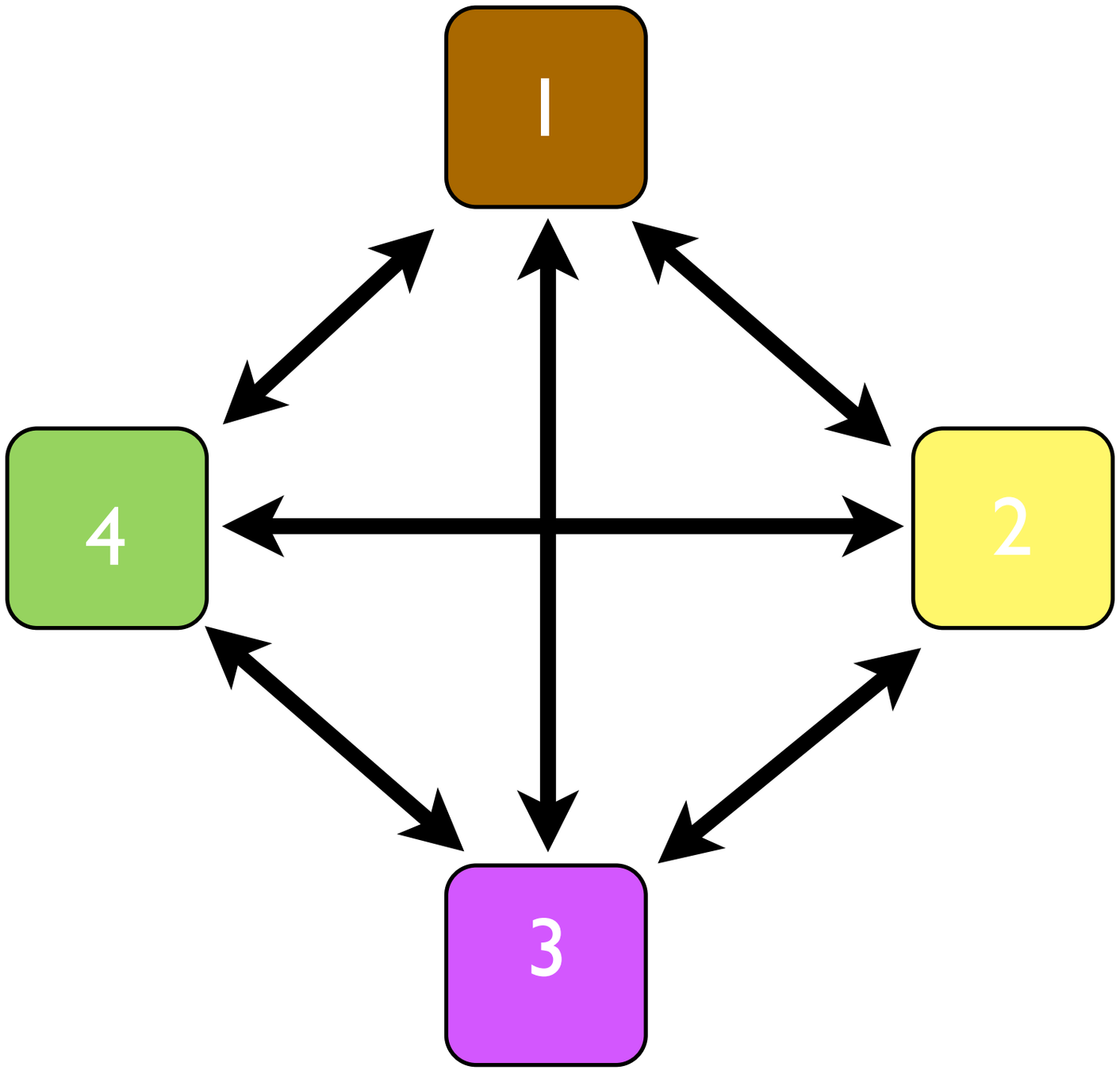
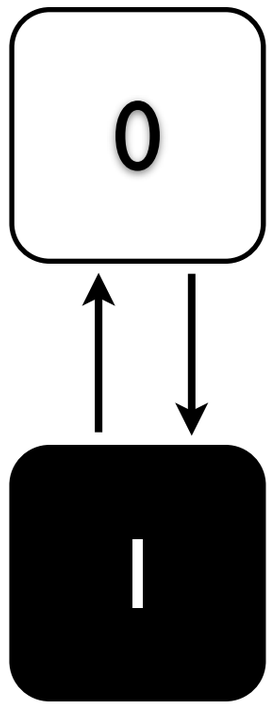
Modeling Discrete Character Evolution

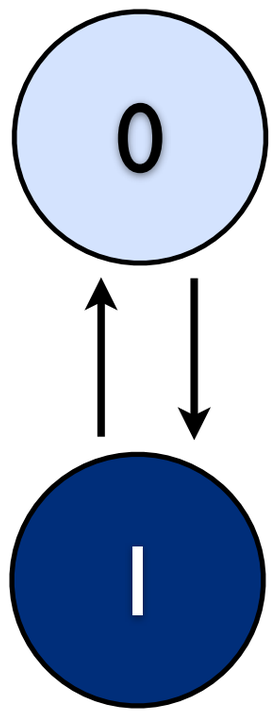

1
4
2
3

Consider two discrete characters

- Are they evolving in a correlated fashion?
- When character A changes to state 1, is character B likely to change to 1 as well?

