FOREST FIRE REGIONS

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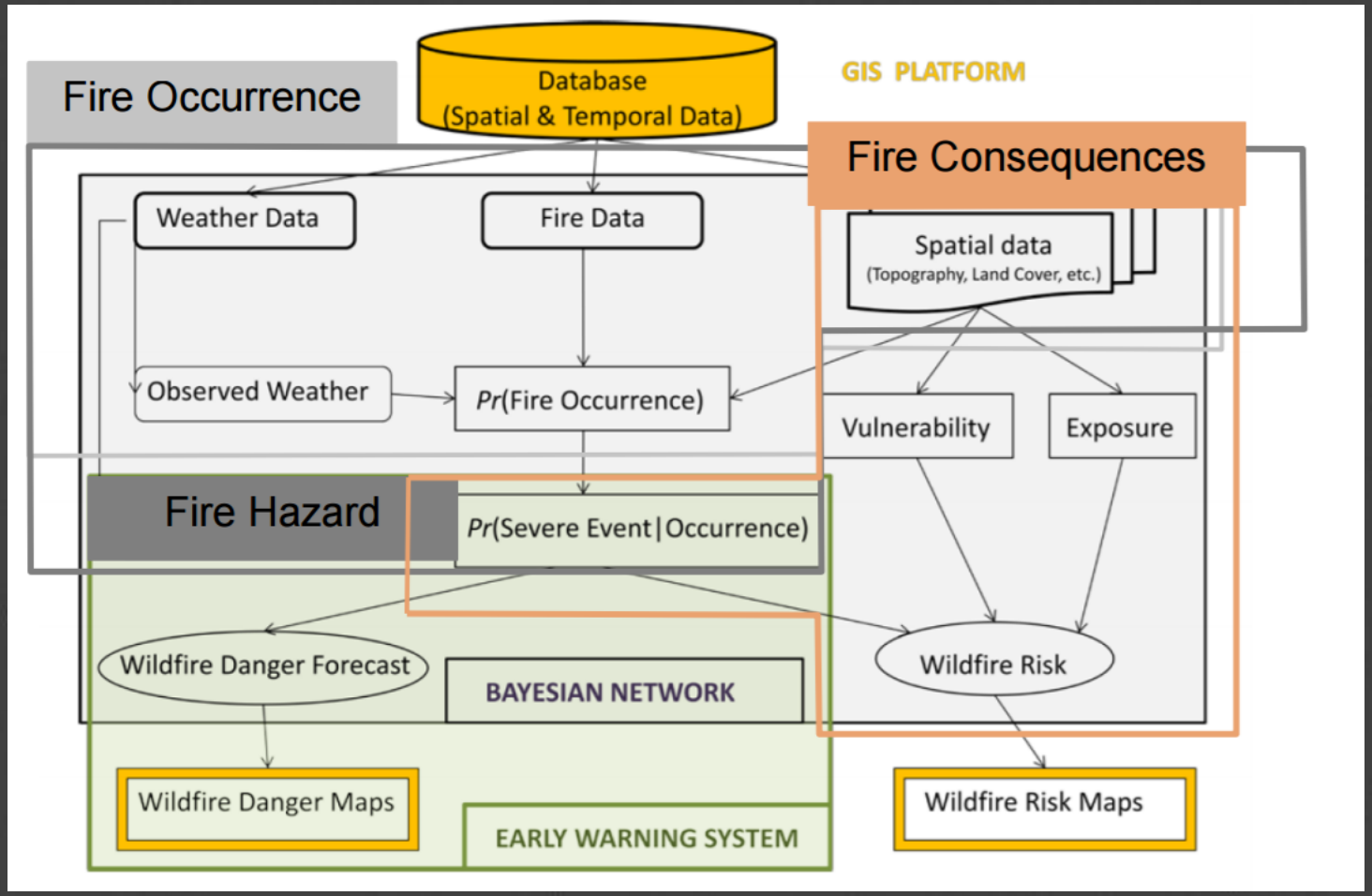
Real case


Fire Occurrence
Database
(Spatial & Temporal Data)
GIS PLATFORM
Fire Consequences
Weather Data
Fire Data
Spatial data
(Topography, Land Cover, etc.)
Observed Weather
Pr(Fire Occurrence)
Vulnerability
Exposure
Fire Hazard
Pr(Severe Event|Occurrence)
Wildfire Danger Forecast
BAYESIAN NETWORK
Wildfire Risk
Wildfire Danger Maps
EARLY WARNING SYSTEM
Wildfire Risk Maps

