CS325 Artificial Intelligence
Chs 13–14 Notes

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Spring 2013

Probability Cheat Sheet

Summation rule: $P(A) + P(\neg A) = 1$

Non-binary: $\sum_x P(A = x) = 1$

Union: $P(A \vee B) = P(A) + P(B) - P(A \wedge B)$

Conditional and joint prob:

$$\begin{aligned} P(A|B)\,P(B) &= P(A, B) \\ P(B|A)\,P(A) &= P(A, B) \end{aligned}$$

Bayes rule:

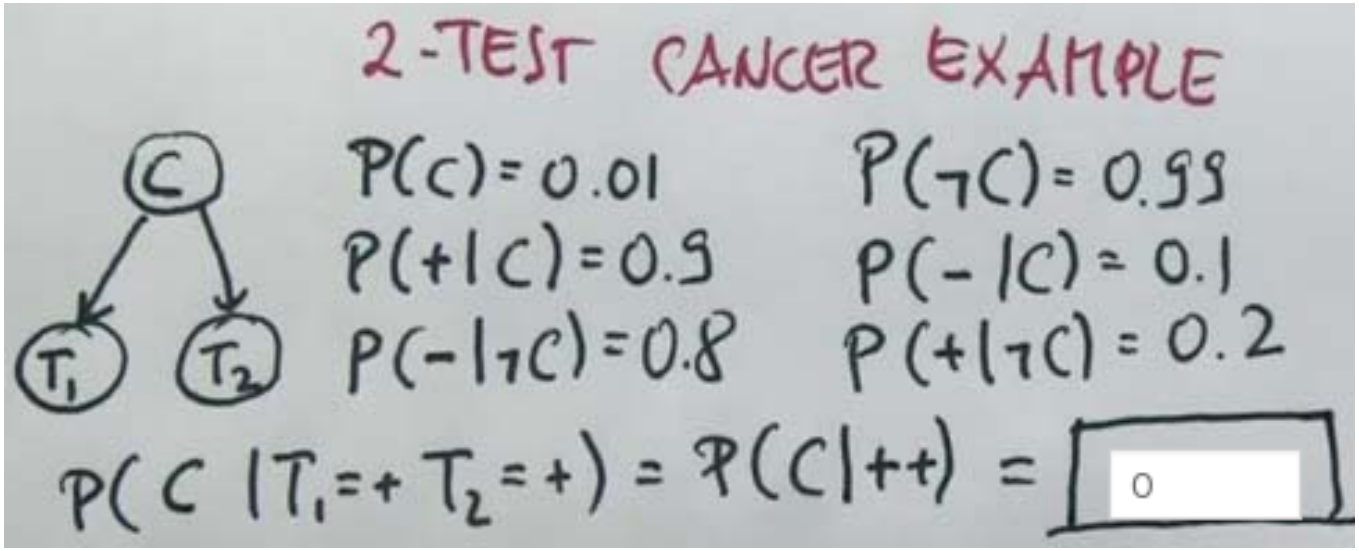
$$P(B|A) = \frac{P(A|B)\,P(B)}{P(A)}$$

Normalize instead of $P(A)$:

$P(A) = P(A|B)\,P(B) + P(A|\neg B)\,P(\neg B)$ because $P(B|A) + P(\neg B|A) = 1$.

In general: $P(A|X) = \alpha \sum_y P(A, X, y)$

Cancer Example with 2 Tests



Dependence

Independence:

$$\begin{aligned} X \perp Y &\Rightarrow P(X|Y) = P(X) \\ &\Rightarrow P(X, Y) = P(X)P(Y) \end{aligned}$$

