Market Basket Analysis on Electronidex

Jeroen Meij

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Blackwell Data analytics department

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1) Summary

Blackwell Electronics' board of directors is considering to acquire Electronidex, a start-up online electronics retailer. They want to understand the clientele that Electronidex currently is serving better. Therefore, a market basket analysis is performed in this report what products Electronidex´s clientele is purchasing frequently.

It appears that Electronidex is very reliant on its sales of laptops and desktop PC´s. Transactions often contain multiple of these products, which indicates that a good part of Electronidex´s customers are businesses, since average consumers do not buy a variety of different PC´s very often. Accompanying the various PC´s is often a specific monitor: the ViewSonic monitor. Blackwell should consider this monitor as well since it seems to cross-sell very well.

I think both Blackwell and Electronidex would benefit with the possible takeover. Blackwell can learn a lot about selling PC's, which are currently not our top-selling products. We can furthermore use our best-practices to diversify Electronidex sales to make them rely less on the sales of PC's. We shouldn't worry too much about becoming competitors and fighting over the same clientele since we sell to consumers and they sell mainly to businesses. Purchasing Electronidex would also give us a perfect opportunity to learn from B2B commerce, which could lead to potential opportunities on the long run.

The following pages contain my full report, where I discuss Electronidex´s transactions more in depth.
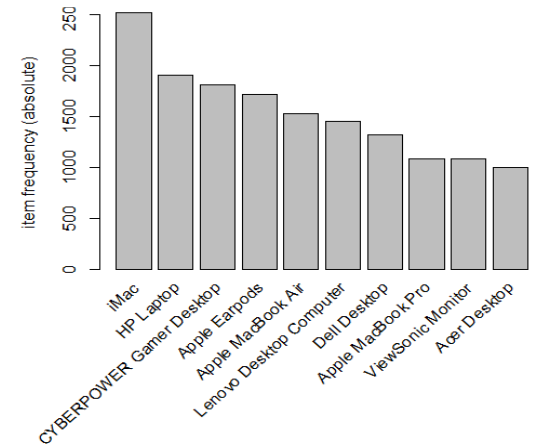
2) About the data:

Danielle Sherman provided me with a dataset of Electronidex´s transactions. This dataset consists of:

- 9832 transactions
- 125 different products consumers can buy
- These products can be categorized into 17 distinct categories

Figure 1.1 contains a histogram which displays the 10 items that were purchased in most transactions. In this top 10:

- 5 products fall in the category: "Desktop"
- 3 in the category: "Laptop"
- 1 in the category: "Active headphones"
- 1 in the category: "Monitors"

It appears that their most frequently bought items, desktops and laptops, are substitutes for each other rather than complimentary.

The data shows a different distribution of products when looking at *figure 2*, which displays the top selling products for transactions where only 1 item was purchased. Here, the MacBook Air is by far the most sold item, followed by Apple Earpods and the iMac. This indicates that customers who buy singular items have different product preferences than costumers that buy various items.
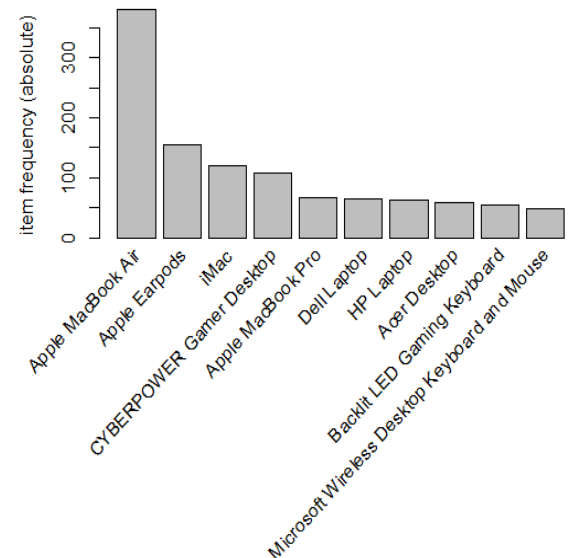
Figure 2 contains a bar chart displaying the frequency of number of distinct items bought per purchase. The bars are distributed in a descending trend, indicating that purchases with only 1 distinct item happened most often, followed by 2, then 3, etc. The maximum item size in a transaction was 30, which only happened once in the dataset. On average, 4.4 distinct items are sold per transaction. The median is 3.

For this report, transactions where 2 or more distinct items were sold will be investigated to see whether certain products are sold more often in combination with particular items.