Workflow

- Find a dataset
- Modal each node
- Form BBN
- MCMC train parameters
- Validation

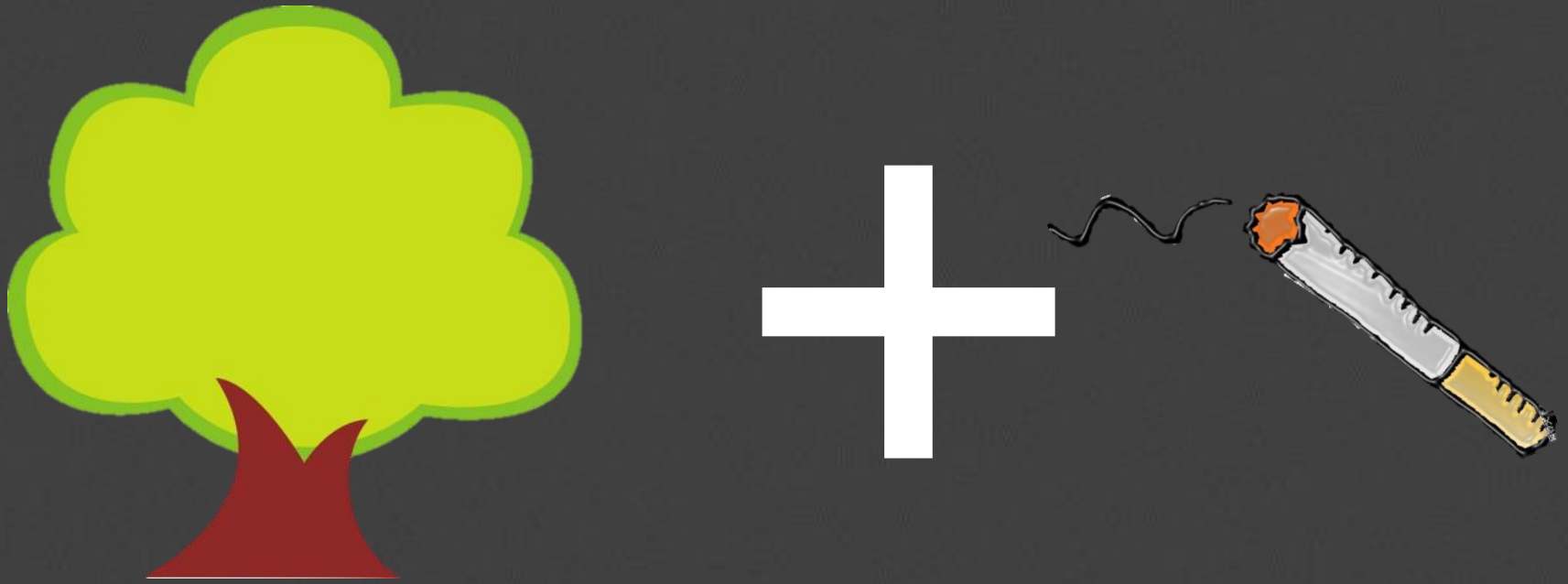
Dataset

- UCI Machine Learning Repository
- Forest Fires Data Set
- About 500 data

	E	F	G	H	I	J	K	L	M
	FFMC	DMC	DC	ISI	temp	RH	wind	rain	area
5	86.2	26.2	94.3	5.1	8.2	51	6.7	0	0
2	90.6	35.4	669.1	6.7	18	33	0.9	0	0
5	90.6	43.7	686.9	6.7	14.6	33	1.3	0	0
5	91.7	33.3	77.5	9	8.3	97	4	0.2	0
7	89.3	51.3	102.2	9.6	11.4	99	1.8	0	0
7	92.3	85.3	488	14.7	22.2	29	5.4	0	0

Reason?

Most people thinks Forest fire is due to this~



Result

But, actually in our real world, that scene like this~

How about the long-distance view?

- Actually, this picture is what we need to discuss and analysis well.
- What do u have in mind?
- And what is our aim?

