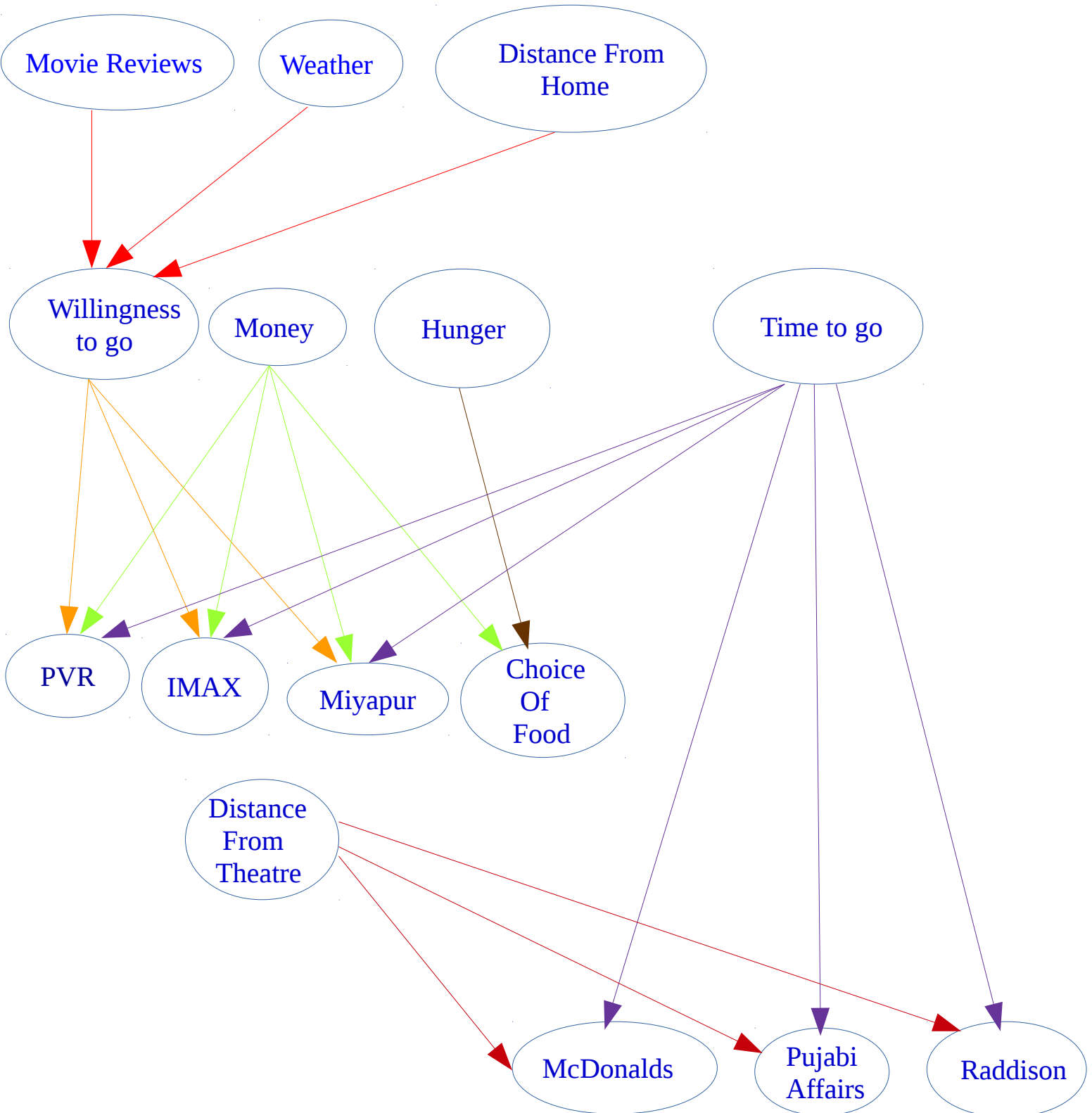


AI ASSIGNMENT-3

Nikhil Rayaprolu- 201501090

Vegulla Sri Kavya- 201501062

Bayesian Network



Key	Nodes/Variables	Values
MR	Movie Reviews	<3.5 star, >=3.5 star
W	Weather	Rainy, Normal
DH	Distance From Home	<5Km, 5-15Km, >15Km
WG	Willingness To Go	Yes,No
PV	PVR	Yes,No
IM	IMAX	Yes,No
MI	Miyapur	Yes,No
TM	Time Of Movie	4-7PM, 6-9PM, 9-12PM
M	Money	Afford, Cannot Afford
H	Hunger	High, Low
CF	Choice Of Food	Snack, Meal
DT	Distance From Theatre	<3Km, 3-10, >10Km
MC	McDonalds	Yes, No
R	Radisson	Yes, No
PA	Punjabi Affairs	Yes, No

