A Model-Based Clinical Decision Support Approach Using DEMATEL, ANP and TOPSIS

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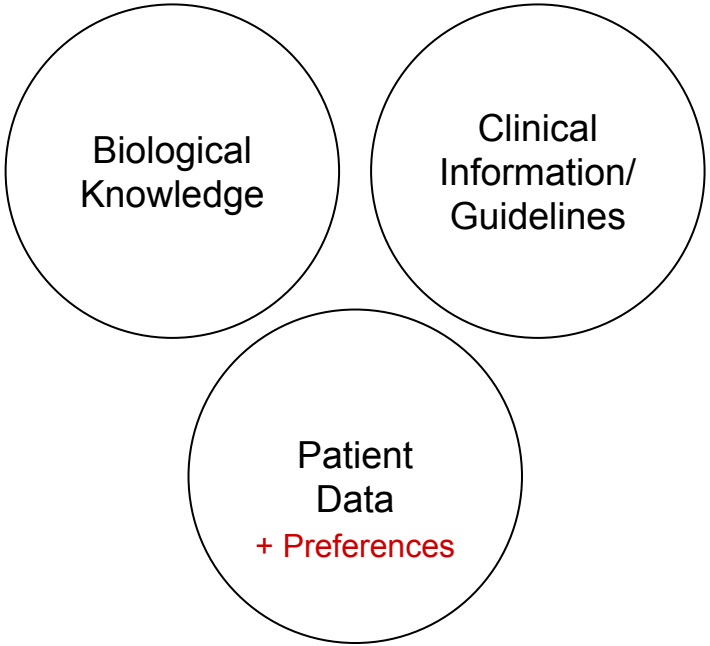
Overview

Paradigm change in healthcare:
From Delayed Interventions to Predictive, Preventive and Personalised Medicine (PPPM)

Non Trivial Medical Decisions



Post diagnosis

- Physicians construct a mental model of the patient
- Define treatment objective, options and criteria
- Analyse, interpret and integrate available data for the patient
- Consider subjective preferences of the patient
- Make tradeoffs between desired outcomes

Construction of a patient model

Based on

- Life expectancy (Age)
- Current stage of disease
- Natural history of disease
- Comorbidities
- and many other factors...

Prepare the decision framework

Define treatment objective, options and criteria

Available framework

- Adjustments might be needed for each patient
- Problem of discrete decisions

New framework

- Gather information
- Adopt an existing framework and modify
- Construct a new framework from scratch

Consider Patient Preferences

Available methods

- Brochures, videos, booklets and other info material
- Built separate from the rest of CDSS
- feeling unintuitive
- mostly can measure differences in decision making among clinicians and patients

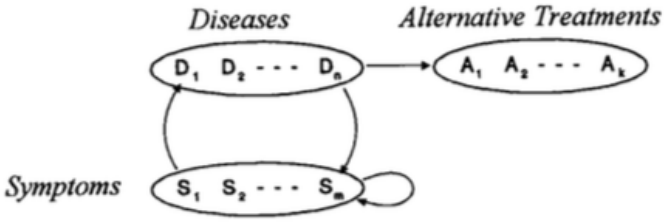


Figure 1 - Disease/Treatment Network

Saaty and Vargas (1998) showed how the AHP framework with dependence across levels in the hierarchy can incorporate expert judgment for medical diagnosis with or without statistical data.

The authors also showed that if expert judgment is unavailable, the approach produces results that agree with Bayes Theorem.

The application of the model to a case study involves a woman in her second trimester who is admitted to the hospital with specific symptoms. Four diagnoses were considered by the doctor given the set of symptoms.

The outcome is a compromise between the Bayesian approach which requires empirical evidence to make a diagnosis, and the more subjective clinical approach, in which physicians use experience, evidence, and environmental variables to diagnose patients.

SAATY:
These judgments can be substituted for statistical frequencies obtained by observing the symptoms more prevalent for each disease when compared with every other symptom.

Since statistical data do not characterize individuals, it is essential to adjust such data to specific situations by taking into account patient specific data.

The judgments can take into account the physician’s perception of how statistical data change from patient to patient.

