

Advertising Network Optimization

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1 Problem Description

Given a set of businesses $\{1, 2, \dots, n\}$ our goal is to optimize the distribution of advertisements across an advertising network. Each day the businesses in the network may publish ads for other businesses in the network and place ads to be published by other businesses. Every business i maintains an account with the network, its value denoted A_i is denominated in ads, and has a daily publishing limit $p_i \geq 0$.

At the end of each day the total number of ads placed by business i is deducted from its account A_i , and at the start of each day the business purchases a_i ads and receives one ad to its account for every two that it published on the preceding day.

Furthermore, advertisements are not all of the same quality. Each business has five preferred publishers and a list of excluded advertisers (e.g. competing businesses for whom it will not publish ads). Let $P = \{(i, j) : j \text{ is a preferred publisher for } i\}$ be the set of preferred ad placements and $S = \{(i, j) : j \text{ will not publish ads for } i\}$ be the set of excluded ad placements.

Let $x_{ij}^{(t)}$ denote the number of advertisements for business i that are published by business j on day $t \geq 1$. Letting $A_i^{(t)}$ denote the account balance of business i at the start of day t , we initialize $A_i^{(0)} = 0$, for all i , and the balances are determined by the recursion

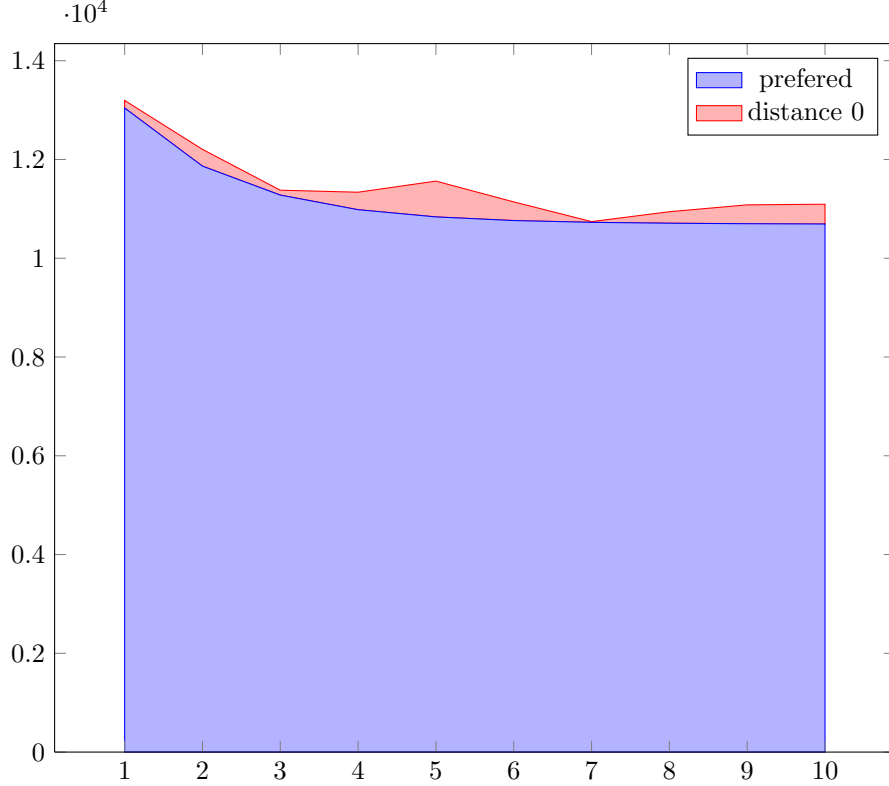
$$A_i^{(t)} = A_i^{(t-1)} + a_i - \sum_j x_{ij}^{(t-1)} + \frac{1}{2} \sum_j x_{ji}^{(t-1)}.$$

For each day t we solve a continuous relaxation of the assignment problem to determine the values of $x_{ij}^{(t)}$. The relaxation is

$$\begin{aligned} & \max \sum_{i,j} c_{ij} x_{ij}^{(t)} \\ & \text{such that} \\ & \sum_i x_{ij}^{(t)} \leq p_j, \text{ for all } j, \\ & \sum_j x_{ij}^{(t)} \leq A_i^{(t)} + p_i, \text{ for all } i, \\ & x_{ij}^{(t)} \leq \frac{1}{2} p_j, \text{ for all } i, j, \\ & x_{ij}^{(t)} = 0, \text{ for all } (i, j) \in S, \\ & x_{ij}^{(t)} \geq 0, \text{ for all } i, j, \end{aligned}$$

where the objective function is $c_{ij} = 2$ for $(i, j) \in P$ or $c_{ij} = (1 + \text{distance}(i, j))^{-1}$ otherwise.

Figure 1: Quality of ads published during the first 10 days



The objective functions emphasizes the value of preferred ads and de-emphasizes ads between businesses in different neighborhoods. The constraints express, in order, the maximum number of ads a business may publish, the maximum number of ads a business may place for other businesses to publish, at most half of the ads a business publishes may come from one advertiser, no excluded ads may be published, and all numbers of ads are nonnegative.

2 Simulation

We implemented the network design described in the previous section in Python using the commercially available Gurobi Optimizer to solve the relaxation. The following sequence of plots and tables describes the solutions during the first (simulated) year of its operation.

Here are the highlights:

1. The steady-state number of ads published is determined by the the fraction, call it α , of each ad that its publisher keeps (currently $\alpha = 1/2$) and by the number of ads purchased, $\sum_i a_i$. The steady-state average number of ads, neglecting publishing constraints, is $\frac{1}{1-\alpha} \sum_i a_i$.
2. For the given trial data, around 90% or more of the advertisements are preferred ads. The remainder are distance 0, i.e. published by a business in the advertiser's neighborhood.

