

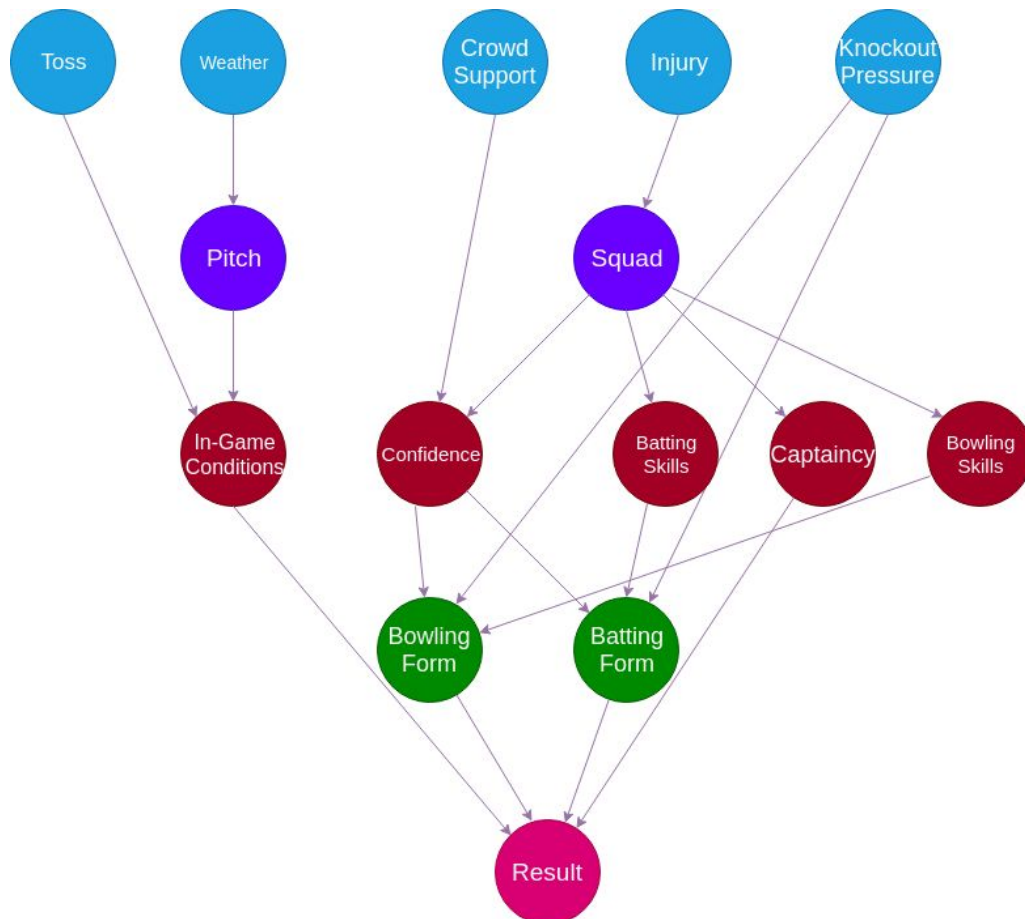
# ARTIFICIAL INTELLIGENCE

## ASSIGNMENT - 3 BAYESIAN NETWORK

### Question

It being IPL season, you have registered yourself for a fantasy league which earns you points if you predict the result of the match correctly. It is the match between CSK and RCB at the chinnaswamy stadium(Banglore). Model a bayesian network predicting who would win the game considering factors like team strength, weather conditions, home ground etc. Give conditional probabilities and justify.

