Evaluation Dimensions and Subcategories for the MGCDS Domain

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| **Dimension and Categories** | **Explanation** |
| *Automated detection of adverse interactions between clinical guidelines* (DET).  Although there are cases where clinical guidelines include multimorbidity recommendations, they typically do not state all potential conflicts and interactions. The DET dimension characterizes the automated detection of multimorbidity interactions (e.g., drug-drug, drug-condition) and conflicts (e.g., starting/stopping the same drug). Hence, it covers functional features related to detection (A1-A7). | |
| Complex reasoning over medical knowledge | External (i.e., non-CPG) knowledge sources contain a wealth of knowledge about, among other things, physiological effects of treatment (e.g., anticoagulation). By annotating CIG tasks with knowledge terms, such as treatment, duration, and modifiers (e.g., increase/decrease), reasoning processes can thus detect conflicting tasks. |
| Querying data sources | External data sources such as DrugBank, DrugCentral, DDInter [41] and AEOLOUS contain validated information on drug-drug interactions (DDI) and drug-condition interactions (DCI). By annotating CIG tasks with drug and condition terms from relevant taxonomies, MGCDS methods can automatically query these sources to find DDI and DCI. |
| *Representation of MGCDS management strategies* (STRAT)*.*  An MGCDS method applies management strategies to detect and/or mitigate conflicts and adverse interactions for a given multimorbidity. The STRAT dimension characterizes the representation of these management strategies, and thus covers detection and mitigation features (A1-A7). | |
| Adaptation constructs | Adaptation constructs represent generic strategies to manage common multimorbidity issues (e.g., overlapping conflicting tasks) by adapting the underlying single-disease CIG. A construct includes an (a) detection part, identifying the type of conflict, and (b) mitigation part, which adapts the CIG in such a way to avoid the issue. A clinician manually instantiates a construct to manage the particular issue for a given multimorbidity. A separate engine is needed to execute the instantiated constructs. |
| Pre-defined algorithms | These custom algorithms implement pre-defined, generic detection and mitigation strategies to manage multimorbidity issues. In contrast to adaptation constructs, the predefined custom algorithms do not require manual instantiation. |
| CIG language modules | A set of separate modules, written using the CIG formalism itself, is manually authored to manage specific multimorbidity conflicts. |
| *Implementation paradigms for MGCDS* (IMPL)*.*  To implement the mitigation of detected multimorbidity conflicts, MGCDS methods often reuse and tailor automated planning, graph-based or logical reasoning paradigms. The IMPL dimension characterizes the utilized implementation paradigm, and covers all mitigation features (B1-B8). | |
| Automated planning | A planning approach can generate a globally optimal plan, such as a multimorbidity care plan or temporal task schedule that solves the multimorbidity problem for a patient. In particular, planning optimizes a multivariate objective function that encodes patient safety, finances, and/or preferences where factors can be weighted. This category includes planners based on Constraint Satisfaction Methods, Local Search, Hierarchical Task Networks, PDDL implementations (e.g., OPTIC) and any other planning mechanism. |
| Graph-based algorithms | Graph-based algorithms leverage the graph structure of CIG workflows to find conflict-free treatment plans. Examples include a backtracking-style algorithm that follows alternative branches at decision nodes to search for conflict-free treatment plans. |
| Logic-based foundations | Logical formalisms, including First Order Logic, Constraint Logic Programming, Description Logic, and Transaction Logic, have been utilized to solve the multimorbidity problem. |
| *Human-in-the-loop mitigation support* (HUM).  Some MGCDS methods support explicit interaction with clinicians to help find treatment plans; explanations can be provided to support these interactions. We further observed push- and pull-based modes of use. The HUM dimension characterizes these human-in-the-loop aspects, and covers detection and mitigation features (A1-A7, B1-B8). | |
| Explanations for recommendations | Explanations can clarify the reason for a detected conflict or mitigation strategy. |
| Mitigation support for clinicians | This dimension concerns concrete tools that can be directly utilized by clinicians as non-programmers. |
| Mode of use: Pull-based | Most evaluated MGCDS methods follow a pull-based, user-initiated paradigm: clinicians input relevant multimorbidity CIG and patient health data, and utilize the method to detect interactions and apply mitigations (i.e., “passive” delivery). |
| Mode of use: Push-based | A push-based, system-initiated paradigm (“active” delivery) where actions are undertaken as new lab results or health data becomes available. |