

AMiDST TOOLBOX

Session 3: Coding an Intelligent Fire Detector System

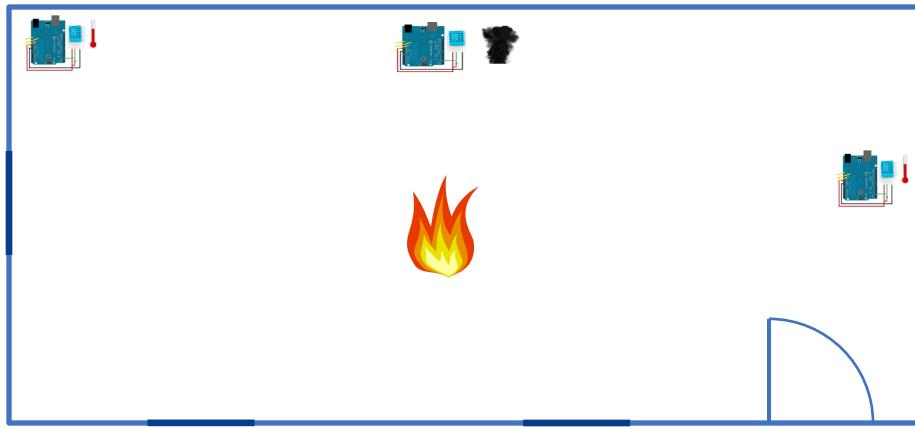
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Intelligent Fire Detector System



Fire Detection from smoke and temperature sensors



- Data Collected
 - Tons of observations in normal settings (no fire).
 - No observations in the presence of fire.

- Data Collected on Normal Conditions
 - Noisy Temperature sensor readings ever few milliseconds.
 - Noisy Smoke sensor readings ever few milliseconds.
 - No fire conditions.
- No Data Collected on Fire Conditions
 - Hard to collect data.
 - Lot of prior knowledge.
 - Fire implies much higher temperatures and presence of smoke.

	A	B	C	D	E
1	Fire	SensorT1	SensorT2	SensorS	
2	0	17,63	18,40	0	
3	0	17,30	19,41	0	
4	0	16,66	15,84	0	
5	0	17,39	16,86	0	
6	0	13,68	14,22	0	
7	0	14,66	17,90	0	
8	0	15,29	15,67	0	
9	0	15,88	14,96	0	
10	0	17,39	19,25	0	
11	0	20,75	19,03	0	
12	0	15,89	16,11	0	
13	0	18,27	19,04	0	
14	0	16,83	19,92	0	
15	0	14,69	15,69	0	
16	0	16,64	16,53	0	
17	0	15,42	17,75	0	
18	0	18,84	15,20	0	
19	0	17,29	18,61	0	
20	0	18,77	22,01	0	
21	0	16,92	15,61	0	
22	0	11,36	14,36	0	
23	0	17,40	15,37	0	
24	0	17,70	16,54	0	
25	0	14,80	14,80	0	
26	0	14,34	16,58	0	
27	0	15,63	17,37	0	
28	0	13,35	14,65	0	
29	0	17,89	19,16	0	
30	0	16,04	14,99	0	
31	0	14,63	13,12	0	
32	0	12,44	11,96	0	
33	0	16,23	15,69	0	
34	0	16,17	15,65	0	
35	0	16,15	18,00	0	
36	0	17,03	18,95	0	

■ ARFF Format

- `./datasets/firedetector.arff`
- Header detailing state space of the attributes.



Model Definition



Fire

$Fire \sim Binomial(\rho)$

T1

T2

$T1, T2 \sim Normal(\mu, \sigma)$

Probabilistic Modeling

Every relevant object is a random variable.

