# AI ASSIGNMENT-3
# Bayesian Networks


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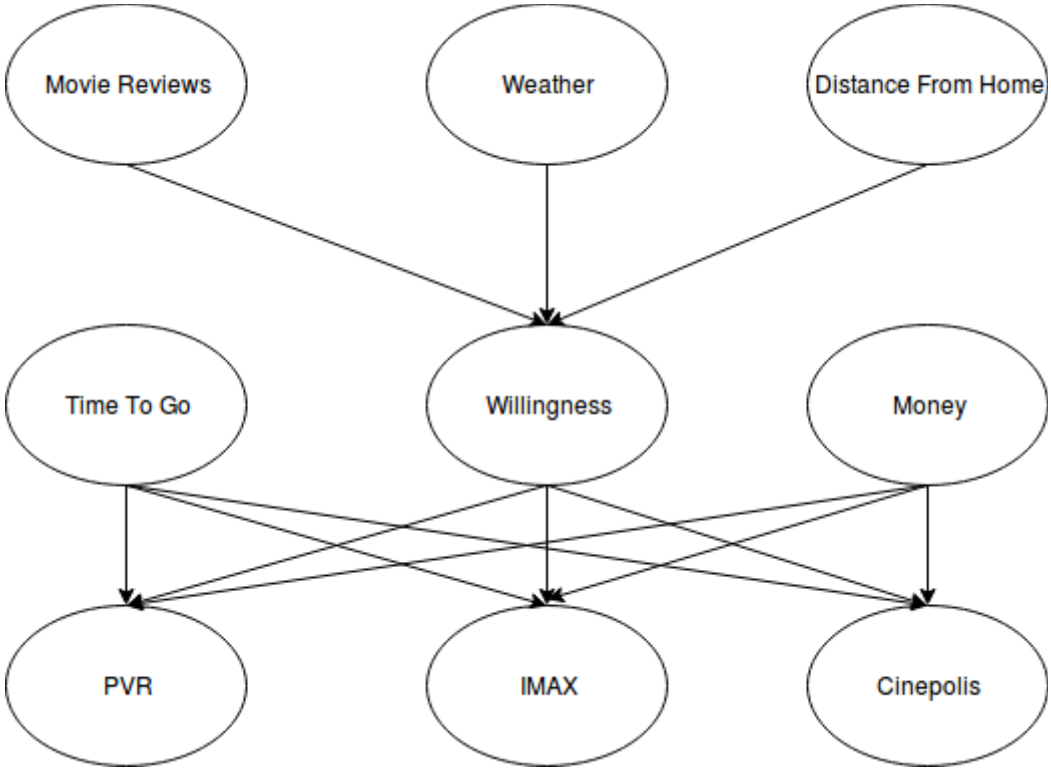

| Key | Nodes/Variables | Values |
|---|---|---|
| MR | Movie Reviews | <3 star, >=3 star |
| W | Weather | Rainy, Normal |
| DH | Distance From Home | <5Km, 5-15Km, >15Km |
| WG | Willingness To Watch | Yes,No |
| PV | PVR | Yes,No |
| IM | IMAX | Yes,No |
| CI | CinePolis | Yes,No |
| TM | Time Of Movie | 3-6PM, 6-9PM, 9-12PM |
| M | Money | Afford,Cannot Afford |

## CPT Tables

### Time

| Time | 3:00pm – 6:00pm | 6:00pm-9:00pm | 9:00pm-00:00am |
|---|---|---|---|
| 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 | Other |
|---|---|---|
| P(W) | 0.1 | 0.9 |

## Movie Reviews

| MR | <3 star | >=3star |
|---|---|---|
| P(MR) | 0.3 | 0.7 |

## Money

| Money | Enough | Not-Enough |
|---|---|---|
| P(Money) | 0.6 | 0.4 |

## Willingness To Go

| MR | W | DH | P(Yes) |
|---|---|---|---|
| <3 Star | Rainy | <5km | 0.3 |
| <3 Star | Other | <5km | 0.4 |
| <3 Star | Rainy | 5-15km | 0.2 |
| <3 Star | Other | 5-15km | 0.25 |
| <3 Star | Rainy | >=15km | 0.1 |
| <3 Star | Other | >=15km | 0.15 |
| >=3 Star | Rainy | <5km | 0.6 |
| >=3 Star | Other | <5km | 0.85 |
| >=3 Star | Rainy | 5-15km | 0.55 |
| >=3 Star | Other | 5-15km | 0.65 |
| >=3 Star | Rainy | >=15km | 0.5 |
| >=3 Star | Other | >=15km | 0.55 |

**PVR**

| WG | TM | M | P(Yes) |
|---|---|---|---|
| Yes | 3-6PM | Afford | 0.7 |
| No | 3-6PM | 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 | 3-6PM | Cannot Afford | 0.5 |
| No | 3-6PM | 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 | 3-6PM | Afford | 0.6 |
| No | 3-6PM | 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 | 3-6PM | Cannot Afford | 0.5 |
| No | 3-6PM | 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 |

