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**Solution(1)**

Given:

* P(M=T)=0.2
* P(B=T∣M=T)=0.2, P(B=T∣M=F)=0.05
* P(S=T∣M=T)=0.8, P(S=T∣M=F)=0.2
* P(C=T∣B,S):
  + P(C=T∣B=T,S=T)=0.8
  + P(C=T∣B=T,S=F)=0.8
  + P(C=T∣B=F,S=T)=0.8
  + P(C=T∣B=F,S=F)=0.05
* P(H=T∣B=T)=0.8, P(H=T∣B=F)= 0.6

### ****Step 1: Calculate the joint probability for the given evidence****

We need to calculate the joint probabilities for both cases M=T and M=F given the evidence. **When** M**=**T: We need the joint probability for the patient having metastatic cancer (M=T), severe headache (H=T), brain tumor (B=T), not in coma (C=F), and no increased serum calcium (S=F): P(H=T,B=T,C=F,S=F∣M=T)\*P(M=T)

P(H=T,B=T,C=F,S=F∣M=T)⋅P(M=T)

* P(B=T∣M=T)=0.2
* P(S=F∣M=T)=1−0.8=0.2
* P(C=F∣B=T,S=F)=1−0.8=0.2
* P(H=T∣B=T)= 0.8

P(H=T,B=T,C=F,S=F∣M=T)=P(H=T∣B=T)\*P(C=F∣B=T,S=F)\*P(S=F∣M=T)\*P(B=T∣M=T)=0.8\*0.2\*0.2\*0.2= 0.0064

P(H=T,B=T,C=F,S=F,M=T)= 0.0064\*0.2 = 0.00128

### ****Step 2:****

When M=F: Compute the probability of not having metastatic cancer and the symptom

We calculate the same joint probability assuming the patient does not have metastatic cancer (M=F):P(H=T,B=T,C=F,S=F∣M=F)\*P(M=F), Using the given probabilities: =0.8\*0.2\*0.8\*0.05=0.0064

P(H=T,B=T,C=F,S=F,M=F)= 0.0064\*0.8=0.00512

### ****Step 3: Use Bayes' Theorem to find** *P***(***M***=***T***∣***H***=***T***,***B***=***T***,***C***=***F***,***S***=***F***)****

### **P(H=T,B=T,C=F,S=F) = P(H=T,B=T,C=F,S=F,M=T)+P(H=T,B=T,C=F,S=F,M=F)**

### **=0.00128+0.00512**

### **P(M=T| H=T,B=T,C=F,S=F) = P(H=T,B=T,C=F,S=F|M=T)\*P(M=T)/P(H=T,B=T,C=F,S=F)**

### **0.00128/0.0064 = 0.2.**

### **The probability that the patient has metastatic cancer given the observed symptoms (severe headache, brain tumor, not in coma, and no increased serum calcium) is **20%****

**Solution(2)**

Given weather data from book.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| SNo | Outlook | Temperature | Humidity | Windy | Play |
| 1 | sunny | hot | high | FALSE | no |
| 2 | sunny | hot | high | TRUE | no |
| 3 | overcast | hot | high | FALSE | yes |
| 4 | rainy | mild | high | FALSE | yes |
| 5 | rainy | cool | normal | FALSE | yes |
| 6 | rainy | cool | normal | TRUE | no |
| 7 | overcast | cool | normal | TRUE | yes |
| 8 | sunny | mild | high | FALSE | no |
| 9 | sunny | cool | normal | FALSE | yes |
| 10 | rainy | mild | normal | FALSE | yes |
| 11 | sunny | mild | normal | TRUE | yes |
| 12 | overcast | mild | high | TRUE | yes |
| 13 | overcast | hot | normal | FALSE | yes |
| 14 | rainy | mild | high | TRUE | no |
|  |  |  |  |  |  |

Original Rule:

**Rule:** Outlook=sunny and temp=cool and humidity=normal and windy=false ➔ Play = yes

* Instances satisfying this condition: Instance 9
* Support: 1 (instance 9)
* Accuracy: 100% (1 out of 1 are yes)

Pruning Steps:

**Rule**: Outlook=sunny and humidity=normal ➔ Play = yes

**Instances satisfying this condition:**

* Instance 9: sunny, cool, normal, false ➔ yes
* Instance 11: sunny, mild, normal, true ➔ yes

**Support: 2** (instances 9 and 11) **Accuracy: 100%** (2 out of 2 are yes)

Support is less than 3. We need to relax the rule further.

**Rule**: Outlook=sunny ➔ Play = yes

**Instances satisfying this condition:**

* Instance 1: sunny, hot, high, false ➔ no
* Instance 2: sunny, hot, high, true ➔ no
* Instance 8: sunny, mild, high, false ➔ no
* Instance 9: sunny, cool, normal, false ➔ yes
* Instance 11: sunny, mild, normal, true ➔ yes

**Support: 5** (instances 1, 2, 8, 9, 11) **Accuracy: 40%** (2 out of 5 are yes)

Accuracy is less than 50%. We need to try a different combination.

**Rule**: humidity=normal ➔ Play = yes

**Instances satisfying this condition:**

* Instance 5: rainy, cool, normal, false ➔ yes
* Instance 6: rainy, cool, normal, true ➔ no
* Instance 9: sunny, cool, normal, false ➔ yes
* Instance 10: rainy, mild, normal, false ➔ yes
* Instance 11: sunny, mild, normal, true ➔ yes
* Instance 13: overcast, hot, normal, false ➔ yes

**Support: 6** (instances 5, 6, 9, 10, 11, 13) **Accuracy: 83.33%** (5 out of 6 are yes)

Support is 6 and accuracy is 83.33%, meeting the criteria.