Conditional ind:

$$X \perp Y|Z \Rightarrow P(X|Z, Y) = P(X|Z)$$

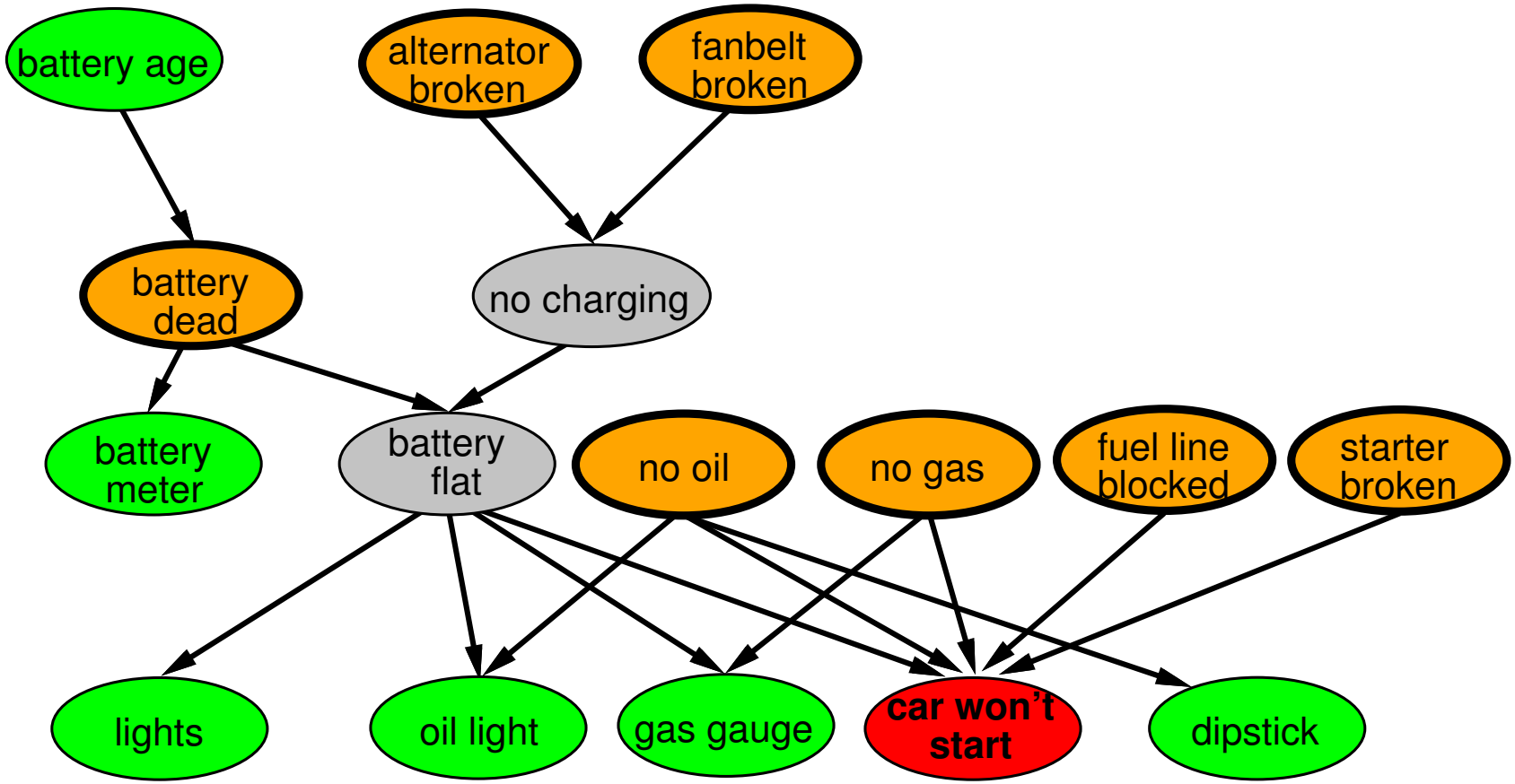
Exercises

$$X \perp Y|Z \Leftrightarrow P(X \perp Y)?$$

Dependence (cont.)

- Explaining away?
- Dependence based on outcome:
  $P(C|A,B) \Rightarrow A \perp B$ but not $A \perp B|C$
- More complex Bayes nets
  - D-separation (reachability); summary of rules
  - joint probability, number of parameters?
  - compactness based on construction