Figure 1.1: Histogram with most purchased items in total

Figure 2.2:Histogram with most purchased singular items

3) Market Basket Analysis for products

78% of the 9832 transactions are transactions where 2 or more distinct items were bought. This equals to 7670 transactions. Using the apriori algorithm, rules were generated making it possible to evaluate which items are sold often with other products.

To get a better understanding what Electronidex´s customers most frequently purchase, I decided to see which sets of 2 and 3 products are sold together most often in baskets. The results can be found in tables A1 and A2 in the Appendix. Interestingly, when looking at the top 5, it appears that the top purchases are usually products which are substitutes. For example, when considering the top 5 of 2 products which are most frequently together in a basket, 1 combination contains a laptop and a desktop computer and 3 combinations contain 2 desktop computers.

These sales indicate that many of Electronidex's customers are likely not the average consumer, since an average

Figure 3:Item size per purchase

consumer would not purchase multiple varying PC's that frequently. Therefore it is likely that a substantial part of Electronidex's sales are B2B. I would even argue that Electronidex is a <u>wholesaler</u>, since for an average company it would not make sense to obtain different types of PCs with varying operating systems instead of many of a specific type.

To see the products that sell well with each other, I created a graph (Appendix *figure* A3) for product **pair** rules (maximum length of 2). I set minimum lift at 2.2 and minimum support at 100 total transactions. This way the graph only shows rules for product pairs that are more likely to be purchased in combination. There are 2 products that seem to have multiple rules with other products. These are the ViewSonic Monitor and the Apple Magic Keyboard.

Interestingly, the Intel desktop computer and the Lenovo desktop computer have a high mutual lift as well, even though these are both desktop computers. This again directs towards the assumption that there is a good possibility that Electronidex is also acting as a wholesaler like mentioned earlier.

When looking at rules that are longer than combinations of 2 products, it depends on the minimum support set which products end up in Electronidex's customers' basket. In Appendix table A4.1 to A4.4 are top 10 lists for support fractions ranging from a minimum of 180 products to 30 products. We see with a high level of support, when people have e.g. 2 PC's in their basket (it being either a laptop or desktop), the high lift values indicate that an extra PC is likely to be purchased. However, when support is decreased, we see that a specific monitor (the ViewSonic monitor) has a very high lift with baskets filled with either 2 or 3 varying types of PCs. Either Electronidex is actively promoting this monitor already when customers are purchasing PC's, or this monitor is customers' favorite monitor to go to when purchasing PCs in bulk.
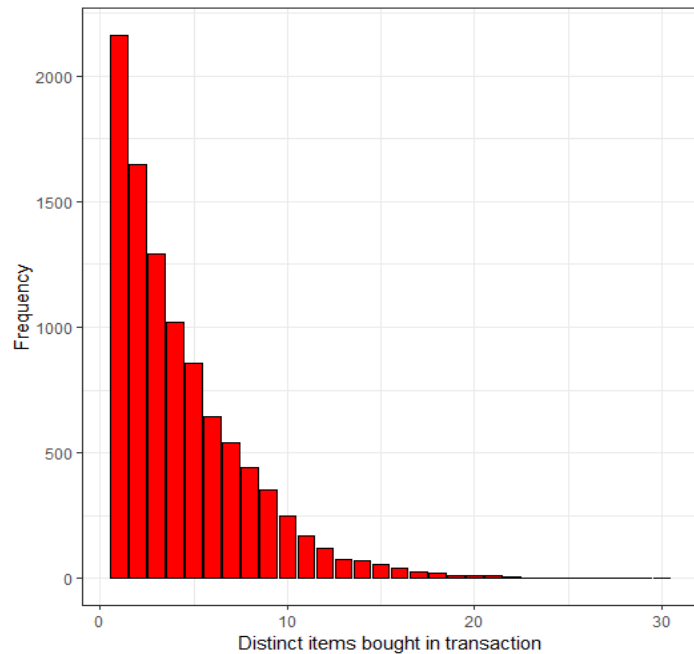
4) Category analysis

Apart from which specific products Electronidex sells, it's interesting to know which product categories are their best sellers, and which categories sell well with the others. *Figure 3* contains a histogram that displays the 10 categories that appear in most transactions. Unsurprisingly after having evaluated the histogram in *figure 1*:

- Desktops sell best across transactions
- Laptops are in second place
- Third are monitors
- Various computer hardware products follow suit

Figure 4 is a category-centered version of *figure 2*, and displays a bar chart with the frequency of transactions and distinct categories bought. The maximum distinct categories purchased in a transaction was 14, which only happened 4 times. On average, 3.4 distinct categories are sold per transaction. The median of distinct categories sold is 3.

