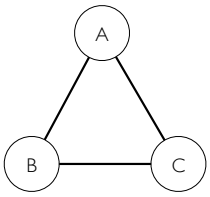
Section 3.

1

Points & Lines in Graph Terms

Some Very Basic Graph Theory



- **Nodes** = {a, b, c}
- **Edges** = { (a,b), (b,c), (a, c)}

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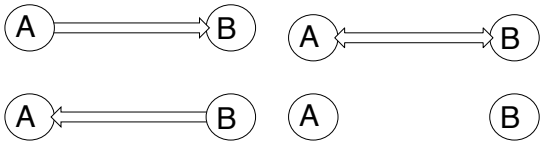
Directed and Undirected Ties

Undirected Ties

- Ties are represented by lines
- No distinction between node A and node B
- Ties are either present or absent

Directed Ties



- Ties are represented by arrows
- Important distinctions between which node is the sender and which node is the receiver
- Ties are either asymmetric, mutual, or absent

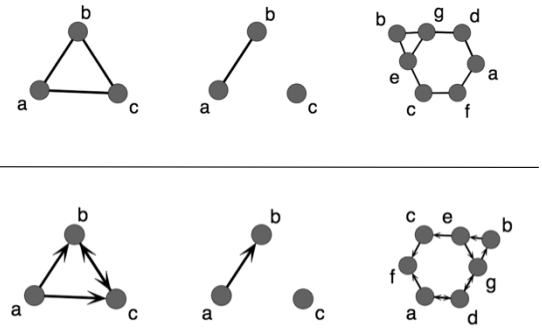


Image courtesy of Ryan Acton

Types of Data Structures

7

Network Data Structures

1. Sociomatrix
2. Edgelist

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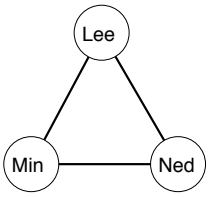
Sociomatrix

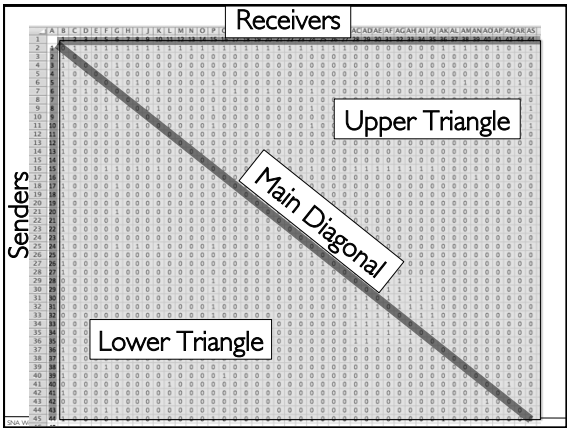
- The matrix is a square with the order of nodes in the 1st row the same as the order of nodes in the 1st column
- Each cell indicates the presence of a tie (1s) or the absence of a tie (0s)
- The diagonal of 0s shows that nodes are not connected to themselves

	Lee	Min	Ned
Lee	0	1	1
Min	1	0	1
Ned	1	1	0

Sociomatrix

	Lee	Min	Ned
Lee	0	1	1
Min	1	0	1
Ned	1	1	0





Row 1 is a header row with numerical id numbers. Column 1 lists the exacts same set of numerical id numbers.

Node #6 Receiver

Node #6 Sender

	A	B	C	D	E	F	G	H	I	J
1		1	2	3	4	5	6	7	8	9
2	1	0	1	1	1	1	1	1	1	1
3	2	1	0	0	0	0	0	0	0	0
4	3	1	0	0	0	0	1	0	0	0
5	4	1	0	0	0	0	0	0	0	0
6	5	1	0	0	0	0	1	0	1	0
7	6	1	0	1	0	1	0	0	1	0
8	7	1	0	0	0	0	0	0	0	0
9	8	1	0	0	0	1	1	0	0	0
10	9	1	0	0	0	0	0	0	0	0

