Bipartite Networks

Structural Analyses

M.K. Lau (Harvard Forest, Harvard University)

Bipartite Networks

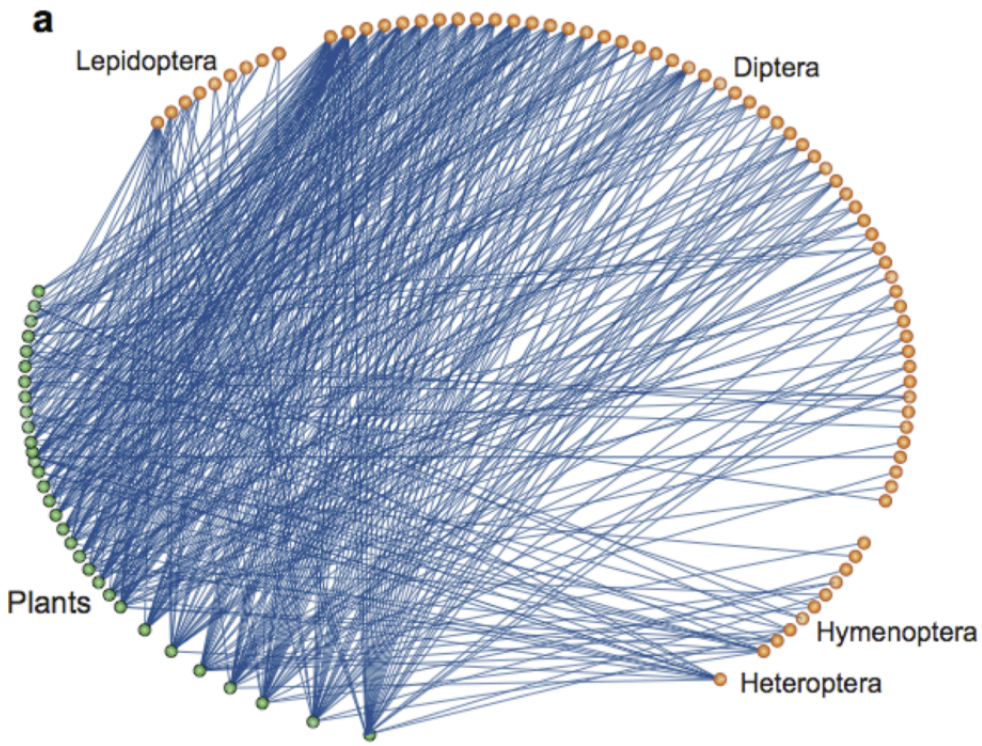
- What are they?
- What are they good for?
- How do I use them?

Bipartite Networks: What are they?

Definition: a network in which has two sets of nodes with edges between and not within sets.

