Aalto-yliopisto
Perustieteiden
korkeakoulu

Optimising the use of genetic testing in prevention of CHD using decision programming

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17.03.2021

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Context

Each patient has a risk (0%-100%) of having a CHD event in the next ten years.

Preventative treatment is only allocated to high-risk (>20%) patients. However, the majority of CHD events occur within the population that is *not* classified to be at high risk.

Targeted genetic screening improves risk classification according to Tikkanen et al. (2013). It is however, more costly than the traditional testing method.

Aim of the paper

The aim was to replicate the cost-benefit analysis by Hynninen et al. (2019) using a different optimisation framework.

The Decision Programming framework was used and its applicability to this optimisation problem was evaluated.

- Combines aspects of stochastic programming and decision analysis
- The optimisation formulation is based on the problem's influence diagram representation

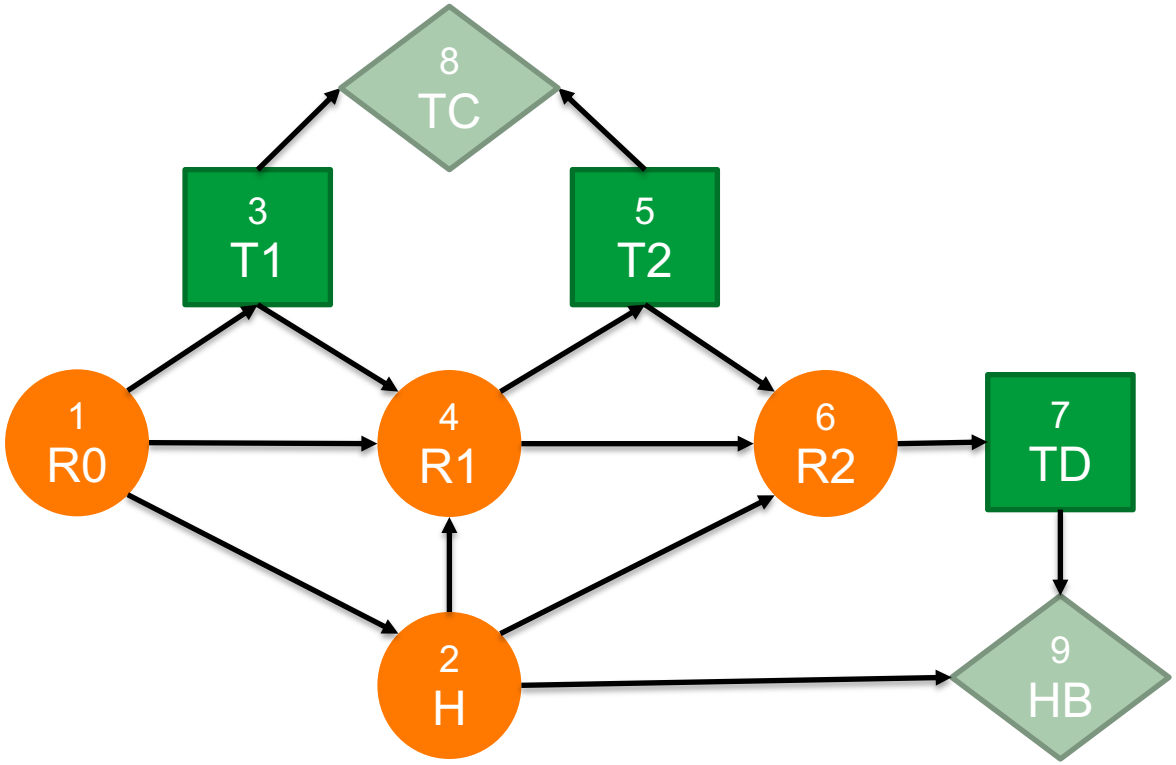
The model in short

- Objective to maximise net monetary benefit

$$NMB = health\ outcomes \cdot \lambda - costs$$

  where λ describes the willingness-to-pay threshold.
- Available tests are traditional risk score (TRS) and genetic risk score (GRS)
- Possible treatment decisions are treat or no treatment
- Task is to determine an optimal 2 or 3 stage decision strategy for the testing and treatment decisions
- The decisions are made based on the risk estimate (0% - 100%) of the patient