Definition

for some measurement

- FFMC - FFMC index from the FWI system:(18.7 ~ 96.20)
- DMC - DMC index from the FWI system: (1.1 ~ 291.3)
- DC - DC index from the FWI system: (7.9 ~ 860)
- ISI - ISI index from the FWI system: (0.0 ~ 56.10)
- temp - temperature in Celsius degrees: (2.2 ~ 33.30)
- RH - relative humidity in %: (15.0 ~ 100)
- wind - wind speed in km/h: (0.40 ~ 9.40)
- rain - outside rain in mm/m^2 : (0.0 ~ 6.4)

Some words are hard for U?

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Fine Fuel Moisture Code(FFMC)

- Numeric rating of the **moisture content of litter** and **other cured fine fuels.**
- This code is an indicator of the relative ease of ignition and the flammability of fine fuel.

Duff Moisture Code(DMC)

- Numeric rating of the **average moisture content of loosely compacted organic layers of moderate depth**.

- Gives an indication of fuel consumption in moderate duff layers and medium-size woody material.

Drought Code(DC)

- Numeric rating of the **average moisture content of** deep, compact **organic layers**.

- A useful indicator of seasonal drought effects on forest fuels and the amount of smoldering in deep duff layers and large logs.

Initial Spread Index(ISI)

- Numeric rating of **the expected rate of fire spread**.

- Combines the effects of wind and the FFMC on rate of spread without the influence of variable quantities of fuel.

Aim

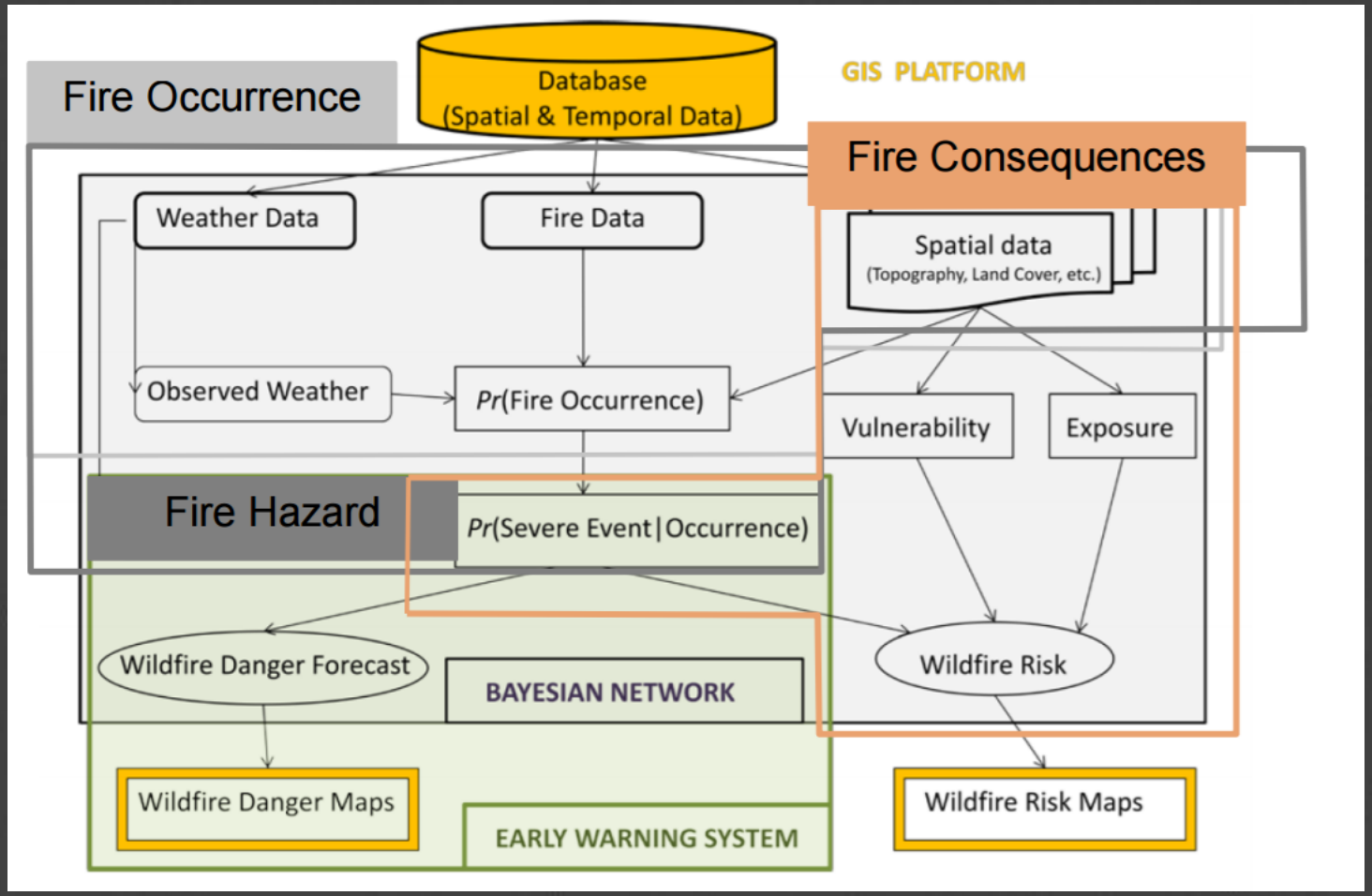
- Using those indicators to estimate how big & large of the "Burnt Area."

