What do you see?

Interactions

Interactions

cow eats grass

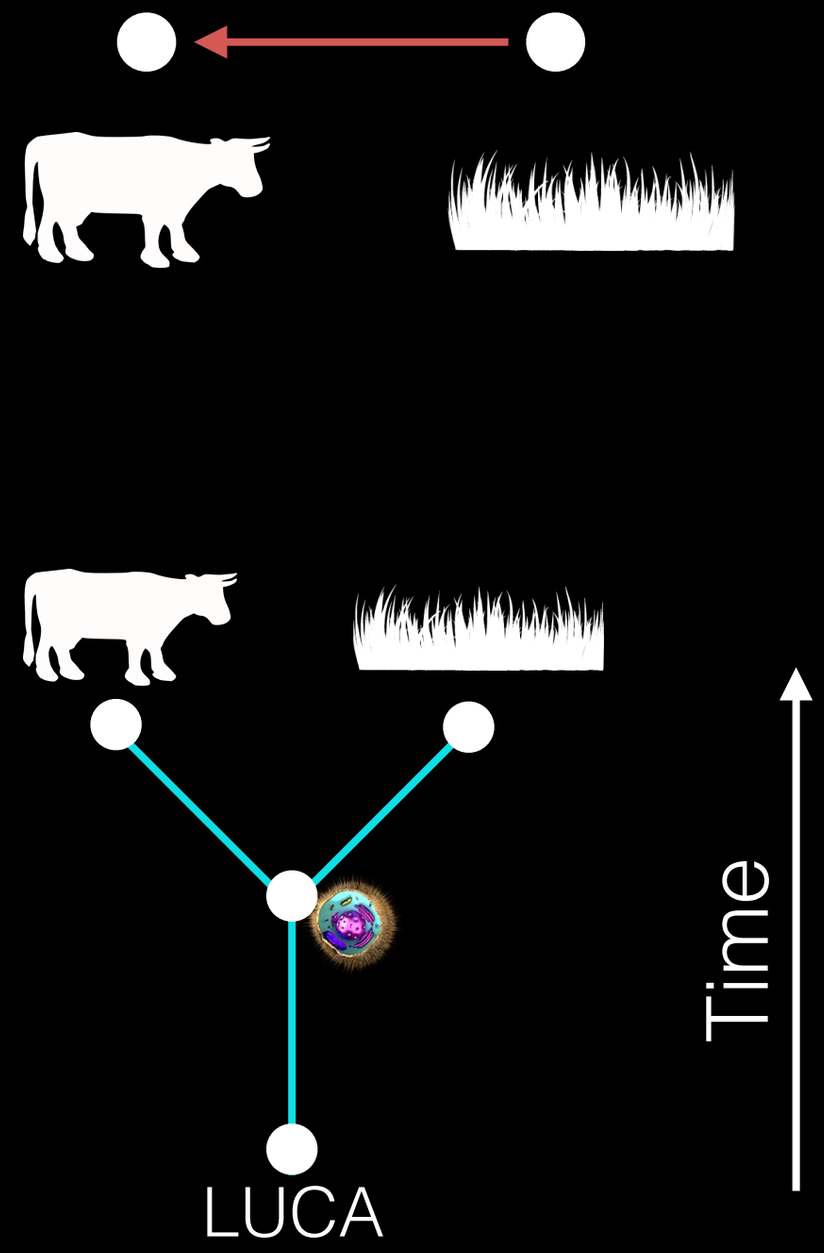
(co)Evolution

(co)Evolution

cow’s stomach digest grass

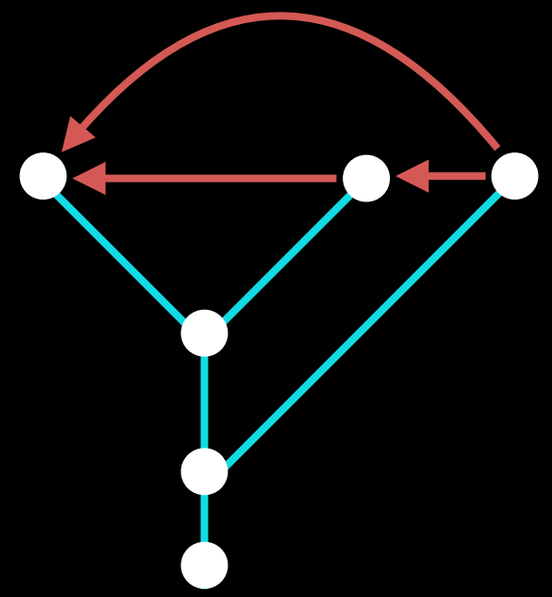
How do you write it?

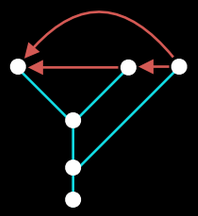
(if you are a mathematician)


LUCA
Time

the Web and the Tree

on the interplay between ecological processes and evolutionary histories





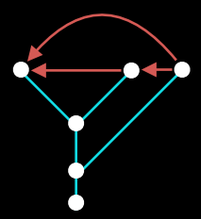
the Web and the Tree

on the interplay between ecological processes and evolutionary histories

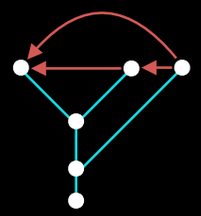
Giulio Valentino Dalla Riva

Supervisors:
Mike Steel
Charles Semple
Daniel Stouffer

University of Canterbury 31 March 2016



1. Random Dot Product Graphs (Chap. 4)
2. Centrality & Uniqueness (Chaps. 5 & 7)
3. Niche Evolution and Diversity (Chap. 6)



RDPG

RDPG

OIKOS

SYNTHESISING ECOLOGY

Research

Exploring the evolutionary signature of food webs' backbones using functional traits

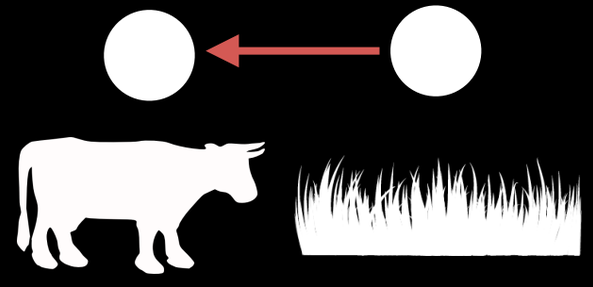
Giulio V. Dalla Riva[1] and Daniel B. Stouffer

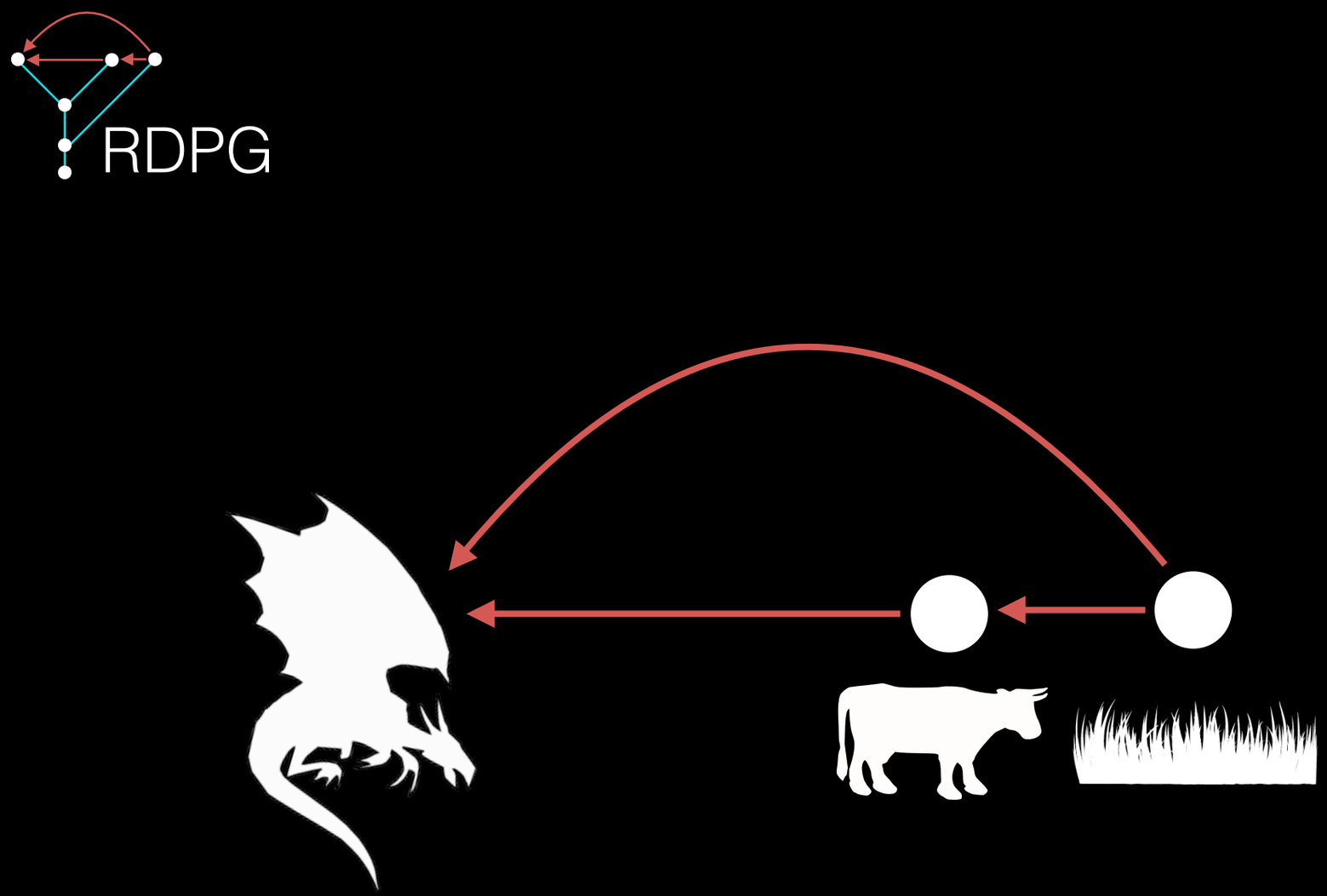
Issue

Did evolution leave a trace
in the structure
of ecological networks?

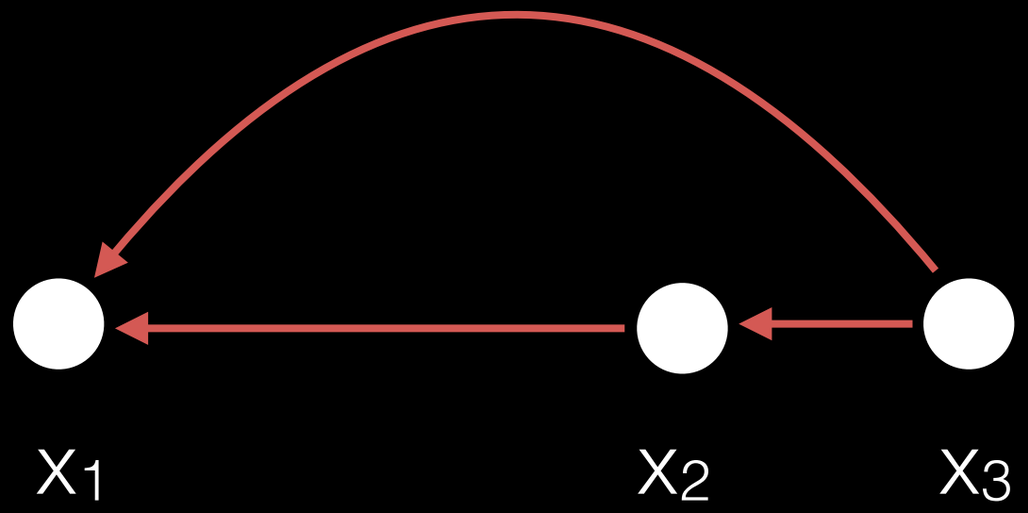
How do we do phylogenetic comparative analysis with food webs?


