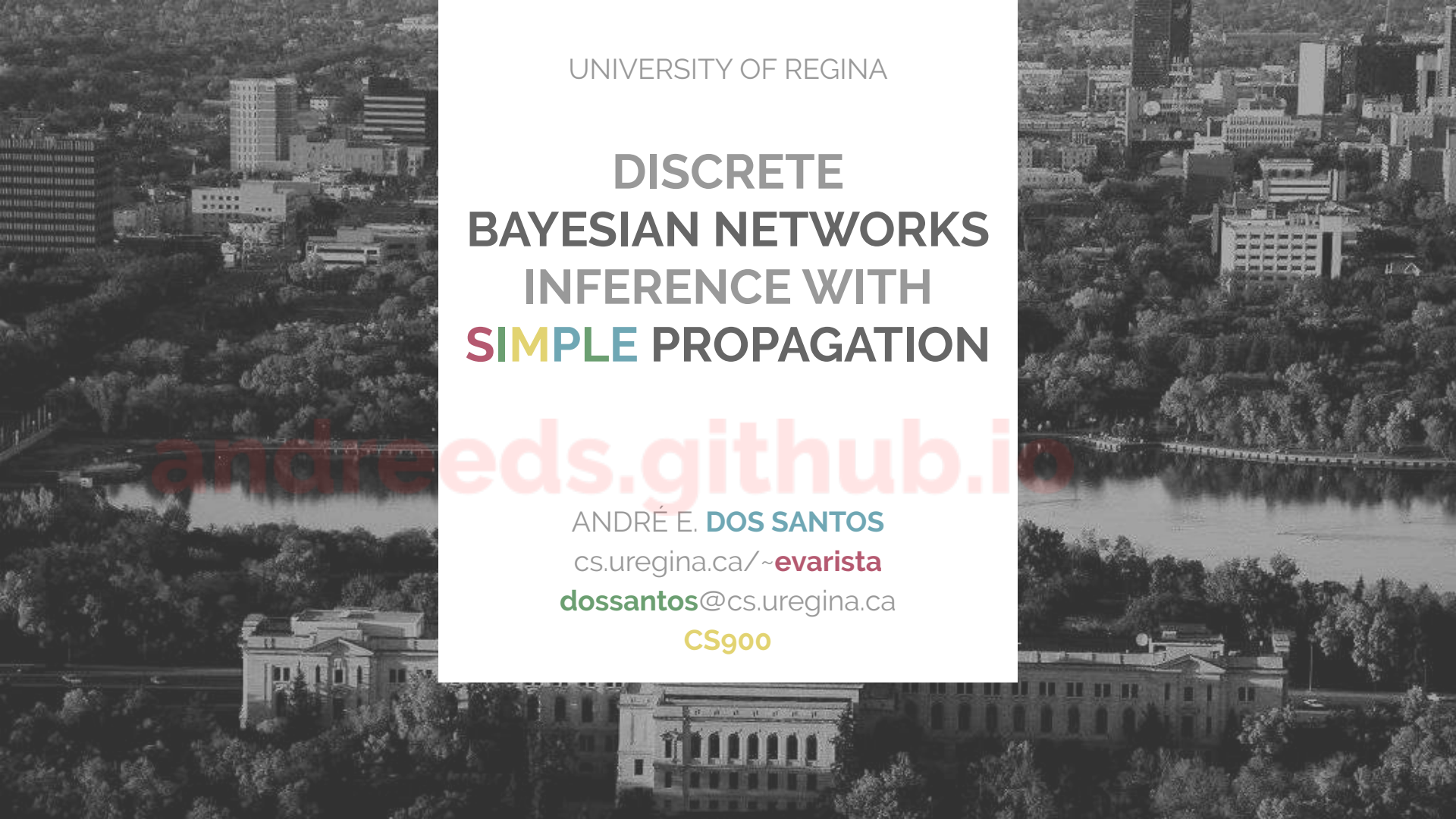

UNIVERSITY OF REGINA

DISCRETE BAYESIAN NETWORKS INFERENCE WITH SIMPLE PROPAGATION

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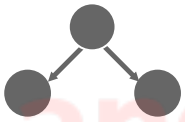
CS900