5) Market basket analysis for categories

Using the apriori algorithm rulesets were created making it possible to see which item categories are frequently sold together. Appendix table A5 shows the top 5 sold category pairs. Here we see that desktops and laptops are combined in transactions most often, followed by desktops and monitors and laptops and monitors.

When looking at the top 5 of frequencies with 3 distinct categories (Appendix table A6), it appears that people often purchase a laptop, a desktop, and a piece of computer hardware (mouse, keyboard, monitor etc.).

Figure 3:Histogram with most purchased item categories

Figure 4:Category size per purchase

To see the categories that sell well with each other, I created a graph of category **pairs** (Appendix *figure A7*). I set the lift to be higher than 1.6 and a support of 0.02. This way the graph only shows rules for category combinations that are more than likely to be purchased in combination.

Interestingly, multiple product categories seem to be sold more often in transactions where printers are sold. 5 product categories have a lift higher than 1.6 with printers. Support is however relatively low, which is probably because the support for these categories in general is relatively low. The highest
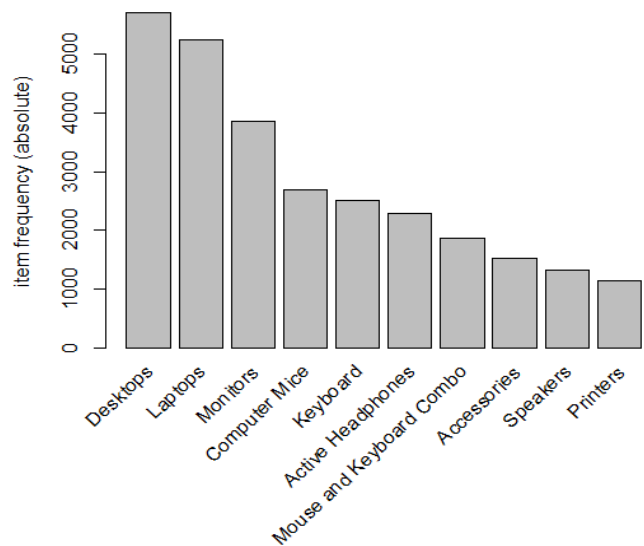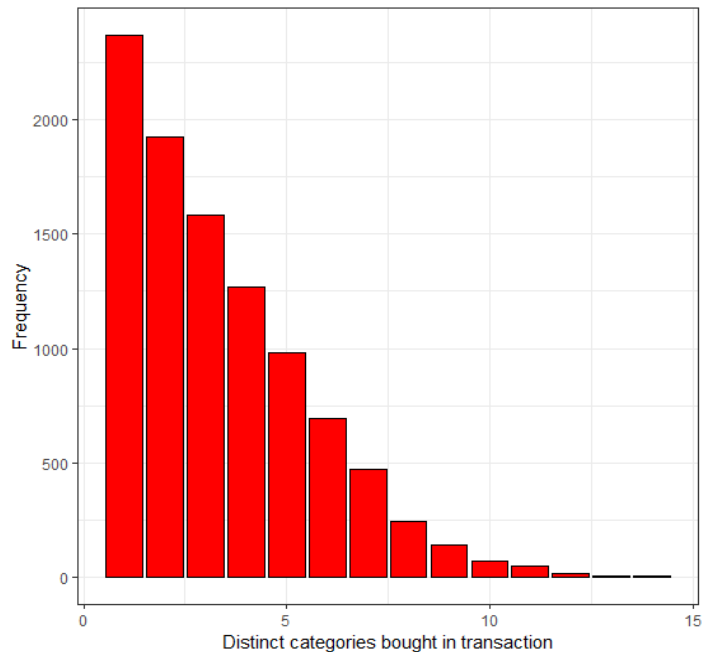
values of lifts were for accessories and computer chords (lift = 1.82) and printers and computer chords (lift = 1.81).

When looking at rules that are longer than combinations of 2 categories, printers and accessories appear to be categories that have a relatively high possibility to be a supplement to Electronidex's customers' basket. In Appendix table A8.1 the top 10 rules by lift are displayed (each with a minimum support of at least 150 transactions). All of these rules have either printers or accessories on the right-hand side, indicating that when people are purchasing a computer or hardware like keyboards and monitors, it is likely that they will an accessory or a printer, instead of other hardware parts. It however does appear that these customers are purchasing complete hardware setups.