Methods

Model-Based Clinical Decision Support

Combining different MCDA methods

DEMATEL

Decision-Making Trial and Evaluation Laboratory

DEMATEL

A comprehensive method for building and analysing a structural model involving causal relationships between complex factors.

Since human judgment about preferences are often unclear and hard to estimate, fuzzy numbers are used.

ANP

Analytic Network Process

ANP

An ANP-based system is a network that replaces single direction relationships among decision levels with dependence and feedback.

Fuzzy numbers are used for handling problems characterized by vagueness and imprecision.

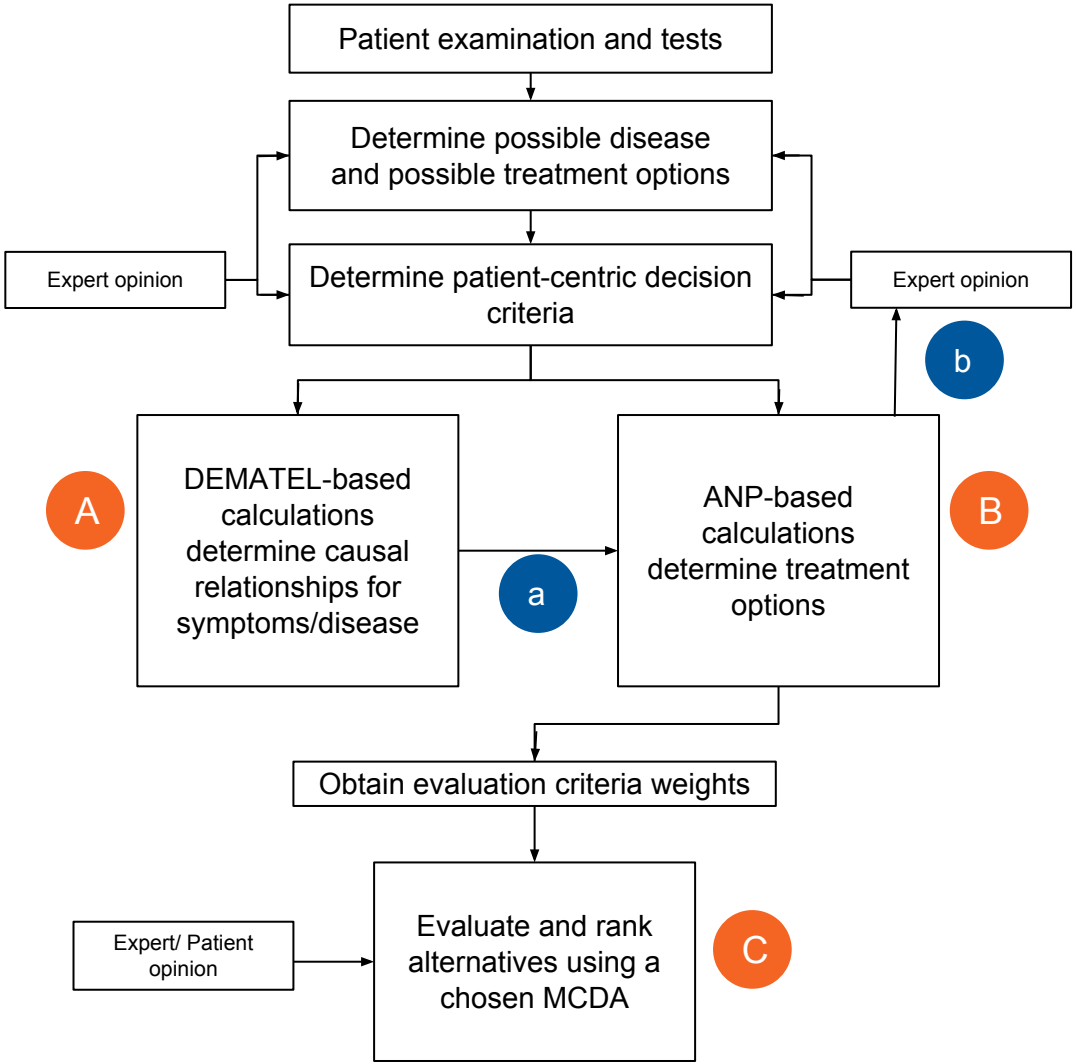
TOPSIS

The Technique for Order Preference by Similarity to Ideal Solution

TOPSIS

A multiple criteria method to identify solutions from a finite set of alternatives.