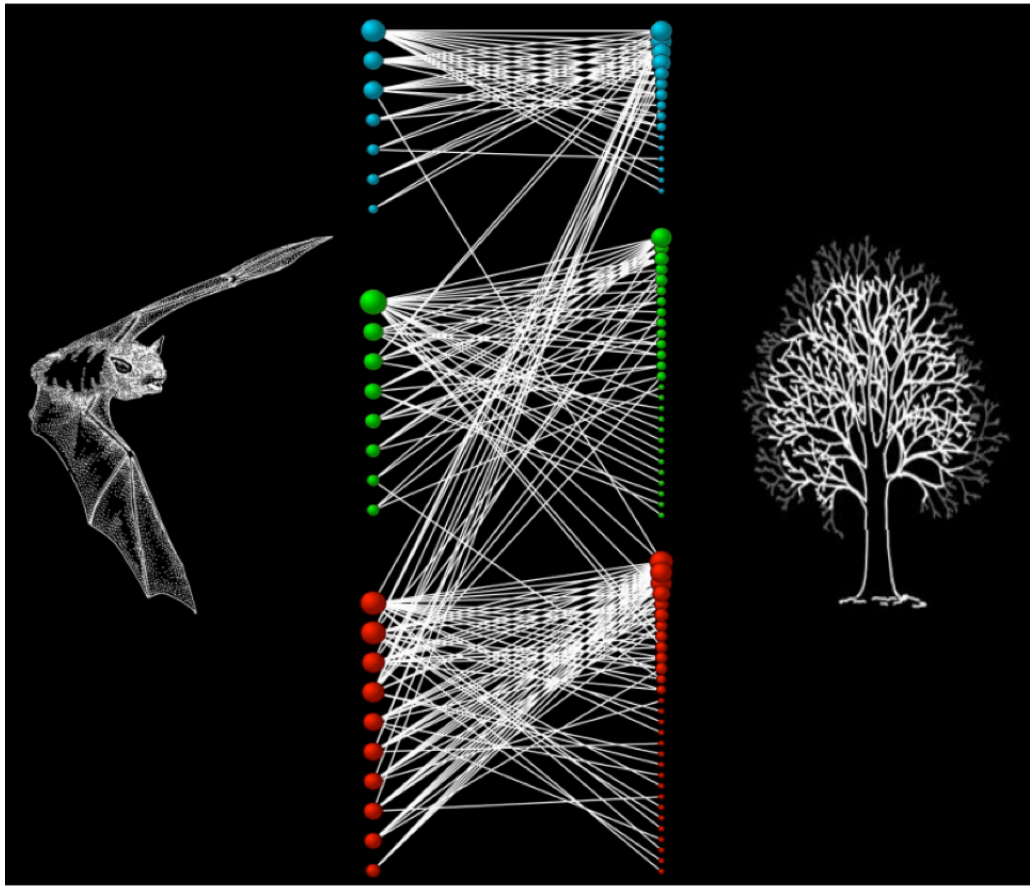
Bipartite Networks: What are they?

Bipartite Networks: What are they?

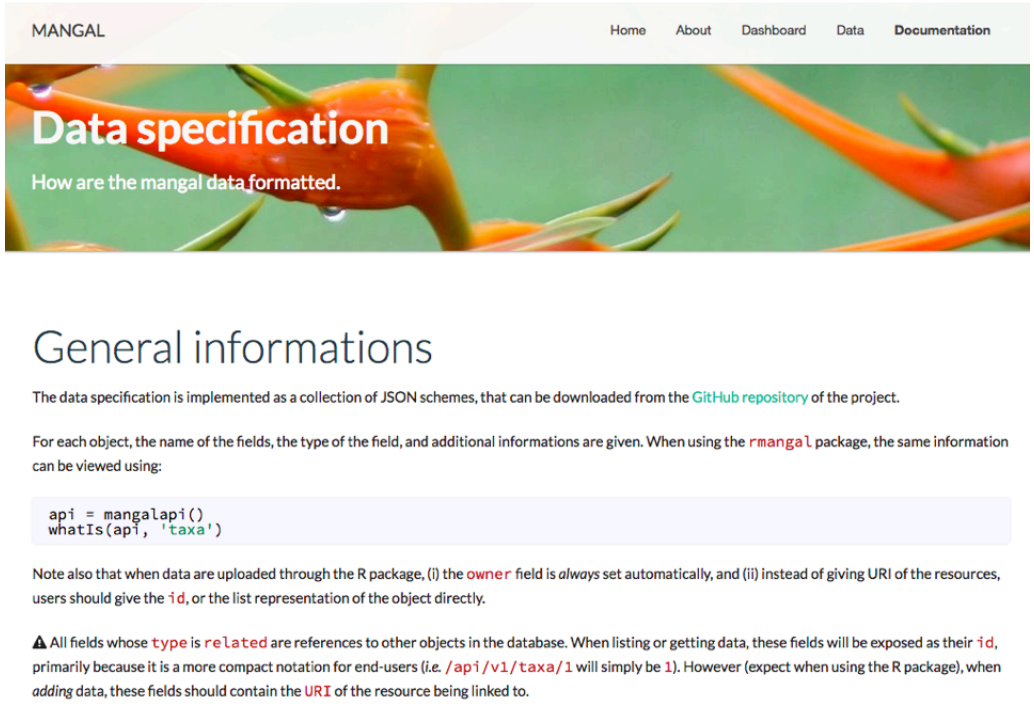


Bipartite Networks: What are they?