RDPG




RDPG

RDPG



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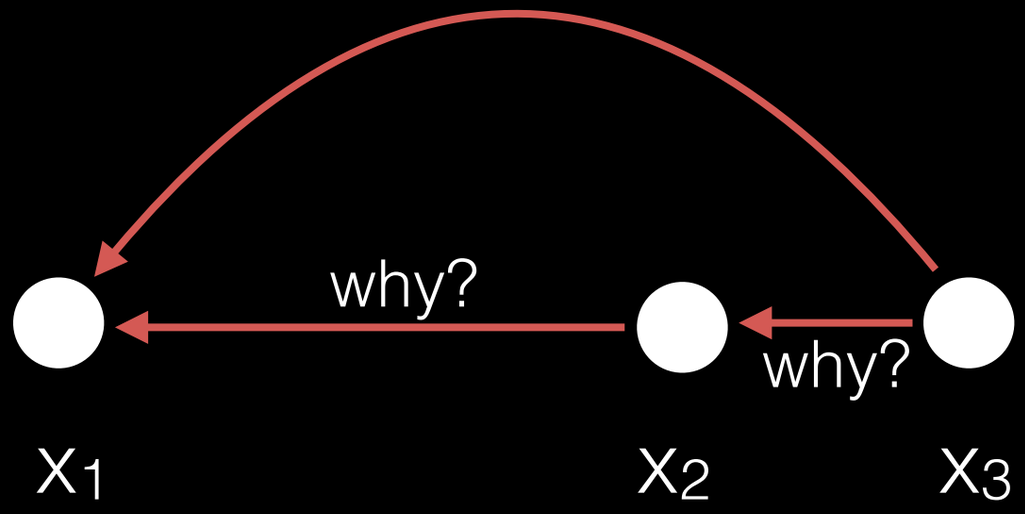
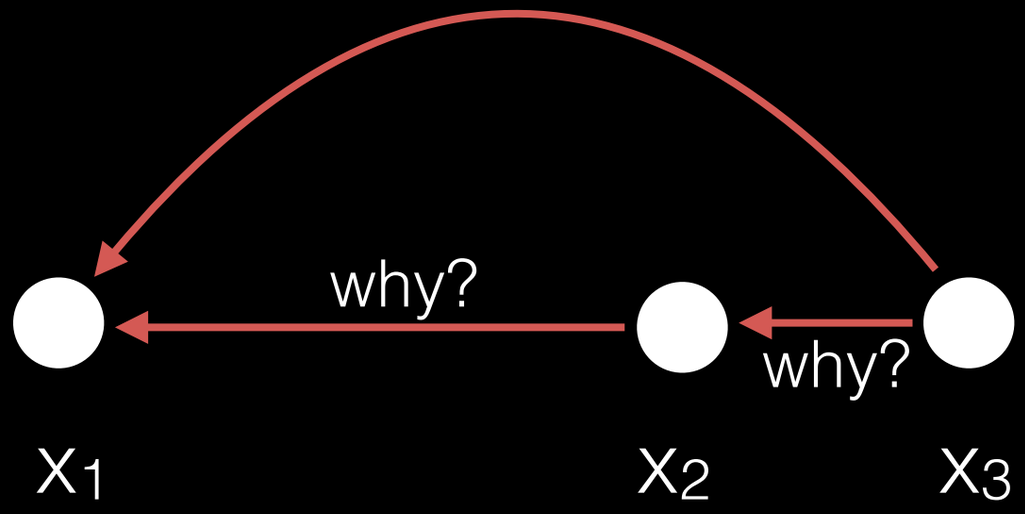
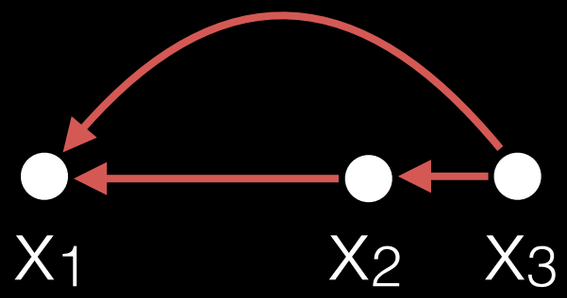
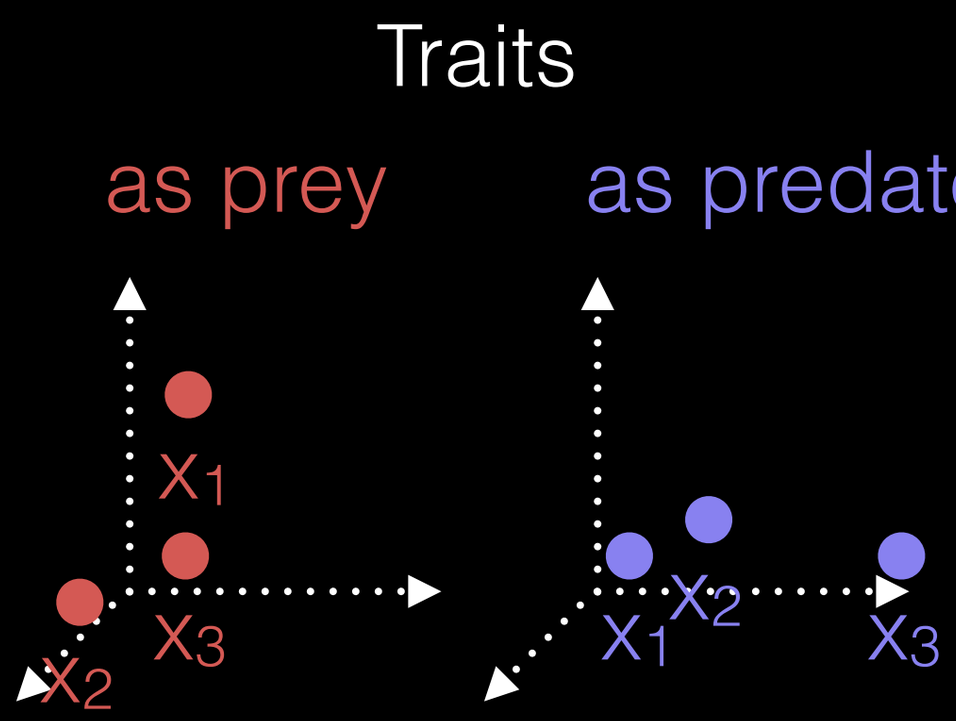


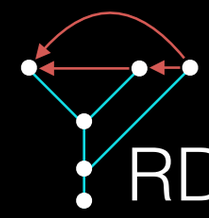


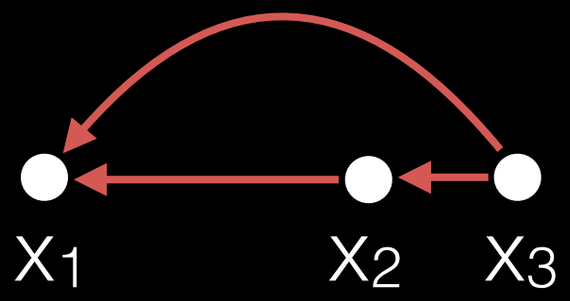
Because *TRAITS*


RDPG


X1
X2
X3

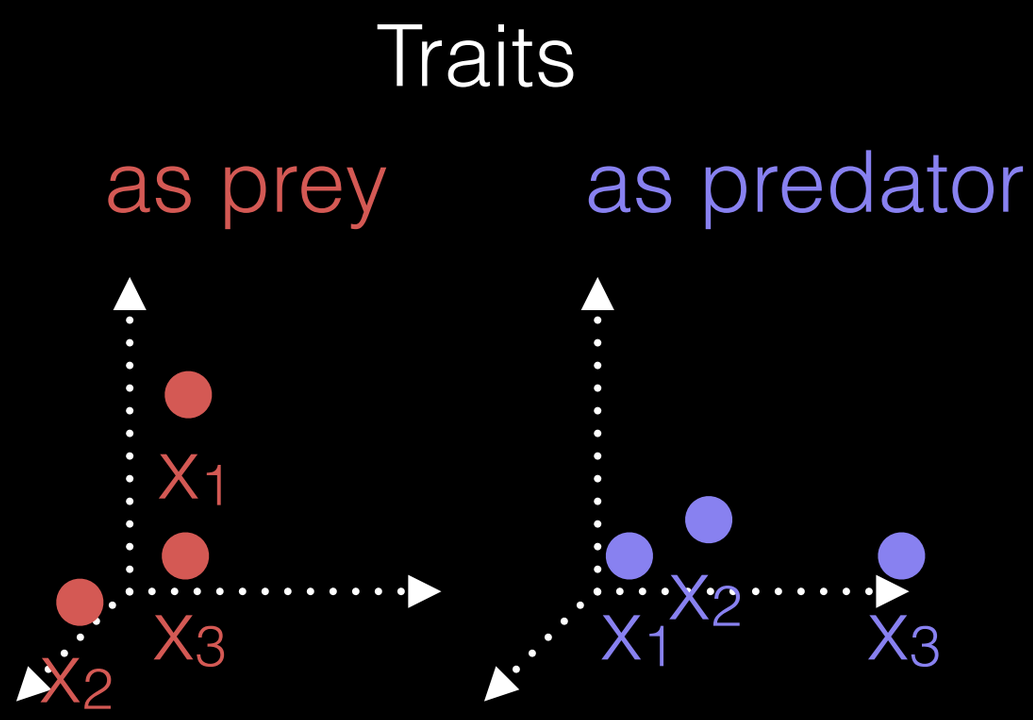

Traits
as prey
as predator
X1
X3
X2
X1
X2
X3



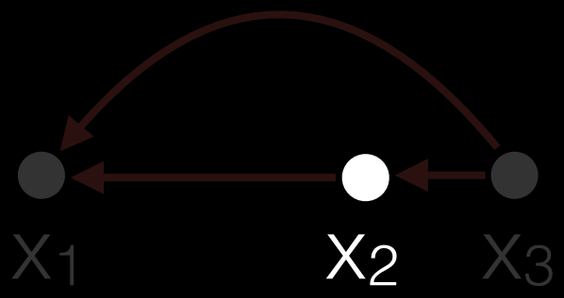


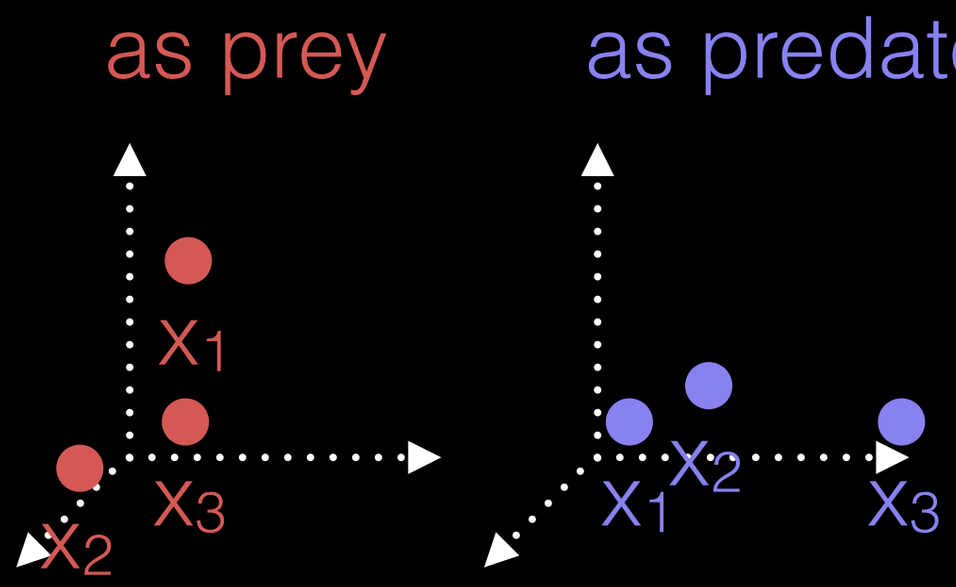
?

