Bayesian Networks

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The Australian National University
Griffith University

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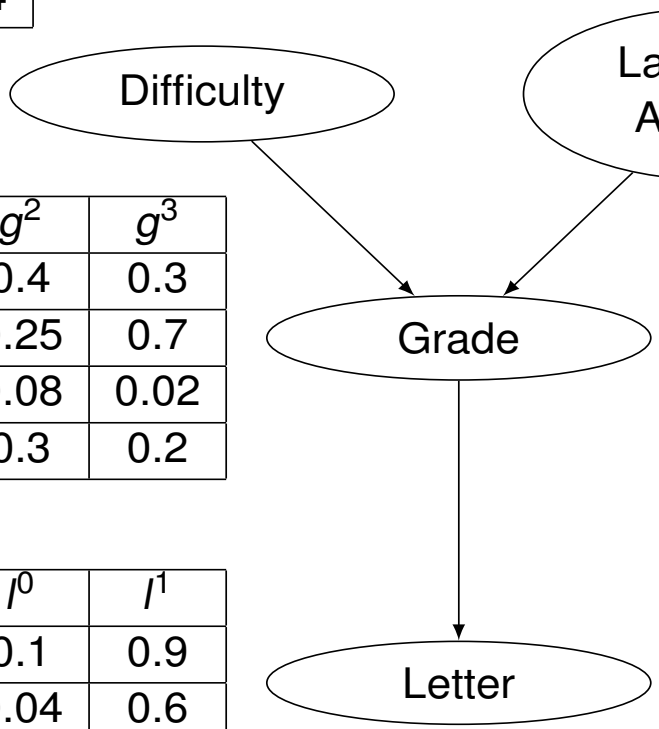
A Bayesian Network



d^0	d^1
0.6	0.4

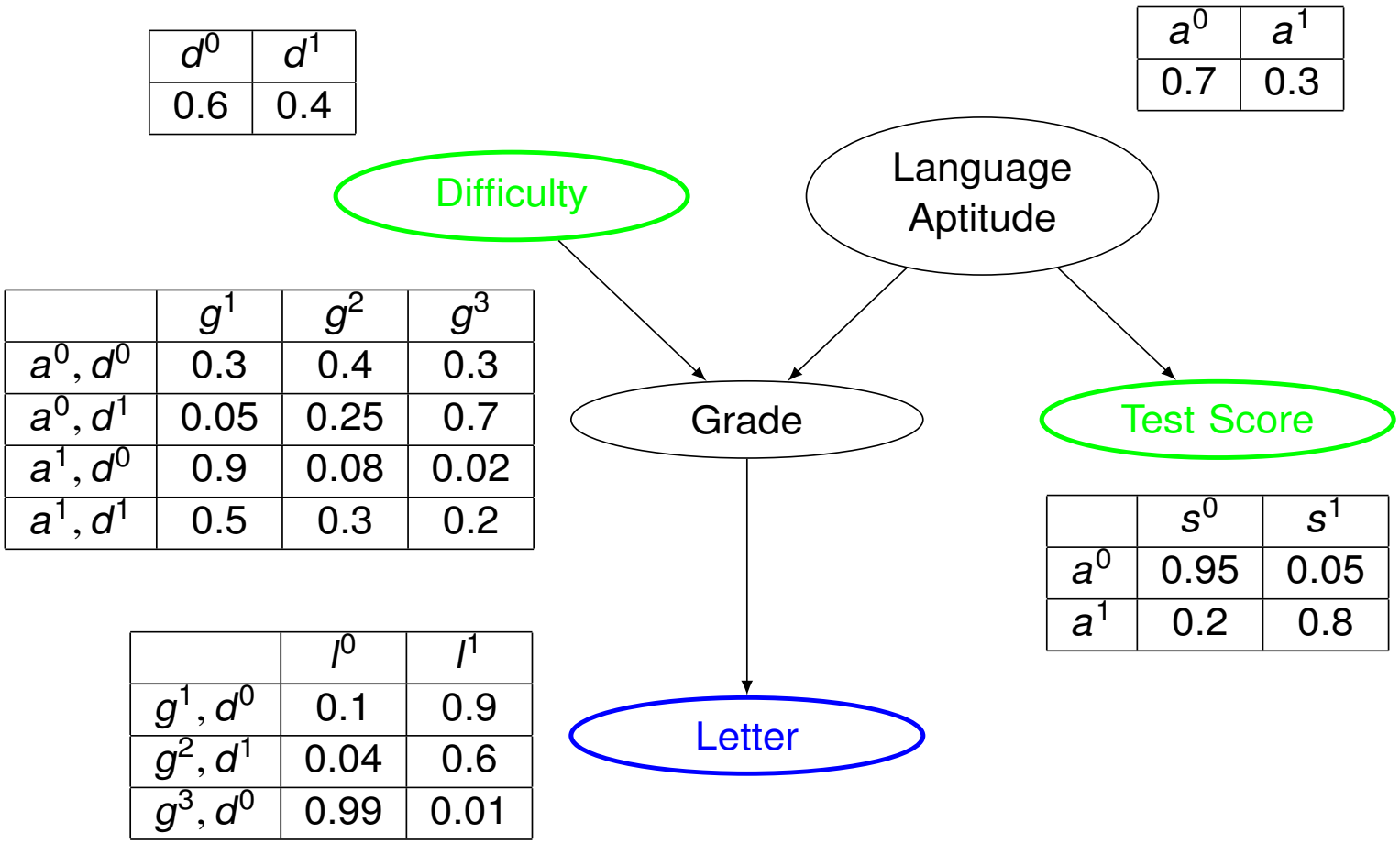
a^0	a^1
0.7	0.3

	g^1	g^2	g^3
a^0, d^0	0.3	0.4	0.3
a^0, d^1	0.05	0.25	0.7
a^1, d^0	0.9	0.08	0.02
a^1, d^1	0.5	0.3	0.2

	s^0	s^1
a^0	0.95	0.05
a^1	0.2	0.8

	l^0	l^1
g^1, d^0	0.1	0.9
g^2, d^1	0.04	0.6
g^3, d^0	0.99	0.01

D-Separation



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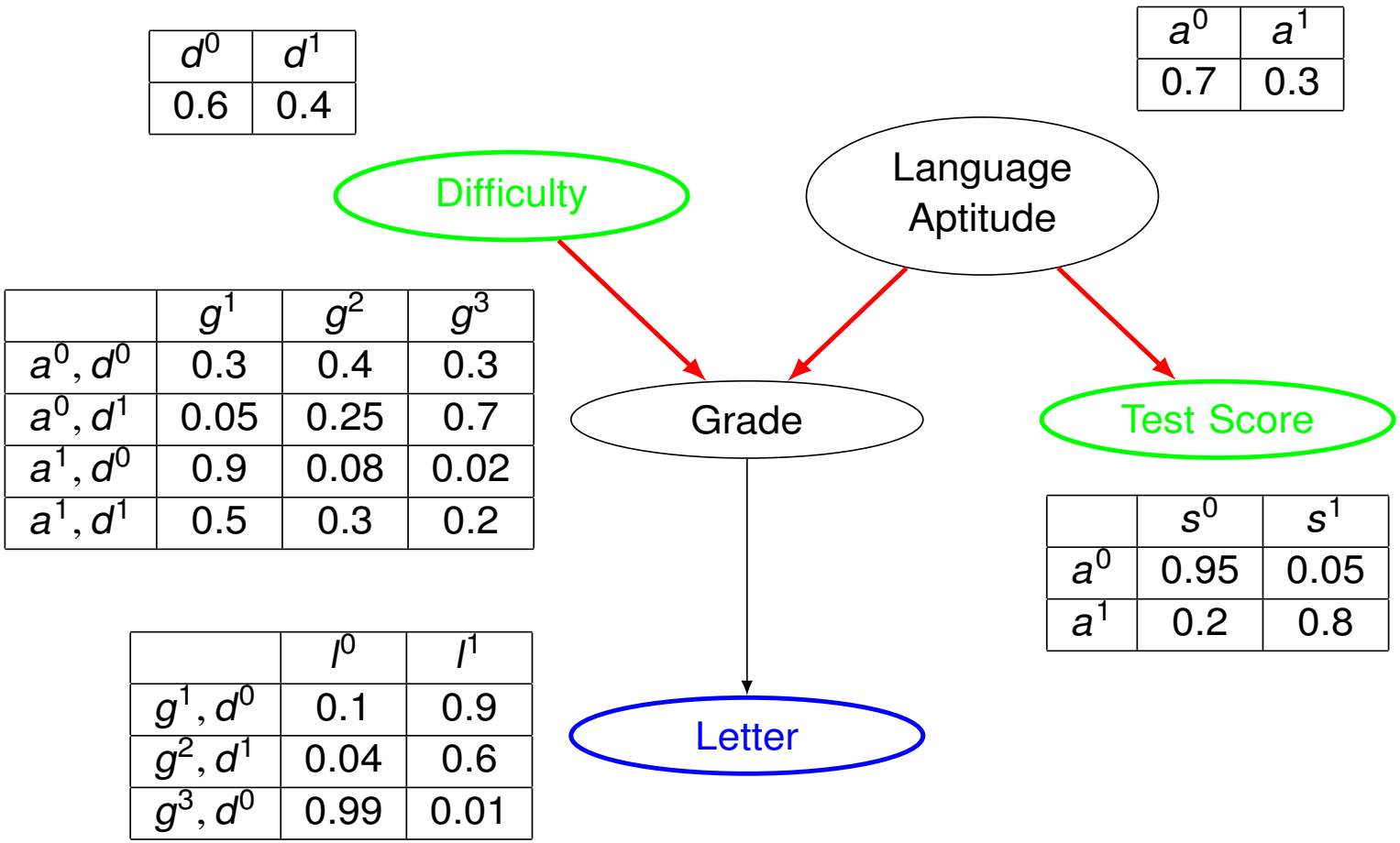

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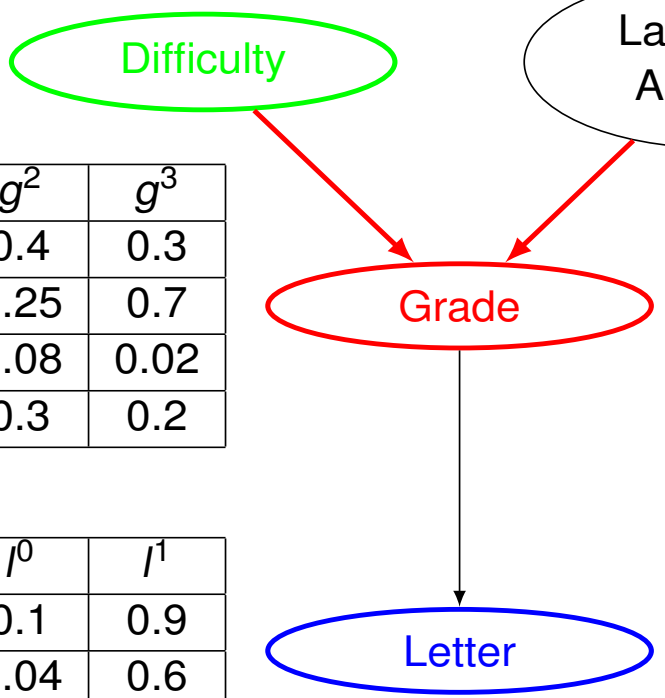

