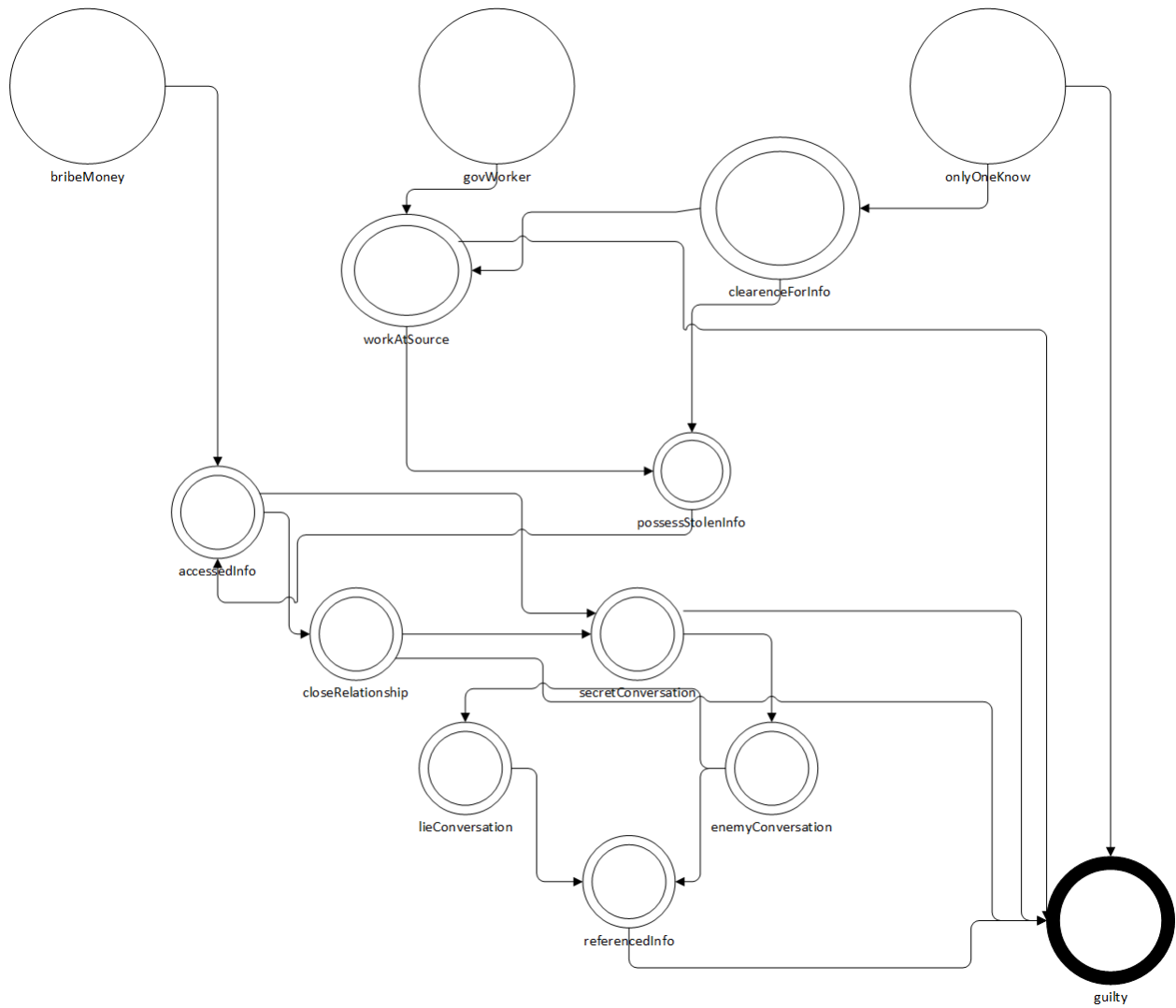


CSC 529- SPRING '17

Implementation of a Bayseian Network and Expert System

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Digital Drawing of Bayseian Network