Code: Session3.A_ModelLearning.java



Fire

$$Fire \sim Binomial(\rho)$$

Temp

$$Temp \sim Normal(\mu, \sigma)$$

T1

T2

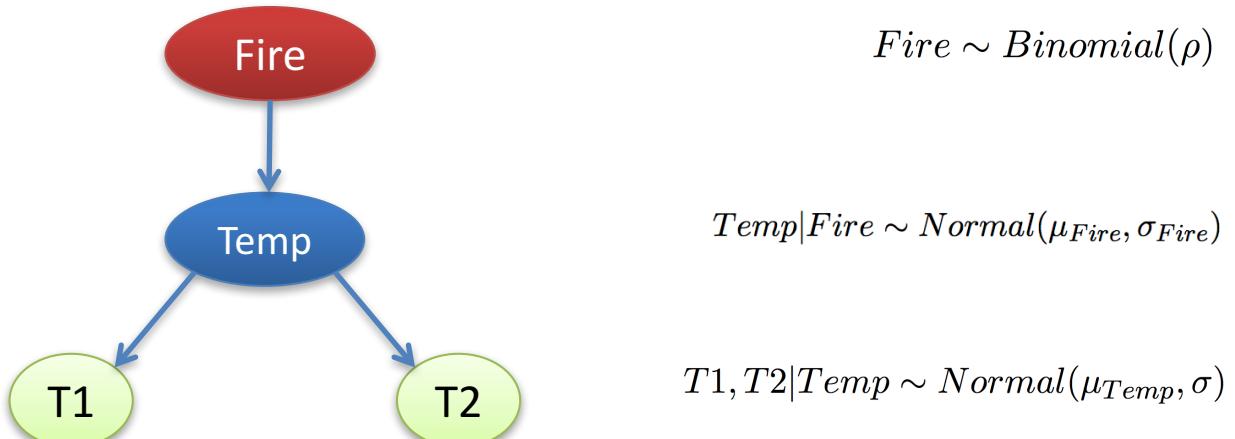
$$T1, T2 \sim Normal(\mu, \sigma)$$

Latent Variables

Non-observable relevant mechanisms

Code: Session3.A_ModelLearning.java



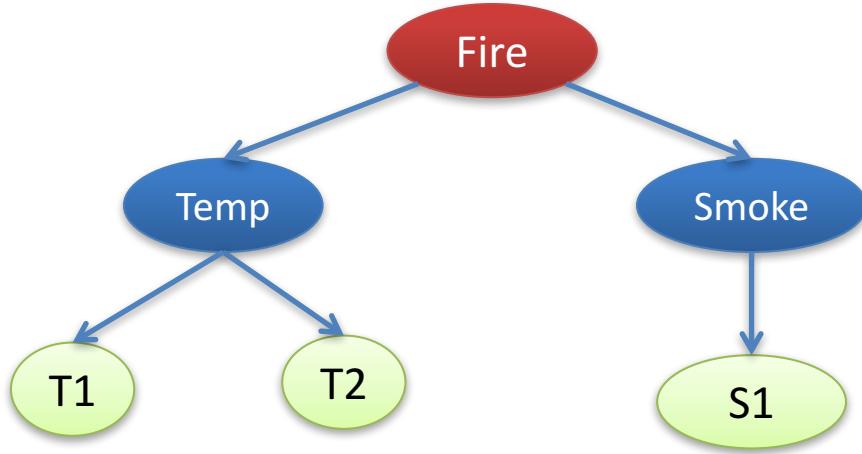


Causal Relationships

They can be extracted for the mechanism itself

Code: Session3.A_ModelLearning.java





What about Smoke Sensor?

Introduce Smoke Sensor into the model

Code: Session3.A_ModelLearning.java



Learning from Data



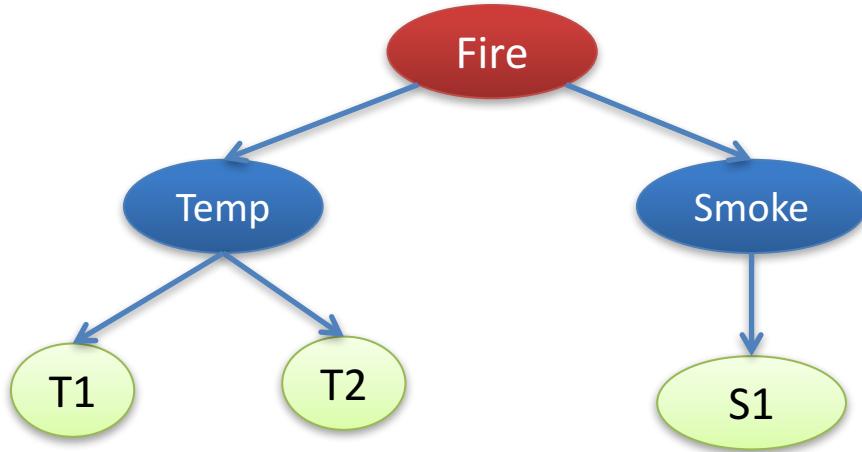
	A	B	C	D	E
1	Fire	SensorT1	SensorT2	SensorS	
2	0	17,63	18,40	0	
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33	0	16,23	15,69	0	
34	0	16,17	15,65	0	
35	0	16,15	18,00	0	
36	0	17,03	18,95	0	

■ ARFF Format

- `./datasets/sensorReadings.arff`
- Header detailing state space of the attributes.

