Previous class
uncertainty
probabilistic reasoning
exponential time
exponential storage
Random variable outcomes, probabilistic
\[ p(C = \text{heads}) \quad p(\text{heads}) \]
Coin-toss
\[ C = \text{heads, tails}^2 \]
\[ \frac{1}{2} \quad \frac{1}{2} \quad 2 \quad \text{should add} \]
\[ 5 \quad \text{to} \quad 4 \]

Weather tomorrow
\[ w = 3 \text{ cloudy, rainy, cloudy, snowy}^3 \]
\[ 0.6 \quad 0.05 \quad 0.3 \quad 0.05 \]
\[ < 0.6, \quad 0.05, \quad 0.3, \quad 0.05 > \]
\[ \text{cloudy, rainy, cloudy, snowy} \]
CS5811 In class exercise - Working with joint probability distribution tables

Consider results of a hypothetical survey of high school students. The survey has with three questions:

- Location of the School: rural (r), suburban (s), urban (u)
- Most Important of these: grades (g), being popular (p), athletics (a)
- Has a pet: yes (y), no (n)

<table>
<thead>
<tr>
<th>Answer</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>r g y</td>
<td>30</td>
</tr>
<tr>
<td>r g n</td>
<td>27</td>
</tr>
<tr>
<td>r p y</td>
<td>29</td>
</tr>
<tr>
<td>r p n</td>
<td>21</td>
</tr>
<tr>
<td>r a y</td>
<td>29</td>
</tr>
<tr>
<td>r a n</td>
<td>13</td>
</tr>
<tr>
<td>s g y</td>
<td>49</td>
</tr>
<tr>
<td>s g n</td>
<td>38</td>
</tr>
<tr>
<td>s p y</td>
<td>30</td>
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<tr>
<td>s p n</td>
<td>12</td>
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<tr>
<td>s a y</td>
<td>18</td>
</tr>
<tr>
<td>s a n</td>
<td>4</td>
</tr>
<tr>
<td>u g y</td>
<td>20</td>
</tr>
<tr>
<td>u g n</td>
<td>83</td>
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<tr>
<td>u p y</td>
<td>9</td>
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<tr>
<td>u p n</td>
<td>40</td>
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<tr>
<td>u a y</td>
<td>6</td>
</tr>
<tr>
<td>u a n</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>478</td>
</tr>
</tbody>
</table>

\[ P(r, a, n) = P(r | a, n) \]

\[ P(S = r) = \frac{149}{478} \]

\[ P(S) = \frac{149}{478} \]

\[ P(S) = \frac{149}{478} \]

\[ P(S) = \frac{151}{478} \]

\[ P(S) = \frac{178}{478} \]

Compute the following probabilities or probability distributions:

1. \( P(r) \)
2. \( P(S) \)
3. \( P(r, a, n) \)
4. \( P(r, a) \)
5. \( P(r, a, H) \)
6. \( P(r, I, H) \)
7. \( P(r \rightarrow p) \)
8. \( P(p \mid r) \)
9. \( P(I \mid r) \)
3. \( P(r, a, n) = \frac{13}{478} \)

4. \( P(r, a) = \frac{29 + 13}{478} = \frac{p(c, a, y) \cdot P(r, a, n)}{H=y \quad H=n} \)

hidden variable \( H \)

\( P(r, a) = \sum_{H=x} P(r, a, x) \rightarrow \text{sum over all values} \)

5. \( P(r, a, H) = \left< \frac{29}{478}, \frac{13}{478} \right> \)

\( \alpha < 5 \quad 5 > \)

\( \left< \frac{3}{10}, \frac{5}{10} \right> = \left< 0.3, 0.5 \right> \)

\( \alpha_1 < \frac{29}{478}, \frac{13}{478} > \quad < \frac{29}{478}, \frac{13}{478} > \)

\( \alpha_2 < 29, 13 > \quad < 29, 13 > \)

As long as it reflects the correct ratio, it can be normalized to add up to 1.
\[ \mathbf{P} = (r, I, H) \]

\[ \begin{align*}
\langle 30, 27, 29, 21, 29, 13 \rangle & \\
p(r, g, n) & \quad p(r, a, y) \\
p(r, g, y) & \quad p(r, a, y) \\
p(r, p, n) & \quad p(r, a, y) \\
\end{align*} \]

\[ \times 149 \]

\[ \langle \frac{30}{149}, \frac{27}{149}, \ldots, \frac{13}{149} \rangle \]