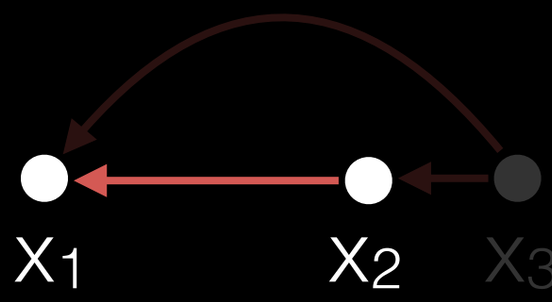
Traits

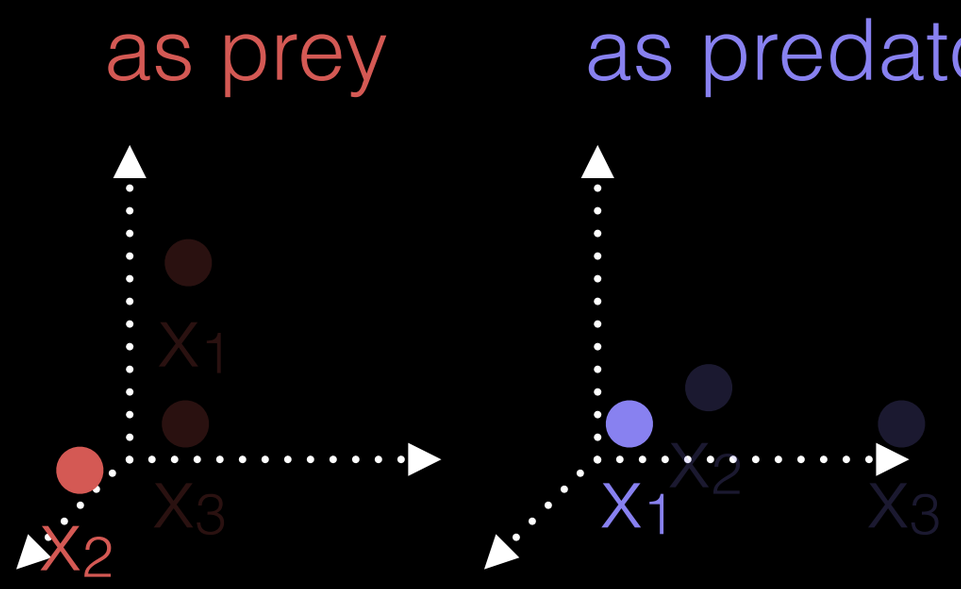



RDPG

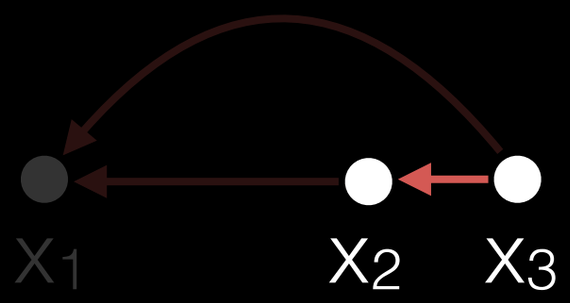

X1
X2
X3

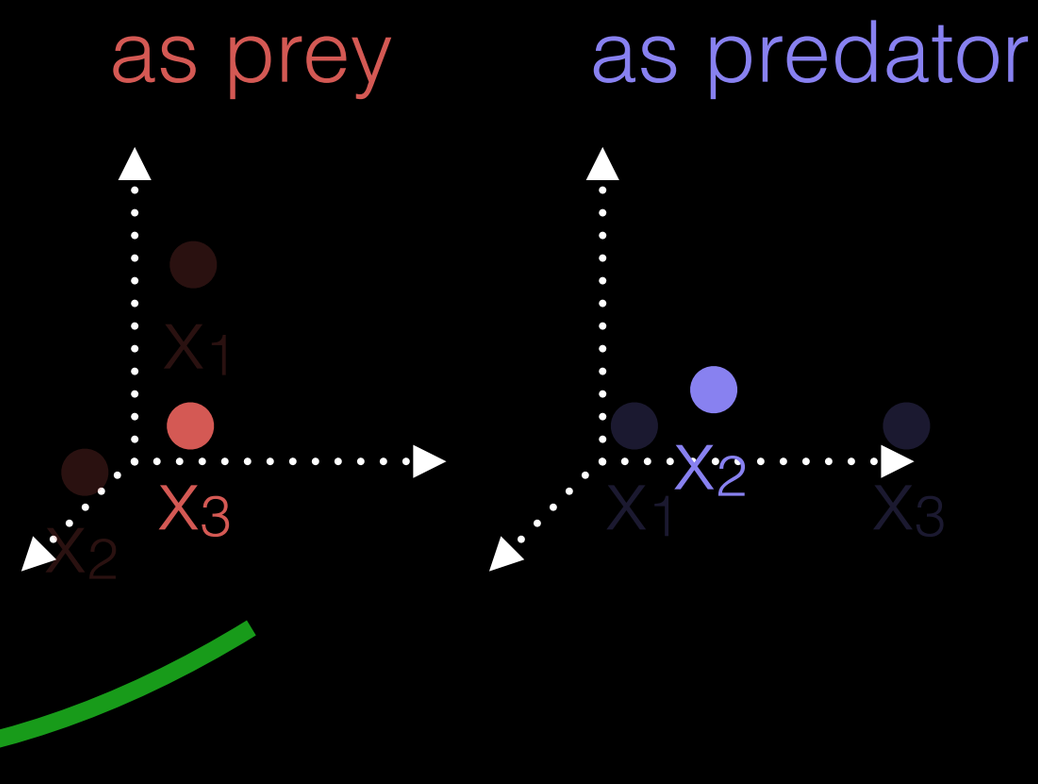

as prey
as predator
X1
X2
X3
X2
X3
X1
X2
X3



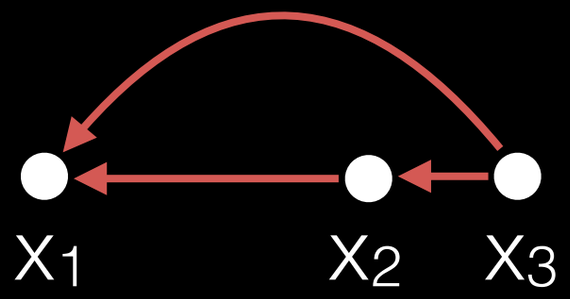


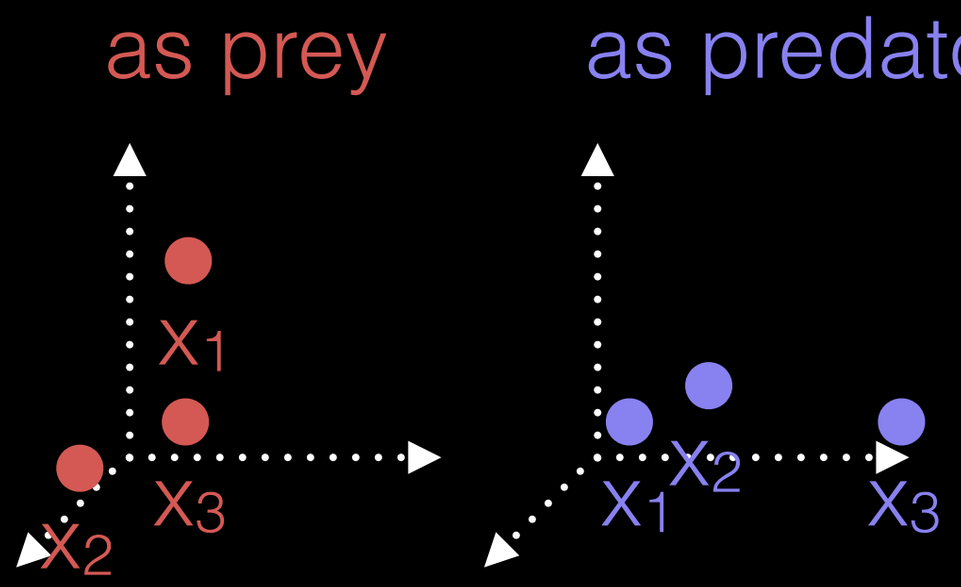
$$\mathbf{P}(x_2 \rightarrow x_1) = X_2 \cdot X_1$$



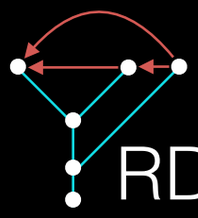


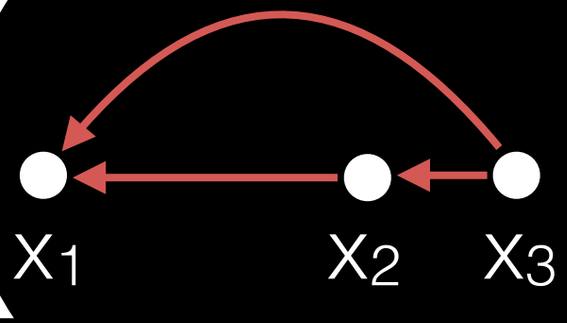
$$\mathbf{P}(x_2 \leftarrow x_3) = X_3 \cdot X_2$$

