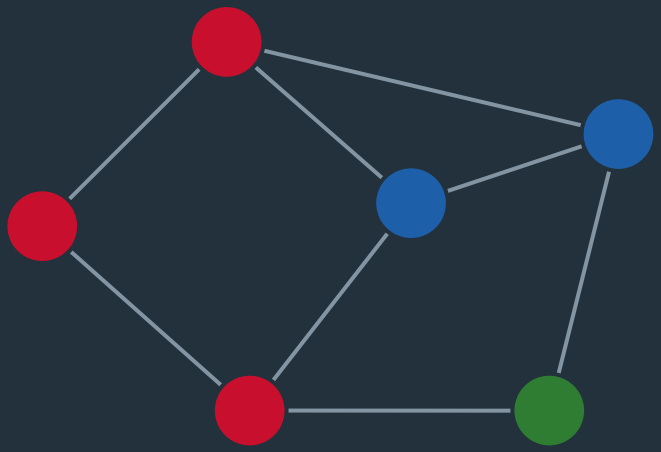
Positions and roles

Course A · Week 8

Chapter 10 of Network Analysis with Stata (Stata Press) · one lecture and one lab, about 90 minutes each

Instructors are free to use, adapt and share these slides.



Today: a lecture, a break and a lab

0:00	**1 Same position without a tie**	25 min
0:25	**2 Blocks from tie profiles**	35 min
1:00	**3 Hierarchies, regular classes and the core**	30 min
1:30	Break	10 min
1:40	**4 Lab: the office and the first blocks**	45 min
2:25	**5 Lab: the core, and who could replace n17**	45 min

Two doctors can influence each other without ever speaking

Contagion (Coleman)

Doctors who talked to many colleagues adopted tetracycline earlier. A doctor heard of the drug from a colleague and was persuaded.

Position (Burt 1987)

A doctor watches the colleagues in the same position, with the same contacts and the same reputation to defend. They need not talk at all.

Peter and Kevin

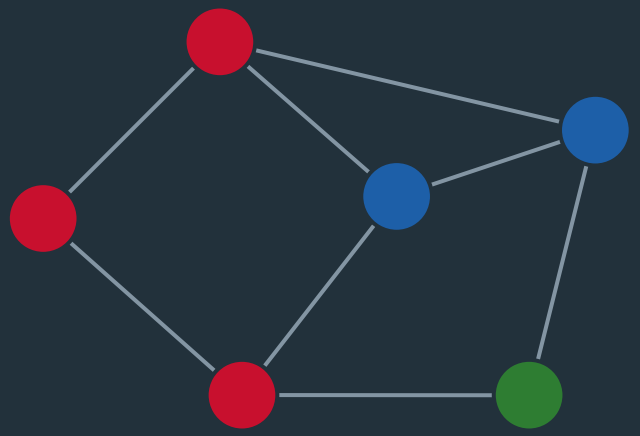
Two associates in different offices who never meet. Both ask the same three senior partners and are asked by few.

The question of the week: are the lawyers who occupy the same position in the advice network the lawyers who hold the same formal position?

1

Same position without a tie

25 min · Chapter 10: structural equivalence, a small office, Jaccard similarity, regular equivalence



Two actors are structurally equivalent if their ties to everyone else are identical

It says

Two actors have the same ties to every other actor. Either could replace the other without any third actor's tie pattern changing.

It does not say

That the two know each other: a tie between them does not count. Nor that they play the same role. Similar ties suggest a role; they do not establish one.

Position

A set of actors with similar ties to the others: what the chapter finds.

Role

A pattern of expected behavior and obligation. Similar ties suggest it; attributes and knowledge of the setting must establish it.

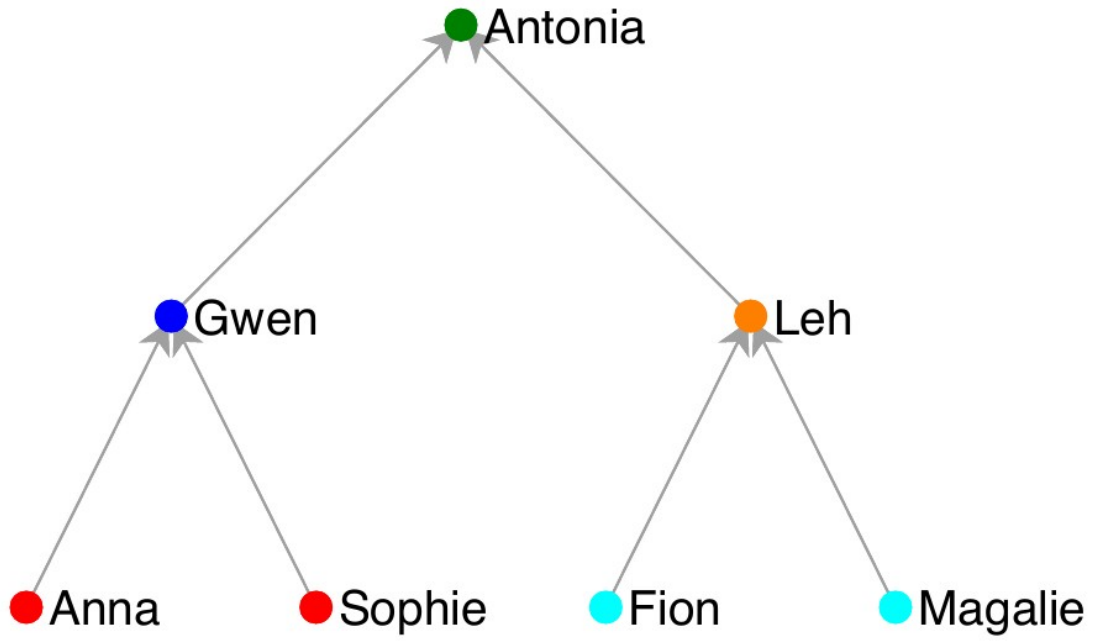
Each step from the definition to the data uses a different command