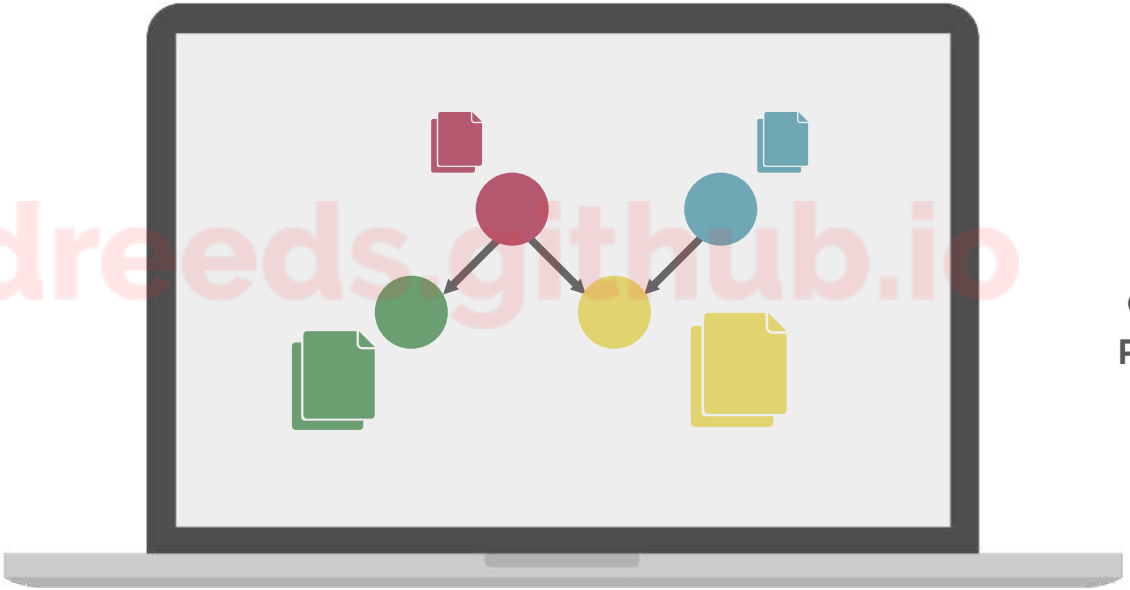
BAYESIAN NETWORKS

PROBABILISTIC GRAPHICAL MODEL



DIRECTED ACYCLIC GRAPH

DAG



CONDITIONAL PROBABILISTIC TABLES

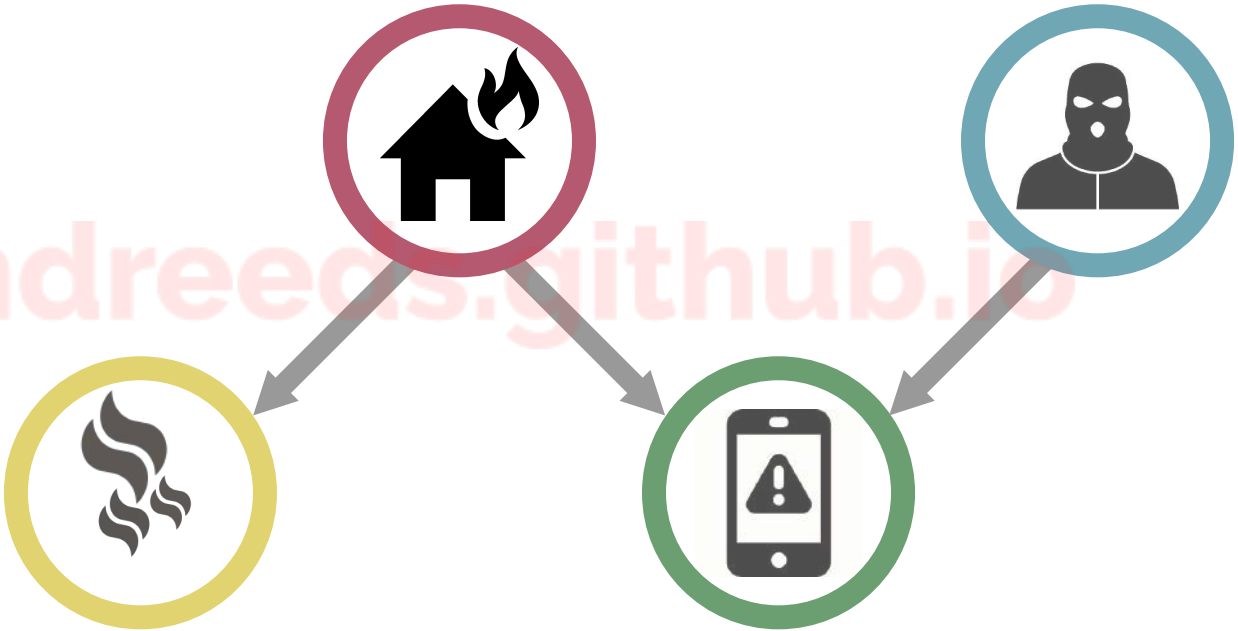
CPTs

Pearl

1988

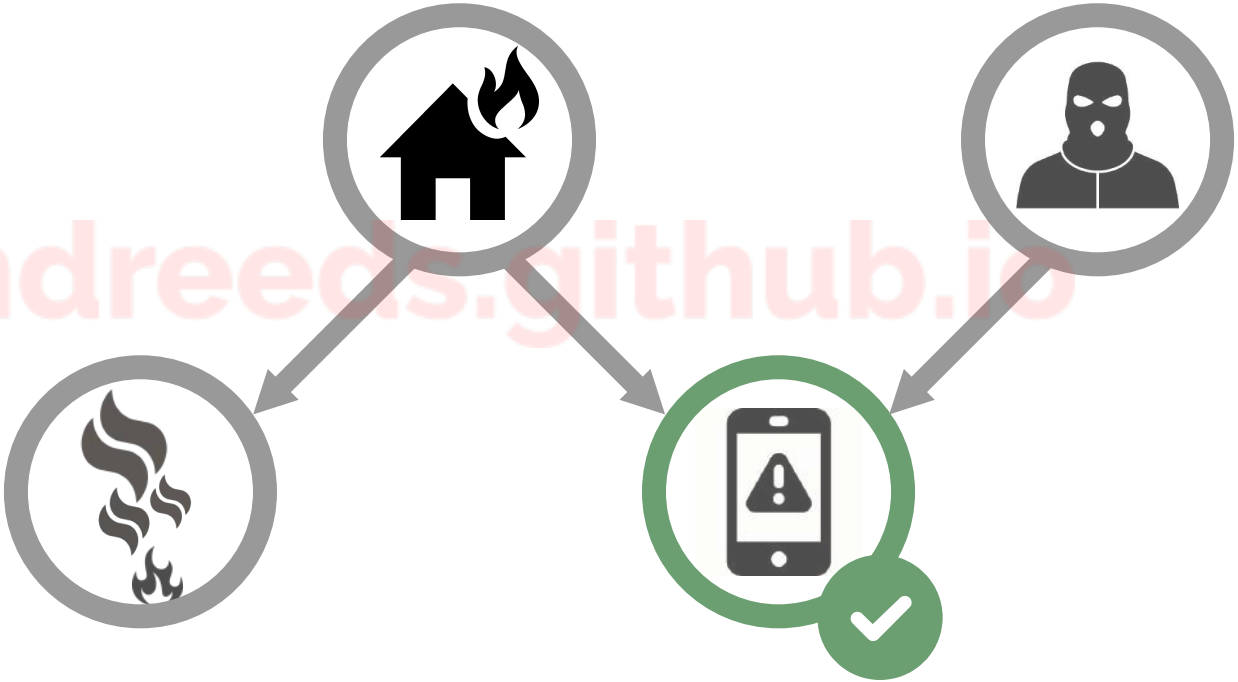

SECURITY
ALARM

BN EXAMPLE

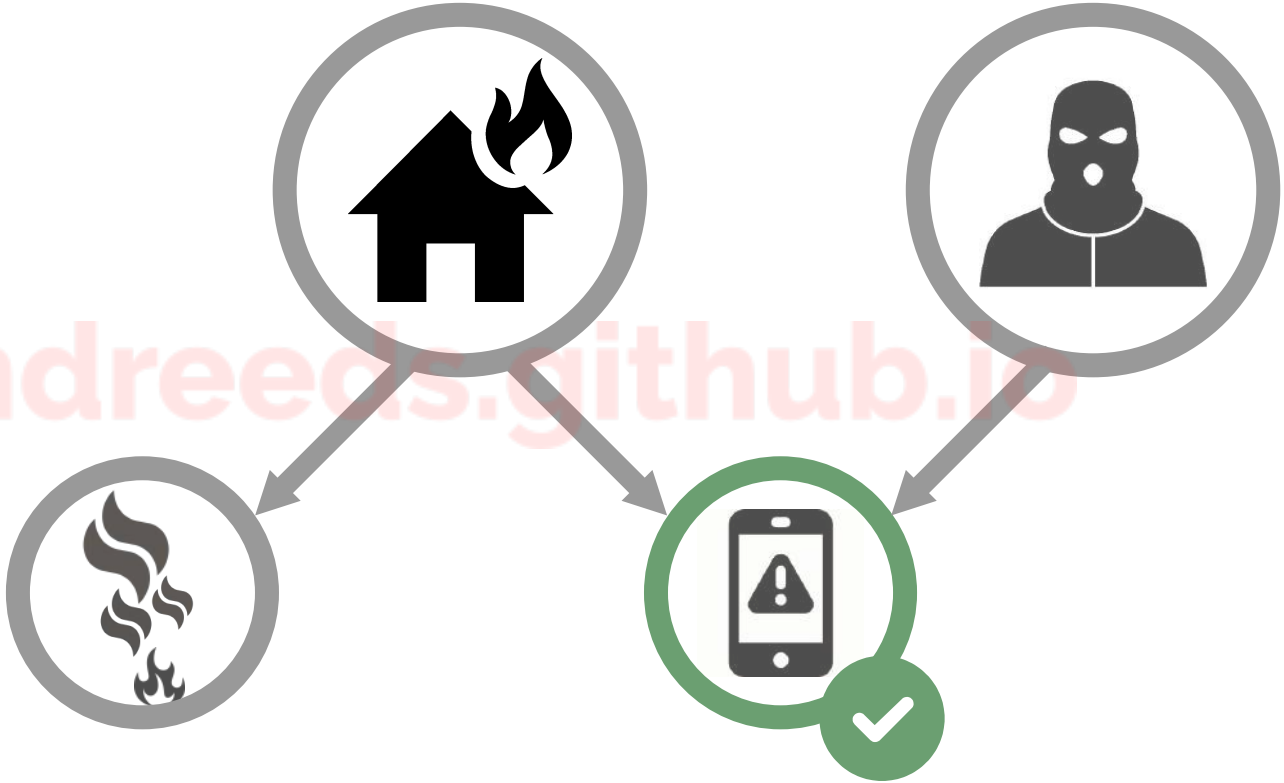


U = { fire, burglar, smoke, cellphone }

BN EXAMPLE



BN EXAMPLE



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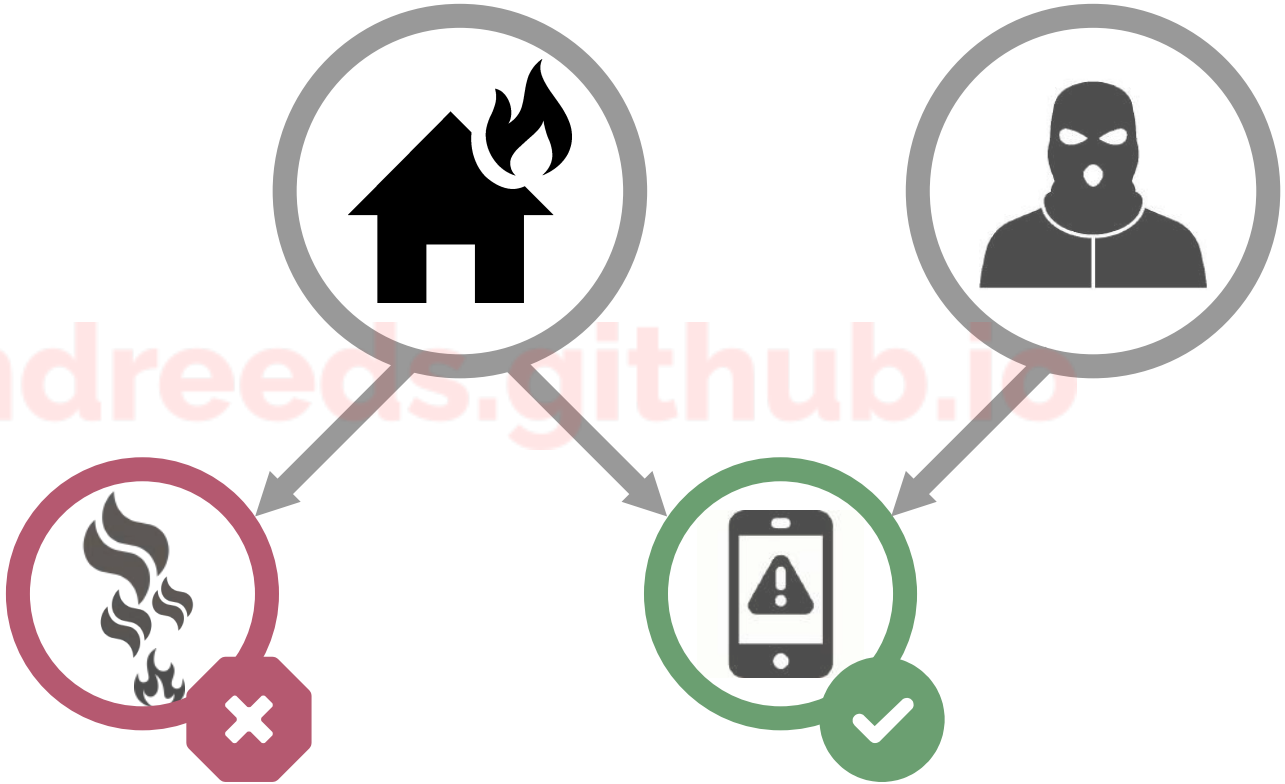
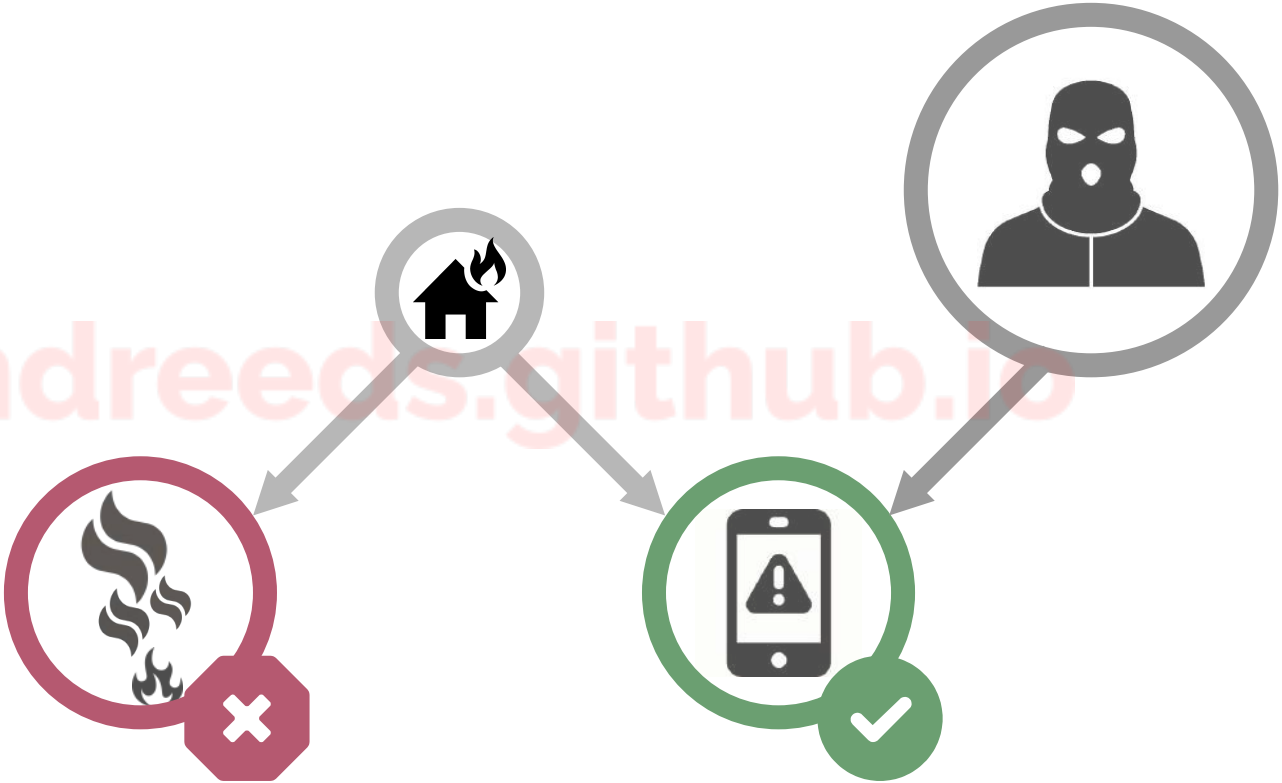


BN EXAMPLE



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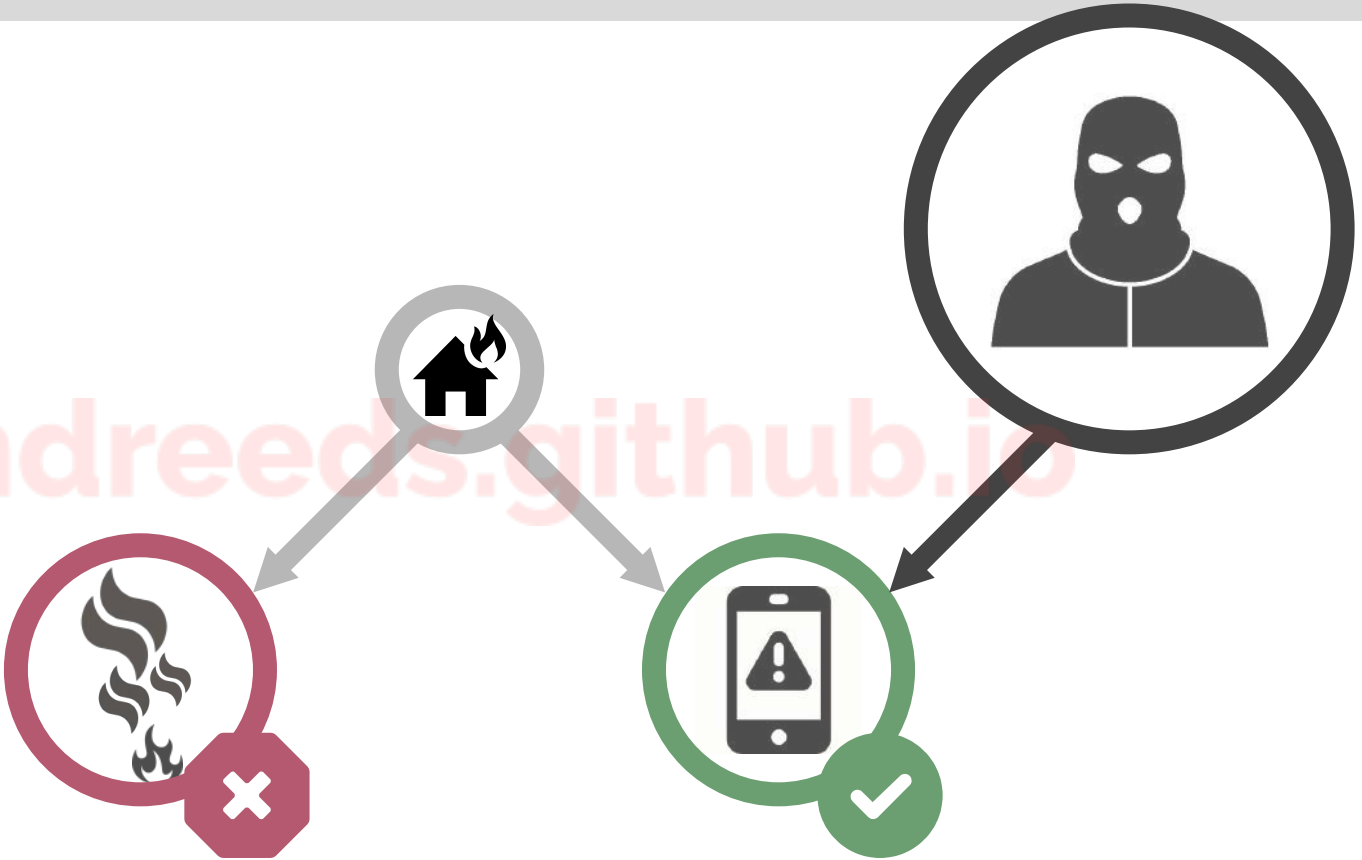
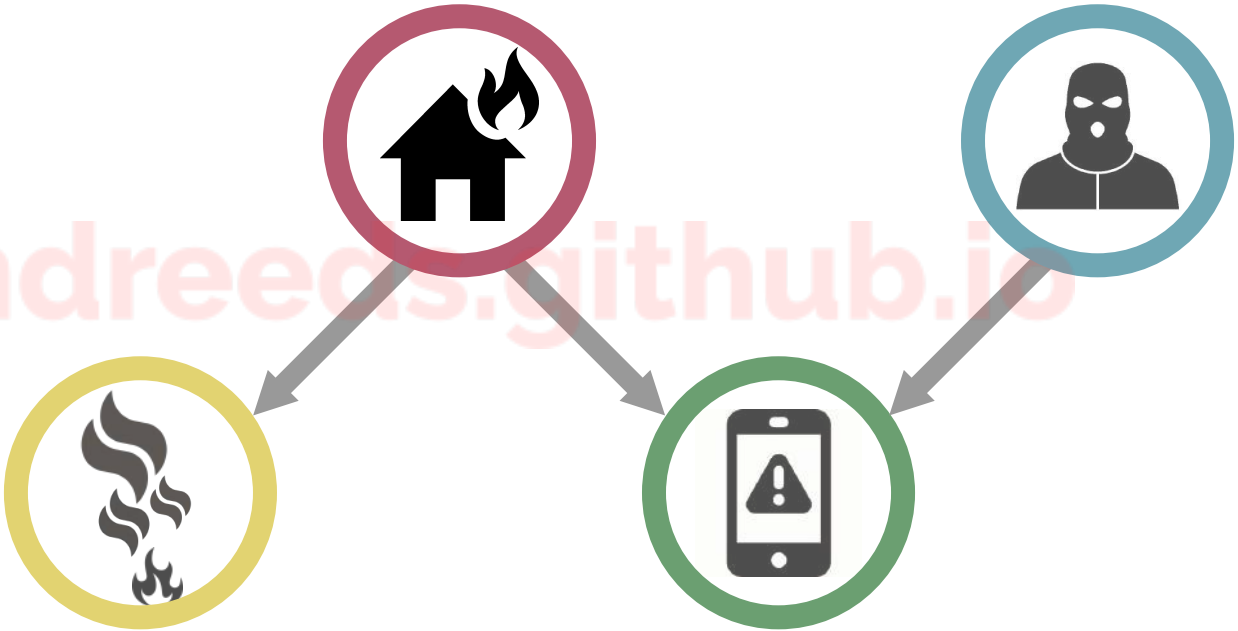