Bipartite Networks: What are they?



mangal

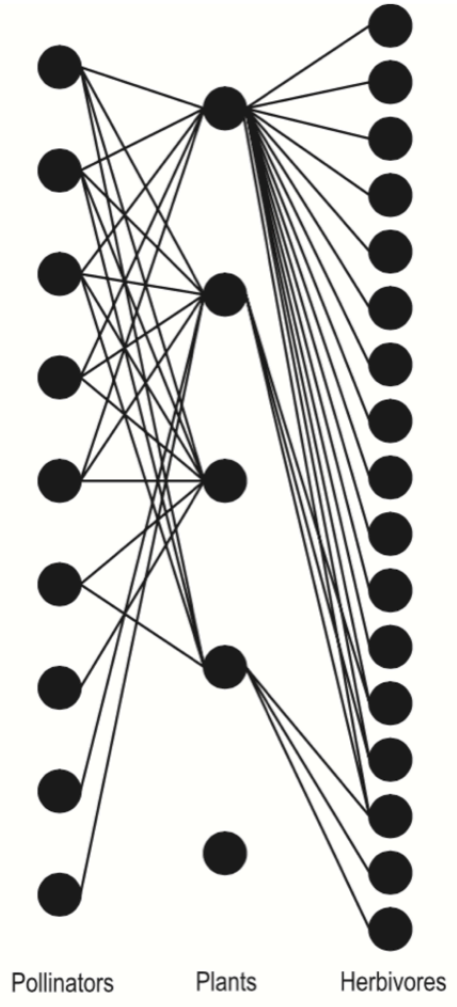


http://mangal.uqar.ca/doc/spec/

Bipartite Networks: What are they good for?

- Simplification (= ignore interactions within sets)
- Stability Theory
- Limitations

Bipartite Networks: Limitations



Bipartite Networks: How do I use them?

Can you represent your network as two distinct sets?

Bipartite Networks: How do I use them?

"Hello, R!"

- Open-source
- Free!
- "Easy/Lazy" programming language

"Hello, R!"