Step	What it establishes	Command
Similarity of tie profiles	how close two actors are to structurally equivalent	nwsimindex
Blocks	a grouping of actors with similar profiles	nwconcor, nwhierarchy
Blockmodel image	the ties within and between the blocks	nwcollapse, nwplotmatrix
Regular equivalence	the same kind of ties to the same kinds of others	nwregular
Core and periphery	one particular two-block pattern and its fit	nwcoreperiphery

A small office: who could replace whom?

```
. nwclear
. clear
. input str8 ego str8 alter
  1. "Anna" "Gwen"
  2. "Sophie" "Gwen"
  3. "Fion" "Leh"
  4. "Magalie" "Leh"
  5. "Gwen" "Antonia"
  6. "Leh" "Antonia"
  7. end
. nwset ego alter, edgelist directed name(firm)
```

Gwen and Leh both ask Antonia, but different people ask them: not structurally equivalent.



Colored by structural equivalence: only Anna and Sophie, and Fion and Magalie, have identical ties.

Arrows point from the person who asks to the person asked.

Jaccard similarity: shared contacts over all contacts

```
. nwsimindex firm, measure(jaccard) name(simfirm)
. nwsummarize simfirm, matonly
        1    2    3    4    5    6    7
  1 |   .
  2 |  .5    .
  3 |   0   .5    .
  4 |   0    0    0    .
  5 |   0    0    0   .2    .
  6 |   0   .5    1    0    0    .
  7 |   1   .5    0    0    0    0    .
```

1 Anna, 2 Antonia, 3 Fion, 4 Gwen, 5 Leh, 6 Magalie, 7 Sophie (alphabetical order).

Read the scale: 1 for identical contacts, 0 for none in common.

Anna and Sophie: 1

One shared contact (Gwen) out of one contact in all.

Gwen and Leh: .2

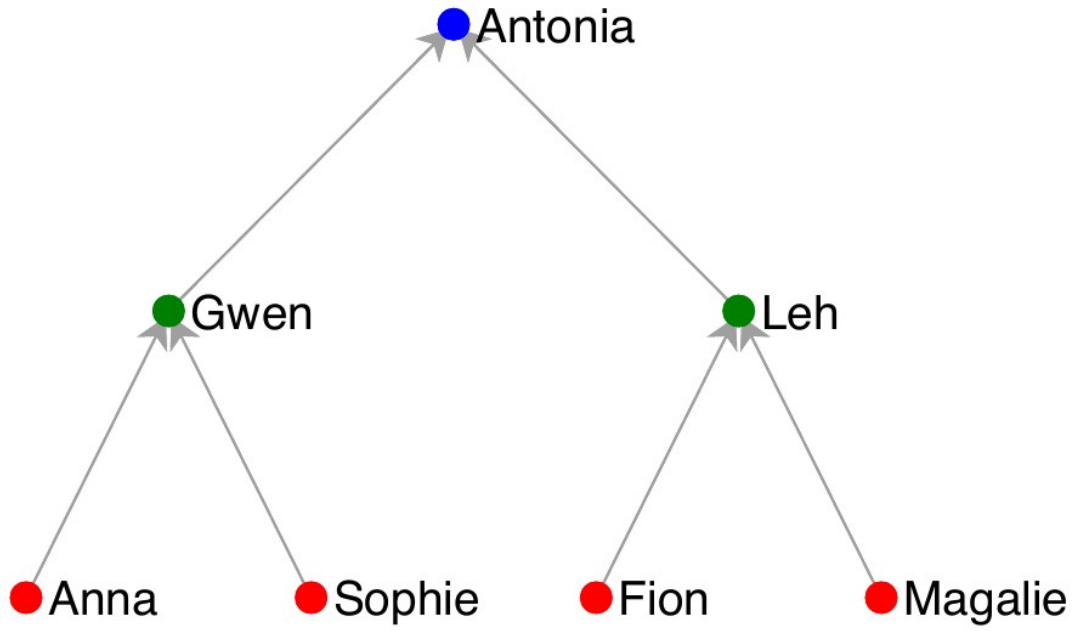
One shared contact (Antonia) out of five people in all.