The ∏ of the CPTs is a **joint probability distribution** ρ(**U**)



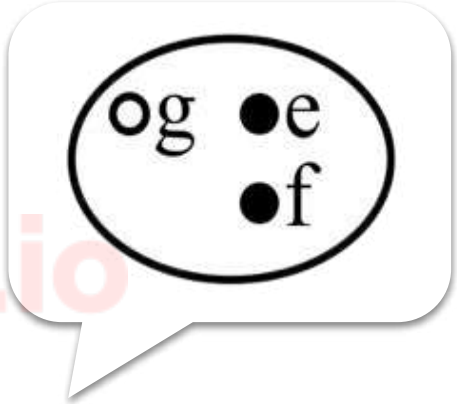
ρ(**U**) = ρ(**fire**) • ρ(**burglar**) • ρ(**smoke** | **fire**) • ρ(**cellphone** | **fire**, **burglar**)

DARWINIAN NETWORKS

SIMPLE PROPAGATION AROSE FROM DARWINIAN NETWORKS

(CAI 2015, CI 2016)

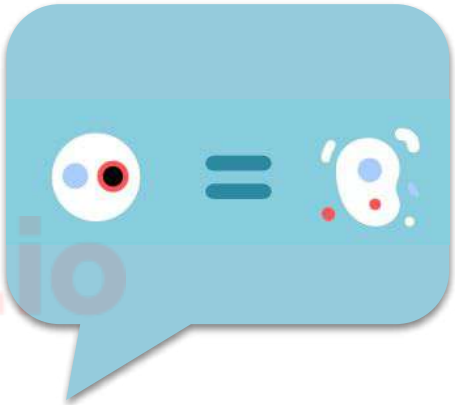
CLEVER WAY TO VIEW CPTs



$$P(g|e,f)$$

DARWINIAN NETWORKS

POPULATION OF MICROORGANISMS



$$P(g|e, f)$$

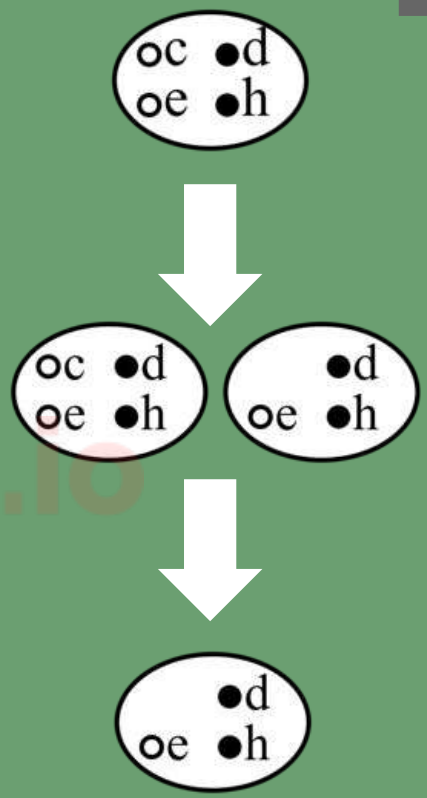
MULTIPLICATION IS MERGE

$$P(c|h) \cdot P(e|c,d) = P(c,e|d,h)$$

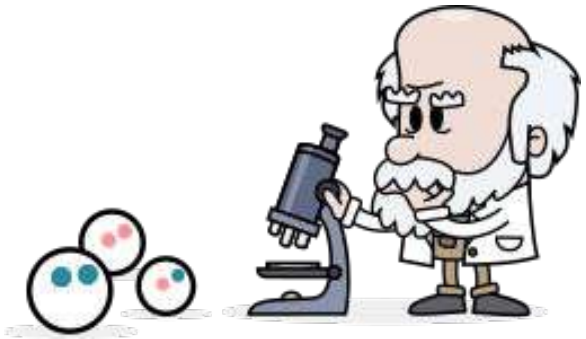
○ white	+	● black	=	○ white			
● black	+	○ white	=	○ white			
● black	+	● black	=	● black			
○ white	+	○ white	=	● black			