Figure 2: Quality of ads published during the first 1000 days

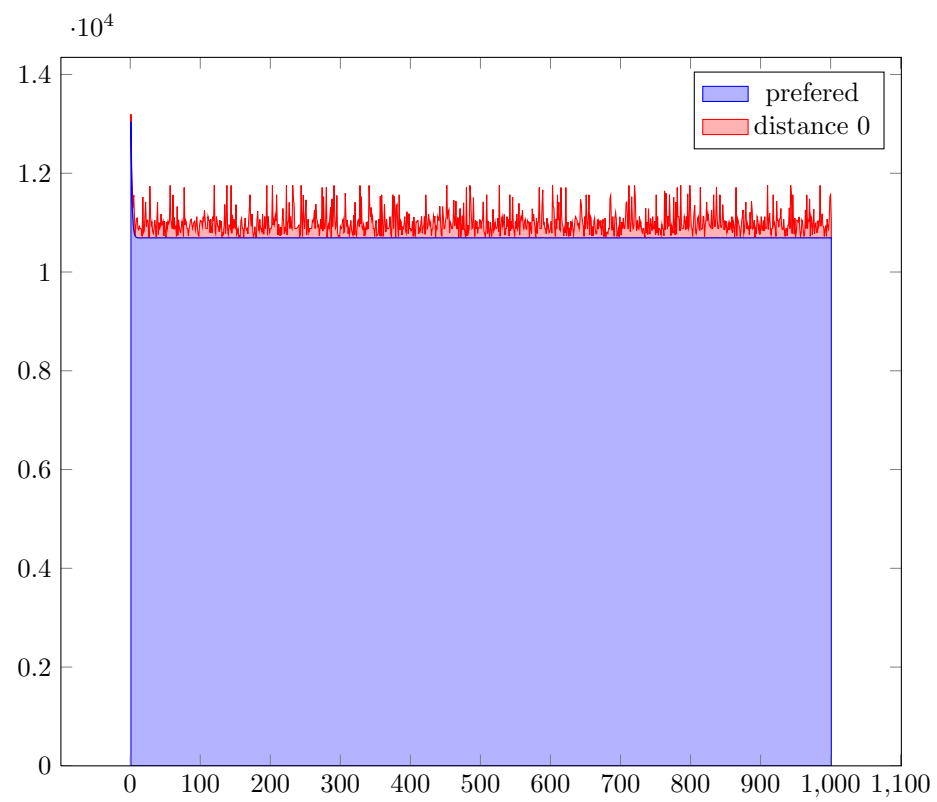


Table 1: Advertising (left) and publishing (top) activity on day 1

	Royal Farms	Brand X	Maggie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	ProYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
Royal Farms	0	-	0	0	0	0	0	0	0	89	89	0	0	491	56	873	0	-	0	0	0	0	0	0	0	0	0	1453	1453
Brand X	0	-	0	0	0	340	0	-	-	403	89	0	0	112	56	0	0	-	0	0	0	0	0	0	0	-	0	1000	1000
Maggie Moos	0	-	0	-	322	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	322	322
Canton Dental	0	-	0	-	0	150	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	150	150
Manchurian Wok	0	-	0	-	-	0	0	-	-	0	0	0	0	378	0	0	-	-	0	-	0	0	0	0	0	-	0	378	378
Jimmy Seafood	0	-	0	-	0	0	0	-	-	-	-	0	0	0	-	0	340	-	0	0	0	0	0	0	0	-	0	340	340
K&K Dry Cleaner	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	167	0	-	0	0	0	0	0	0	0	-	0	167	167
Brand Y	534	-	0	-	61	190	167	-	-	0	0	0	0	126	56	153	0	-	0	0	0	0	0	24	178	-	11	1500	1500
Theo Harris	0	-	0	-	100	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	100	100
C&R Pub	0	-	0	-	0	-	0	-	-	-	-	0	0	0	-	503	0	-	0	0	0	0	0	0	0	-	0	503	503
Brewer's Cask	89	-	0	-	0	0	0	-	-	0	0	0	0	0	-	0	0	-	0	0	0	0	0	0	0	-	0	89	89
Daily Grind	0	-	0	-	0	0	0	-	-	0	0	-	0	243	0	0	0	-	-	0	0	0	0	0	178	-	11	432	432
Royal Farms	-	0	0	-	0	0	0	-	-	0	0	0	-	0	0	0	354	-	37	272	0	360	0	0	0	-	0	1023	1023
Seven Eleven Fells	0	-	0	-	249	0	0	-	-	0	0	426	0	0	0	-	0	-	0	0	0	0	0	0	0	-	0	675	675
Yellow Dog Tavern	0	-	0	-	0	-	0	-	-	-	-	0	167	0	-	0	14	-	0	0	0	0	0	0	0	-	0	181	181
Seven Eleven	470	-	0	-	0	0	0	-	-	403	0	0	0	-	0	-	0	-	234	-	0	0	0	0	0	-	0	873	873
Pasta Mista	0	-	0	-	0	0	120	-	-	0	0	0	0	0	0	0	-	-	0	0	0	0	0	0	0	-	0	354	354
Brand Z	1453	-	0	-	0	0	0	-	-	0	0	0	547	0	0	0	0	-	-	302	32	0	0	0	0	-	0	2000	2000
Station Coffee House	0	-	0	-	0	0	0	-	-	0	0	-	0	0	0	0	0	-	-	0	0	0	0	0	0	-	0	334	334
Towson Hot Bagles	0	-	0	-	-	0	0	-	-	0	0	0	0	0	0	0	-	-	0	-	0	307	260	0	0	-	0	567	567
ProYo	0	-	-	-	-	0	0	-	-	0	0	208	0	0	0	0	0	-	0	0	-	-	0	24	0	-	0	232	232
Canton Car Wash	360	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	560	0	-	0	0	0	-	0	360	360
Ace Hardware	0	-	0	-	0	0	47	-	-	0	0	0	0	0	0	0	0	-	0	0	0	53	-	0	0	-	0	660	660
Cloud 9	0	-	0	-	24	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	-	-	-	0	24	24
Natty Bo Store	0	-	0	-	0	0	0	-	-	0	0	0	178	0	0	0	0	-	0	0	0	0	0	0	-	-	0	178	178
Dr Oz	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	50	0	-	0	0	0	0	0	0	0	-	0	50	50
Handbags in the City	2906	0	161	0	756	680	334	0	0	806	178	634	892	1350	112	1746	708	0	271	1134	32	720	260	48	356	0	22	14106	14106
ads published	2906	0	161	0	756	680	334	0	0	806	178	634	892	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	14106	14106
constraint	2906	0	644	0	756	680	334	0	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	16462	16462