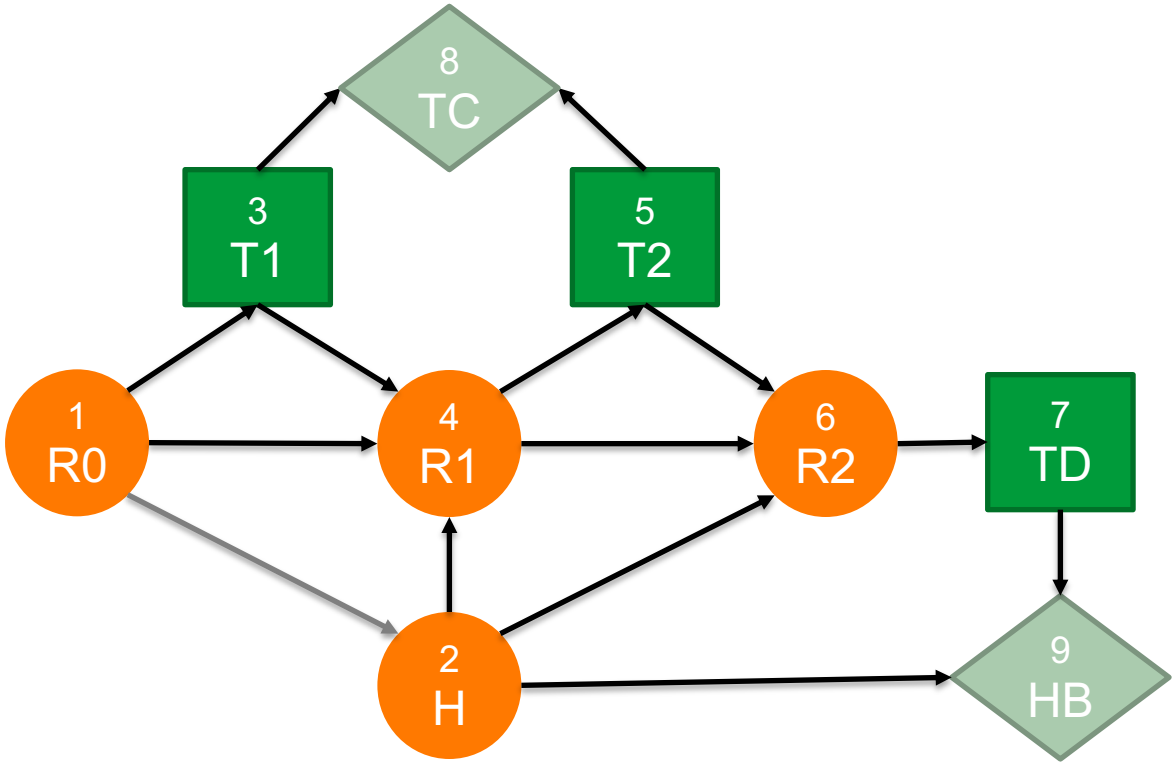
Influence diagram



R0 prior risk estimate
R1 updated risk estimate
R2 second updated risk estimate

T1 first test decision
(TRS, GRS, no test)
T2 second test decision
(TRS, GRS, no test)

