Aufgabe 2) Technical Applications: Car Start Problem 1 (1 Point)

Car Diagnostics 1

Use GeNIe to calculate the following probabilities:

Car Diagnostics 1

Frage 1 von 2 (5 Punkte)
Nicht beantwortet (in Bearbeitung)

Aktionen

Story:

Oh no, my car does not start! I should call the repair shop. But if it turns out to be a bagatelle only, I spend money for nothing. However, as I am a layperson when it comes to engines and stuff, I would not even be capable of fixing the simplest things. On the other hand, I recently saw my neighbor's son repairing his bike. Maybe he can fix my car if no spare parts are needed. In order to decide on whether I call the repair shop or not, I should have more information on the potential cause.

Mission:

Use GeNIe and the Bayesian network provided on ILIAS to answer this question. In GeNIe, first fix the values of evidence nodes (there is one evidence node in this example) and mark all target nodes (there are 5 target nodes in this example). Finally, call update belief (execution of fusion) on the network. Your target nodes show a green check mark now. Mouse over the check mark and read out the values.

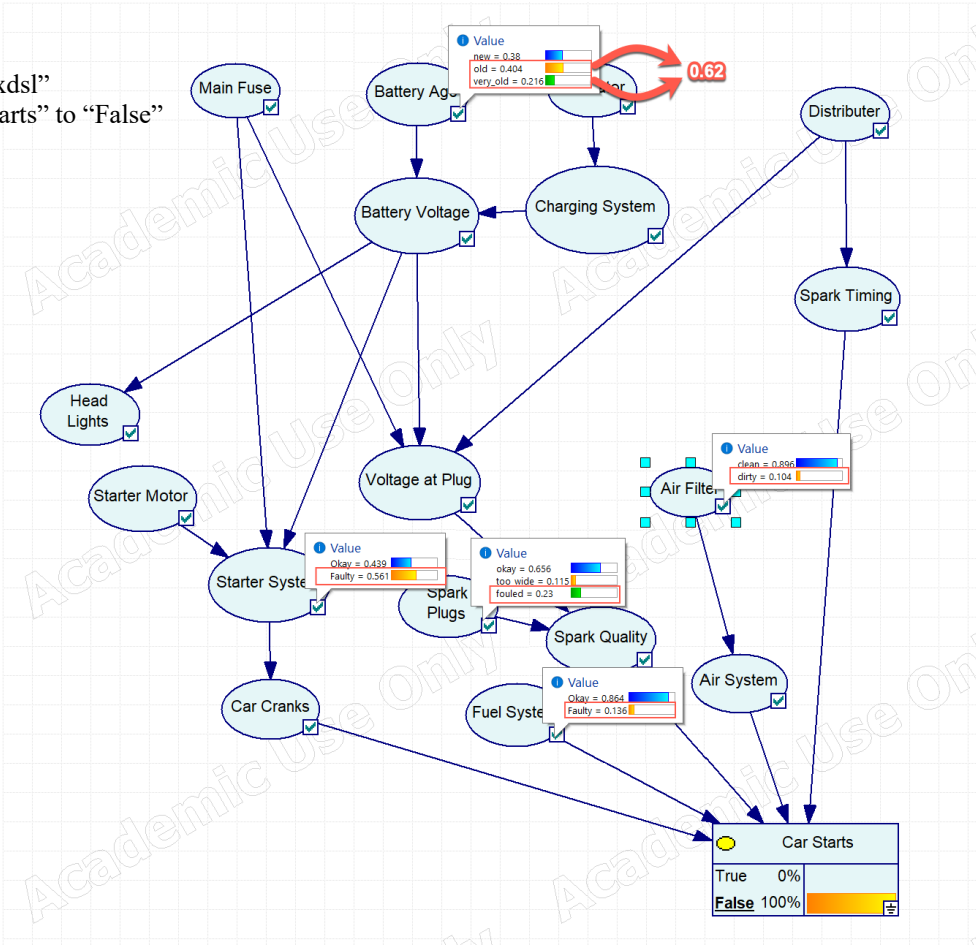
The probability for the cause being a dirty air filter is ...	0.104
The probability for the cause being an old or too old battery is ...	0.62
The probability for the cause being a fouled spark plug is ...	0.23
The probability for the cause being the fuel system is ...	0.136
The probability for the cause being the starter system is ...	0.561