Table 3: Advertising (left) and publishing (top) activity on day 3

	Royal Farms	Brand X	Maggie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
Royal Farms	0	-	0	-	0	0	0	-	-	403	89	0	0	0	0	0	709	0	0	0	0	0	0	0	0	0	-	0	1201
Brand X	0	-	0	-	0	340	0	-	-	0	0	0	0	660	0	0	0	-	0	0	0	0	0	0	0	0	-	0	1000
Maggie Moos	0	-	0	-	0	0	0	-	-	0	0	301	0	0	0	0	0	-	0	21	-	0	0	0	0	0	-	0	322
Canton Dental	0	-	0	-	0	150	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	-	0	322
Manchurian Wok	0	-	0	-	-	0	0	-	-	0	0	0	0	280	0	0	0	-	0	-	0	0	0	0	0	0	-	0	150
Jimmy Seafood	0	-	0	-	0	0	0	-	-	0	0	0	0	0	-	0	-	-	0	0	0	0	0	0	0	0	-	0	280
K&K Dry Cleaner	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	-	0	340
Brand Y	0	-	0	-	378	190	167	-	-	0	0	0	0	0	56	0	242	-	99	0	0	0	155	24	178	-	0	0	167
Theo Harris	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	100	0	0	0	-	0	100
C&R Pub	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	492	0	0	0	0	0	0	0	0	0	0	-	11	503
Brewer's Cask	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	89	0	0	0	0	-	0	89
Daily Grind	0	-	168	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	-	0	168
Royal Farms	-	0	0	0	0	0	0	-	-	0	0	0	0	0	0	0	0	-	135	0	0	0	0	0	0	0	-	0	135
Seven Eleven Fells	0	-	154	-	378	0	0	-	-	0	0	21	0	-	0	0	0	0	0	0	0	0	0	0	119	0	0	0	672
Yellow Dog Tavern	0	-	0	-	0	0	0	-	-	0	0	0	181	0	-	0	0	-	0	0	0	0	0	0	0	0	-	0	181
Seven Eleven	0	-	322	-	0	0	0	-	-	403	89	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	-	0	873
Pasta Mista	0	-	0	-	0	0	120	-	-	0	0	0	0	0	0	0	0	-	234	-	0	0	0	0	0	0	-	0	354
Brand Z	1453	-	0	-	0	0	0	-	-	0	0	0	0	0	0	378	0	-	0	0	0	169	0	0	0	0	-	0	2000
Station Coffee House	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	-	334	0	0	0	0	0	0	-	0	334
Towson Hot Bagles	0	-	0	-	0	0	47	-	-	0	0	0	0	0	56	0	-	-	0	-	0	360	7	0	0	0	-	0	470
FroYo	0	-	0	-	0	0	0	-	-	0	0	208	0	0	0	0	0	-	0	0	-	0	0	24	0	0	-	0	232
Canton Car Wash	109	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	251	0	-	0	0	0	0	-	0	360
Ace Hardware	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	504	0	0	-	0	0	0	-	0	504
Cloud 9	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	24	0	0	0	0	-	-	-	24	24
Natty Bo Store	0	-	0	-	0	0	0	-	-	0	0	178	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	0	178
Dr Oz	50	-	0	-	0	0	0	-	-	0	0	156	0	0	0	0	0	-	0	0	0	0	0	0	0	0	-	0	50
Handbags in the City	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	-	0	156
ads published	1612	0	644	0	756	680	334	0	0	806	178	864	181	940	112	1746	582	0	468	1134	0	360	520	48	356	0	22	12343	12343
constraint	2006	0	644	0	756	680	334	0	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	16462	

Table 4: Advertising (left) and publishing (top) activity on day 4

	Royal Farms	Brand X	Maggie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint	
	Royal Farms	-	0	-	0	0	0	Brand X	403	89	0	0	-	314	0	0	0	0	0	0	0	0	0	0	0	0	0	806	806	
	Maggie Moos	0	-	-	0	340	0	Brand X	403	0	0	0	0	257	0	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	
	Canton Dental	0	-	0	-	150	0	-	0	0	0	0	0	0	0	0	0	0	0	142	-	0	0	0	0	0	0	322	322	
	Manchurian Wok	0	-	0	-	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	150	150	
	Jimmy Seafood	0	-	0	0	0	0	-	0	0	-	0	0	0	-	0	340	0	0	0	0	0	0	0	0	0	0	378	378	
	K&K Dry Cleaner	0	-	0	0	0	-	-	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	167	167	
	Brand Y	0	-	0	0	190	167	-	0	0	0	0	0	520	0	56	0	354	-	0	0	0	0	24	178	-	11	1500	1500	
	Theo Harris	0	-	0	0	0	0	-	0	0	0	100	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	100	100	
	C&R Pub	0	-	0	0	-	0	-	0	0	-	0	0	0	0	479	0	0	0	0	0	0	0	24	0	0	0	503	503	
	Brewer's Cask	89	-	0	0	0	0	-	0	0	-	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	89	89	
	Daily Grind	0	-	254	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	178	-	0	0	432	432	
	Royal Farms	-	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	91	0	0	0	0	0	0	0	91	91	
	Seven Eleven Fells	0	-	0	67	0	0	-	0	0	0	403	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	470	470	
	Yellow Dog Tavern	0	-	0	0	0	0	-	0	0	0	0	0	181	0	0	0	0	0	0	0	0	0	0	0	0	0	181	181	
	Seven Eleven	784	-	0	0	0	0	-	0	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	873	873	
	Pasta Mista	0	-	0	0	0	0	-	0	0	0	0	0	291	0	0	-	0	0	0	0	0	0	0	0	0	0	291	291	
	Brand Z	1127	-	0	0	0	0	-	0	0	0	0	0	0	0	873	0	0	-	0	0	0	0	0	0	0	0	2000	2000	
	Station Coffee House	0	-	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	334	334	
	Towson Hot Bagles	0	-	0	-	0	0	-	0	0	0	0	0	0	56	0	0	0	0	0	0	360	151	0	0	0	0	567	567	
	FroYo	0	-	0	0	0	167	-	0	0	0	200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	200	200	
	Canton Car Wash	0	-	0	0	0	0	-	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	180	180	
	Ace Hardware	0	-	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	567	0	93	-	0	0	0	0	660	660	
	Cloud 9	0	-	0	0	0	0	-	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	-	24	0	24	24	
	Natty Bo Store	0	-	0	0	0	0	-	0	0	0	0	0	178	0	0	0	0	0	0	0	0	0	-	-	-	178	178	178	
	Dr Oz	0	-	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	
	Handbags in the City	0	-	0	0	0	0	-	0	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	161	161	
	ads published	2000	0	254	0	297	680	334	0	806	178	864	1172	1151	112	1352	694	0	1134	0	453	0	453	151	48	356	0	11	12047	12047
	constraint	2906	0	644	0	756	680	334	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	22	356	0	22	16462	16462	