The limit: Antonia and Anna, .5

Jaccard pools those asked and those who ask. Use nwdissimilar when direction matters.

Gwen and Leh do the same job, so they are regularly equivalent

```
. nwregular firm, generate(regular)
  Classes of regularly equivalent nodes: 3
. matrix list r(image)
        class1  class2  class3
class1       0       0       1
class2       0       0       0
class3       0       1       0
```



Colored by regular equivalence: the juniors, the two team leaders and the head.

Three classes, two kinds of tie

Juniors (class 1) ask the team leaders (class 3), who ask the head (class 2). Gwen and Leh share a class although different juniors ask them.

Same contacts is a stricter test than the same kind of contacts

Pair	Jaccard	Structurally equivalent	Regularly equivalent
Anna and Sophie	1	**yes**	**yes**
Gwen and Leh	.2	no	**yes**
Anna and Gwen	0	no	no

Structural: the same contacts

Strict, and exact equivalence is rare. Fits the claim that actors in one position face the same pressures.

Regular: the same kind of contacts

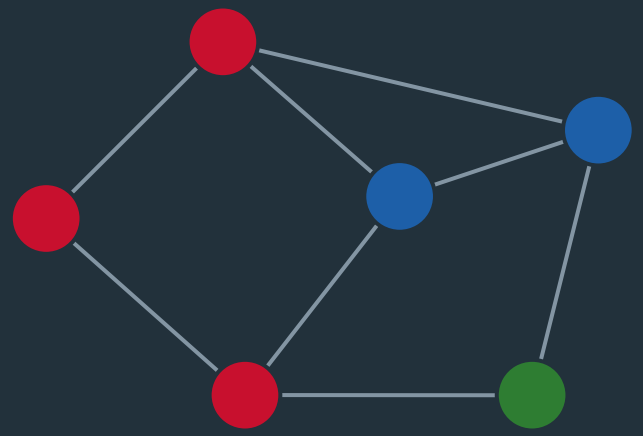
Looser and closer to a role. Fits hierarchies and food webs; on dense data it finds nothing (block 3).

A tie between two actors is not what is compared. Both ideas ask about everyone else.

2

Blocks from tie profiles

35 min · Chapter 10: Jaccard among the 71 lawyers, CONCOR, the image matrix



Among 2,485 lawyer pairs, none is structurally equivalent

```
. nwwebuse lazega, nwclear
. nwsimindex lazega_adv, measure(jaccard) name(simj)
. preserve
. quietly nwtoedge simj, egovars(partner practicenum) ///
>    altervars(partner practicenum)
. keep if _ego > _alter
. generate byte same_status = (partner_ego == partner_alter)
. generate byte same_practice = (practicenum_ego == practicenum_alter)
. summarize simj
        simj |      2,485    .1826882    .1058332          0    .6363636
```

.183

mean Jaccard of the 2,485 pairs

.636

the highest pair: none is equivalent

- **One row per pair**

  nwtoedge turns the similarity network into a list of pairs; keep if _ego > _alter keeps each pair once, and the indicators compare the two lawyers' attributes.

Pairs of the same status or practice are more similar, but only modestly

Pairs	Mean Jaccard	N
same status	.200	1,225
different status	.166	1,260
same practice	.211	1,255
different practice	.154	1,230

Top five pairs	Jaccard	Status
n53, n44	.636	both associates
n28, n14	.581	both partners
n35, n14	.552	both partners
n20, n12	.548	both partners
n41, n40	.538	both associates

- **Part of who has similar ties, not most**

  Differences of a third to a half of a standard deviation (.106): consistent in direction, modest in size.

- **The measure belongs in the report**

  By Adamic-Adar the most similar pairs are the most active lawyers instead.

CONCOR splits the firm into four blocks of 24, 23, 12 and 12

```
. nwconcor lazega_adv, splits(2) generate(block)
  Splits: 2   Blocks found: 4
      block |      Freq.     Percent
          1 |         24       33.80
          2 |         23       32.39
          3 |         12       16.90
          4 |         12       16.90
```

- **The number of blocks is chosen in advance**

  splits(2) means up to four blocks. CONCOR does not say whether four is right: try more than one value and report which.