MARGINALIZATION IS REPLICATION AND NATURAL SELECTION

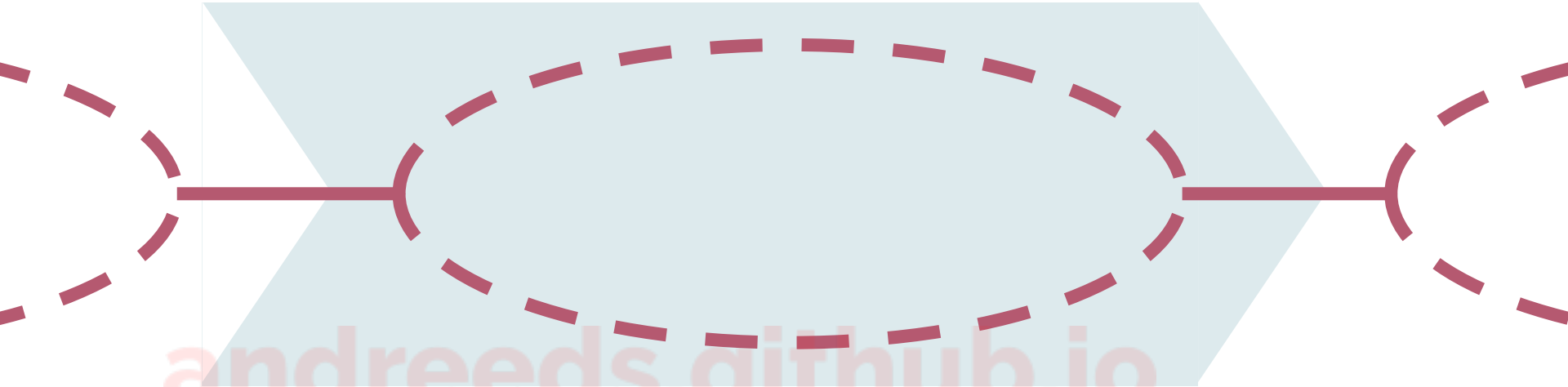
$$\sum_c P(c, e|d, h) = P(e|d, h)$$



Darwinian Networks Lab



Scan me



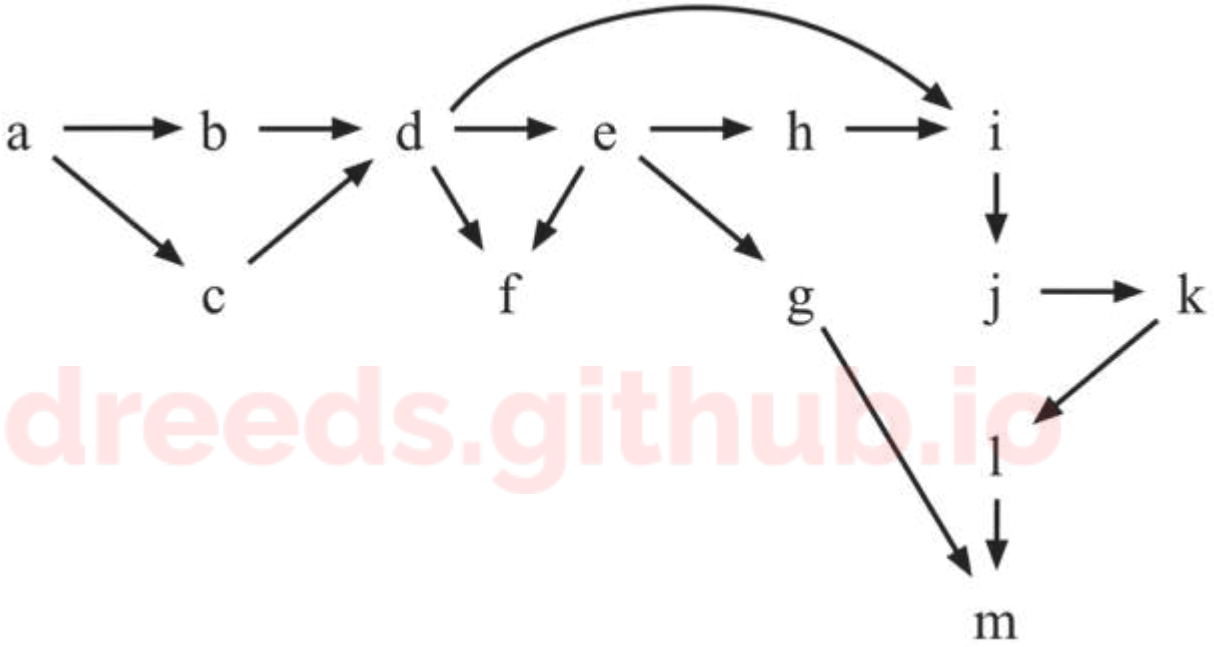
SIMPLE PROPAGATION

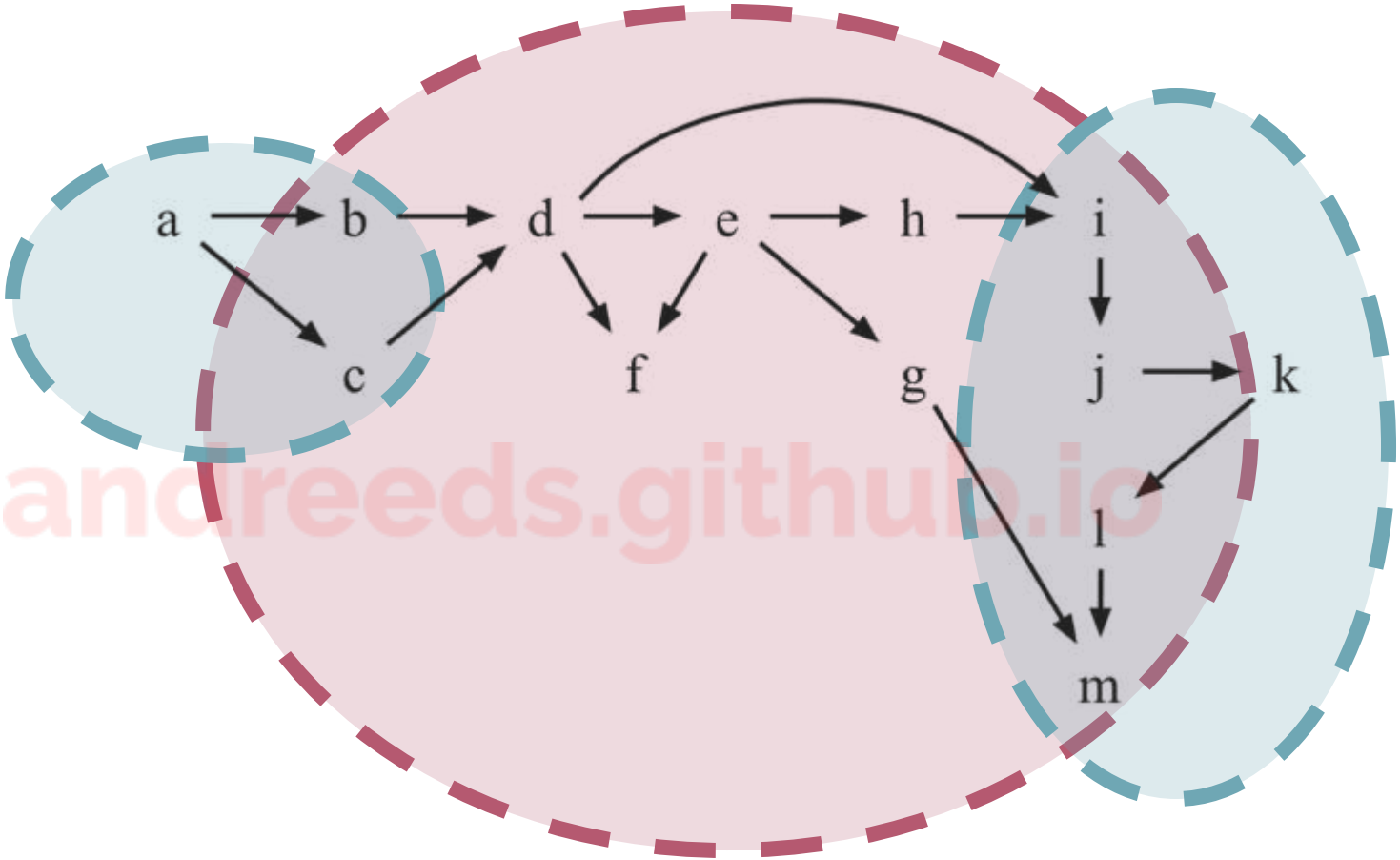
SP ONLY USES THE **“ONE IN, ONE OUT”** PROPERTY FOR JOIN TREE PROPAGATION

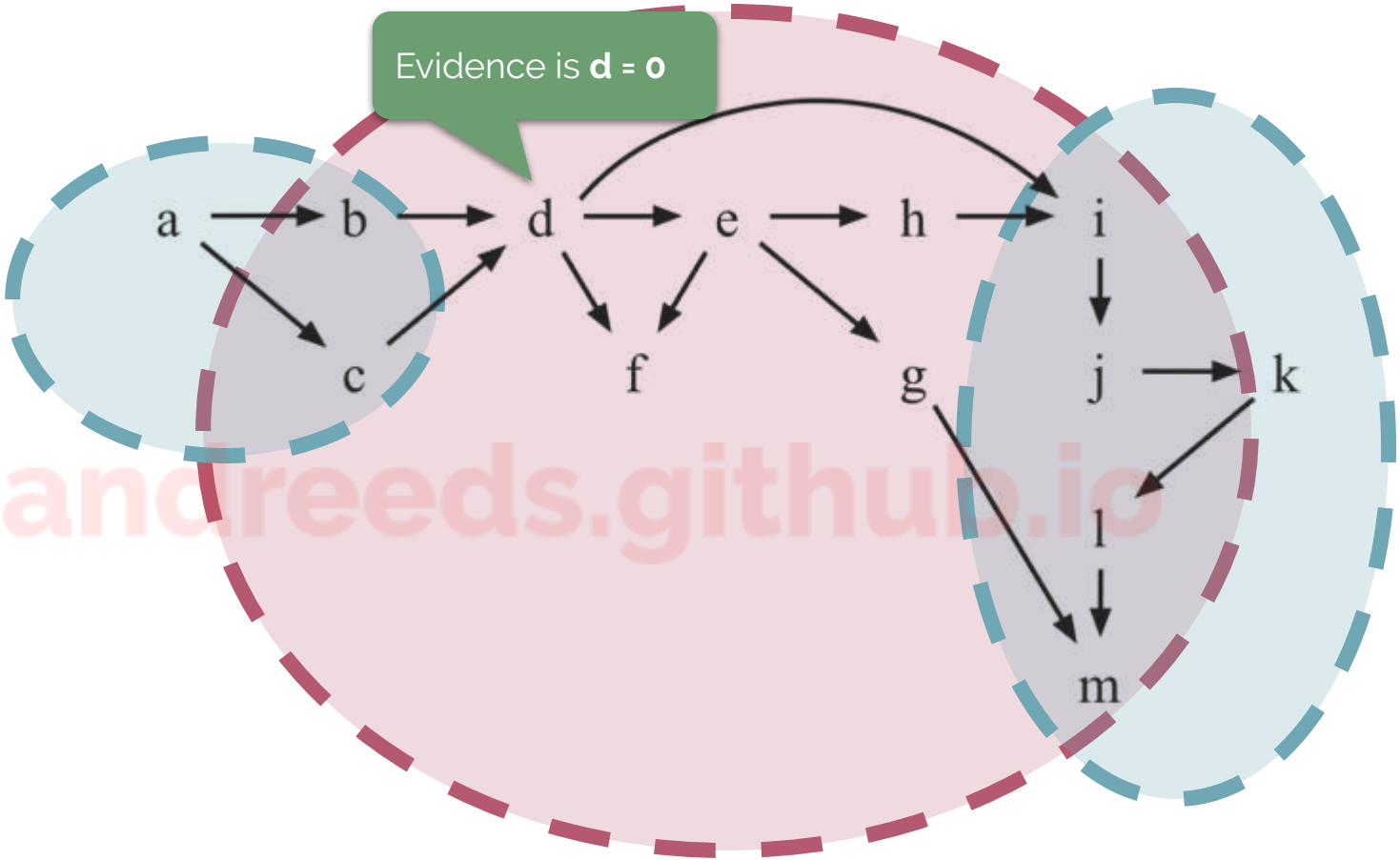
JOIN TREE PROPAGATION

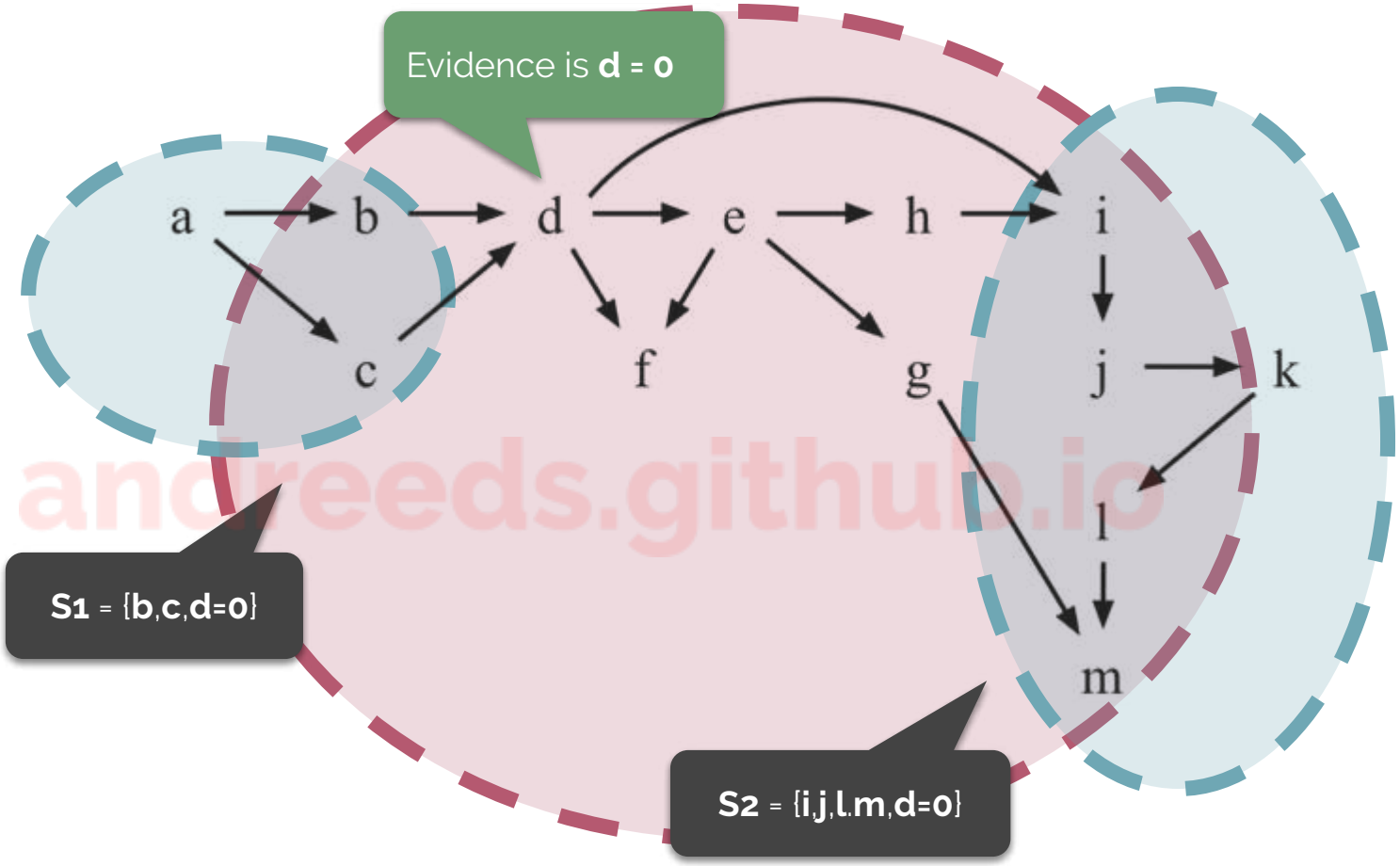
JTP IS CENTRAL TO THE THEORY AND PRACTICE OF PROBABILISTIC EXPERT SYSTEMS

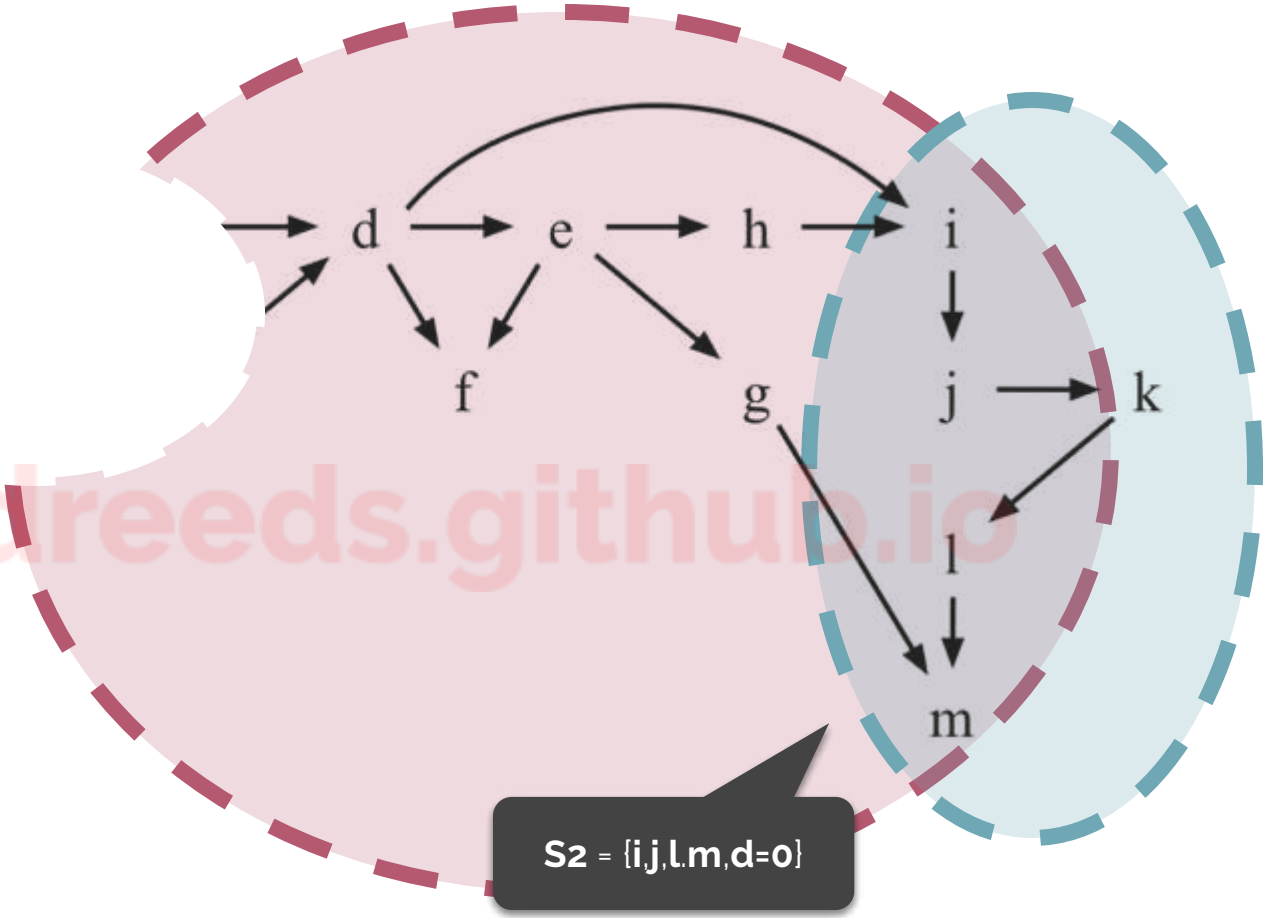
(Shafer 1996)