- Packages
- CRAN
- GitHub

"Hello, R!"

```
2+2
```

```
## [1] 4
```

"Hello, R!"

```
four = 2 + 2
```

"Hello, R!"

```
four = 2 + 2

print(four)
```

```
## [1] 4
```

"Hello, bipartite!"

```
library(bipartite)
```

bipartite: models

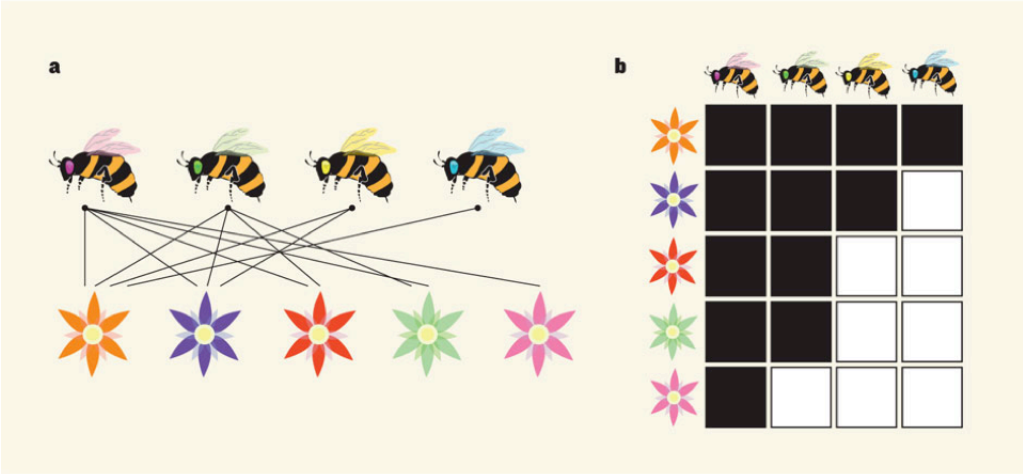
Import/Load models using read.csv

people.fas.harvard.edu/~matthewklau/bipmodel.csv

bipartite: models

```
our.binet <- read.csv('../data/bipmodel.csv')
```

bipartite: nestedness



bipartite: nestedness

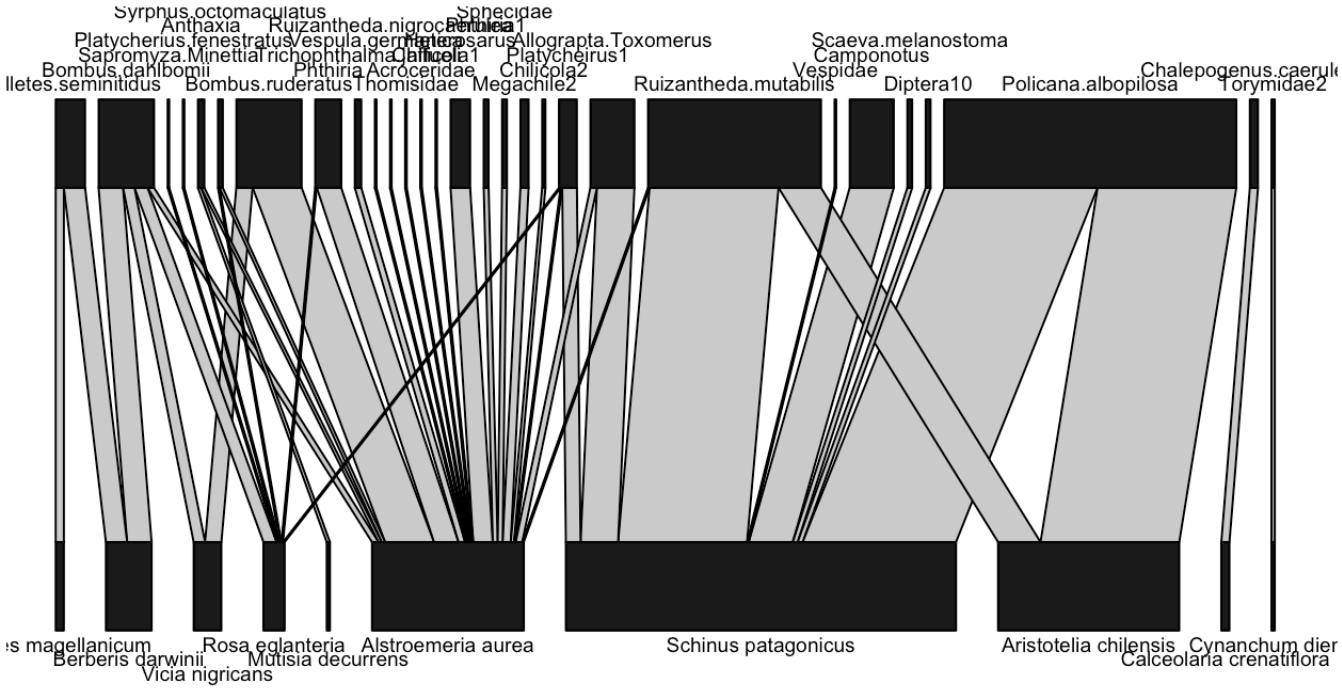
```
binet.nest <- nestedness(our.binet,null.models=FALSE)
names(binet.nest)
binet.nest$temperature
```