CPT Tables

Time

Time	16:00-19:00	18:00-21:00	21:00-00:00
P(Time)	0.2	0.3	0.5

Distance from Home

DH	<5Km	5-15Km	>15Km
p(DH)	0.2	0.6	0.2

Weather

W	Rainy	Normal
P(W)	0.1	0.9

Movie Reviews

MR	<3.5 star	≥ 3.5 star
P(MR)	0.3	0.7

Hunger

H	High	Low
P(H)	0.8	0.2

Money

Money	Enough	Not-Enough
P(Money)	0.8	0.2

Willingness To Go

MR	W	DH	P(Yes)
<3.5 Star	Rainy	<5km	0.3
<3.5 Star	Normal	<5km	0.4
<3.5 Star	Rainy	5-15km	0.2
<3.5 Star	Normal	5-15km	0.25
<3.5 Star	Rainy	≥ 15 km	0.1
<3.5 Star	Normal	≥ 15 km	0.15
≥ 3.5 Star	Rainy	<5km	0.6
≥ 3.5 Star	Normal	<5km	0.85
≥ 3.5 Star	Rainy	5-15km	0.55
≥ 3.5 Star	Normal	5-15km	0.65
≥ 3.5 Star	Rainy	≥ 15 km	0.5
≥ 3.5 Star	Normal	≥ 15 km	0.55

PVR

WG	TM	M	P(Yes)
Yes	4-7PM	Afford	0.7
No	4-7PM	Afford	0.2
Yes	6-9PM	Afford	0.8
No	6-9PM	Afford	0.3
Yes	9-12PM	Afford	0.85
No	9-12PM	Afford	0.4
Yes	4-7PM	Cannot Afford	0.5
No	4-7PM	Cannot Afford	0.1
Yes	6-9PM	Cannot Afford	0.55
No	6-9PM	Cannot Afford	0.15
Yes	9-12PM	Cannot Afford	0.65
No	9-12PM	Cannot Afford	0.2

IMAX

WG	TM	M	P(Yes)
Yes	4-7PM	Afford	0.6
No	4-7PM	Afford	0.3
Yes	6-9PM	Afford	0.6
No	6-9PM	Afford	0.25
Yes	9-12PM	Afford	0.9
No	9-12PM	Afford	0.3
Yes	4-7PM	Cannot Afford	0.5
No	4-7PM	Cannot Afford	0
Yes	6-9PM	Cannot Afford	0.6
No	6-9PM	Cannot Afford	0.11
Yes	9-12PM	Cannot Afford	0.6

No	9-12PM	Cannot Afford	0.05
----	--------	---------------	------

Miyapur

WG	TM	M	P(Yes)
Yes	4-7PM	Afford	0.6
No	4-7PM	Afford	0.45
Yes	6-9PM	Afford	0.8
No	6-9PM	Afford	0.4
Yes	9-12PM	Afford	0.95
No	9-12PM	Afford	0.4
Yes	4-7PM	Cannot Afford	0.6
No	4-7PM	Cannot Afford	0.2
Yes	6-9PM	Cannot Afford	0.6
No	6-9PM	Cannot Afford	0.3
Yes	9-12PM	Cannot Afford	0.6
No	9-12PM	Cannot Afford	0.25

Distance of Restaurant from Theatre

Distance	Less than 3Km	Between 3-10Km	Greater than 10Km
P(Distance)	0.4	0.5	0.1

Choice of Food

H	M	P(CF=Snacks)	P(CF=Meal)
Low	Enough	0.8	0.2
Low	Not Enough	0.9	0.1
High	Enough	0.1	0.9
High	Not Enough	0.3	0.7

