

Learning to Address Health Inequality in the United States with a Bayesian Decision Network

Supplementary Material

Here, we discuss the working procedure to carry-out Bayesian Decision Network exploration, Inference and subsequent Decision Making on our interactive dashboard presented in the main paper. The dashboard provides interactive visualizations including leaflet maps for geographic regions of the United States that can be explored for interactive inference. The dashboard is available as an open-source web-application downloadable from https://github.com/SAFE-ICU/Longevity_Gap_Action. The Graphical User Interface of the dashboard is shown in Figure-1.

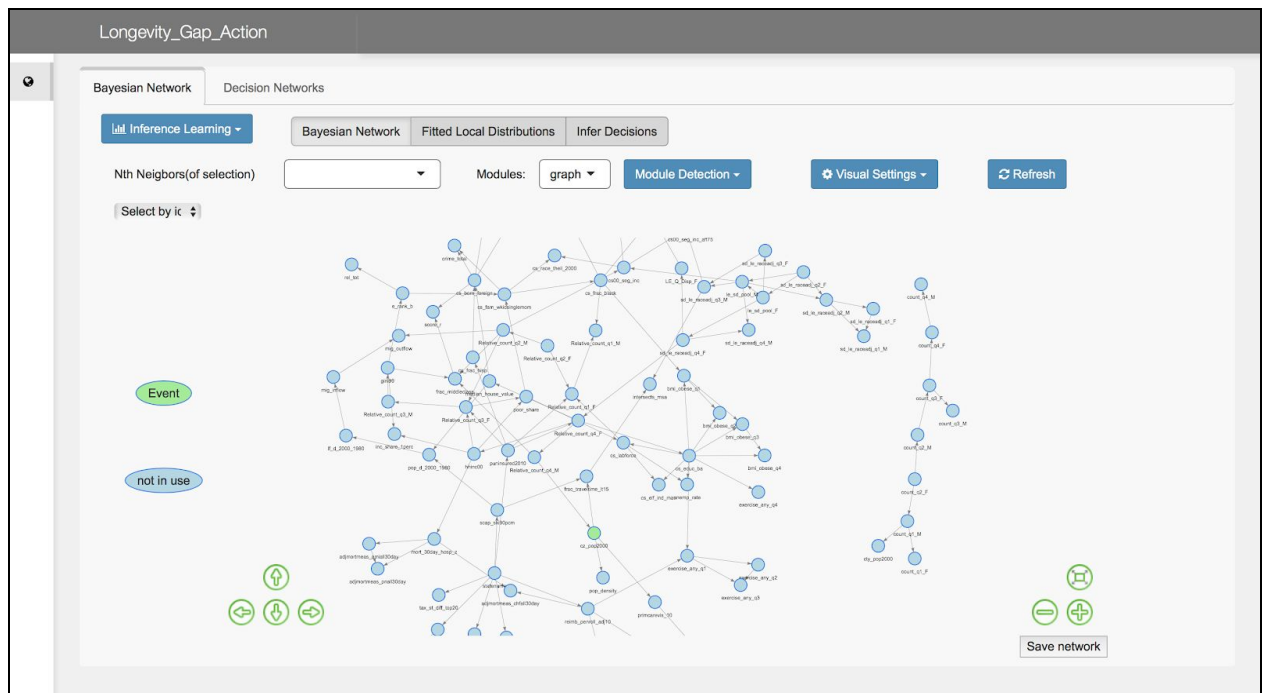


Figure-1: Graphical User Interface of the Longevity_Gap_Action dashboard

The visual settings menu as shown in Figure-2 is used to explore the graph. Variable grouping allows the user to group different nodes by selecting variable names/vector of variable indices/variables belonging to a module and selecting a node shape they want to give these variables.