- Once we can approach the estimation of the burnt area, then we can assign and make best use of our human power (ex: firefighter) and natural resource like (ex: fire engine, water and helicopter...etc)

Observations

- Each factors are a continuous random variable.
- How are those factors correlated?
- What is the casual network?

Real case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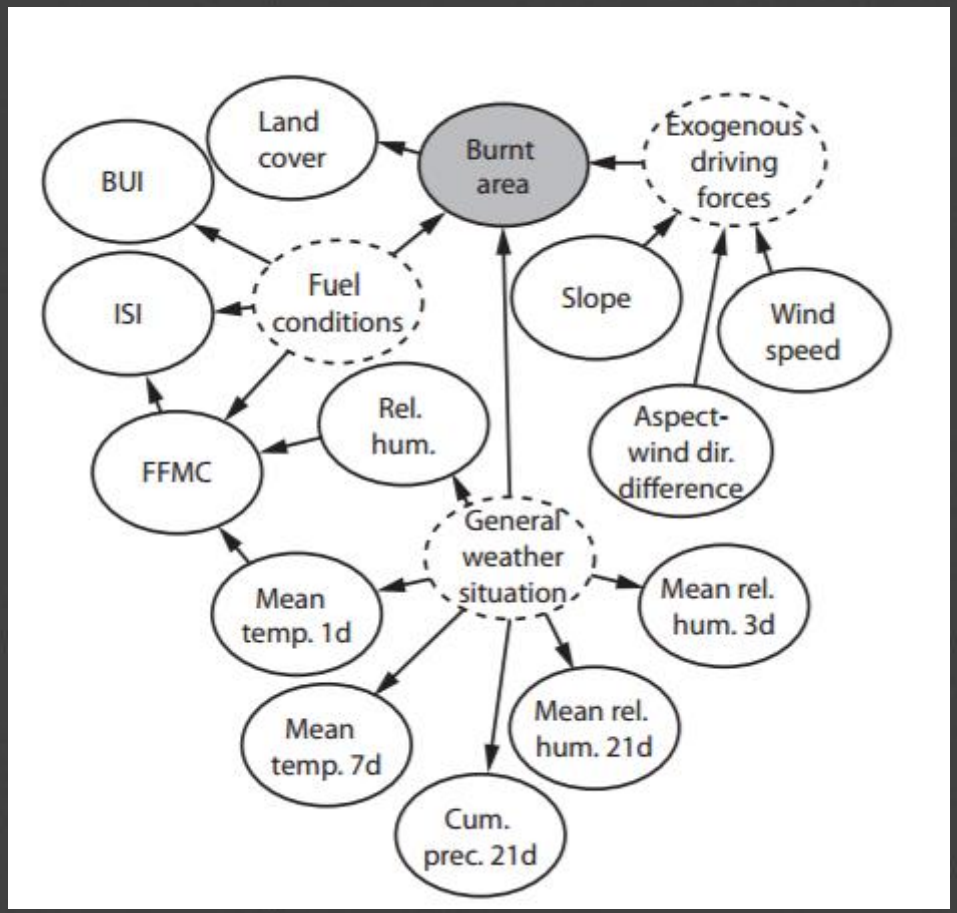
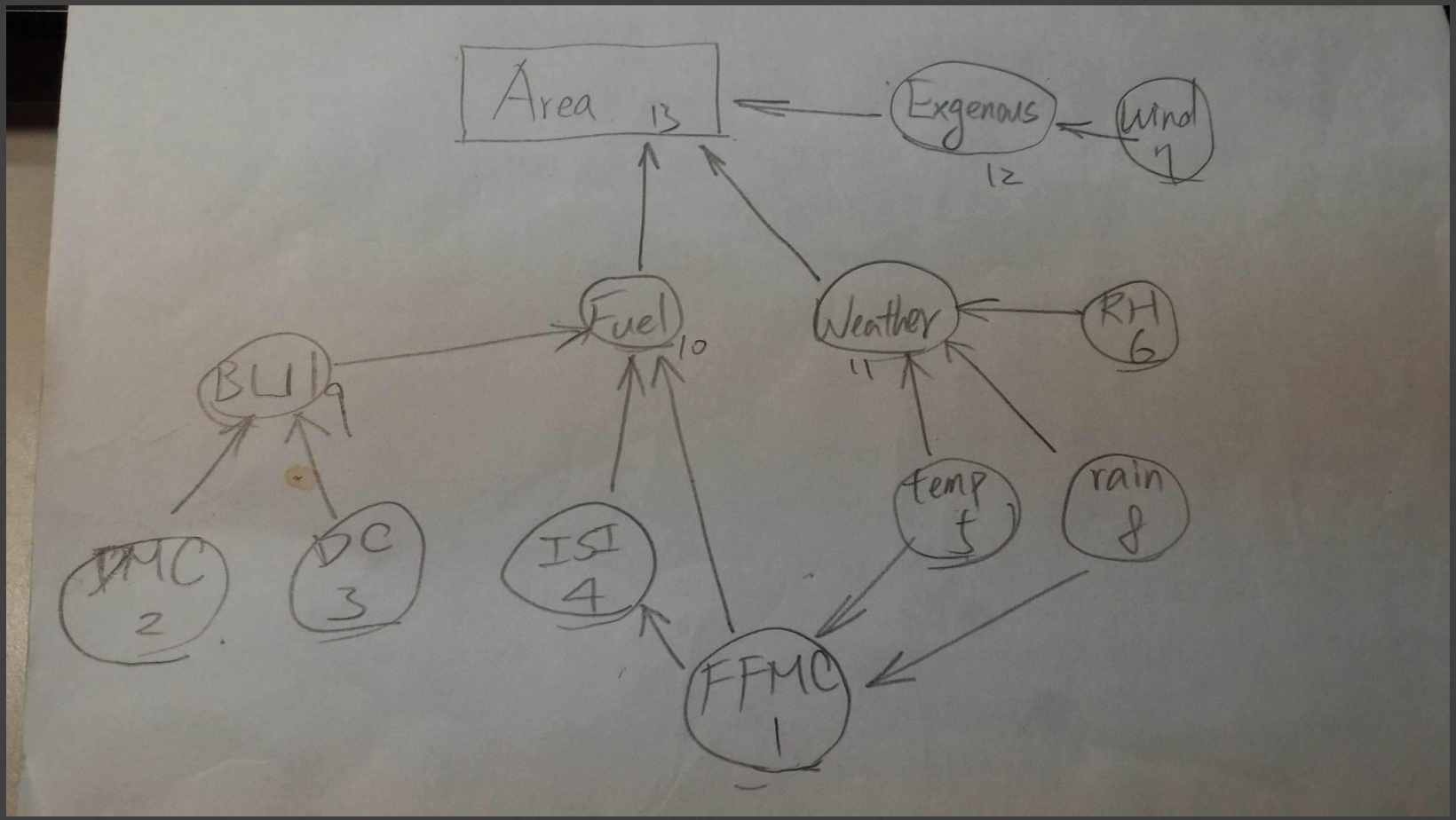
Modal each node