Car diagnosis

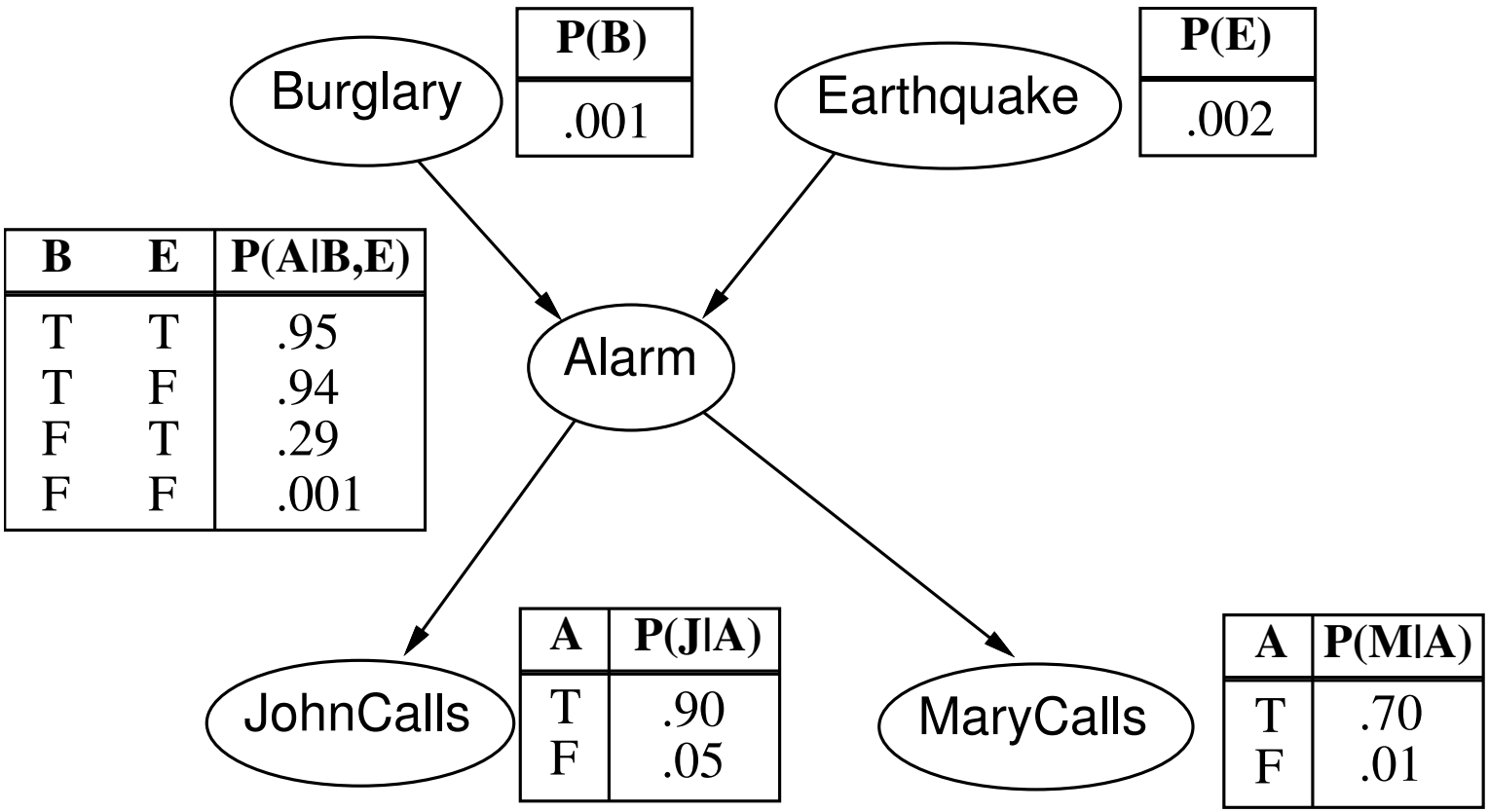


Number of params?