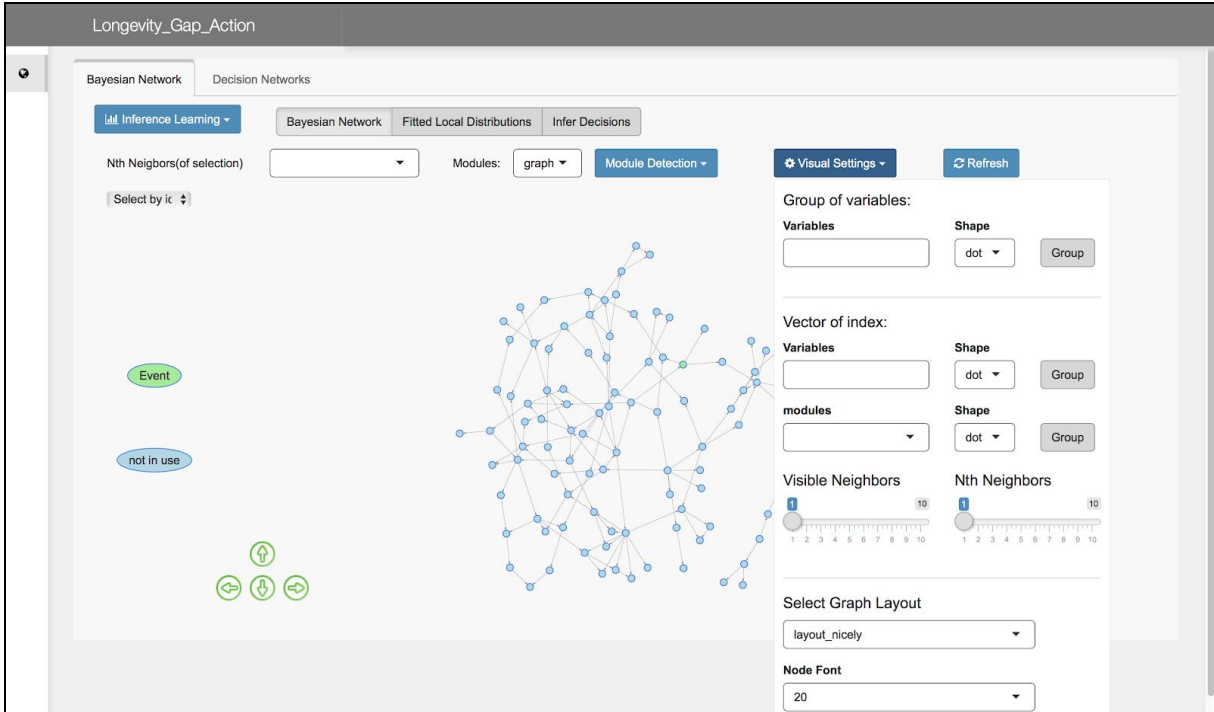


Figure-2: Visual Settings for graph exploration

The inference learning menu, shown in Figure-3, enables the user to learn and explore conditional probability plots on the learned structure. The user can set an event and multiple evidences can be inserted and removed. This crucial feature enables the user to explore probability plots on event nodes in the network conditionalized on number of evidences.

Two ways to perform inference learning are as follows

- Approximate Inference for very fast sampling based inference.
- Exact inference fast for small networks.

While the app learns approximate learning as default, user must explicitly learn exact inferences whenever the structure is learned or updated. The user can then enable exact inferences instead of approximate. To compensate for wavering accuracy of approximate inference, option for inference with error estimates is given.