Table 5: Advertising (left) and publishing (top) activity on day 5

	Royal Farms	Brand X	Magpie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
Royal Farms	0	-	0	0	0	0	0	0	403	89	89	0	0	138	56	0	370	0	0	0	0	0	0	0	0	0	0	1000	1000
Brand X	0	-	0	-	0	340	0	-	403	89	89	0	0	112	56	0	0	-	0	0	0	0	0	0	0	-	0	1000	1000
Magpie Moos	0	-	-	-	127	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	127	127
Canton Dental	0	-	0	-	0	150	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	130	150
Manchurian Wok	0	-	0	-	-	0	0	-	0	0	0	0	0	138	0	0	0	-	0	0	0	0	0	0	0	-	11	149	149
Jimmy Seafood	0	-	0	-	0	0	0	-	0	0	-	0	0	0	-	0	340	-	0	0	0	0	0	0	0	-	0	340	340
K&K Dry Cleaner	0	-	143	-	0	0	-	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	24	0	-	0	167	167
Brand Y	725	-	0	0	0	0	167	-	0	0	0	0	0	0	56	0	0	-	0	339	0	0	0	24	178	-	11	1500	1500
Theo Harris	0	-	0	-	100	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	100	100
C&R Pub	0	-	0	-	0	-	0	-	0	-	-	0	0	0	-	503	0	-	0	0	0	0	0	0	0	-	0	503	503
Brewer's Cask	89	-	0	-	0	0	0	-	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	0	0	-	0	89	89
Daily Grind	0	-	322	-	110	0	0	-	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	432	432
Royal Farms	-	0	-	0	0	0	0	-	0	0	0	0	-	0	0	0	0	-	226	0	0	360	0	0	0	-	0	586	586
Seven Eleven Fells	0	-	20	-	378	0	0	-	0	0	-	0	0	-	0	0	0	-	0	0	0	0	0	0	178	-	0	576	576
Yellow Dog Tavern	0	-	0	-	0	-	0	-	0	0	-	0	181	0	-	0	0	-	0	0	0	0	0	0	0	-	0	181	181
Seven Eleven	676	-	0	-	0	0	0	-	0	0	0	0	0	-	0	0	0	-	0	0	0	0	0	0	0	-	0	676	676
Pasta Mista	0	-	0	-	-	0	0	-	0	0	0	0	81	0	0	0	0	-	234	-	32	0	0	0	0	-	0	347	347
Brand Z	1127	-	0	-	0	0	0	-	0	0	0	-	0	0	0	0	873	0	-	100	0	0	0	0	0	-	0	2000	2000
Station Coffee House	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	100	100
Towson Hot Bagles	0	-	0	-	-	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	307	260	0	0	-	0	567	567
FroYo	0	-	-	-	0	0	0	-	0	0	0	200	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	200	200
Canton Car Wash	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	227	0	-	0	0	0	-	0	227	227
Ace Hardware	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	444	32	0	-	0	0	-	0	476	476
Cloud 9	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	24	0	0	0	-	-	-	24	24	24
Natty Bo Store	0	-	11	-	0	0	167	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	178	178
Dr Oz	50	-	0	-	0	0	0	-	0	0	0	115	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	50	50
Handbags in the City	2667	0	496	0	756	490	334	0	0	806	178	315	262	388	112	1746	340	0	460	1134	64	667	260	48	356	0	22	11901	11901
constraint	2906	0	644	0	756	680	334	0	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	16462	16462