MC Donalds

Movie Time	Choice of Food	Distance from	P(Yes)	P(No)
16:00-19:00	Snacks	Less than 3 km	0.9	0.1
16:00-19:00	Snacks	Between 3-10 km	0.7	0.3
16:00-19:00	Snacks	Greater than 10 km	0.3	0.7
16:00-19:00	Meal	Less than 3 km	0.3	0.7
16:00-19:00	Meal	Between 3-10 km	0.2	0.8
16:00-19:00	Meal	Greater than 10 km	0.1	0.9
18:00-21:00	Snacks	Less than 3 km	0.9	0.1
18:00-21:00	Snacks	Between 3-10 km	0.6	0.4
18:00-21:00	Snacks	Greater than 10 km	0.2	0.8
18:00-21:00	Meal	Less than 3 km	0.4	0.6
18:00-21:00	Meal	Between 3-10 km	0.2	0.8
18:00-21:00	Meal	Greater than 10 km	0.1	0.9
21:00-00:00	Snacks	Less than 3 km	1.0	0.0
21:00-00:00	Snacks	Between 3-10 km	0.9	0.1
21:00-00:00	Snacks	Greater than 10 km	0.7	0.3
21:00-00:00	Meal	Less than 3 km	0.6	0.4
21:00-00:00	Meal	Between 3-10 km	0.4	0.6
21:00-00:00	Meal	Greater than 10 km	0.1	0.9

Punjabi Offers

Movie Time	Choice of Food	Distance from	P(Yes)	P(No)
16:00-19:00	Snacks	Less than 3 km	0.3	0.7
16:00-19:00	Snacks	Between 3-10 km	0.2	0.8
16:00-19:00	Snacks	Greater than 10 km	0.1	0.9
16:00-19:00	Meal	Less than 3 km	0.9	0.1
16:00-19:00	Meal	Between 3-10 km	0.7	0.3
16:00-19:00	Meal	Greater than 10 km	0.3	0.7
18:00-21:00	Snacks	Less than 3 km	0.4	0.6
18:00-21:00	Snacks	Between 3-10 km	0.2	0.8
18:00-21:00	Snacks	Greater than 10 km	0.1	0.9
18:00-21:00	Meal	Less than 3 km	0.9	0.1
18:00-21:00	Meal	Between 3-10 km	0.6	0.4
18:00-21:00	Meal	Greater than 10 km	0.2	0.8
21:00-00:00	Snacks	Less than 3 km	1.6	0.4
21:00-00:00	Snacks	Between 3-10 km	0.4	0.6
21:00-00:00	Snacks	Greater than 10 km	0.1	0.9
21:00-00:00	Meal	Less than 3 km	1.0	0.0
21:00-00:00	Meal	Between 3-10 km	0.9	0.1
21:00-00:00	Meal	Greater than 10 km	0.7	0.3

Redisson

Movie Time	Choice of Food	Distance from	P(Yes)	P(No)
16:00-19:00	Snacks	Less than 3 km	0.3	0.7
16:00-19:00	Snacks	Between 3-10 km	0.2	0.8
16:00-19:00	Snacks	Greater than 10 km	0.1	0.9
16:00-19:00	Meal	Less than 3 km	0.9	0.1
16:00-19:00	Meal	Between 3-10 km	0.7	0.3
16:00-19:00	Meal	Greater than 10 km	0.3	0.7
18:00-21:00	Snacks	Less than 3 km	0.4	0.6
18:00-21:00	Snacks	Between 3-10 km	0.2	0.8
18:00-21:00	Snacks	Greater than 10 km	0.1	0.9
18:00-21:00	Meal	Less than 3 km	0.9	0.1
18:00-21:00	Meal	Between 3-10 km	0.6	0.4
18:00-21:00	Meal	Greater than 10 km	0.2	0.8
21:00-00:00	Snacks	Less than 3 km	1.6	0.4
21:00-00:00	Snacks	Between 3-10 km	0.4	0.6
21:00-00:00	Snacks	Greater than 10 km	0.1	0.9
21:00-00:00	Meal	Less than 3 km	1.0	0.0
21:00-00:00	Meal	Between 3-10 km	0.9	0.1
21:00-00:00	Meal	Greater than 10 km	0.7	0.3