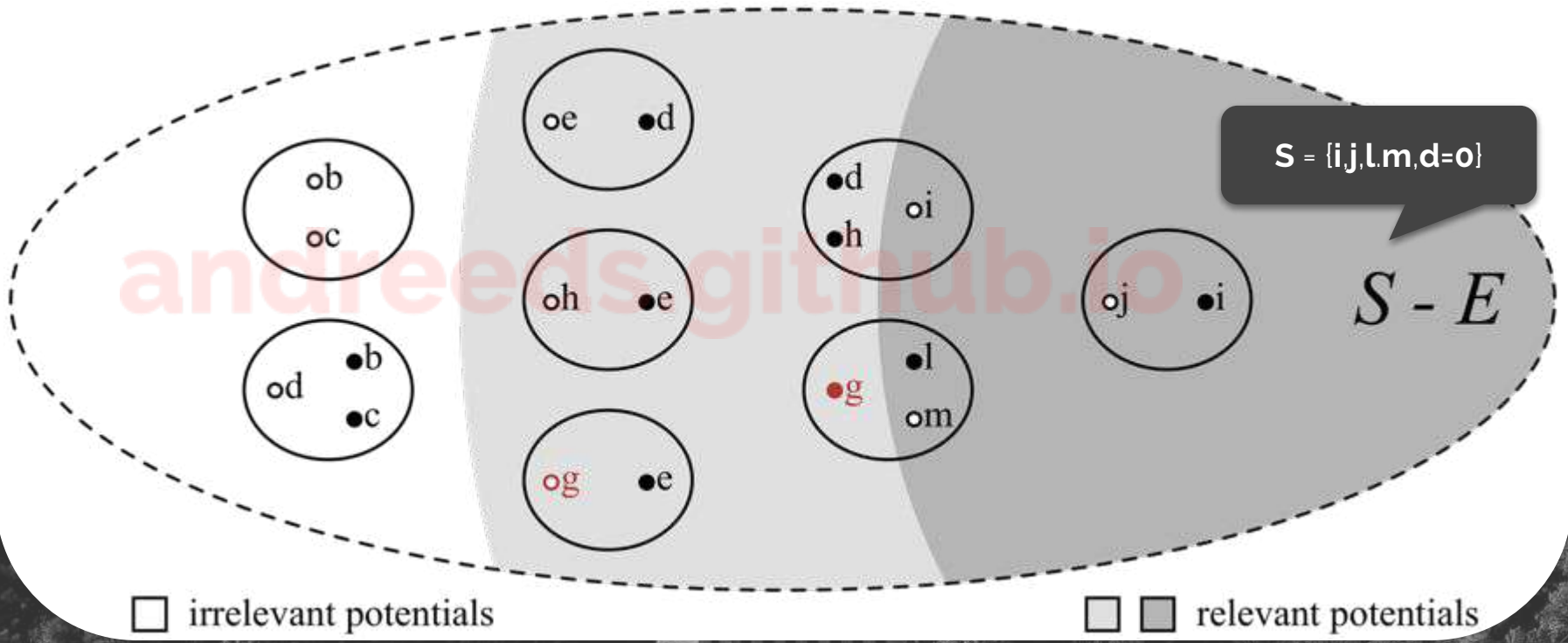


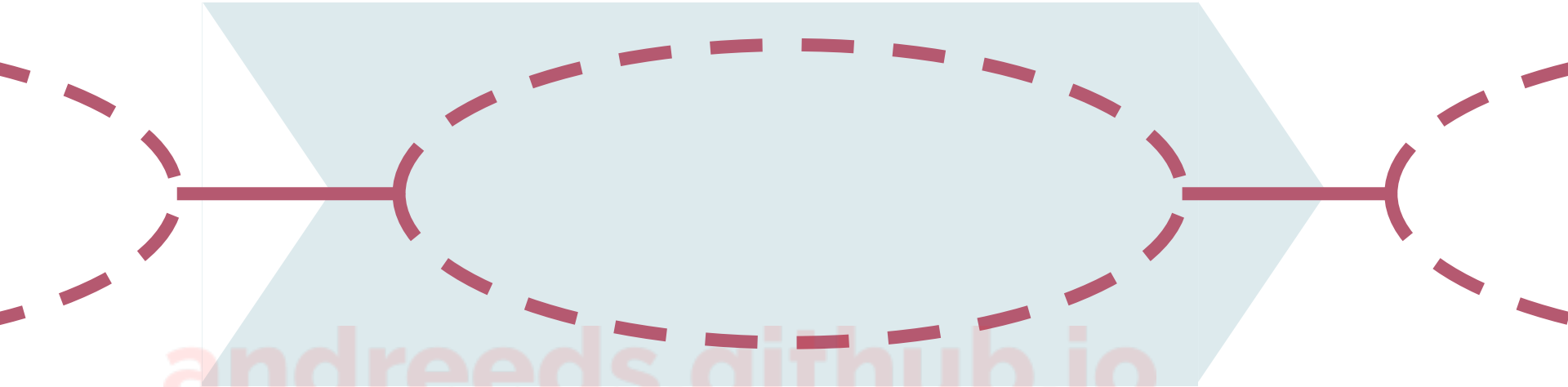












SIMPLE PROPAGATION

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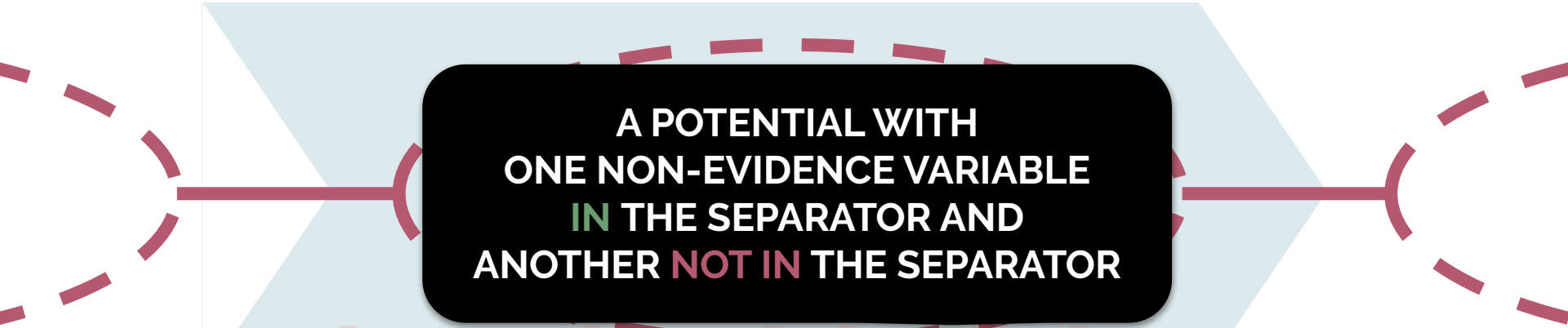

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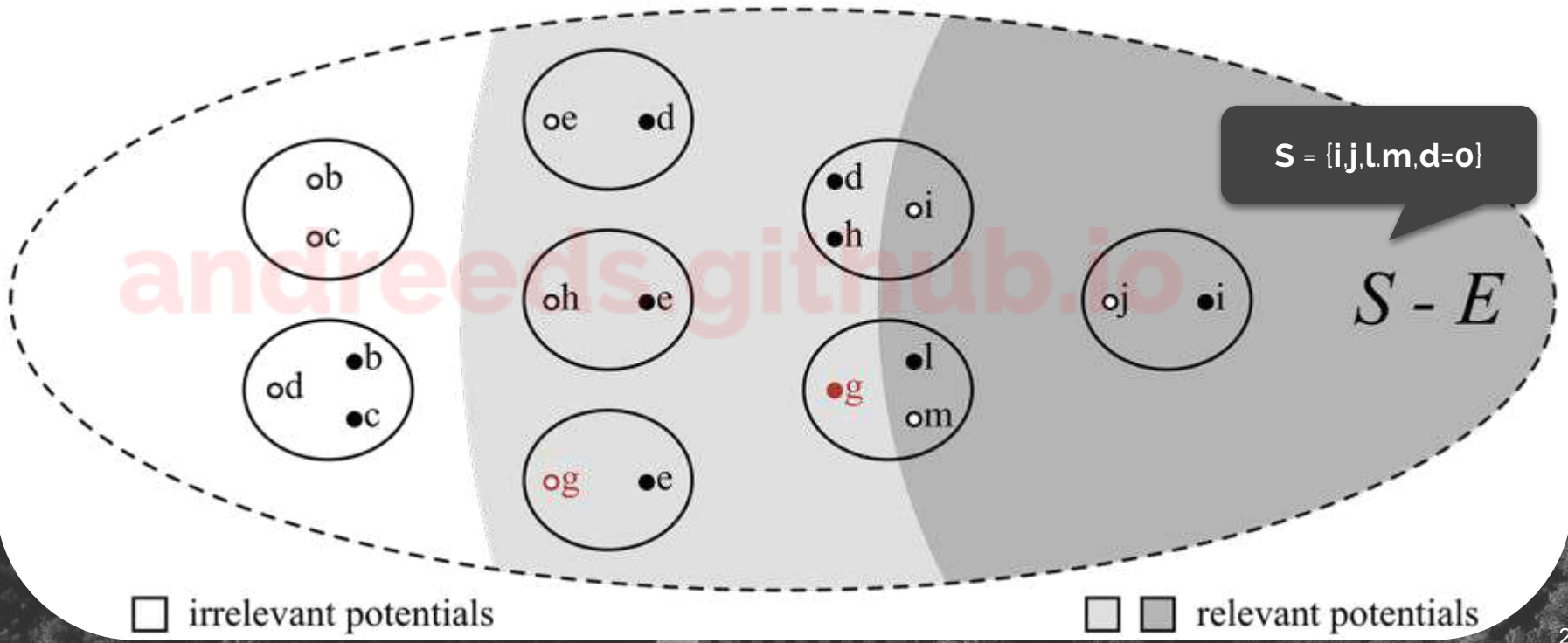