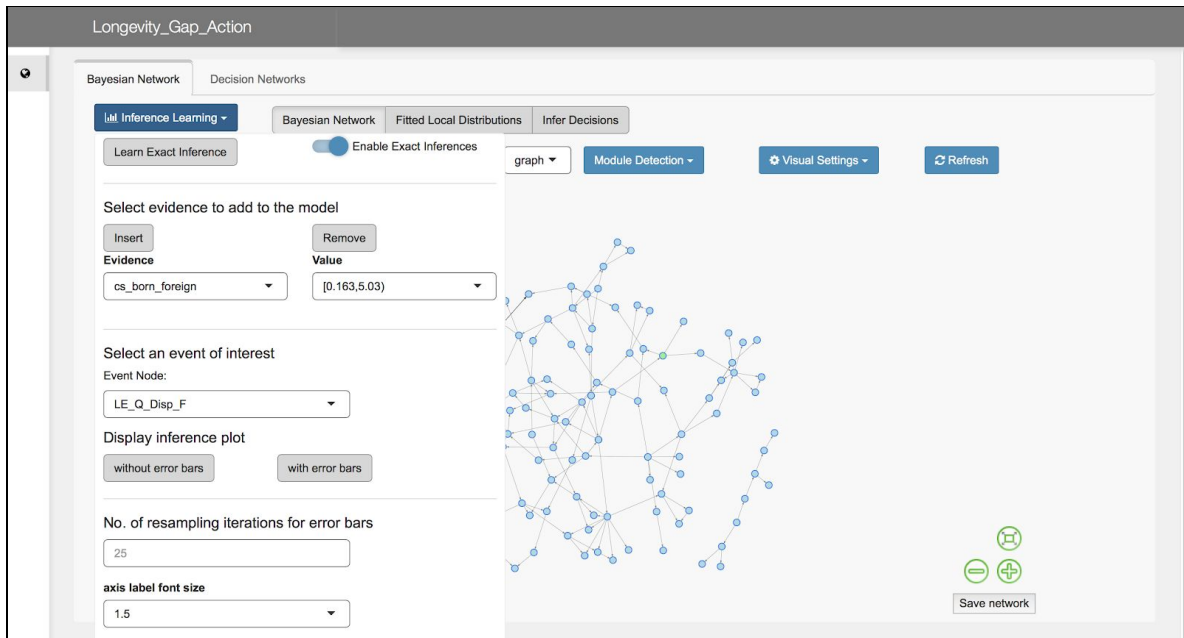


Figure-3: Inference setting to explore predictive insights from the learned bayesian model

Figure-4 shows the inference plots obtained from Inferential learning using Exact Inference. The plot pops-up on the separate 'Infer Decisions' tab. It is easy to switch between 'Infer Decision' and 'Bayesian Network' tabs to go back and forth while exploring and drawing inferences.

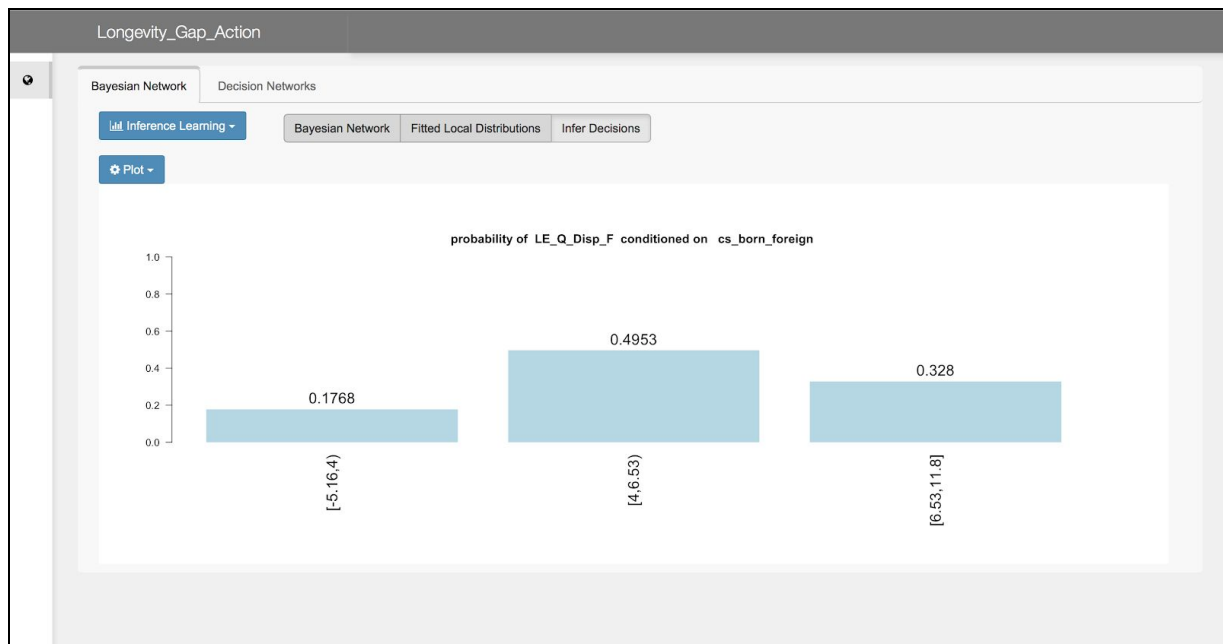


Figure-4 Visualisation of Inference plots obtained from Exact Inference learning

Figure-5 shows the map of United States with a resolution upto state level. This map is used to assist in visualizing the inference plots obtained earlier. A heatmap is generated according to the number of states selected using a slider on the "Infer Decisions" tab.