Table 6: Advertising (left) and publishing (top) activity on day 6

	Royal Farms	Brand X	Magpie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mistra	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
	Royal Farms	0	0	-	0	0	0	-	403	89	0	0	-	0	0	842	0	0	0	0	0	0	0	0	0	0	1334	1334	
	Brand X	0	-	-	0	340	0	-	403	89	0	248	0	112	56	0	0	-	0	0	0	0	0	0	0	-	0	1000	1000
	Magpie Moos	0	-	0	0	150	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	248	248	
	Canton Dental	0	0	-	-	0	0	-	0	0	0	0	0	378	0	0	-	0	0	0	0	0	0	0	0	0	150	150	
	Manchurian Wok	0	-	0	0	-	0	-	-	-	-	0	0	0	-	0	245	-	0	0	0	0	0	0	0	0	378	378	
	Jimmy Seafood	0	-	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	245	245	
	K&K Dry Cleaner	0	-	0	0	0	0	-	0	0	0	0	143	0	0	0	0	0	0	0	0	0	0	0	0	0	167	167	
	Brand Y	0	117	378	190	167	0	-	0	0	0	0	0	56	214	133	0	0	0	0	32	0	24	178	-	11	1500	1500	
	Theo Harris	0	0	-	100	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	100	100	
	C&R Pub	0	0	0	-	0	0	-	0	-	-	0	0	0	-	503	0	0	0	0	0	0	0	0	0	0	503	503	
	Brewer's Cask	89	0	0	0	0	0	-	0	0	0	0	0	0	-	0	0	0	-	0	0	0	0	0	0	0	89	89	
	Daily Grind	0	158	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	158	158	
	Royal Farms	-	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	131	0	0	0	0	0	0	0	131	131	
	Seven Eleven Fells	0	16	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	178	0	194	194	
	Yellow Dog Tavern	0	-	0	0	0	0	0	-	0	0	0	181	0	-	0	0	0	0	0	0	0	0	0	0	0	181	181	
	Seven Eleven	873	0	0	0	0	0	0	-	0	0	0	0	-	0	-	0	-	0	0	0	0	0	0	0	0	873	873	
	Pasta Mistra	0	-	0	-	0	40	-	0	0	0	0	0	0	0	0	0	-	130	0	0	0	0	0	0	0	170	170	
	Brand Z	1453	0	0	-	0	0	-	0	0	0	0	0	0	0	187	0	-	0	-	0	360	0	0	0	-	2000	2000	
	Station Coffee House	0	-	0	-	0	0	-	0	0	0	-	0	0	0	0	330	-	-	0	0	0	0	0	0	-	330	330	
	Towson Hot Bagles	0	-	0	-	0	0	-	0	0	0	0	0	0	0	0	-	207	-	0	0	360	0	0	0	-	567	567	
	FroYo	0	-	-	0	0	0	-	0	0	232	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	232	232	
	Canton Car Wash	334	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	-	0	0	0	0	0	334	334	
	Ace Hardware	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	530	0	0	0	0	0	0	530	530	
	Cloud 9	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	-	24	24	24	
	Natty Bo Store	0	0	0	0	0	0	-	0	0	0	0	178	0	0	0	0	0	0	0	0	0	0	-	-	178	178	178	
	Dr Oz	50	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	50	50	
	Handbags in the City	0	-	0	-	161	0	0	-	0	178	480	502	514	112	1746	708	0	468	530	32	720	0	0	-	-	161	161	
	ads published	2799	0	291	0	639	680	207	0	806	178	864	2046	1134	720	480	708	0	468	530	32	720	0	48	356	0	11	11827	11827
	constraint	2906	0	644	0	756	680	334	0	806	178	864	2046	1134	720	480	708	0	468	530	32	720	0	48	356	0	22	16462	16462

Table 7: Advertising (left) and publishing (top) activity on day 7

[illegible]

Table 8: Advertising (left) and publishing (top) activity on day 8

	Royal Farms	Brand X	Magpie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
Royal Farms	0	-	0	0	0	0	0	0	91	89	0	0	0	0	342	56	0	0	0	0	0	0	0	0	0	0	0	180	180
Brand X	0	-	0	0	0	340	0	-	263	0	0	0	0	0	44	0	0	-	-	0	0	0	0	0	0	-	0	1000	1000
Magpie Moos	0	-	0	-	278	0	0	-	0	0	0	0	0	0	0	0	0	-	-	0	0	0	0	0	0	-	0	322	322
Canton Dental	0	-	0	-	0	150	0	-	0	0	0	0	0	0	0	0	-	-	0	0	0	0	0	0	0	-	0	150	150
Manchurian Wok	0	-	0	-	-	0	0	-	0	0	0	0	0	0	330	0	0	-	-	0	0	0	0	0	0	-	0	330	330
Jimmy Seafood	0	-	0	-	0	0	0	-	0	0	-	0	0	0	0	0	-	-	0	0	0	0	0	0	0	-	0	245	245
K&K Dry Cleaner	0	-	0	-	0	0	0	-	0	0	0	0	0	0	167	0	0	0	-	0	0	0	0	0	0	-	0	167	167
Brand Y	0	-	0	0	0	190	167	-	0	0	0	233	488	0	56	0	0	-	153	0	0	0	0	24	178	-	11	1500	1500
Theo Harris	0	-	0	-	100	0	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	100	100
C&R Pub	0	-	0	-	0	0	0	-	0	0	-	0	0	0	0	503	0	0	-	0	0	0	0	0	0	-	0	503	503
Brewer's Cask	0	-	0	-	0	0	0	-	0	0	-	89	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	89	89
Daily Grind	0	-	322	-	0	0	0	-	0	0	0	-	0	32	0	0	0	-	0	0	0	0	0	0	0	-	0	354	354
Royal Farms	-	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	234	567	0	112	0	0	0	-	0	913	913
Seven Eleven Fells	0	-	0	-	378	0	0	-	0	0	0	178	0	0	0	0	-	0	-	0	0	0	0	0	0	-	0	675	675
Yellow Dog Tavern	0	-	0	-	0	0	0	-	0	0	-	0	181	0	0	0	0	-	0	0	0	0	0	0	0	-	0	181	181
Seven Eleven	0	-	322	-	0	0	0	-	0	403	89	0	0	0	0	0	-	0	-	0	0	0	0	0	0	-	0	873	873
Pasta Mista	0	-	0	-	0	0	0	-	0	0	0	0	3	0	0	0	0	-	0	0	0	0	0	0	0	-	0	170	170
Brand Z	0	-	0	-	0	0	0	-	0	0	0	0	1023	0	0	0	717	0	-	0	0	0	260	0	0	-	0	2000	2000
Station Coffee House	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	-	198	0	0	0	0	0	-	0	198	198
Towson Hot Bagles	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	81	0	0	0	0	0	0	-	0	163	163
FroYo	0	-	-	0	0	0	0	-	0	0	0	208	0	0	0	0	0	-	0	0	-	0	82	0	24	-	0	232	232
Canton Car Wash	0	-	0	-	0	0	0	-	0	0	0	6	0	0	0	0	0	-	0	0	0	-	0	0	0	-	0	360	360
Ace Hardware	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	0	345	0	315	-	0	0	-	0	660	660
Cloud 9	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	-	24	0	0	0	0	-	-	-	0	24	24
Natty Bo Store	0	-	0	-	0	0	0	-	0	0	0	0	178	0	0	0	0	-	0	0	0	0	0	-	-	-	0	178	178
Dr Oz	0	-	0	-	0	0	0	-	0	50	0	0	0	0	0	0	0	-	0	0	0	0	0	-	-	-	0	50	50
Handbags in the City	0	-	0	-	0	0	0	-	0	0	0	156	0	0	0	0	0	-	0	0	0	0	0	-	-	-	0	156	156
ads published	0	0	644	0	756	680	334	0	0	806	178	864	2046	748	112	1220	599	0	468	1134	0	427	342	48	356	0	11	11773	11773
constraint	2906	0	644	0	756	680	334	0	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	16462	