bipartite: nestedness

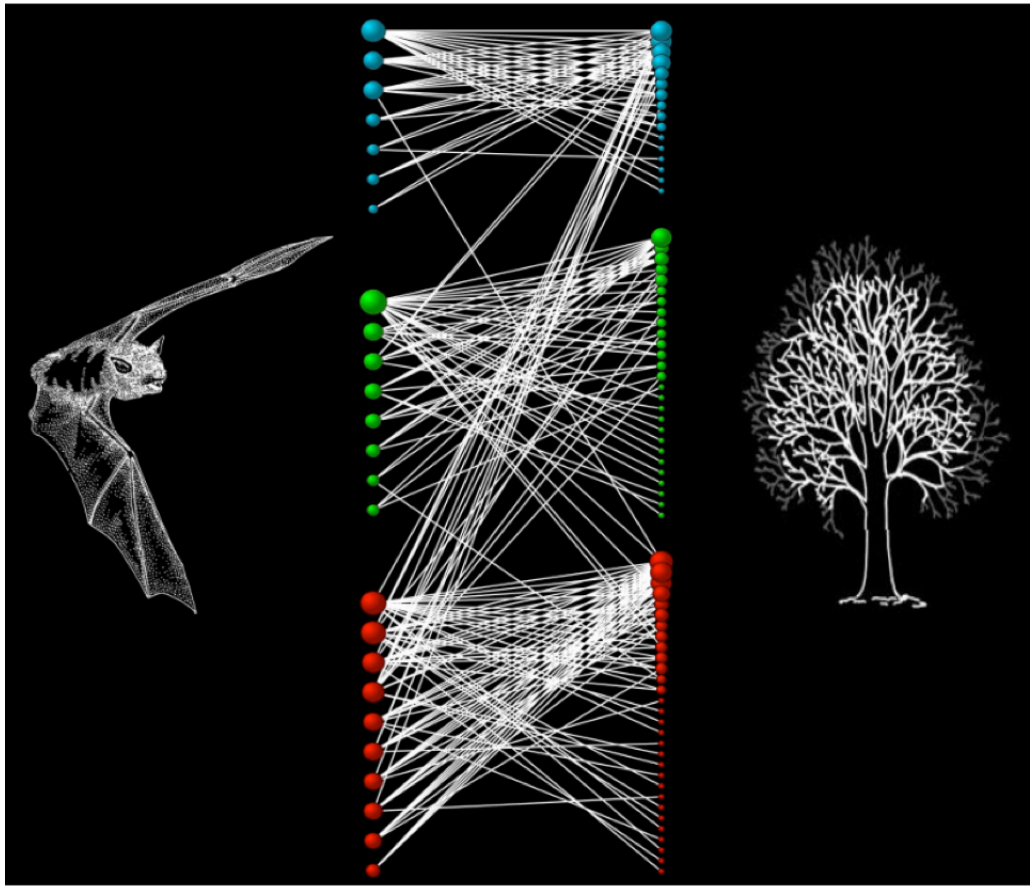
```
binet.nest <- nestedness(our.binet,null.models=TRUE,n.nulls=10)
```

bipartite: nestedness

```
plotweb(our.binet)
```



bipartite: modularity



bipartite: modularity

```
binet.mods <- computeModules(our.binet)
```

```
binet.mods
```

```
plotModuleWeb(binet.mods)
```