Variable Names

| Variable Computer Name | Variable English Name |
|------------------------|--|
| accessedInfo | true if suspect was found to have accessed the information |
| bribeMoney | true if the suspect was found to receive bribes |
| clearenceForInfo | True suspect had the proper security clearance for the information |
| closeRelationship | true if the suspect had close ties to someone that did access the information |
| enemyConversation | true if the suspect had talked with an enemy |
| govWorker | True if the suspect was a government worker/contractor |
| guilty | Variable that holds the probability of the suspect being guilty |
| lieConversation | true if the suspect lied about the conversations in question above |
| onlyOneKnow | true if suspect was the only person that knew the information |
| possessStolenInfo | true if suspect was in the possession of the stolen information |
| referencedInfo | true if the suspect seemed to have referenced the information in the conversations above |
| secretConversation | true if the suspect had been in secret talks with someone |
| workAtSource | true if the suspect worked at/for the source of the information |

Probability Table

| Variable Name | Probability Value |
|-------------------|--|
| accessedInfo | $p(\text{accessedInfo}, [\text{bribeMoney}], 0.4).$ $p(\text{accessedInfo}, [\text{not}(\text{bribeMoney})], 0.01).$ |
| bribeMoney | $p(\text{bribeMoney}, \text{ASK}).$ (initial probability) |
| clearanceForInfo | $p(\text{clearanceForInfo}, [\text{onlyOneKnow}], 0.999).$ $p(\text{clearanceForInfo}, [\text{not}(\text{onlyOneKnow})], 0.85).$ |
| closeRelationship | $p(\text{closeRelationship}, [\text{accessedInfo}], 0.1).$ $p(\text{closeRelationship}, [\text{not}(\text{accessedInfo})], 0.74).$ |
| enemyConversation | $p(\text{enemyConversation}, [\text{secretConversation}], 0.9).$ $p(\text{enemyConversation}, [\text{not}(\text{secretConversation})], 0.05).$ |
| govWorker | $p(\text{govWorker}, \text{ASK}).$ (initial probability) |
| guilty | $\text{prob}(\text{guilty}, [\text{onlyOneKnow}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{secretConversation}, \text{closeRelationship}, \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{secretConversation}, \text{closeRelationship}, \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{not}(\text{secretConversation}), \text{closeRelationship}, \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{secretConversation}, \text{not}(\text{closeRelationship}), \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{secretConversation}, \text{closeRelationship}, \text{not}(\text{referencedInfo})], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{not}(\text{secretConversation}), \text{closeRelationship}, \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{secretConversation}, \text{not}(\text{closeRelationship}), \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{secretConversation}, \text{closeRelationship}, \text{not}(\text{referencedInfo})], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{not}(\text{secretConversation}), \text{not}(\text{closeRelationship}), \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{not}(\text{secretConversation}), \text{closeRelationship}, \text{not}(\text{referencedInfo})], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{not}(\text{secretConversation}), \text{not}(\text{closeRelationship}), \text{referencedInfo}], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{not}(\text{secretConversation}), \text{closeRelationship}, \text{not}(\text{referencedInfo})], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{workAtSource}, \text{not}(\text{secretConversation}), \text{not}(\text{closeRelationship}), \text{not}(\text{referencedInfo})], N).$ $\text{prob}(\text{guilty}, [\text{not}(\text{onlyOneKnow}), \text{not}(\text{workAtSource}), \text{not}(\text{secretConversation}), \text{not}(\text{closeRelationship}), \text{not}(\text{referencedInfo})], N).$ |
| lieConversation | $p(\text{lieConversation}, [\text{enemyConversation}], 0.9).$ $p(\text{lieConversation}, [\text{not}(\text{enemyConversation})], 0.001).$ |
| onlyOneKnow | $p(\text{onlyOneKnow}, \text{ASK}).$ (initial probability). |
| possessStolenInfo | $p(\text{possessStolenInfo}, [\text{workAtSource}, \text{clearanceForInfo}], 0.7).$ $p(\text{possessStolenInfo}, [\text{not}(\text{workAtSource}), \text{clearanceForInfo}], 0.2).$ |