Justifications

Key	Nodes/Variables	Justification
MR	Movie Reviews	Movie reviews help in determining whether we want to watch a movie or not.
W	Weather	Whether has a huge impact on your willingness to go and watch a movie. If

		whether is bad we would not want to go and watch the movie.
DH	Distance From Home	Distance of theater from our home plays a role.If a good movie in a theater is at a considerable distance from our house we would rather go and watch that movie in place of a less popular movie which is at a small distance from our home.
WG	Willingness To Go	Willingness to go depends on the three factors mentioned- How the movie is critically acclaimed(movie rating), whether (good or bad)and distance from home.
PV	PVR	This is one of the choices for movie theatres. This is preferable when we want to watch a movie with good seating space, in good quality and we do not have any money constraint. Also distance of the theatre matters.
IM	IMAX	This is one of the choices for movie theatres. This is preferable when we want to watch a 3D movie in good quality and we do not have any money constraint.
MI	Miyapur	This is one of the choices for movie theatres. This is preferable when we want to watch a movie cheaply, almost half the price of the the two movie theatres.
TM	Time Of Movie	We students generally prefer the 9-12PM slots, then 6-9PM and then 4-7PM in that order.
M	Money	Money is an important constraint which apart from affecting the willingness to go also affects the type of theatre in which we want to watch the movie. Also it affects

		whether we want to have dinner in an expensive restaurant or just anywhere.
H	Hunger	Hunger determines whether we want to just eat some fast food or a good meal/buffet which in turn affects the restaurant we are opting for.
CF	Choice Of Food	Choice of food depends on what money we have and the direction of our hunger, the direction as in sometimes we feel like eating fast food and sometimes a proper Indian or some continental meal.
DT	Distance From Theatre	Distance of the restaurant from the theatre matters from the time point of view and also from the monetary point of view. Since the timing of movie shows we go to are generally late it leaves us only with a few options.
MC	McDonalds	Fast food restaurant which serves quick snacks like burger, old-drinks etc.
R	Radisson	A very expensive restaurant that serves good quality food of all types.
PA	Punjabi Affairs	A punjabi restaurant which serves a good Punjabi meal along with Lasii.

Query

$P(\text{PVR}=\text{Yes} \mid \text{Willingness to go(WG)} = \text{No}, \text{MovieReviews(MR)}$
is ≥ 3.5 star)

query of the form $P(X \mid p(X), p(p(X)))$.

$P(\text{PVR} = \text{Yes} \mid (\text{Willingness to go(WG)} = \text{No} \wedge \text{MovieReviews}$
(MR) is ≥ 3.5 star))

$$\begin{aligned}
&= P((PVR = \text{Yes}) \wedge (WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star})) / P((WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star})) \\
&= (P((PVR = \text{Yes}) \mid (WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star})) * P((WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star}))) / P((WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star}))
\end{aligned}$$

[By bayes formula $P(A \wedge B) = P(A \mid B) * P(B)$]

$P((WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star}))$ gets cancelled in numerator and denominator.

Now by bayesian network, we can say that going to PVR depends only on WG and not on MR. So

$$\begin{aligned}
&P((PVR = \text{Yes}) \mid (WG = \text{No}) \wedge (MR \text{ is } \geq 3.5 \text{ star})) \\
&= P((PVR = \text{Yes}) \mid (WG = \text{No}))
\end{aligned}$$

$$\begin{aligned}
&P((PVR = \text{Yes}) \mid (WG = \text{No})) \\
&= P((PVR = \text{Yes}) \wedge (WG = \text{No})) / P(WG = \text{No})
\end{aligned}$$

First finding $P((PVR = \text{Yes}) \wedge (WG = \text{No})) \rightarrow$

$$\begin{aligned}
&P((PVR = \text{Yes}) \wedge (WG = \text{No})) = \\
&\text{summation for } t \text{ belonging to TM} (\text{summation for } m \text{ belong to } M (P((PVR = \text{Yes}) \mid \\
&((WG = \text{No}) \wedge (TM = t) \wedge (M = m)))) * P(WG = \text{No}) * P(M = m) * \\
&P(TM = t)))
\end{aligned}$$

$$\begin{aligned}
&= P(WG = \text{No}) * \text{summation for } t \text{ belonging to TM} (\text{summation for } m \text{ belong to } M (P((PVR = \text{Yes}) \mid ((WG = \text{No}) \wedge (TM = t) \wedge (M = m)))) \\
&* P(M = m) * P(TM = t)))
\end{aligned}$$

$$P(M = \text{Afford}) = 0.8$$

$$P(M = \text{Cannot Afford}) = 0.2$$

[From CPT table of M]

$$P(TM = 16:00 - 19:00) = 0.2$$

$$P(TM = 18:00 - 21:00) = 0.3$$

$$P(TM = 21:00 - 00:00) = 0.5$$

[From CPT table of TM]