24

block 1 (lawyers)

23

block 2 (lawyers)

12

block 3 (lawyers)

12

block 4 (lawyers)

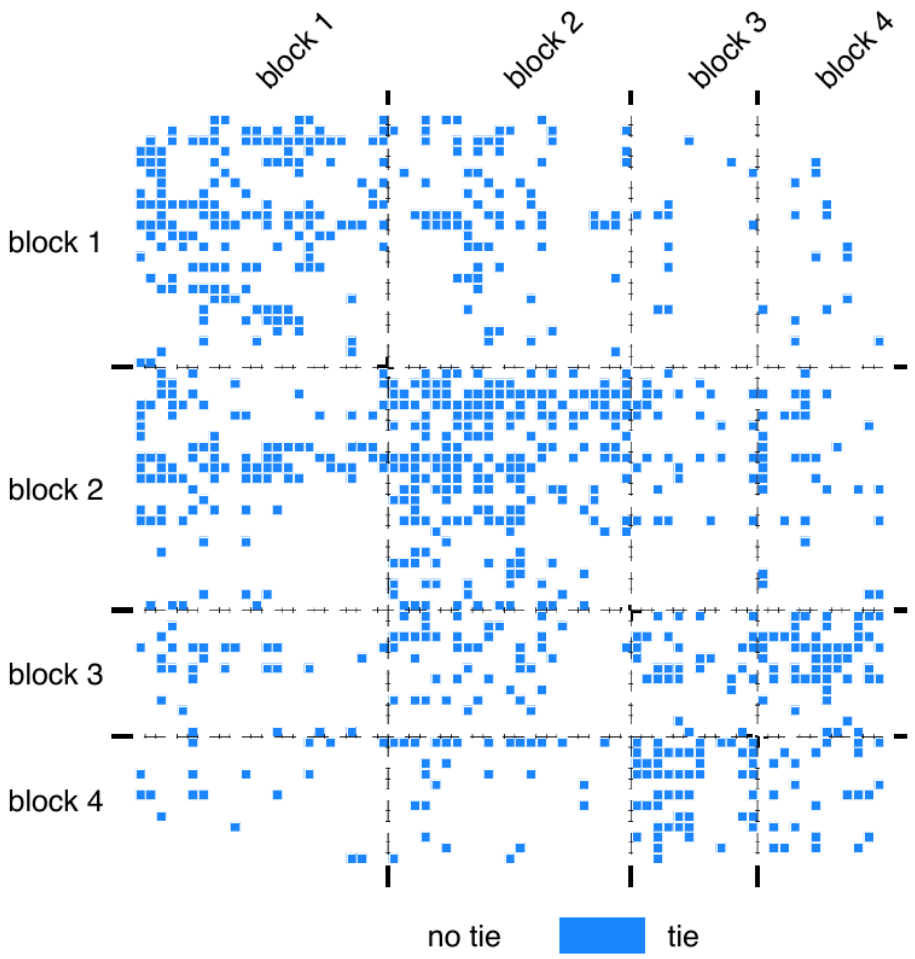
Two blocks follow practice and status; two do not

```
. tab block practice
. tab block status
```

block	n	corporate	litigation	associate	partner
1	24	1	**23**	**18**	6
2	23	**17**	6	7	**16**
3	12	6	6	4	8
4	12	6	6	6	6

Blocks 1 and 2 are practice-and-status positions. Blocks 3 and 4 are mixed in practice and in rank: the formal structure leaves a trace in the advice network, not the whole pattern.

The image matrix: the blocks 3 and 4 advise each other



nwplotmatrix lazega_adv, group(block)

from \ to	block 1	block 2	block 3	block 4
block 1	.281	.134	.042	.052
block 2	.179	**.401**	.109	.120
block 3	.097	.152	.227	**.361**
block 4	.059	.101	**.354**	.174

```
. quietly nwtoedge lazega_adv, egovars(block) ///
>    altervars(block)
. drop if _ego == _alter
. table block_ego block_alter, ///
>   statistic(mean lazega_adv) nformat(%5.3f)
```

Rows send advice, columns receive. Inside preserve … restore; the diagonal is not in the nwcollapse image.

A block is a position, not a clique

It says

Members of blocks 3 and 4 resemble the other members of their own block in whom they are tied to, and the two blocks are tied to each other more than to themselves.

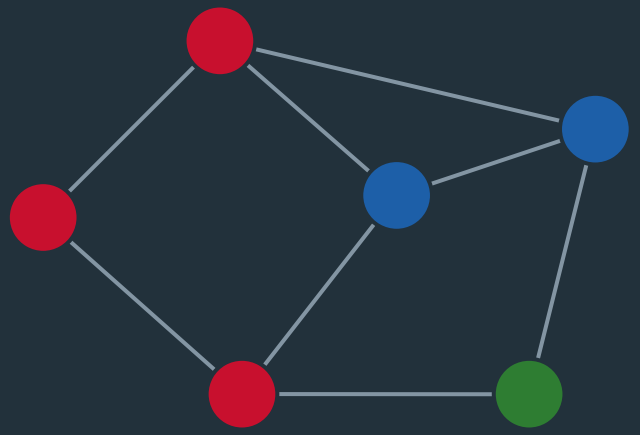
It does not say

That a block is a clique or a closely tied group. A block says nothing about ties among its own members, and a sparse inside is entirely compatible with structural equivalence.