Code: Session3.A_ModelLearning.java

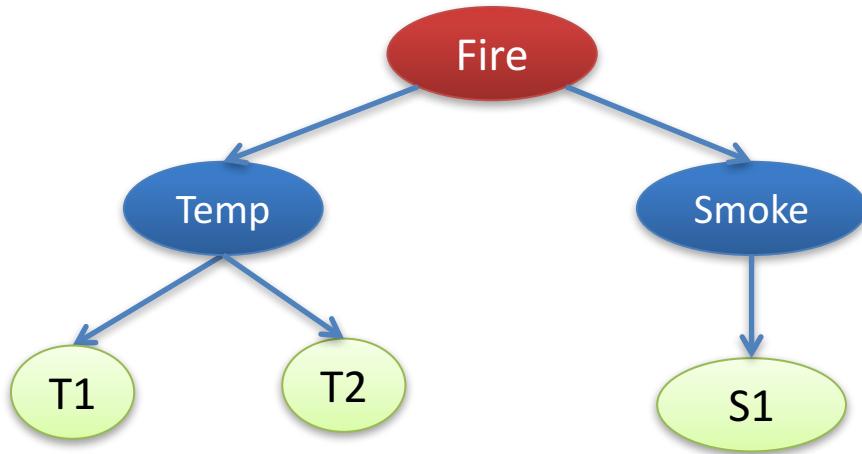




Learn the model from data
Using Streaming Variational Bayes

Code: Session3.A_ModelLearning.java

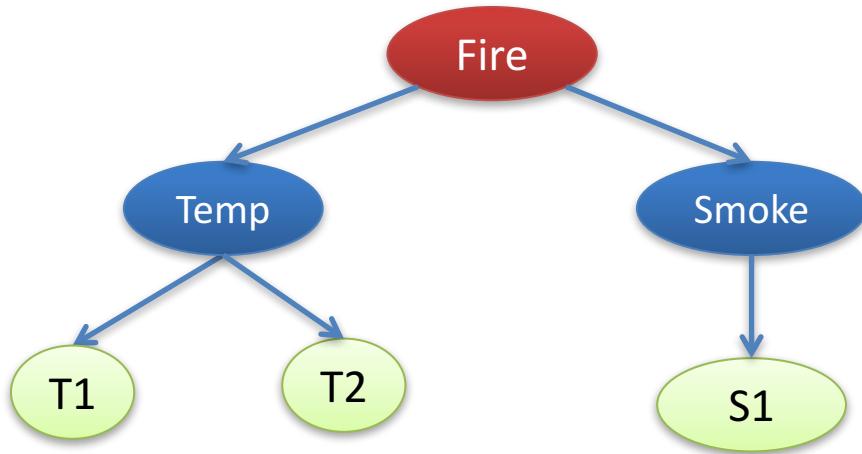




$P(\text{Fire})$ follows a Multinomial
[0.9998000799680128, 1.9992003198720512E-4]