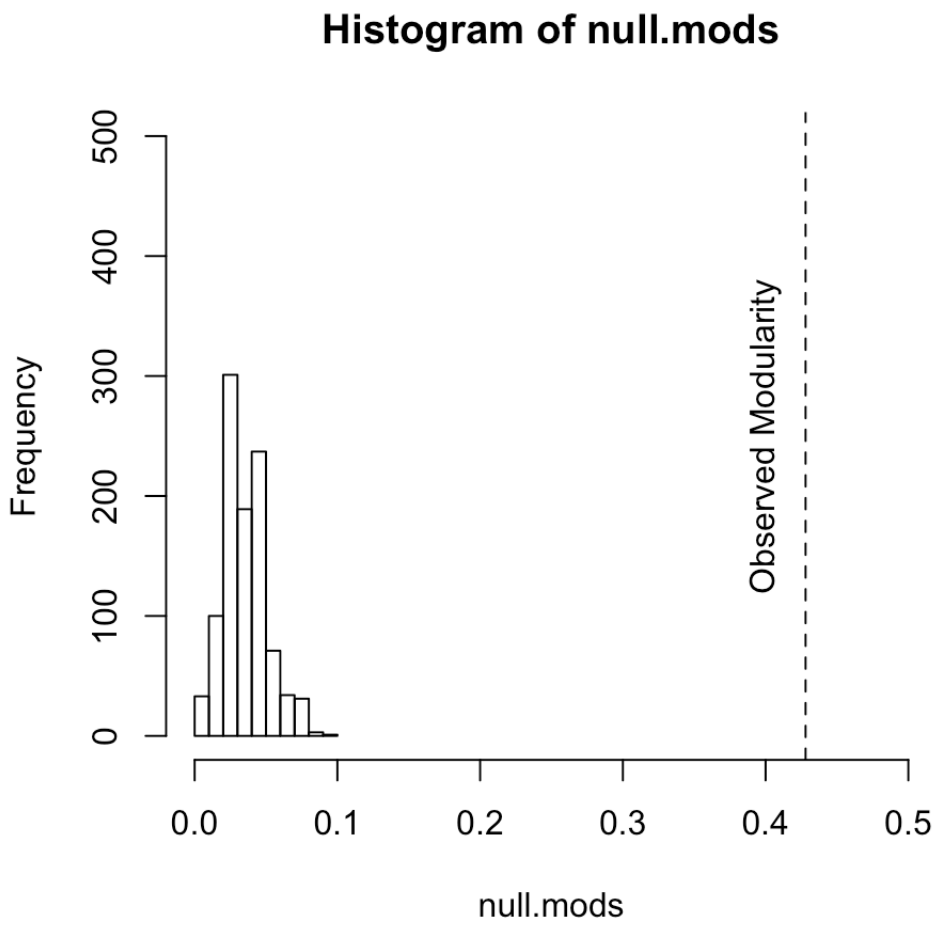
bipartite: modularity

```
null.nets <- nullmodel(our.binet, N=1000, method="r2d")

null.mods <- lapply(null.nets,computeModules)

null.mods <- lapply(null.mods,slot,name='likelihood')
```

bipartite: modularity



bipartite: modularity

Caclulate z-value and p-value for right-tailed test:

```
obs.mods <- slot(obs.mods,name='likelihood')
```

```
null.mods <- unlist(null.mods)
```

```
z.val <- (obs.mods - mean(null.mods)) / sd(null.mods)
z.val
```

```
## [1] 24.52201
```

```
p.val <- length(null.mods[null.mods >= obs.mods]) / length(null.mods)
p.val
```

```
## [1] 0
```

What does it all mean?

- Structural analysis with dynamic implications
- Nestedness minimizes competition and facilitates diversity
- Modularity stabilizes through compartmentalization

What does it all mean?

Bascompte J. and Jordano P. 2014. Mutualistic networks. Prineton University Press.

Fortuna M.A. et al. 2010. Nestedness versus modularity in ecological networks: two sides of the same coin?. J. Anim. Ecol., 7:811-817.

Gotelli N.J. and Ellison A.M. 2013. Primer of Ecological Statistics. Sinauer Associates, Inc.

Bluthgen N. et al. 2008. What do interaction network metrics tell us about specialization and biological traits?. Ecology, 89: 3387-3399.

Fontaine et al. 2011. Stability of ecological communities and the architecture of mutualistic and trophic networks. Ecol. Lett., 14: 1170-1181.

Connect: The R network world

Other Network Packages

- *sna*
- *network*
- *statnet*
- *igraph*
- *Rgraphviz*
- *vegan*

Connect: enaR to EcoNet

This function will right a network class model to a text file formatted for *EcoNet*.

```
data(oyster)
write.EcoNet(oyster,file='./oyster.txt',mn='ena_model_oyster')
```