3

Hierarchies, regular classes and the core

30 min · Chapter 10: nwhierarchy, nwdendrogram, nwregular, nwcoreperiphery, what can go wrong



Single linkage chains: 68 lawyers in one cluster

```
. nwhierarchy lazega_adv, groups(4) generate(role_single)
. tab role_single
role_single |      Freq.     Percent
          1 |         68       95.77
          2 |          1        1.41
          3 |          1        1.41
          4 |          1        1.41
```

68

lawyers in one cluster

3

singletons

- **The default linkage chains**

  Single linkage joins a cluster to its nearest single node. A tree always comes back, whether or not the actors fall into groups: set linkage() and look at the sizes of the groups before reading anything into them.

Ward linkage finds four groups, and they are partly formal

```
. nwhierarchy lazega_adv, groups(4) ///
>    linkage(wardslinkage) generate(role)
. tab role status
. tab role practice
. tab role office
```

Partly formal, partly not

Group 4: the juniors. Group 3: Hartford. Group 2: corporate partners. Group 1: Boston, mostly litigation partners.

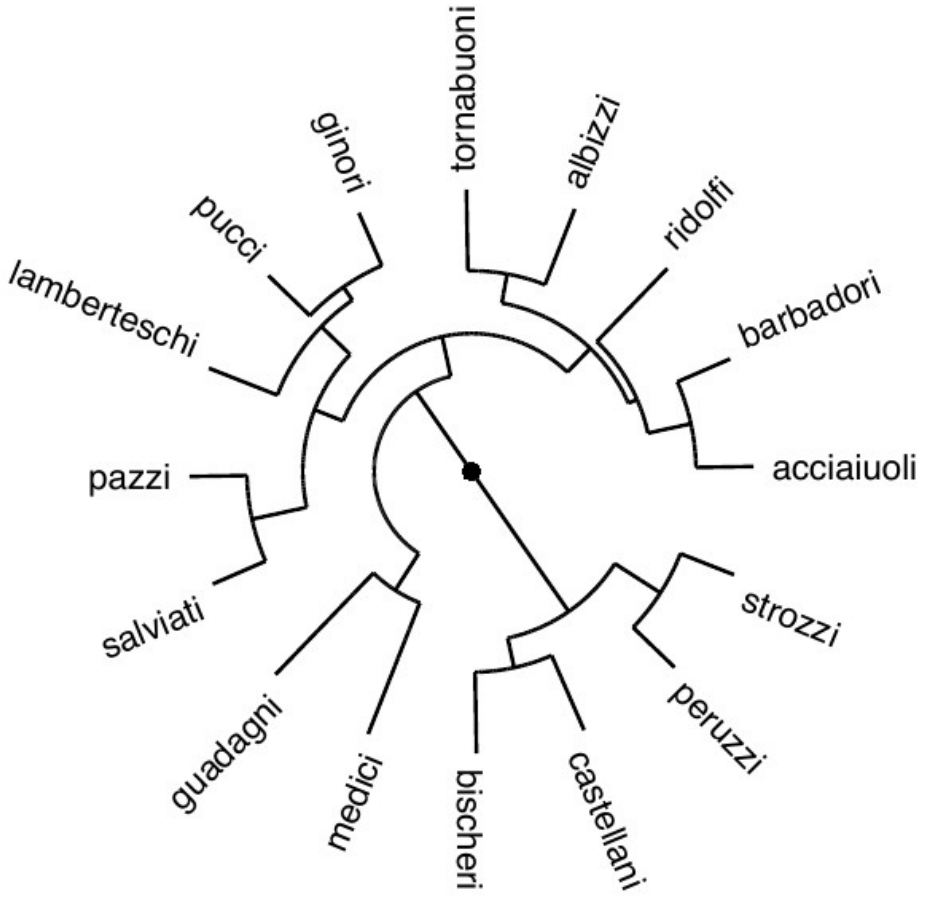
group	n	associate	partner	corporate	litigation	Boston	Hartford	Provid.
1	15	3	12	3	12	**15**	0	0
2	9	0	**9**	**9**	0	8	0	1
3	17	5	12	6	11	0	**17**	0
4	30	**27**	3	12	18	25	2	3

Counts from tab role status, practice and office (Chapter 10 listing). The comparison does not show that the formal structure causes the advice pattern.