Code: Session3.A_ModelLearning.java



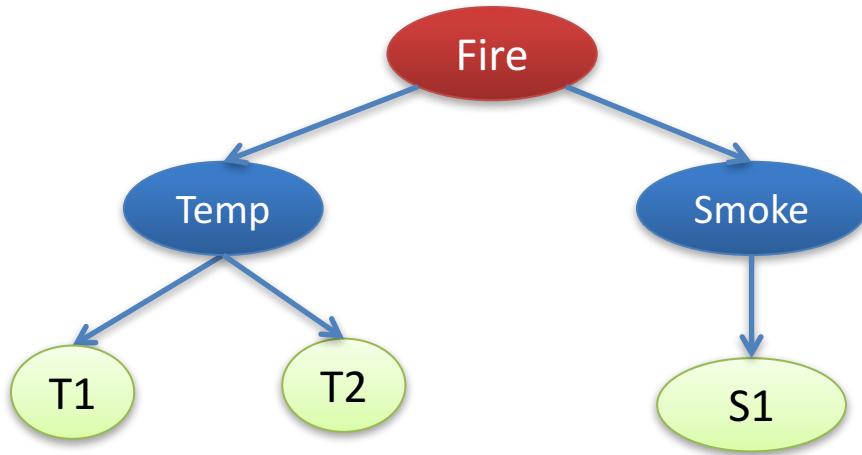


$P(\text{Temperature} \mid \text{Fire})$ follows a Normal|Multinomial

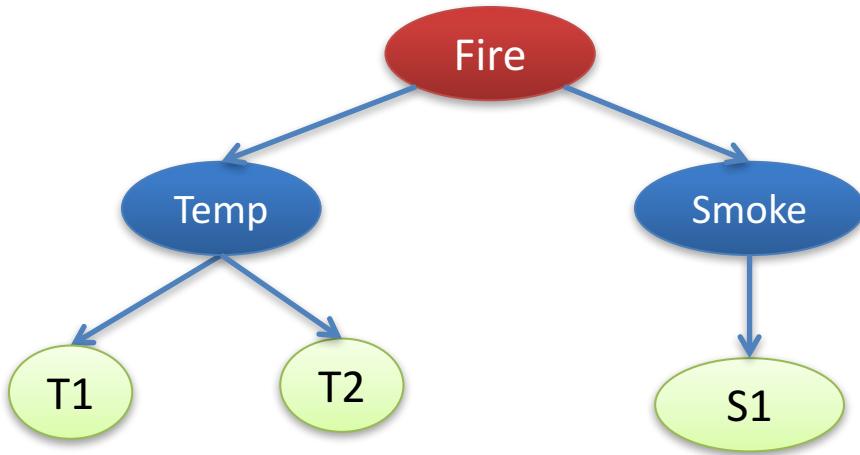
Normal [mu = 14.996849091136134, var = 3.135089756689407] | {Fire = 0}

Normal [mu = 0.0, var = 1.0] | {Fire = 1}

Code: Session3.A_ModelLearning.java



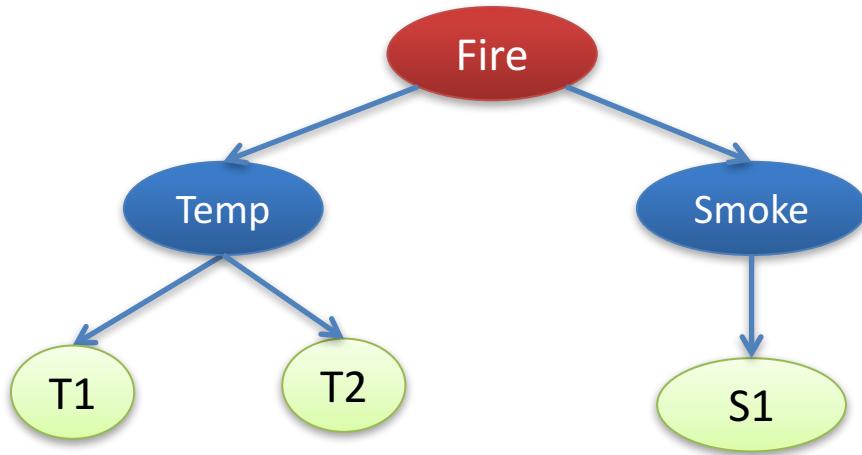
$P(\text{Smoke} \mid \text{Fire})$ follows a Multinomial|Multinomial
[0.9919032387045182, 0.008096761295481807] | {Fire = 0}
[0.5, 0.5] | {Fire = 1}



```
P(SensorTemp1 | Temperature) follows a Normal|Normal  
[ alpha = 0.4365915357650518, beta1 = 0.9725166649571894, var = 1.5001985019341324 ]  
P(SensorTemp2 | Temperature) follows a Normal|Normal  
[ alpha = 0.03689270663901116, beta1 = 0.9965529301305499, var = 1.520267619780247 ]
```