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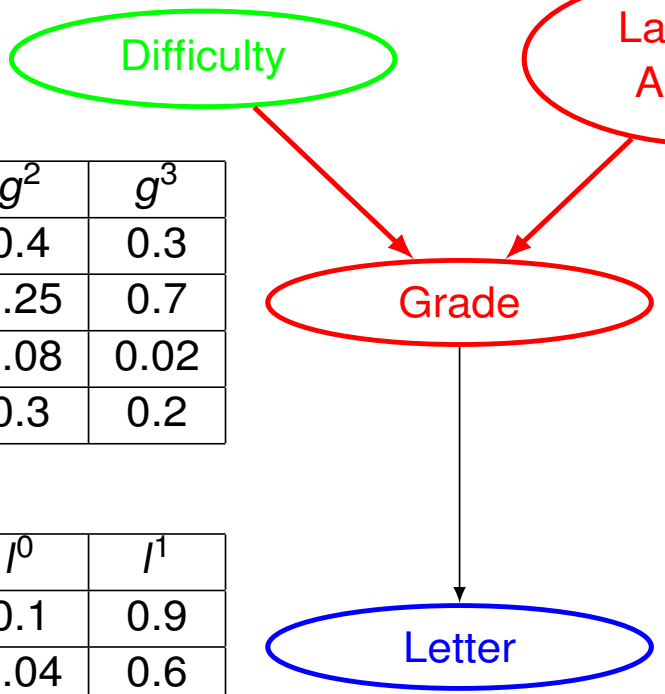

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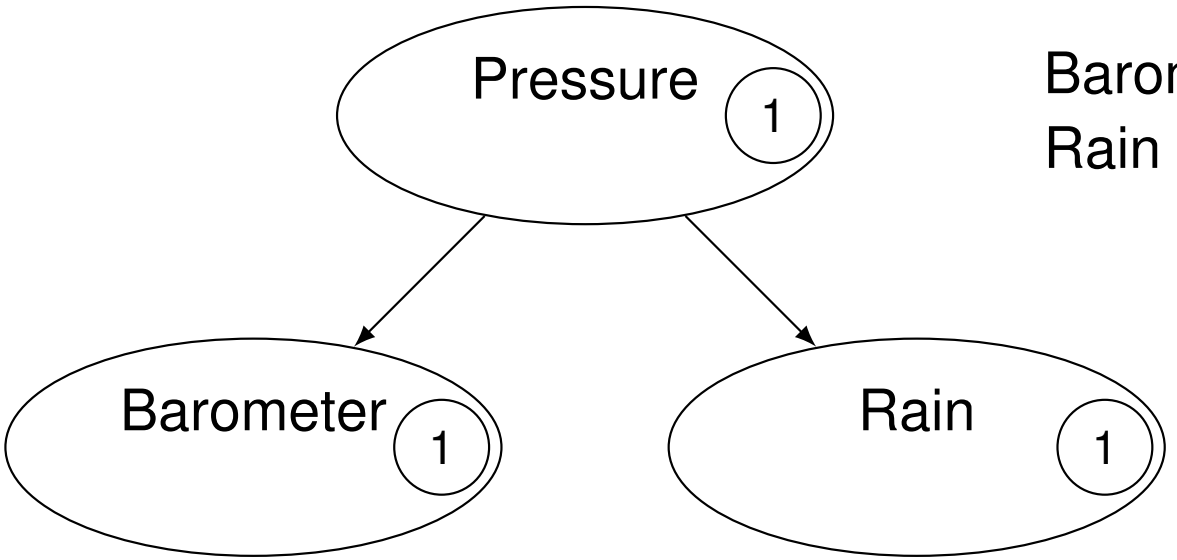
A Deterministic Example

It always rains when my barometer is low. Yesterday, my barometer was low and it rained. Why couldn't I have stopped the rain by breaking my barometer?



Barometer = Pressure
Rain = Pressure

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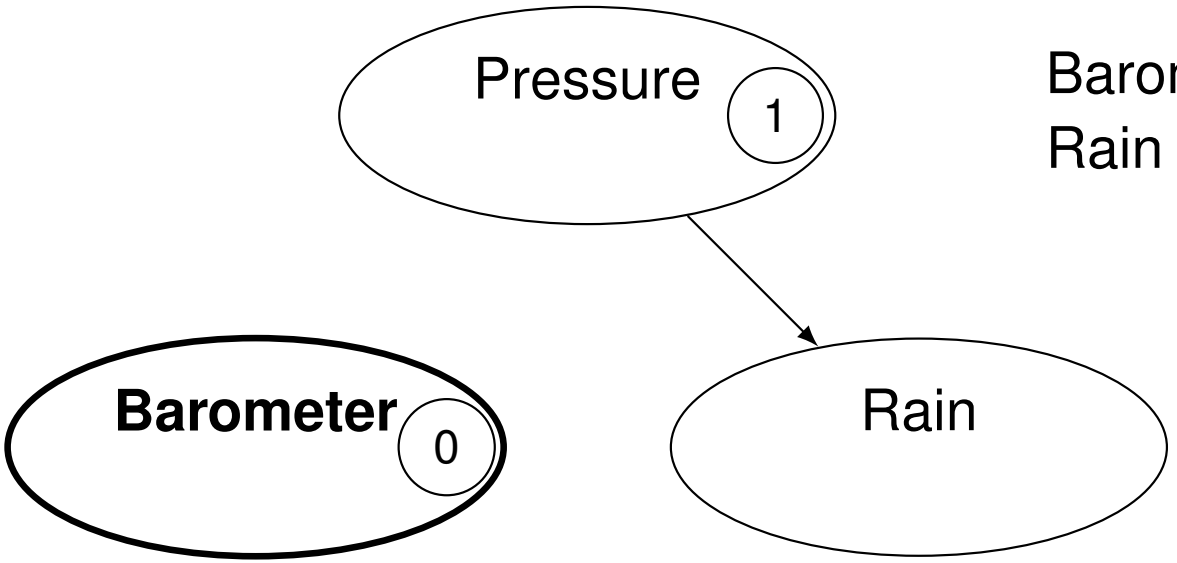

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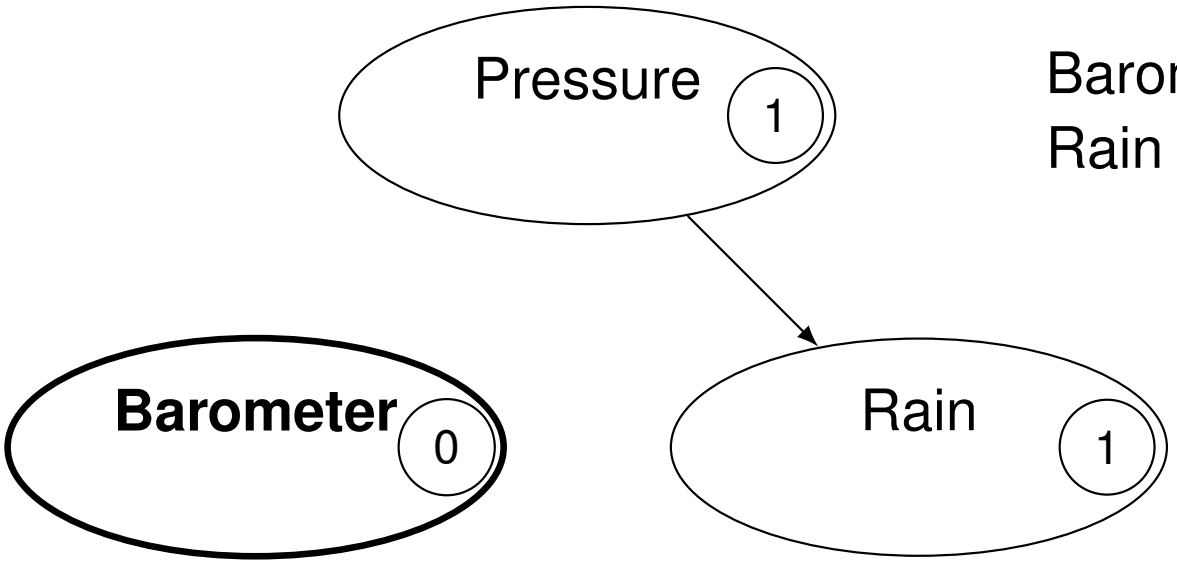
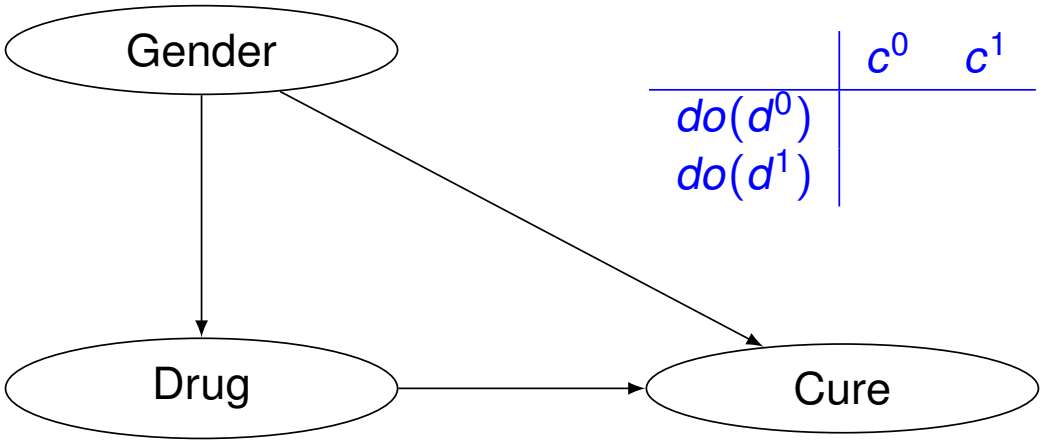