Simple to use since only ideal and non-ideal judgements are required. The weights for the criteria will be derived from the previous two methods.



DEMATEL determines factors of order, direction and level, in the complex causal relationship, without prioritization of the important factors; hence, a complete feedback system must factor in the need to consider the importance and the relationships among factors.

If we only consider the causal relationship, we will ignore the importance of the factors that influence the velocity or degree of change, different levels of actual factors; and if we only consider the important factors, the factors and feedback mechanism of discrete implicit relationships among the important factors may incorrectly be deemed important factors of equal importance; hence in addition to DEMATEL, it is essential to include ANP in an integrated approach.

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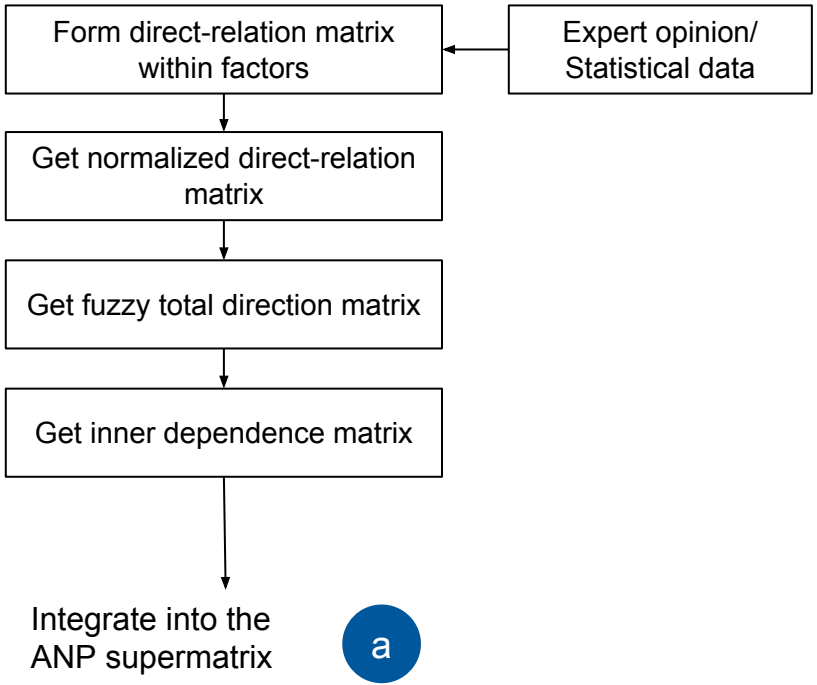
Form direct-relation matrix within factors
Expert opinion/ Statistical data
Get normalized direct-relation matrix
Get fuzzy total direction matrix
Get inner dependence matrix
Integrate into the ANP supermatrix
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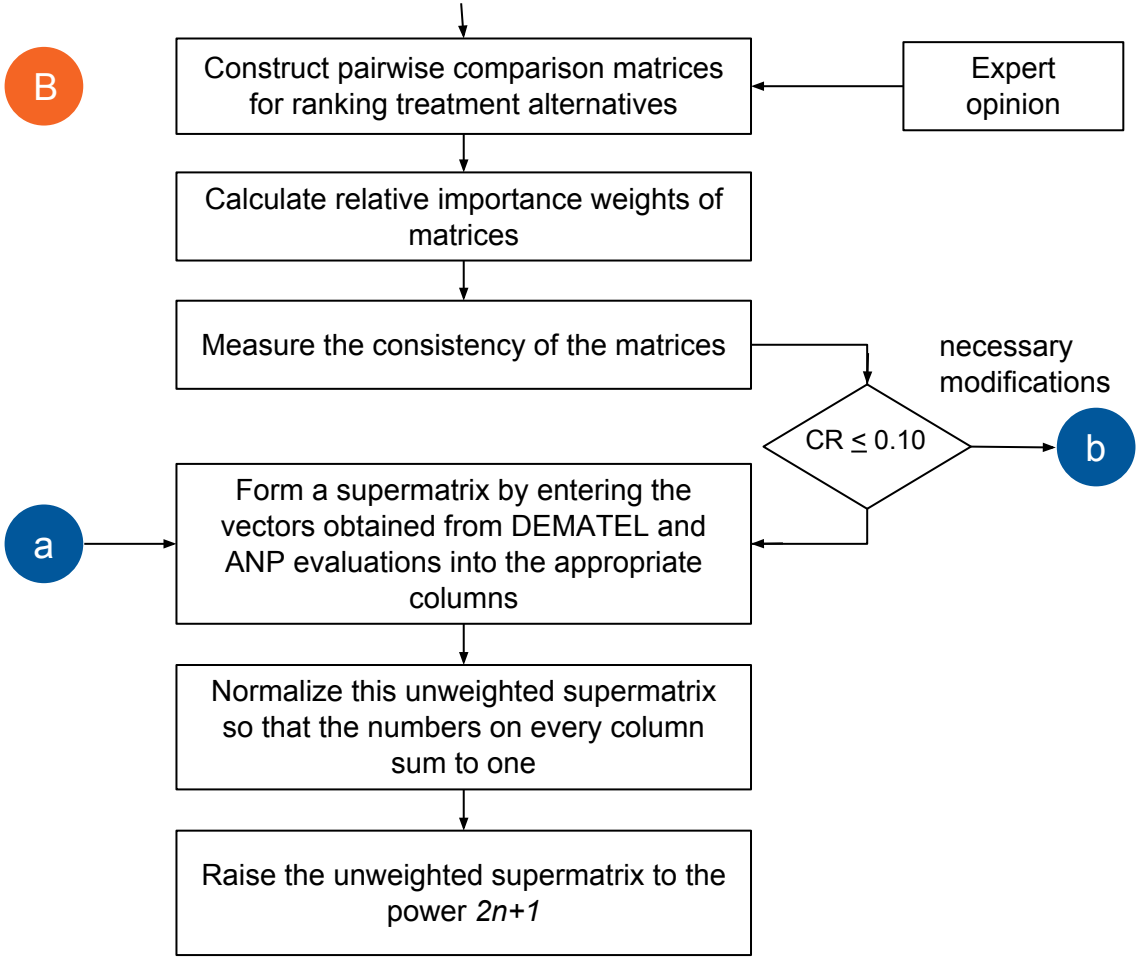

