Advertising Network Optimization

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1 Problem Description

Given a set of businesses $\{1, 2, ..., n\}$ 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 has a daily publishing limit $p_i > 0$.

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 prefered publishers and a list of excluded advertisers (e.g. competing businesses for whom it will not publish ads). Let $P = \{(i,j): j \text{ is a prefered publisher for } i\}$ be the set of prefered 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

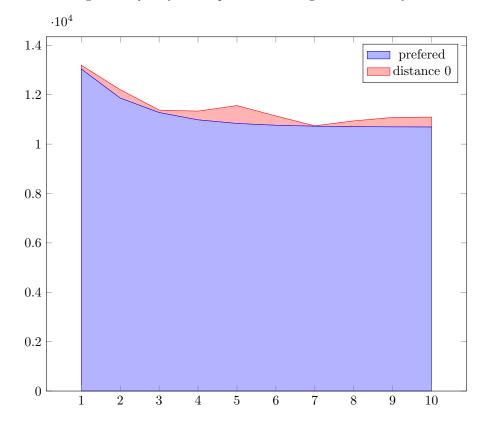
$$A_i^{(t)} = A_i^{(t-1)} + a_i - \sum_j x_{ij}^{(t-1)} + \frac{1}{2} \sum_j x_{ji}^{(t-1)}.$$

For each day t we solve a continuous relaxation of the assignment problem to deterimne 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 $c_{ij} = (1 + distance(i, j))^{-1}$ otherwise.

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



The objective functions emphasizes the value of prefered 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 prefered 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

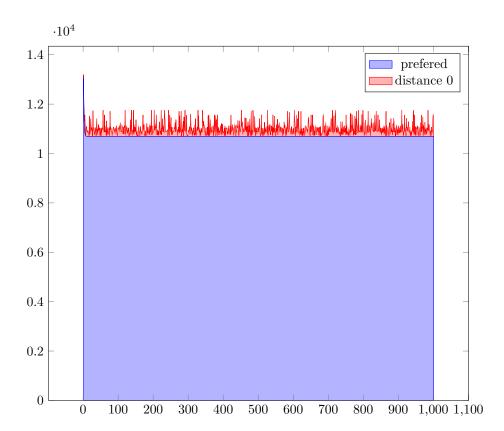


Table 1: Advertising (left) and publishing (top) activity on day 1

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	distraint	148	100	32	15	37	34	16	120	10	50	88	43	102	29	18	87	35	200	33	56	23	36	99	24	17	2(16	14106	
	sqs bjsceq	1453	1000	322	150	378	340	167	1500	100	503	88	432	1023	675	181	873	354	2000	334	292	232	360	099	24	178	20	161	14106	16462
	Handbags in the City	0	0	0	0	0	0	0	11	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0			0		22	22
	Dr Oz	١.														١.													0	0
	Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	178	0	0	0	0	0	0	0	0	0	0	0			0		356	356
	Cloud 9	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0			0		48	48
	Асе Нагdwаге	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	260	0	0		0	0	0	0	260	520
	Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	360	0	0	0	0	0	0	307	0		53	0	0	0	0	720	720
	oYorA	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0		0	0	0	0	0	0	32	64
	Towson Hot Bagles	0	0	0	0		0	0	0	0	0	0	0	272	0	0	0		0	302		0	0	260	0	0	0	0	1134	1134
3	Station Coffee House	0	0	0	0	0	0	0	0	0	0	0		37	0	0	0	234	0		0	0	0	0	0	0	0	0	271	468
1	Z basīd					١.					١.				١.	,													0	0
	Pasta Mista	0	0	0	0	١.	340	0	0	0	0	0	0	354	0	14	0		0	0		0	0	0	0	0	0	0	208	208
farriand arms (ara) Surrandard Land	2even Eleven	873	0	0	0	0	0	167	153	0	503	0	0	0		0		0	0	0	0	0	0	0	0	0	20	0	1746	1746
0	Yellow Dog Tavern	0	56	0	0	0		0	56	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	112	112
	Seven Eleven Fells	491	112	0	0	378	0	0	126	0	0	0	243	0		0		0	0	0	0	0	0	0	0	0	0	0	1350	1350
2	Royal Farms		0	0	0	0	0	0	0	0	0	0	0		0	167	0	0	547	0	0	0	0	0	0	178	0	0	892	2046
1	Daily Grind																													
0	Brewer's Cask																													178
1	С&В Риб																													
	zirrsH oədT	,														,		,											0	0
•	Frand Y	١.				١.									١.	١.													0	0
TANKE IT OFFICE	K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	120	0	0	0	0	0	47	0	0	0	0	334	334
1	Jimmy Seafood	0	340	0	150	0		0	190	0			0	0	0	١.	0	0	0	0	0	0	0	0	0	0	0	0	089	089
	Мапсћигіап Wok	0	0	322	0	١.	0	0	61	100	0	0	0	0	249	0	0		0	0		0	0	0	24	0	0	0	756	756
	Canton Dental					١.					١.				١.	١.													0	0
	sooM siggsM	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	161	161	644
	X basat	١.														١.													0	0
	Royal Farms		0	0	0	0	0	0	534	0	0	88	0		0	0	470	0	1453	0	0	0	360	0	0	0	0	0	2906	2906
		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 published	constraint