Increasing the support parameter, we still see these categories ranked high when sorted by each rules' lift values. The rules become shorter and the start of a shift in product categories is observable. Appendix tables A8.2 to A8.4 show top rules for minimum purchase frequencies of 400, 600 and 800. With the minimal support increasing, the length of the rules logically decreases as well. On the tables mentioned we see that the higher the support, the lower the maximum lift. We can furthermore notice a shift on the right-hand side from printers and accessories towards monitors and occasionally mice/keyboards. This indicates that when people purchase a computer system, it being either a laptop or a desktop, the products they are most likely to purchase with it are monitors.
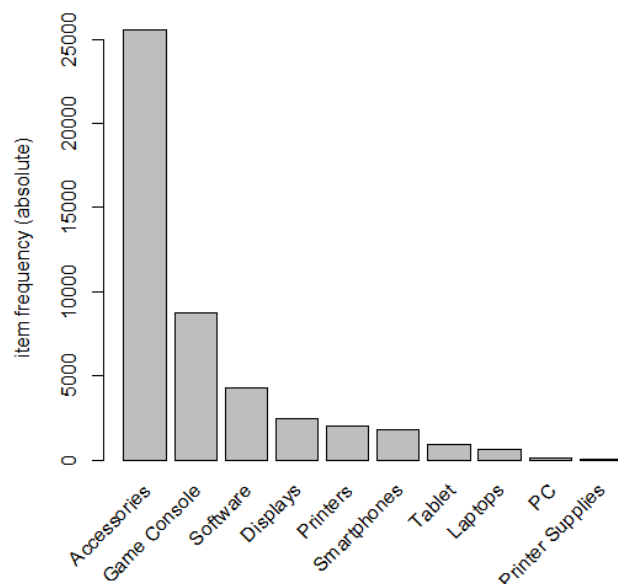
6) Electronidex and Blackwell comparison

Electronidex and Blackwell appear to be relatively different companies, that have some similarities due to the products they are selling. Blackwell is a retailer with over 30 electronics stores. We have been in business for over 40 years and have a business to consumer orientation. Our eCommerce platform has been up and running for one year and we recently started with analyzing the data we are collecting.

Figure 5: Top selling categories at Blackwell based on sales volume

Our product scope is diversified. Our top selling products by volume are displayed in *figure 5*. Accessories, game consoles and software are our top selling products. Our sales volume for PC´s and accompanying hardware are relatively low.

Electronidex is an online electronics retailer. They have been in business for not very long, but already have a broad product scope. Their customers are mainly businesses, and there's a good chance that they serve as a wholesaler since they often sell a variety of similar products in the same transaction.

Even though Electronidex sells various electronics, its core business involves computers and computer hardware. Its consumers purchase PC's (desktops and laptops) most frequently. They furthermore manage to cross sell computer hardware with their PC's very well. Their best-selling brands for PC's are: Apple, HP and CYBERPOWER. Electronidex however does **not** sell any Sony products, which should be taken into account if we were going to pursue into a strategic relationship with Sony. They have Acer products, but these are not their top-selling items as was shown in *figure* 1.

7) My opinion regarding the purchase of Electronidex:

There appear to be many disparities between Electronidex and Blackwell, and although we sell products in similar categories, our actual sales are totally different.

I do believe that acquiring Electronidex could be a way to learn from their best practices and apply them to our customer base. This way we could sell more laptops, desktops, and accompanying hardware. The ViewSonic monitor for example should be a product that is interesting for Blackwell to sell with our PC´s as well, since this product accompanies many of Electronidex' purchases. We can vice-versa evaluate whether we can increase their number of transactions where customers purchase accessories or software. This way we diversify both companies, which leads to a more stable income in the long run.

Since Electronidex often serves businesses, and Blackwell serves consumers, we do not have to worry too much about becoming each other's competitor. Also, since there is a good chance that Electronidex functions as a wholesaler, they have business intel that could be very valuable for Blackwell.

Since Electronidex is only an online platform, our Blackwell stores can serve as a pick-up spot for items bought on their website. We can furthermore use Electronidex´s experience in online sales to boost our relatively young online sales platform

However, if we acquire Electronidex, we **must** make sure we diversify their sales. Because the way it currently stands, if there was something that caused laptop and desktop purchases to decrease, the company suffers extensively.

We furthermore **must** make sure that we contract Electronidex´s decisive employees. We currently do not have any experience with B2B sales, which is why we need experienced people to keep everything running. Over time, when we are more experienced, we can reconsider our HR to see if we have all employees on their rightful position.