This sociomatrix …

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44
1	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	1	0	1	1
2	2	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	1	0	0	0	0	1	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	0	0	0	0	0	0	0	0	0	0
4	4	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	5	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
6	6	1	0	1	0	1	0	0	1	0	1	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
7	7	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	8	1	0	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
9	9	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	10	1	0	0	0	0	1	0	1	0	0	0	0	0	1	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	0	1
11	11	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
12	12	1	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	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0
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14	14	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	15	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	16	1	0	0	0	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	1
17	17	1	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	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
18	18	1	0	0	0	0	1	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	0	0	0	0	0	0	0	0	0	0
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23	23	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
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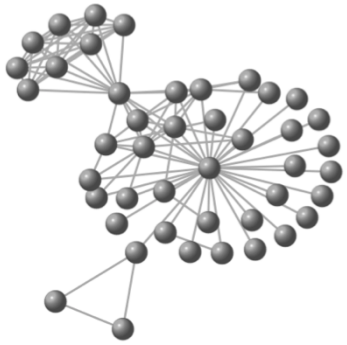
25	25	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26	26	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	27	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	28	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
29	29	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
30	30	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
31	31	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0
32	32	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0	1	1	1	0	0	0	0	0	0	0	0	0
33	33	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0
34	34	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0	0
35	35	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	0	1	0	0	0	0	0	0	0	0
36	36	1	0	0	0	0	0	0	0	1	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	0	0	0	0	0	0	1
37	37	1	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	38	1	0	0	0	1	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	0	0	0	0	0	0	0	0	0	0	0
39	39	1	0	0	0	1	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	0	0	0	0	0	0	0	0	0	0	0
40	40	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	41	1	0	0	0	0	0	0	0	0	1	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	0	1	0	1	0	0
42	42	1	0	0	0	0	0	0	0	0	0	1	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	0	1	0	0	0
43	43	1	0	0	0	1	1	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	0	0	0	0	0	0	0	0	0	0
44	44	1	0	0	0	0	1	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

… produces this network.



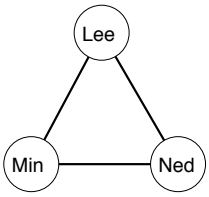
Edgelist

- Each row in an edgelist represents one tie in the network
- Edgelists require at least 2 columns: column 1 is the sender and column 2 is the receiver
- The order of sender and receiver do not matter for undirected ties

Sender	Receiver
Lee	Min
Lee	Ned
Ned	Min

Edgelist

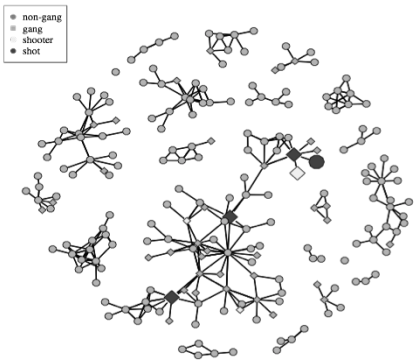
Sender	Receiver
Lee	Min
Lee	Ned
Ned	Min



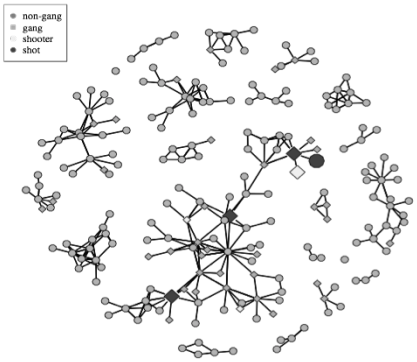
This edgelist …

V1	V2
1	221
1	238
1	254
1	217
1	234
1	3
1	151
1	6
1	12
1	108
1	328
1	4
1	184
1	265
1	324
1	67
1	7
1	193
1	2
1	5
1	17
1	133
1	135
1	339
1	231

… produces this network.



… produces this network.

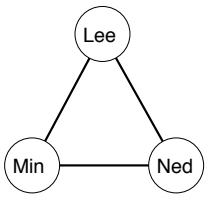


One-Mode vs. Two-Mode Data

20

One-Mode Data

A single set of nodes that are all the same type.