Table 2: Advertising (left) and publishing (top) activity on day 2

	tnis1tsnoo	153	000	31	20	78	40	29	200	00	03	39	17	46	75	81	73	54	000	36	29	16	09	30	24	78	05	61	2929	
																													1	2
	sqz bjsceq	145	1000	81	150	378	340	167	150	100	503	88	317	446	675	181	873	354	2000	236	292	216	360	530	24	178	20	161	12929	16462
	Handbags in the City		0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	•	11	22
	Natty Bo Store								- 82				- C		30		× ×								ľ	ľ			356 0	356 0
	Cloud 9																													
	Асе Нагамаге																												207	
	Canton Car Wash																													
	oYo14																													
	Towson Hot Bagles																											0		1134
; 1	Station Coffee House	0	0	0	0																									468 1
	Z basī												,	- 2				- 2											0 4	0
	Pasta Mista	0	0	0	0		340	0	156	0	0	0	0	212	0	0	0		0	0		0	0	0	0	0	0	0	802	208
; ?	Seven Eleven	286	0	0	0	0	0	34	0	0	503	0	0	0		0		0	873	0	0	0	0	0	0	0	20	0	1746	1746
Grand (Jos) Surrent Paratral (Social Social	Yellow Dog Tavern	0	56	0	0	0		0	56	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0			112
	Seven Eleven Fells	375	112	0	0	378	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	0	841	0			1350
; ;	Royal Farms																													
3																														
(0101)	Daily Grind																													
0	Brewer's Cask																													178
		403	403			0				0			0	0	0		0	0	0			0	0			0	0	0		
	Prand Y Theo Harris	'																											0 0	0 0
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	0	0	0	334	334
	Jimmy Seafood	0	340	0	0	0		0	340	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0		089
	Manchurian Wok	0	0	81	0		0	0	0	100	0	0	0	0	378	0	0		0	0		0	0	0	0	0	0			756
	Canton Dental																												0	0
	Raggie Moos	0	0		0	0	0	109	88	0	0	0	317	0	0	0	0	0	0	0	0		0	0	0	0	0	129	644	644
	X basad X	١.				١.																							0	0
	Royal Farms		0	0	0	0	0	0	0	0	0	88	0		0	0	825	0	1127	0	0	0	360	0	0	0	0	0	2401	2906
		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 published	constraint

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

		l	l			l										l						l			l	l			_	
	constraint	1201	1000	322	150	280	340	167	1500	100	503	88	168	135	672	181	873	354	2000	334	470	232	360	504	24	178	20	156	12343	
	sqs bjsceq	1201	1000	322	150	280	340	167	1500	100	503	88	168	135	672	181	873	354	2000	334	470	232	360	504	24	178	20	156	12343	16462
	Handbags in the City	0	0	0	0	0	0	0	11	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	١.		0		22	22
	Dr Oz			,	,		,	,	,	,	,	,		,	,		,	,		,	,		,				,		0	0
	Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	0	0	119	0	59	0	0	0	0	0	0	0			0		356	356
	6 buolO	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0			0		48	48
	Ace Hardware	0	0	0	0	0	0	0	155	100	0	88	0	0	0	0	0	0	169	0	7	0	0		0	0	0	0	520	520
	Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	0		0	0	0	0	0	360	720
	oYorA	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	64
	Towson Hot Bagles	0	0	21	0		0	0	0	0	0	0	0	0	0	0	0		0	334		0	251	504	24	0	0	0	1134	1134
2	Station Coffee House	0	0	0	0	0	0	0	66	0	0	0		135	0	0	0	234	0		0	0	0	0	0	0	0	0	468	468
3	Z basıd			,	,		,	,	,	,	,	,		,	,		,	,		,	,		,				,	,	0	0
Y 10.V	Pasta Mista	0	0	0	0	١.	340	0	242	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	582	208
tioning (not) and papingning (nob) activity on day	Zeven Eleven	402	0	0	0	0	0	167	0	0	492	0	0	0		0		0	378	0	0	0	0	0	0	0	0	0	1746	1746
2	Yellow Dog Tavern	0	0	0	0	0		0	26	0			0	0	0		0	0	0	0	26	0	0	0	0	0	0	0	112	112
	Zeven Eleven Fells	0	099	0	0	280	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	940	1350
222	Royal Farms		0	0	0	0	0	0	0	0	0	0	0		0	181	0	0	0	0	0	0	0	0	0	0	0	0	181	2046
130	Daily Grind	0	0	301	0	0	0	0	0	0	0	0		0	21	0	0	0	0		0	208	0	0	0	178	0	156	864	864
1	Brewer's Cask	88	0	0	0	0		0	0	0			0	0	0		88	0	0	0	0	0	0	0	0	0	0	0	178	178
	СКВ Бир	403	0	0	0	0		0	0	0			0	0	0		403	0	0	0	0	0	0	0	0	0	0	0	908	908
2	sirrsH oədT					١.												,	,						١.				0	0
;	Y basad					١.	١.				١.			١.			١.	,							١.				0	0
	K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	120	0	0	47	0	0	0	0	0	0	0	334	334
	Jimmy Seafood	0	340	0	150	0		0	190	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	089	089
	Малсһигіал Wok	0	0	0	0	١.	0	0	378	0	0	0	0	0	378	0	0	,	0	0		0	0	0	0	0	0	0	756	756
	Canton Dental					١.												,	,						١.				0	0
	Maggie Moos	0	0		0	0	0	0	0	0	0	0	168	0	154	0	322	0	0	0	0		0	0	0	0	0	0	644	644
	X basad					١.							1																0	0
	Royal Farms		0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	1453	0	0	0	109	0	0	0	20	0	1612	2906
		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 published	constraint