Appendix

Table A1: Sets of 2 Items sold most frequently together

Rank	Item 1	Item 2	Count
1	iMac	HP Laptop	743
2	iMac	Lenovo Desktop Computer	578
3	iMac	CYBERPOWER Gamer Desktop	558
4	iMac	Dell Desktop	537
5	iMac	ViewSonic Monitor	486

Table A2: Sets of 3 Items sold most frequently together

Rank	Item 1	Item 2	Item 3	Count
1	HP Laptop	iMac	ViewSonic Monitor	233
2	HP Laptop	Lenovo Desktop Computer	iMac	227
3	HP Laptop	iMac	Dell Desktop	219
4	iMac	Lenovo Desktop Computer	Dell Desktop	183
5	CYBERPOWER Gamer Desktop	HP Laptop	iMac	177

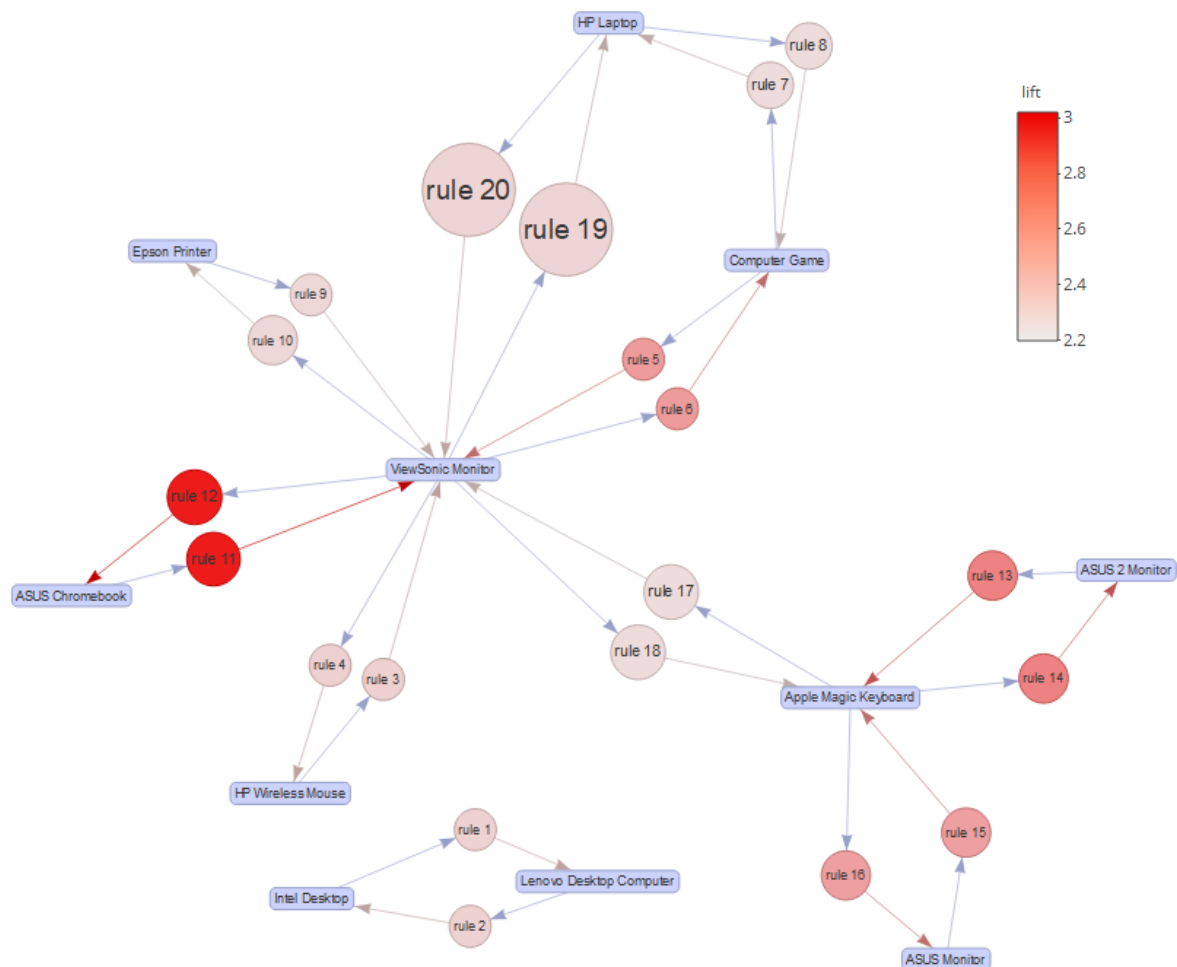*Figure A3: Graph of bilateral rules. (The bigger the size of the circles, the bigger the support for the rule)*