0.561
0.136
0.104
0.23
0.62

Weiter

Proof via *GeNIe*

1. Start GeNIe
2. Load Network "carBN.xdsl"
3. Set evidence on "Car Starts" to "False"
4. Update Network

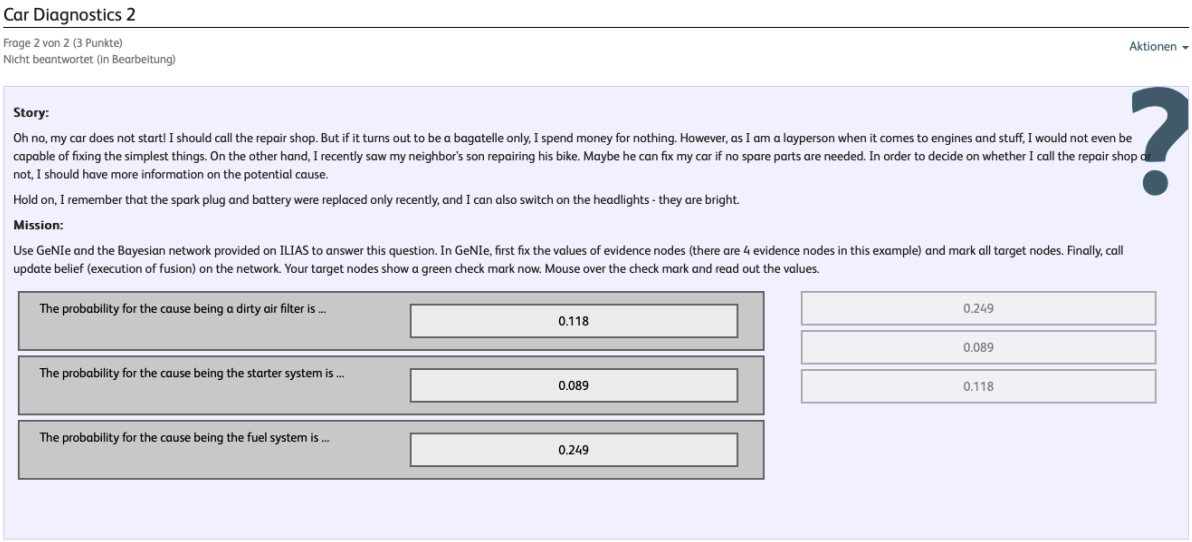


Which recommendation would you give to the person in the story?

Antwort:

- Wie alt die Batterie ist → Licht einschalten und Tank kontrollieren.

Car Diagnostics 2



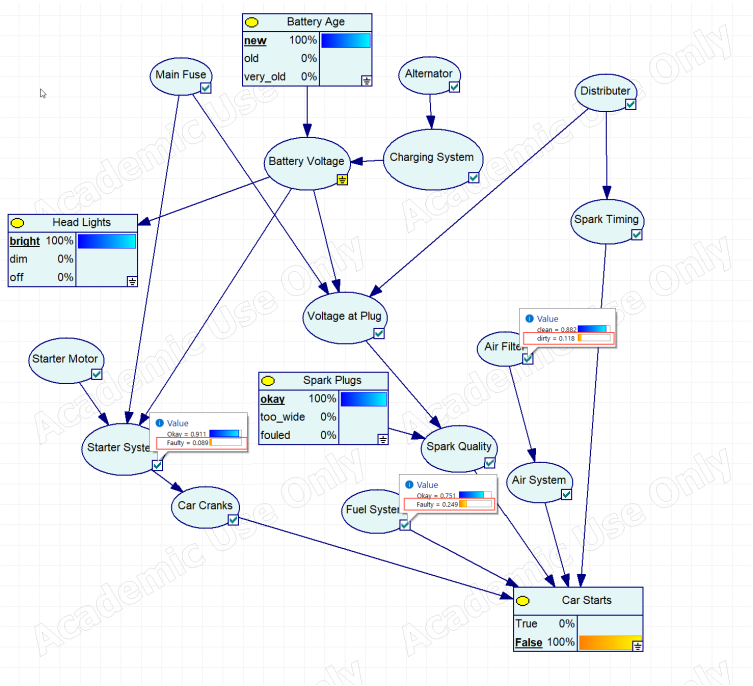
Ergebnisse von Testdurchlauf 1 für

Matrikelnummer: Evento:

