

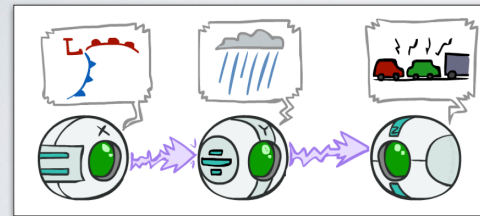
D-SEPARATION

CSE 511A: Introduction to Artificial Intelligence

Some content and images are from slides created by Dan Klein and Pieter Abbeel for CS188 Intro to AI at UC Berkeley.
All CS188 materials are available at <http://ai.berkeley.edu>.

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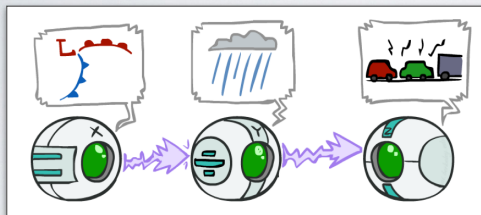
X: low pressure Y: rain Z: traffic

$$P(X,Y,Z) = P(Z|Y) P(Y|X) P(X)$$

- Are X and Z guaranteed to be independent of each other?

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D-SEPARATION



X: low pressure Y: rain Z: traffic

$$P(X,Y,Z) = P(Z|Y) P(Y|X) P(X)$$

- Are X and Z guaranteed to be independent of each other? **No.**
- High-level intuition:
 - $P(Z|X) = P(Z,X) / P(X)$
 - $P(Z) = P(Z,X) + P(Z,\neg X)$
 - $P(Z) \neq P(Z|X)$ for some CPTs

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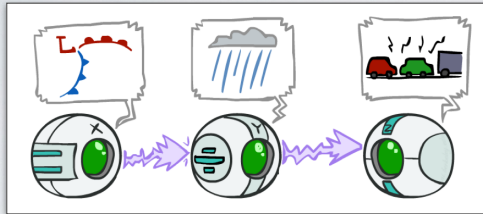
X: low pressure Y: rain Z: traffic

$$P(X,Y,Z) = P(Z|Y) P(Y|X) P(X)$$

- Are X and Z guaranteed to be independent of each other given Y?

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D-SEPARATION



X: low pressure Y: rain Z: traffic

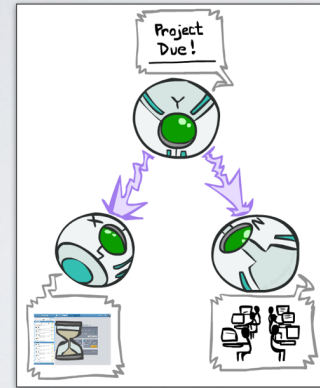
$$P(X,Y,Z) = P(Z|Y) P(Y|X) P(X)$$

- Are X and Z guaranteed to be independent of each other given Y? **Yes!**
- Evidence along the chain “blocks” the influence

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D-SEPARATION

Y: project due



X: forums busy

Z: lab full

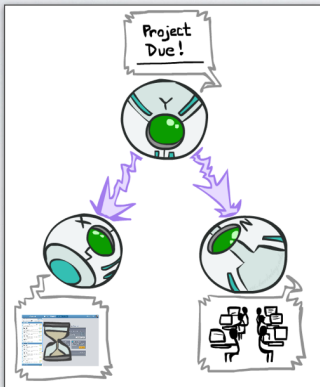
$$P(X,Y,Z) = P(X|Y) P(Z|Y) P(Y)$$

- Are X and Z guaranteed to be independent of each other?

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D-SEPARATION

Y: project due



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Z: lab full

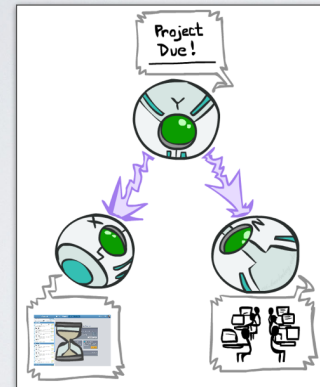
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D-SEPARATION

Y: project due



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Z: lab full

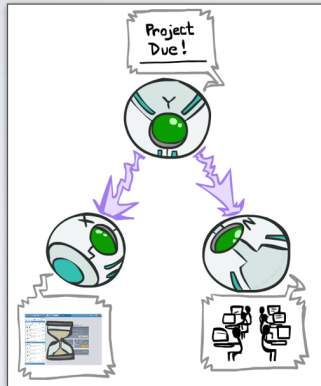
$$P(X,Y,Z) = P(X|Y) P(Z|Y) P(Y)$$

- Are X and Z guaranteed to be independent of each other given Y?

