Technion – Israel Institute of Technology



HW5

Vision Aided Navigation

086761

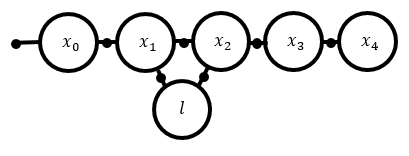
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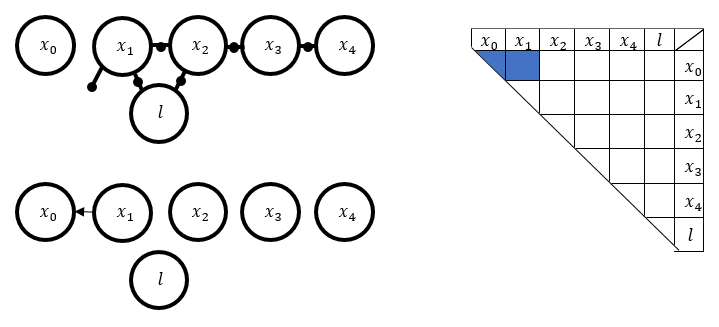
## Question 1: Factor graph, variable elimination and Bayes net. Consider a SAM problem where a robot travels through an unknown environment and captures observations using its onboard sensors. Assume the robot starts at time , with a known prior and consider motion and observation models and , respectively, where denotes the landmark. The robot moves according to given controls and observes a single landmark at time instances and .

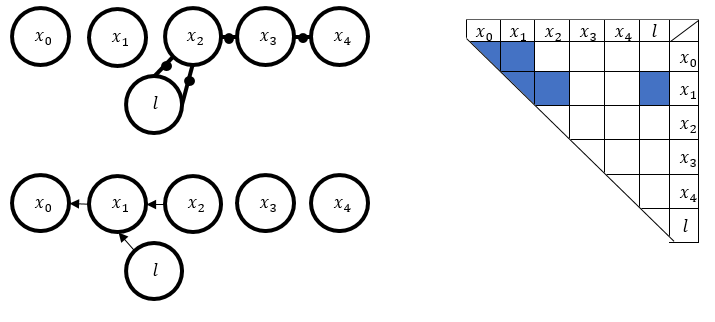
### a: Write the joint pdf corresponding to the above scenario until time

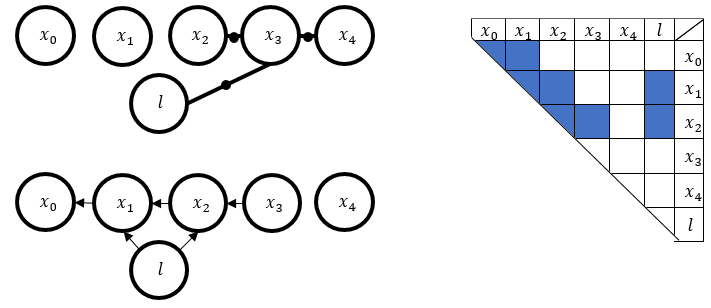
### b: Draw the corresponding factor graph.

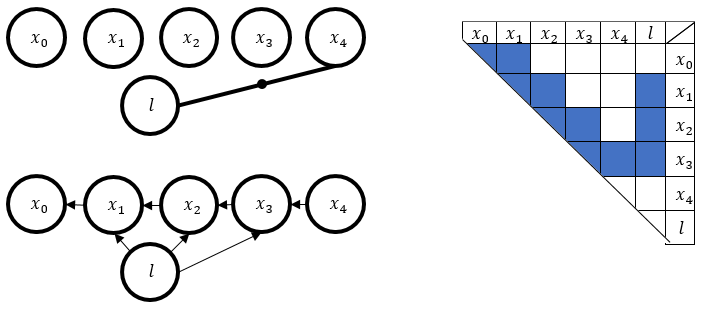


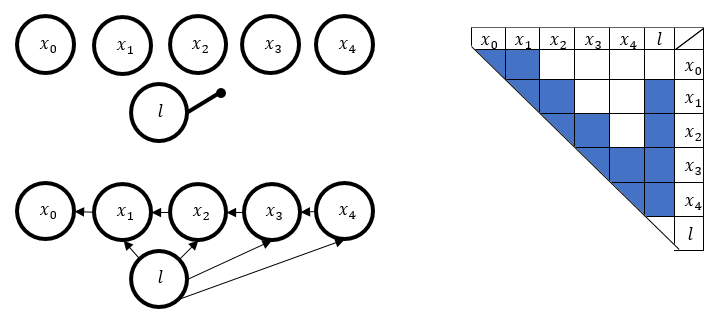
### c: Eliminate the factor graph into a Bayes net, assuming elimination order:

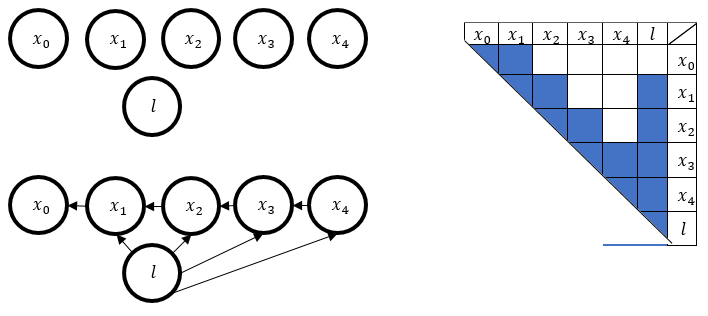




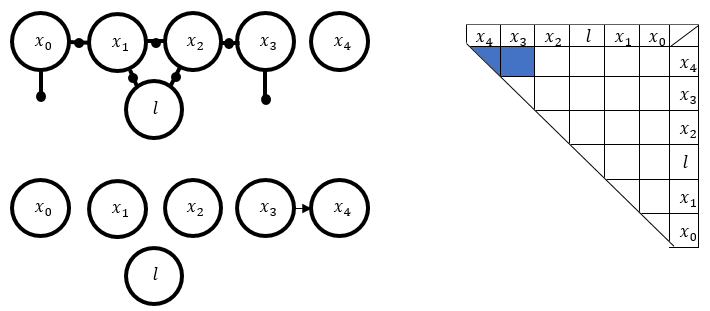


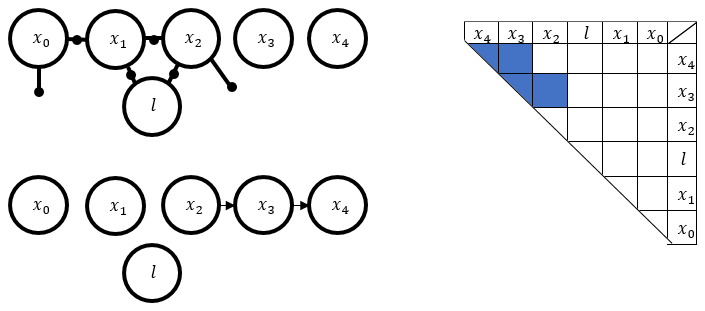


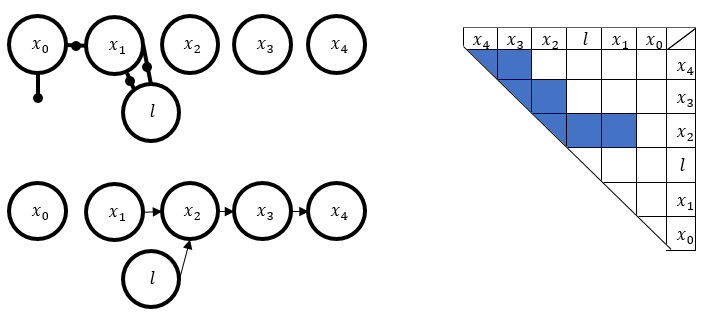


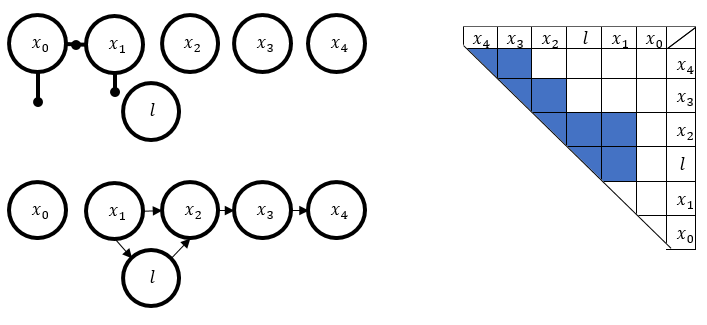


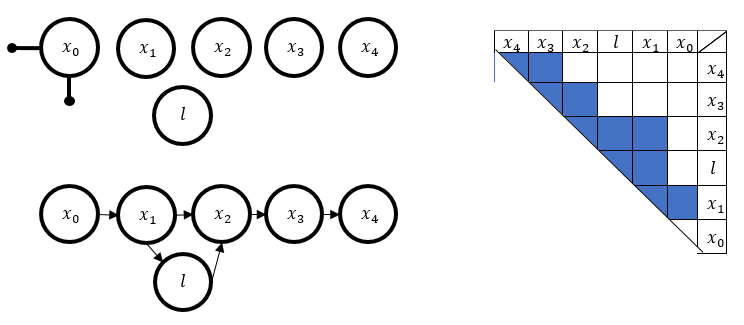
### d: Repeat the previous clause using a different variable elimination order:

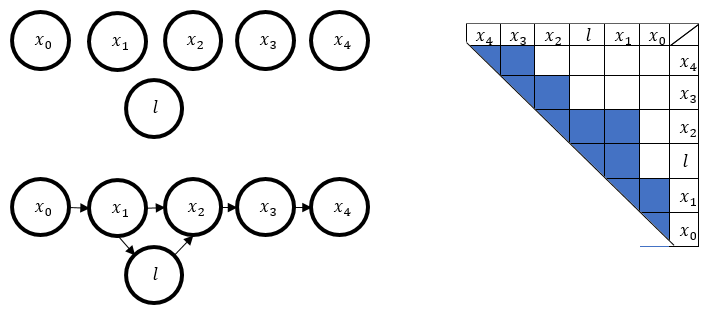












### e: Which of the two elimination orders you would prefer in terms of estimation accuracy and computational aspects?

We show the elimination order and resulting matrix for each section below.

|  |  |
| --- | --- |
| {c}  Elimination Order: | {d}  Elimination Order: |
|  |  |

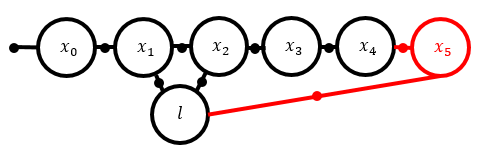
Regarding computation efficiency: We would prefer the elimination order in {d}, as it produces a sparser matrix (12 non-zero elements vs 14), and with more structure – all rows but one contains two elements at the start of the row.

Regarding Accuracy: Both matrices contain the same information. As such, the solution of the LMS problem is independent of the elimination order, or which matrix we choose to use.

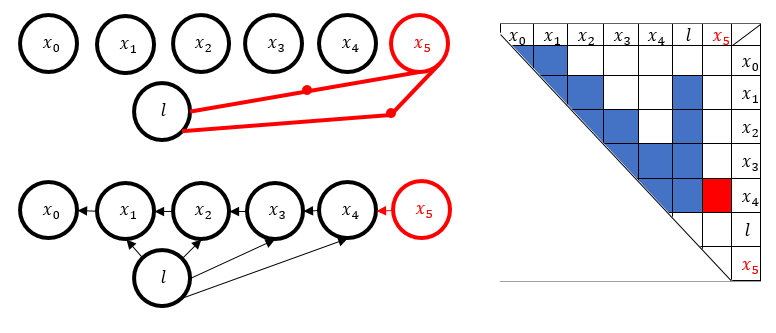
## Question 2: Incremental factorization. Consider now the robot, from question 1, executes command and moves to a new location; denote its new pose by . Assume the robot observes again the landmark from the new location.

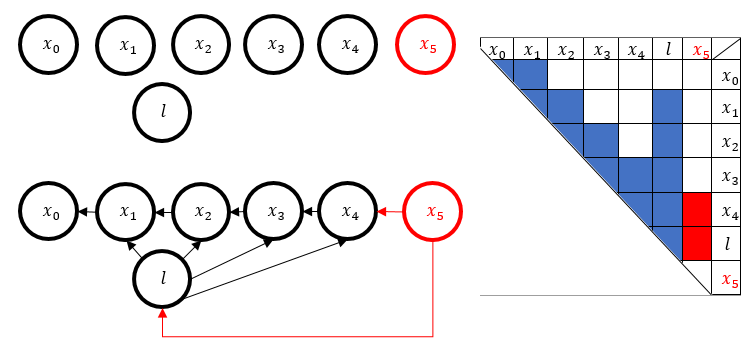
### a: Draw the factor graph of the problem and indicate the new factors and variable nodes.

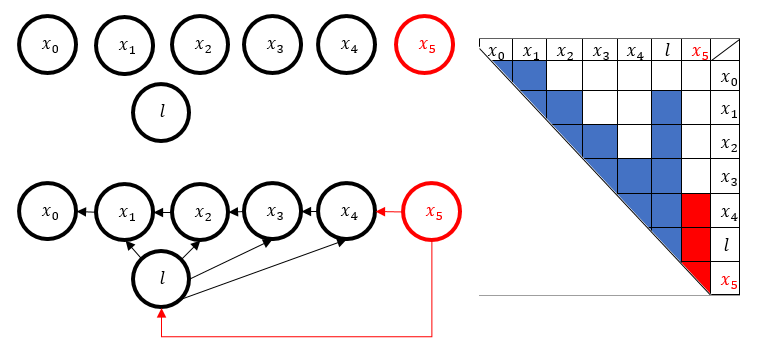
We add one node for pose , and two additional nodes for the factors that need to be computed: one for the motion model, and one for the measurement model.



### b: Consider the Bayes net from question 1(c) with elimination order Perform incremental factorization by updating this Bayes net with the new information using the elimination order:







### c: Show the corresponding updated square root information matrix

The new non-zero elements, the boxes colored red in the new matrix, describe states that depend on in the bayes-net graph.   
In general, values in the red triangle are in the “update impact zone” and are subject to change when computing the new matrix.