### FLOW DIAGRAM



## KEY

Variable	Denoted By	Possible Values
Toss	T	RCB, CSK
Weather	W	Sunny, Rainy, Other
Injury	I	RCB, CSK
Crowd Support	Cs	RCB, CSK, None
Knockout Pressure	Kp	RCB, CSK
Pitch	P	Green, Wet, Other
Squad	S	RCB, CSK
Batting Skills	Bts	RCB, CSK
Bowling Skills	Bws	RCB, CSK
In-Game Conditions	In	RCB, CSK
Captaincy	C	RCB, CSK
Confidence	Cf	RCB, CSK
Batting Form	Btf	RCB, CSK
Bowling Form	Bwf	RCB, CSK
Result	R	RCB, CSK

## CONDITIONAL PROBABILITY TABLES

### Toss

T	RCB	CSK
P(T)	0.5	0.5

### Weather

W	Sunny	Rainy	Other
P(W)	0.5	0.4	0.1

### Injury

I	RCB	CSK
P(I)	0.7	0.3

### Knockout Pressure

Kp	RCB	CSK
P(Kp)	0.9	0.1

### Crowd Support

Cs	RCB	CSK	None
P(Cs)	0.5	0.3	0.2

### Pitch

W	P.Green	P.Wet	P.Other
Sunny	0.6	0.1	0.3
Rainy	0	1	0
Other	0.2	0.1	0.7

### Squad

I	S.RCB	S.CSK
RCB	0.4	0.6
CSK	0.7	0.3

### Batting Skills

S	Bts.RCB	Bts.CSK
RCB	0.8	0.2

<b>CSK</b>	0.3	0.7
------------	-----	-----

### Bowling Skills

<b>S</b>	<b>Bws.RCB</b>	<b>Bws.CSK</b>
<b>RCB</b>	0.7	0.3
<b>CSK</b>	0.1	0.9

### Captaincy

<b>S</b>	<b>C.RCB</b>	<b>C.CSK</b>
<b>RCB</b>	0.6	0.4
<b>CSK</b>	0.2	0.8

### In-Game Conditions

<b>T</b>	<b>P</b>	<b>In.RCB</b>	<b>In.CSK</b>
<b>RCB</b>	<b>Green</b>	0.8	0.2
<b>RCB</b>	<b>Wet</b>	0.6	0.4
<b>RCB</b>	<b>Other</b>	0.7	0.3

<b>CSK</b>	<b>Green</b>	0.4	0.6
<b>CSK</b>	<b>Wet</b>	0.2	0.8
<b>CSK</b>	<b>Other</b>	0.3	0.7

### Confidence

<b>S</b>	<b>Cs</b>	<b>Cf.RCB</b>	<b>Cf.CSK</b>
<b>RCB</b>	<b>RCB</b>	0.9	0.1
<b>RCB</b>	<b>CSK</b>	0.7	0.3
<b>RCB</b>	<b>None</b>	0.8	0.2
<b>CSK</b>	<b>RCB</b>	0.4	0.6
<b>CSK</b>	<b>CSK</b>	0.2	0.8
<b>CSK</b>	<b>None</b>	0.3	0.7

### Batting Form

<b>Cf</b>	<b>Bts</b>	<b>Kp</b>	<b>Btf.RCB</b>	<b>Btf.CSK</b>
<b>RCB</b>	<b>RCB</b>	<b>RCB</b>	0.8	0.2
<b>RCB</b>	<b>RCB</b>	<b>CSK</b>	0.9	0.1
<b>RCB</b>	<b>CSK</b>	<b>RCB</b>	0.6	0.4
<b>RCB</b>	<b>CSK</b>	<b>CSK</b>	0.7	0.3

<b>CSK</b>	<b>RCB</b>	<b>RCB</b>	0.2	0.8
<b>CSK</b>	<b>RCB</b>	<b>CSK</b>	0.3	0.7
<b>CSK</b>	<b>CSK</b>	<b>RCB</b>	0	1
<b>CSK</b>	<b>CSK</b>	<b>CSK</b>	0.1	0.9

### Bowling Form

<b>Cf</b>	<b>Bws</b>	<b>Kp</b>	<b>Bwf.RCB</b>	<b>Bwf.CSK</b>
<b>RCB</b>	<b>RCB</b>	<b>RCB</b>	0.8	0.2
<b>RCB</b>	<b>RCB</b>	<b>CSK</b>	0.9	0.1
<b>RCB</b>	<b>CSK</b>	<b>RCB</b>	0.6	0.4
<b>RCB</b>	<b>CSK</b>	<b>CSK</b>	0.7	0.3
<b>CSK</b>	<b>RCB</b>	<b>RCB</b>	0.2	0.8
<b>CSK</b>	<b>RCB</b>	<b>CSK</b>	0.3	0.7
<b>CSK</b>	<b>CSK</b>	<b>RCB</b>	0	1
<b>CSK</b>	<b>CSK</b>	<b>CSK</b>	0.1	0.9

