Bayesian Belief Network Model of a Clinical Caremap: Implementation of the Radical Prostatectomy Caremap in MET Support Environment

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Outline

- Clinical Caremap
- Bayesian Belief Network (BBN)
- Radical Prostatectomy Caremap (RPC)
- BBN Model for RPC
- MET Decision Support Environment
- Mobile Caremap Monitor (MCM) – Implementation Using Ontological Engineering
- Discussion

Clinical Caremap

- Represents sequencing and timing of interventions for a particular clinical presentation
- Designed to minimize delays and resource utilizations and to maximize the quality of care
- Used to monitor and control patient's progress measured according to standard process and clinical outcomes, e.g., length of stay (LOS)

Radical prostatectomy caremap (RPC) describes patient's management from a post-op to a fourth day of stay in the hospital

Bayesian Belief Network (BBN)

- Models a stochastic process composed of the events with associated conditional probabilities and relationships between these events.
- Generates an answer to conditional-type queries, e.g., considering the patient's health status on a given day, what impact would X have on meeting the expected day of discharge

BBN Model for the RPC – Variables

- Independent variables describing the patient's state on a specific post-op day

	Day 1	Day 2	Day 3
Psychological condition	√		
Vital signs	√	√	√
Temperature		√	√
Activity with the RPC	√	√	√
Nutrition with the RPC		√	√
Nutrition outcome	√	√	√
Pain at rest	√	√	√

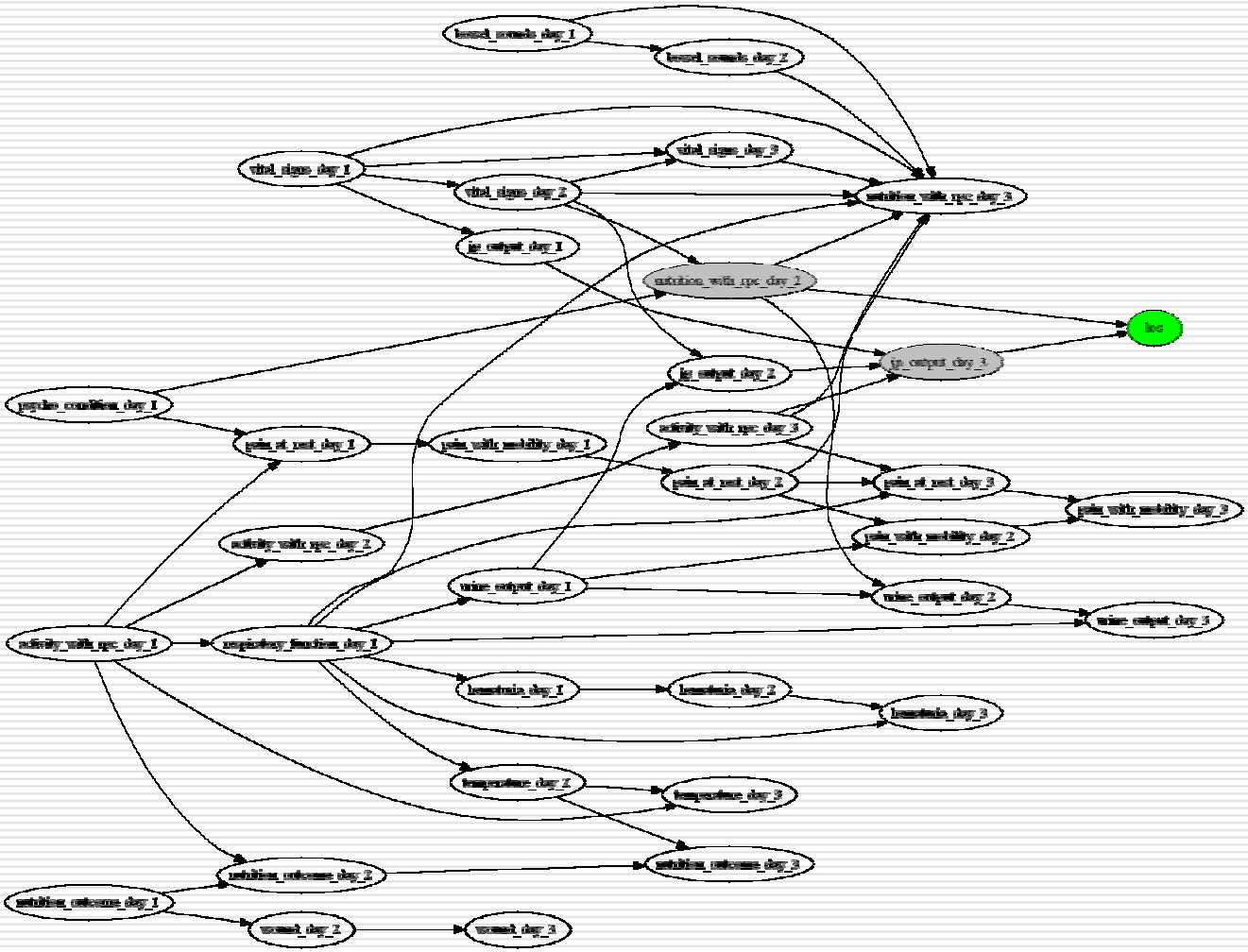
	Day 1	Day 2	Day 3
Respiratory function	√		
JP output	√	√	√
Evidence of hematuria	√	√	√
Urine output	√	√	√
Bowel sounds	√	√	
Pain with mobility	√	√	√
Wound		√	√

