University of Glasgow | School of Computing Science

THE AWARDS 2020 | UNIVERSITY OF THE YEAR

Decision Curve Analysis

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WORLD CHANGING GLASGOW

Clinical Consequences

- Breast cancer detection as a use case:
  - A false-negative result is much more harmful than a false-positive result
  - A model with greater specificity but slightly worse sensitivity could have a better AUC
  - Worse choice for a clinical decision system for breast cancer detection

Decision Analysis

- Decision Trees
  - Assign probabilities and
- Explicit valuation of health outcomes
  - Number of complications prevented
  - Quality-adjusted life-years saved

A Simpler Method

For each model:

For p_t in range(a,b):

- Calculate the number of true- and false-positive results using p_t as the cut-point for determining a positive or negative result.

$$\boldsymbol{Net\ Benefit} = \frac{\boldsymbol{True\ Positives}}{\boldsymbol{N}} - \frac{\boldsymbol{False\ Positives}}{\boldsymbol{N}}\ \boldsymbol{x}\ \frac{p_t}{\mathbf{1} - p_t}$$

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- Plot net benefit on the y axis against p_t on the x axis.

- Repeat steps assuming all patients are positive

- Draw a straight line parallel to the x-axis at y=0 representing the net benefit associated with the strategy of assuming that all patients are negative

Decision Curve Analysis - Examples

- Prostate cancer with elevated PSA – intervention would mean a biopsy
- In patients with an infection – intervention would mean antibiotics
- In preventing heart disease – intervention might be statins/medication
- Decision curve analysis includes results for
    - ‘intervention for all’
    - ‘intervention for none’

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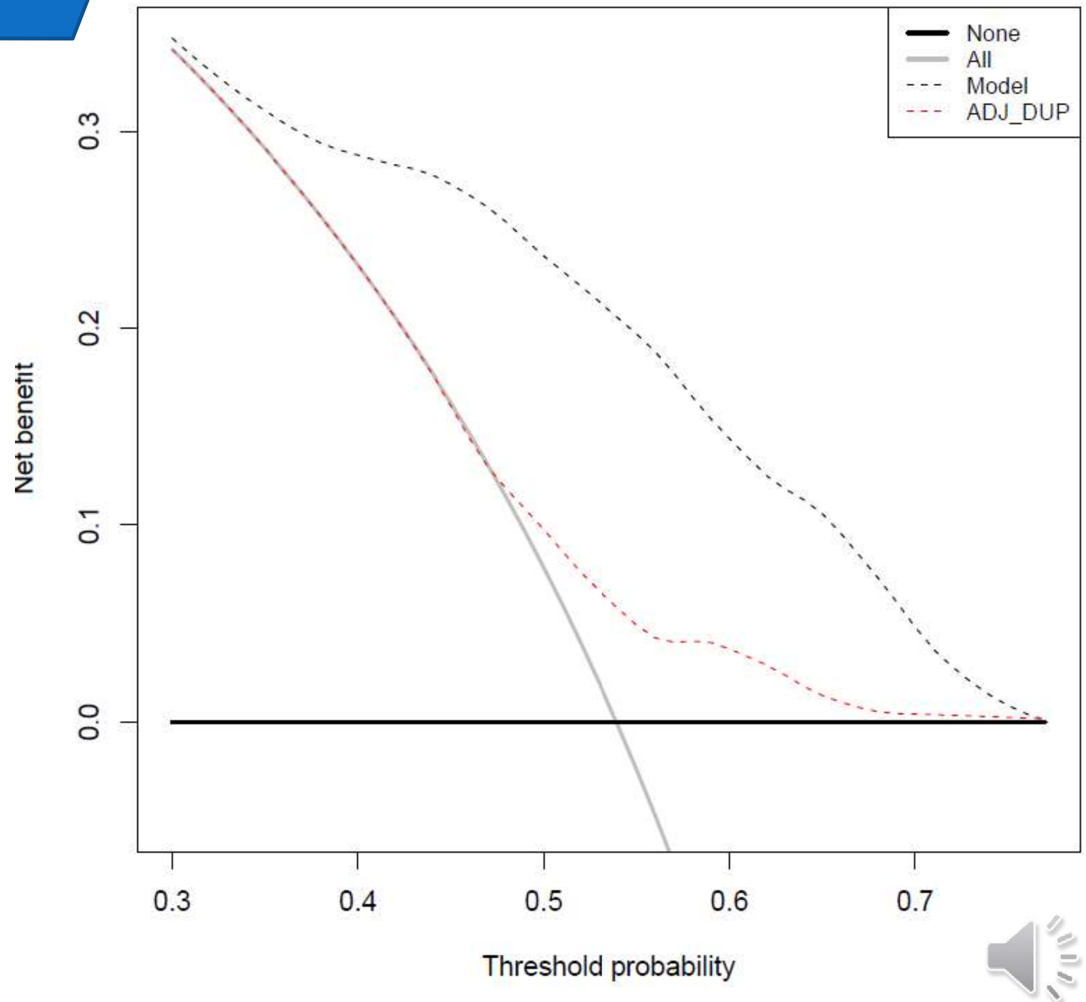
Decision Curve Analysis