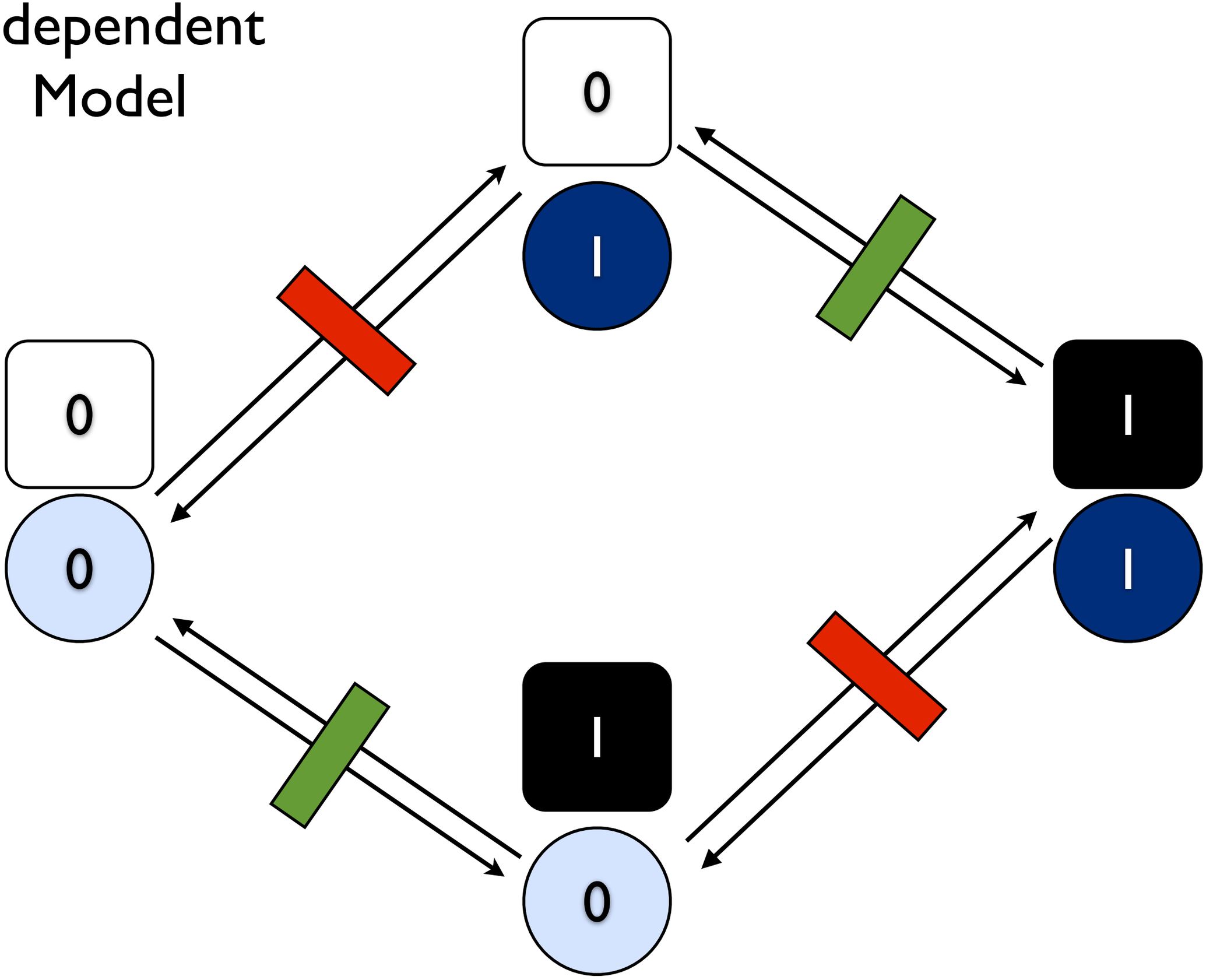


Character 1

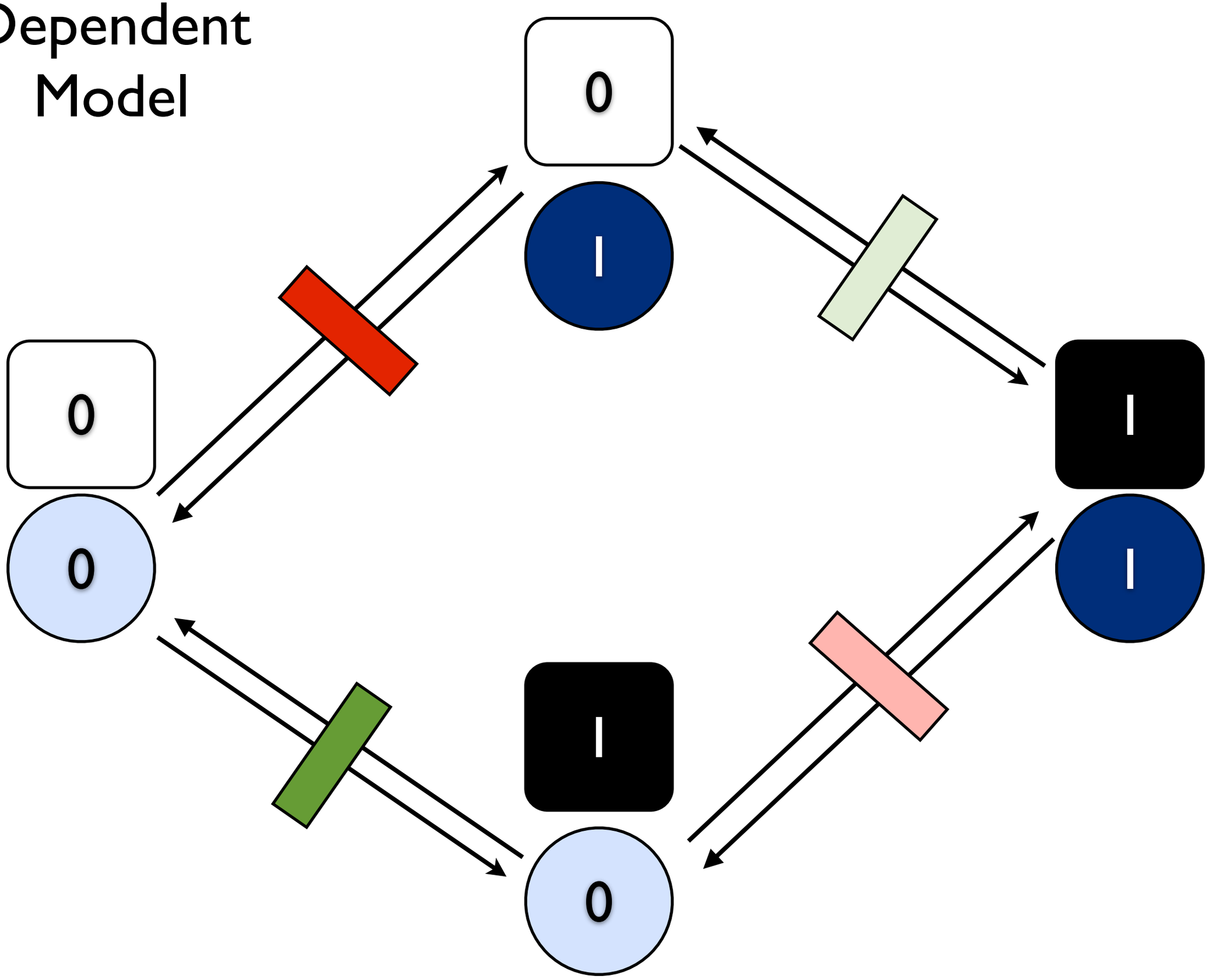


Character 2

Independent Model



Dependent Model



Correlation of Discrete Characters

- Does the rate of change of character 2 depend on the state of character 1?
- Compare models using maximum likelihood

X	0	0	1	1
Y	0	1	0	1
X,Y				
0,0	$1-(q_{12}+q_{13})$	q_{12}	q_{13}	0
0,1	q_{21}	$1-(q_{21}+q_{24})$	0	q_{24}
1,0	q_{31}	0	$1-(q_{31}+q_{34})$	q_{34}
1,1	0	q_{42}	q_{43}	$1-(q_{42}+q_{43})$

X	0	0	1	1
Y	0	1	0	1
X,Y				
0,0	$1-(q_{12}+q_{13})$	q_{12}	q_{13}	0
0,1	q_{21}	$1-(q_{21}+q_{24})$	0	q_{24}
1,0	q_{31}	0	$1-(q_{31}+q_{34})$	q_{34}
1,1	0	q_{42}	q_{43}	$1-(q_{42}+q_{43})$

Independent model: character rates do NOT depend on the state of the other character

X	0	0	1	1
Y	0	1	0	1

X,Y				
0,0	$1-(q_{12}+q_{13})$	q_{12}	q_{13}	0
0,1	q_{21}	$1-(q_{21}+q_{24})$	0	q_{24}
1,0	q_{31}	0	$1-(q_{31}+q_{34})$	q_{34}
1,1	0	q_{42}	q_{43}	$1-(q_{42}+q_{43})$

X	0	0	1	1
Y	0	1	0	1
X,Y				
0,0	$1-(q_{12}+q_{13})$	q_{12}	q_{13}	0
0,1	q_{21}	$1-(q_{21}+q_{24})$	0	q_{24}
1,0	q_{31}	0	$1-(q_{31}+q_{34})$	q_{34}
1,1	0	q_{42}	q_{43}	$1-(q_{42}+q_{43})$

Dependent model: character rates DO depend on the state of the other character

Example

- Data on evolution of dewlap color (red, yellow) and perch behavior (high, low) of anoles
- Fit the two models to these data
- Obtain the following results:

Example

Model	lnL	k	AIC
independent	-132.2	4	272.4
dependent	-125.3	8	266.6