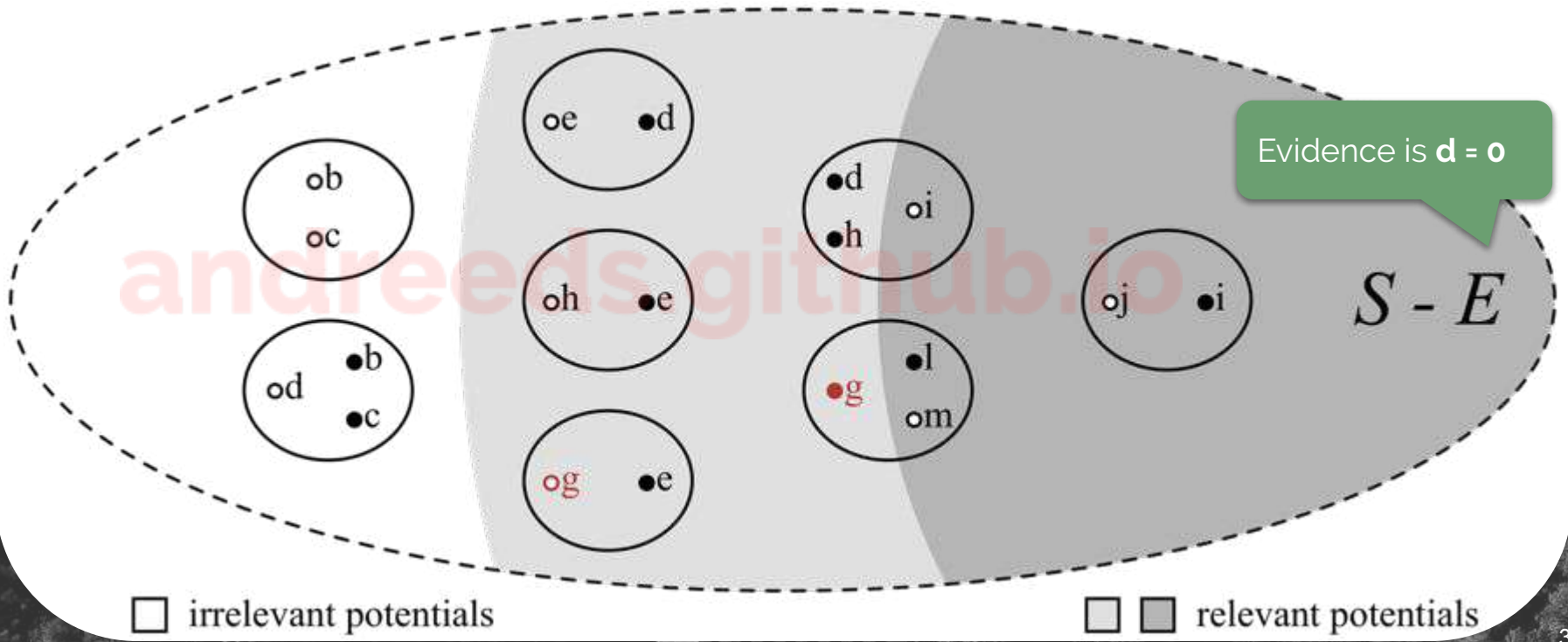

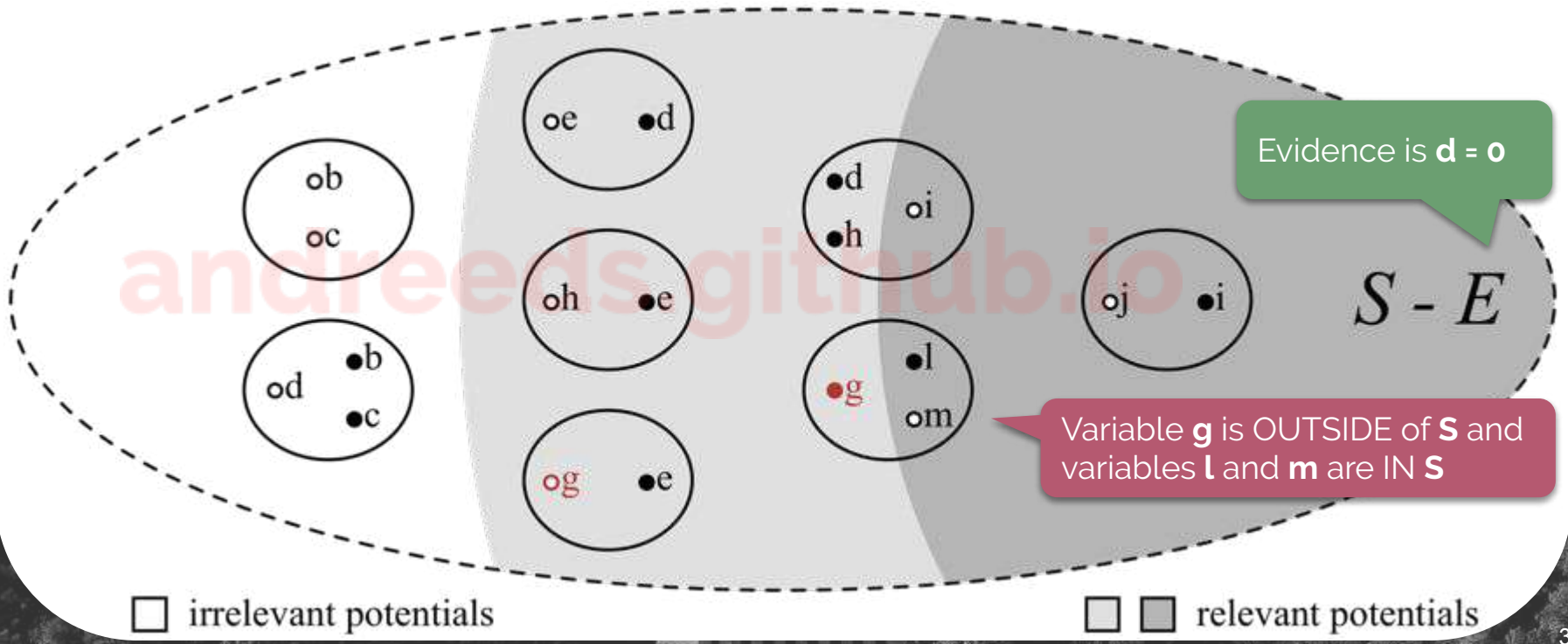

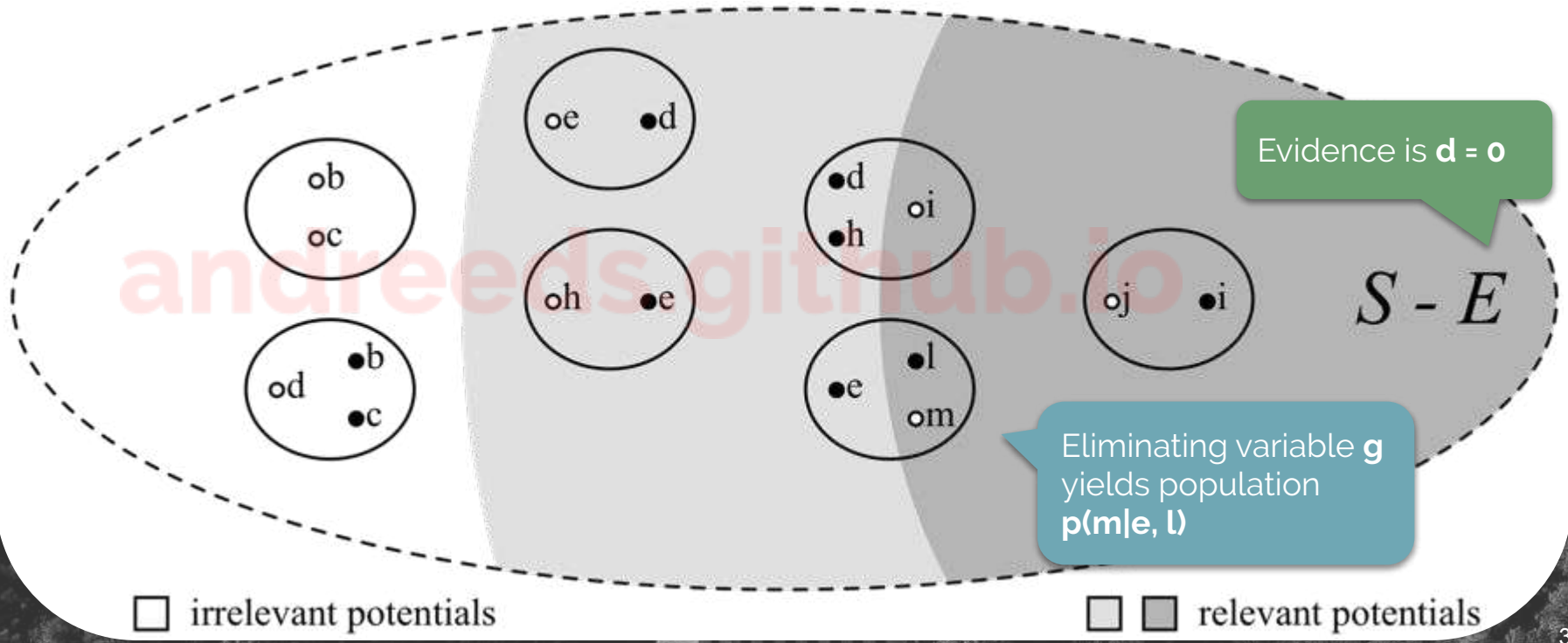

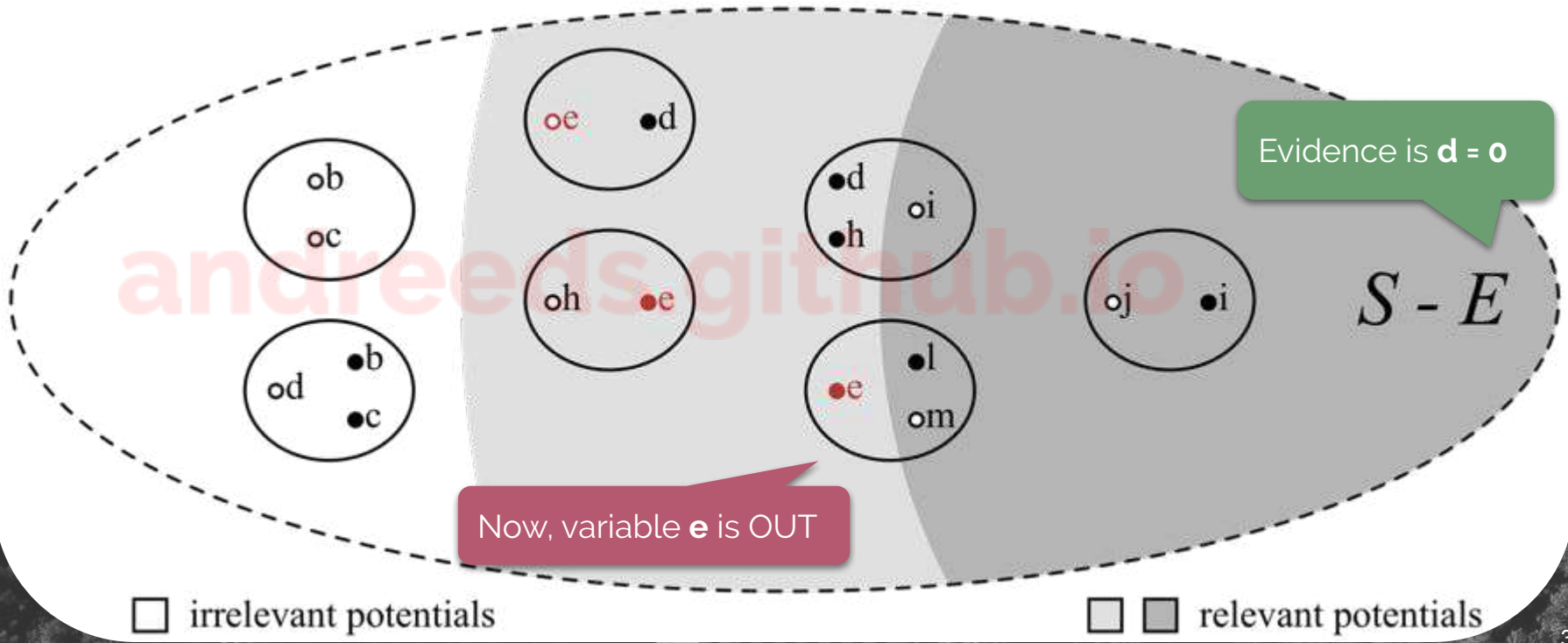

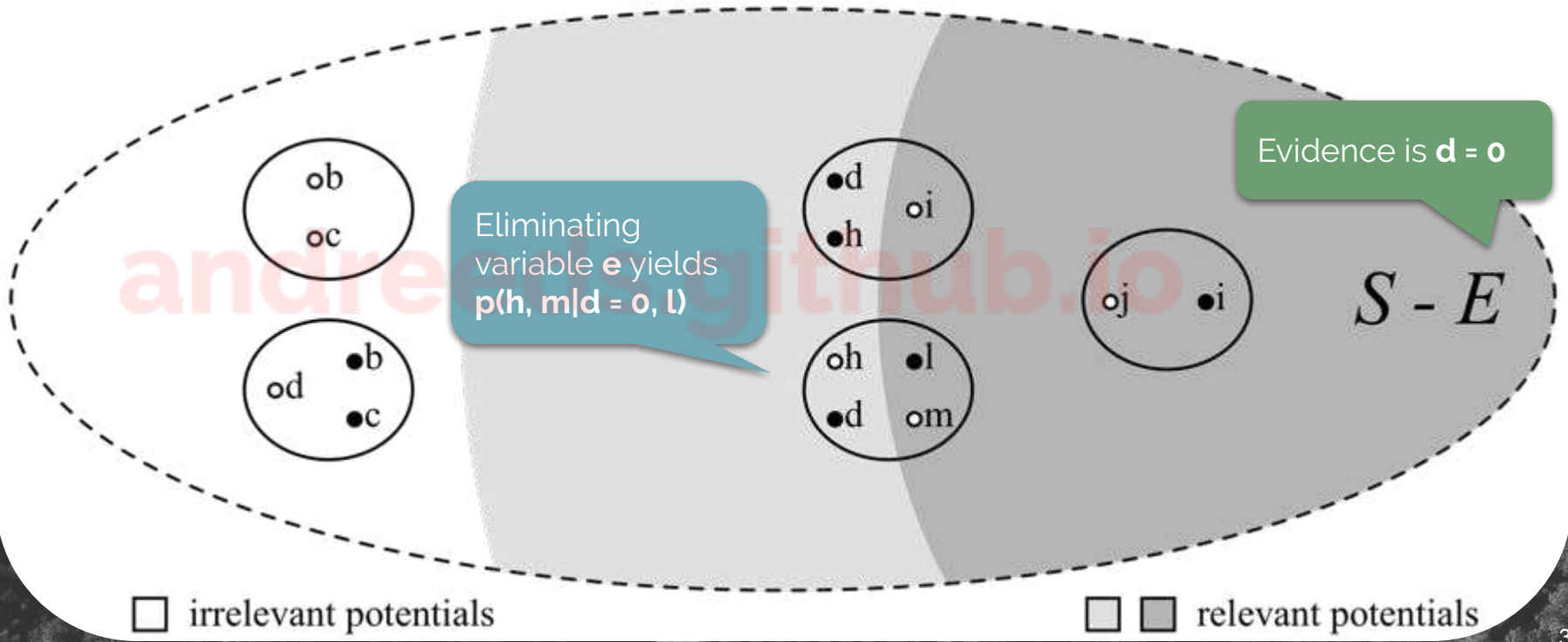

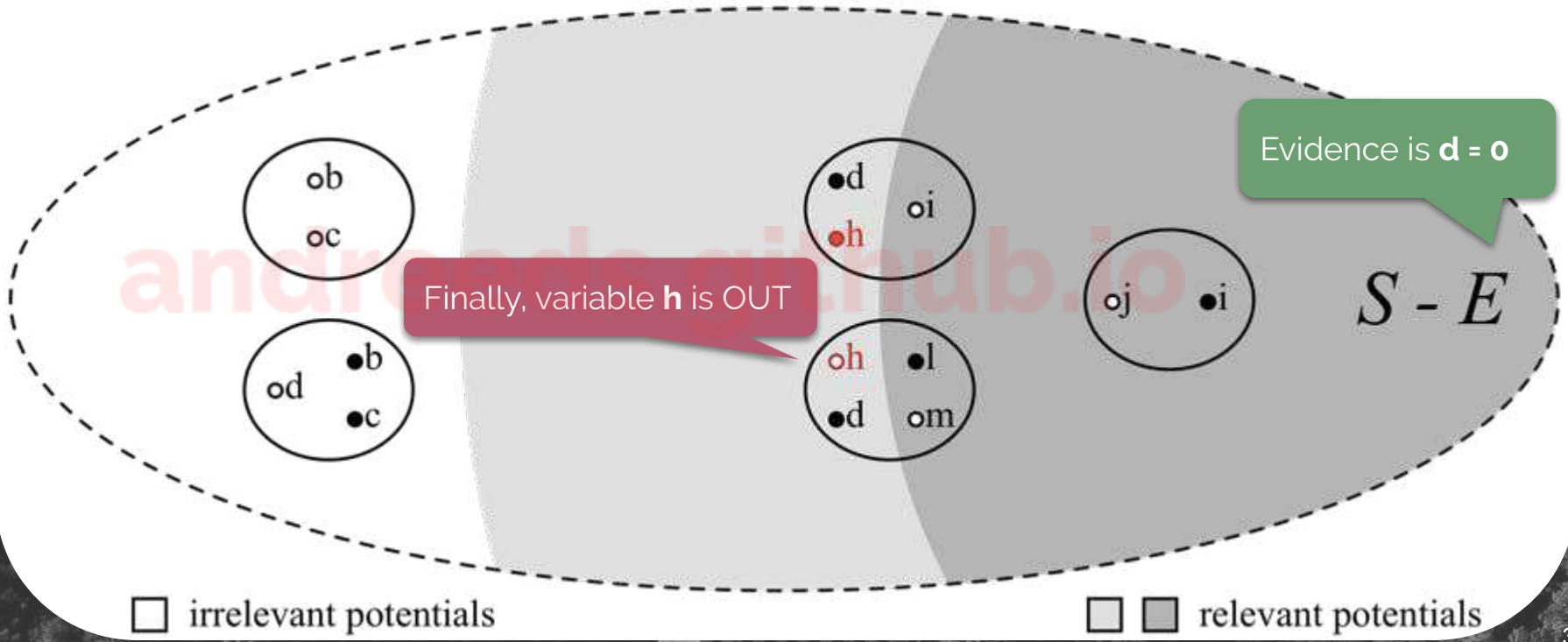
ob
oc
od
•b
•c
•d
oi
oh
oh
•l
•d
om
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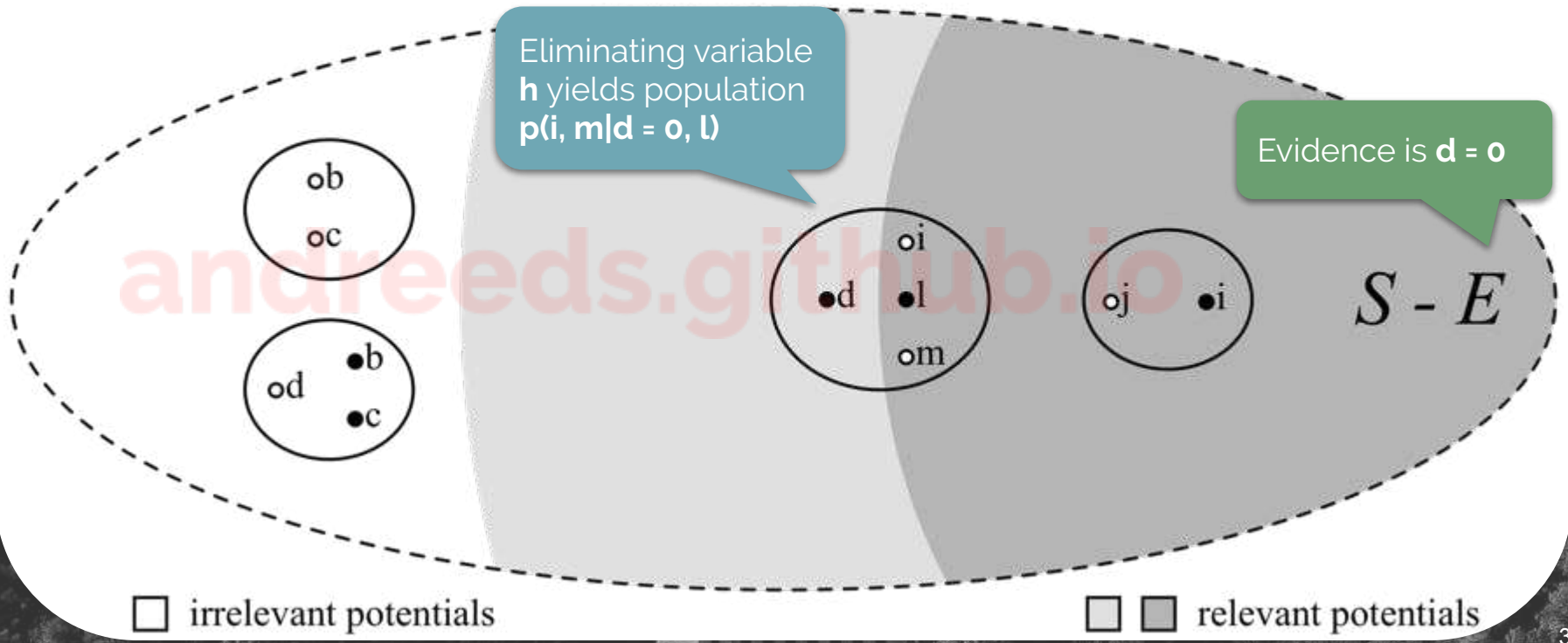
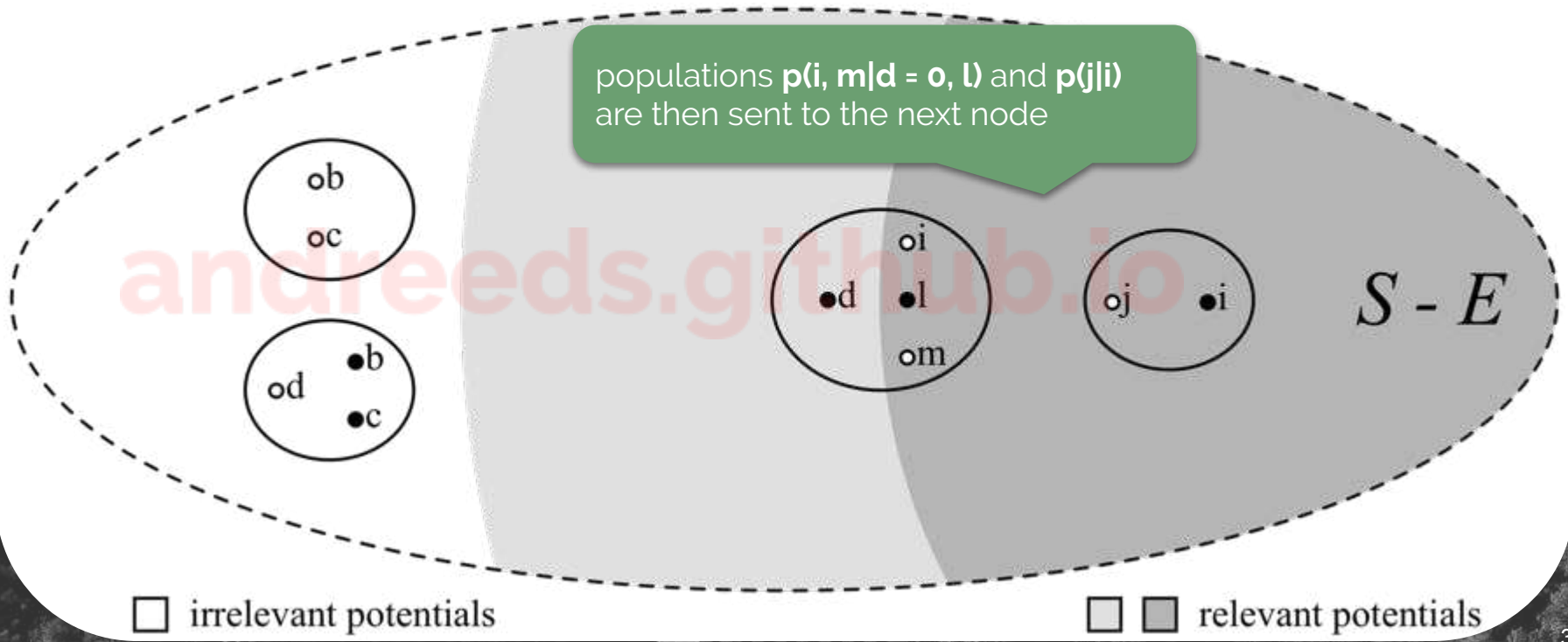
•i
S - E
Evidence is d = o
Finally, variable h is OUT
irrelevant potentials
relevant potentials



No more populations with the **"ONE IN, ONE OUT"** property

$$P(j|i) \cdot P(i, m|d = 0, l)$$

populations **p(i, m|d = 0, l)** and **p(j|i)** are then sent to the next node

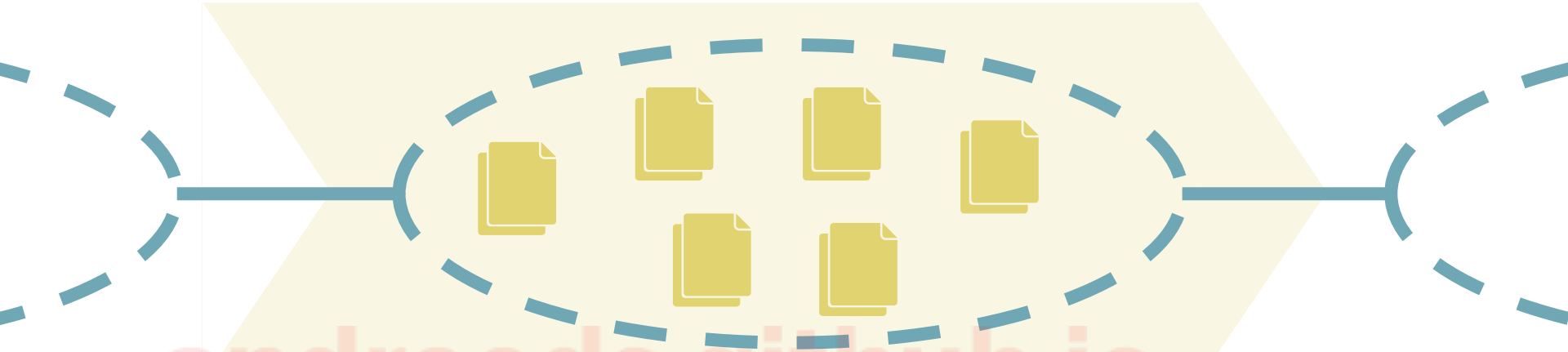


