

# Redes Bayesianas

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# Causalidade

- Tema filosófico
- Definições...

# Causalidade

- X é causa de Y se os valores de Y dependem de X
- Temporal (experimentos, estudos longitudinais)
- Causas necessárias e suficientes
  - Se  $X \rightarrow Y$ , então a presença de Y requer a ocorrência prévia de X
  - Se  $X \rightarrow Y$ , então a ocorrência de X é seguida da presença de Y
- Probabilística
  - $P(Y|X) = (P(Y,X)/P(X))$



# CAUSAL INFERENCE IN STATISTICS

A Primer

**Judea Pearl**  
**Madelyn Glymour**  
**Nicholas P. Jewell**



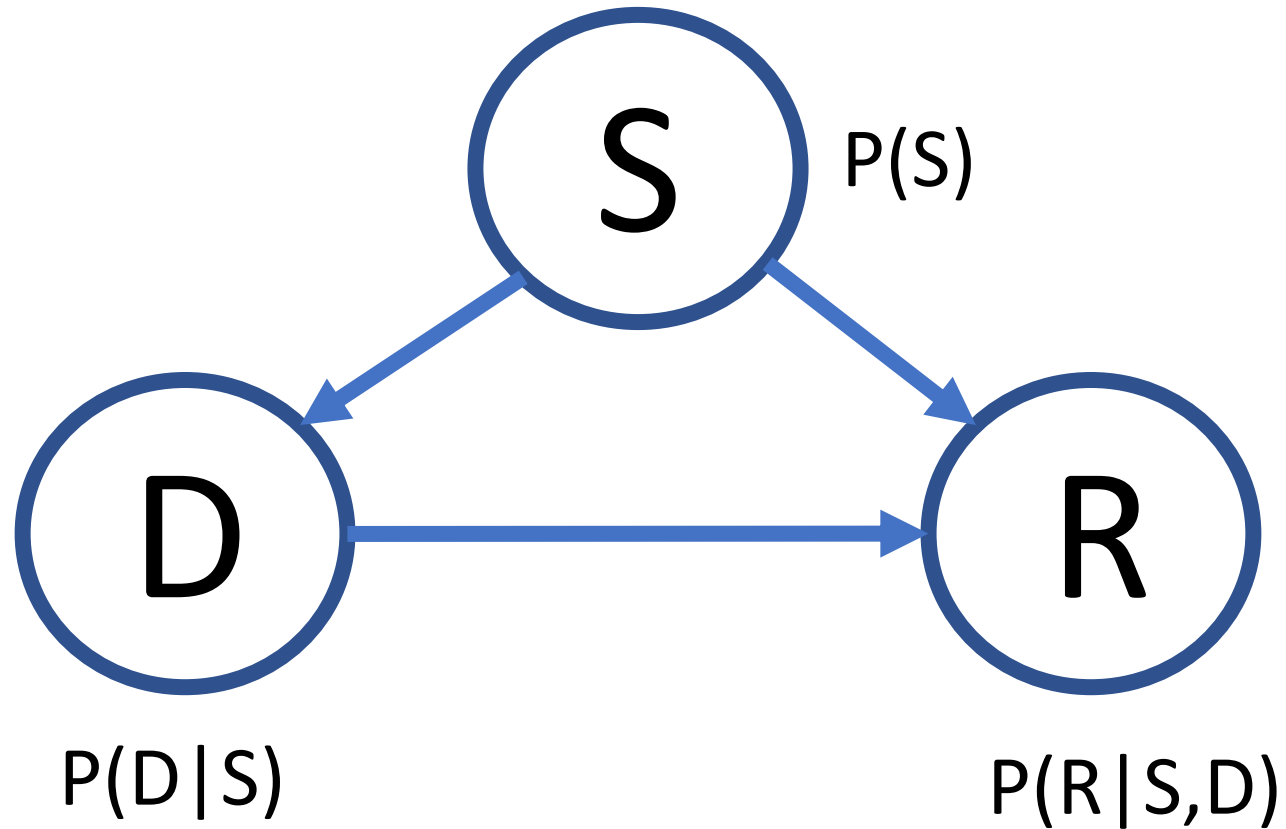
WILEY

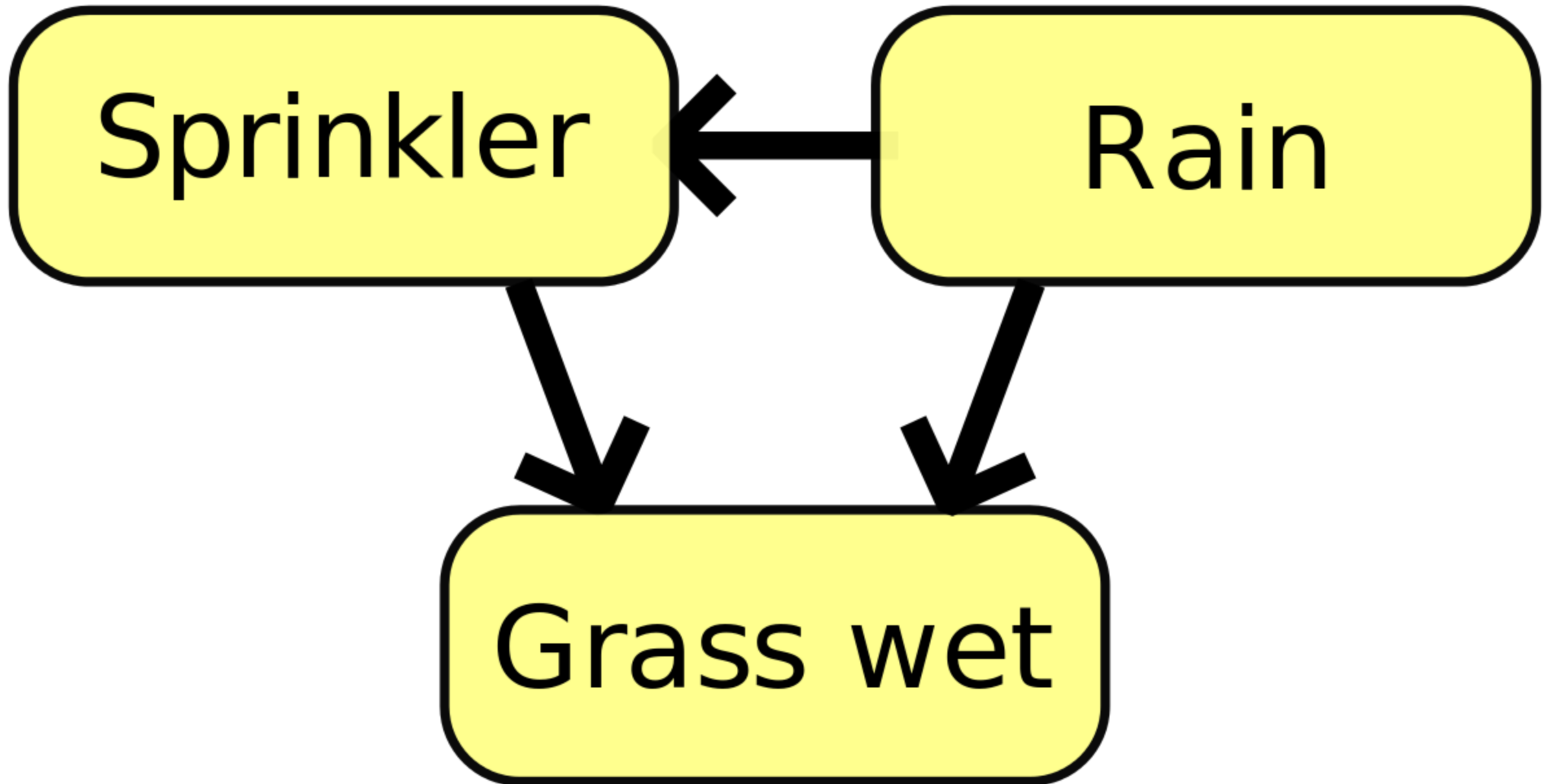
**Example 1.2.1** *We record the recovery rates of 700 patients who were given access to the drug. A total of 350 patients chose to take the drug and 350 patients did not. The results of the study are shown in Table 1.1.*