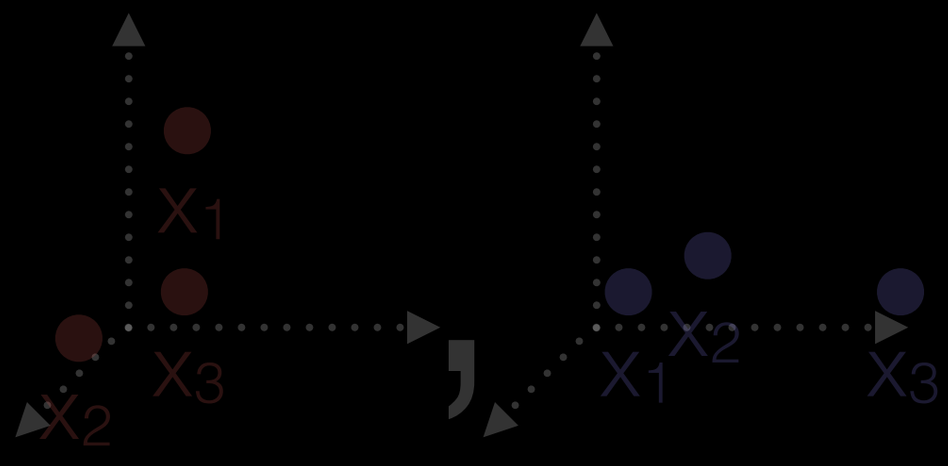


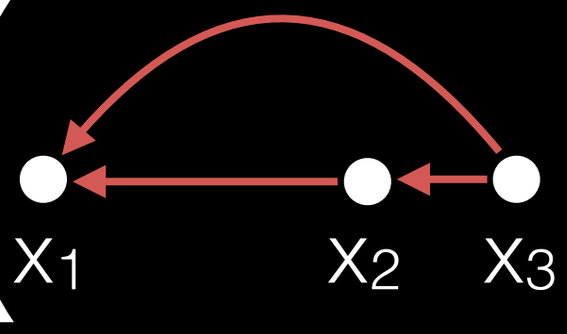


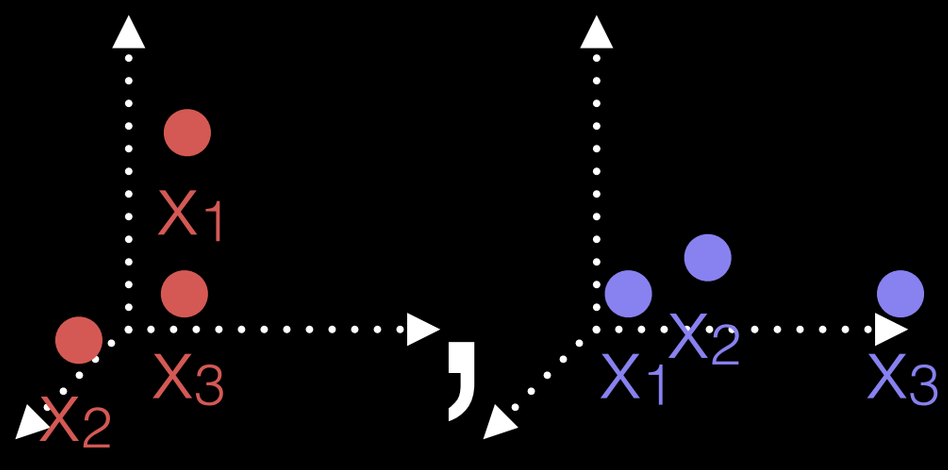
$$\mathbf{M} := \mathbf{X} \cdot \mathbf{X}^{t} \qquad \mathbf{M}_{ij} = \mathbf{P}(x_i \rightarrow x_j)$$



$$P\left(\right.$$


$$\left.\right| \left.\right)=$$


$$P\left(\right.$$ 

$$\left.\right|$$ 

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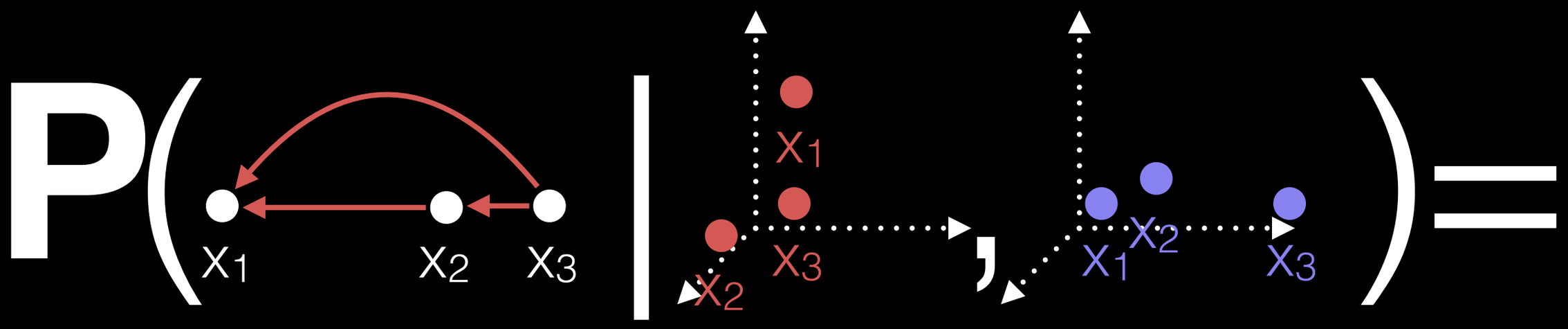
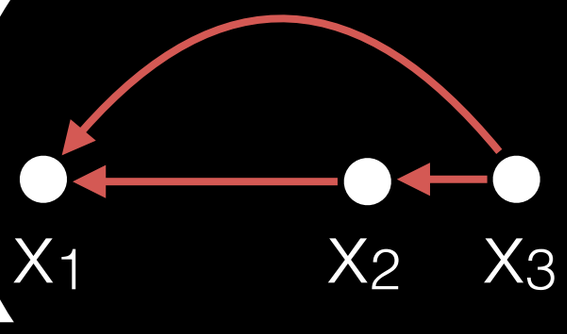
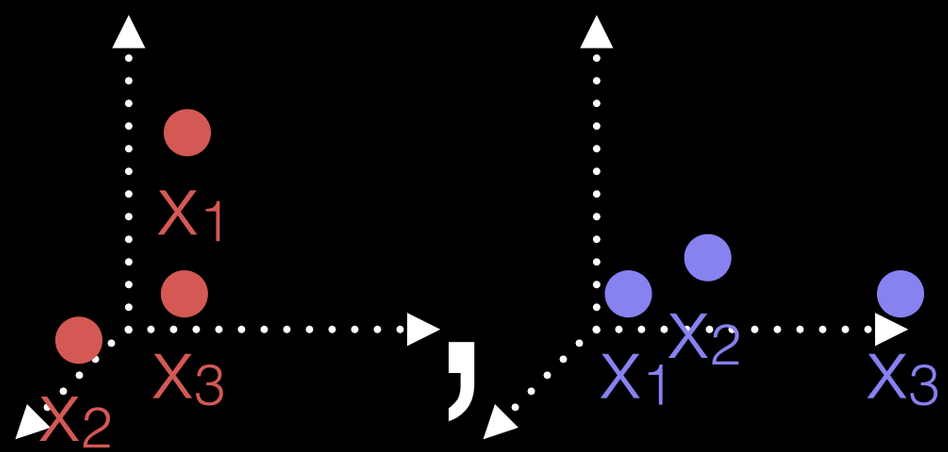
RDPG

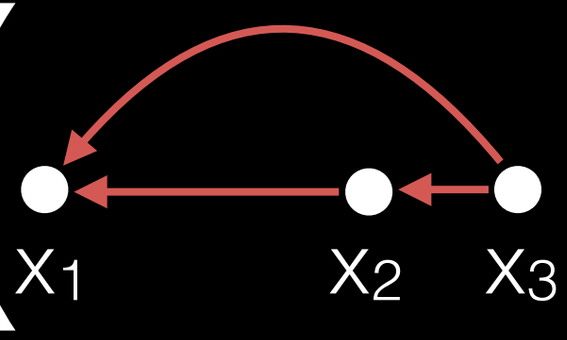


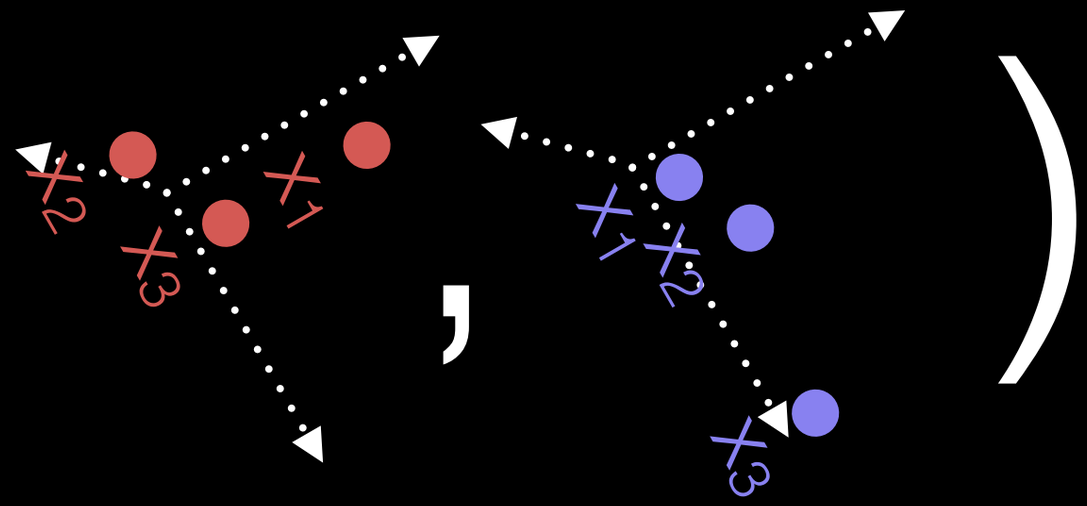
B(A,M)