Barometer = 0
Rain = Pressure

Simpson's Paradox

g^f	g^m
0.5	0.5

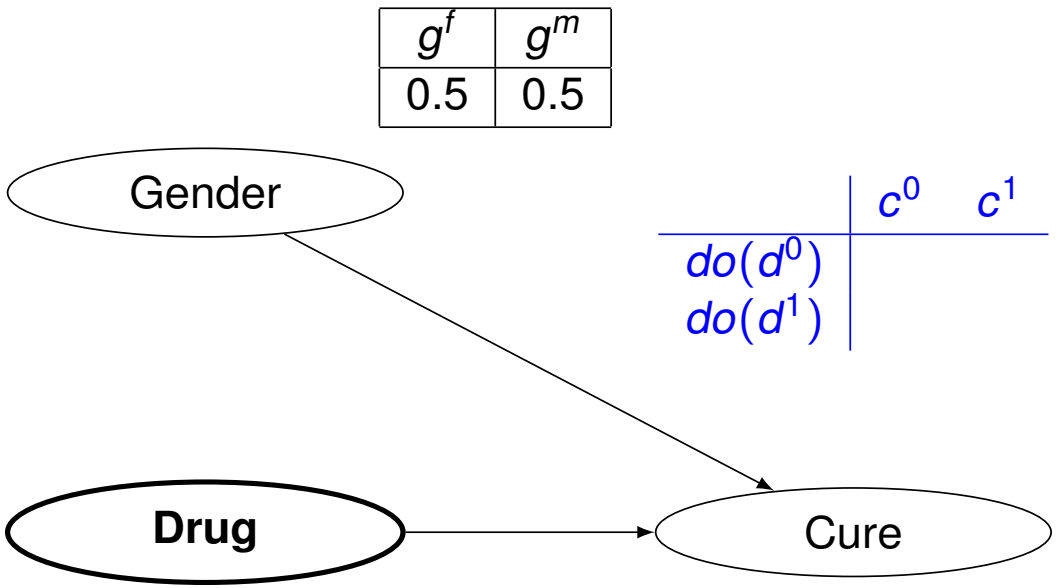


	c^0	c^1
$do(d^0)$		
$do(d^1)$		

	c^1	d^1
g^f	0.25	0.75
g^m	0.75	0.25

	c^0	c^1
g^f, d^0	0.6	0.4
g^f, d^1	0.8	0.2
g^m, d^0	0.2	0.8
g^m, d^1	0.3	0.7

Simpson's Paradox

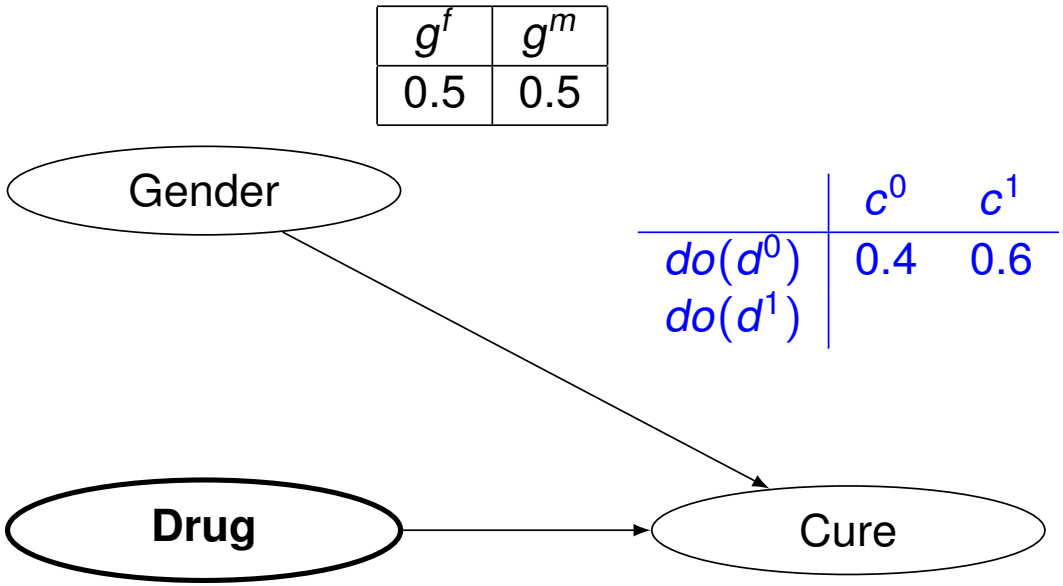


g^f	g^m
0.5	0.5

	c^1	d^1
g^f	0	1
g^m	0	1

	c^0	c^1
g^f, d^0	0.6	0.4
g^f, d^1	0.8	0.2
g^m, d^0	0.2	0.8
g^m, d^1	0.3	0.7

Simpson's Paradox



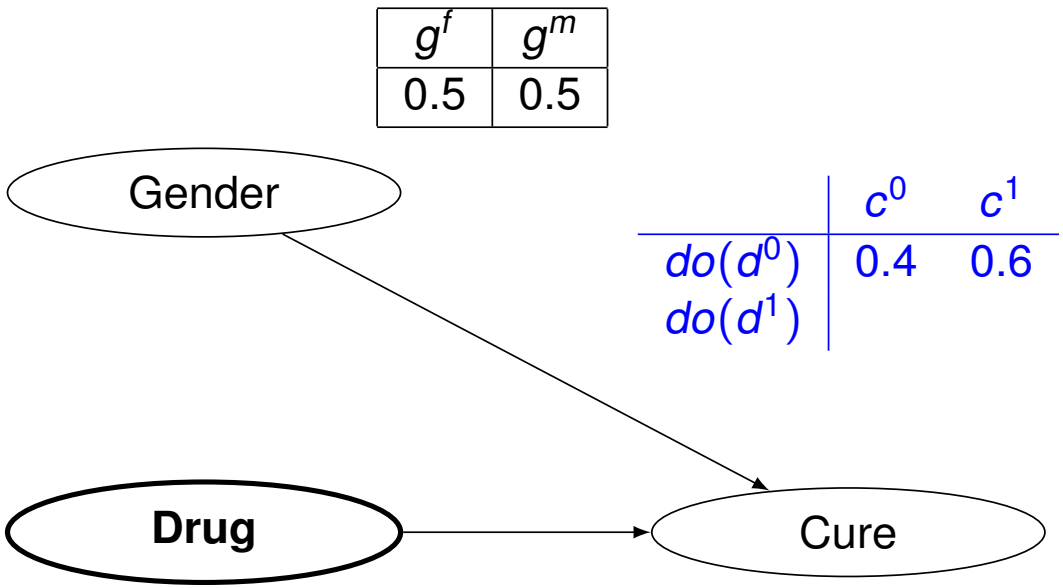
g^f	g^m
0.5	0.5

	c^0	c^1
$do(d^0)$	0.4	0.6
$do(d^1)$		

	c^1	d^1
g^f	0	1
g^m	0	1

	c^0	c^1
g^f, d^0	0.6	0.4
g^f, d^1	0.8	0.2
g^m, d^0	0.2	0.8
g^m, d^1	0.3	0.7

Simpson's Paradox



g^f	g^m
0.5	0.5

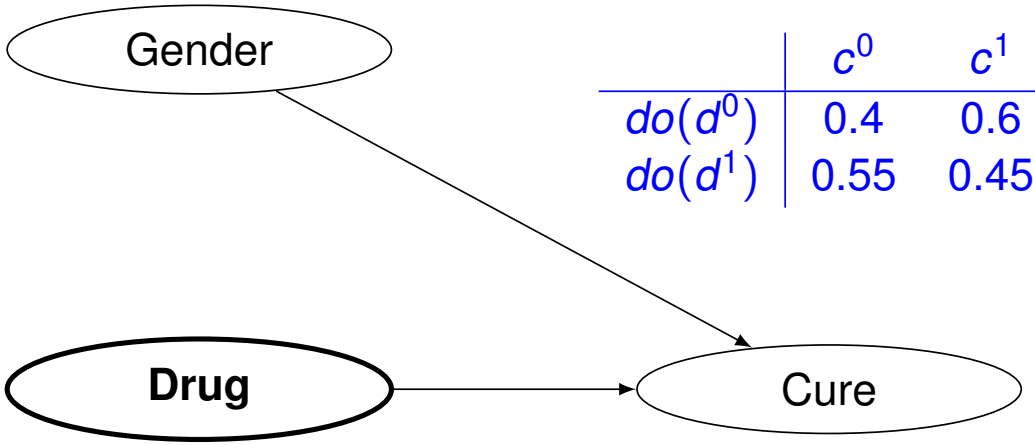
	c^0	c^1
$do(d^0)$	0.4	0.6
$do(d^1)$		

	c^1	d^1
g^f	1	0
g^m	1	0

	c^0	c^1
g^f, d^0	0.6	0.4
g^f, d^1	0.8	0.2
g^m, d^0	0.2	0.8
g^m, d^1	0.3	0.7

Simpson's Paradox

g^f	g^m
0.5	0.5

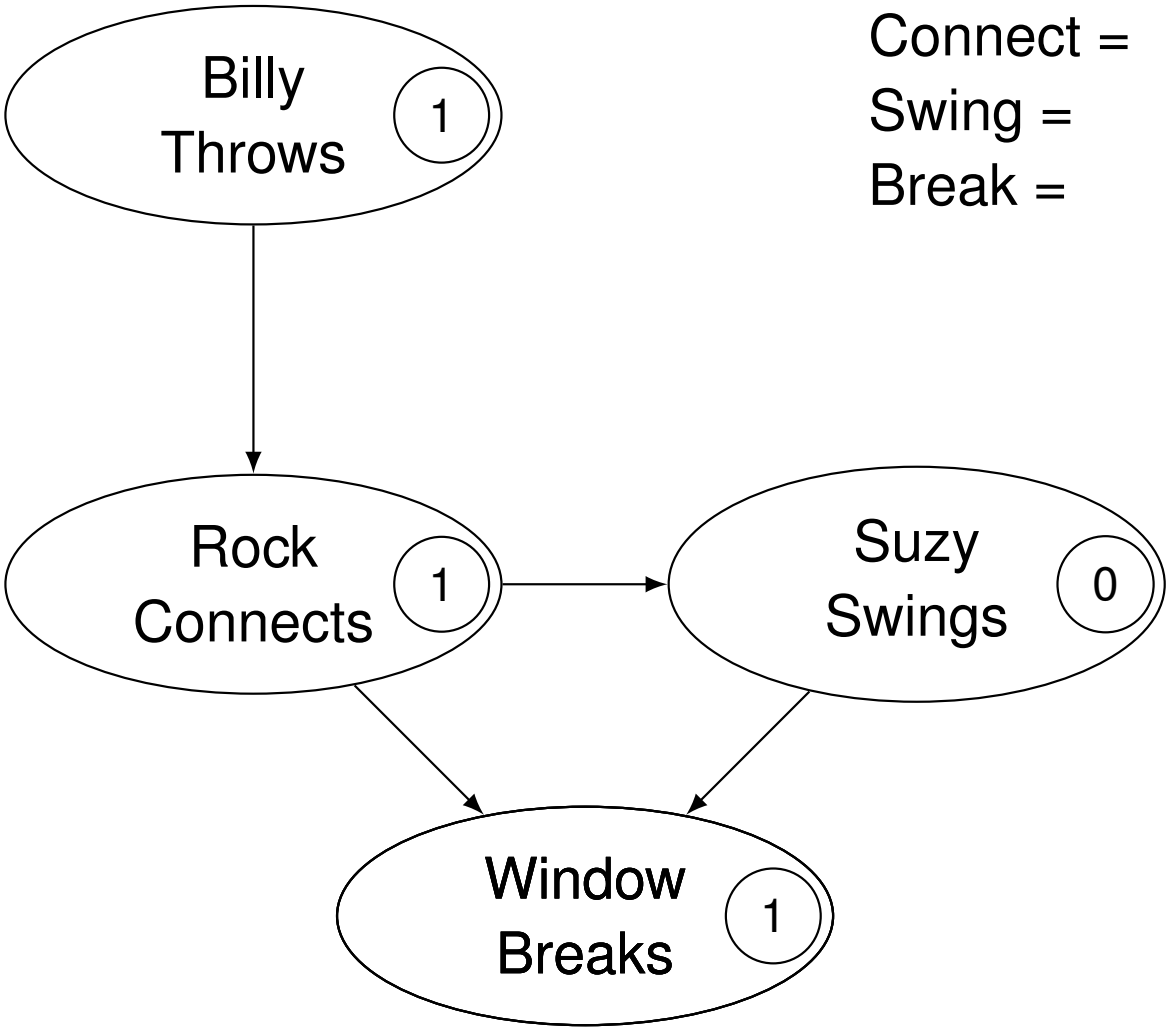


	c^0	c^1
$do(d^0)$	0.4	0.6
$do(d^1)$	0.55	0.45

	c^1	d^1
g^f	1	0
g^m	1	0

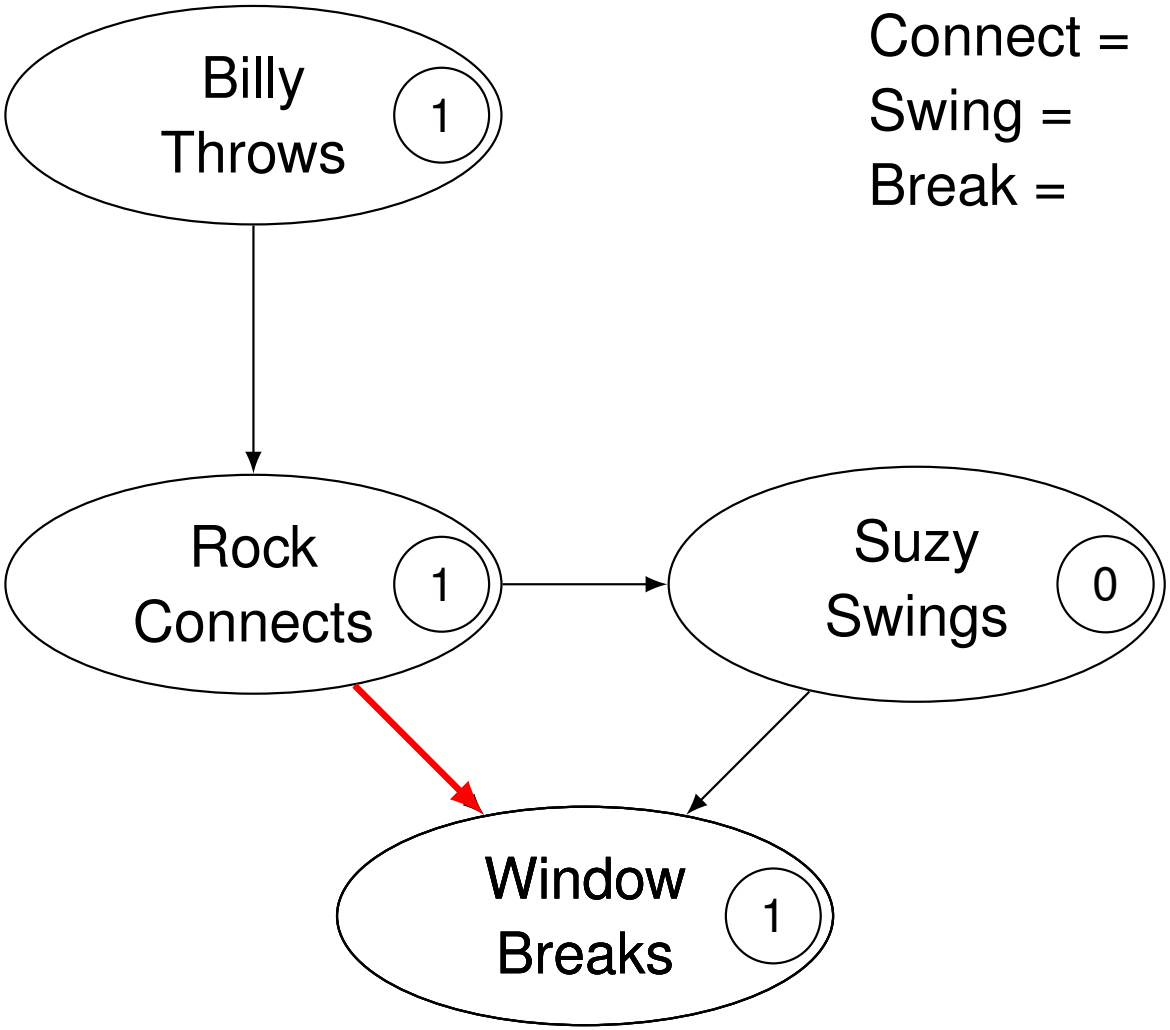
	c^0	c^1
g^f, d^0	0.6	0.4
g^f, d^1	0.8	0.2
g^m, d^0	0.2	0.8
g^m, d^1	0.3	0.7