Table 9: Advertising (left) and publishing (top) activity on day 9

	Royal Farms	Brand X	Magpie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
Royal Farms	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0
Brand X	0	-	0	-	0	340	0	-	-	403	0	0	0	0	0	257	0	0	0	0	0	0	0	0	0	-	0	1000	1000
Magpie Moos	0	-	0	-	322	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	322	322
Canton Dental	0	-	0	-	0	150	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	150	150
Manchurian Wok	0	-	0	-	-	0	0	-	-	0	0	0	0	0	56	0	-	-	-	0	0	0	0	0	0	-	11	378	378
Jimmy Seafood	0	-	0	-	0	-	0	-	-	-	-	308	0	0	-	0	0	0	0	0	32	0	0	0	0	-	0	340	340
K&K Dry Cleaner	0	-	0	-	0	0	-	-	-	0	0	0	0	0	0	167	0	-	-	0	0	0	0	0	0	-	0	167	167
Brand Y	382	-	0	-	0	190	167	-	-	403	89	0	0	0	56	0	0	0	0	0	0	0	0	24	178	-	11	1500	1500
Theo Harris	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	100	0	0	-	0	100	100
C&R Pub	0	-	0	-	0	-	0	-	-	-	-	0	0	0	0	503	0	0	0	0	0	0	0	0	0	-	0	503	503
Brewer's Cask	0	-	89	-	0	-	0	-	-	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	-	0	89	89
Daily Grind	0	-	233	-	0	0	0	-	-	0	0	-	0	21	0	0	0	0	0	-	0	0	0	0	178	-	0	432	432
Royal Farms	-	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	567	0	360	96	0	0	-	0	1023	1023
Seven Eleven Fells	0	-	0	-	0	0	52	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	374	374
Yellow Dog Tavern	0	-	0	-	0	-	0	-	-	0	89	0	0	0	-	0	0	0	0	0	0	0	0	0	0	-	0	181	181
Seven Eleven	521	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	610	610
Pasta Mista	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	300	300
Brand Z	1453	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	2000	2000
Station Coffee House	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	334	-	-	0	0	0	0	0	0	-	0	334	334
Towson Hot Bagles	0	-	0	-	-	0	115	-	-	0	0	0	0	0	0	0	-	192	-	0	0	0	260	0	0	-	0	567	567
FroYo	0	-	-	-	0	0	0	-	-	0	0	200	0	0	0	0	0	0	0	0	-	0	0	0	0	-	0	200	200
Canton Car Wash	0	-	0	-	0	0	0	-	-	0	0	0	214	0	0	0	0	0	0	0	0	-	0	0	0	-	0	214	214
Ace Hardware	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	567	4	0	-	0	0	-	0	571	571
Cloud 9	0	-	0	-	24	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	24	24	24
Natty Bo Store	0	-	0	-	0	0	0	-	-	0	0	0	178	0	0	0	0	0	0	0	0	0	0	0	-	-	178	178	178
Dr Oz	50	-	0	-	0	0	0	-	-	0	0	156	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	50	50
Handbags in the City	0	-	0	-	0	0	0	-	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	0	156	156
ads published	2406	0	644	0	346	680	334	0	0	806	178	664	1731	278	112	670	334	0	192	1134	36	360	456	24	356	0	22	11763	11763
constraint	2906	0	644	0	756	680	334	0	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	16462	16462

Table 10: Advertising (left) and publishing (top) activity on day 10

	Royal Farms	Brand X	Maggie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mistia	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
	Royal Farms	-	0	-	0	0	0	89	403	89	0	0	675	0	36	0	0	0	0	0	0	0	0	0	0	0	1203	1203	
	Brand X	-	0	-	322	0	0	0	403	89	0	0	112	56	0	0	0	0	0	0	0	0	0	0	0	0	1000	1000	
	Maggie Moos	0	-	-	0	340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	322	322		
	Canton Dental	0	-	0	0	150	0	0	-	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	150	150	
	Manchurian Wok	0	-	0	-	0	0	0	0	0	0	0	162	0	0	0	-	0	0	0	0	0	0	0	0	11	173	173	
	Jimmy Seafood	0	-	0	0	0	0	-	0	0	-	0	0	0	0	0	340	0	0	0	0	0	0	0	0	0	340	340	
	K&K Dry Cleaner	0	-	0	0	0	-	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	167	167	
	Brand Y	0	-	0	0	190	167	0	0	0	0	0	473	401	56	0	0	0	0	0	0	0	24	178	0	11	1500	1500	
	Theo Harris	0	-	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	
	C&R Pub	0	-	0	0	0	0	-	0	0	-	0	0	0	-	479	0	0	0	0	0	0	24	0	0	0	503	503	
	Brewer's Cask	0	-	0	0	0	0	0	89	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	89	89	
	Daily Grind	0	-	322	-	10	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	0	332	332	
	Royal Farms	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	567	0	299	0	0	0	0	0	0	866	866	
	Seven Eleven Fells	0	-	0	139	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	139	139	
	Yellow Dog Tavern	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	181	-	0	0	0	0	0	0	0	0	181	181	
	Seven Eleven	157	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	335	335	
	Pasta Mistia	0	-	0	-	0	0	0	0	0	0	0	135	0	0	0	-	0	0	0	32	0	0	0	178	0	167	167	
	Brand Z	0	-	0	0	0	0	0	0	0	0	0	0	0	0	873	0	-	0	164	32	0	260	0	0	0	2000	2000	
	Station Coffee House	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	0	196	196	
	Towson Hot Bagles	0	-	0	-	0	0	167	-	0	0	0	0	0	0	0	0	-	0	0	140	260	0	0	0	0	567	567	
	FroYo	0	-	-	0	0	0	0	0	0	218	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	218	218	
	Canton Car Wash	0	-	0	0	0	0	0	0	0	0	0	124	0	0	0	0	0	56	0	-	0	0	0	0	0	180	180	
	Ace Hardware	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	347	0	281	-	0	0	0	628	628	
	Cloud 9	0	-	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	12	12	
	Natty Bo Store	0	-	178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	-	-	178	178	
	Dr Oz	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	
	Handbags in the City	1074	0	500	0	744	680	334	0	806	178	307	899	1350	112	1388	521	0	1134	64	720	520	48	356	0	22	11757	11757	
	ads published	2906	0	644	0	756	680	334	0	806	178	307	899	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	10462	10462
	constraint																												