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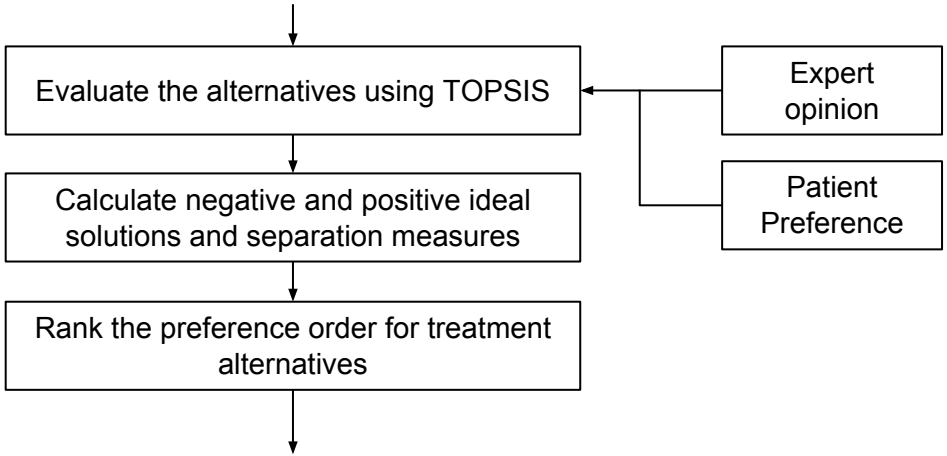
Evaluate the alternatives using TOPSIS
Expert opinion
Patient Preference
Calculate negative and positive ideal solutions and separation measures
Rank the preference order for treatment alternatives
Choosing an alternative

Next

Digging for Improvements

Expectations and evaluations

- A need to be as objective as possible - remove need for expert opinion - supplementing data driven opinion
- DEMATEL outputs a network-relation-map: better visualization
- Weights provided for ANP
- Patient-specific information separated from biological data
- Shared decision making

Discussion

Ideas for future research