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D-SEPARATION

Y: project due



X: forums busy

Z: lab full

$$P(X,Y,Z) = P(X|Y) P(Z|Y) P(Y)$$

- Are X and Z guaranteed to be independent of each other given Y? **Yes!**
- Observing the cause “blocks” influence between effects

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D-SEPARATION

X: raining

Y: ballgame



Z: traffic

$$P(X,Y,Z) = P(Z|X,Y) P(X) P(Y)$$

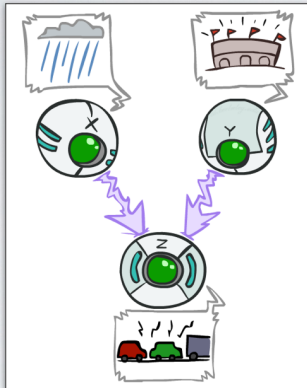
- Are X and Y guaranteed to be independent of each other?

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D-SEPARATION

X: raining

Y: ballgame



Z: traffic

$$P(X,Y,Z) = P(Z|X,Y) P(X) P(Y)$$

- Are X and Y guaranteed to be independent of each other? **Yes!**
- Both raining and ballgames cause traffic, but they are not correlated

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D-SEPARATION

X: raining

Y: ballgame



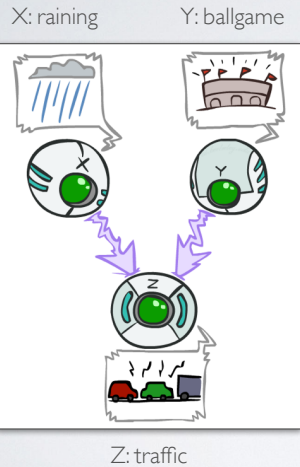
Z: traffic

$$P(X,Y,Z) = P(Z|X,Y) P(X) P(Y)$$

- Are X and Y guaranteed to be independent of each other? **Yes!**
- Both raining and ballgames cause traffic, but they are not correlated
- Are X and Y guaranteed to be independent of each other given Z?

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- Are X and Y guaranteed to be independent of each other? **Yes!**
 - Both raining and ballgames cause traffic, but they are not correlated
- Are X and Y guaranteed to be independent of each other given Z? **No!**
 - Seeing traffic puts both rain and ballgame in competition as the explanation
- Observing an effect “activates” influence between possible causes

$$P(X,Y,Z) = P(Z|X,Y) P(X) P(Y)$$

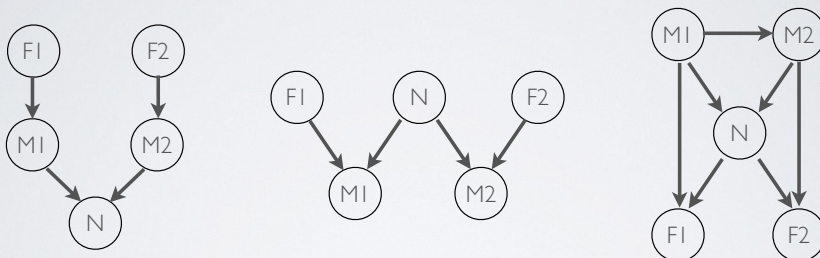
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EXAMPLE

Two astronomers, in different parts of the world, make measurements M1 and M2 of the expected number of stars N in some small region of the sky, using their telescopes. Normally, there is a small possibility of error by up to one star. Each telescope can also (with a slightly smaller probability) be badly out of focus (events F1 and F2), in which case, the scientist will undercount by three or more stars.

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EXAMPLE



Which are correct?
Which are incorrect? Why?

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