Table 11: Advertising (left) and publishing (top) activity on day 30

	Royal Farms	Brand X	Maggie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mistra	Brand Z	Station Coffee House	Towson Hot Bagles	FroYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	Ads placed	constraint	
	Royal Farms	0	0	0	0	0	0	0	333	0	0	0	0	0	0	873	0	0	0	0	0	0	0	0	0	0	0	1206	1206	
	Brand X	0	-	0	0	340	0	0	0	0	0	0	0	660	0	0	0	0	0	0	0	0	0	0	127	0	1000	1000		
	Maggie Moos	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	127	127	0	
	Canton Dental	0	-	0	0	150	0	0	0	0	0	0	367	0	0	0	0	-	0	0	0	0	0	0	0	0	150	150	0	
	Manchurian Wok	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	378	378	0	
	Jimmy Seafood	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	308	0	0	0	32	0	0	0	0	0	340	340	0	
	K&K Dry Cleaner	0	-	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	167	167	0	
	Brand Y	0	-	322	0	127	167	-	0	0	89	0	0	0	56	0	0	0	234	0	32	0	260	24	178	0	11	1500	1500	
	Theo Harris	0	-	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	100	0	
	C&R Pub	0	-	0	0	0	0	0	0	0	0	0	0	0	0	478	0	0	0	0	0	0	0	0	0	0	478	478	0	
	Brewer's Cask	45	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	45	45	0	
	Daily Grind	0	-	322	110	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	432	432	0	
	Royal Farms	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	81	0	0	0	0	0	0	0	0	81	81	0	
	Seven Eleven Fells	0	-	0	143	0	0	0	0	0	432	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	575	575	0	
	Yellow Dog Tavern	0	-	0	0	0	0	0	0	0	0	0	169	0	0	0	0	0	0	0	0	0	0	0	0	0	169	169	0	
	Seven Eleven	784	0	0	0	0	0	0	0	0	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	161	873	873	0
	Pasta Mistra	0	-	0	0	0	0	0	0	0	0	0	161	0	0	0	0	0	0	0	0	0	0	0	0	0	161	161	0	
	Brand Z	996	0	0	0	0	0	0	0	0	0	0	1004	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	2000	0	
	Station Coffee House	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	100	-	0	0	0	140	260	0	0	0	100	100	0	
	Towson Hot Bagles	0	-	0	-	0	167	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	567	567	0	
	FroYo	0	-	0	0	0	0	0	0	0	232	0	0	0	0	0	0	-	0	0	0	0	0	0	0	0	232	232	0	
	Canton Car Wash	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ace Hardware	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	567	0	93	-	0	0	0	660	660	0	
	Cloud 9	0	-	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	-	-	24	24	0	
	Natty Bo Store	0	-	0	0	0	0	0	0	0	0	0	178	0	0	0	0	0	0	0	0	0	0	-	-	-	178	178	0	
	Dr Oz	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50	50	0	
	Handbags in the City	0	-	0	0	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	161	161	0	
	ads published	1875	0	644	0	514	617	334	0	333	178	664	2046	684	56	1351	408	0	315	567	64	233	520	24	305	0	22	11754	11754	0
	constraint	2906	0	644	0	756	680	334	0	806	178	864	2046	1350	112	1746	708	0	468	1134	64	720	520	24	356	0	22	10462	10462	0

Table 12: Advertising (left) and publishing (top) activity on day 90

[illegible]