### Result

<b>In</b>	<b>Btf</b>	<b>Bwf</b>	<b>C</b>	<b>R.RCB</b>	<b>R.CSK</b>
<b>RCB</b>	<b>RCB</b>	<b>RCB</b>	<b>RCB</b>	0.95	0.05

RCB	RCB	CSK	RCB	0.85	0.15
RCB	CSK	RCB	RCB	0.9	0.1
RCB	CSK	CSK	RCB	0.7	0.3
CSK	RCB	RCB	RCB	0.8	0.2
CSK	RCB	CSK	RCB	0.75	0.25
CSK	CSK	RCB	RCB	0.65	0.35
CSK	CSK	CSK	RCB	0.05	0.95
RCB	RCB	RCB	CSK	0.85	0.15
RCB	RCB	CSK	CSK	0.3	0.7
RCB	CSK	RCB	CSK	0.2	0.8
RCB	CSK	CSK	CSK	0.15	0.85
CSK	RCB	RCB	CSK	0.25	0.75
CSK	RCB	CSK	CSK	0.15	0.85
CSK	CSK	RCB	CSK	0.1	0.9
CSK	CSK	CSK	CSK	0	1

### **Justification:**

- The toss is a determining factor for any match. It can have two possibility that either CSK or RCB can win.
- Bengaluru has a pleasant climate. It has two major possibilities that is sunny and rainy.



- Injury variable determines the possibility that a team gets injured in the match.
- Crowd Support determines the no.of supporters of a particular team / total number of people.Support can be in favour of CSK/RCB or Neutral.(We observe that the stadium is RCB home ground therefore probability of RCB support is greater.)
- As RCB is a underperforming team the Knockout pressure on RCB is a lot more than on CSK.
- The pitch in Chinnaswamy Stadium is wet on rainy days and green on sunny days. Hence, the pitch type is directly dependent on weather.
- Captaincy depends on quality of squad.It can be better for RCB or CSK.
- Squad variable determines the quality of team which is directly related to injury and directly influences the confidence, batting skills, captaincy and bowling skills of the team. Either CSK has better squad or RCB has better squad.
- In-Game conditions is directly influenced by pitch conditions, and result of toss. In-Game conditions can be in favour of RCB or CSK.
- Confidence of team is influenced by the squad conditions and crowd support. It can be in-favour of CSK or RCB.
- Squad also determines bowling and batting skills which can be better for either CSK or RCB.
- Batting form and Bowling form determines the current form of the team.It depends on several factors like confidence, knockout pressure etc.It can be in favour of CSK or RCB.

- Result is directly influenced by a large number of factors like in-game conditions, captaincy, batting and bowling form of both the teams. **We considered that the game will not result in a draw based on the rules of IPL.**

### **QUERY STRUCTURE:**

- $P(X \mid p(X), p(p(X)))$
- $P(p(p(X)) \mid X)$
- $P(p(X) \mid X, p(p(X)))$

where  $p(X)$  refers to the parent of  $X$ .

### **SAMPLE QUERY:**

**To find  $P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bts} = \text{CSK}, \text{Bws} = \text{CSK}, P = \text{Green}, I = \text{CSK}, \text{Cs} = \text{RCB}, \text{Kp} = \text{RCB})$**