EXPERIMENTAL RESULTS

BN	Vars	LP	SP	Savin
Water	32	0.06	0.05	17%
Oow	33	0.07	0.06	14%
Oow_Bas	33	0.04	0.03	25%
Mildew	35	0.05	0.04	20%
Oow_Solo	40	0.07	0.06	14%
Hkv2005	44	0.23	0.27	-17%
Barley	48	0.09	0.1	-11%
Kk	50	0.09	0.09	0%
Ship	50	0.16	0.17	-6%
Hailfinder	56	0.02	0.02	0%
Medianus	56	0.04	0.03	25%
3Nt	58	0.02	0.01	50%
Hepar_Ii	70	0.03	0.03	0%
Win95Pts	76	0.03	0.03	0%
System_V57	85	0.06	0.05	17%
Fwe_Model8	109	0.14	0.15	-7%
Pathfinder	109	0.12	0.11	8%
Adapt_T1	133	0.04	0.04	0%
Cc145	145	0.1	0.08	20%
Munin1	189	0.54	0.75	-39%
Andes	223	0.15	0.13	13%
Cc245	245	0.2	0.18	10%
Diabetes	413	0.34	0.31	9%
Adapt_T2	671	0.24	0.22	8%
Amirali	681	0.45	0.41	9%
Munin2	1003	0.49	0.45	8%
Munin4	1041	0.61	0.57	7%
Munin3	1044	0.66	0.64	3%