Testdurchlauf beendet am:

DETAILLIERTE TESTERGEBNISSE FÜR TESTDURCHLAUF 1

Reihenfolge	Fragen-ID	Fragentitel	Maximale Punktezahl	Erreichte Punkte	Prozent gelöst
1		Car Diagnostics 1	5	5	100.00 %
2		Car Diagnostics 2	3	3	100.00 %



Which recommendation would you now give to the person in the story?

Antwort:

- Tanken

Aufgabe 3) Agricultural Applications: A Stud Farm (1 Point)

Stud Farm

Frage 1 von 1 (10 Punkte)
Nicht beantwortet (in Bearbeitung)

Aktionen

Problem:

The stallion Alan has with the mare Ann sired Betsy and with the mare Alice sired Benny. Betsy has with Bill born Carl, and Benny has with Bonnie sired Cecily. Both Bill and Bonnie are born by Ann, but their fathers A1 and A2 (names are unknown) are in no way related. Carl and Cecily have just born a colt, Dennis.

It turns out that Dennis suffers from a life threatening hereditary disease carried by a recessive gene a. The corresponding dominant gene is A. The disease is so serious that Dennis is put down instantly, and as the farm wants the gene out of production, Carl and Cecily are taken out of breeding because they both must be carriers of the gene with genotype Aa. Which other horses are to be taken out of breeding? Bonnie is a very fine mare, whereas Alan more easily can be replaced in the production. What will the stud farm be best off doing? It would be nice to know the probabilities of each of the horses being carrier of the sick gene. Normally the probability of being carrier is known to be 0.01.

Mission:

Draw the Bayesian network in GeNIe, add the conditional probability tables to all nodes, insert evidence (there is one evidence node in this example) and mark all nodes as target nodes. Update belief (execute fusion) and read out the probability of being carrier for each horse.

A1 is carrier with probability ...	0.02	0.02
A2 is carrier with probability ...	0.018	0.018
Alan is carrier with probability ...	0.38	0.38
Alice is carrier with probability ...	0.019	0.019
Ann is carrier with probability ...	0.624	0.624
Benny is carrier with probability ...	0.386	0.386
Betsy is carrier with probability ...	0.805	0.805
Bill is carrier with probability ...	0.449	0.449
Bonnie is carrier with probability ...	0.625	0.625
Carl and Cecily are carrier with probability ...	1	1