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

			0	_		000		L	0		_		_			L	_	L	0	L.					l	000			17	
	distraint	80	100	323	12(378	34(16,	150	100	203	88	433	91	47	18	87:	59	200	33,	56'	200	18(99	24	178	20	16	12047	
	sds placed	908	1000	322	150	378	340	167	1500	100	503	88	432	91	470	181	873	291	2000	334	267	200	180	099	24	178	20	161	12047	16462
	Handbags in the City	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0		11	22
	Dr Oz	١.																										1	0	0
	Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	178	0	0	0	0	0	0	0	0	0	0	0			0	٠	356	356
	Cloud 9	0	0	0	0	0	0	0	24	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0			0		48	48
	Ace Hardware	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	151	0	0		0	0	0	0	151	520
	Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	0		93	0	0	0	0	453	720
	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	0	0	64
	Towson Hot Bagles	0	0	142	0		0	0	0	0	0	0	0	91	0	0	0		0	334		0	0	267	0	0	0	0	1134	1134
·	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	0	0	0	468
1	Z basıd																												0	0
	Pasta Mista	0	0	0	0	١.	340	0	354	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	694	208
	Seven Eleven	0	0	0	0	0	0	0	0	0	479	0	0	0		0		0	873	0	0	0	0	0	0	0	0	0	1352	1746
0	Yellow Dog Tavern	0	0	0	0	0		0	56	0			0	0	0		0	0	0	0	26	0	0	0	0	0	0	0	112	112
	Seven Eleven Fells	314	257	0	0	378	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	24	178	0	0	1151	1350
Carriago (dos) Surriago da pue (ara) Surara	Royal Farms		0	0	0	0	0	167	520	0	0	0	0		0	181	0	291	0	0	0	0	13	0	0	0	0	0	1172	2046
1780	Daily Grind																												864	
0	Brewer's Cask	89	0	0	0	0		0	0	0			0	0	0		68	0	0	0	0	0	0	0	0	0	0	0	178	178
110101	С%К Бир	403	403	0	0	0		0	0	0			0	0	0															908
	sirrsH oədT																											,	0	0
•	Brand Y	١.				١.									١.	١.													0	0
1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	334	334
1	Jimmy Seafood	0	340	0	150	0		0	190	0			0	0	0	١.	0	0	0	0	0	0	0	0	0	0	0	0	089	089
	Manchurian Wok	0	0	180	0	١.	0	0	0	0	0	0	0	0	29	0	0		0	0		0	0	0	0	0	20	0	297	756
	Canton Dental					١.									١.	١.													0	0
	sooM siggsM	0	0		0	0	0	0	0	0	0	0	254	0	0	0	0	0	0	0	0		0	0	0	0	0	0	254	644
	X basta	١.																											0	0
	Royal Farms		0	0	0	0	0	0	0	0	0	88	0		0	0	784	0	1127	0	0	0	0	0	0	0	0	0	2000	2906
		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 published	constraint

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

tnisrtznoo	1000	1000	127	150	149	340	167	1500	100	503	89	432	586	576	181	929	347	2000	100	267	200	227	476	24	178	50	156	1901	
sqs bjsceq	000	000	127	150	149	340	167	.500	100	503	68	432	586	576	181	929	347	0000	100	292	200	227	476	24	178	50	156	1901	6462
Dr Oz Handbags in the City		-			- 1			-				-				-) -	-) -	-				ľ	ľ			0 2	
Natty Bo Store	0	0	0	0	0	0	0	821	0	0	0	0	0	841	0	0	0	0	0	0	0	0	0			0		356	
Cloud 9																												48	
Ace Hardware																													
Canton Car Wash																													
ProYo																													
Towson Hot Bagles	0	0	0	0		0	0	339	0	0	0	0	0	0	0	0		0	100	,	0	227	444	24	0	0	0	1134	1134
Station Coffee House	0	0	0	0	0	0	0	0	0	0	0		526	0	0	0	234	0											
Z bns18												,	1			,	-	,		,								0	
Pasta Mista	0	0	0	0		340	0	0	0	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	0	340	208
Зелеи Ејелеи	370	0	0	0	0	0	0	0	0	503	0	0	0		0	,	0	873	0	0	0	0	0	0	0	0	0	1746	1746
Yellow Dog Tavern	0	56	0	0	0		0	56	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	112	112
Seven Eleven Fells	138	112	0	0	138	0	0	0	0	0	0	0	0		0	,	0	0	0	0	0	0	0	0	0	0	0	388	1350
Royal Farms																													
Daily Grind																													
Brewer's Cask																													
C&R Pub																													
sirrsH oədT	- 4	- 4										,				,		,		,								8 0	8
Y bnsīd												,				,				,								0	0
K&K Dry Cleaner	0	0	0	0	0	0	١.	167	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	167	0	0	334	334
Jimmy Seafood	0	340	0	150	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	490	089
Manchurian Wok	0	0	127	0		0	0	0	100	0	0	110	0	378	0	0		0	0		0	0	0	0	0	0	41	756	756
Canton Dental	١.						١.	١.	١.			,				,		,		,								0	0
sooM əiggsM	0	0		0	0	0	143	0	0	0	0	322	0	20	0	0	0	0	0	0		0	0	0	11	0	0	496	644
X basad	١.						١.	١.		١.							1		1									0	0
Royal Farms	١.	0	0	0	0	0	0	725	0	0	88	0		0	0	929	0	1127	0	0	0	0	0	0	0	20	0	2667	2906
	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 published	constraint