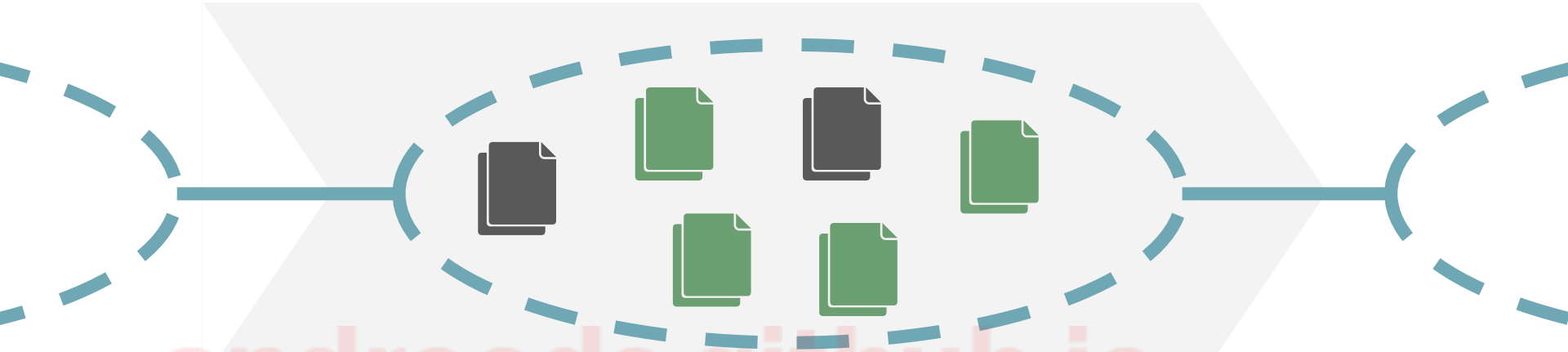
EXPERIMENTS CONDUCTED ON OPTIMAL JTs BUILT FROM 28 REAL-WORLD AND BENCHMARK BNs

- **SP** was **faster** in **18**
- **SP** tied **LP** in **5**
- **LP** was faster in **5**



LAZY PROPAGATION

LP TESTS INDEPENDENCY AND DETERMINE ELIMINATION ORDERING



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CONCLUSION

SP IS A NEW BN INFERENCE ALGORITHM

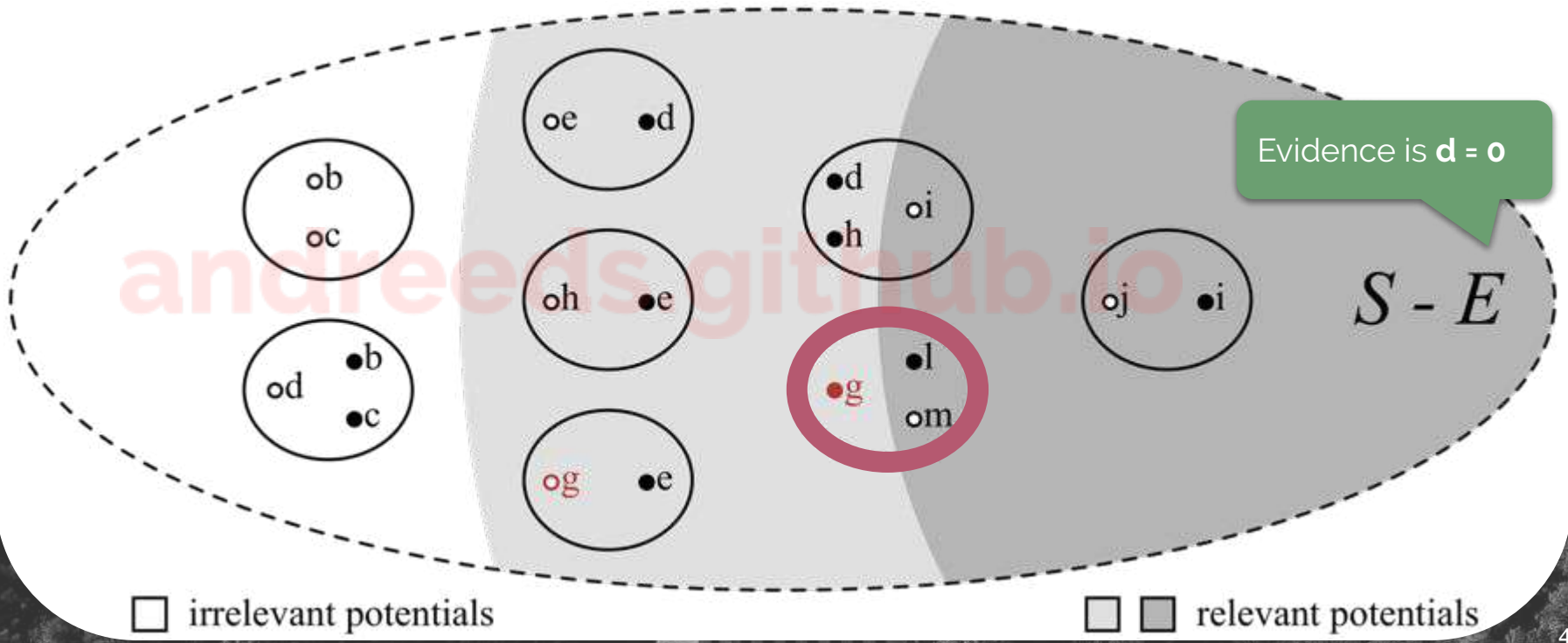
NO TESTING OF INDEPENDENCIES

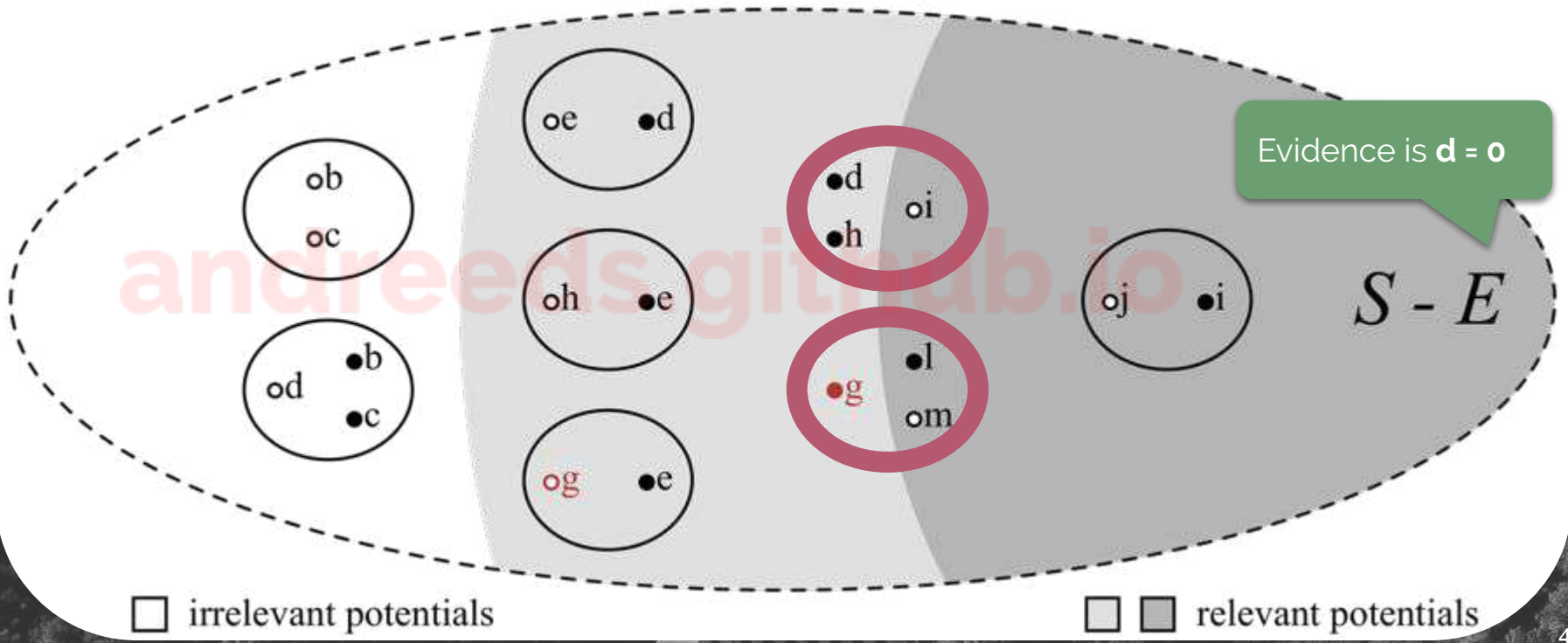
"ONE IN, ONE OUT" PROPERTY

NO ELIMINATION ORDERINGS

SP IS FASTER THAN LP IN 18/28 REAL-WORLD BNs

SP PERFORMS POORLY IN NON-OPTIMAL JOIN TREES





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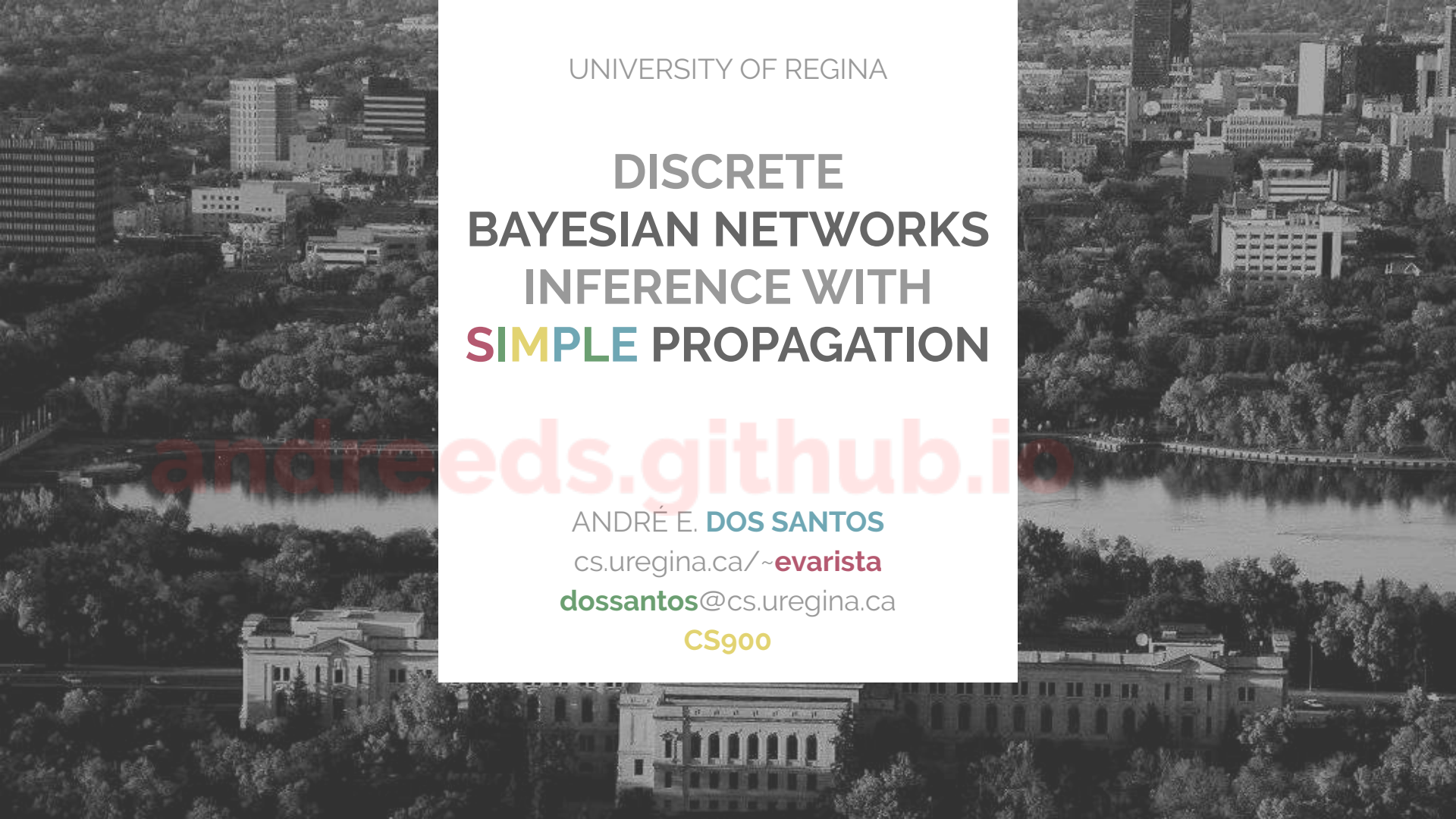

UNIVERSITY OF REGINA

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