Pre-Emption



Connect = Throw
Swing = ¬Connect
Break = Throw ∨ Swing

Pre-Emption



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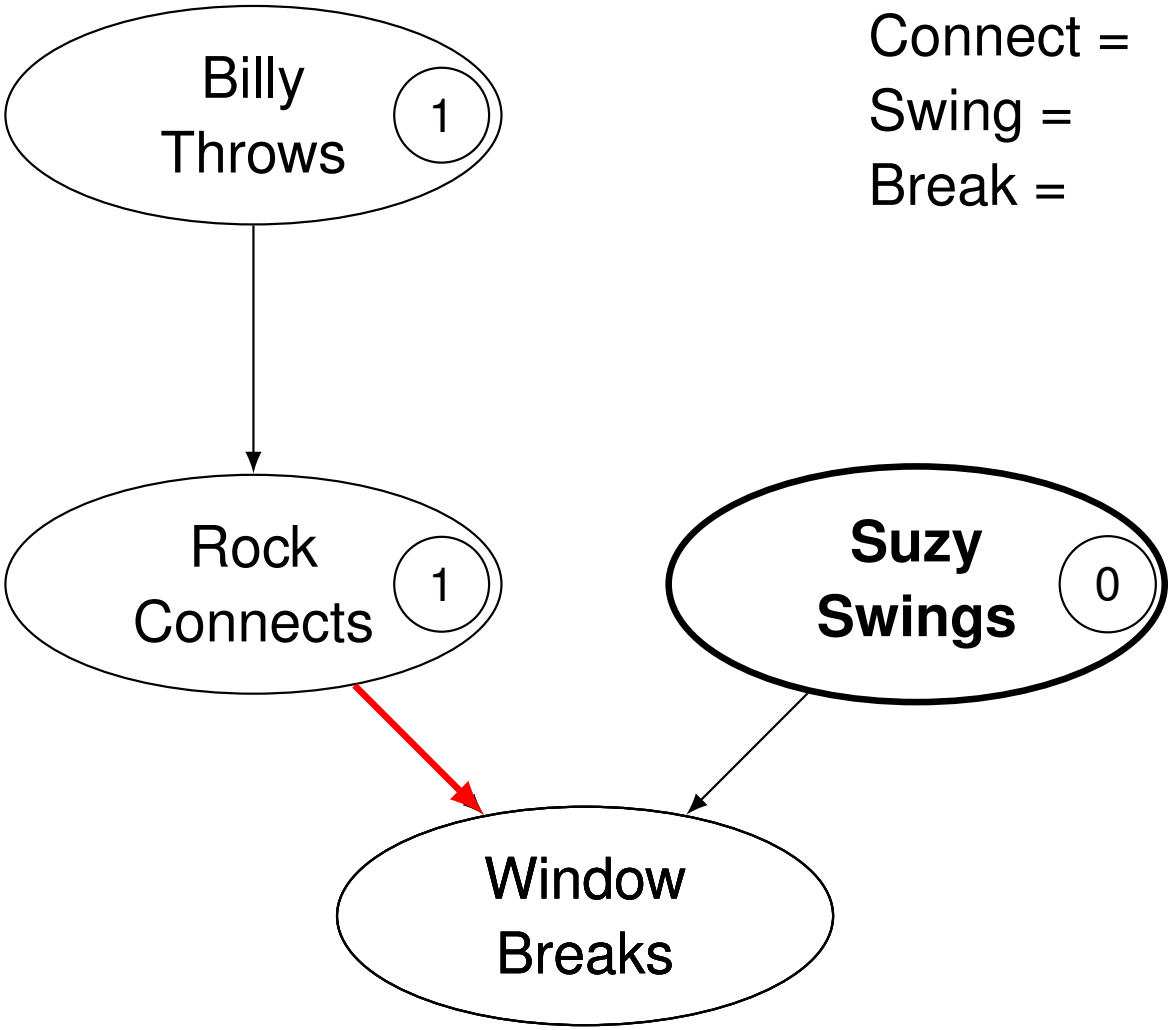
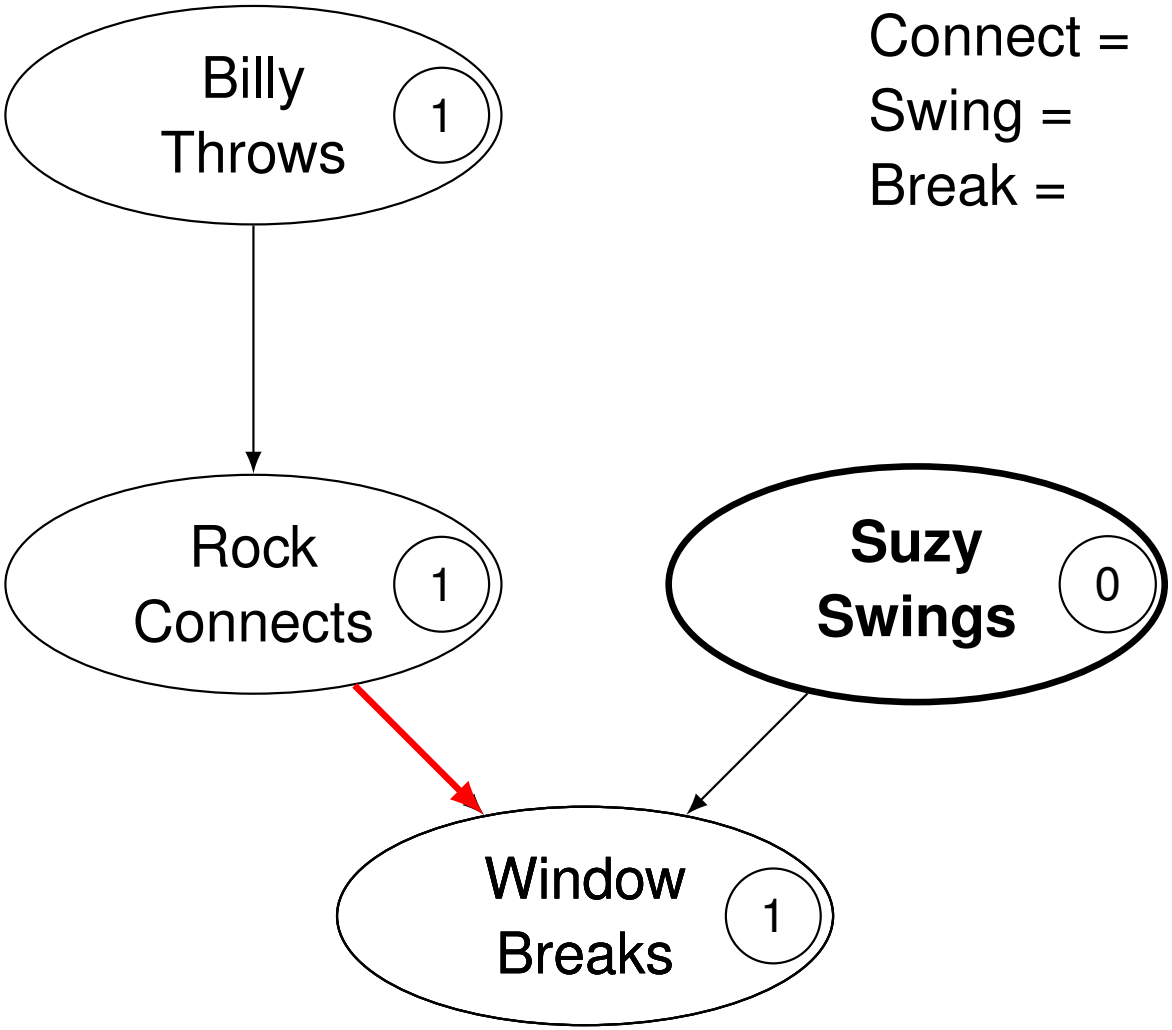


Connect = Throw
Swing = 0
Break = Throw $\vee$ Swing

Pre-Emption



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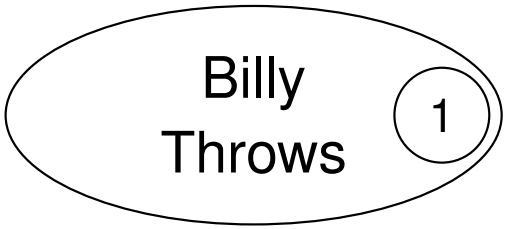

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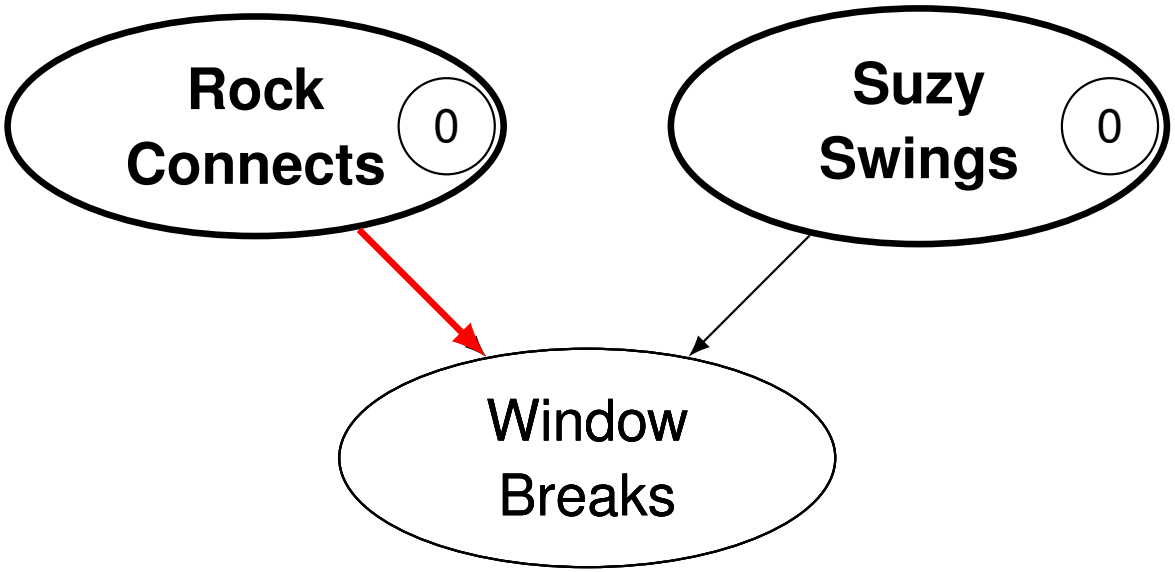
Break = Throw $\vee$ Swing