Influence diagram



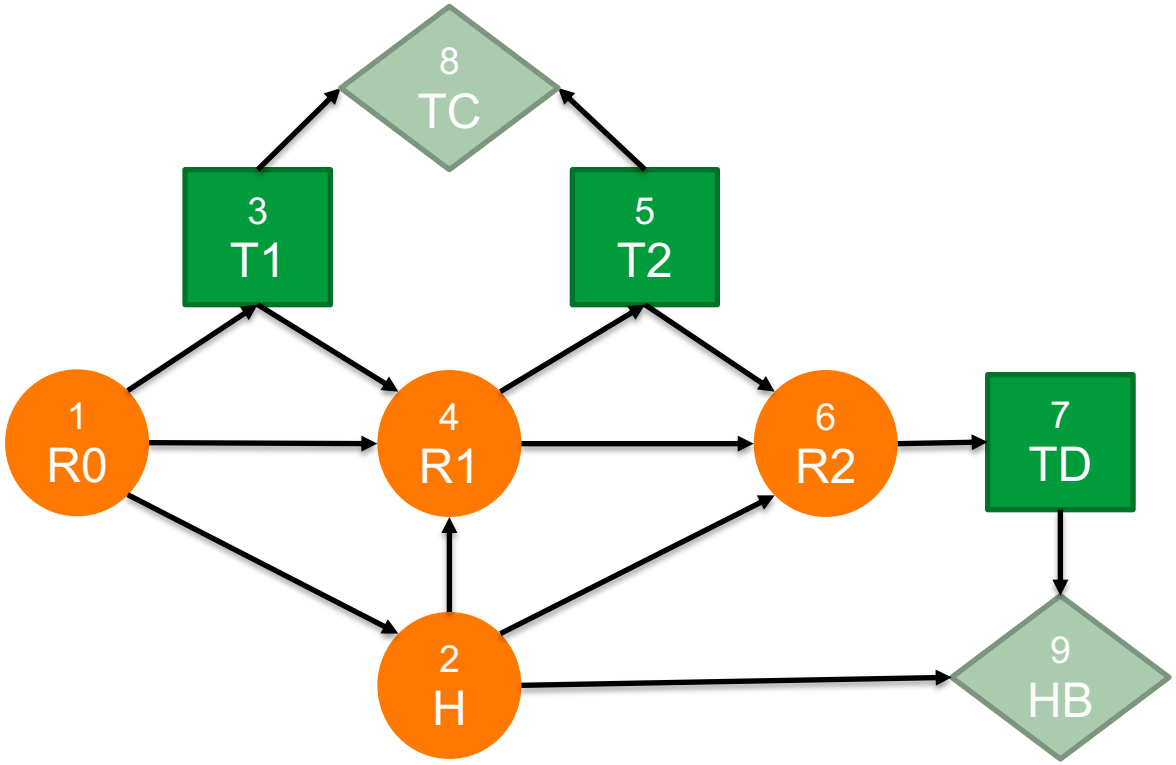
R0 prior risk estimate
R1 updated risk estimate
R2 second updated risk estimate

T1 first test decision
(TRS, GRS, no test)
T2 second test decision
(TRS, GRS, no test)

H health, i.e. whether the patient has a CHD event or not

TD treatment decision
(treat, no treatment)