**Table 1.1** Results of a study into a new drug, with gender being taken into account

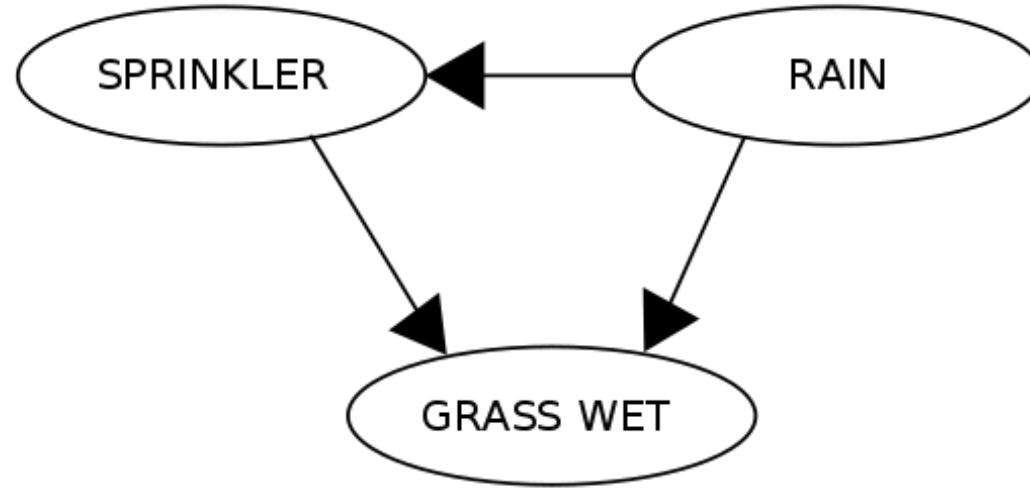
	Drug	No drug
Men	81 out of 87 recovered (93%)	234 out of 270 recovered (87%)
Women	192 out of 263 recovered (73%)	55 out of 80 recovered (69%)
Combined data	273 out of 350 recovered (78%)	289 out of 350 recovered (83%)

