinket dishes with different collections and colour, but customers of UK like buying this item with coaster.

For customers in the rest of world, we found that they usually purchase products of stationaries together.

Q2:

In quarter2, Christmas was coming and we found that people in different areas excepting France usually purchase Christmas products like different decorations in different collection or colour or icons, some storage bags and suitcases for Christmas holiday together.

Different area has different purchasing behaviour of mugs. Customers in Key account area bought mugs with keyrings, trinket dishes and flasks together. However, in the rest of world area, customer usually bought mugs with kawaii friends as collection but in different colours together. And, the people in France purchase mug with cutley set together, which was happened in Q1 as well.

Lunch bag is popular in Q2. People in UK bought it with glasses case, rug and lunch bags of different collection and colour. However, people in France usually purchased it with cutley set or hook.

And we also found that **the bear camp collection was very popular in Q1 and Q2 in France.**

Q3:

Mugs are popular as well in Q3. We found that customers in Key account area usually purchase mugs with different collection and colour at the same time. Compared to the UK customers, they usually purchased mugs with toy.

People in the France and the rest of the world area bought items in “beer camp” collection together.

In Q3, people in Key account and the rest of world area like buying different Christmas products at the same time.

For the people in France and the rest of world, they usually bought kitchen accessories with home accessories. For example, lunch box is often purchased with other home accessories.

In Q3, UK customer tended to buy the same categories items but in different collection and colour, such as cushion and plant pots.

Q4:

In Q4, customers in Key account and France area bought cutlery set with bowls, plates together. We also found that **people in these 4 areas prefer to purchase items of kitchen accessories and of home accessories together.** In addition, products of Kitchen accessories are particularly likely to be purchased together. For example, UK and the rest of world customers usually bought mugs at the same time.

In Q4, we found that **stationary items were hot sale in France.** Compared to UK area, home accessories were popular this quarter and usually were bought together. For example, customers bought bookends in different collection together. As for customers in the rest of world area, items in “Carticorn” and “Vintage map” are popular and customers usually purchased items together in the same collection.

6 Limitation

In order to reduce the number of rules to ensure the analysability of the dataset, we have stated in based on the fact that each itemset in the data only contains 2 items and ignored those missing values which may have features without any details, and used the complete data to do it. Thus, the views we elaborate may have limited universality.

The main purpose of market basket analysis is to use the results to help the client to find out what products should be put together. However in our case, it is limited to completely used in commercial, due to the lack of information of the customers and the background of the

market, we cannot analyse the customer's purchase behaviour, understand what type of customers is and why they buy the products, we can only find out the relevant association rules, allow the company to use these rules to gain benefits and establish their competitive advantage.

7 Conclusion

The implementation of models into given data has outlined some unexpected findings where products in different collections or categories are brought together. From what we observed from analysis, results are mostly different from two models. This can be explained by how different network science model and association rules abstract nodes to fulfil market basket analysis.

In conclusion, there are some interesting findings in common of all dataset. Discounts and offers are included when consumers purchased certain amount of single product as profit margin shown. Another finding is products that bought together are festival related. For example, during Q2 and Q3 period (July to September, October to December), consumers tend to buy goods under decoration category. Furthermore, products that bought at the same time are related, also known as supplementary goods i.e. lunch box and lunch bag in Rest of the World dataset. Therefore, we can then suggest businesses to encourage consumer purchase by recommendations based on these findings to boost their sales.