Code: Session3.A_ModelLearning.java





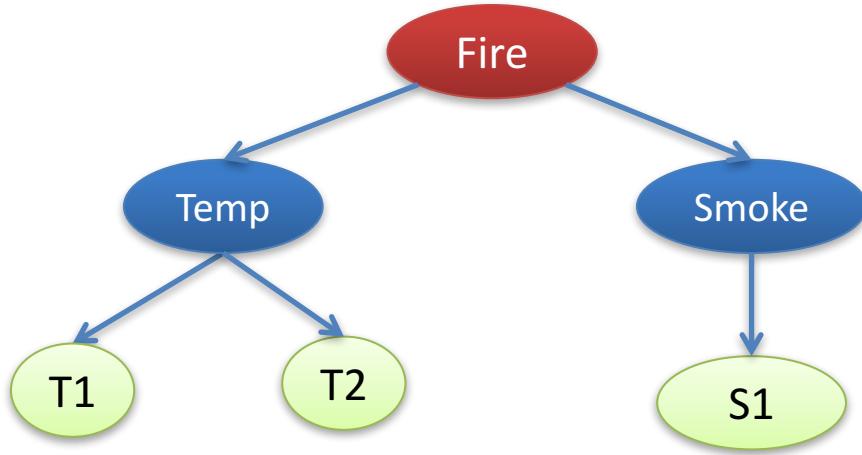
$P(\text{SensorSmoke} \mid \text{Smoke})$ follows a Multinomial|Multinomial
[0.9910327455919395, 0.008967254408060453] | {Smoke = 0}
[0.08433734939759036, 0.9156626506024096] | {Smoke = 1}

Code: Session3.A_ModelLearning.java



Integrating Expert Knowledge





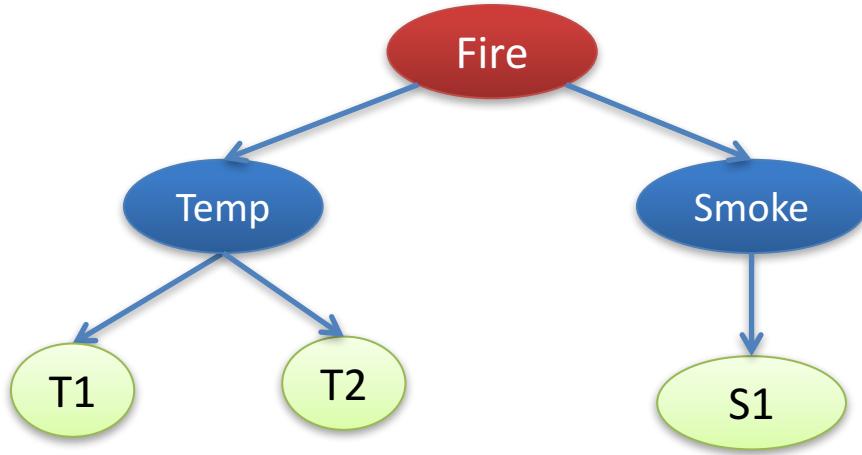
Modify the non-learnt conditional probabilities

Code: Session3.B_AddExpertKnowledge.java



Making Predictions

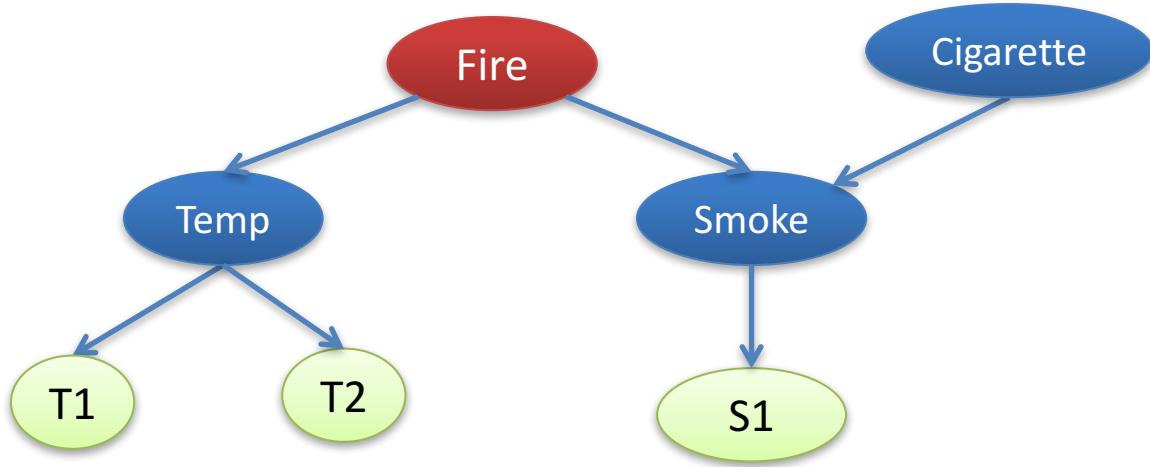
Code: Session3.C_ModelInference.java



$$p(Fire = True | t_1, t_2, s_1)$$

Query the Model

EXAMPLE OF PGMS



Extend the model

Thanks for your attention

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