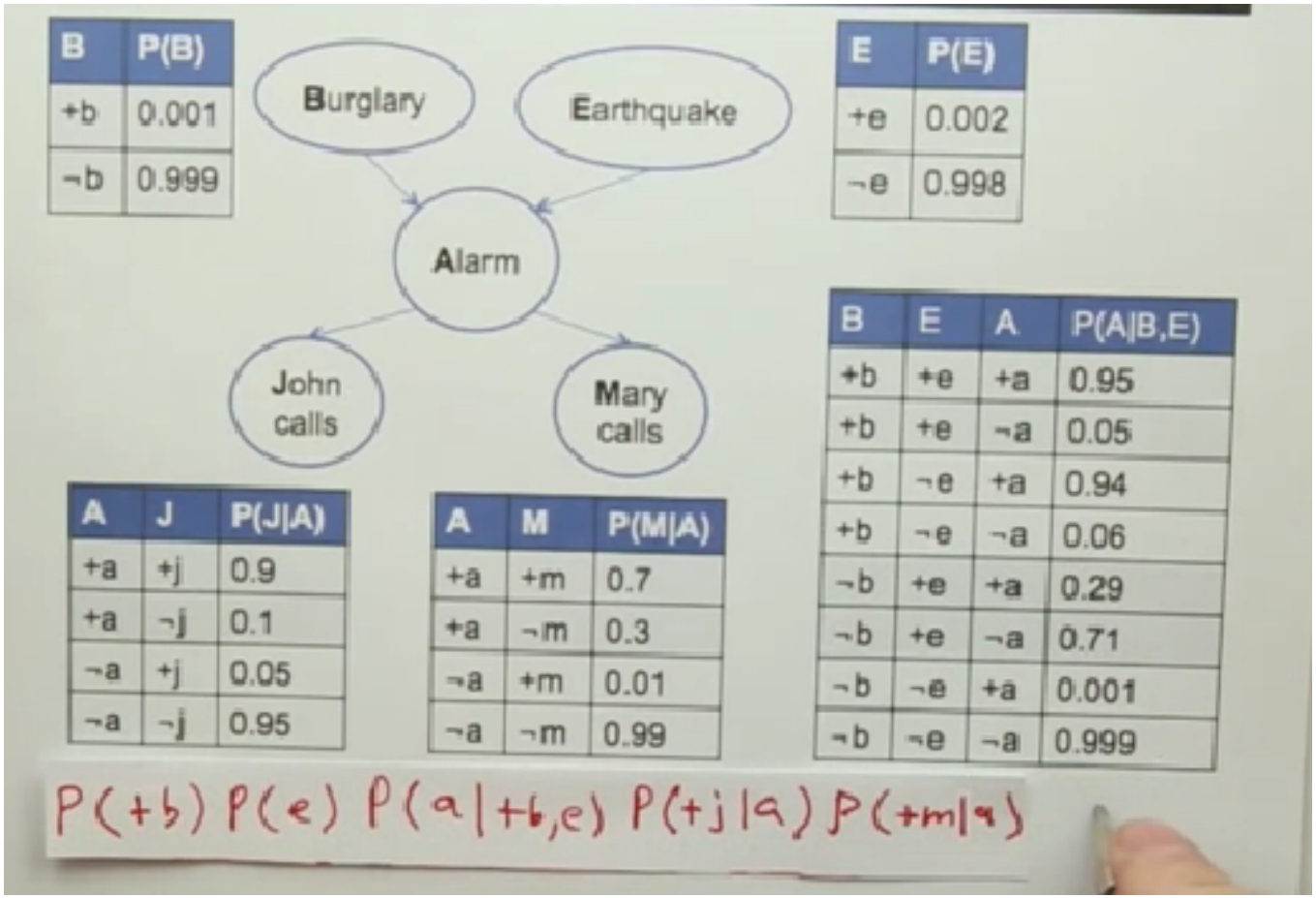
Continuous random variables?

- Natural values
- Discretization
- Hybrid Bayes nets
- Sigmoid and Gaussian
- Fuzzy logic

Burglary or Earthquake?



Burglary or Earthquake?



B	P(B)
+b	0.001
¬b	0.999

E	P(E)
+e	0.002
¬e	0.998

B	E	A	P(A|B,E)
+b	+e	+a	0.95
+b	+e	¬a	0.05
+b	¬e	+a	0.94
+b	¬e	¬a	0.06
¬b	+e	+a	0.29
¬b	+e	¬a	0.71
¬b	¬e	+a	0.001
¬b	¬e	¬a	0.999

A	J	P(J|A)
+a	+j	0.9
+a	¬j	0.1
¬a	+j	0.05
¬a	¬j	0.95

A	M	P(M|A)
+a	+m	0.7
+a	¬m	0.3
¬a	+m	0.01
¬a	¬m	0.99