Influence diagram



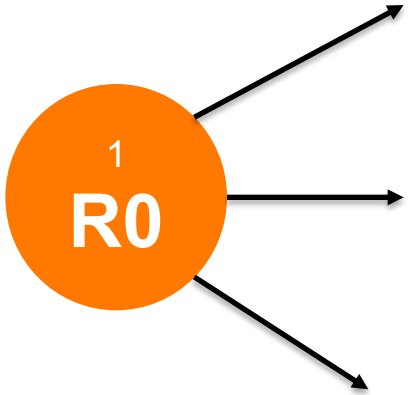
TC test costs

	TRS	GRS	TRS & GRS
Test cost (€)	173	200	373

HB health benefits

	Treated	Not treated
CHD	6.90	6.65
No CHD	7.65	7.70

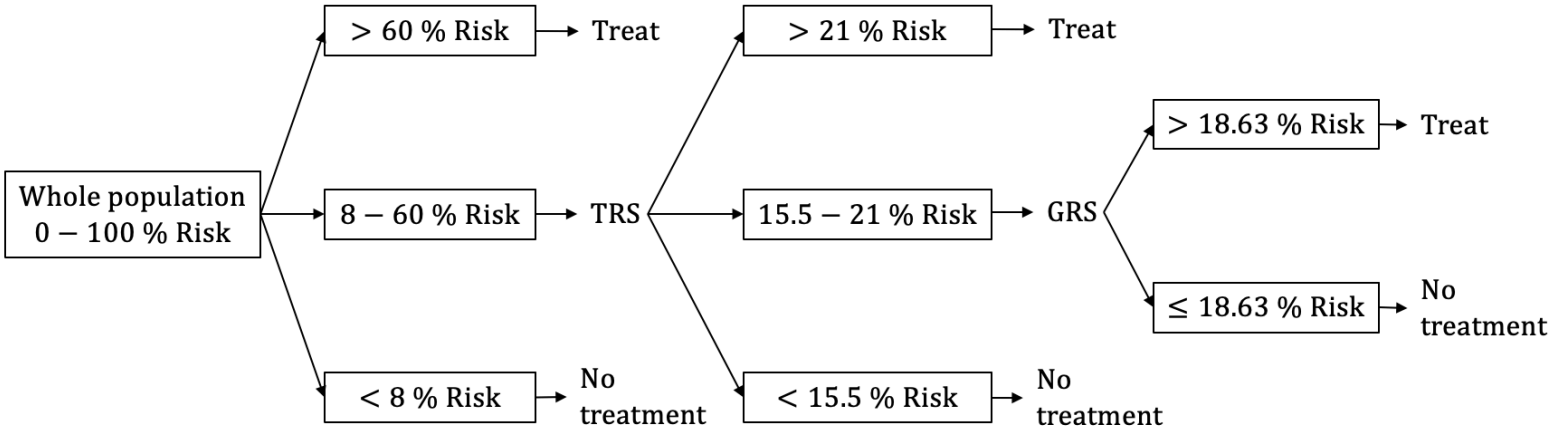
Model modifications



- Originally, the probabilities of the prior risk estimates were set according to the population risk distribution.
  - The model was computationally intractable.
- In response, the prior risk node *R0* was made deterministic.
  - Then, we had 101 subproblems – one for each prior risk estimate (0% - 100%).
  - The weighted sum of the objective values of the subproblems was the overall net monetary benefit. The population risk distribution was used in the weighting.

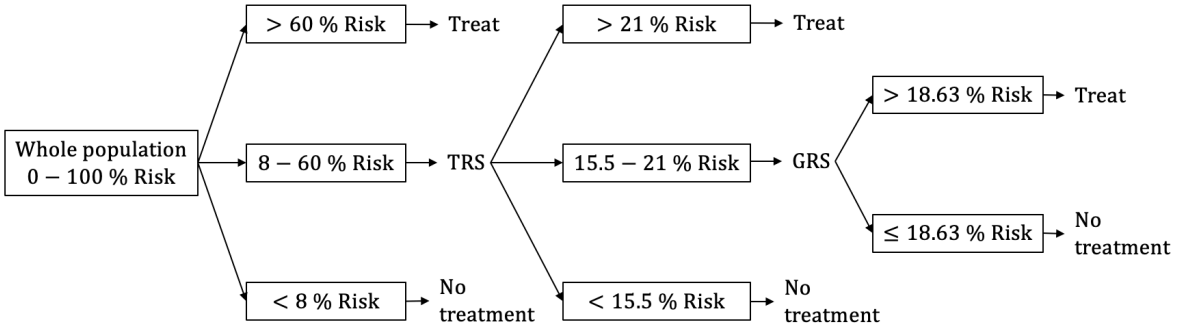
Results

The optimal decision strategy found using Decision Programming:



Results

Decision programming:



Dynamic programming:

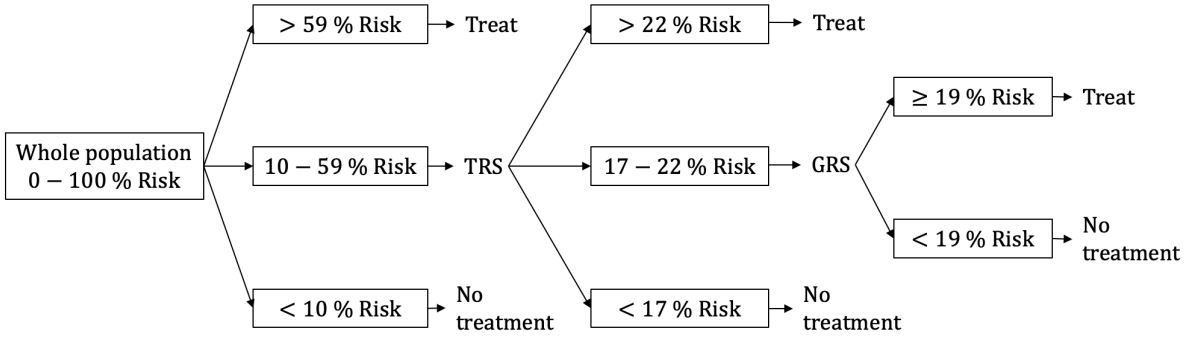


Figure adapted from Hynninen et al. (2019)

Conclusions

The Decision Programming framework was successfully applied to the problem in question.

Challenges arose from the model becoming computationally intractable. However, the 101 smaller subproblems were solvable.

The results found using Decision Programming were in line with those found by Hynninen et al. (2019).

References

- Tikkanen E, Havulinna AS, Palotie A, Salomaa V, Ripatti S. (2013) Genetic risk prediction and a 2-stage risk screening strategy for coronary heart disease. Arterioscler Thromb Vasc Biol. 2013; 33(9):2261–6. https://doi.org/10.1161/ATVBAHA.112.301120 PMID: 23599444

- Hynninen Y, Linna M, Vilkkumaa E. (2019) Value of genetic testing in the prevention of coronary heart disease events. PLoS ONE 14(1): e0210010. https://doi.org/10.1371/journal. pone.0210010