- Dependent variable describing clinical outcome
  - LOS (*met* if 4 days or shorter, *delayed* otherwise)

BBN Model for the RPC – Knowledge Discovery

- Learning data set
  - 75 patients managed by various clinical teams between 2002 and 2003 at the Ottawa Hospital – Civic Campus
  - Data transcribed from patient's files and evaluated by urology specialists for consistency and correctness
- Learning method
  - K2 algorithm (implemented in Bayesware Discoverer) used to build the BBN structure and calculate the conditional probabilities

BBN Model for the RPC – Structure



BBN Model for the RPC – Verification

- Testing data set
  - 50 patients managed by various clinical teams between 2002 and 2003 at the Ottawa Hospital – Civic Campus
  - Independent from the learning set
  - Data reviewed according to the same regimen as learning data set

- Test results:
  - Overall accuracy: 82%
  - Accuracy for predicting LOS *met* : 90%
  - Accuracy for predicting LOS *delayed* : 65%

MET Decision Support Environment

- Decision support environment for applications supporting various clinical decision problems
  - Triage of acute pain (abdomen, scrotum, hip)
  - Triage of asthma exacerbations
- Easily adaptable to support any other clinical decision problem
- Accessible on a variety of computing platforms when and where required – ubiquitous support
- Designed according to the anytime & anywhere architecture (A^3)

A^3 Architecture

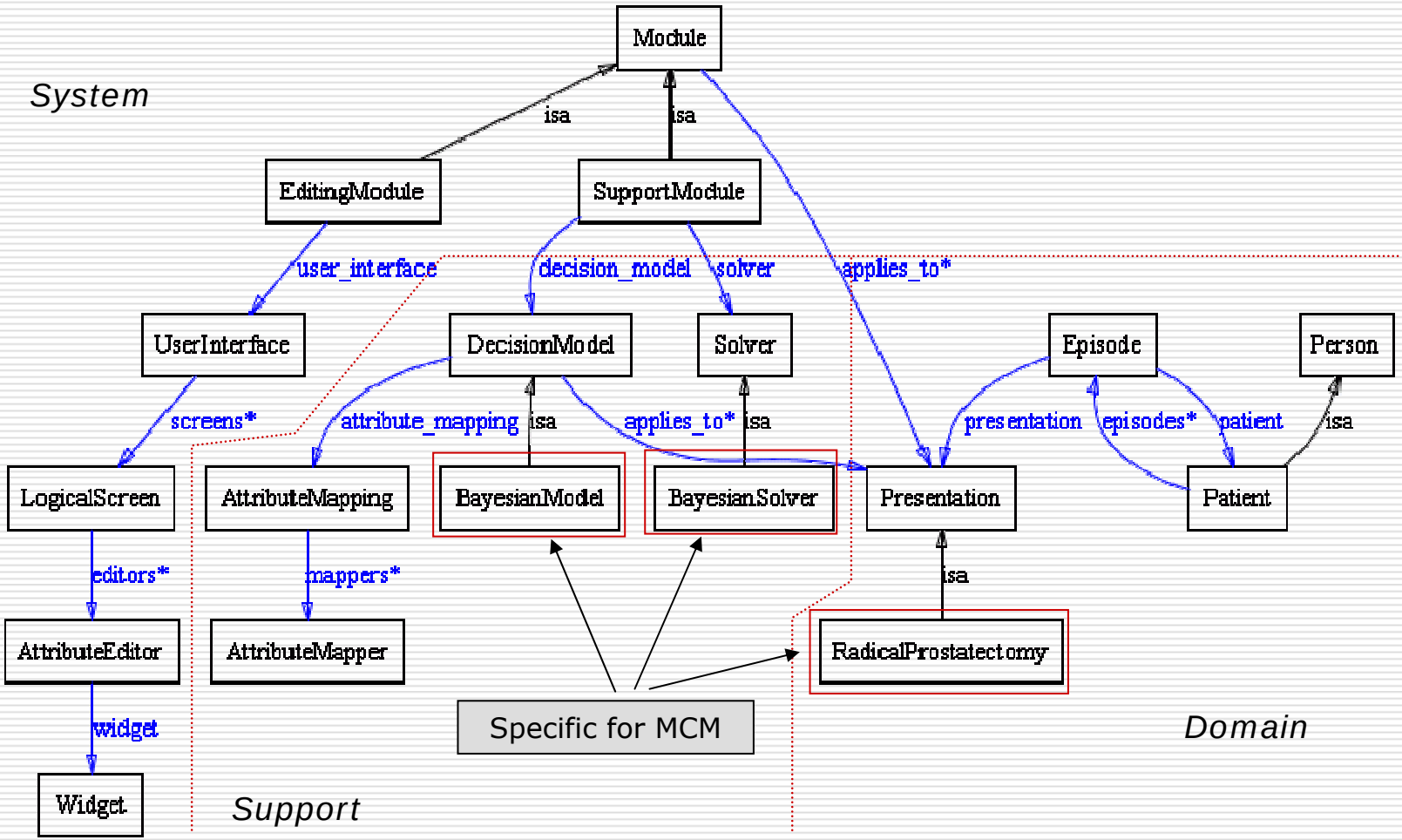
- Relies on logical models of domain, support and system components and models of access platforms
- Specific applications (for a given decision problem and access platform) are rendered on demand from these logical models
- Logical models are represented as ontologies divided into several areas (referring to specific models)
  - Domain (patients, episodes, presentations)
  - Support (decision models and solvers)
  - System (user interface and application modules)