- Continuous Random Variable
- Quantization / Discretize
- CPD -> CPT

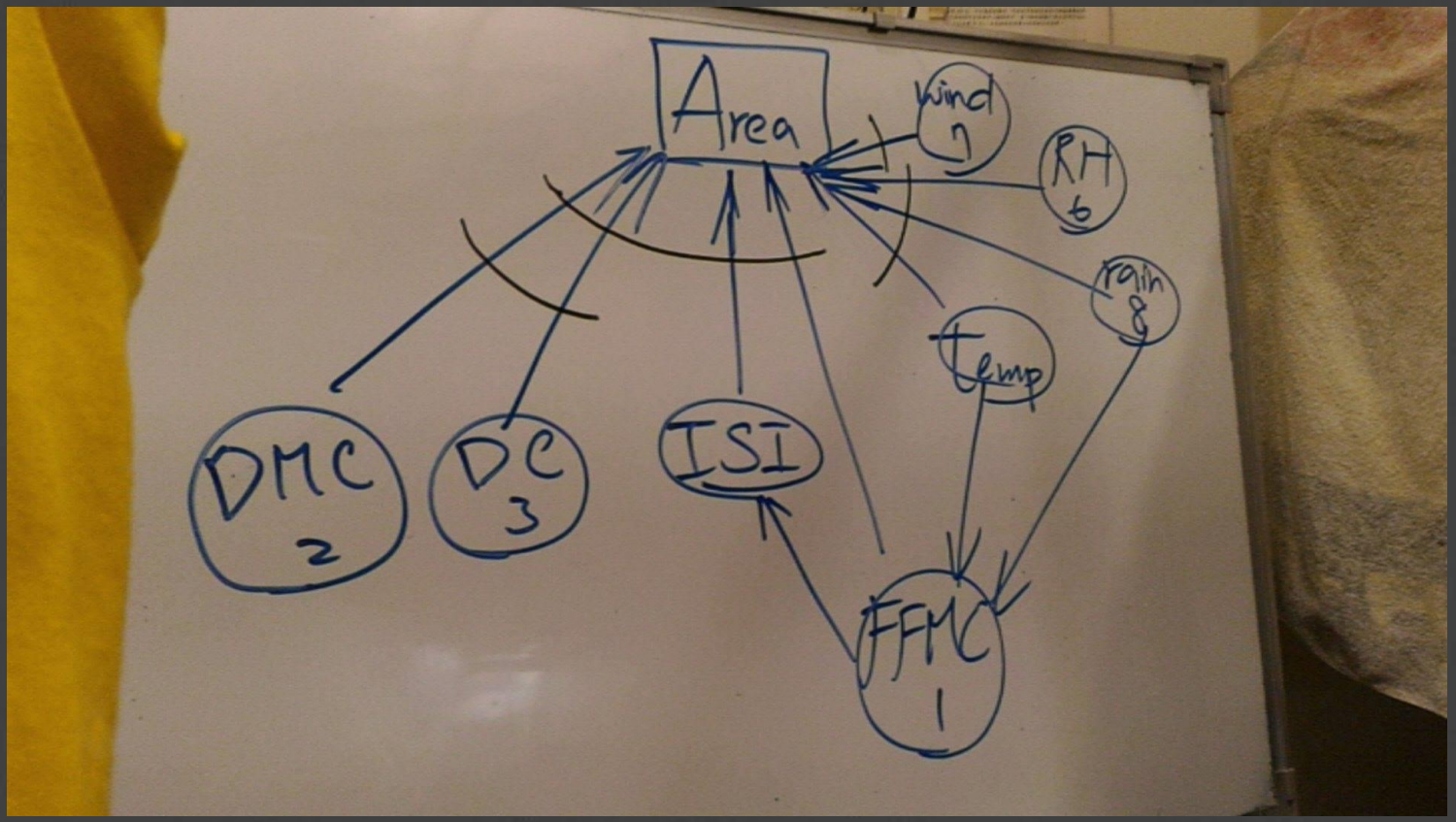