Table A4.1: Top 10 rules sorted by lift (min support transactions = 180)

Left hand side	Right hand side	Confidence	Lift	Count
{HP Laptop,iMac}	{ViewSonic Monitor}	0.313594	2.841707	233
{iMac,ViewSonic Monitor}	{HP Laptop}	0.479424	2.469196	233
{iMac,Lenovo Desktop Computer}	{Dell Desktop}	0.316609	2.361836	183
{Dell Desktop,iMac}	{Lenovo Desktop Computer}	0.340782	2.301216	183
{HP Laptop,iMac}	{Dell Desktop}	0.294751	2.19878	219
{Dell Desktop,iMac}	{HP Laptop}	0.407821	2.100418	219
{HP Laptop,iMac}	{Lenovo Desktop Computer}	0.305518	2.063087	227
{iMac,Lenovo Desktop Computer}	{HP Laptop}	0.392734	2.022712	227
{Dell Desktop,Lenovo Desktop Computer}	{iMac}	0.506925	1.978598	183
{HP Laptop,Lenovo Desktop Computer}	{iMac}	0.5	1.951568	227

Table A4.2: Top 10 rules sorted by lift (min support transactions = 130)

Left hand side	Right hand side	Confidence	Lift	Count
{Dell Desktop,HP Laptop}	{ViewSonic Monitor}	0.3393665	3.075255	150
{Dell Desktop,ViewSonic Monitor}	{HP Laptop}	0.5747126	2.959966	150
{HP Laptop,iMac}	{ViewSonic Monitor}	0.3135935	2.841707	233
{HP Laptop,Lenovo Desktop Computer}	{ViewSonic Monitor}	0.3039648	2.754453	138
{HP Laptop,iMac}	{Apple Magic Keyboard}	0.1951548	2.721648	145
{Lenovo Desktop Computer,ViewSonic Monitor}	{HP Laptop}	0.4946237	2.54748	138
{iMac,ViewSonic Monitor}	{HP Laptop}	0.4794239	2.469196	233
{Dell Desktop,iMac}	{ViewSonic Monitor}	0.2700186	2.446842	145
{HP Laptop,Lenovo Desktop Computer}	{Dell Desktop}	0.3259912	2.431825	148
{iMac,Lenovo Desktop Computer}	{ViewSonic Monitor}	0.2681661	2.430054	155

Table A4.3: Top 10 rules sorted by lift (min support transactions = 80)

Rules products (min count = 80)

Left hand side	Right hand side	Confidence	Lift	Count
{ASUS Chromebook,HP Laptop}	{ViewSonic Monitor}	0.410256	3.717641	80
{Dell Desktop,HP Laptop,iMac}	{ViewSonic Monitor}	0.392694	3.558496	86
{ASUS Chromebook,iMac}	{ViewSonic Monitor}	0.380952	3.452096	80
{Acer Aspire,HP Laptop}	{ViewSonic Monitor}	0.370629	3.358551	106
{HP Laptop,iMac,Lenovo Desktop Computer}	{ViewSonic Monitor}	0.365639	3.313328	83
{HP Laptop,ViewSonic Monitor}	{ASUS Chromebook}	0.169492	3.229536	80
{iMac,Lenovo Desktop Computer}	{ASUS 2 Monitor}	0.185121	3.210072	107
{HP Laptop,Lenovo Desktop Computer}	{Apple Magic Keyboard}	0.229075	3.194701	104
{iMac,ViewSonic Monitor}	{ASUS Chromebook}	0.164609	3.136504	80
{Acer Aspire,ViewSonic Monitor}	{HP Laptop}	0.602273	3.10191	106

Table A4.4: Top 10 rules sorted by lift (min support transactions = 30)

Left hand side	Right hand side	Confidence	Lift	Count
{ASUS Monitor,Dell Desktop,HP Laptop}	{Apple Magic Keyboard}	0.461538	6.436661	30
{Apple Magic Keyboard,Dell Desktop,HP Laptop}	{ASUS Monitor}	0.315789	5.696958	30
{ASUS Chromebook,Dell Desktop,HP Laptop}	{ViewSonic Monitor}	0.614035	5.564233	35
{Acer Aspire,Dell Desktop,HP Laptop,iMac}	{ViewSonic Monitor}	0.587302	5.321981	37
{iMac,ViewSonic Monitor}	{HP Black & Tri-color Ink}	0.08642	5.310494	42
{Apple Magic Keyboard,Dell Desktop,iMac}	{ASUS 2 Monitor}	0.3	5.202116	30
{Dell Desktop,HP Laptop,iMac,ViewSonic Monitor}	{Acer Aspire}	0.430233	5.196617	37
{HP Laptop,ViewSonic Monitor}	{HP Black & Tri-color Ink}	0.082627	5.077436	39
{Dell 2 Desktop,iMac}	{Apple Magic Keyboard}	0.358974	5.006292	42
{Apple Magic Keyboard,HP Laptop,iMac}	{ASUS Monitor}	0.275862	4.976653	40