# Direct Acyclic Graphs





RAIN	SPRINKLER	
	T	F
F	0.4	0.6
T	0.01	0.99

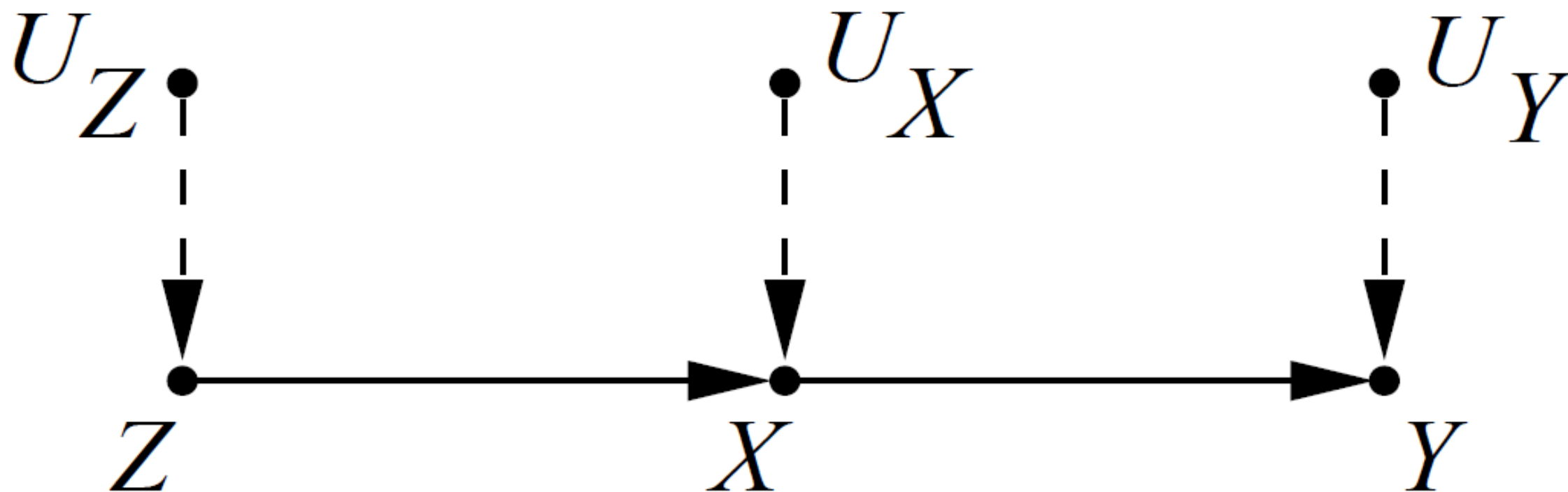


	RAIN	
	T	F
	0.2	0.8

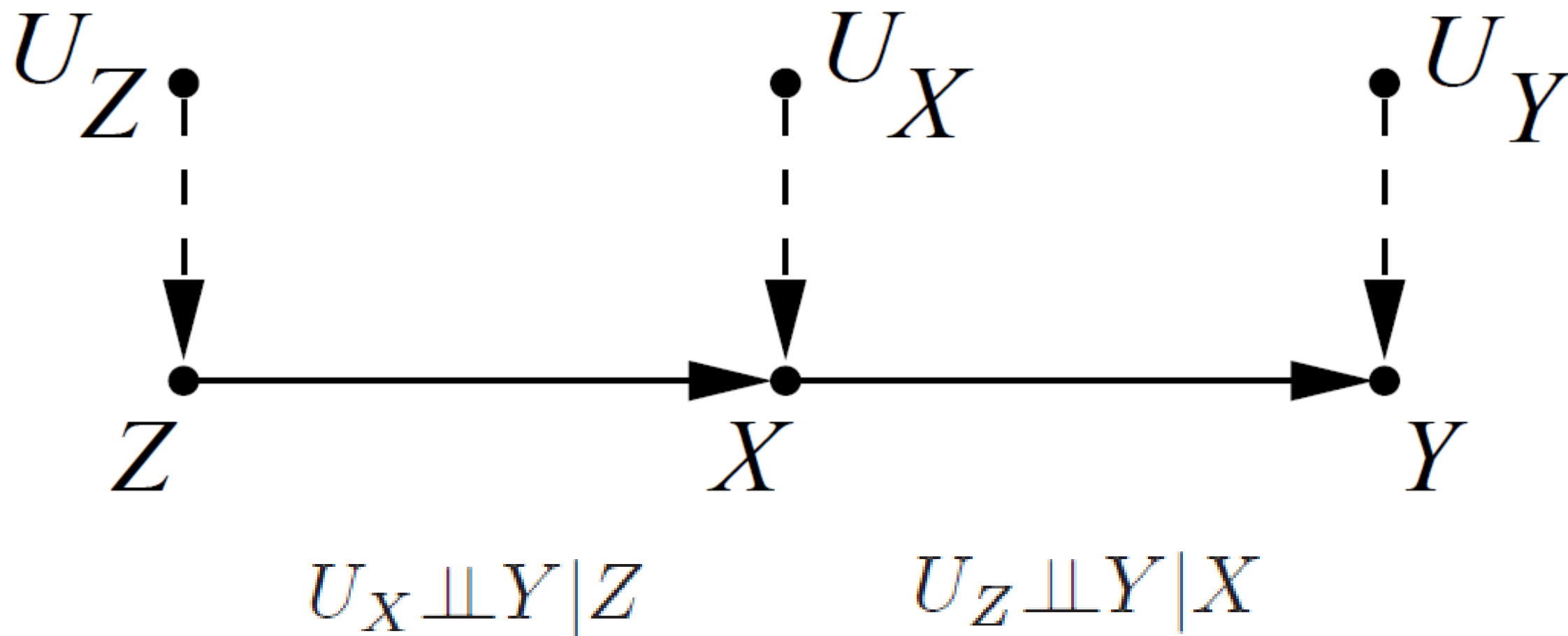
SPRINKLER	RAIN	GRASS WET	
		T	F
F	F	0.0	1.0
F	T	0.8	0.2
T	F	0.9	0.1
T	T	0.99	0.01



## d-separation



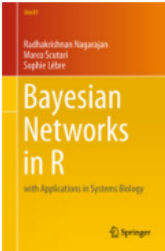
## d-separation




# Exemplo prático!

## bnlearn - an R package for Bayesian network learning and inference

- [Home Page](#)
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- [Research Notes](#)
- [Bayesian Network Repository](#)
- [About the Author](#)



[data & R code](#)



**bnlearn** is an R package for learning the graphical structure of Bayesian networks, estimate their parameters and perform some useful inference. It was first released in 2007, it has been under continuous development [for more than 10 years](#) (and still going strong). To get started and install the latest development snapshot type

```
install.packages("http://www.bnlearn.com/releases/bnlearn_latest.tar.gz")
```

in your R console. (More detailed installation instructions below.)

**bnlearn** implements the following *constraint-based structure learning algorithms*:

- PC (the *stable* version);
- Grow-Shrink (GS);
- Incremental Association Markov Blanket (IAMB);
- Fast Incremental Association (Fast-IAMB);
- Interleaved Incremental Association (Inter-IAMB);
- Incremental Association with FDR Correction (IAMB-FDR);
- Max-Min Parents & Children (MMPC);
- Semi-Interleaved Hiton-PC (SI-HITON-PC);
- Hybrid Parents & Children (HPC);

the following *score-based structure learning algorithms*:

### Downloads

**current release on CRAN:**  
4.4.1 [\[ link \]](#)

**latest snapshot + bugfixes:**  
4.5-20190617 [\[ link \]](#)

**From the R Studio CRAN Mirror:**

CRAN	4.4.1
downloads	4354/month

**Research Impact:**

Depsy	98th percentile
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- <http://www.bnlearn.com/>