$$P\left(\right.$$ 

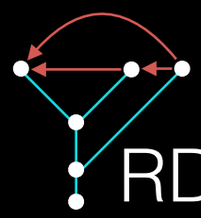
$$\left|\right.$$ 

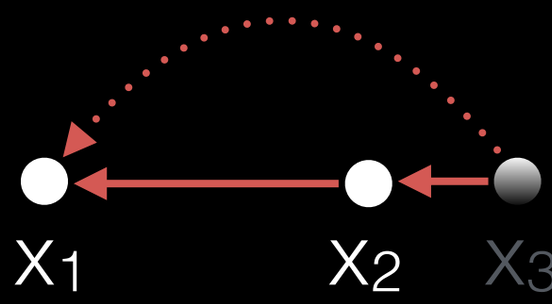
$$\left.\right)=$$

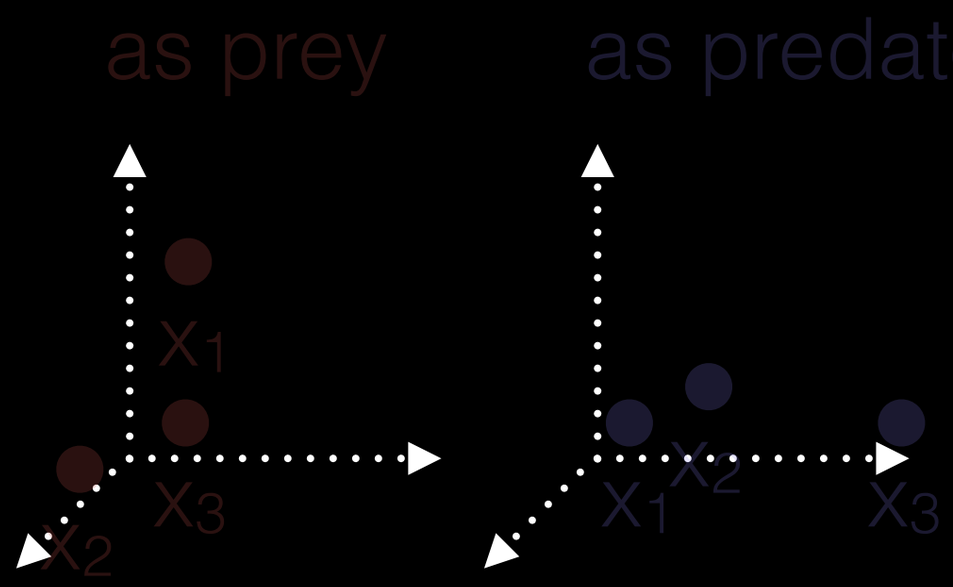
$$P\left(\right.$$ 

$$\left|\right.$$ 

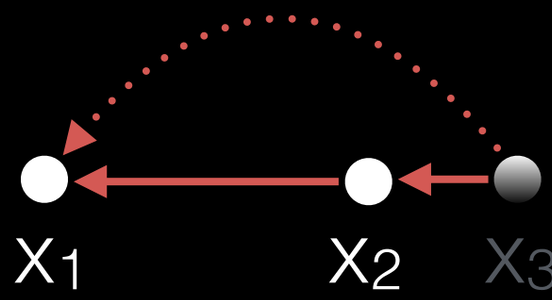
$$\left.\right)$$

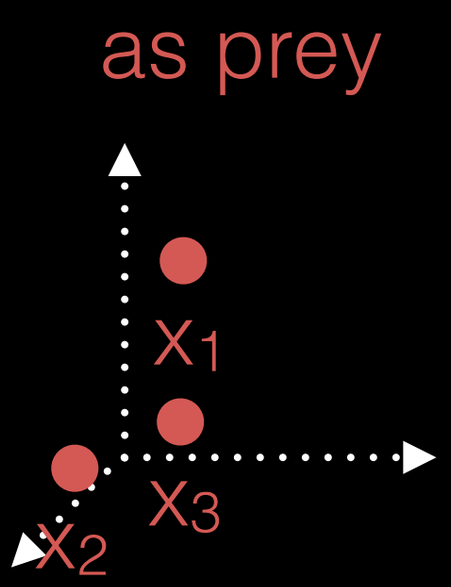


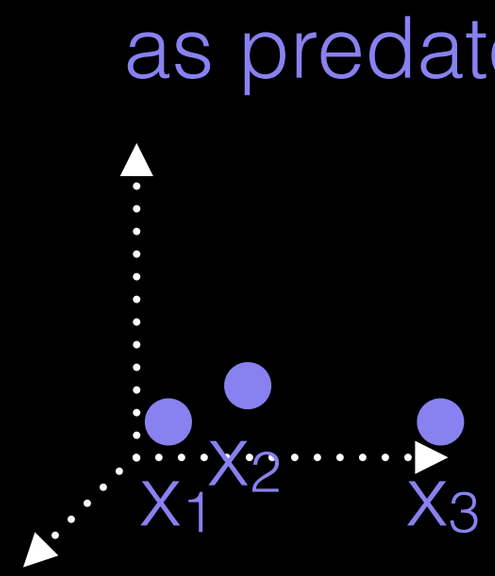




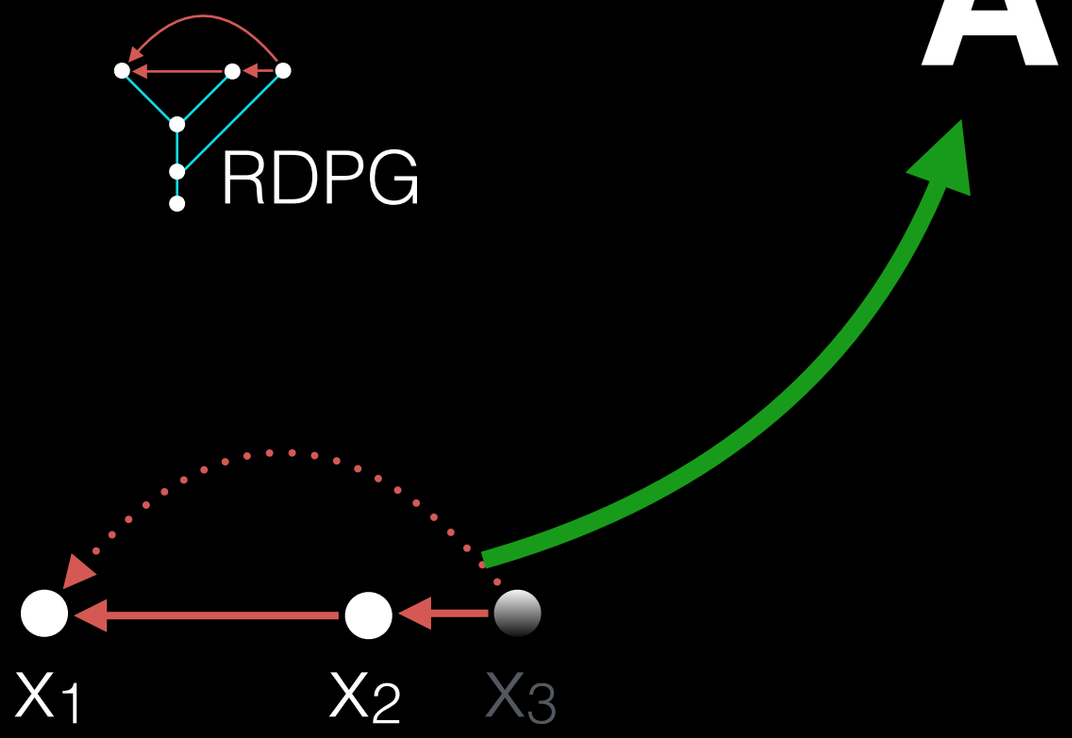
Alas!

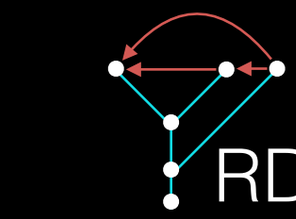


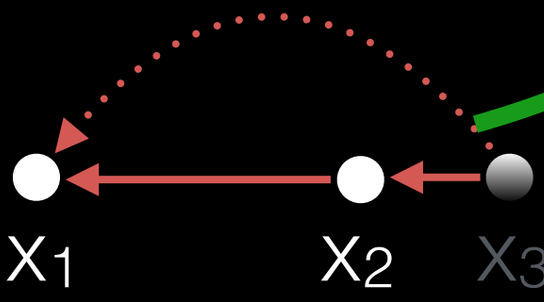


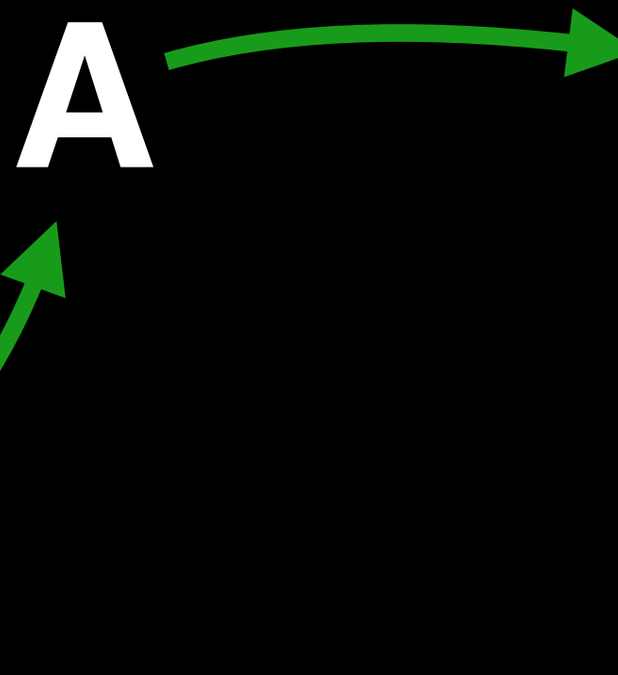


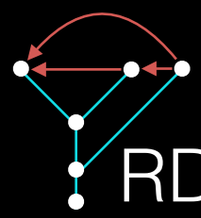
SVD!