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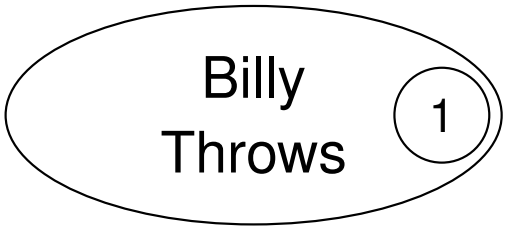

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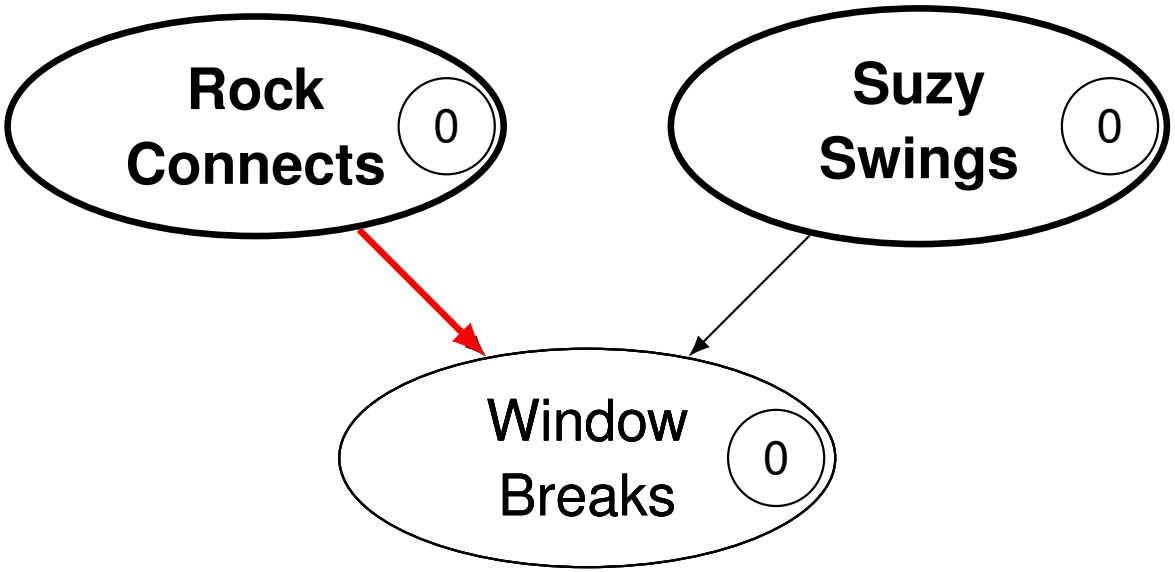
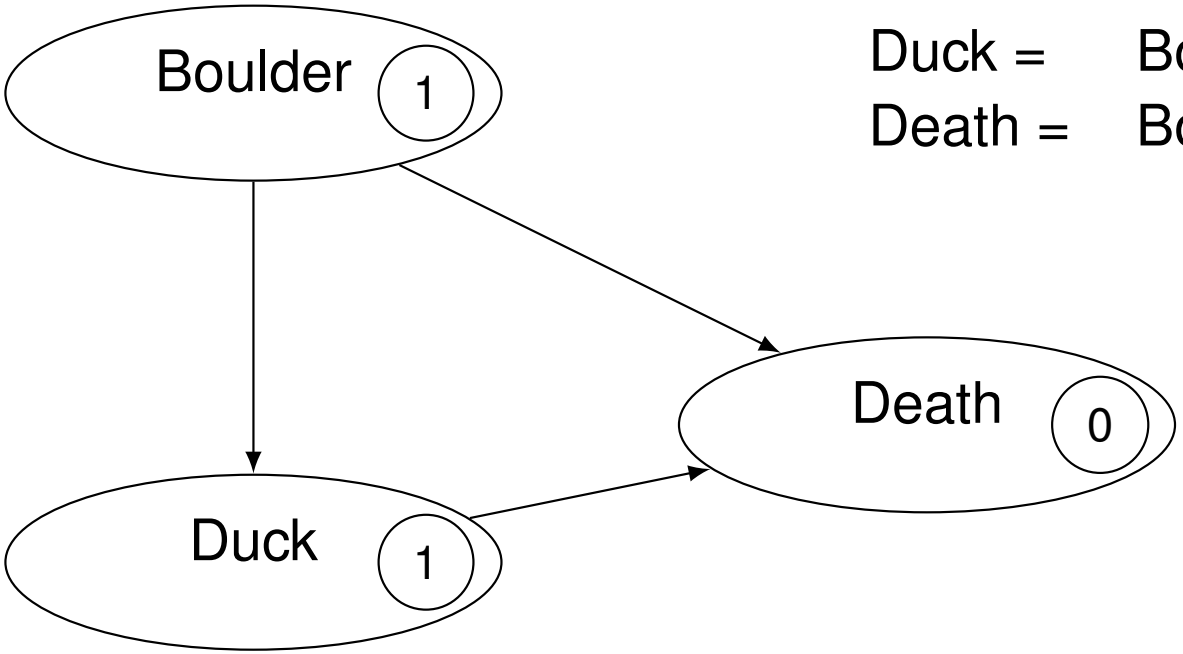


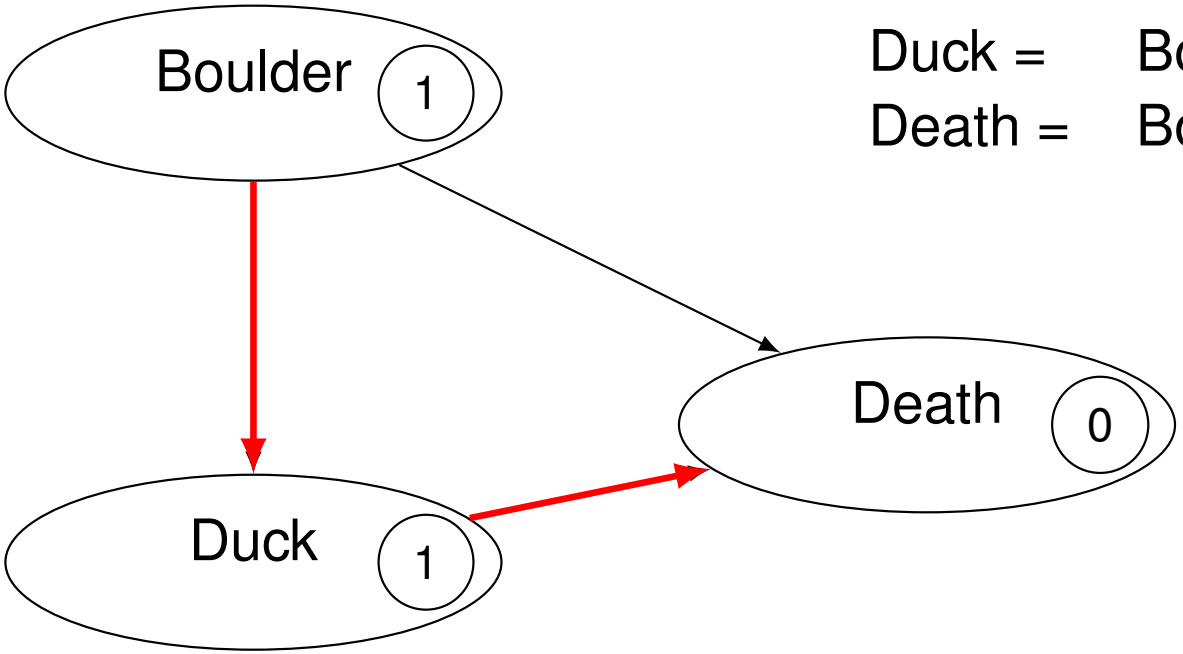
Intransitive Causation



Duck = Boulder

Death = Boulder $\wedge \neg$ Duck

Intransitive Causation



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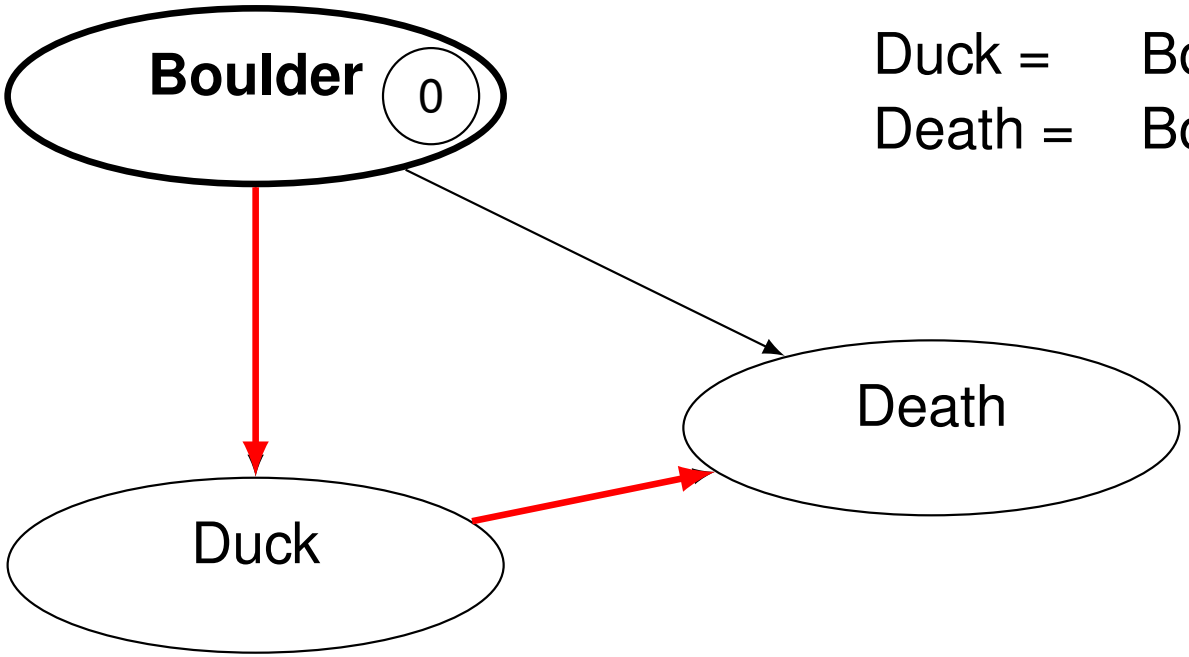

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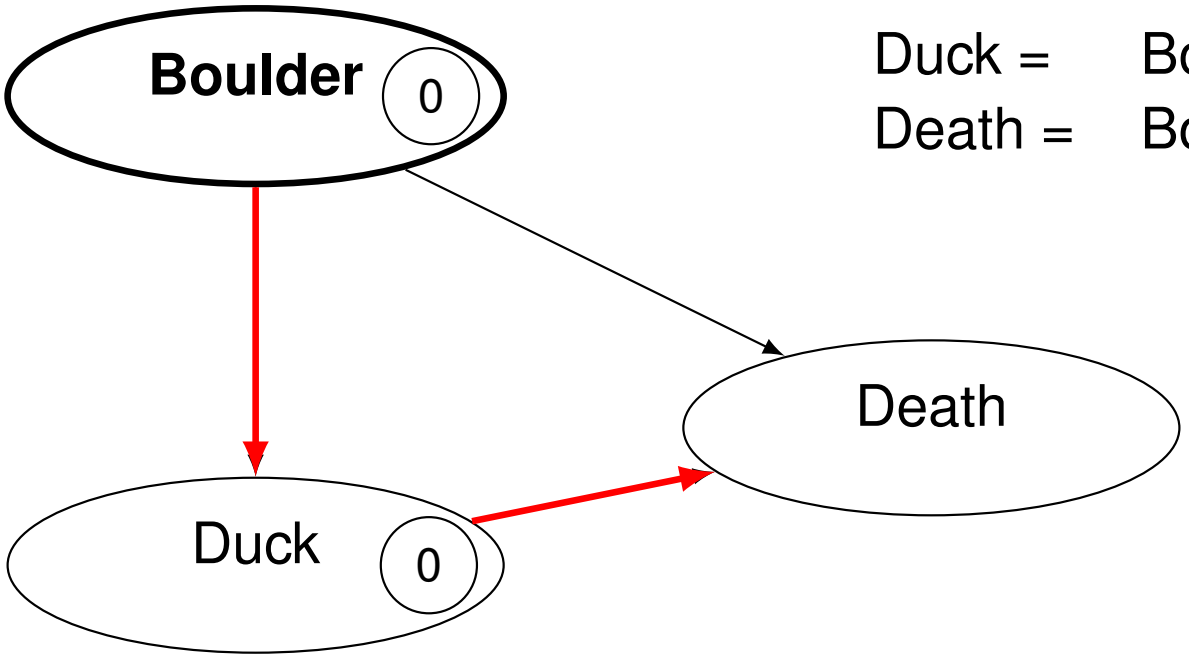