The tree of the Florentine families, drawn as a wheel

```
. nwwebuse florentine, nwclear
. nwhierarchy flomarriage, linkage(wardslinkage)
cluster name: _clus_1
. nwdendrogram _clus_1, lab scheme(s1network)
. quietly nwwebuse lazega, nwclear
```

- Last merge: Strozzi, Peruzzi, Castellani and Bischeri, who marry among themselves, against everyone else.
- Next, the Medici (six marriages) and the Guadagni (four) split off.
- The rest: the Medici's in-laws, and the peripheral families.



Ward's linkage, marriage network of sixteen families (book, Figure 10.3).

Exact regular equivalence finds no roles in dense data

```
. nwregular lazega_adv, generate(regadv)
  Classes of regularly equivalent nodes: 1
. nwregular lazega_fr, generate(regfr) silent
. display r(classes)
71
```

1

class for all 71 lawyers in the advice network

71

classes in the friendship network

- **All or nothing on dense or noisy social data**

  Advice: every lawyer asks someone and is asked by someone, so nothing splits. Friendship: two lawyers name no friend, and that difference spreads until everyone is alone. Exact regular equivalence works where ties follow levels or kinds, as in a formal hierarchy or a food web.

A core of 18 lawyers, and a fit of .281

```
. nwcoreperiphery lazega_adv, generate(core)
  Core size: 18   Fitness: .281
. tab core status
       core | associate    partner
          0 |        33         20
          1 |         2         16
```

18
core lawyers

16
of them partners

.281
fitness

Mean	core	periphery
advice ties sent	24.3	8.6
advice ties received	16.7	11.2
seniority rank (lower: senior)	24.2	40.0
years in the firm	14.6	9.2

- **20 of 36 partners sit in the periphery**

  The core is more active and senior, but being a partner alone does not place a lawyer at the center. A fitness of .281 means the pattern fits the advice ties loosely.

Six things that go wrong with positions

Two-mode data

nwconcor and nwhierarchy stop with error 6088. Project first, or cluster the profiles of one mode.

Isolates

CONCOR rejects a node with no tie. Check after symmetrizing or subsetting, and report who was dropped.

The default linkage

Single linkage put 68 lawyers in one cluster. A tidy cluster variable comes back either way.

The image has no diagonal

Take within-block densities from the list of pairs, not from nwcollapse.

Pooled Jaccard

Antonia and Anna score .5. When direction matters, use nwdissimilar.

Exact regular classes on dense data

One class for all 71, or one class per lawyer, says nothing about roles.

What to take away from Chapter 10

Position, not tie

Structural equivalence asks who is similar to whom, tied or not. A different question from centrality or cohesion.

Report the choices

The similarity measure, the linkage rule and the number of splits belong in the report.

A block is not a group

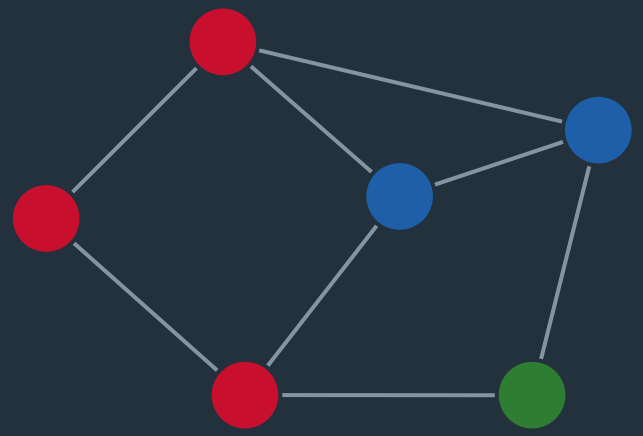
Blocks group substitutable positions. They can send more ties to each other than to themselves.

Position is not role

Similar tie profiles define a position. Whether occupants share a role is a further question.

Break

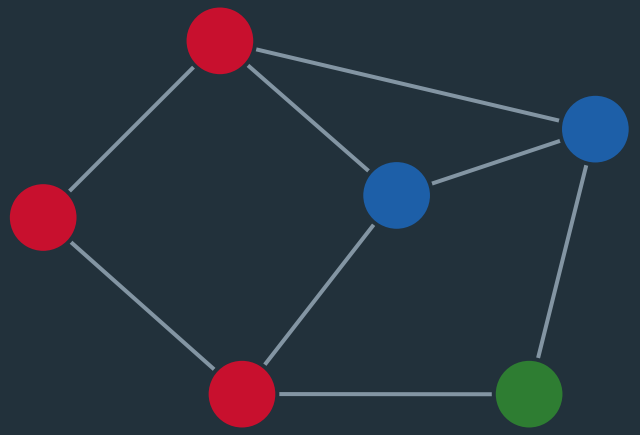
10 minutes



4

Lab: the office and the first blocks

45 min · Run along: the small office, Jaccard, regular classes, CONCOR; Ch. 10, Ex. 3 and 4



Run along 1: type the office and declare the network

```
. nwclear
. clear
. input str8 ego str8 alter
  1. "Anna" "Gwen"
  2. "Sophie" "Gwen"
  3. "Fion" "Leh"
  4. "Magalie" "Leh"
  5. "Gwen" "Antonia"
  6. "Leh" "Antonia"
  7. end
. nwset ego alter, edgelist directed name(firm)
```

Checkpoint	Value
nodes of firm	7
arcs of firm	6

A typo checker: every name is in double quotes, and end closes the input.