Table A5: Sets of 2 categories sold most frequently together

Rank	Category 1	Category 2	Count
1	Desktops	Laptops	3155
2	Desktops	Monitors	2740
3	Laptops	Monitors	2365
4	Computer Mice	Desktops	1848
5	Keyboard	Desktops	1753

Table A6: Sets of 3 categories sold most frequently together

Rank	Item 1	Item 2	Item 3	Count
1	Desktops	Laptops	Monitors	1795
2	Desktops	Laptops	Computer Mice	1204
3	Desktops	Laptops	Keyboard	1128
4	Desktops	Computer Mice	Monitors	1077
5	Desktops	Keyboard	Monitors	1030

Figure A7: Graph of bilateral category rules. (The bigger the size of the circles, the bigger the support for the rule)
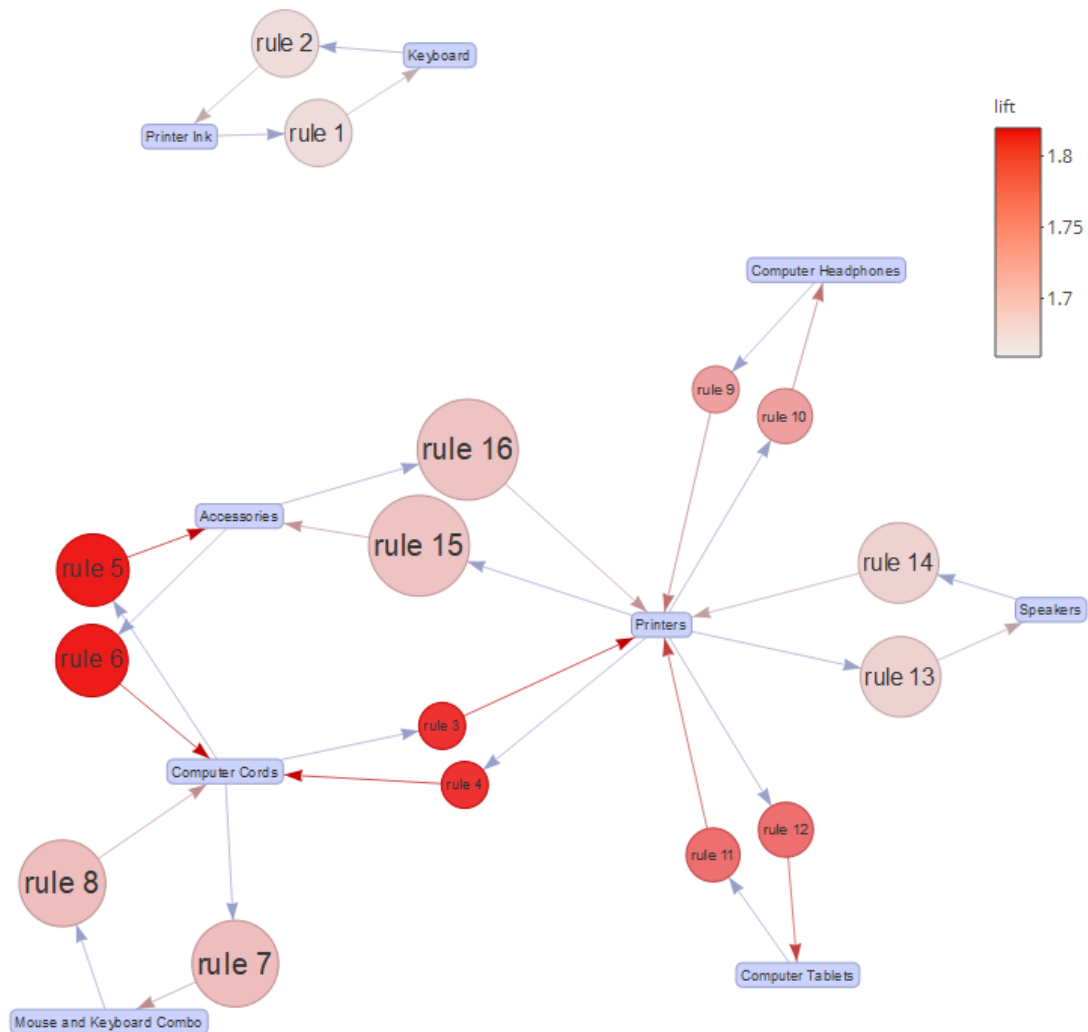
Table A8.1: Top 10 category rules sorted by lift (min support transactions = 150)