BBN theoretically



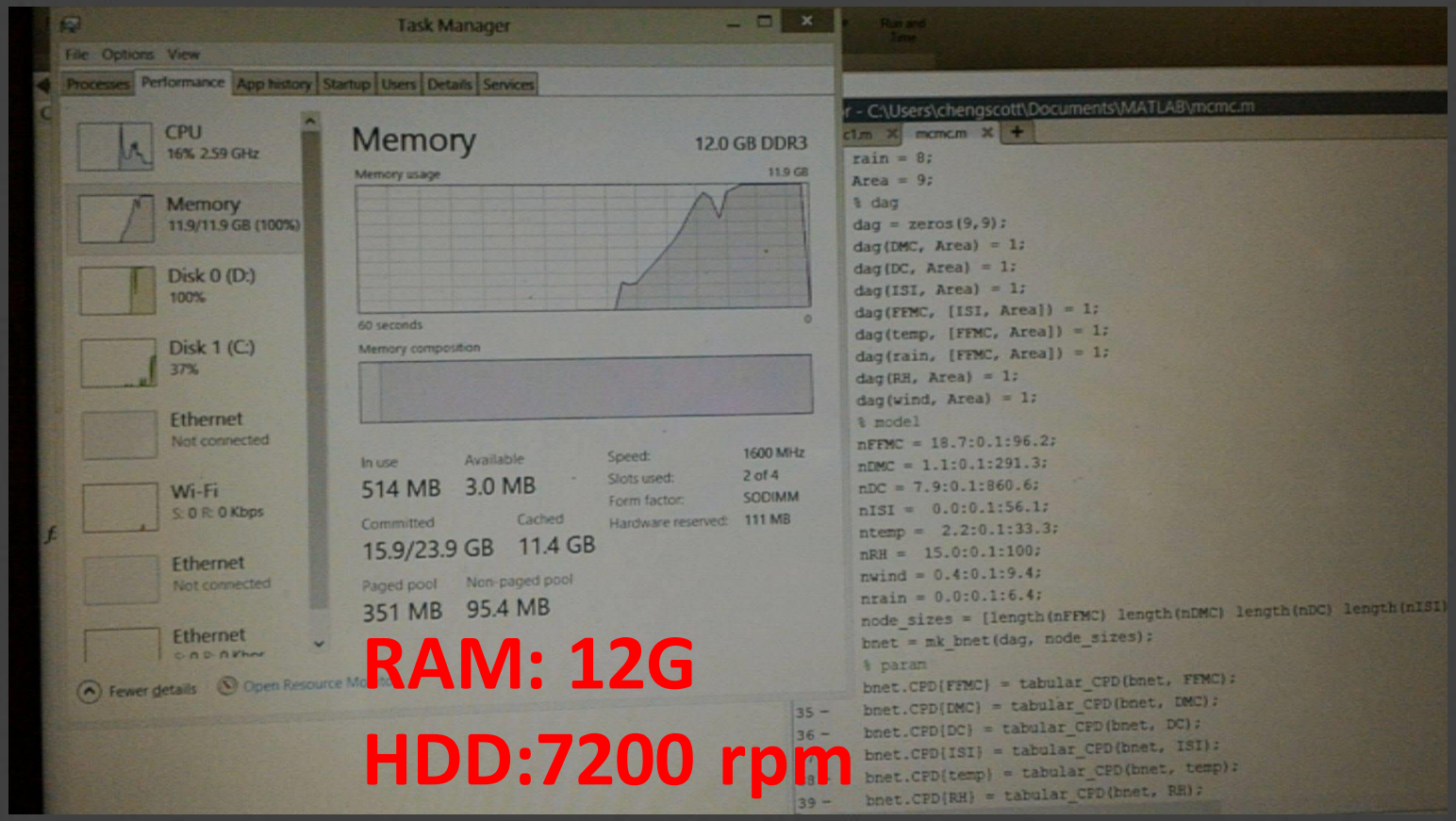
BBN Formulation (I)



BBN Formulation (II)