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

	tnisrtenoo	34	00	, ∞		oo.	2	7	00		2		, ∞	L	4	L	8		000		7	2	4		Ļ			1	11827	
	taiestanoo	13	10	24	15	37	24	16	15	10	50	ã	15	13	19	18	87	17	20	33	26	23	33	53	2	17	ŭ	16		
	sqs bjsceq	1334	1000	248	150	378	245	167	1500	100	503	88	158	131	194	181	873	170	2000	330	292	232	334	530	24	178	20	161	11827	16462
	Handbags in the City	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0		11	22
	Dr Oz																												0	0
	Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	0	0	178	0	0	0	0	0	0	0	0	0			0	٠	356	356
	Cloud 9	0	0	0	0	0	0	24	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	1	48	48
	Ace Hardware	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	520
	Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	0	360	0		0	0	0	0	0	720	720
	ProYo	0	0		0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0	١.	0	0	0	0	0	0	32	64
	Towson Hot Bagles	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	530	0	0	0	0	530	1134
	Station Coffee House	0	0	0	0	0	0	0	0	0	0	0		131	0	0	0	130	0		207	0	0	0	0	0	0	0	468	468
1	Z basid															,													0	0
	Pasta Mista	0	0	0	0	١.	245	0	133	0	0	0	0	0	0	0	0		0	330		0	0	0	0	0	0	0	208	208
	Зеvеп Еleven	842	0	0	0	0	0	0	214	0	503	0	0	0		0		0	187	0	0	0	0	0	0	0	0	0	1746	1746
farting (do) Summand and (and) Summan	Yellow Dog Tavern	0	56	0	0	0		0	56	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	112	112
ì	Seven Eleven Fells	0	112	0	0	378	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	24	0	0	0	514	1350
,	Royal Farms																													
3																														
(0.10.1)	Daily Grind																													
0	Brewer's Cask	89	88	0	0	0		0	0	0	ľ		0	0	0	'	0	0	0	0	0	0	0	0	0	0	0	0	178	178
	СКВ Pub	403	403	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	806	806
1	Theo Harris	'				ľ					ľ				ľ	'						ľ						1	0	0
Table of the	Y brand Y	ľ	ľ			ľ	ľ		167 -	ľ	ľ			ľ	ľ	'	ľ		ľ		ľ	ľ	ľ	ľ	ľ	ľ	ľ	1	0 4	4 0
3	K&K Dry Cleaner				0	0	0			0	0	0	0	0	0	0	0	40	0	0	0	0	0	0	0	0	0			334
	Jimmy Seafood	0	340	0	150	0		0	190	0	ľ	ľ	0	0	0	ľ	0	0	0	0	0	0	0	0	0	0	0			089
	Manchurian Wok	0	0	0	0	ľ	0	0	378	100	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	161	639	756
	Canton Dental	ľ				ľ			- 2		ľ				ľ	ľ						ľ						1	0 1	0
	Maggie Moos	0	0		0	0	0	0	117	0	0	0	158	0	16	0	0	0	0	0	0	ľ	0	0	0	0	0			644
	X basad	'		ľ		ľ		ľ			ľ	ľ	ľ	ľ	ľ	'		ľ	3	ľ	ľ			ľ	ľ	ľ	ľ	1	0 6	9
	Royal Farms	ľ	0	0	0	0	0	0	0	0	0	88	0		0	0	873	0	1453	0	0	0	334	0	0	0	20		2799	2906
		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 published	constraint