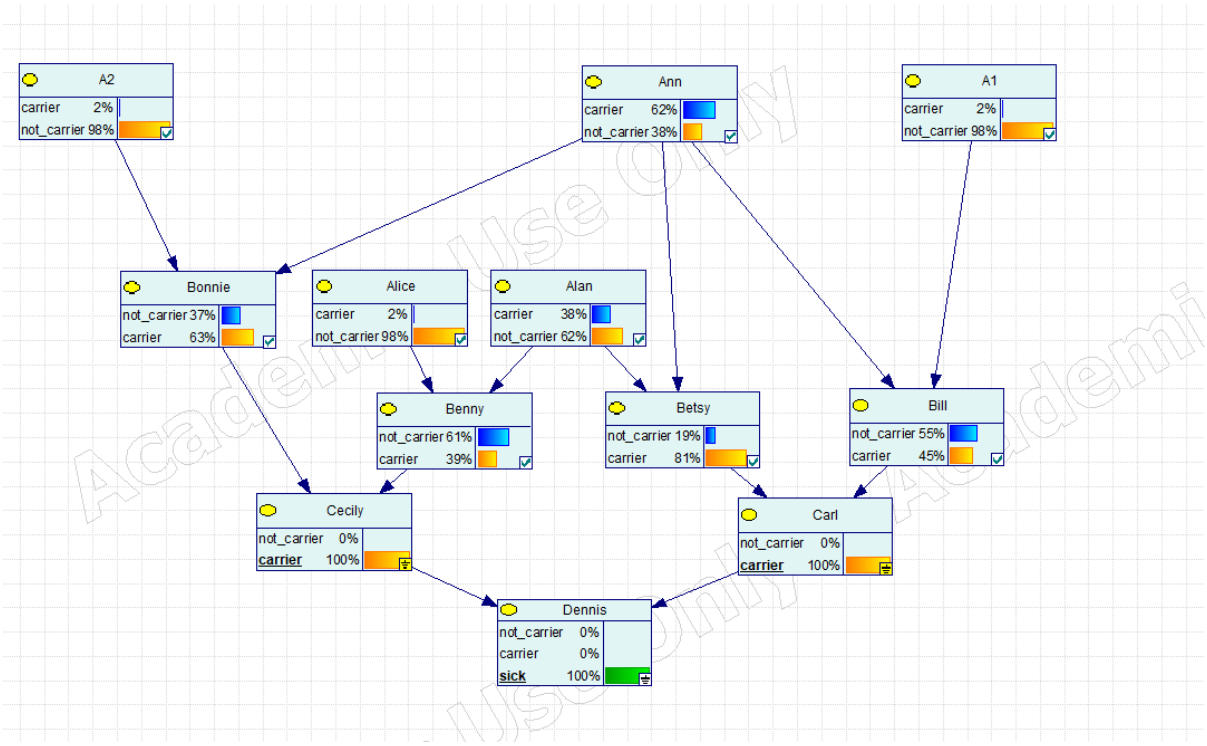
Ergebnisse von Testdurchlauf 1

Matrikelnummer: Evento

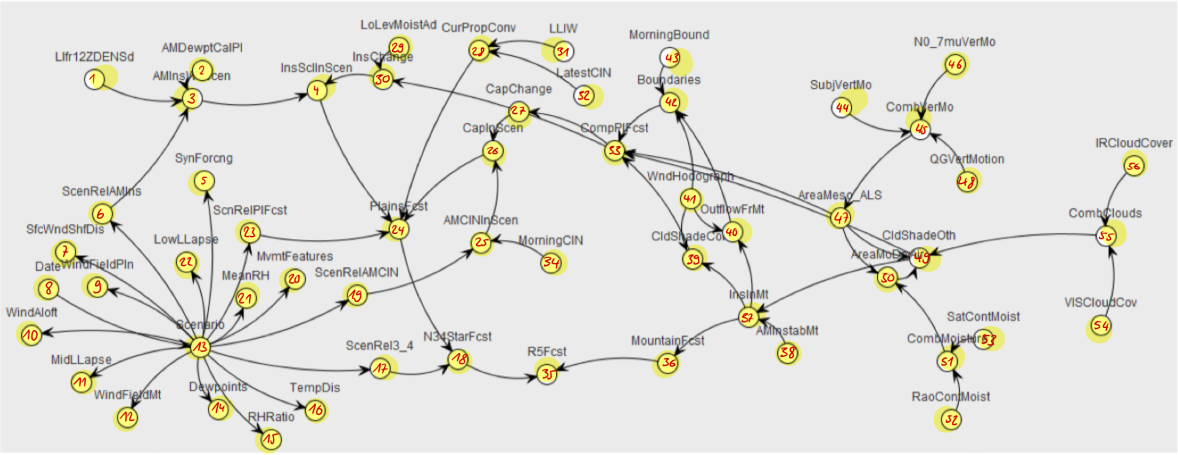
Testdurchlauf beendet am:

DETAILLIERTE TESTERGEBNISSE FÜR TESTDURCHLAUF 1

Reihenfolge	Fragen-ID	Fragentitel	Maximale Punktezahl	Erreichte Punkte	Prozent gelöst
1		Stud Farm	10	10	100.00 %


A2
carrier 2%
not_carrier 98%
Ann
carrier 62%
not_carrier 38%
A1
carrier 2%
not_carrier 98%
Bonnie
not_carrier 37%
carrier 63%
Alice
carrier 2%
not_carrier 98%
Alan
carrier 38%
not_carrier 62%
Benny
not_carrier 61%
carrier 39%
Betsy
not_carrier 19%
carrier 81%
Bill
not_carrier 55%
carrier 45%
Cecily
not_carrier 0%
carrier 100%
Carl
not_carrier 0%
carrier 100%
Dennis
not_carrier 0%
carrier 0%
sick 100%