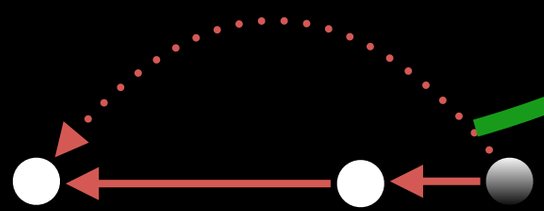

RDPG
A
X1
X2
X3


RDPG


X1
X2
X3

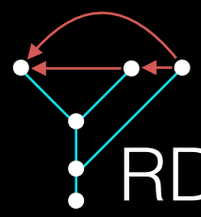

A
LSR

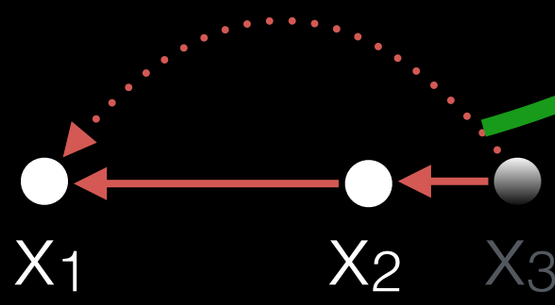




$$A \rightarrow LSR$$

$$L\sqrt{S}\ \sqrt{S}R$$





$$A \rightarrow LSR$$

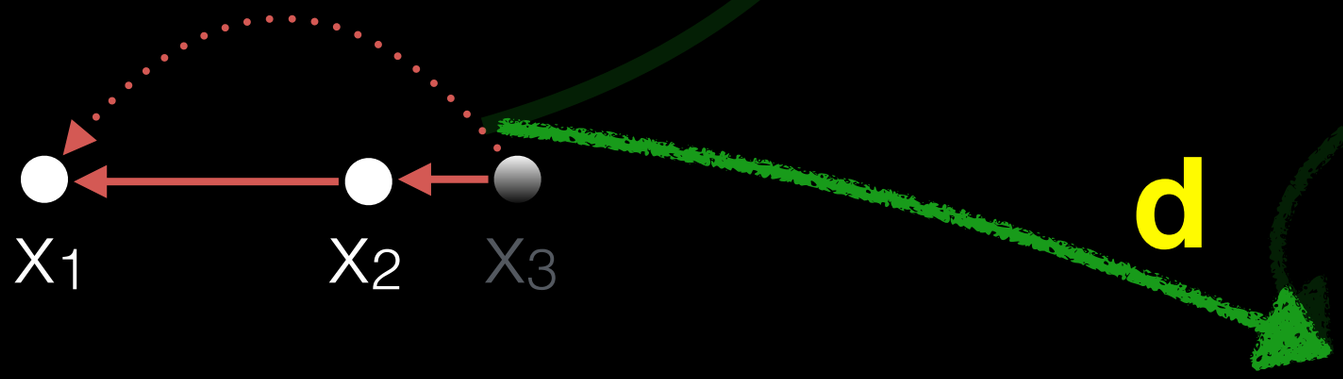
$$L\sqrt{S}\ \sqrt{S}R$$

$$d$$

$$L_d\sqrt{S_d}\ \sqrt{S_d}R_d$$

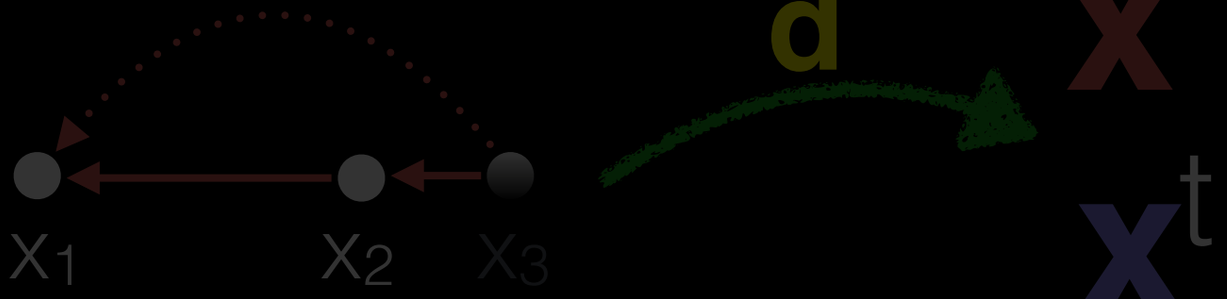
A → LSR

L√S √SR



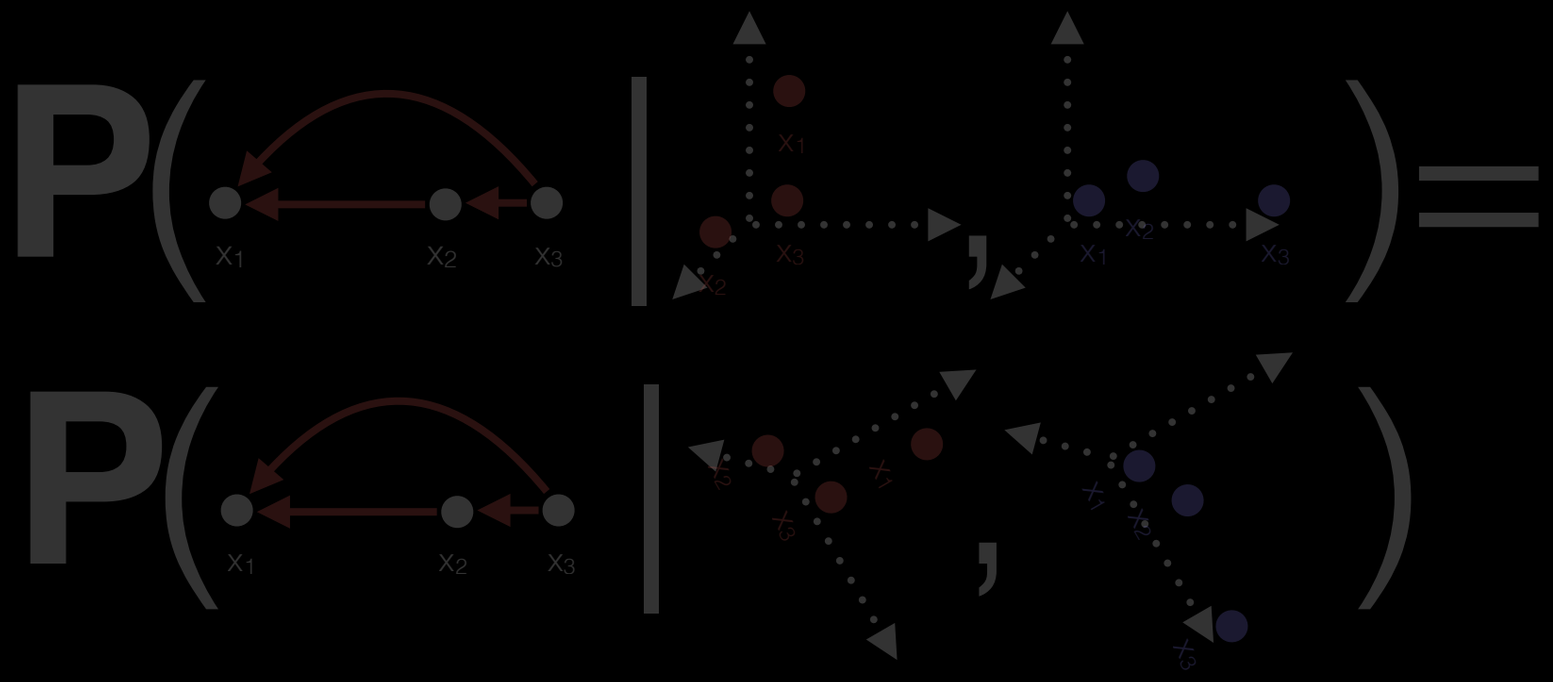
$$L_d\sqrt{S_d} = X$$

$$\sqrt{S_d}R_d = X^t$$



we need to choose **d**

RDPG



X , X unique up to an orthogonal transformation

Did evolution leave a trace
in the structure
of ecological networks?

Did evolution leave a trace
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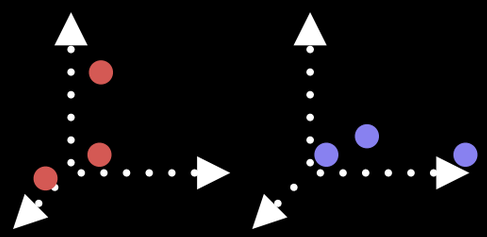
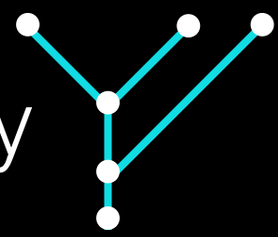
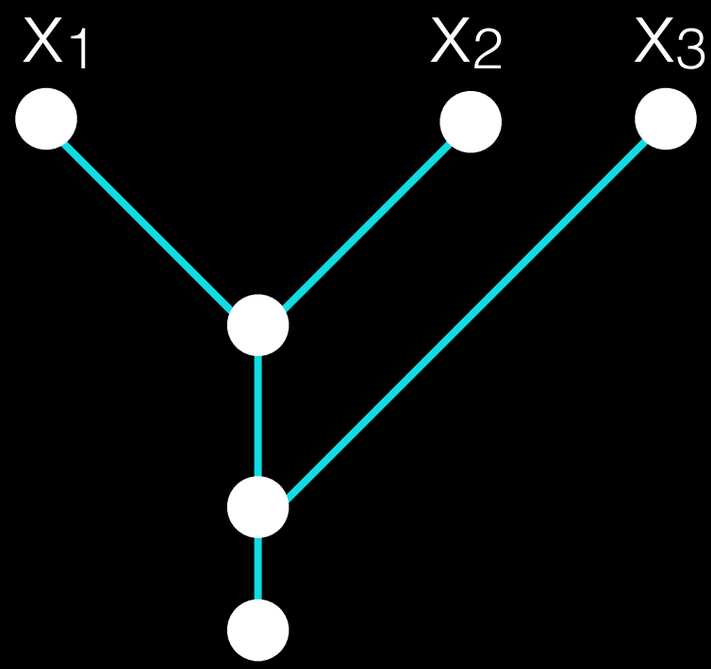
Are  *predicted* by  ?

Did evolution leave a trace in the topological structure of ecological networks?



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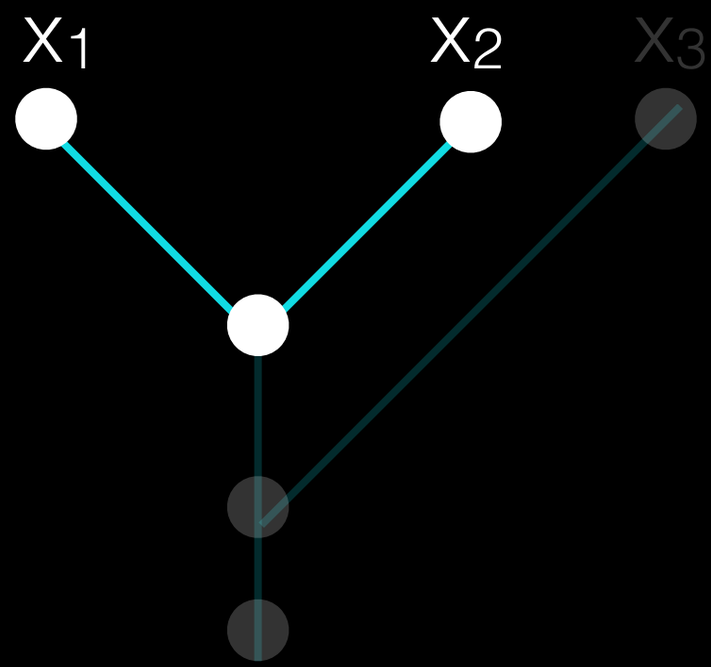

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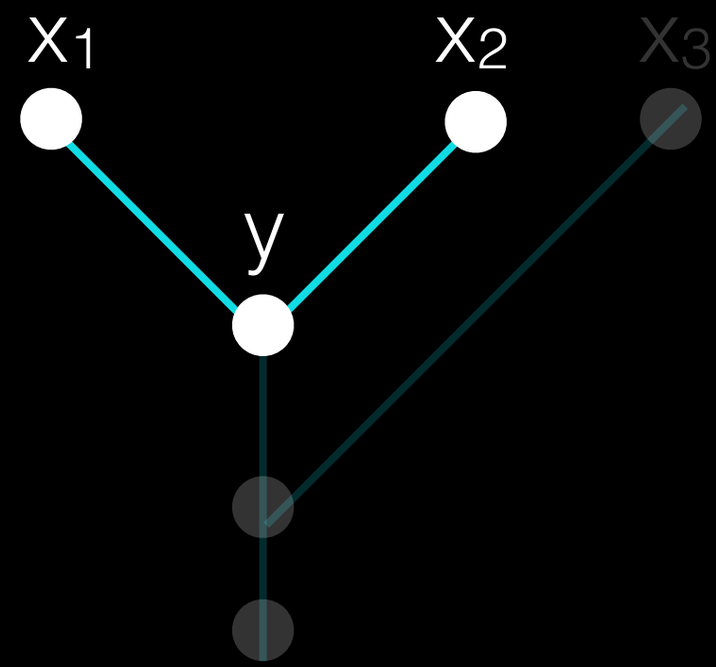
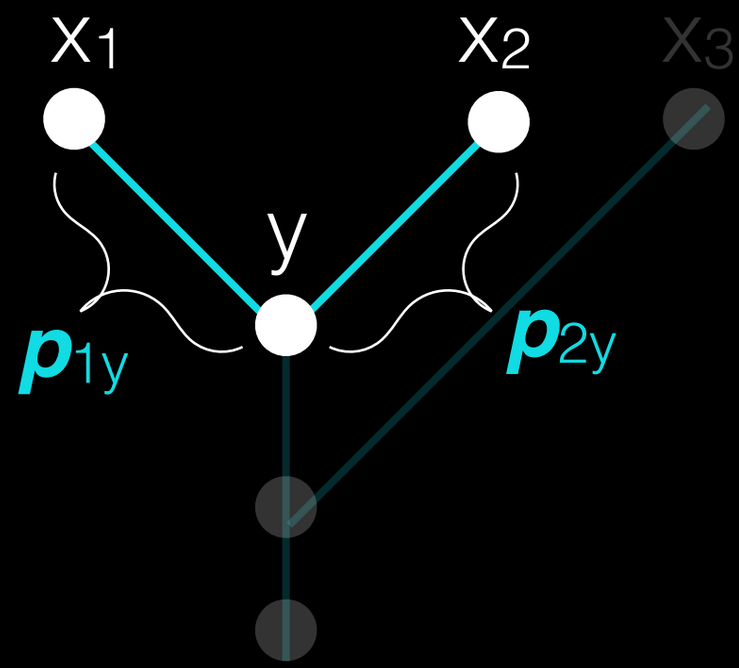
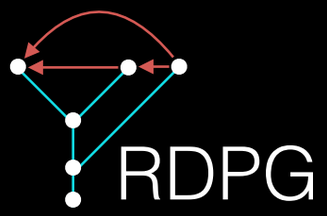
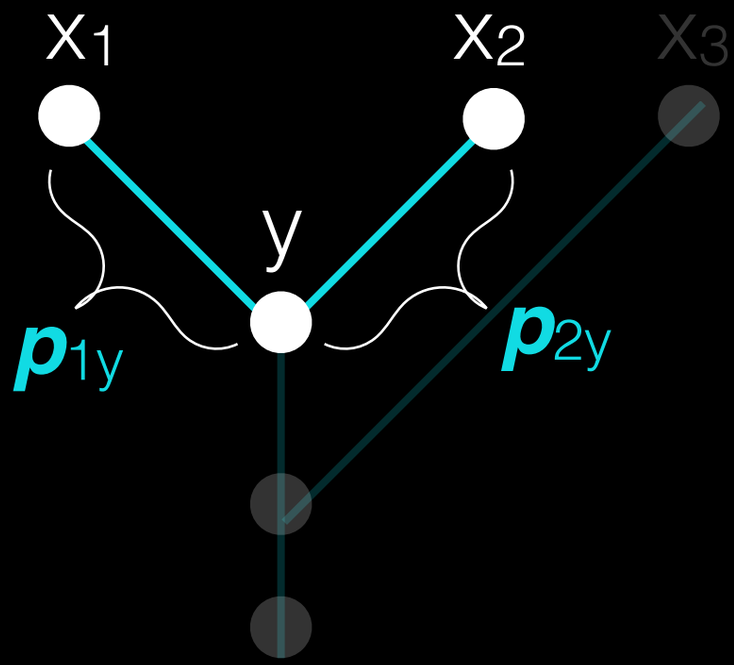


Did evolution leave a trace in the topological structure of ecological networks?