Table 13: Advertising (left) and publishing (top) activity on day 180

	Royal Farms	Brand X	Maggie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	ProYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint		
Royal Farms	0	-	0	-	0	0	0	0	403	0	0	0	-	0	0	221	0	0	0	0	0	0	0	0	0	0	0	624	624		
Brand X	0	-	0	-	322	0	0	-	403	89	0	0	0	112	56	0	0	0	-	0	0	0	0	0	0	0	-	0	1000	1000	
Maggie Moos	0	-	-	0	-	150	0	-	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	322	322	
Canton Dental	0	-	0	-	0	0	0	-	0	0	0	0	240	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	150	150	
Manchurian Wok	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	240	240	
Jimmy Seafood	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	167	0	0	0	42	0	0	0	0	0	0	-	0	42	42	
K&K Dry Cleaner	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	260	24	178	-	11	1500	1500		
Brand Y	0	-	0	-	0	0	167	-	0	0	0	432	372	0	56	0	0	0	0	0	0	0	0	0	0	0	-	0	100	100	
Theo Harris	0	-	0	-	100	0	0	-	0	0	0	0	0	0	0	0	435	0	0	0	0	33	0	24	0	0	-	11	503	503	
C&R Pub	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	53	0	0	0	0	-	0	89	89	
Brewer's Cask	36	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	297	297	
Daily Grind	0	-	297	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	57	0	293	0	0	0	0	-	0	350	350	
Royal Farms	-	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	556	556	
Seven Eleven Fells	0	-	222	0	334	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	181	181	
Yellow Dog Tavern	0	-	0	-	0	0	0	-	0	0	0	0	14	0	0	0	0	0	0	167	0	0	0	0	0	0	-	0	873	873	
Seven Eleven	481	-	125	-	0	0	0	-	0	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	178	-	0	873	873	254	254
Pasta Mista	0	-	0	-	0	0	167	-	0	0	0	0	0	0	0	0	0	0	55	0	32	0	0	0	0	0	-	0	2000	2000	
Brand Z	104	-	0	-	0	0	0	-	0	0	0	0	1023	0	0	873	0	0	0	0	0	0	0	0	0	0	-	0	334	334	
Station Coffee House	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	360	207	0	0	0	-	0	567	567	
Towson Hot Bagles	0	-	0	-	0	0	0	-	0	0	0	232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	232	232	
ProYo	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	360	360	
Canton Car Wash	360	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	567	0	34	-	0	0	0	-	0	601	601	
Ace Hardware	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	-	-	-	24	24	24	
Cloud 9	0	-	0	-	0	0	0	-	0	0	0	39	139	0	0	0	0	0	0	0	0	0	0	-	-	-	-	178	178	178	
Natty Bo Store	0	-	0	-	0	0	0	-	0	0	0	0	0	0	0	0	50	0	0	0	0	0	0	0	0	0	-	0	50	50	
Dr Oz	0	-	0	-	0	0	0	-	0	0	0	161	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	161	161	
Handbags in the City	981	0	644	0	756	490	334	0	806	178	864	1788	1788	112	112	1746	0	0	112	1134	32	720	520	48	356	0	22	11755	11755		
ads published	2906	0	644	0	756	680	334	0	806	178	864	2046	2046	1350	112	1746	708	0	468	1134	64	720	520	48	356	0	22	16462	16462		

Table 14: Advertising (left) and publishing (top) activity on day 365

	Royal Farms	Brand X	Magpie Moos	Canton Dental	Manchurian Wok	Jimmy Seafood	K&K Dry Cleaner	Brand Y	Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Seven Eleven	Pasta Mista	Brand Z	Station Coffee House	Towson Hot Bagles	ProYo	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	ads placed	constraint
Royal Farms	0	-	0	0	0	0	0	0	403	89	89	0	0	0	0	0	260	0	0	0	0	0	0	0	0	0	0	752	752
Brand X	0	-	0	-	0	340	0	-	403	89	89	0	0	168	0	0	0	-	0	0	0	0	0	0	0	-	0	1000	1000
Magpie Moos	0	-	0	-	0	0	0	0	0	0	0	0	0	322	0	0	0	-	0	0	0	0	0	0	0	-	0	322	322
Canton Dental	0	-	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	150	-	0	150	150
Manchurian Wok	0	-	0	-	-	0	0	0	0	0	0	0	0	287	0	0	-	-	0	-	0	0	0	0	0	-	11	298	298
Jimmy Seafood	0	-	245	-	0	0	0	-	0	-	-	0	0	0	-	0	0	-	0	95	0	0	0	0	0	-	0	340	340
K&K Dry Cleaner	0	-	0	0	0	0	-	0	0	0	0	0	167	0	0	0	0	-	0	0	0	0	0	0	0	-	0	167	167
Brand Y	0	-	0	-	378	340	167	-	0	0	0	0	0	314	56	0	0	-	0	0	32	0	0	24	178	-	11	1500	1500
Theo Harris	0	-	0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	100	100
C&R Pub	503	-	0	0	0	-	0	-	-	-	-	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	503	503
Brewer's Cask	0	-	45	0	0	0	0	0	0	0	0	0	0	88	0	0	0	-	0	0	0	0	0	0	0	-	0	45	45
Daily Grind	0	-	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	88	88
Royal Farms	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	567	0	196	260	0	0	-	0	1023	1023
Seven Eleven Fells	0	-	322	0	0	0	0	0	0	0	0	353	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	675	675
Yellow Dog Tavern	0	-	0	0	0	0	0	0	0	0	-	0	181	0	0	0	0	-	0	0	0	0	0	0	0	-	0	181	181
Seven Eleven	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	0	0
Pasta Mista	0	-	0	0	0	0	0	0	0	0	0	0	193	0	0	0	0	-	0	0	0	0	0	0	0	-	0	209	209
Brand Z	104	-	0	-	0	0	0	0	0	0	0	0	1023	0	0	0	873	0	-	0	0	0	0	0	0	-	0	2000	2000
Station Coffee House	0	-	0	-	0	0	0	0	0	0	0	-	0	0	0	0	0	-	0	0	0	0	0	0	0	-	0	334	334
Towson Hot Bagles	0	-	0	-	0	0	151	0	0	0	0	0	0	0	56	0	0	-	0	0	0	360	0	0	0	-	0	567	567
ProYo	0	-	-	0	0	0	0	0	0	0	0	232	0	0	0	0	0	-	0	0	-	0	0	0	0	-	0	232	232
Canton Car Wash	0	-	0	0	0	0	0	0	0	0	0	0	351	0	0	0	0	-	0	0	0	-	0	0	0	-	0	351	351
Ace Hardware	0	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	472	32	0	-	0	0	-	0	504	504
Cloud 9	0	-	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	-	0	0	0	0	0	-	-	-	24	24	24
Natty Bo Store	0	-	0	0	0	0	0	0	0	0	0	178	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	178	178
Dr Oz	50	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	-	-	-	50	50
Handbags in the City	0	-	0	-	161	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0	0	0	0	0	0	-	-	161	161
ads published	657	0	612	0	639	680	334	0	806	178	763	1915	1203	112	1133	112	1746	708	0	1134	64	556	260	24	328	0	22	11754	11754
constraint	2906	0	644	0	756	680	334	0	806	178	864	2046	1350	112	1746	1134	708	0	468	1134	64	720	520	48	356	0	22	16462	16462