Left hand side	Right hand side	Confidence	Lift	Count
{Desktops, Monitors, Speakers}	{Printers}	0.301587	2.58518	152
{Computer Mice, Desktops, Keyboard, Laptops}	{Printers}	0.289773	2.48391	153
{Computer Mice, Keyboard, Laptops, Monitors}	{Accessories}	0.384248	2.47409	161
{Computer Cords, Laptops, Monitors}	{Accessories}	0.384224	2.47393	151
{Computer Cords, Desktops, Monitors}	{Accessories}	0.380631	2.45079	169
{Computer Mice, Desktops, Keyboard, Monitors}	{Accessories}	0.379085	2.44084	174
{Computer Mice, Keyboard, Monitors}	{Printers}	0.284387	2.43774	153
{Monitors, Speakers}	{Printers}	0.283048	2.42626	182
{Computer Tablets, Monitors}	{Printers}	0.282609	2.42250	156
{Computer Cords, Desktops, Laptops}	{Accessories}	0.372807	2.40042	170

Table A8.2: Top 10 category rules sorted by lift (min support transactions = 400)

Left hand side	Right hand side	Confidence	Lift	Count
{Keyboard,Monitors}	{Accessories}	0.312744	2.013688	400
{Desktops,Laptopsonitors}	{Accessories}	0.303621	1.954947	545
{Desktops,Laptops,Monitors}	{Printers}	0.224513	1.924505	403
{Keyboard,Laptops}	{Accessories}	0.289165	1.861866	419
{Computer Mice,Laptops}	{Accessories}	0.275841	1.776074	443
{Laptops,Monitors}	{Accessories}	0.274841	1.76964	650
{Laptops,Monitors}	{Printers}	0.205074	1.757879	485
{Accessories,Keyboard}	{Monitors}	0.690846	1.756958	400
{Keyboard,Laptops,Monitors}	{Computer Mice}	0.479954	1.748392	419
{Accessories,Desktops,Laptops}	{Monitors}	0.687264	1.747847	545

Table A8.3: Top 10 category rules sorted by lift (min support transactions = 600)

Left hand side	Right hand side	Confidence	Lift	Count
{Laptops, Monitors}	{Accessories}	0.274841	1.76964	650
{Desktops, Monitors}	{Accessories}	0.268978	1.731888	737
{Active Headphones, Desktops, Laptops}	{Monitors}	0.664502	1.68996	614
{Computer Mice, Desktops, Laptops}	{Monitors}	0.654485	1.664484	788
{Desktops, Keyboard, Laptops}	{Monitors}	0.652482	1.659391	736
{Accessories, Desktops}	{Monitors}	0.652212	1.658705	737
{Accessories, Laptops}	{Monitors}	0.646766	1.644854	650
{Desktops, Laptops}	{Accessories}	0.251347	1.618366	793
{Desktops, Laptops, Monitors}	{Keyboard}	0.410028	1.604216	736
{Desktops, Mouse and Keyboard Combo}	{Monitors}	0.630225	1.602787	784

Table A8.4: Top 10 category rules sorted by lift (min support transactions = 800)

Left hand side	Right hand side	Confidence	Lift	Count
{Monitors}	{Accessories}	0.239007	1.538909	924
{Keyboard, Laptops}	{Monitors}	0.602485	1.532237	873
{Computer Mice, Laptops}	{Monitors}	0.601494	1.529719	966
{Active Headphones, Desktops}	{Monitors}	0.587824	1.494951	840
{Desktops, Keyboard}	{Monitors}	0.587564	1.494292	1030
{Laptops, Monitors}	{Computer Mice}	0.408457	1.487938	966
{Computer Mice, Desktops}	{Monitors}	0.582792	1.482155	1077
{Desktops, Monitors}	{Keyboard}	0.375912	1.47074	1030
{Desktops, Laptops}	{Monitors}	0.568938	1.446922	1795
{Laptops, Monitors}	{Keyboard}	0.369133	1.444217	873