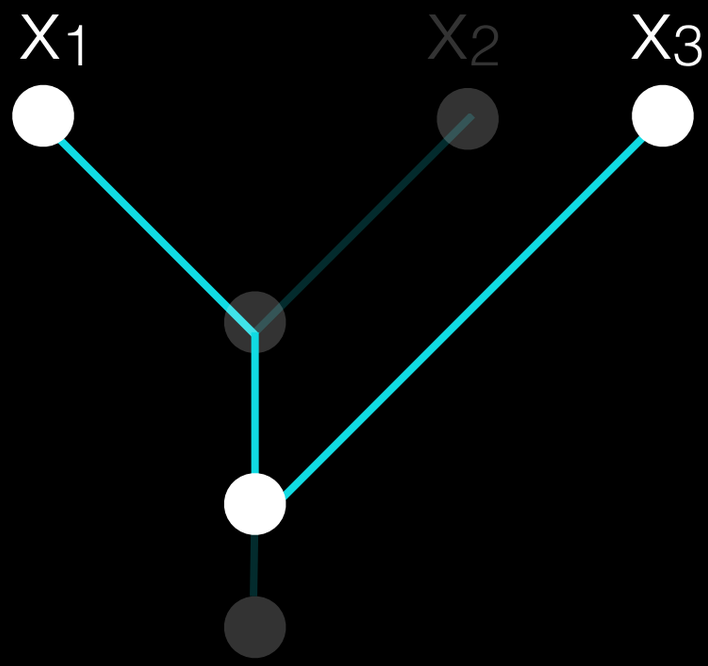


Did evolution leave a trace in the topological structure of ecological networks?



$$\boldsymbol{p}_{12} = \boldsymbol{p}_{1y} + \boldsymbol{p}_{2y}$$

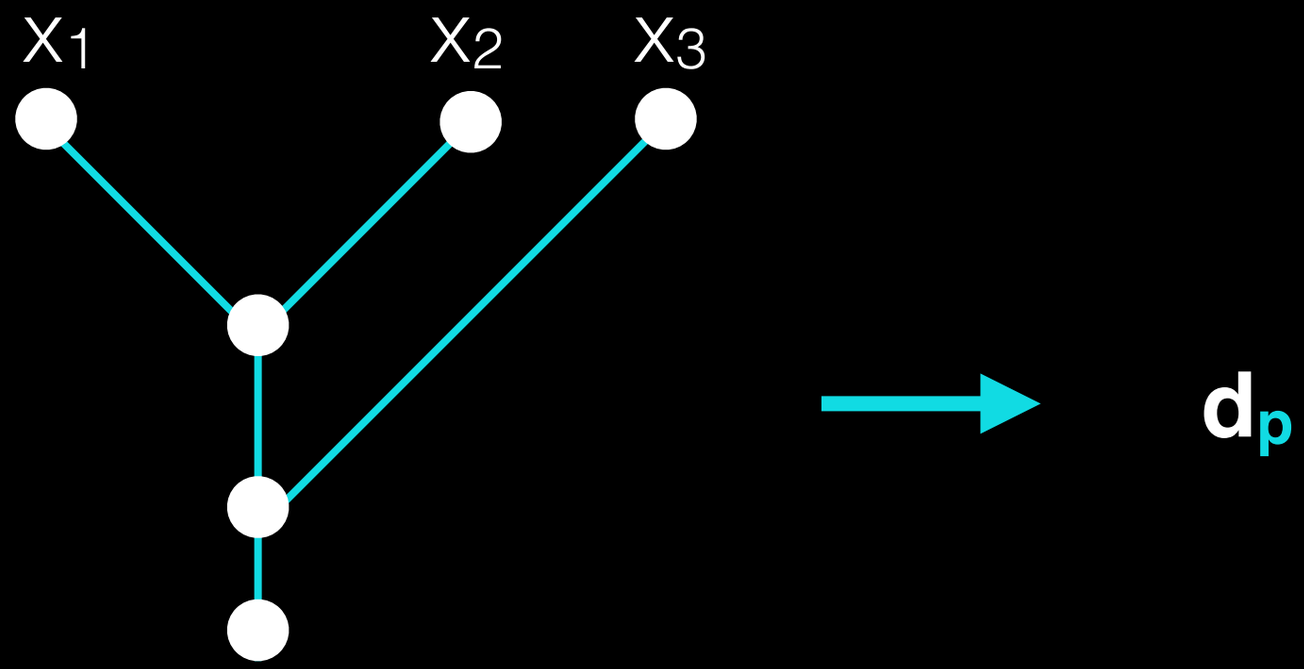
Did evolution leave a trace in the topological structure of ecological networks?

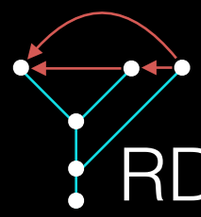


$$\boldsymbol{p}_{12} = \boldsymbol{p}_{1y} + \boldsymbol{p}_{2y}$$

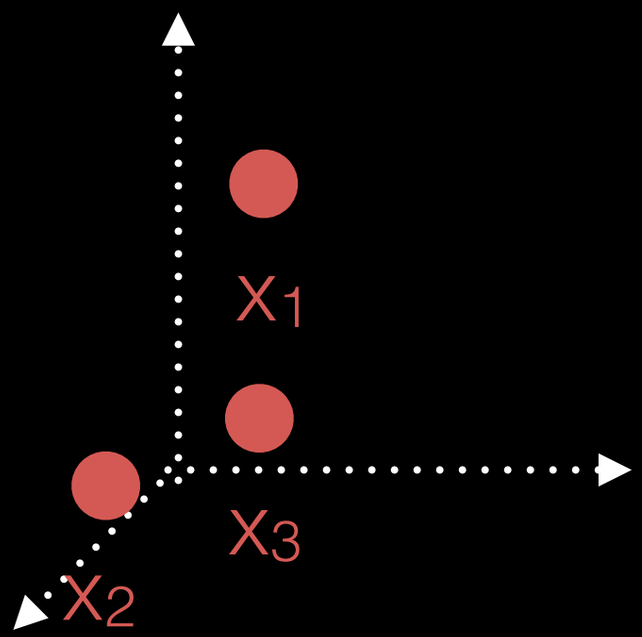
$$\boldsymbol{p}_{13} = \ldots$$

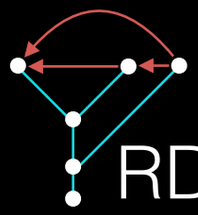
Did evolution leave a trace in the topological structure of ecological networks?





Did evolution leave a trace in the topological structure of ecological networks?





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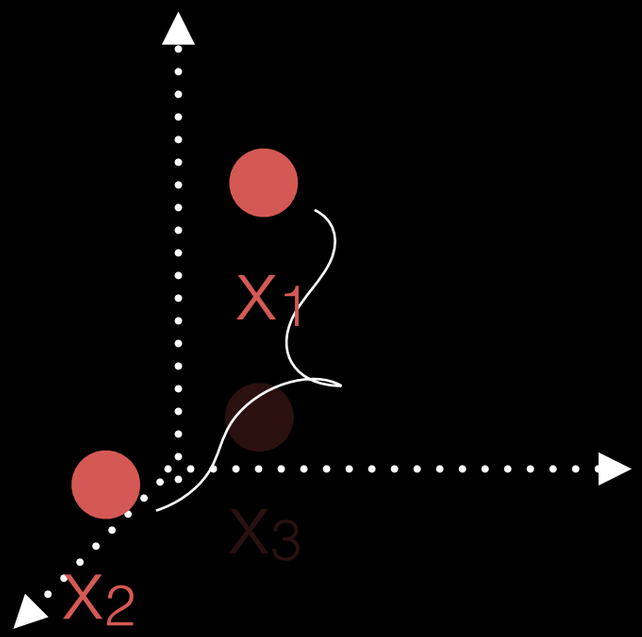
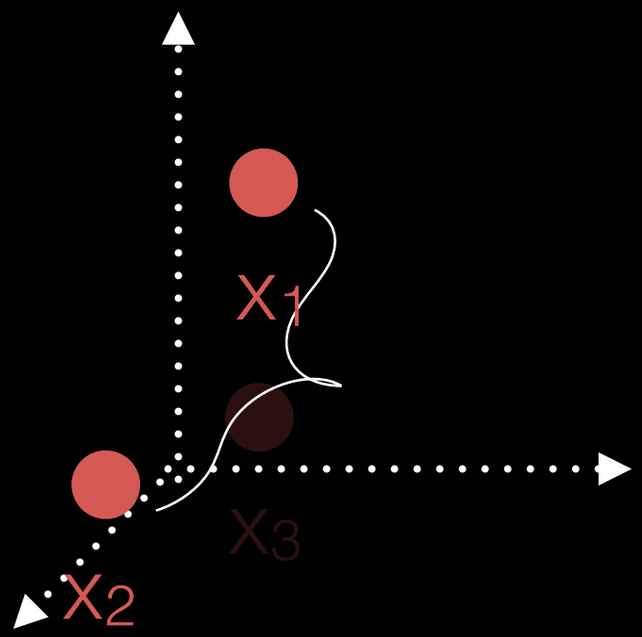
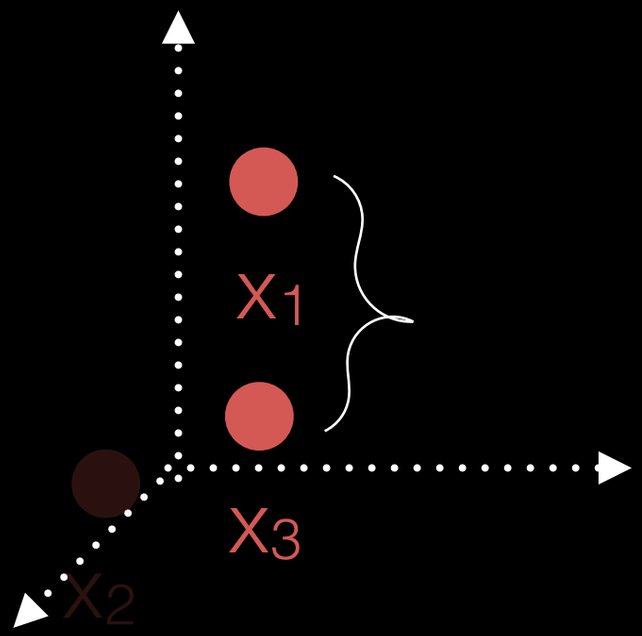


Did evolution leave a trace in the topological structure of ecological networks?