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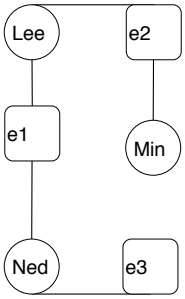
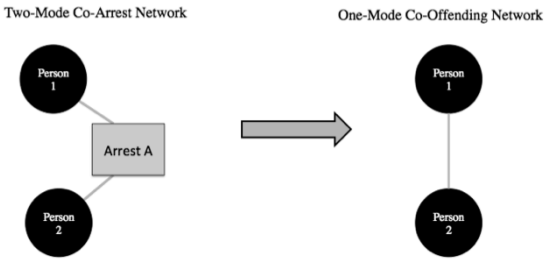
Two-Mode Data

Two different types of nodes that are connected.



Arrest Records



Classic Arrest Data

DATE	ARREST_NO	ID_NO
6/1/15 12:10 AM	ARN 105711	2055047
6/1/15 12:12 AM	ARN 105723	2386552
6/1/15 12:15 AM	ARN 105725	2966102
6/1/15 12:15 AM	ARN 105774	2843250
6/1/15 12:18 AM	ARN 105773	2420701
6/1/15 12:18 AM	ARN 105773	2534758
6/1/15 12:20 AM	ARN 105746	3190981
6/1/15 12:20 AM	ARN 105761	2916244
6/1/15 12:20 AM	ARN 105761	3190906
6/1/15 12:22 AM	ARN 105714	2888633
6/1/15 12:22 AM	ARN 105731	2248610

Classic Arrest Data

DATE	ARREST_NO	ID_NO
6/1/15 12:10 AM	ARN 105711	2055047
6/1/15 12:12 AM	ARN 105723	2386552
6/1/15 12:15 AM	ARN 105725	2966102
6/1/15 12:15 AM	ARN 105774	2843250
6/1/15 12:18 AM	ARN 105773	2420701
6/1/15 12:18 AM	ARN 105773	2534758
6/1/15 12:20 AM	ARN 105746	3190981
6/1/15 12:20 AM	ARN 105761	2916244
6/1/15 12:20 AM	ARN 105761	3190906
6/1/15 12:22 AM	ARN 105714	2888633
6/1/15 12:22 AM	ARN 105731	2248610

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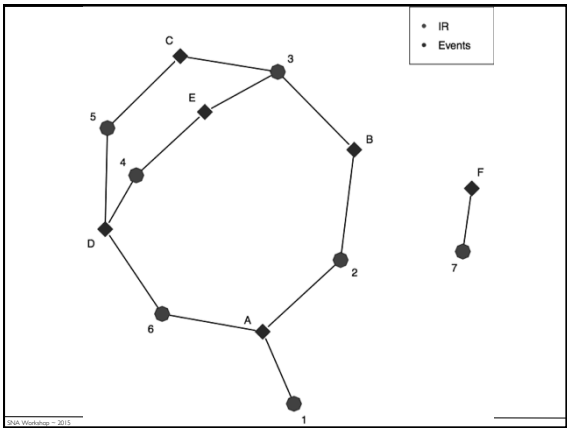

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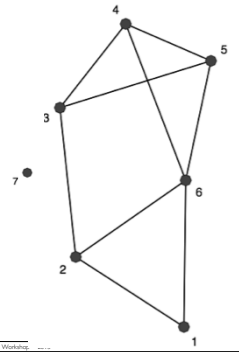
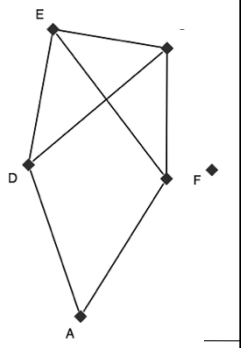
Person-by-Person



