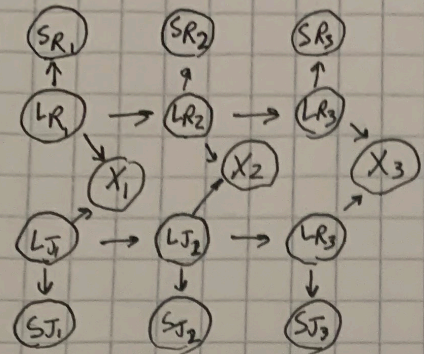
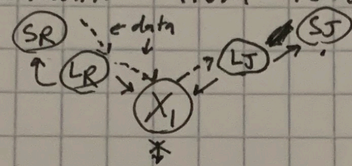
Sam Hopkins
CS 470
Hw 4

1a) 

SR = Sonar Romeo
LR = Location Romeo
X_t = Proximity sensor
LJ = Location Juliet
SJ = sensor Juliet

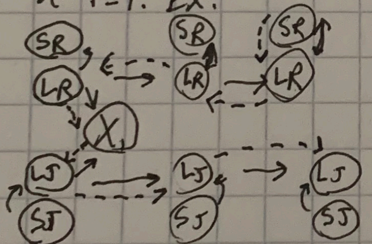
b) yes, Because both robots have access to the sensor, Juliet could gain valuable information from Romeo's sensor. ex:

X is a given sensor



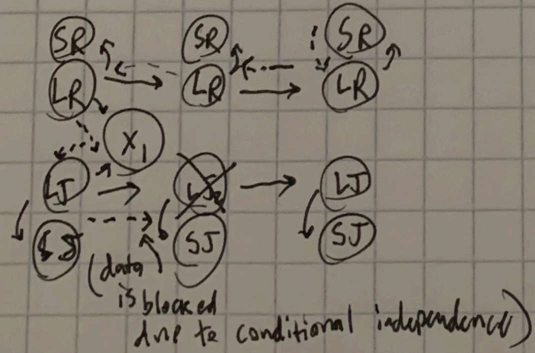
No, they are not independent because there is influence

c) yes, because the Robots can still use the data given from the sensor a t=1: EX:

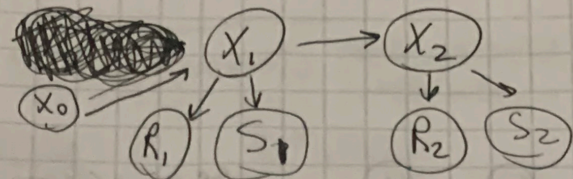


They are still dependent given the Baysian Network, the robots can us information give by the sensor at t=1

d) No, because when Juliet is given her exact location, No other past observations matter because future readings are conditionally independent given LJ: (given LJ_2)



2a)



b) i)

X_0	$P(X_0)$
T	.7
F	.3

ii)

X_t	X_{t-1}	$P(X_t \mid X_{t-1})$
T	T	.8
F	T	.2
T	F	.3
F	F	.7

iii)

R_t	X_t	$P(R_t \mid X_t)$
T	T	.2
F	T	.8
T	F	.7
F	F	.3

iv)

S_t	X_t	$P(S_t \mid X_t)$
T	T	.1
F	T	.9
T	F	.3
F	F	.7

c) i) $P(X_1) = \sum_{X_0} P(X_0, X_1) = \sum_{X_0} P(X_0)P(X_1 \mid X_0) =$

$X_1 = t$: $.7 \cdot .8 + .3 \cdot .3 = .56 + .09 = .65 = P(X_1 = t)$

$X_1 = f$: $= .3 \cdot .7 + .7 \cdot .2 = .21 + .14 = .35 = P(X_1 = f)$

$P(X_1 \mid e_1) = P(X_1 \mid \neg r, \neg s_1) = \alpha(\neg r, \neg s \mid X_1)P(X_1)$

$X_1 = t \Rightarrow .8 \cdot .65 \cdot .9 = .498$

$X_1 = f \Rightarrow .35 \cdot .3 \cdot .7 = .0735$ $\;> .5715$

$P(X_1 = t \mid \neg r, \neg c) = .871$

$P(X_1 = f \mid \neg r, \neg c) = \boxed{.129}$

ii) $P(X_2 \mid e_1) = \sum_{X_1} P(X_1, X_2 \mid e_1)$ ← $\neg r, \neg c$

$= \sum_{X_1} P(X_1 \mid \neg r, \neg c) P(X_2 \mid X_1, \neg r, \neg c) = \sum_{X_1} P(X_1 \mid \neg r, \neg c) P(X_2 \mid X_1)$

X_2 is $\perp$ of e_1 given X_1

$X_1 = T$

↳ $.8 \cdot .871 + .3 \cdot .129$

↳ $.6968 + .0387$ $= P(X_2 = T \mid e_1) = .7355$

$X_2 = f$: $.7 \cdot .129 + .871 \cdot .2 = .0903 + .1758 = .2645$

$P(X_2 \mid e_{1:2}) = \alpha(r_2, \neg c_2 \mid X_2) P(X_2 \mid \underbrace{\neg r, \neg c}_{(e_{1:1})})$

$X_2 = t \Rightarrow .2 \cdot .9 \cdot .7355 = .1324$

$X_2 = f \Rightarrow .7 \cdot .7 \cdot .2645 = .1296$ $\;> .262$

$P(X_2 = t \mid e_{1:2}) = \boxed{.5053}$

$P(X_2 = f \mid e_{1:2}) = \boxed{.4947}$

iii) $P(X_3 \mid e_{1:2}) = \sum_{X_2} P(X_2, X_3 \mid e_{1:2})$

$= \sum_{X_2} P(X_2 \mid e_{1:2}) P(X_3 \mid X_2, r, \neg c)$ ← independent

$= \sum_{X_2} P(X_2 \mid e_{1:2}) P(X_3 \mid X_2)$

$X_3 = t \rightarrow .5053 \cdot .8 + .4947 \cdot .3 = .4042 + .14841 = .5526$

$X_3 = f \rightarrow .4947 \cdot .7 + .5053 \cdot .2 = .3463 + .1011 = .4474$

$P(X_3 \mid e_{1:3}) = \alpha P(r_3, c_3 \mid X_3) P(X_3 \mid e_{1:2})$

$X_3 = t \rightarrow .2 \cdot .1 \cdot .5526 = .0111$

$X_3 = f \rightarrow .7 \cdot .3 \cdot .4474 = .0940$ $\;> .1051$

$P(X_3 = t \mid e_{1:3}) = \boxed{.1056}$

$P(X_3 = f \mid e_{1:3}) = \boxed{.8944}$