| | |
|--------------------|---|
| | p(possessStolenInfo, [workAtSource, not(clearanceForInfo)], 0.01). p(possessStolenInfo, [not(workAtSource), not(clearanceForInfo)], 0.001). |
| referencedInfo | p(referencedInfo, [lieConversation, enemyConversation], 0.9). p(referencedInfo, [not(lieConversation), enemyConversation], 0.82). p(referencedInfo, [lieConversation, not(enemyConversation)], 0.85). p(referencedInfo, [not(lieConversation), not(enemyConversation)], 0.4). |
| secretConversation | p(secretConversation, [closeRelationship, accessedInfo], 0.4). p(secretConversation, [not(closeRelationship), accessedInfo], 0.65). p(secretConversation, [closeRelationship, not(accessedInfo)], 0.35). p(secretConversation, [not(closeRelationship), not(accessedInfo)], 0.25). |
| workAtSource | p(workAtSource, [govWorker, clearanceForInfo], 0.8). p(workAtSource, [not(govWorker), clearanceForInfo], 0.32). p(workAtSource, [govWorker, not(clearanceForInfo)], 0.2). p(workAtSource, [not(govWorker), not(clearanceForInfo)], 0.01). |

Prolog Definition of BN

parent(bribeMoney, accessedInfo).
parent(govWorker, workAtSource).
parent(onlyOneKnow, guilty).
parent(onlyOneKnow, clearanceForInfo).
parent(clearanceForInfo, workAtSource).
parent(clearanceForInfo, possessStolenInfo).
parent(workAtSource, possessStolenInfo).
parent(workAtSource, guilty).
parent(possessStolenInfo, accessedInfo).
parent(accessedInfo, closeRelationship).
parent(accessedInfo, secretConversation).
parent(closeRelationship, secretConversation).
parent(closeRelationship, guilty).
parent(secretConversation, enemyConversation).
parent(secretConversation, guilty).
parent(enemyConversation, referencedInfo).
parent(enemyConversation, lieConversation).
parent(lieConversation, referencedInfo).
parent(referencedInfo, guilty).

Sample Queries

prob(guilty, [onlyOneKnow], N).
prob(guilty, [not(onlyOneKnow), workAtSource, secretConversation, closeRelationship, referencedInfo], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), secretConversation, closeRelationship, referencedInfo], N).
prob(guilty, [not(onlyOneKnow), workAtSource, not(secretConversation), closeRelationship, referencedInfo], N).
prob(guilty, [not(onlyOneKnow), workAtSource, secretConversation, not(closeRelationship), referencedInfo], N).
prob(guilty, [not(onlyOneKnow), workAtSource, secretConversation, closeRelationship, not(referencedInfo)], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), not(secretConversation), closeRelationship, referencedInfo], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), secretConversation, not(closeRelationship), referencedInfo], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), secretConversation, closeRelationship, not(referencedInfo)], N).
prob(guilty, [not(onlyOneKnow), workAtSource, not(secretConversation), not(closeRelationship), referencedInfo], N).
prob(guilty, [not(onlyOneKnow), workAtSource, not(secretConversation), closeRelationship, not(referencedInfo)], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), not(secretConversation), not(closeRelationship), referencedInfo], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), not(secretConversation), closeRelationship, not(referencedInfo)], N).
prob(guilty, [not(onlyOneKnow), workAtSource, not(secretConversation), not(closeRelationship), not(referencedInfo)], N).
prob(guilty, [not(onlyOneKnow), not(workAtSource), not(secretConversation), not(closeRelationship), not(referencedInfo)], N).

Forward Chaining Rules

if military then the_punishment_for_the_suspect_is_death.

if not(military) and criminal and willing and serious then
the_punishment_for_the_suspect_is_death.

if not(military) and criminal and willing and petty then
the_punishment_for_the_suspect_is_life_with_possible_parole.

if not(military) and criminal and not(willing) and not(ill) then
the_punishment_for_the_suspect_is_10000_dollar_fine_and_20_years.

if not(military) and criminal and not(willing) and ill then
the_punishment_for_the_suspect_is_20_years.

if not(military) and not(criminal) and willing and serious then
the_punishment_for_the_suspect_is_death.

