

Problem 1

We can find $P(+u|+e)$ by finding $P(+u, +e)$ and $P(-u, +e)$.

$$\begin{aligned}
 P(+u, +e) &= \sum_t P(+e|+u, t) \sum_i P(t|i)P(i) \sum_h P(+u|i, h)P(h) \\
 &= \sum_t P(+e|+u, t) \sum_i P(t|i)P(i)f_1(i) \\
 &= \sum_t P(+e|+u, t)f_2(t) \\
 &= f_3 \\
 f_1(-i) &= P(+u|-i, -h)P(-h) + P(+u|-i, +h)P(+h) \\
 &= 0.1(0.4) + 0.5(0.6) = 0.34 \\
 f_1(+i) &= P(+u|+i, -h)P(-h) + P(+u|+i, +h)P(+h) \\
 &= 0.3(0.4) + 0.9(0.6) = 0.66 \\
 f_2(+t) &= P(+t|-i)f_1(-i)P(-i) + P(+t|+i)f_1(+i)P(+i) \\
 &= .119 + .1584 = 0.2774 \\
 f_2(-t) &= P(-t|-i)f_1(-i)P(-i) + P(-t|+i)f_1(+i)P(+i) \\
 &= .119 + .0396 = 0.1586 \\
 f_3 &= P(+e|+u, +t)f_2(+t) + P(+e|+u, -t)f_2(-t) \\
 &= 0.9(0.2774) + 0.7(0.1586) \\
 &= 0.36068 \\
 P(+u, +e) &= 0.36068
 \end{aligned}$$

$$\begin{aligned}
 P(-u, +e) &= \sum_t P(+e | -u, t) \sum_i P(t | i) P(i) \sum_h P(-u | i, h) P(h) \\
 &= \sum_t P(+e | -u, t) \sum_i P(t | i) P(i) f_1(i) \\
 &= \sum_t P(+e | -u, t) f_2(t) \\
 &= f_3 \\
 f_1(-i) &= P(-u | -i, -h) P(-h) + P(-u | -i, +h) P(+h) \\
 &= 0.9(0.4) + 0.5(0.6) = 0.66 \\
 f_1(+i) &= P(-u | +i, -h) P(-h) + P(-u | +i, +h) P(+h) \\
 &= 0.7(0.4) + 0.1(0.6) = 0.34 \\
 f_2(+t) &= P(+t | -i) f_1(-i) P(-i) + P(+t | +i) f_1(+i) P(+i) \\
 &= .099 + .1904 = .2894 \\
 f_2(-t) &= P(-t | -i) f_1(-i) P(-i) + P(-t | +i) f_1(+i) P(+i) \\
 &= .099 + .0476 = 0.1466 \\
 f_3 &= P(+e | -u, +t) f_2(+t) + P(+e | -u, -t) f_2(-t) \\
 &= 0.5(0.2894) + 0.3(0.1466) \\
 &= 0.18868 \\
 P(-u, +e) &= 0.18868
 \end{aligned}$$

$$\begin{aligned}
 P(+u | +e) &= \frac{P(+u, +e)}{P(+e)} \\
 &= \frac{P(+u, +e)}{P(+u, +e) + P(-u, +e)} \\
 &= \frac{0.36068}{0.36068 + 0.18868} \\
 &= \frac{0.36068}{0.54936} \\
 &= 0.6565458 \approx 0.66
 \end{aligned}$$

Problem 2

1. FALSE: T and U are dependent through I
2. FALSE: There is a path from T to U through E that is active because E is in the given set

3. TRUE: The path from T to U through I is blocked because I is given, and the path through E is inactive because E is not given
4. FALSE: Although the direct path from H to E is blocked since U is given the path from through U , I , and T is active
5. TRUE: The direct path through U is blocked because U is given, and the indirect path through I and T are blocked because I and T are given
6. FALSE: There is a dependency between I and H through U because its child E is included in the given set
7. TRUE: The direct path through the collider U is inactive, and the indirect path through T is blocked because T is given
8. TRUE: Both paths between T and H have colliders and the given set is empty, so these paths are inactive
9. FALSE: There is an active path from H to T because the collider E is given
10. FALSE: Since U is given the path in (9) is blocked, but it activates the path from H to T through U and I .