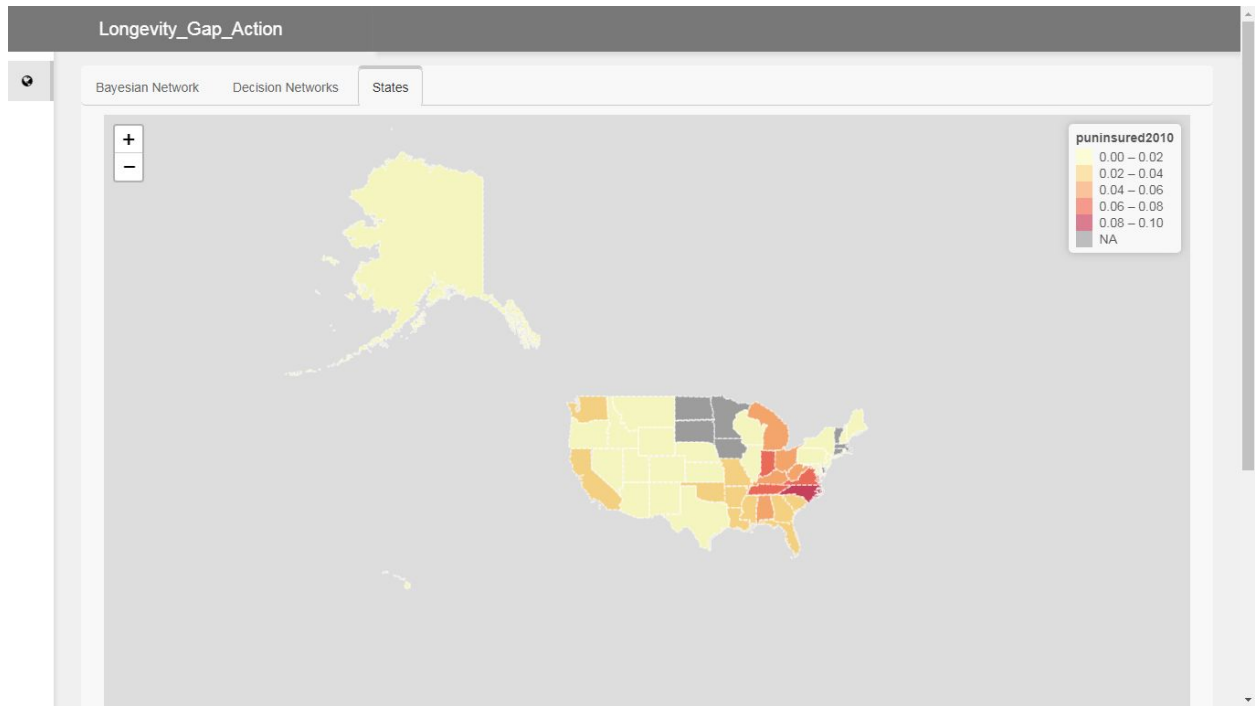


Figure 5: Heatmap of Inference plot

Bayesian Decision Networks

Figure 6 shows the overview of the Bayesian Decision Network, which is built using the underlying learned bayesian network to enable decision makers to make policy related decisions for maximum payoff on selected utility