Here, Result = Winning of CSK keeping given conditions:-

Batting Form: RCB

Batting Skill: CSK

Bowling Skill: CSK

Pitch: Green

Injury: CSK

Crowd Support: RCB

Knockout Pressure: RCB

**=>  $P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, P = \text{Green}) * P(\text{Bwf} = \text{RCB} \mid \text{Bts} = \text{CSK}, I = \text{CSK}) + P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{CSK}, P = \text{Green}) * P(\text{Bwf} = \text{CSK} \mid \text{Bts} = \text{CSK}, I = \text{CSK})$**

$$P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, P = \text{Green}) = P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{RCB}) * P(\text{In} = \text{RCB} \mid P = \text{Green}) + P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{CSK}) * P(\text{In} = \text{CSK} \mid P = \text{Green})$$

$$P(\text{In} = \text{RCB} \mid P = \text{Green}) = P(\text{In} = \text{RCB} \mid P = \text{Green}, T = \text{RCB}) * P(T = \text{RCB}) + P(\text{In} = \text{RCB} \mid P = \text{Green}, T = \text{CSK}) * P(T = \text{CSK}) = 0.8 * 0.5 + 0.4 * 0.5 = 0.6$$

$$P(\text{In} = \text{CSK} \mid P = \text{Green}) = P(\text{In} = \text{CSK} \mid P = \text{Green}, T = \text{RCB}) * P(T = \text{RCB}) + P(\text{In} = \text{CSK} \mid P = \text{Green}, T = \text{CSK}) * P(T = \text{CSK}) = 0.2 * 0.5 + 0.6 * 0.5 = 0.4$$

$$\begin{aligned} P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{RCB}) &= P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{RCB}, C = \text{CSK}) * [P(C = \text{CSK} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{CSK} \mid S = \text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK})] \\ &+ P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{RCB}, C = \text{RCB}) * [P(C = \text{RCB} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{RCB} \mid S = \text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK})] \\ &= 0.15 * [0.8 * 0.3 + 0.4 * 0.7] + 0.05 * [0.2 * 0.3 + 0.6 * 0.7] \\ &= 0.15 * [0.24 + 0.28] + 0.05 * [0.06 + 0.42] = 0.102 \end{aligned}$$

$$\begin{aligned} P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{CSK}) &= P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{CSK}, C = \text{CSK}) * [P(C = \text{CSK} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{CSK} \mid S = \text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK})] \\ &+ P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{In} = \text{CSK}, C = \text{RCB}) * [P(C = \text{RCB} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{RCB} \mid S = \text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK})] \\ &= 0.75 * [0.8 * 0.3 + 0.4 * 0.7] + 0.2 * [0.2 * 0.3 + 0.6 * 0.7] \\ &= 0.75 * [0.24 + 0.28] + 0.2 * [0.06 + 0.42] = 0.486 \end{aligned}$$

$$P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{CSK}, P = \text{Green}) = P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{CSK}, \text{In} = \text{RCB}) * P(\text{In} = \text{RCB} \mid P = \text{Green}) + P(R = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{CSK}, \text{In} = \text{CSK}) * P(\text{In} = \text{CSK} \mid P = \text{Green})$$

$$P(\text{In} = \text{RCB} \mid P = \text{Green}) = P(\text{In} = \text{RCB} \mid P = \text{Green}, T = \text{RCB}) * P(T = \text{RCB}) + P(\text{In} = \text{RCB} \mid P = \text{Green}, T = \text{CSK}) * P(T = \text{CSK}) = 0.8 * 0.5 + 0.4 * 0.5 = 0.6$$

$$P(\text{In} = \text{CSK} \mid P = \text{Green}) = P(\text{In} = \text{CSK} \mid P = \text{Green}, T = \text{RCB}) * P(T = \text{RCB}) + P(\text{In} = \text{CSK} \mid P = \text{Green}, T = \text{CSK}) * P(T = \text{CSK}) = 0.2 * 0.5 + 0.6 * 0.5 = 0.4$$

$$\begin{aligned}
P(R = \text{CSK} \mid B_{tf} = \text{RCB}, B_{wf} = \text{CSK}, I_n = \text{RCB}) &= P(R = \text{CSK} \mid B_{tf} = \text{RCB}, B_{wf} = \text{CSK}, \\
&I_n = \text{RCB}, C = \text{CSK}) * [P(C = \text{CSK} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{CSK} \mid S = \\
&\text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK})] + P(R = \text{CSK} \mid B_{tf} = \text{RCB}, B_{wf} = \text{CSK}, I_n = \text{RCB}, C = \\
&\text{RCB}) * [P(C = \text{RCB} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{RCB} \mid S = \text{RCB}) * P(S = \\
&\text{RCB} \mid I = \text{CSK})] \\
&= 0.7 * [0.8 * 0.3 + 0.4 * 0.7] + 0.15 * [0.2 * 0.3 + 0.6 * 0.7] \\
&= 0.7 * [0.24 + 0.28] + 0.15 * [0.06 + 0.42] = 0.436
\end{aligned}$$