$$P((PVR = \text{Yes}) \wedge (WG = \text{No}))$$

$$= P(WG=\text{No}) * (P(PVR = \text{Yes} \mid (WG = \text{No} \wedge TM = 16:00 - 19:00 \wedge M = \text{Afford})) * P(TM = 16:00 - 19:00) * P(M = \text{Afford}) + P(PVR = \text{Yes} \mid (WG = \text{No} \wedge TM = 16:00 - 19:00 \wedge M = \text{Cannot Afford})) * P(TM = 16:00 - 19:00) * P(M = \text{Cannot Afford}) + P(PVR = \text{Yes} \mid (WG = \text{No} \wedge TM = 18:00 - 21:00 \wedge M = \text{Afford})) * P(TM = 18:00 - 21:00) * P(M = \text{Afford}) + P(PVR = \text{Yes} \mid (WG = \text{No} \wedge TM = 18:00 - 21:00 \wedge M = \text{Cannot Afford})) * P(TM = 18:00 - 21:00) * P(M = \text{Cannot Afford}) + P(PVR = \text{Yes} \mid (WG = \text{No} \wedge TM = 21:00 - 00:00 \wedge M = \text{Afford})) * P(TM = 21:00 - 00:00) * P(M = \text{Afford}) + P(PVR = \text{Yes} \mid (WG = \text{No} \wedge TM = 21:00 - 00:00 \wedge M = \text{Cannot Afford})) * P(TM = 21:00 - 00:00) * P(M = \text{Cannot Afford}))$$

$$P((PVR = \text{Yes}) \wedge (WG = \text{No}))$$

$$= P(WG=\text{No}) * (0.2 * 0.2 * 0.8 + 0.1 * 0.2 * 0.2 + 0.3 * 0.3 * 0.8 + 0.15 * 0.3 * 0.2 + 0.4 * 0.5 * 0.8 + 0.2 * 0.5 * 0.2)$$

$$P((PVR = \text{Yes}) \wedge (WG = \text{No})) = P(WG=\text{No}) * (0.28)$$

Now we'll calculate $P(WG = \text{No}) \rightarrow$

$$P(WG = \text{No}) = \text{summation over MR}(\text{summation over DH}(\text{summation over W} (P(WG = \text{No} \mid (MR = m \wedge DH = d \wedge W = w)) * P(MR = m) * P(DH = d) * P(W = w))))$$

$$P(MR \text{ is } > 3.5 \text{ star}) = 0.7$$

$$P(MR \text{ is } < 3.5 \text{ star}) = 0.3$$

[From CPT table of MR]

$P(DH < 5 \text{ km}) = 0.2$
 $P(DH \text{ in } 5\text{-}15 \text{ km}) = 0.6$
 $P(DH > 15 \text{ km}) = 0.2$
 [From CPT table of DH]

$P(W = \text{rainy}) = 0.1$
 $P(W = \text{normal}) = 0.9$

$P(WG = \text{No})$
 $= 0.1 * 0.4 * 0.3 * 0.3 + 0.4 * 0.1 * 0.3 * 0.9 + 0.2 * 0.3 * 0.5 * 0.1 + 0.25 * 0.3 * 0.5 * 0.9 + 0.1 * 0.3 * 0.2 * 0.3 + 0.15 * 0.1 * 0.2 * 0.9 + 0.6 * 0.9 * 0.3 * 0.3 + 0.85 * 0.7 * 0.3 * 0.9 + 0.55 * 0.6 * 0.5 * 0.3 + 0.65 * 0.9 * 0.5 * 0.7 + 0.5 * 0.6 * 0.2 * 0.3 + 0.55 * 0.9 * 0.2 * 0.7$

$P(WG = \text{No}) = 0.5151$
 $P((PVR = \text{Yes}) \wedge (WG = \text{No}))$
 $= P(WG = \text{No}) * (0.28)$
 $= (0.5151) * (0.28)$
 $= 0.144228$
 $P((PVR = \text{Yes}) \wedge (WG = \text{No})) = 0.144228$

$P((PVR = \text{Yes}) \mid (WG = \text{No} \wedge \text{MR is } \geq 3 \text{ star}))$
 $= P((PVR = \text{Yes}) \mid WG = \text{No}) / P(WG = \text{No})$
 $= 0.144228 / 0.5151$
 $= 0.28$

So, $P(PVR = \text{Yes} \mid \text{Willingness to go}(WG) = \text{No}, \text{MovieReviews}(MR) \text{ is } \geq 3 \text{ star})$
 $= 0.28$