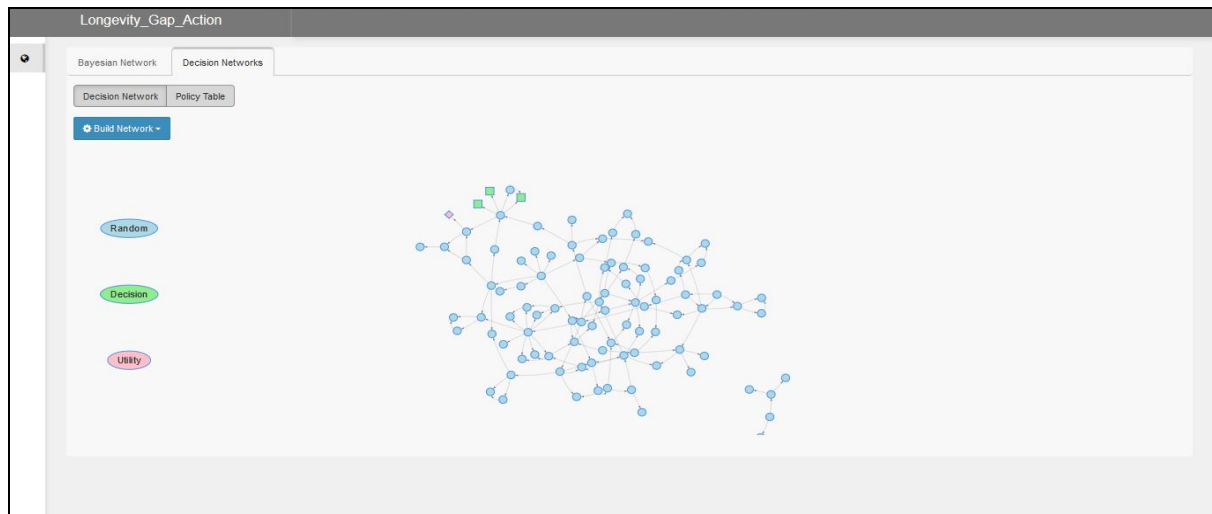


Figure 6: Bayesian Decision Network

Figure 7 shows the control panel to set utility node and corresponding pay-off values, and subsequent building of Decision Network by setting the decision nodes for optimal policy learning.

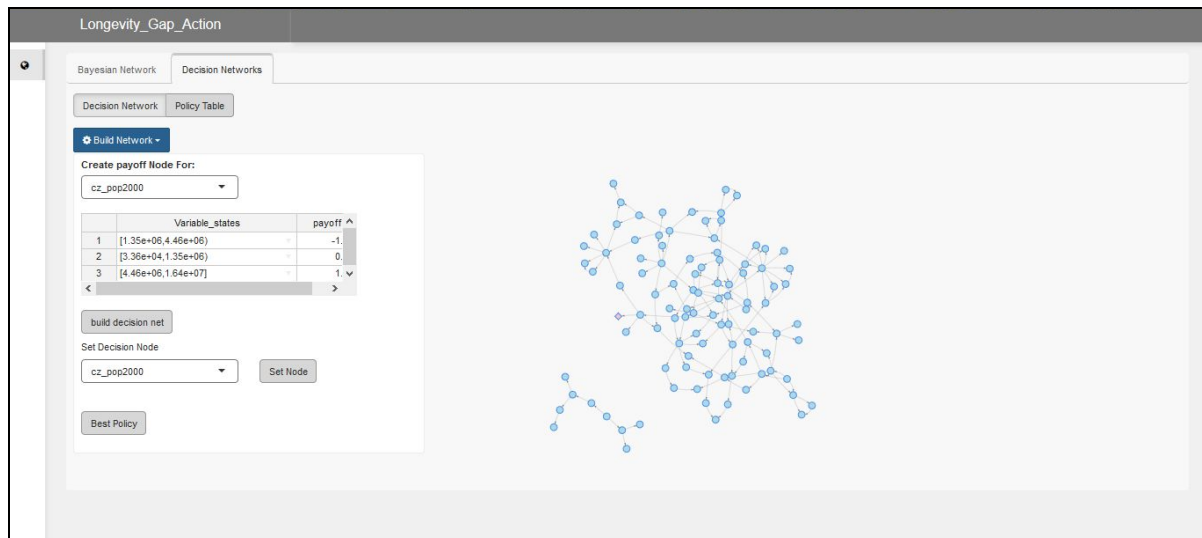


Figure 7: Control panel for building Bayesian Decision Network

Once the utility node and decision nodes are set, the graph updates the nodes to green square for decision nodes and red diamond for utility node. (Diamond shaped nodes for utility variables and square shaped nodes for decision variables and circle shaped nodes for chance variables is standard notation for BDN's. Differentiating color is used for ease of visualization on the graph). This is shown in the Figure 8.