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

						1			4	0	(0.00	1	for them (Jon) Surrey James (and) Surrey	100	,												
	Royal Farms	X basid	Maggie Moos	Canton Dental	Мапсћигіап Wok	Jimmy Seafood	K&K Dry Cleaner	Frand Y Theo Harris	C&R Pub	Brewer's Cask	Daily Grind	Royal Farms	Seven Eleven Fells	Yellow Dog Tavern	Зечеп Ејечеп	Pasta Mista	Brand Z Station Coffee House	Towson Hot Bagles	oYo14	Canton Car Wash	Ace Hardware	Cloud 9	Natty Bo Store	Dr Oz	Handbags in the City	sqz bjsceq	constraint
Royal Farms			0				0		403	82	0		675	0	240	0						0	0	١.		400	1400
Brand X	0		0		0	340	0	'	0	88	0	0	515	56	0	0	0					0	0			000	1000
Maggie Moos	0				146				0	0	0	0	0	0	0	0	0					0	0	١.		146	146
Canton Dental	0		0		0 1	150	0		0	0	0	0	0	0	0	0	0					0	0	١.		150	150
Manchurian Wok	0		0			0	0		0	0	0	160	160	0	0		0 -					0	0			320	320
Jimmy Seafood	0		0		0		0				0	0	0		0	340	0					0	0			340	340
K&K Dry Cleaner	0		0	,	0	0			0	0	0	0	0	0	104	0	- 0					0	0			104	104
Brand Y	0		0		0		167		0	0	432	461	0	56	0	0	0					24	178			1500	1500
Theo Harris	0		0		100	0	0		0	0	0	0	0	0	0	0	0 -					0	0			100	100
C&R Pub	0		0		0		0	ľ			0	0	0		479	0	0					24	0	١.		503	503
Brewer's Cask	0		0				0				0	0	0		0	0						0	0			88	89
Daily Grind	0		240		0		0		0	0		0	0	0	0	0						0	0			240	240
Royal Farms	,		0		0		0		0	0	0		0	0	0	0						0	0			251	251
Seven Eleven Fells	0		0	,	257		0		0	0	0	0		0		0	0					0	0			257	257
Yellow Dog Tavern	0		0								0	181	0		0	0	0					0	0			181	181
Seven Eleven	0		285	,	0		0		403	2	0	0		0		0	- 0					0	178			873	873
Pasta Mista	0		0				159		0	0	0	0	0	0	0		- 19					0	0			354	354
Brand Z	0		0	,	0		0		0	0	0	1023	0	0	873	0	0 -					0	0	,		0000	2000
Station Coffee House	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			265	265
FroYo	0				0	0	0		0	0	216	0	0	0	0	0	0					0	0			216	216
Canton Car Wash	360		0		0		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			400	400
Cloud 9	0		0		0		0		0	0	0	0	0	0	0	0	0									24	24
Natty Bo Store	0		119		0	0	0		0	0	59	0	0	0	0	0	0									178	178
Dr Oz	0		0		0		0		0	0	0	0	0	0	20	0	0					0	0			50	50
Handbags in the City	0		0	,					0	0	0	0	0	0	0	0		0								156	156
ads published	360		644						806	178	202	1825	1350	112	1746	340	0 19					48	356	0	11 1	11791	11791
constraint	2906	0	644	0	756 6	680 3	334	0 0	806	178	864	2046	1350	112	1746	708	0 468	8 1134	_			48	356	0		16462	

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

constraint	180	1000	322	150	330	245	167	1500	100	503	89	354	913	675	181	873	170	2000	198	163	232	360	099	24	178	50	156	11773	
sqs bjsceq	180	1000	322	150	330	245	167	1500	100	503	68	354	913	675	181	873	170	2000	198	163	232	360	099	24	178	50	156	11773	16462
Handbags in the City	0	0	0	0	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0		11	22
Dr Oz	,	,																										0	0
Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	0	0	119	0	29	0	0	0	0	0	0	0			0		356	356
6 buolO	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0			0		48	48
Асе Нагамате	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	260	0	82	0	0		0	0	0	0	342	520
Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	112	0	0	0	0	0	0	0	0		315	0	0	0	0	427	720
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	0	0	64
Towson Hot Bagles	0	0	0	0		0	0	0	0	0	0	0	267	0	0	0		0	198		0	0	345	24	0	0	0	1134	1134
Station Coffee House	0	0	0	0	0	0	0	153	0	0	0		234	0	0	0	0	0		81	0	0	0	0	0	0	0	468	468
Brand Z		,			١.																							0	0
Pasta Mista	0	0	0	0		245	0	0	0	0	0	0	0	0	0	0		0	0		0	354	0	0	0	0	0	599	208
Seven Eleven	0	0	0	0	0	0	0	0	0	503	0	0	0		0		0	717	0	0	0	0	0	0	0	0	0	1220	1746
O natern Dog Tavern	0	26	0	0	0		0	26	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	112	112
Seven Eleven Fells	0	342	44	0	330	0	0	0	0	0	0	32	0		0		0	0	0	0	0	0	0	0	0	0	0	748	1350
Royal Farms	,	0	0	0	0	0	167	488	0	0	0	0		0	181	0	3	1023	0	0	0	9	0	0	178	0	0	2046	2046
Daily Grind	0	0	0	0	0	0	0	233	0	0	88		0	178	0	0	0	0		0	208	0	0	0	0	0	156	864	864
Brewer's Cask	88	0	0	0	0		0	0	0			0	0	0		89	0	0	0	0	0	0	0	0	0	0	0	178	178
С&Я Риб	91	262	0	0	0		0	0	0			0	0	0		403	0	0	0	0	0	0	0	0	0	20	0	908	806
sirrsH oədT	,	,			١.																		١.					0	0
Frand Y		,			١.							1				1	1	1										0	0
K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	334	334
Jimmy Seafood	0	340	0	150	0		0	190	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	089	680
Manchurian Wok	0	0	278	0	١.	0	0	0	100	0	0	0	0	378	0	0		0	0		0	0	0	0	0	0	0	756	756
Canton Dental	,	,			١.																							0	0
sooM əiggsM	0	0		0	0	0	0	0	0	0	0	322	0	0	0	322	0	0	0	0		0	0	0	0	0	0	644	644
Brand X												1				1	1	1										0	0
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	2906
	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 published	constraint

piaced adaption of the princed Handbags in the City Dr Oz Natty Bo Store 6 pnoto O Canton Car Wash Towson Hot Bagles Station Coffee House Brand Z 334 Pasta Mista Seven Eleven Yellow Dog Tavern 278 1350 O Seven Eleven Fells ${\bf Royal\ Farms}$ 0 181 0 300 547 O Daily Grind Brewer's Cask O C&R Pub Theo Harris Brand Y K&K Dry Cleaner 0 340 089 Jimmy Seafood Canton Dental Maggie Moos Brand X Royal Farms Royal Farms
Brand X
Maggie Moos
Canton Dental
Manchurian Wok
Jimmy Saafood
Kk K Dry Cleaner
Brand Y
Theo Hartis
C&R Pub
Brand Y
Theo Hartis
C&R Pub
Brand Y
Flow Doily Grind
Patra Mista
Royal Farms
Seven Eleven Fells
Yellow Dos Taven
Brand Z
Farmin Seven Eleven
Fars Mista
Brand Z
Station Coffee House
Towson Hat Bagles
Froyo
Canton Coffee House
Conton Coffee House
Towson Hat Bagles
Froyo
Naty Bo Store
Cloud 9
Naty Bo Store
Cloud 9
Naty Bo Store
Cloud 9
Naty Bo Store
Are Hardware
Cloud 9
Naty Bo Store