$$\begin{aligned}
P(R = \text{CSK} \mid B_{tf} = \text{RCB}, B_{wf} = \text{CSK}, I_n = \text{CSK}) &= P(R = \text{CSK} \mid B_{tf} = \text{RCB}, B_{wf} = \text{CSK}, \\
&I_n = \text{CSK}, C = \text{CSK}) * [P(C = \text{CSK} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{CSK} \mid S = \\
&\text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK})] + P(R = \text{CSK} \mid B_{tf} = \text{RCB}, B_{wf} = \text{CSK}, I_n = \text{CSK}, C = \\
&\text{RCB}) * [P(C = \text{RCB} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C = \text{RCB} \mid S = \text{RCB}) * P(S = \\
&\text{RCB} \mid I = \text{CSK})] \\
&= 0.85 * [0.8 * 0.3 + 0.4 * 0.7] + 0.25 * [0.2 * 0.3 + 0.6 * 0.7] \\
&= 0.85 * [0.24 + 0.28] + 0.25 * [0.06 + 0.42] = 0.562
\end{aligned}$$

$$P(B_{wf} = \text{RCB} \mid B_{ts} = \text{CSK}, I = \text{CSK}) = P(B_{wf} = \text{RCB} \mid C_f = \text{RCB}) * (C_f = \text{RCB} \mid I = \text{CSK}) + P(B_{wf} = \text{RCB} \mid C_f = \text{CSK}) * (C_f = \text{CSK} \mid I = \text{CSK})$$

$$P(B_{wf} = \text{RCB} \mid C_f = \text{RCB}) = P(B_{wf} = \text{RCB} \mid C_f = \text{RCB}, B_{ws} = \text{CSK}, K_p = \text{RCB}) = 0.6$$

$$P(B_{wf} = \text{RCB} \mid C_f = \text{CSK}) = P(B_{wf} = \text{RCB} \mid C_f = \text{CSK}, B_{ws} = \text{CSK}, K_p = \text{RCB}) = 0$$

$$\begin{aligned}
P(C_f = \text{RCB} \mid I = \text{CSK}) &= P(C_f = \text{RCB} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C_f = \\
&\text{RCB} \mid S = \text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK}) \\
&= [P(C_f = \text{RCB} \mid S = \text{CSK}, C_s = \text{RCB})] * P(S = \text{CSK} \mid I = \text{CSK}) + [P(C_f = \text{RCB} \mid S = \\
&\text{RCB}, C_s = \text{RCB}) * P(C_s = \text{RCB})] * P(S = \text{RCB} \mid I = \text{CSK}) \\
&= [0.4] * 0.3 + [0.9] * 0.7 \\
&= 0.75
\end{aligned}$$

$$\begin{aligned}
(C_f = \text{CSK} \mid I = \text{CSK}) &= P(C_f = \text{CSK} \mid S = \text{CSK}) * P(S = \text{CSK} \mid I = \text{CSK}) + P(C_f = \text{CSK} \\
&\mid S = \text{RCB}) * P(S = \text{RCB} \mid I = \text{CSK}) \\
&= [P(C_f = \text{CSK} \mid S = \text{CSK}, C_s = \text{RCB})] * P(S = \text{CSK} \mid I = \text{CSK}) + [P(C_f = \text{CSK} \mid S = \\
&\text{RCB}, C_s = \text{RCB}) * P(C_s = \text{RCB})] * P(S = \text{RCB} \mid I = \text{CSK}) \\
&= [0.6] * 0.3 + [0.1] * 0.7 \\
&= 0.25
\end{aligned}$$

$$P(B_{wf} = \text{CSK} \mid B_{ts} = \text{CSK}, I = \text{CSK}) = P(B_{wf} = \text{CSK} \mid C_f = \text{RCB}) * (C_f = \text{RCB} \mid I = \text{CSK}) + P(B_{wf} = \text{CSK} \mid C_f = \text{CSK}) * (C_f = \text{CSK} \mid I = \text{CSK})$$