Aufgabe 4) Meteorological Applications: Hailfinder (1 Point)



a) 2^{56} bits $\Rightarrow$ 9.00719925 peta bytes

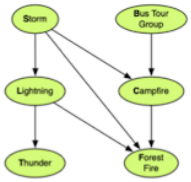
b) $\dfrac{2^{56} \cdot 10^{-6}}{356 \cdot 24 \cdot 60 \cdot 60}$ (Jahr) $= \dfrac{\frac{2^{56}}{10^6}}{365 \times 24 \times 60 \times 60} =$ 2284,9 Jahre

Um die globale Wahrscheinlichkeitsverteilung zu berechnen, würde man rund 2285 Jahre benötigen.

Aufgabe 5) Fire Detection (1 Point)

5 Fire Detection (1 Point)

The following network is part of an early detection and alarm system for forest fires.



1. Give the factorization of the global probability distribution represented by this Bayesian networks.
2. Show the formula that computes the probability of a forest fire given a campfire and thunder. Identify the marginals to be computed.
3. Carry out the fusion algorithm for $p(F,T)$ with the elimination sequence $L \to S \to B \to C$ and determine the complexity of these computations.
4. Can you find a better elimination sequence that shows lower complexity?

① $p(x_1, x_2 \dots x_n) = \prod_{i=1}^{n} p(x_i \mid pa(x_i))$

$p(B,C,F,S,L,T) = p(S) \cdot p(L|S) \cdot p(T|L) \cdot p(B) \cdot p(C|SB) \cdot p(F|CSL)$

② $p(F,T,C)$ and $p(T,C)$

$p(F,T,C) = \sum_{SBL} p(B,C,F,S,L,T)$

↳ marginals

③ Fusion algorithm for $p(F,T)$

elimination sequence: L → S → B → C

knowledge base: $p(S)$, $p(L|S)$, $p(T|L)$, $p(B)$, $p(C|SB)$, $p(F|CSL)$

Step 1

1. $\Psi_L = \sum_L p(L|S)\, p(T|L)\, p(F|CSL)$ → vars: L, S, T, F, C

↳ $p(S), p(B), p(C|SB), \Psi_L$ ⇒ new knoledge base

2. $\Psi_S = \sum_S p(S)\, p(C|SB)\, \Psi_L$ → vars: S, C, B, T, F

↳ $p(B), \Psi_S$ ⇒ new knoledge base

3. $\Psi_B = \sum_B p(B)\, \Psi_S$ → vars: C, B, T, F

↳ Ψ_B ⇒ new knoledge base

4. $\Psi_C = \sum_C \Psi_B$ → vars: C, F, T

↳ Ψ_C → output

$p(F,T) = \Psi_C$

Step 2

Backward substitution of Ψ_C

$L \leftarrow S \leftarrow B \leftarrow C$

1. Sub Ψ_C : $\sum_C \Psi_B$
2. Sub Ψ_B : $\sum_C \left(\sum_B p(B)\, \Psi_S \right)$
3. Sub Ψ_S : $\sum_C \left(\sum_B p(B) \left(\sum_S p(S)\, p(C|SB)\, \Psi_L \right) \right)$
4. Sub Ψ_L : $\sum_C \left(\sum_B p(B) \left(\sum_S p(S)\, p(C|SB) \left(\sum_L p(L|S)\, p(T|L)\, p(F|CSL) \right) \right) \right)$

treewith: 5 → with binary distribution: $2^5 = 32$ values

④ Elimination sequence: B → C → S → L

1.) $\Psi_B = \sum_B p(B)\, p(C|SB)$ vars: B, C, S

↳ $p(S), p(L|S), p(T|L), p(F|CSL), \Psi_B$

2.) $\Psi_C = \sum_C p(F|CSL)\, \Psi_B$ vars: F, C, S, L

↳ $p(S), p(L|S), p(T|L), \Psi_C$

3.) $\Psi_S = \sum_S p(S)\, p(L|S)\, \Psi_L$ vars: S, L, T

↳ $p(T|L), \Psi_S$

4.) $\Psi_L = \sum_L p(T|S)\, \Psi_S$ vars: T, L, F

↳ Ψ_L tree with = 4

Aufgabe 6) Car Start Problem 2 (1 Point)

By Michi…