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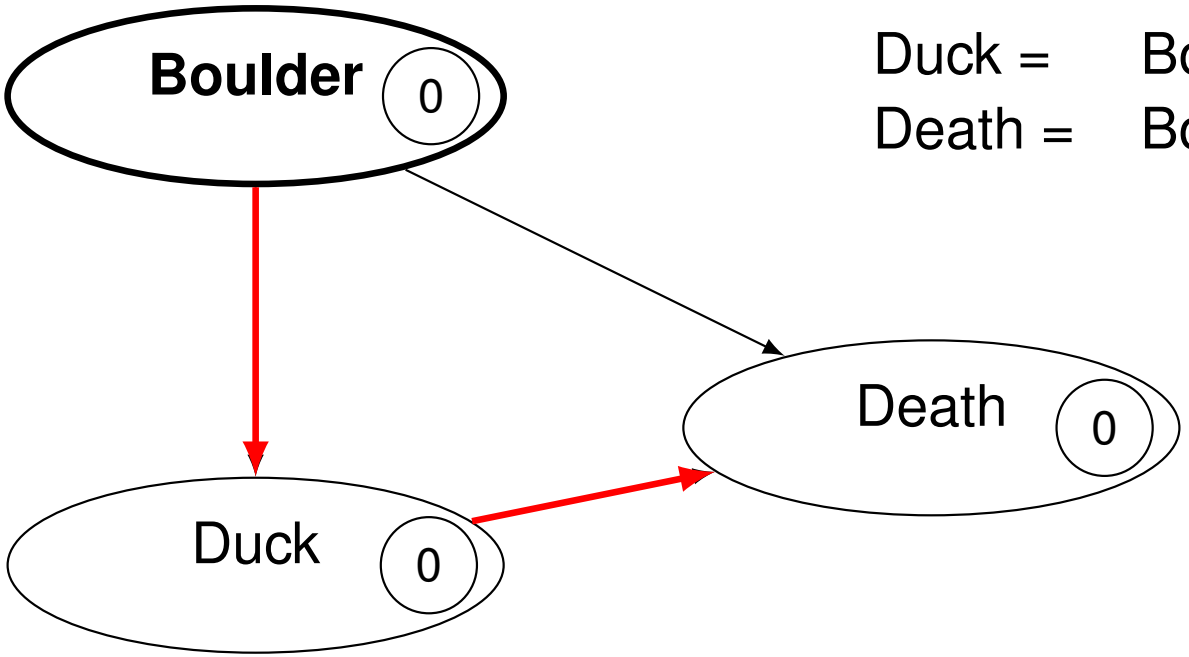

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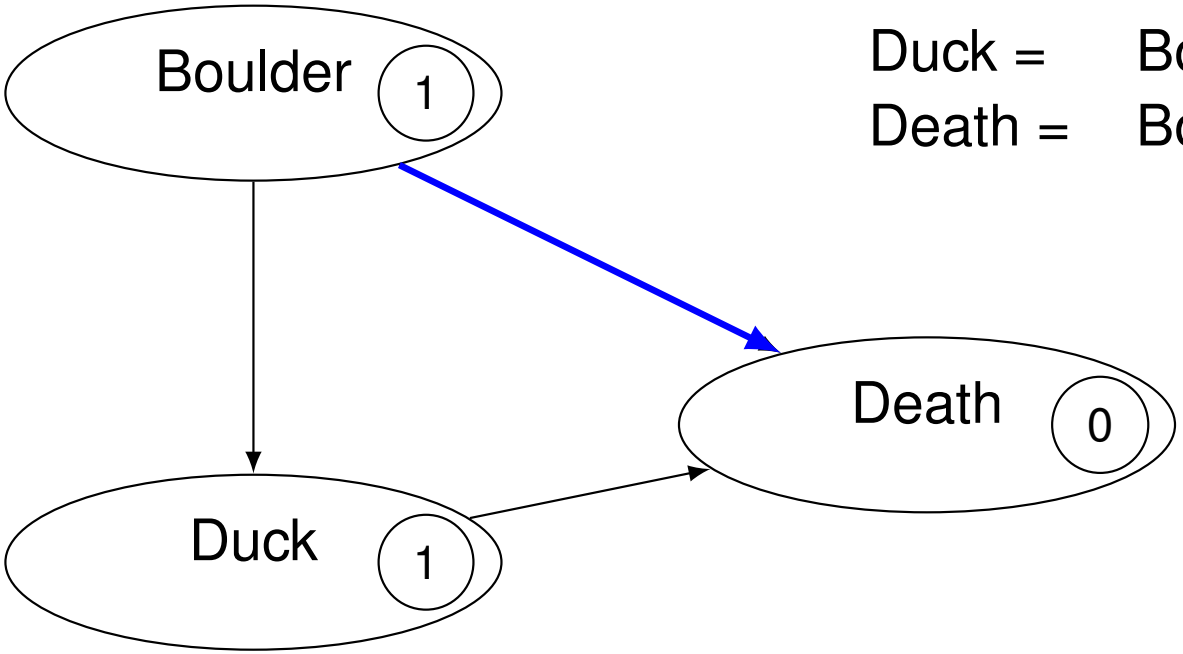

Duck = Boulder

Death = Boulder $\wedge \neg$ Duck

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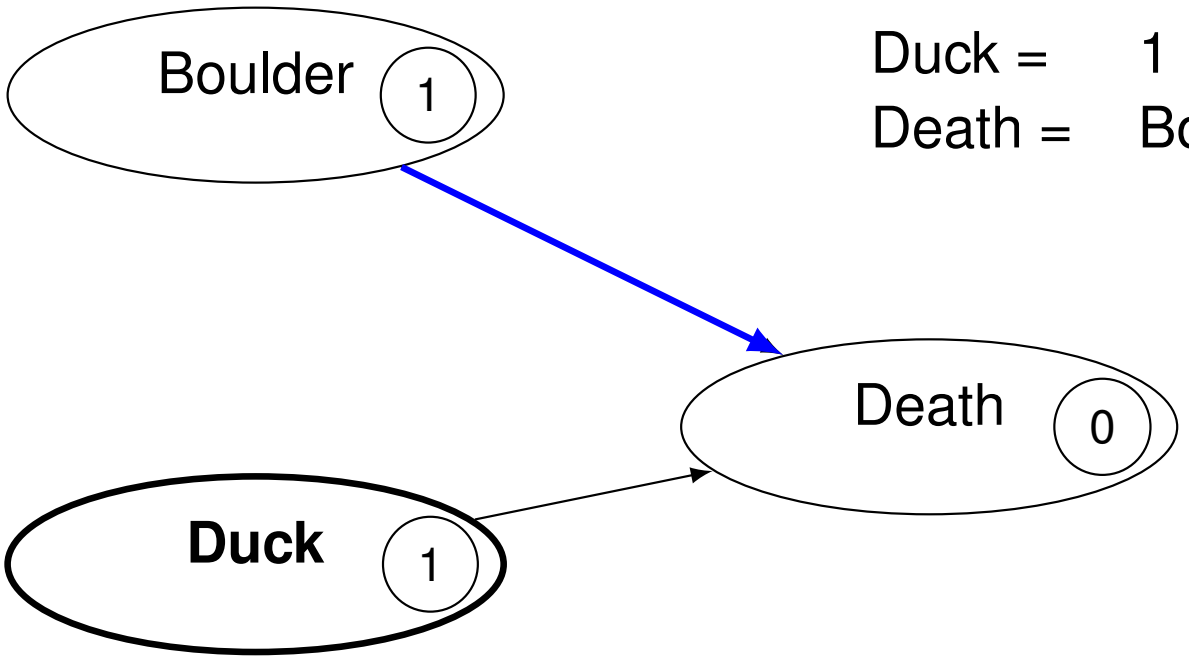
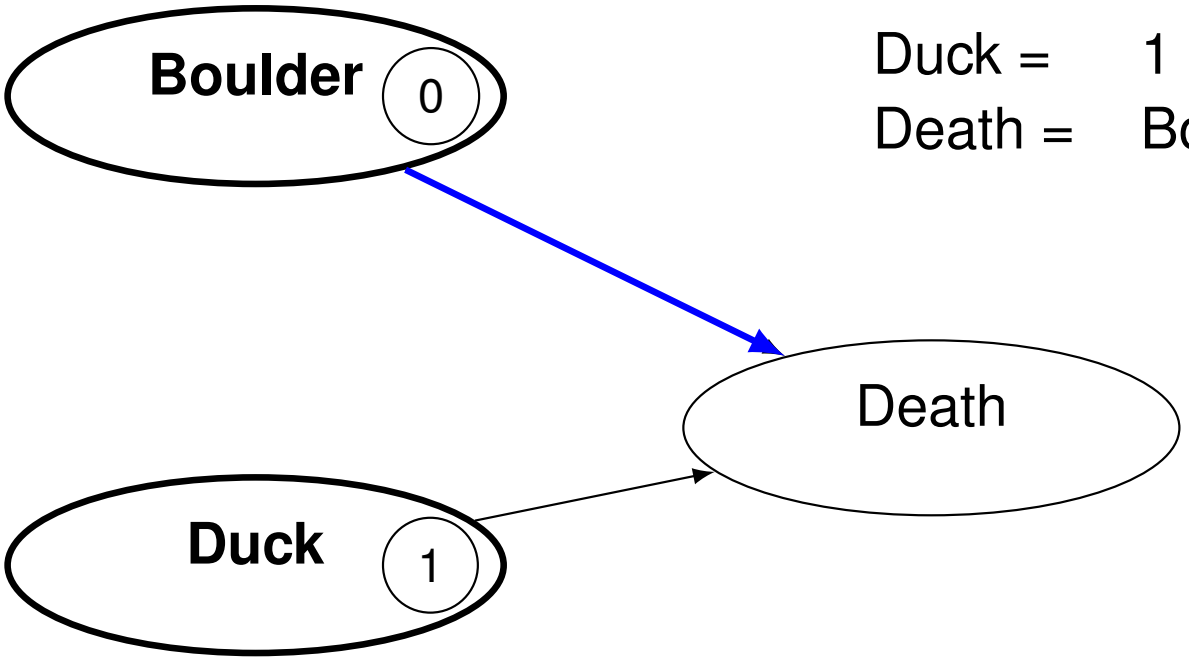