$$P(\text{Bwf} = \text{CSK} \mid \text{Cf} = \text{RCB}) = P(\text{Bwf} = \text{CSK} \mid \text{Cf} = \text{RCB}, \text{Bws} = \text{CSK}, \text{Kp} = \text{RCB}) = 0.4$$

$$P(\text{Bwf} = \text{CSK} \mid \text{Cf} = \text{CSK}) = P(\text{Bwf} = \text{CSK} \mid \text{Cf} = \text{CSK}, \text{Bws} = \text{CSK}, \text{Kp} = \text{RCB}) = 1$$

$$\begin{aligned} P(\text{Cf} = \text{RCB} \mid \text{I} = \text{CSK}) &= P(\text{Cf} = \text{RCB} \mid \text{S} = \text{CSK}) * P(\text{S} = \text{CSK} \mid \text{I} = \text{CSK}) + P(\text{Cf} = \text{RCB} \mid \text{S} = \text{RCB}) * P(\text{S} = \text{RCB} \mid \text{I} = \text{CSK}) \\ &= [P(\text{Cf} = \text{RCB} \mid \text{S} = \text{CSK}, \text{Cs} = \text{RCB})] * P(\text{S} = \text{CSK} \mid \text{I} = \text{CSK}) + [P(\text{Cf} = \text{RCB} \mid \text{S} = \text{RCB}, \text{Cs} = \text{RCB}) * P(\text{Cs} = \text{RCB})] * P(\text{S} = \text{RCB} \mid \text{I} = \text{CSK}) \\ &= [0.4] * 0.3 + [0.9] * 0.7 \\ &= 0.75 \end{aligned}$$

$$\begin{aligned} (\text{Cf} = \text{CSK} \mid \text{I} = \text{CSK}) &= P(\text{Cf} = \text{CSK} \mid \text{S} = \text{CSK}) * P(\text{S} = \text{CSK} \mid \text{I} = \text{CSK}) + P(\text{Cf} = \text{CSK} \mid \text{S} = \text{RCB}) * P(\text{S} = \text{RCB} \mid \text{I} = \text{CSK}) \\ &= [P(\text{Cf} = \text{CSK} \mid \text{S} = \text{CSK}, \text{Cs} = \text{RCB})] * P(\text{S} = \text{CSK} \mid \text{I} = \text{CSK}) + [P(\text{Cf} = \text{CSK} \mid \text{S} = \text{RCB}, \text{Cs} = \text{RCB}) * P(\text{Cs} = \text{RCB})] * P(\text{S} = \text{RCB} \mid \text{I} = \text{CSK}) \\ &= [0.6] * 0.3 + [0.1] * 0.7 \\ &= 0.25 \end{aligned}$$

$$P(\text{R} = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{RCB}, \text{P} = \text{Green}) = 0.102 * 0.6 + 0.486 * 0.4 = 0.2556$$

$$P(\text{Bwf} = \text{RCB} \mid \text{Bts} = \text{CSK}, \text{I} = \text{CSK}) = 0.6 * 0.75 + 0 * 0.25 = 0.45$$

$$P(\text{R} = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bwf} = \text{CSK}, \text{P} = \text{Green}) = 0.436 * 0.6 + 0.562 * 0.4 = 0.4864$$

$$P(\text{Bwf} = \text{CSK} \mid \text{Bts} = \text{CSK}, \text{I} = \text{CSK}) = 0.4 * 0.75 + 1 * 0.25 = 0.55$$

$$\begin{aligned} P(\text{R} = \text{CSK} \mid \text{Btf} = \text{RCB}, \text{Bts} = \text{CSK}, \text{Bws} = \text{CSK}, \text{P} = \text{Green}, \text{I} = \text{CSK}, \text{Cs} = \text{RCB}, \text{Kp} = \text{RCB}) \\ = 0.2556 * 0.45 + 0.4864 * 0.55 = \underline{0.38254} \end{aligned}$$