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

tnisttenoc

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

	ı		ı	ı	ı	ı	ı	ı	ı		ı		ı	ı	ı				ı	ı	ı	ı	ı	ı	ı	ı		1	ı
constraint	1203	1000	322	150	173	340	167	1500	100	503	88	332	998	139	181	335	167	2000	196	267	218	180	628	12	178	20	161	11757	
sqs bjsceq	1203	1000	322	150	173	340	167	1500	100	503	88	332	998	139	181	335	167	2000	196	267	218	180	628	12	178	20	161	11757	16462
Handbags in the City	0	0	0	0	11	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	,	22	22
Dr Oz	,	,	,																								,	0	0
Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	0	0	0	0	178	0	0	0	0	0	0	0			0	,	356	356
6 buolO	0	0	0	0	0	0	0	24	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0			0	,	48	48
Асе Нагамате	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	260	0	260	0	0		0	0	0	0	520	520
Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	599	0	0	0	0	0	0	140	0		281	0	0	0	0	720	720
FroYo	0	0	,	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	32	0		0	0	0	0	0	0	64	64
Towson Hot Bagles	0	0	0	0		0	0	0	0	0	0	0	267	0	0	0		0	164		0	56	347	0	0	0	0	1134	1134
serion 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	0	0	0	468
Z basia	,	,	,																								,	0	0
Pasta Mista	0	0	0	0		340	0	0	0	0	0	0	0	0	181	0		0	0		0	0	0	0	0	0	0	521	208
Seven Eleven	36	0	0	0	0	0	0	0	0	479	0	0	0		0		0	873	0	0	0	0	0	0	0	0	0	1388	1746
Yellow Dog Tavern	0	26	0	0	0		0	56	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	112	112
Seven Eleven Fells	675	112	0	0	162	0	0	401	0	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	1350	1350
Royal Farms		0	0	0	0	0	167	473	0	0	0	0		0	0	0	135	0	0	0	0	124	0	0	0	0	0	899	2046
Daily Grind	0	0	0	0	0	0	0	0	0	0	88		0	0	0	0	0	0		0	218	0	0	0	0	0	0	307	864
Brewer's Cask	88	89	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	178	178
С&Я Риь	403	403	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	908	908
sirrsH oədT		,										,				,	,											0	0
Brand Y	,	,										1				1	1	1										0	0
K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	334	334
Jimmy Seafood	0	340	0	150	0		0	190	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	089	089
Малсһигіал Wok	0	0	322	0		0	0	0	100	0	0	10	0	139	0	0		0	0		0	0	0	12	0	0	161	744	756
Canton Dental		,																									,	0	0
sooM əiggsM	0	0		0	0	0	0	0	0	0	0	322	0	0	0	0	0	0	0	0		0	0	0	178	0	0	200	644
X basa X												1				1	1	1										0	0
Royal Farms	,	0	0	0	0	0	0	0	0	0	0	0		0	0	157	0	867	0	0	0	0	0	0	0	20	0	1074	2906
	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 published	constraint

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

constraint	1206	1000	127	150	378	340	167	1500	100	478	45	432	81	575	169	873	161	2000	100	267	232	0	099	24	178	50	161	11754	
sds placed	1206	1000	127	150	378	340	167	1500	100	478	45	432	81	575	169	873	161	2000	100	567	232	0	099	24	178	20	161	11754	16462
Handbags in the City	0	0	0	0	11	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		,	0		22	22
Dr Oz									,	,								,	,						,	,		0	0
Natty Bo Store	0	0	127	0	0	0	0	178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		,	0		305	356
Cloud 9	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		,	0		24	48
Ace Hardware	0	0	0	0	0	0	0	260	0	0	0	0	0	0	0	0	0	0	0	260	0	0		0	0	0	0	520	520
Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	140	0		93	0	0	0	0	233	720
ProYo	0	0		0	0	32	0	32	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	64	64
Towson Hot Bagles	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0	0		0	0	267	0	0	0	0	267	1134
Station Coffee House	0	0	0	0	0	0	0	234	0	0	0		81	0	0	0	0	0	,	0	0	0	0	0	0	0	0	315	468
Z basid									,	,								,	,						,	,		0	0
Pasta Mista	0	0	0	0		308	0	0	0	0	0	0	0	0	0	0		0	100		0	0	0	0	0	0	0	408	208
Зечеп Еleven	873	0	0	0	0	0	0	0	0	478	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	1351	1746
Yellow Dog Tavern	0	0	0	0	0		0	26	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	26	112
Seven Eleven Fells	0	099	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	24	0	0	0	684	1350
Royal Farms		0	0	0	367	0	167	0	0	0	0	0		0	169	0	161	1004	0	0	0	0	0	0	178	0	0	2046	2046
Daily Grind	0	0	0	0	0	0	0	0	0	0	0		0	432	0	0	0	0	1	0	232	0	0	0	0	0	0	664	864
Brewer's Cask	0	0	0	0	0		0	88	0	,		0	0	0		88	0	0	0	0	0	0	0	0	0	0	0	178	178
СКВ Бир	333	0	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	333	908
zirrisH oədT									,	,						١.		,	,						,	,		0	0
Y bns1									•	٠						ŀ	٠	,	•						,	٠	-		0
K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	334	334
Jimmy Seafood	0	340	0	150	0		0	127	0	٠		0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	617	089
Manchurian Wok	0	0	0	0		0	0	0	100	0	0	110	0	143	0	0		0	0		0	0	0	0	0	0	161	514	756
Canton Dental									٠	٠								,	٠						,	٠			0
Maggie Moos	0	0		0	0	0	0	322	0	0	0	322	0	0	0	0	0	0	0	0		0	0	0	0	0	0	644	644
Brand X																ľ		,	•						,	•	1		9
Royal Farms		0	0	0	0	0	0	0	0	0	45	0		0	0	784	0	966	0	0	0	0	0	0	0	20	0	1875	2906
	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 published	constraint