Duck = 1

Death = Boulder $\wedge$ $\neg$ Duck

Intransitive Causation



Duck = 1

Death = Boulder $\wedge$ $\neg$ Duck

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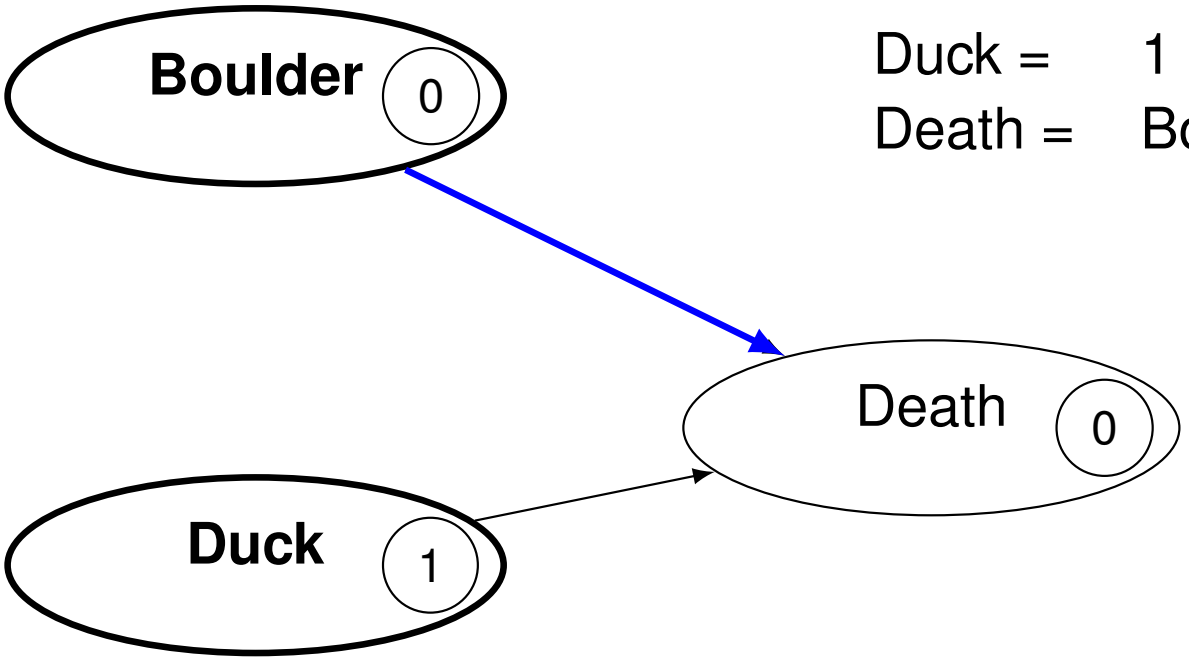
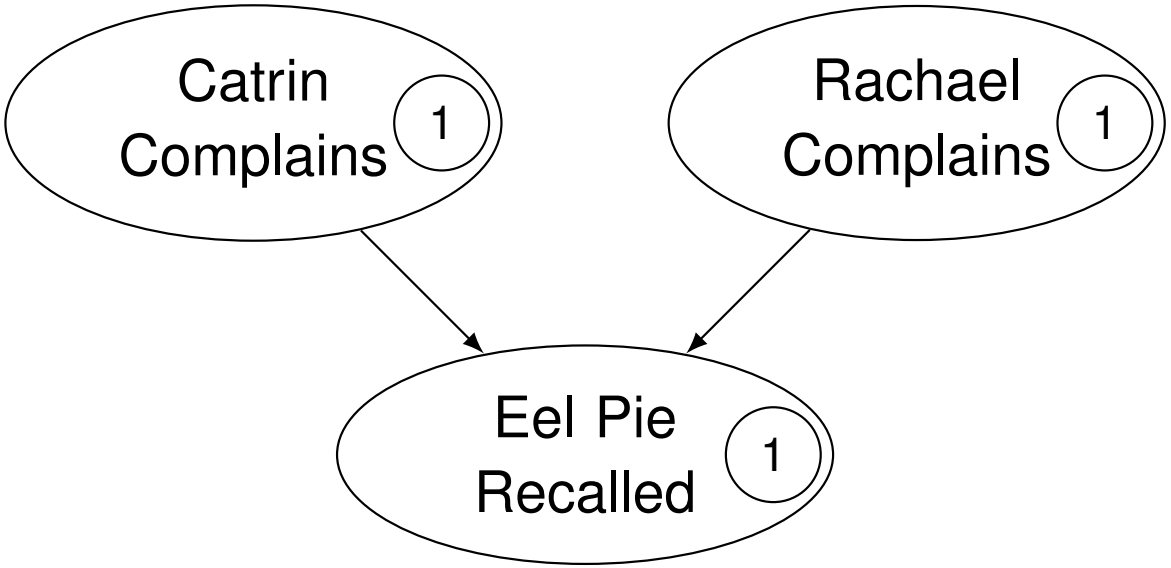


Duck = 1

Death = Boulder $\wedge$ $\neg$ Duck

Overdetermination

Recall = Rachael $\vee$ Catrin



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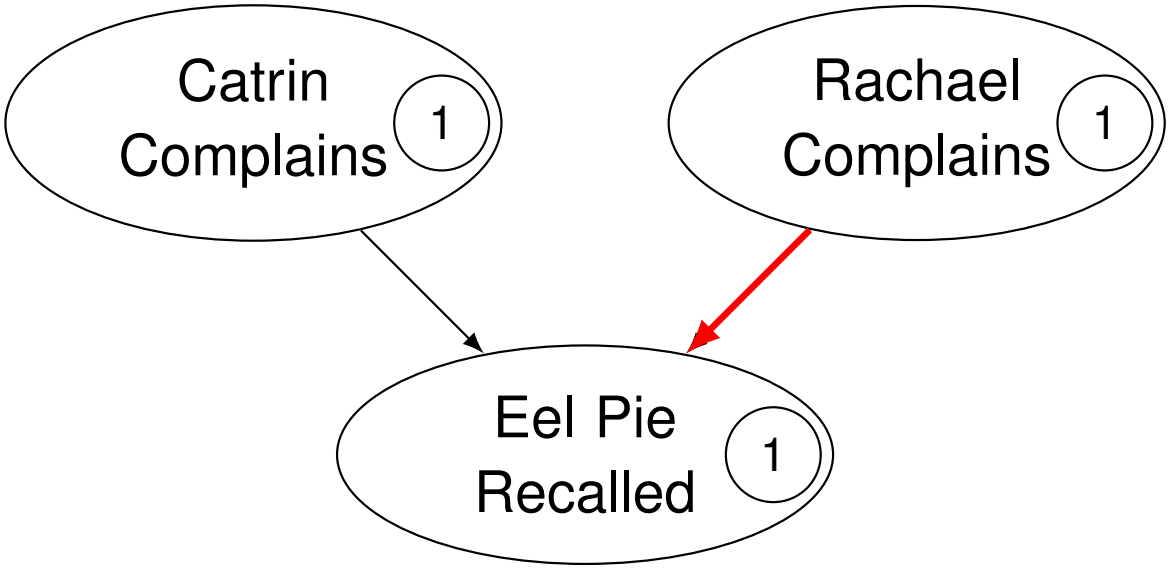

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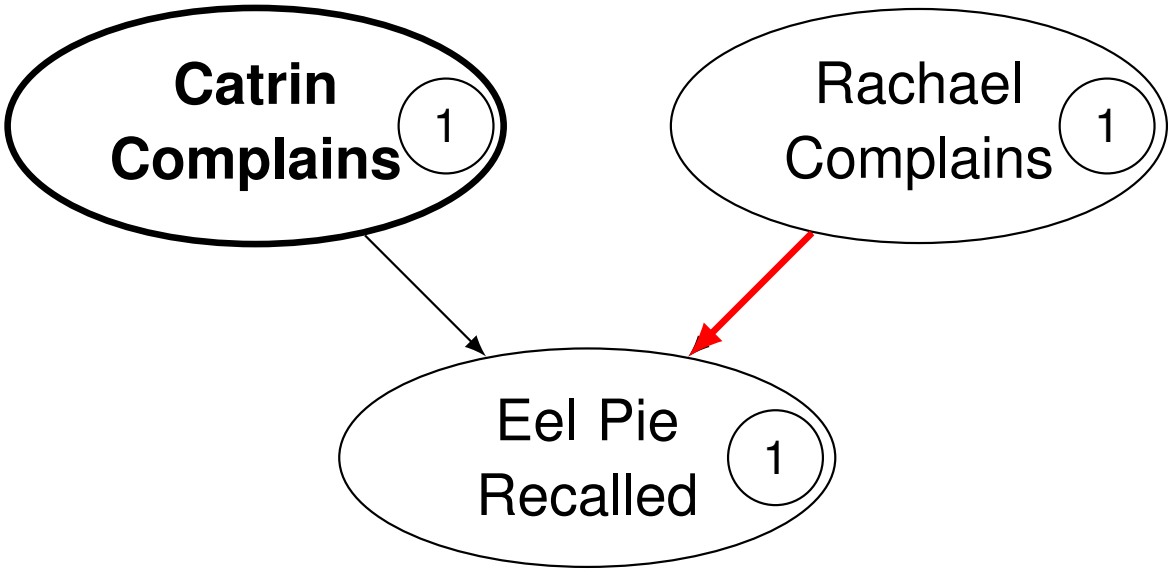

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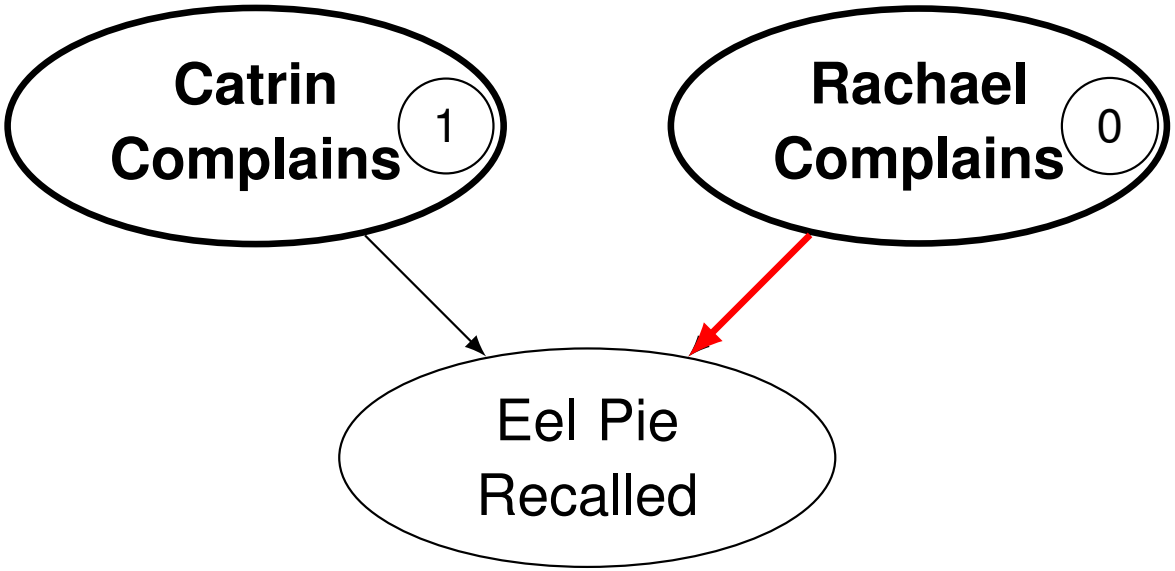
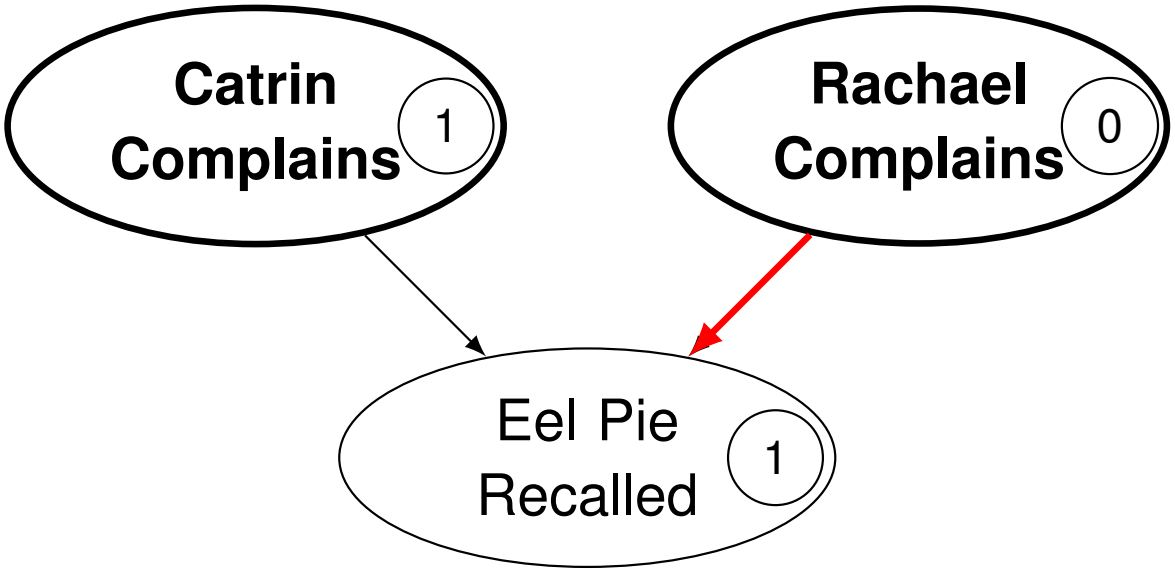