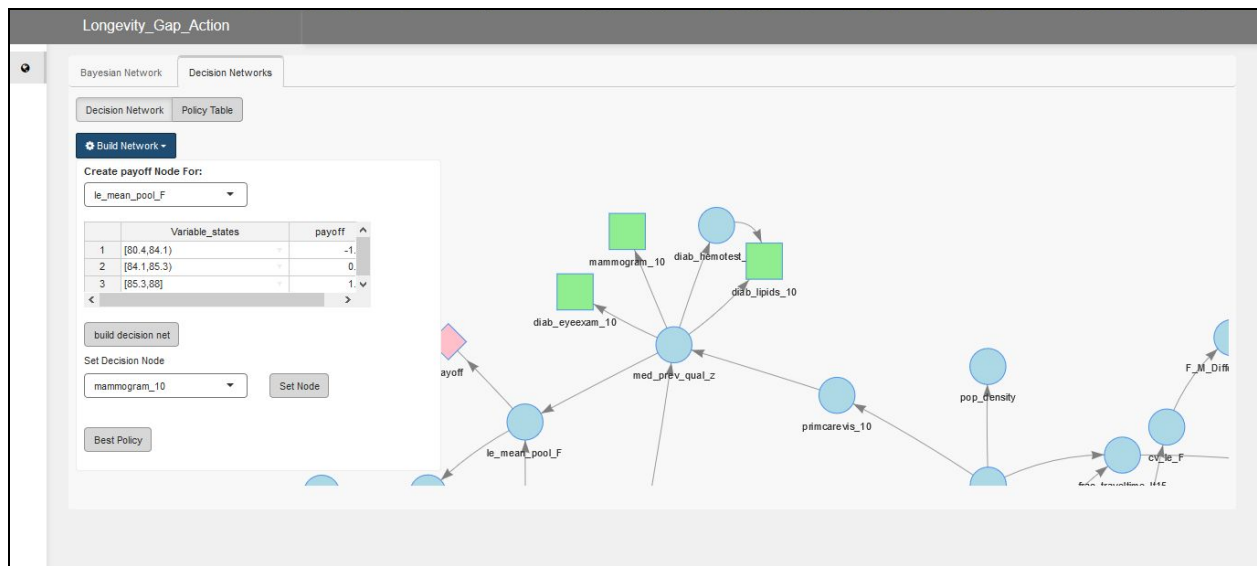


Figure 8: Visualisation of build Bayesian Decision Network

The generated policy table is in descending order of payoff as shown in Figure 9. The first row represents the optimal policy for decision makers to maximize payoff on the selected utility node.

Longevity_Gap_Action				
Bayesian Network		Decision Networks		
Decision Network		Policy Table		
Show	10	entries	Search: <input type="text"/>	
diab_eyeexam_10	mammogram_10	diab_lipids_10	payoff	
[70.2,85.6]	[88.2,86.1]	[79.3,92.9]	0.5259999999999999	
[70.2,85.6]	[88.2,86.1]	[85.6,79.3]	0.475	
[82.2,70.2]	[88.2,86.1]	[79.3,92.9]	0.4510000000000002	
[70.2,85.6]	[59.5,68.2]	[79.3,92.9]	0.399	
[82.2,70.2]	[88.2,86.1]	[85.6,79.3]	0.2589999999999999	
[70.2,85.6]	[59.5,68.2]	[85.6,79.3]	0.2319999999999999	
[42.4,62.2]	[88.2,86.1]	[79.3,92.9]	0.1990000000000002	
[82.2,70.2]	[59.5,68.2]	[79.3,92.9]	0.1320000000000002	
[70.2,85.6]	[31.1,59.5]	[79.3,92.9]	0.129	
[42.4,62.2]	[88.2,86.1]	[85.6,79.3]	0.1060000000000001	
Showing 1 to 10 of 27 entries			Previous	1 2 3 Next

Figure 9: Generated policy table