Event-by-Event



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attributes

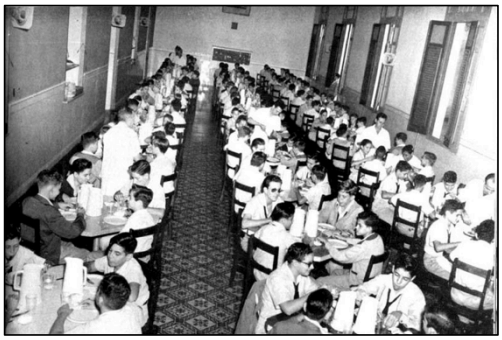
Attributes

sender	receiver
1	2
1	3
1	4
2	3
2	4
3	4
4	5
5	6
6	7
7	8
7	9
10	11
12	13
12	14

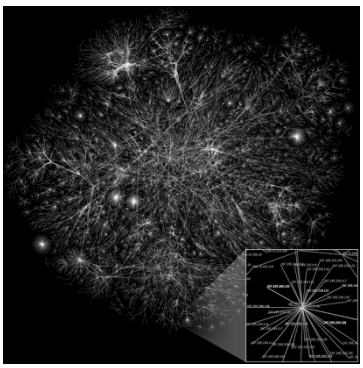
ID Number	Name	Sex	GPA
1	Joe	male	3.2
2	Sandy	female	3.5
3	Tom	male	2.5
4	Alicia	female	4
5	Andy	male	2.9
6	Don	male	3
7	Jen	female	3.1
8	Tina	female	3.5
9	Brad	male	2.8
10	Moreno	male	3
11	Joe	male	3.8
12	Hector	male	2.9
13	MJ	female	3
14	Joan	female	3

Where can you find relational data?

Observations



The Internet



Surveys

Please think about the relations between the people you just mentioned. Some of them may be total strangers in the sense that they wouldn't recognize each other if they bumped into each other on the street. Others may be especially close, as close or closer to each other as they are to you.

First, think about NAME 1 and NAME 2.
ASK CLOSE1 FOR FIRST PAIR.
A. Are _____ and _____ total strangers?

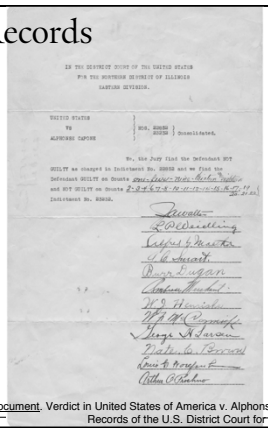
IF YES……(ASK NAME1, NAME2, NAME3, NAME4, NAME5 FOR NEXT PAIR DOWN)
IF NO……(ASK CLOSE12, CLOSE13, CLOSE14, CLOSE15, CLOSE 23, CLOSE24, CLOSE25, CLOSE34, CLOSE35, CLOSE45)

B. Are they especially close? PROBE: As close or closer to each other as they are to you?

IF YES……(ASK NAME1, NAME2, NAME3, NAME4, NAME5 FOR NEXT PAIR DOWN)
IF NO……(ASK NAME1, NAME2, NAME3, NAME4, NAME5 FOR NEXT PAIR DOWN)

PERSON	NAME1	NAME2	NAME3	NAME4	NAME5
NAME 2	A. YES…1 NO…2 B. YES…1 NO…2				
NAME 3	A. YES…1 NO…2 B. YES…1 NO…2	A. YES…1 NO…2 B. YES…1 NO…2			
NAME 4	A. YES…1 NO…2 **B. YES…1** NO…2	A. YES…1 NO…2 **B. YES…1** NO…2	A. YES…1 NO…2 **B. YES…1** NO…2		
NAME 5	A. YES…1 NO…2 B. YES…1 NO…2	A. YES…1 NO…2 B. YES…1 NO…2	A. YES…1 NO…2 B. YES…1 NO…2	A. YES…1 NO…2 B. YES…1 NO…2	

Archival Records


IN THE DISTRICT COURT OF THE UNITED STATES
FOR THE NORTHERN DISTRICT OF ILLINOIS
EASTERN DIVISION.

UNITED STATES
vs
ALPHONSE CAPONE
NOS. 22252 22253 Consolidated.

We, the Jury find the Defendant NOT GUILTY as charged in Indictment No. 22252 and we find the Defendant GUILTY on Counts [illegible] and NOT GUILTY on Counts [illegible] Indictment No. 22252.

National Archives Today's Document. Verdict in United States of America v. Alphonse Capone, October 17, 1931; Records of the U.S. District Court for the Northern District of Illinois

Firm Roster

Here is the list of all the members of your Firm.