## Cinepolis

| WG | TM | M | P(Yes) |
|---|---|---|---|
| Yes | 3-6PM | Afford | 0.6 |
| No | 3-6PM | 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 | 3-6PM | Cannot Afford | 0.6 |
| No | 3-6PM | 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 |

## Justifications

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

| | | |
|---|---|---|
| | | weather 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 theaters. 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 theater matters. |
| IM | IMAX | This is one of the choices for movie theaters. This is preferable when we want to watch a 3D movie in good quality and we do not have any money constraint. |
| CI | Cinepolis | 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 3-6PM in that order. |
| M | Money | Money is an important constraint which apart from affecting the willingness to go also affects the type of theater in which we want to watch the movie. |

**Query**

P(PVR=Yes | Willingness to go(WG) = No,
MovieReviews(MR) is >= 3 star)
query of the form P(X | p(X),p(p(X)) ).

P(PVR = Yes | (Willingness to go(WG) = No ^
MovieReviews (MR) is >= 3 star))

=P((PVR = Yes) ^ (WG = No) ^ (MR is >= 3 star)) / P((WG = No) ^ (MR is >= 3 star))
=(P((PVR = Yes) | (WG = No) ^ (MR is > 3 star)) * P((WG = No) ^ (MR is >= 3star))) / P((WG = No) ^ (MR is >= 3star))

[ By bayes formula P(A^B) = P(A | B) * P(B) ]

P((WG = No) ^ (MR is >= 3 star)) gets canceled in numerator and denominator.

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

P((PVR = Yes) | (WG = No) ^ (MR is >= 3 star))
= P((PVR = Yes) | (WG = No))

P((PVR = Yes) | (WG = No))
= P((PVR = Yes) ^ (WG = No)) / P(WG = No)

First finding P((PVR = Yes) ^ (WG = No)) -> P((PVR = Yes) ^

(WG = No)) =
summation for t belonging to TM(summation for m belong to M(P((PVR = Yes) |
((WG= No) ^ (TM = t) ^ (M = m))) * P(WG=No)*P(M=m) * P(TM = t)))

=P(WG=No)*summation for t belonging to TM(summation for m belong to M(P((PVR = Yes) |((WG= No) ^ (TM = t) ^ (M = m)))

*P(M=m) * P(TM = t)))

P(M = Afford) = 0.8
P(M = 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 = Yes) ^ (WG = No))
= P(WG=No)*(P(PVR = Yes | (WG = No ^ TM = 16:00 – 19:00 ^ M= Afford)) * P(TM = 16:00 – 19:00) * P(M =Afford) + P(PVR = Yes | (WG = No ^TM =16:00 – 19:00 ^ M = Cannot Afford)) * P(TM = 16:00 – 19:00) * P(M = CannotAfford) + P(PVR = Yes | (WG = No ^ TM = 18:00 – 21:00 ^ M = Afford)) * P(TM =18:00 – 21:00) * P(M = Afford) + P(PVR = Yes | (WG = No ^ TM = 18:00 – 21:00 ^M = Cannot Afford) * P(TM = 18:00 – 21:00) * P(M = Cannot Afford) + P(PVR =Yes | (WG = No ^ TM = 21:00 – 00:00 ^ M = Afford)) * P(TM = 21:00 – 00:00) *P(M = Afford) + P(PVR = Yes | (WG = No ^ TM = 21:00 – 00:00 ^ M = CannotAfford) * P(TM = 21:00 – 00:00) * P(M = Cannot Afford))

P((PVR = Yes) ^ (WG = No))
= P(WG=No)*(0.2 * 0.2 * 0.6 + 0.1 * 0.2 * 0.4 + 0.3 * 0.3 * 0.6 +0.15 * 0.3 * 0.4 + 0.4 * 0.5 * 0.6 + 0.2 * 0.5 * 0.4)

P((PVR = Yes) ^ (WG = No)) = P(WG=No)*(0.264)

Now we'll calculate P(WG = No) ->

P(WG = No) = summation over MR(summation over DH( summation over W (P(WG= No | (MR = m ^ DH = d ^ W=w) ) * P(MR = m) * P(DH = d) * P(W = w)))

P(MR is > 3 star) = 0.7
P(MR is < 3 star) = 0.3 [
From CPT table of MR ]

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

P(W = rainy) = 0.1
P(W = normal) = 0.9

P(WG = 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 = No) = 0.5151
P((PVR = Yes) ^ (WG = No))
= P(WG=No)*(0.264)
=(0.5151)*(0.264)
=0.1359864
P((PVR = Yes) ^ (WG = No)) =0.1359864

P((PVR = Yes) | (WG = No ^ MR is >=3 star))
= P((PVR = Yes) | WG = No) / P(WG= No)
= 0.1359864/0.5151
= 0.264

So, P(PVR=Yes | Willingness to go(WG) = No, MovieReviews(MR ) is >= 3 star)
=0.264