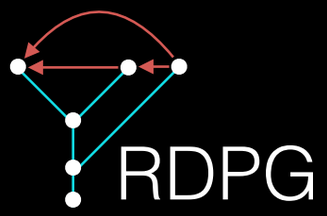
$\mathbf{x}_{12} = d(x_1, x_2)$

Did evolution leave a trace in the topological structure of ecological networks?

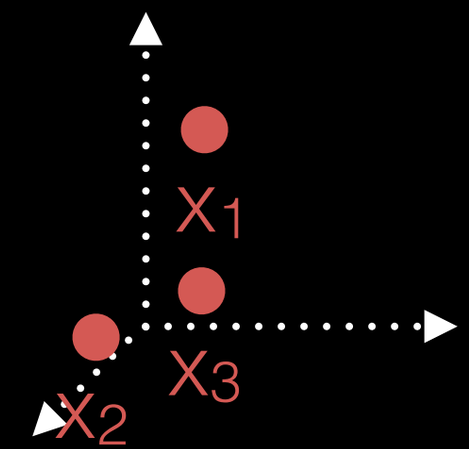


$\mathbf{x}_{12} = d(x_1, x_2)$

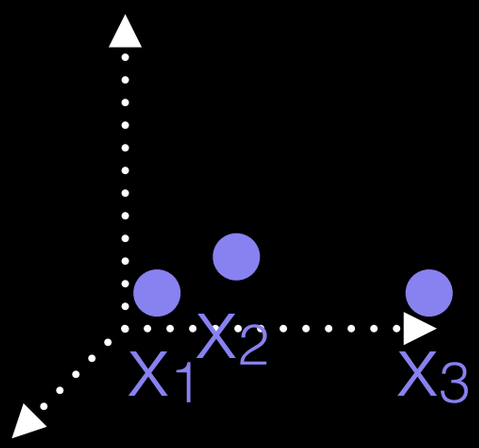
$\mathbf{x}_{13} = d(x_1, x_3)$



Did evolution leave a trace in the topological structure of ecological networks?



d_x



d_x

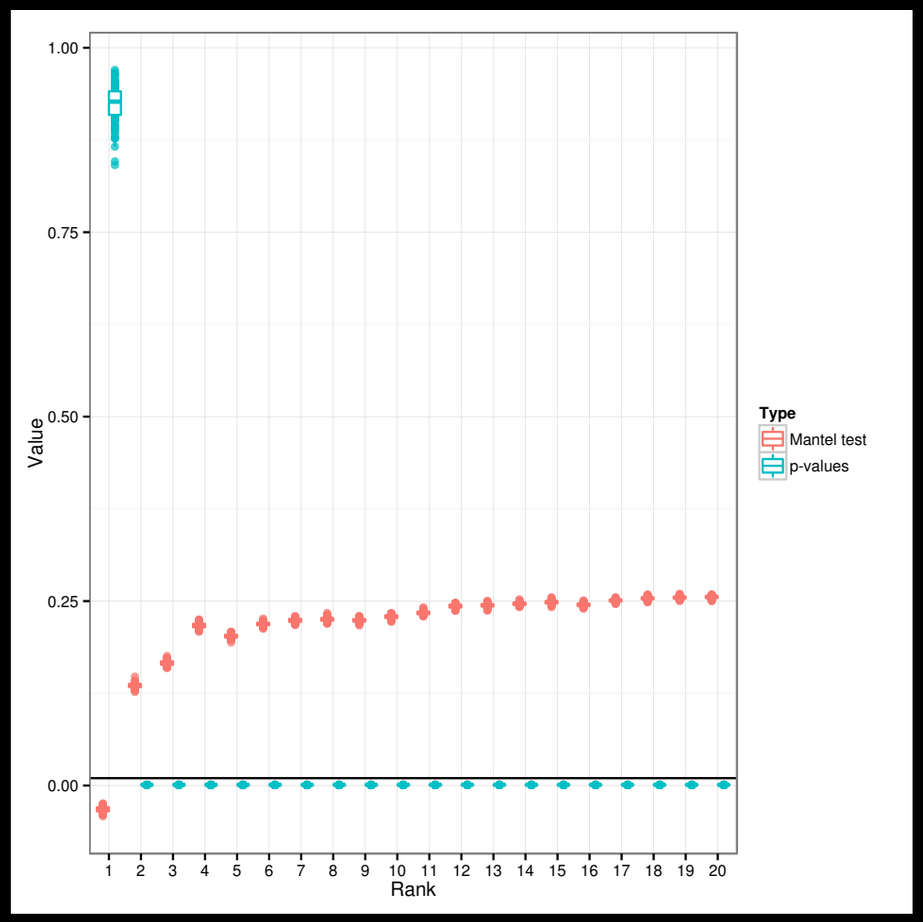
Did evolution leave a trace
in the structure
of ecological networks?

Are $\mathbf{d_x}$ $\mathbf{d_x}$ *predicted* by $\mathbf{d_p}$?

Did evolution leave a trace
in the structure
of ecological networks?

yes

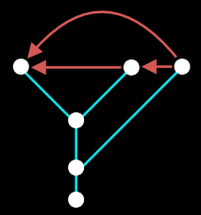
Dalla Riva, G. V. and Stouffer, D. B. (2015), Exploring the evolutionary signature of food webs' backbones using functional traits. Oikos. doi: 10.1111/oik.02305



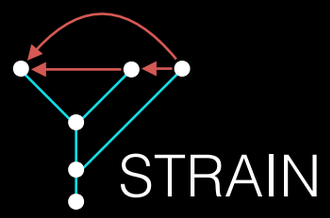
Did evolution leave a trace in the structure of ecological networks?

yes, and starting from **d**

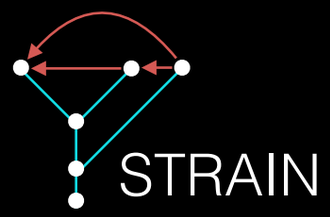
Dalla Riva, G. V. and Stouffer, D. B. (2015), Exploring the evolutionary signature of food webs' backbones using functional traits. Oikos. doi: 10.1111/oik.02305



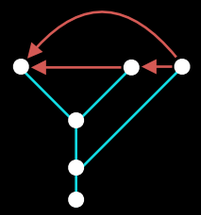
CENTRALITY



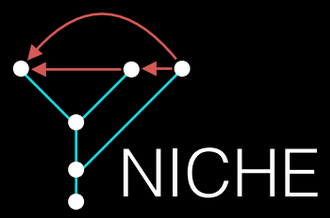
How do we measure the importance of nodes in a RDPG framework?



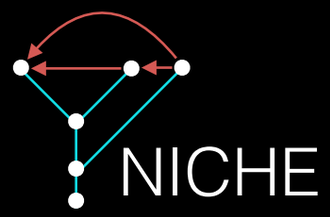
Are ecological unique species evolutionary distinctive?



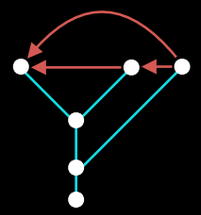
NICHE



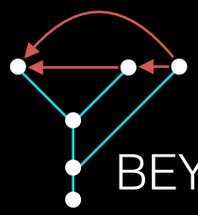
How do species’ niches evolve?



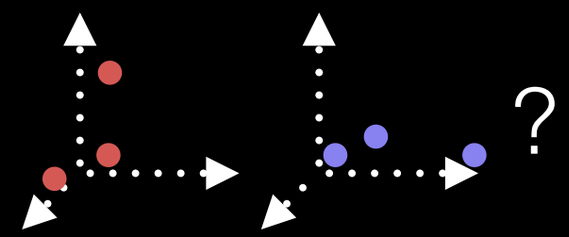
How do we detect the effect of interactions in species' evolution?

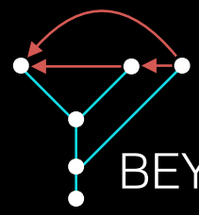


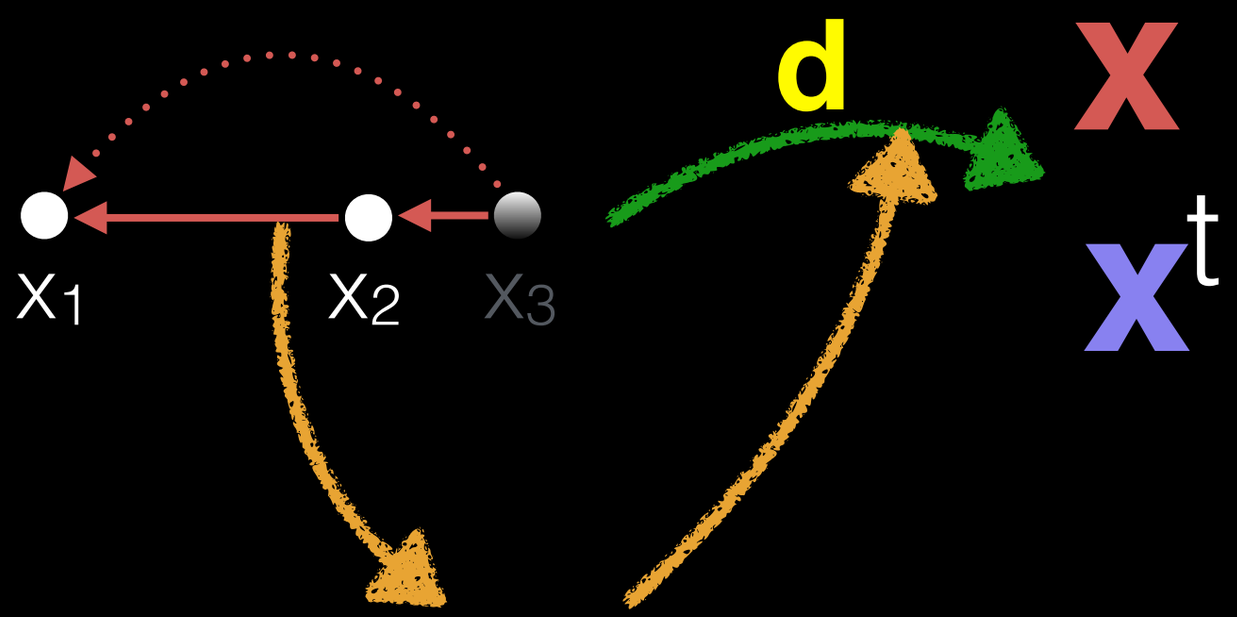
BEYOND

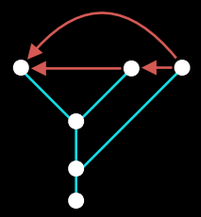


BEYOND

How do species’ evolve in  ?


BEYOND


x1
x2
x3
d
x
x^t
?
ontological priors



Because we are all responsible for all
[…] I go for all […]

–Fyodor Dostoyevsky
The Brothers Karamazov