STA 294 Homework 4

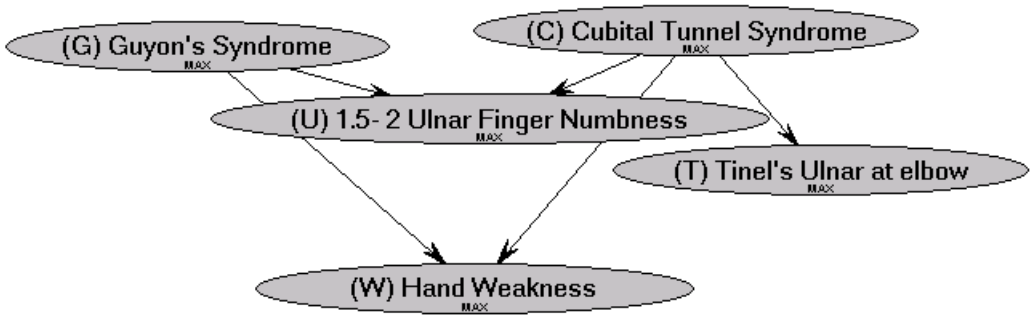
Due 2/15/99

Cite work that you use outside of the assigned text and readings.
Readings relevant to this homework:

- Ross Shachter. Bayes-Ball: The Rational Pastime.
  (Paper 1 in Reader).
- Mark Peot and Ross Shachter. Fusion and Propagation with Multiple Observations.
  (Paper 2 in Reader).
- Lecture notes.
- Chapter 8 of CGH.

1. (10) Using the graph in Figure 5.11, determine the nodes in N_e and N_p for the following queries: $P\{E\}, P\{E|H\}, P\{F\}, P\{B|D, G\}$. (same as Problem 6 on H/W 1)

2. (50) Consider the following expert system.



Guyon's Syndrome and Cubital Tunnel Syndrome compress the ulnar nerve causing hand weakness and numbness in the ulnar digits ("pinkie" and "ring" fingers).
Cubital tunnel syndrome is compression of the ulnar nerve where it passes through the cubital fossa, "the funny bone." This nerve innervates both the top (dorsal) and palm (volar) side of the hand. If the nerve is compressed, it is likely that the person affected will have numbness both on the volar and dorsal side of the ulnar digits. Their grip strength may be affected. In addition, the patient may also have Tinel's sign at the elbow: tapping on the cubital fossa creates an electric shock or tingling effect radiating to the ulnar digits.
Guyon's syndrome is compression of the ulnar nerve at the ulnar side of the wrist. The ulnar nerve is responsible for the instrinsic (gripping) muscles in the hand. Compression at this point strongly affects grip strength and causes numbness only on the volar side of the hand (palm side).

Guyon's syndrome, G. can be present (p) or absent (a). The probability that $G = p$ is 0.05.

Cubital tunnel syndrome, C, can be present (p) or absent (a). The prior probability that $C = p$ is 0.35.

Ulnar finger numbness, U, can be absent (a), present in the volar side only (v), or present in the volar and dorsal side (vd). $P\{U = v|G = p, C = p\} = 0.17$,

$P\{U = vd|G = p, C = p\} = 0.82$, $P\{U = v|G = a, C = p\} = 0.15$,

$P\{U = vd | G = p, C = p\} = 0.8$, $P\{U = v | G = p, C = a\} = 0.84$,
$P\{U = vd | G = p, C = a\} = 0.11$, $P\{U = v | G = a, C = a\} = 0.01$,
$P\{U = vd | G = a, C = a\} = 0.01$.

Ulnar finger weakness, W, can be absent (a) or present (p).

$P\{W = p | G = p, C = p\} = 0.89$, $P\{W = p | G = p, C = a\} = 0.81$,
$P\{W = p | G = a, C = p\} = 0.43$, $P\{W = p | G = a, C = a\} = 0.05$.

Tinel's sign at the cubital tunnel, T, can be absent (a) or present (p).

$P\{T = p | C = p\} = 0.71$, $P\{T = p | C = a\} = 0.02$.

a. (10) Construct a junction (or join) tree for this problem. What are the initial potentials in the tables?

b. (10) Set $W = p$ and $U = v$ in the join tree and propagate evidence. What is probability that the patient has Guyon's syndrome (G) given that they experience hand weakness and have ulnar finger numbness or pain? What is the probability of cubital tunnel syndrome (C)? Compute the joint distribution of G and C given $\{W = p, U = v\}$.

> Note that G and C are inversely correlated. This negative correlation is called *explaining away* and arises in many diagnosis problems. Observing that Guyon's syndrome leads you to believe that cubital tunnel syndrome is less likely. Observing that Guyon's syndrome is absent leads you to believe that cubital tunnel syndrom is more likely.
>
> Also note that zeros play no role in your calculations. Hugin, a commercial expert system (www.hugin.com), uses *zero compression* to compact joint probability tables and speed inference: potential tables are represented as lists of non-zero potentials.

c. (10) The doctor decides to test for Tinel's sign at the cubital fossa. He observes it to be present. What are the marginal probabilities for G and V given $W = p$, $U = v$, and $T = p$? Note that you can add the evidence to the potential calculated for part (b) directly without recalculating $P\{G, C | W = p, U = v\}$.

d. (10) Suppose that the doctor observed that Tinel's sign is absent. What are the marginal probabilities for G and V given $W = p$, $U = v$, and $T = a$? In order to calculate this probability, you cannot directly *retract* the evidence added to the potential tables calculated in part (c). You have to either reform the potential tables from scratch or reuse the tables in part (b).