**Final Pruned Rule**

**humidity=normal ➔ Play = yes**

**Other possible combinations**

**Rule:** Outlook=sunny

**Instances satisfying this condition:**

* + Instance 1: sunny, hot, high, false ➔ no
  + Instance 2: sunny, hot, high, true ➔ no
  + Instance 8: sunny, mild, high, false ➔ no
  + Instance 9: sunny, cool, normal, false ➔ yes
  + Instance 11: sunny, mild, normal, true ➔ yes

**Support: 5 Accuracy: 40% (2/5 are yes)**

**Rule**: Outlook=overcast

**Instances satisfying this condition:**

* + Instance 3: overcast, hot, high, false ➔ yes
  + Instance 7: overcast, cool, normal, true ➔ yes
  + Instance 12: overcast, mild, high, true ➔ yes
  + Instance 13: overcast, hot, normal, false ➔ yes

**Support: 4 Accuracy: 100% (4/4 are yes)**

**Rule**: Outlook=rainy

**Instances satisfying this condition:**

* + Instance 4: rainy, mild, high, false ➔ yes
  + Instance 5: rainy, cool, normal, false ➔ yes
  + Instance 6: rainy, cool, normal, true ➔ no
  + Instance 10: rainy, mild, normal, false ➔ yes
  + Instance 14: rainy, mild, high, true ➔ no

**Support: 5 Accuracy: 60% (3/5 are yes)**

**Rule**: Temperature=hot

**Instances satisfying this condition:**

* + Instance 1: sunny, hot, high, false ➔ no
  + Instance 2: sunny, hot, high, true ➔ no
  + Instance 3: overcast, hot, high, false ➔ yes
  + Instance 13: overcast, hot, normal, false ➔ yes

**Support: 4 Accuracy: 50% (2/4 are yes)**

**Rule**: Temperature=mild

**Instances satisfying this condition:**

* + Instance 4: rainy, mild, high, false ➔ yes
  + Instance 8: sunny, mild, high, false ➔ no
  + Instance 10: rainy, mild, normal, false ➔ yes
  + Instance 11: sunny, mild, normal, true ➔ yes
  + Instance 12: overcast, mild, high, true ➔ yes
  + Instance 14: rainy, mild, high, true ➔ no

**Support: 6 Accuracy: 66.67% (4/6 are yes)**

**Rule**: Temperature=cool

**Instances satisfying this condition:**

* + Instance 5: rainy, cool, normal, false ➔ yes
  + Instance 6: rainy, cool, normal, true ➔ no
  + Instance 7: overcast, cool, normal, true ➔ yes
  + Instance 9: sunny, cool, normal, false ➔ yes

**Support: 4 Accuracy: 75% (3/4 are yes)**

**Rule**: Humidity=high

**Instances satisfying this condition:**

* + Instance 1: sunny, hot, high, false ➔ no
  + Instance 2: sunny, hot, high, true ➔ no
  + Instance 3: overcast, hot, high, false ➔ yes
  + Instance 4: rainy, mild, high, false ➔ yes
  + Instance 8: sunny, mild, high, false ➔ no
  + Instance 12: overcast, mild, high, true ➔ yes
  + Instance 14: rainy, mild, high, true ➔ no
* Support: 7
* Accuracy: 42.86% (3/7 are yes)

**Rule**: Windy=true

**Instances satisfying this condition:**

* + Instance 2: sunny, hot, high, true ➔ no
  + Instance 6: rainy, cool, normal, true ➔ no
  + Instance 7: overcast, cool, normal, true ➔ yes
  + Instance 11: sunny, mild, normal, true ➔ yes
  + Instance 12: overcast, mild, high, true ➔ yes
  + Instance 14: rainy, mild, high, true ➔ no

**Support: 6 Accuracy: 50% (3/6 are yes)**

**Rule**: Windy=false

**Instances satisfying this condition:**

* + Instance 1: sunny, hot, high, false ➔ no
  + Instance 3: overcast, hot, high, false ➔ yes
  + Instance 4: rainy, mild, high, false ➔ yes
  + Instance 5: rainy, cool, normal, false ➔ yes
  + Instance 8: sunny, mild, high, false ➔ no
  + Instance 9: sunny, cool, normal, false ➔ yes
  + Instance 10: rainy, mild, normal, false ➔ yes
  + Instance 13: overcast, hot, normal, false ➔ yes

**Support: 8 Accuracy: 62.5% (5/8 are yes)**

**Additional Rules Meeting Criteria**

**Rule:** Outlook=overcast ➔ Play = yes

* + Support: 4
  + Accuracy: 100%

**Rule:** Outlook=rainy ➔ Play = yes

* + Support: 5
  + Accuracy: 60%

**Rule:** Temperature=mild ➔ Play = yes

* + Support: 6
  + Accuracy: 66.67%

**Rule:** Temperature=cool ➔ Play = yes

* + Support: 4
  + Accuracy: 75%

**Rule:** Windy=false ➔ Play = yes

* + Support: 8
  + Accuracy: 62.5%

**Summary of Possible Rules**

* + humidity=normal ➔ Play = yes (Support: 6, Accuracy: 83.33%)
  + Outlook=overcast ➔ Play = yes (Support: 4, Accuracy: 100%)
  + Outlook=rainy ➔ Play = yes (Support: 5, Accuracy: 60%)
  + Temperature=mild ➔ Play = yes (Support: 6, Accuracy: 66.67%)
  + Temperature=cool ➔ Play = yes (Support: 4, Accuracy: 75%)
  + Windy=false ➔ Play = yes (Support: 8, Accuracy: 62.5%)