Start with nwclear: networks from earlier work (the lawyers) stay in memory otherwise.

Run along 2: similarity and regular classes of the office

```
. nwsimindex firm, measure(jaccard) name(simfirm)
. nwsummarize simfirm, matonly
. nwregular firm, generate(regular)
. list _nwnode regular, noobs sep(0)
. matrix list r(image)
```

Predict first. How many classes will nwregular find?

Say in one sentence why Antonia and Anna score .5 although their positions are not alike.

Checkpoint	Value
Jaccard, Sophie and Anna	1
Jaccard, Gwen and Leh	.2
Jaccard, Antonia and a junior	.5
classes from nwregular	3 (sizes 4, 1, 2)

Run along 3: the lawyers' similarity and the CONCOR blocks

```
. nwwebuse lazega, nwclear
. nwsimindex lazega_adv, measure(jaccard) name(simj)
. nwconcor lazega_adv, splits(2) generate(block)
. tab block practice
. tab block status
. list _nwnode block in 1/5, clean noobs
```

Checkpoint	Value
block sizes	24, 23, 12, 12
block 1: litigation, associates	23, 18
block 2: corporate, partners	17, 16

Look at the two mixed blocks. Blocks 3 and 4 have 6 corporate and 6 litigation lawyers each.

'variable block already defined' means a second run: drop block or start again at nwwebuse.

Hands-on (20 min)

Ch. 10, Ex. 3

In an undirected network the ties are A-C, B-C, C-D and D-E. Which pairs of nodes are structurally equivalent? Is C structurally equivalent to D?

Hint Write down the neighbors of every node. To compare two nodes, drop each of them from the other's list, since a tie between the two does not count, and see whether the remaining lists are identical.

Ch. 10, Ex. 4

Split the lawyers into two positions in two ways: with nwhierarchy on lazega_adv using Ward linkage and groups(2), and with nwconcor using splits(1). Tabulate each two-group variable against status, practice and office. Which attribute does each method's first division follow, and how far do the two divisions agree?

Hint nwhierarchy lazega_adv, groups(2) linkage(wardslinkage) generate(role2) and nwconcor lazega_adv, splits(1) generate(b1); then tab role2 office, tab b1 office and the same for the other attributes, and tab role2 b1.

Debrief Ex. 3: A and B are equivalent, C and D are not

Node	Neighbors
A	C
B	C
C	A, B, D
D	C, E
E	D

Check in Stata: Jaccard of A and B is 1, of C and D is 0.

Pair	Lists without each other	Equivalent?
A and B	{C} and {C}	**yes**
C and D	{A, B} and {E}	no
A and E	{C} and {D}	no

- **Neighbors can differ and still be tied**

  C and D are tied to each other and are not equivalent. A and B are not tied and are equivalent. A tie between the two does not count.

Debrief Ex. 4: Ward splits by status, CONCOR splits by office

Two groups by …	n	associate	partner	Boston	Hartford	Provid.
Ward, group 1	24	3	21	23	0	1
Ward, group 2	47	32	15	25	19	3
CONCOR, block 1	47	25	22	47	0	0
CONCOR, block 2	24	10	14	1	19	4

tab role2 b1	CONCOR 1	CONCOR 2
Ward 1	23	1
Ward 2	24	23

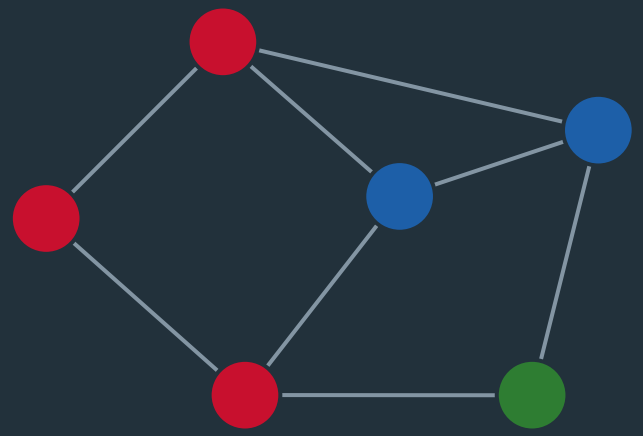
Different questions, same profiles

Ward's first division follows status, CONCOR's follows office. Neither follows practice. The two divisions overlap only partly.