Basic advice
"Think back over the past year, consider all the lawyers in your Firm. To whom did you go for basic professional advice? For instance, you want to make sure that you are handling a case right, making a proper decision, and you want to consult someone whose professional opinions are in general of great value to you. By advice I do not mean simply technical advice."

Friendship
"Would you go through this list, and check the names of those you socialize with outside work. You know their family, they know yours, for instance. I do not mean all the people you are simply on a friendly level with, or people you happen to meet at Firm functions."

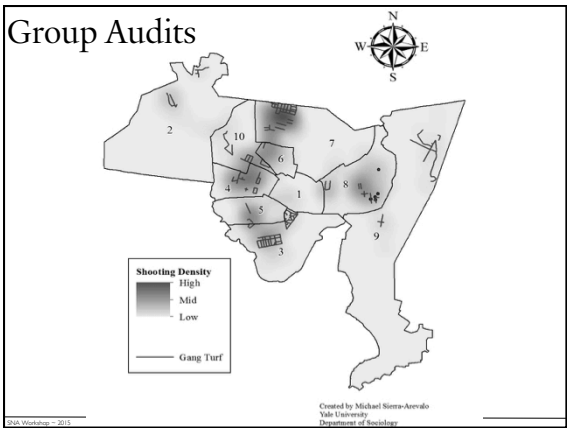
(Lazega & Pattison 1999:88)

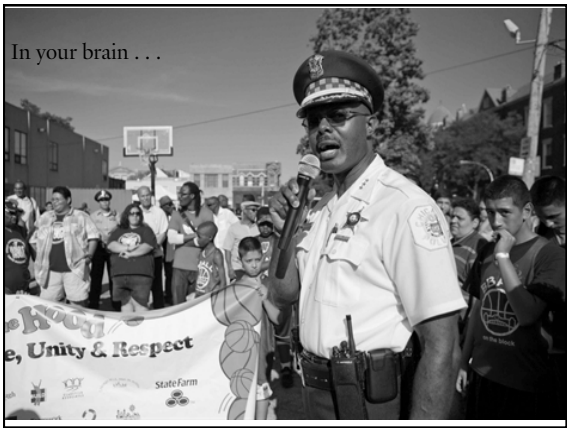
Official Records

Providence Police Department

Arrest Charge Statute Description	First Name	Last Name	Age	Arrest Date And Time	Arrestee City	Arrestee State	Case Number
Murder-1St Degree; Loitering For Indecent Purposes Prostitution - Prostitution; Failure To Appear/Answer Summons;	Jovani	Torres	31	10/12/2012 00:00:00	Providence	RI	2012-00050110
Loitering For Indecent Purposes Prostitution - Prostitution; Failure To Appear/Answer Summons;	Sandra	Rivera	48	10/12/2012 00:00:00	Providence	RI	2012-00098812
Failure To Appear/Answer Summons;	Lillian	Rivera	51	10/12/2012 00:00:00	Providence	RI	2012-00098812
Loitering For Indecent Purposes Prostitution - Prostitution;	Hye Min	Jung	37	10/12/2012 01:01:00	Whitestone	NY	2012-00099112
Assault W/ Intent To Commit A Felony - Minor Injury;	Francisco	Depina	20	10/12/2012 01:10:00	Providence	RI	2012-00099092
Resisting Legal Or Illegal Arrest; Disorderly Conduct;	Kyle	Mcneil	19	10/12/2012 01:19:00	Warwick	RI	2012-00099116
Loitering For Indecent Purposes Prostitution - Assist/Promot;	Mi Jang	Park	46	10/12/2012 01:48:00	Milford	MA	2012-00099109
Loitering For Indecent Purposes Prostitution - Assist/Promot;	Ji Yu	Jin	43	10/12/2012 01:49:00	Flushing	NY	2012-00099109

Providence Police Department Daily Arrest Log October 12, 2012


Group Audits
N
W
E
S
2
10
7
6
4
1
8
5
9
3
Shooting Density
High
Mid
Low
Gang Turf
Created by Michael Sierra-Arevalo
Yale University
Department of Sociology
SNA Workshop – 2015


In your brain . . .
Unity & Respect
StateFarm