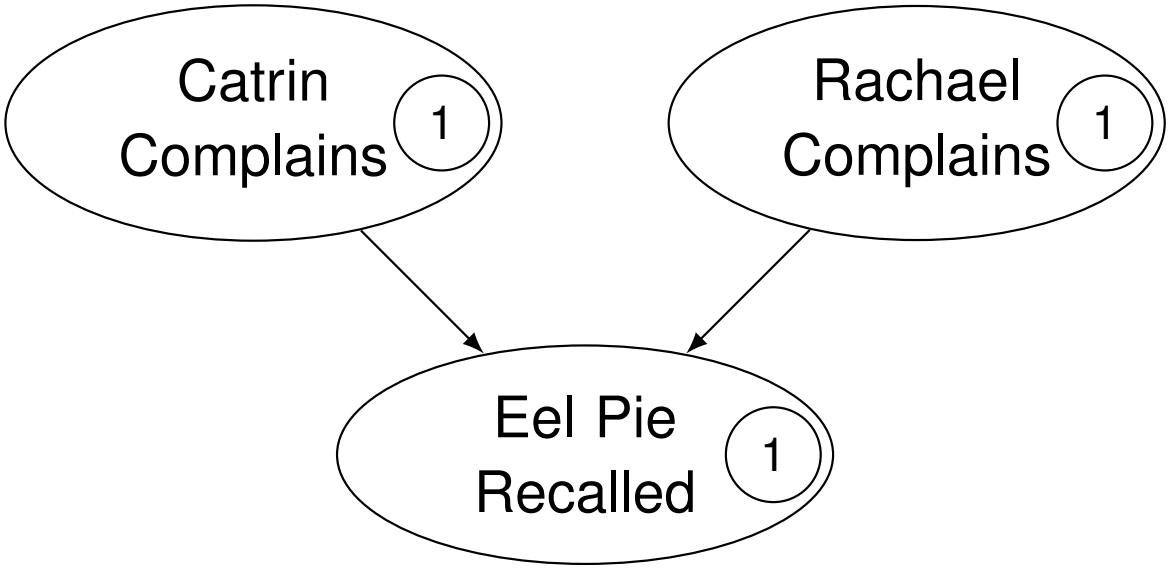
Overdetermination

$$\text{Recall} = \text{Rachael} \vee \text{Catrin}$$



Overdetermination

Recall = Rachael $\vee$ Catrin



Overdetermination

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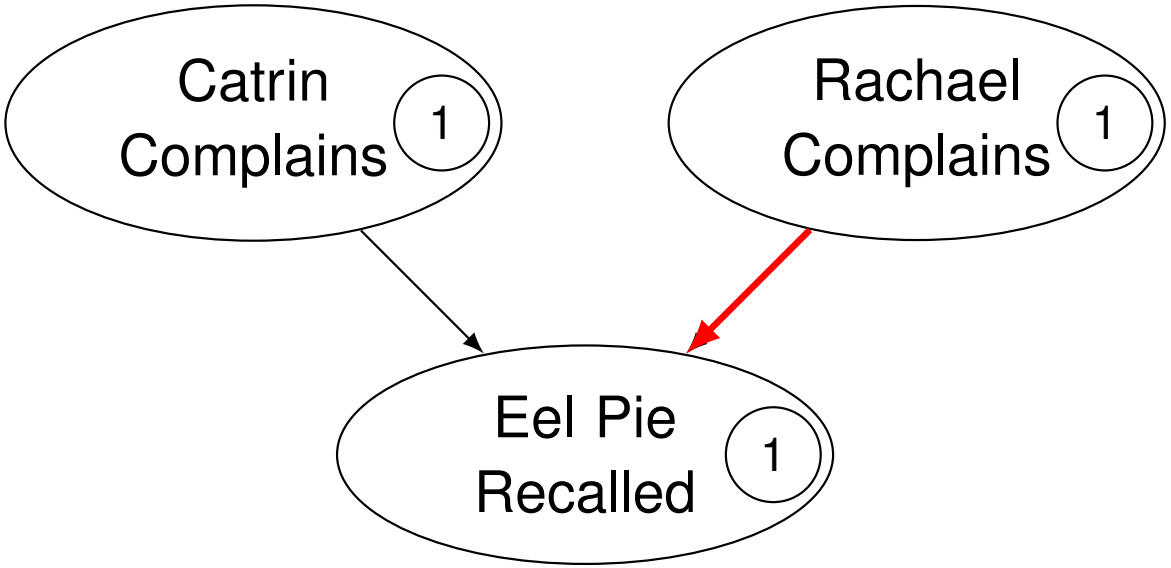

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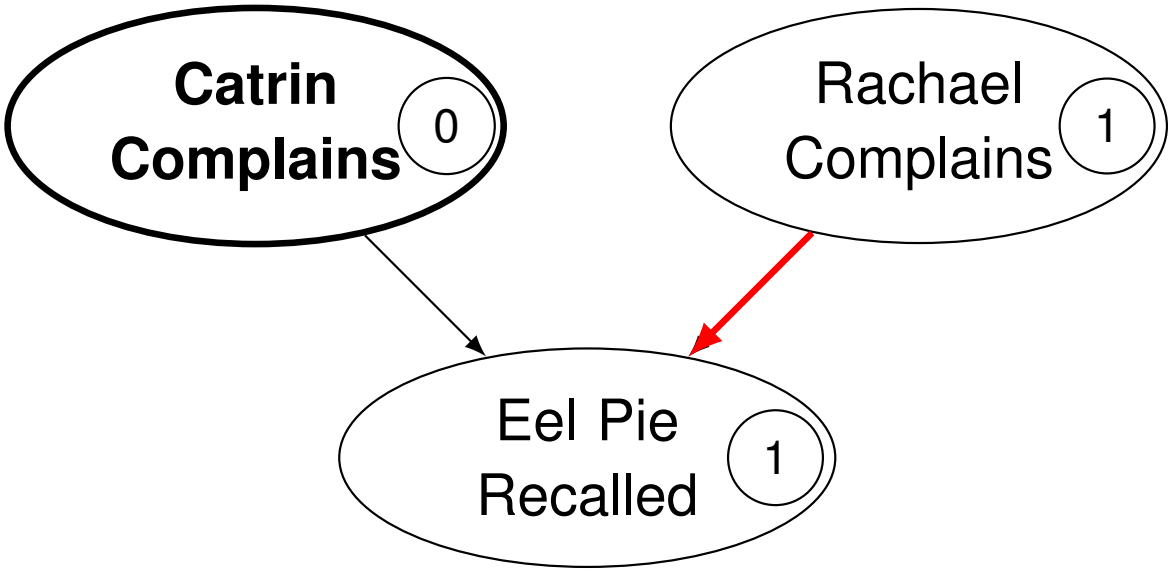
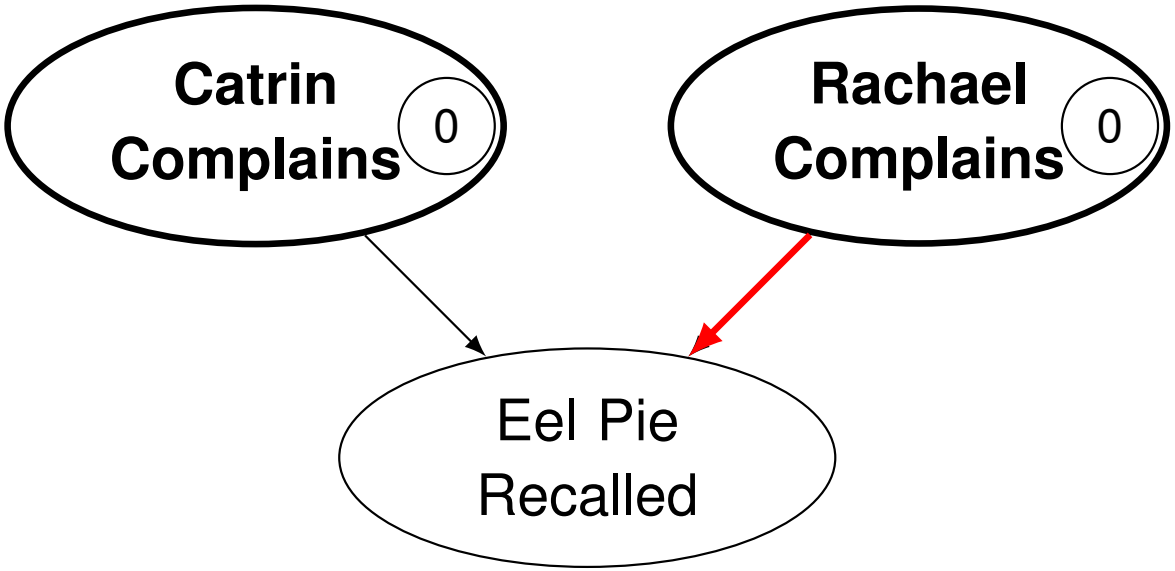
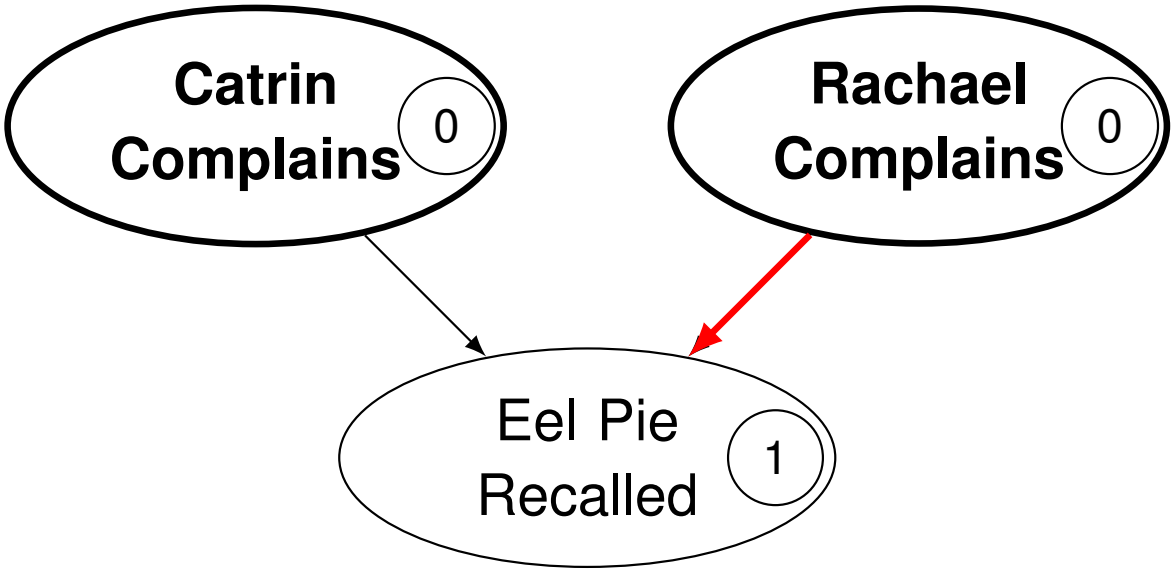


Overdetermination

Recall = Rachael $\vee$ Catrin



Overdetermination

Recall = Rachael ∨ Catrin