5

Lab: the core, and who could replace n17

45 min · Run along: Ward, single linkage, the core; Ch. 10, Ex. 7 and 8



Run along 4: Ward, single linkage and the core

```
. nwwebuse lazega, nwclear
. nwhierarchy lazega_adv, groups(4) generate(role_single)
. nwhierarchy lazega_adv, groups(4) ///
>    linkage(wardslinkage) generate(role)
. tab role_single
. tab role status
. nwcoreperiphery lazega_adv, generate(core)
. nwdegree lazega_adv, generate(adv_out adv_in) silent
. tab core status
```

Checkpoint	Value
single linkage, group sizes	68, 1, 1, 1
Ward, group sizes	15, 9, 17, 30
core size, fitness	18, .281
core: associates, partners	2, 16

Predict first. Will the 18 core lawyers be the 18 lawyers with the most advice ties? Exercise 7 checks.

Hands-on (25 min)

Ch. 10, Ex. 7

The core of nwcoreperiphery could be no more than a list of the busiest lawyers. Check this rival reading. Compute each lawyer's total number of advice ties (out-degree plus in-degree), mark the 18 lawyers with the highest totals, and cross-tabulate this marker with the core variable. How many of the 18 core lawyers are among the 18 busiest, and what does that imply for reading the core as a position?

Hint adv_out and adv_in are in the data from the core section (in a fresh session, create them with nwdegree lazega_adv, generate(adv_out adv_in)); then generate tot = adv_out + adv_in, gsort -tot, generate top18 = _n <= 18 and tab top18 core.

Ch. 10, Ex. 8

The firm wants to know which lawyers could take over lawyer n17's advisory role if n17 left (n17 is the most sought lawyer of Chapter 8). Say why a measure of tie-profile similarity answers this question better than in-degree or membership in a densely tied group. Then use the Jaccard similarities to list the three lawyers most similar to n17, with their status, office and practice.

Hint After nwsimindex lazega_adv, measure(jaccard) name(simj), use nwtoedge simj, egovars(status office practice) altervars(status office practice) inside preserve and restore. Keep the rows with (_ego == "n17" | _alter == "n17") & _ego != _alter, sort by -simj and read the other lawyer's attributes from the _ego or _alter columns.

Debrief Ex. 7: the core is largely the busiest lawyers

tab top18 core	periphery	core	Total
not among the 18 busiest	50	3	53
among the 18 busiest	3	15	18
Total	53	18	71

- **Three exceptions on each side**

  Core, but not among the busiest: n10, n33 and n35. Busiest, but not core: n28, n2 and n20. All six are partners.

15 of 18

core lawyers who are among the 18 busiest

It says

Most of the core is the busiest lawyers: the position adds little to a count of ties.

It does not say

That busy lawyers are the core because they are busy, or the reverse: both describe the same ties.

Debrief Ex. 8: n4, n16 and n15 could take over

Most similar to n17	Jaccard	Status	Office	Practice
n4	.535	partner	Boston	corporate
n16	.489	partner	Boston	corporate
n15	.457	partner	Providence	corporate
n17 itself		partner	Boston	corporate

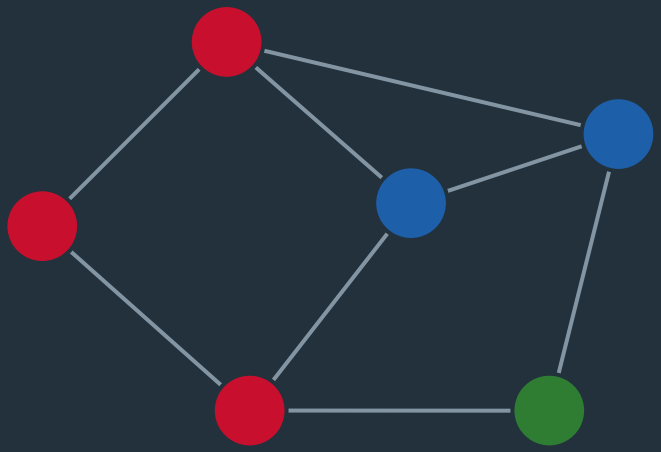
Why not in-degree?

In-degree counts how often n17 is asked. A replacement is someone with the same contacts: whom they ask and who asks them.

Similar profile, not same skill

The score says who sits in n17's position. It does not say who has n17's competence. n15 is in another office.

To read after the session



Before next week: read Chapter 11 (Ego networks)

Left over from Chapter 10: Ex. 1 and 2 (the clerks; n24 in the blocks and the core), Ex. 5 and 6 (Florentine chaining; friendship blocks), Ex. 9 (a third team in the office) and Ex. 10

Start Stata, run nwwebuse lazega, nwclear and nwdegree lazega_adv, generate(adv_out adv_in) silent

Do-files and teaching material: nwcommands.org/book

Instructors are free to use, adapt and share these slides.