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

constraint	1018	1000	225	150	378	170	167	1500	100	503	88	330	72	675	181	873	0	2000	263	267	200	261	625	24	178	50	156	11755	
sqs bjsceq	1018	1000	225	150	378	170	167	1500	100	503	68	330	72	675	181	873	0	2000	263	267	200	261	625	24	178	50	156	11755	16462
Handbags in the City	0	0	0	0	11	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	,		0	,	22	22
Dr Oz																١.	١.	,									,	0	0
Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			0	,	178	356
6 buolO	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0			0	,	48	48
Ace Hardware	0	0	0	0	0	0	0	260	0	0	0	0	0	0	0	0	0	260	0	0	0	0		0	0	0	0	520	520
Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	360	176		56	0	0	0	0	562	720
ProYo	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	0		0	32	0	0	0	0	64	64
Towson Hot Bagles	0	0	0	150		0	0	0	0	0	0	0	0	0	0	0		0	0	,	0	0	292	0	0	0	0	717	1134
Station Coffee House	0	0	0	0	0	0	0	0	0	0	0		72	0	0	0	0	0		0	0	0	0	0	0	0	0	72	468
Z basid																١.	١.	,									,	0	0
Pasta Mista	0	0	0	0		170	0	323	0	0	0	0	0	0	0	0	١.	0	215		0	0	0	0	0	0	0	208	208
Зечеп Еlечеп	873	0	0	0	0	0	0	0	0	503	0	0	0	,	0		0	287	0	0	0	0	0	0	0	0	0	1663	1746
Yellow Dog Tavern	0	0	0	0	0		0	56	0			0	0	0		0	0	0	16	40	0	0	0	0	0	0	0	112	112
Seven Eleven Fells	0	571	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	571	1350
Royal Farms	,	0	0	0	367	0	167	0	0	0	0	0		0	181	0	0	0	0	0	0	261	0	0	178	0	0	1154	2046
Daily Grind	0	0	0	0	0	0	0	0	0	0	88		0	276	0	0	0	0		0	0	0	0	0	0	0	0	365	864
Brewer's Cask	88	88	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	178	178
C&R Pub	26	0	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	26	908
zirrsH oədT																١.	١.	,	,	,			,	,			,	0	0
Prand Y																		,	,	,			٠	٠	-		,		0
K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	334	334
Jimmy Seafood	0	340	0	0	0		0	340	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	089	089
Мапсһигіап Wok	0	0	225	0		0	0	0	100	0	0	330	0	22	0	0		0	0		0	0	0	24	0	0	0	756	756
Canton Dental																			٠	٠			٠	٠	1				0
sooM əiggsM	0	0		0	0	0	0	0	0	0	0	0	0	322	0	0	0	0	0	0		0	0	0	0	0	156	478	644
X basid																		,	•	•			•	•	1		,		0
Royal Farms		0	0	0	0	0	0	141	0	0	0	0		0	0	873	0	1453	0	0	0	0	0	0	0	20	0	2517	2906
	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 published	constraint