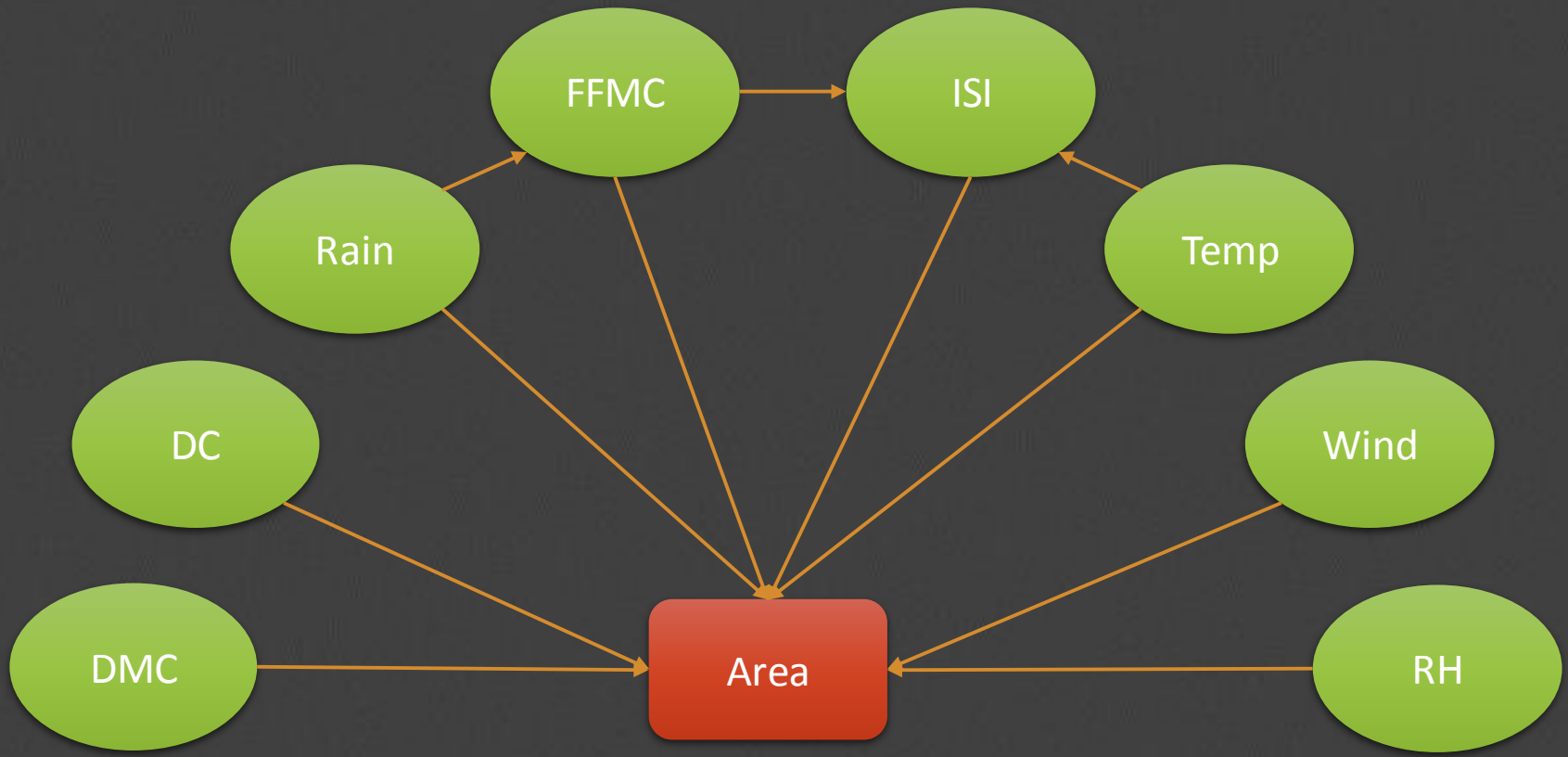
Experiments: Crashes



Difficulties

- Computation resources
- Sparse DAG

BBN reduction



Bayesian Probability

- $P(x|y) = P(x,y) \times P(y)$
- $P(y|x) = \frac{P(x|y)P(y)}{P(x)} = \frac{P(x|y)P(y)}{\sum_y P(x|Y=y)P(Y=y)}$

Bayesian Network

- A network which describe probability of cause-effect relation. For given Bayesian network(BN), one of the sample like (x1,...xn), its probability could be given by

Metropolis sampler

- Propose a transition with probability TQ($y \rightarrow y'$) , where y is current state, and y' is next state
- Accept with probability A=min(1, P(y')/P(y))
- If for all y, y' TQ($y \rightarrow y'$)=TQ($y' \rightarrow y$) then the resulting Markov chain satisfies detailed balance

Markov Chain Monte Carlo

```
Algorithm MCMC-Ask(X,e,bn, N) returns an estimate of P(X|e)
  local variables : N[X], a vector of counts over X, initially zero
                            Z, the nonevidence variables in bn
                            x, the current state of the network, initially copied from e.
  initialize x with random values for the variable for the variables in Z
  for j=1 to N do
      N[x] = N[x] + 1 where x is the value of X in x
      for each Zi in Z do
         sample the value of Zi in x from P(Zi | mb(Zi)) given the value of MB(Zi) in X
  return Normalize(N[X])
```