Mobile Caremap Monitor (MCM)

- New application within the MET environment
- Allows estimating variances from the RPC
- Easily expandable to support caremaps for other clinical presentations

- Ontological model for the MCM is built from the MET generic ontology and specialized for the RPC

Ontological Model of the MCM – Structure



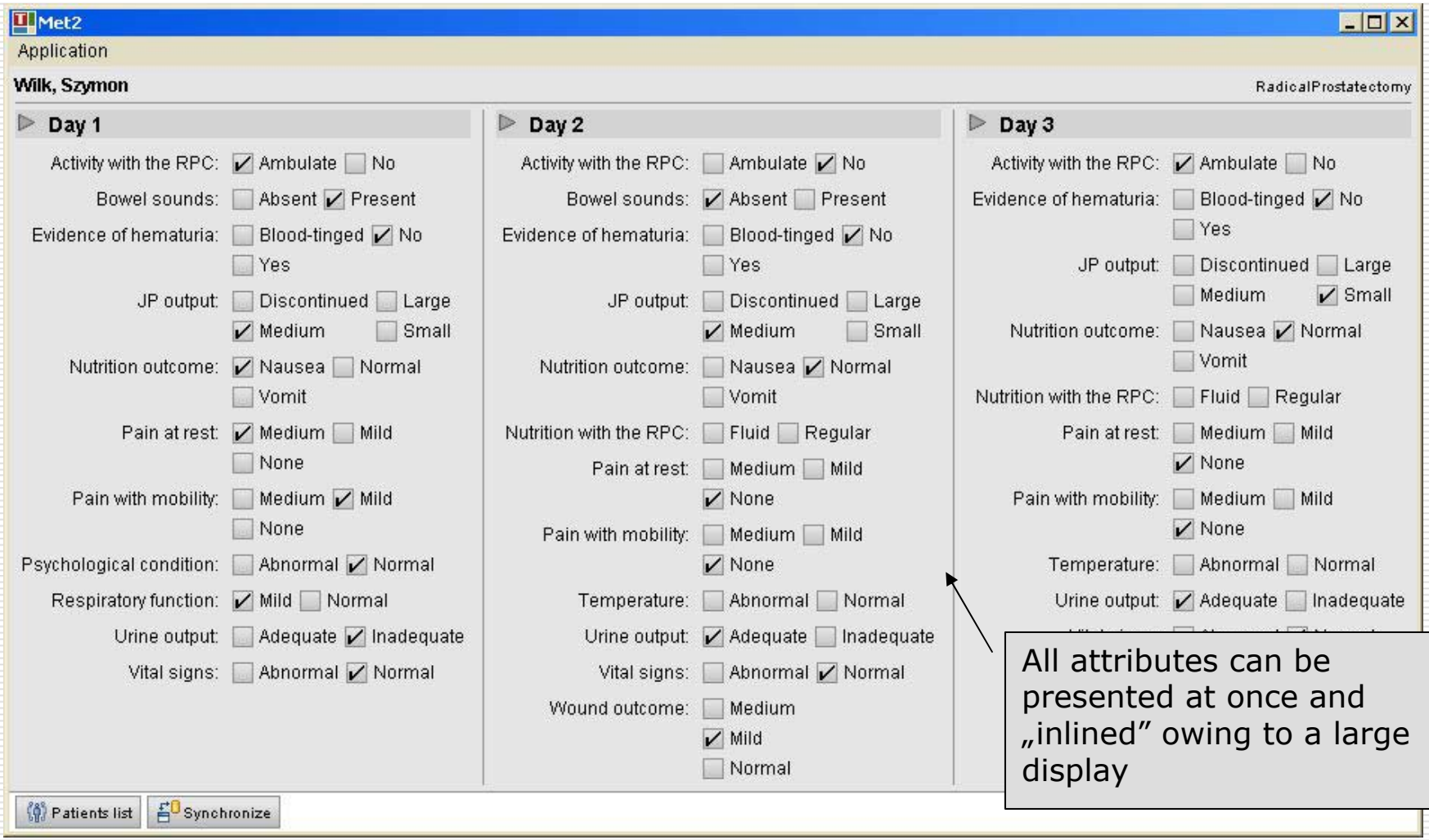
Ontological Model of MCM – Description (1)