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

tnisttsnoo	624	1000	322	150	240	42	167	1500	100	503	89	297	350	556	181	873	254	2000	334	567	232	360	601	24	178	20	161	11755	
sqe bjøceq	624	1000	322	150	240	42	167	1500	100	503	88	297	350	556	181	873	254	2000	334	567	232	360	109	24	178	50	161	11755	16462
Handbags in the City																													
Dr Oz									,			,				,	,		,			,		,				0	
Natty Bo Store	0	0	0	0	0	0	0	178	0	0	0	0	0	0	0	178	0	0	0	0	0	0	0	,		0		356	356
6 buolO	0	0	0	0	0	0	0	24	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	,		0		48	48
Ace Hardware	0	0	0	0	0	0	0	260	0	0	53	0	0	0	0	0	0	0	0	202	0	0		0	0	0	0	520	520
Canton Car Wash	0	0	0	0	0	0	0	0	0	33	0	0	293	0	0	0	0	0	0	360	0	,	34	0	0	0	0	720	720
ProYo	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	32	0	0	0		0	0	0	0	0	0	32	64
Towson Hot Bagles	0	0	0	0	,	42	0	0	0	0	0	0	0	0	167	0	,	0	334	,	0	0	567	24	0	0	0	1134	1134
Station Coffee House	0	0	0	0	0	0	0	0	0	0	0	,	22	0	0	0	22	0	,	0	0	0	0	0	0	0	0	112	468
Brand Z																,								,				0	0
Pasta Mista	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	208
Зеvеп Еleven	221	0	0	0	0	0	167	0	0	435	0	0	0		0		0	873	0	0	0	0	0	0	0	20	0	1746	1746
Yellow Dog Tavern	0	26	0	0	0		0	26	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	112	112
Seven Eleven Fells	0	112	0	0	0	0	0	0	0	0	0	0	0		0		0	0	0	0	0	0	0	0	0	0	0	112	1350
Royal Farms	,	0	0	0	240	0	0	372	0	0	0	0	,	0	14	0	0	1023	0	0	0	0	0	0	139	0	0	1788	2046
Daily Grind	0	0	0	0	0	0	0	432	0	0	0		0	0	0	0	0	0		0	232	0	0	0	39	0	161	864	864
Brewer's Cask	0	88	0	0	0		0	0	0			0	0	0		88	0	0	0	0	0	0	0	0	0	0	0	178	178
C%R Pub	403	403	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	908	908
Theo Harris																,								,				0	0
Brand Y																,		1						,	1	1	٠	0	0
K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	167	0	0	0	0	0	0	0	0	0	0	334	334
Jimmy Seafood	0	340	0	150	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	490	089
Малсһигіал Wok	0	0	322	0		0	0	0	100	0	0	0	0	334	0	0		0	0		0	0	0	0	0	0	0	756	756
Canton Dental																	٠	1	٠					,	1	1		0	0
Raggie Moos	0	0		0	0	0	0	0	0	0	0	297	0	222	0	125	0	0	0	0		0	0	0	0	0	0	644	644
Erand X									•									1							1	1		0	0
Royal Farms		0	0	0	0	0	0	0	0	0	36	0		0	0	481	0	104	0	0	0	360	0	0	0	0	0	981	2906
	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 published	constraint

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

constraint	752	1000	322	150	298	340	167	1500	100	503	45	88	1023	675	181	0	209	2000	334	267	232	351	504	24	178	20	161	11754	
sqz bjsceq	752	1000	322	150	298	340	167	1500	100	503	45	88	1023	675	181	0	209	2000	334	292	232	351	504	24	178	20	161	11754	16462
Handbags in the City	0	0	0	0	11	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	,		0	١,	22	22
Dr Oz		,							,			,				,	,		,			,		,			١.	0	0
Natty Bo Store	0	0	0	150	0	0	0	178	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	,		0	١.	328	356
Cloud 9	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	,		0		24	48
Ace Hardware	0	0	0	0	0	0	0	0	0	0	0	0	260	0	0	0	0	0	0	0	0	0		0	0	0	0	260	520
Canton Car Wash	0	0	0	0	0	0	0	0	0	0	0	0	196	0	0	0	0	0	0	360	0	,	0	0	0	0	0	556	720
Fro Ko	0	0		0	0	0	0	32	0	0	0	0	0	0	0	0	0	0	0	0		0	32	0	0	0	0	64	64
Towson Hot Bagles	0	0	0	0	,	95	0	0	0	0	0	0	267	0	0	0	,	0	0		0	0	472	0	0	0	0	1134	1134
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	0	0	0	468
Erand Z		,														,								,			١,	0	0
Pasta Mista	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0		0	334		0	0	0	0	0	0	0	334	708
Зечеп Еleven	260	0	0	0	0	0	0	0	0	0	0	0	0		0		0	873	0	0	0	0	0	0	0	0	0	1133	1746
Yellow Dog Tavern	0	0	0	0	0		0	26	0			0	0	0		0	0	0	0	26	0	0	0	0	0	0	0	112	112
Seven Eleven Fells	0	168	322	0	287	0	0	314	0	0	0	88	0		0		0	0	0	0	0	0	0	24	0	0	0	1203	1350
Royal Farms	1	0	0	0	0	0	167	0	0	0	0	0	,	0	181	0	193	1023	0	0	0	351	0	0	0	0	0	1915	2046
Daily Grind	0	0	0	0	0	0	0	0	0	0	0	,	0	353	0	0	0	0	,	0	232	0	0	0	178	0	0	763	864
Brewer's Cask	89	89	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	178	178
C&R Pub	403	403	0	0	0		0	0	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	806	806
Theo Harris		,							,			,				,	,		,			,		,			١.	0	0
Brand Y	1		1															1		1	1				1	1		0	0
K&K Dry Cleaner	0	0	0	0	0	0		167	0	0	0	0	0	0	0	0	16	0	0	151	0	0	0	0	0	0	0	334	334
bools92 ymmil	0	340	0	0	0		0	340	0			0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	089	089
Manchurian Wok	0	0	0	0		0	0	378	100	0	0	0	0	0	0	0		0	0		0	0	0	0	0	0	161	639	756
Canton Dental		,							,			,				,								,			,	0	0
sooM əiggsM	0	0		0	0	245	0	0	0	0	45	0	0	322	0	0	0	0	0	0		0	0	0	0	0	0	612	644
Brand X	1	,	1															1		1	1				1	1	,	0	0
Royal Farms		0	0	0	0	0	0	0	0	503	0	0		0	0	0	0	104	0	0	0	0	0	0	0	20	0	657	2906
	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 published	constraint