if not(military) and not(criminal) and willing and petty then
the_punishment_for_the_suspect_is_10000_dollar_fine_and_30_years.

if not(military) and not(criminal) and not(willing) and remorse and ill then
the_punishment_for_the_suspect_is_5000_dollar_fine_and_mental_health_help.

if not(military) and not(criminal) and not(willing) and remorse and not(ill) then
the_punishment_for_the_suspect_is_5000_dollar_fine_and_1_year.

if not(military) and not(criminal) and not(willing) and not(remorse) and ill then
the_punishment_for_the_suspect_is_7500_dollar_fine_and_5_years.

if not(military) and not(criminal) and not(willing) and not(remorse) and not(ill) then
the_punishment_for_the_suspect_is_7500_dollar_fine_and_10_years.

FC Variable Definition Table

| TERM | EXPLANATION |
|-----------------|--|
| ask_user | Actually starts calling the program to run. |
| criminal | Fact asserted if the suspect had a prior criminal activity. |
| forward | Utilizes the Bratko Forward Chaining interpreter. |
| guilt | Starts the Forward Chaining Rules by calling ask_user and forward. |
| ill | Fact asserted if the suspect was mentally ill. |
| military | Fact asserted if the suspect was active in military. |
| petty | Fact asserted if the suspect intended to cause minor problems within the United States Armed Forces, such as disloyalty, or insubordination. |
| remorse | Fact asserted if the suspect showed remorse. |
| serious | Fact asserted if the suspect intended to cause severe harm towards the United States Armed Forces, and aid its enemies. |
| willing | Fact asserted if the suspect willingly committed the crime. |

Sample Queries on System

```
SWI-Prolog -- c:/Users/jcwilhel.CAMPUS/Documents/HW4.pl
File Edit Settings Run Debug Help
Welcome to SWI-Prolog (Multi-threaded, 32 bits, Version 7.2.3)
Copyright (c) 1990-2015 University of Amsterdam, VU Amsterdam
SWI-Prolog comes with ABSOLUTELY NO WARRANTY. This is free software,
and you are welcome to redistribute it under certain conditions.
Please visit http://www.swi-prolog.org for details.

For help, use ?- help(Topic). or ?- apropos(Word).

1 ?- guilt.
Was the suspect in the military? (y or n): n.
Does the suspect have a criminal record? (y or n): |: y.
Does the suspect show remorse? (y or n): |: n.
Did the suspect willingly commit this crime? (y or n): |: y.
Did the suspect intend to interfere with the operation or
success of the armed forces of the United States of America, or
promote success of its enemies? (y or n): |: n.
Did the suspect intend to cause insubordination,
disloyalty, mutiny, refusal of duty, or to obstruct the recruitment
or enlistment service of the United States of America?
(y or n): |: y.
Was the suspect mentally ill? (y or n): |: y.
End of questions.Derived: the_punishment_for_the_suspect_is_life_with_possible_parole
No more facts
true.

2 ?- █
```

```
SWI-Prolog -- c:/Users/jcwilhel.CAMPUS/Documents/HW4.pl
File Edit Settings Run Debug Help
Welcome to SWI-Prolog (Multi-threaded, 32 bits, Version 7.2.3)
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Please visit http://www.swi-prolog.org for details.

For help, use ?- help(Topic). or ?- apropos(Word).

1 ?- guilt.
Was the suspect in the military? (y or n): n.
Does the suspect have a criminal record? (y or n): |: n.
Does the suspect show remorse? (y or n): |: n.
Did the suspect willingly commit this crime? (y or n): |: y.
Did the suspect intend to interfere with the operation or
success of the armed forces of the United States of America, or
promote success of its enemies? (y or n): |: n.
Did the suspect intend to cause insubordination,
disloyalty, mutiny, refusal of duty, or to obstruct the recruitment
or enlistment service of the United States of America?
(y or n): |: y.
Was the suspect mentally ill? (y or n): |: n.
End of questions.Derived: the_punishment_for_the_suspect_is_10000_dollar_fine_and_30_years
No more facts
true.

2 ?- █
```