- Domain
  - A single patient can have several episodes (e.g., visits in the ED or hospitalizations)
  - Each episode is bound to a single clinical presentation
- Support
  - Decision model contains the knowledge necessary to support a clinical presentation
  - Solver instantiates model using actual data to arrive at a solution
  - Attribute mappers pre-process values of attributes according to the requirements of decision models

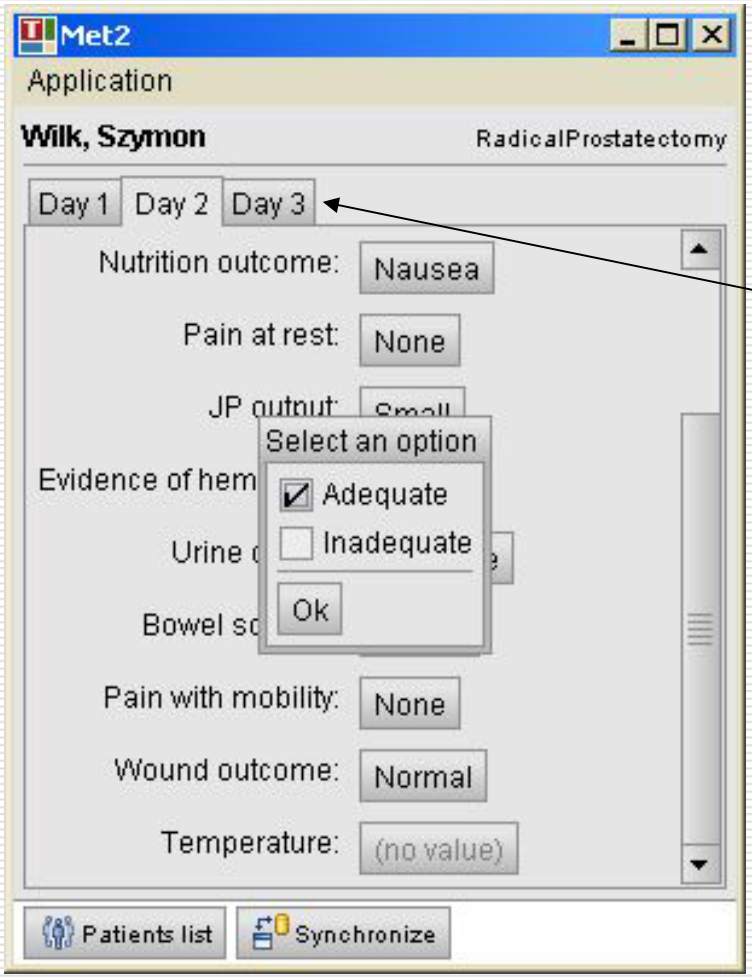
Ontological Model of MCM – Description (2)

- System
  - Editing modules manage user interface for presenting and modifying patient's data
  - Support modules provide support functionality for clinical presentations
  - User interface renderers lay-out and manage logical screens
  - Logical screens group and manage several attribute editors
  - Attribute editors bind specific widgets (editing tools) to specific attributes

MCM in Action – Desktop computer



MCM in Action – Handheld Device



Tabs and pop-up dialogs are used to fit the interface on a small display

Discussion

- BBN adequately models the RPC and very well describes probabilistic inferences, as verified on testing data set
- MET decision support environment is rich enough to include the MCM
- Ontological engineering provides necessary high level abstract models to capture intertwined nature of clinical domain description and clinical domain support

Acknowledgments

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Thank You

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