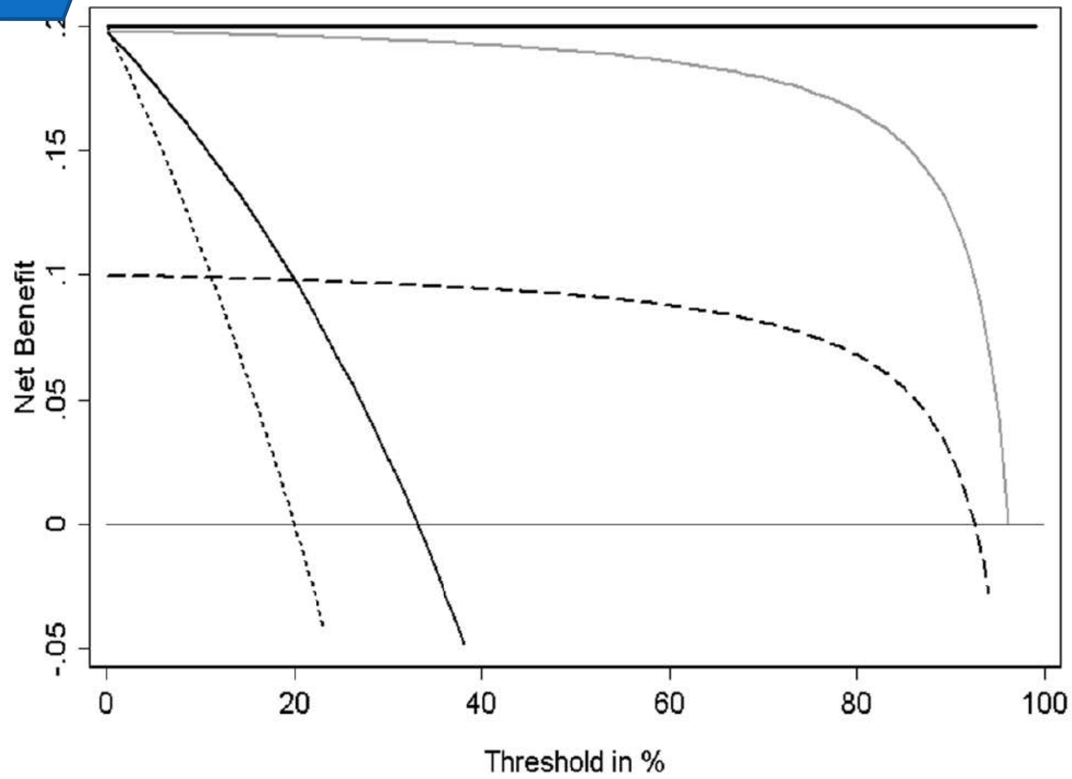
- Compare model with treating all positive, treating none or treating based on the duration of untreated psychosis alone
- Treatment probability threshold: 40-60%



Leighton et al. 2021

Theoretical Examples

- Disease incidence is 20%
- Sensitivity vs Specificity across threshold probabilities

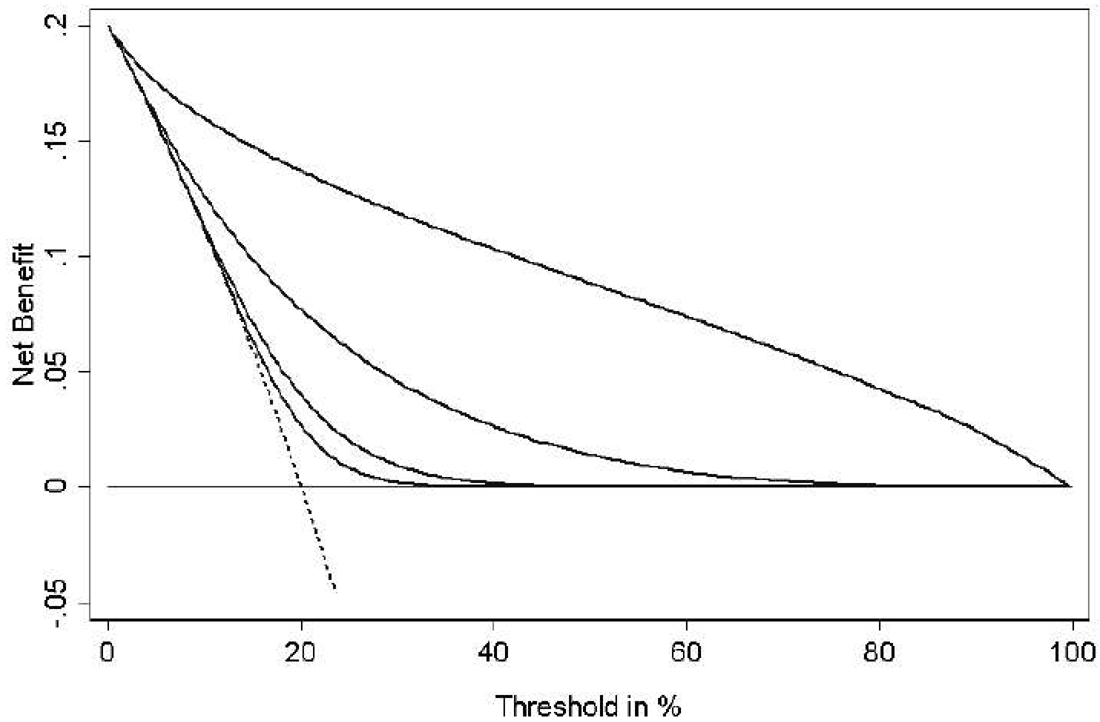


$$\textit{Net Benefit} = \text{sensitivity}\ x\ prevalence - (1 - specificity) x (1 - prevalance)\ x\ \frac{Threshold\ Probabilty}{1 - Threshold\ Probability}$$

Vickers et al. ‘Decision curve analysis: a novel method for evaluating prediction models’, 2006

Theoretical Examples

- Disease incidence is 20%
- Laboratory test, normally distributed



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Summary

- Incorporating clinical consequences is important in clinical decision models
- Clinical benefits can be easily quantified with decision curve analysis
- Decision curve analysis is an intuitive way to compare prediction models
- Decision curves do not replace other forms of validation and measures of accuracy

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