

## 4 Guideline 2 - Hypertension

### 4.1 Combining Drugs

... Please model the decision to add another antihypertensive drug in a modular way, that will take into account that there may be other indications, contraindications, and drug interactions that may later be added into the model. The model should be constructed in such a way that will enable adding these without changing the way the decision model is represented.

Asbru does not include a reasoning module or domain ontology to implement such reasoning as the selection of the optimal drug class based on a set of relations. However, there are ways to integrate domain specific reasoning modules (DSRMs) into a plan library (e.g., `function-def` and `function-call`).

We are also considering to incorporate an interface to Jess [21] into the execution unit. This will allow the implementation of a little knowledge base like the one discussed here in a CLIPS-style representation. There was already a student project to evaluate Jess [22] but further steps depend on the development of the execution unit, of course.

In our solution for this comparison, we assume an external reasoning module containing the lists of drugs and indications (diseases) as well as the relations indication, contra-indication, relative-indication, relative-contra-indication, good-partner, and bad-partner. It is queried through a function call.

The part of the solution expressed in Asbru consists of the declaration of the function `propose-partner` taking both `indication` and `first-drug` as an argument and returning the name of the proposed drug (i.e., drug class) which is displayed as an argument of the user-performed plan `administer-drug`. Both indication and first drug are taken from the patient record. All these steps are contained in plan `administer-second-drug`.

```
...
<patient-record-def name="patient-record">
  <primary-key name="name"/>
  <field-def name="indication" type="String"/>
  <field-def name="first-drug" type="String"/>
</patient-record-def>
...
<function-def class-name="asgaard.addins.DrugReasoner"
              method-name="ProposePartner"
              name="propose-partner"
              return-type="String">
  <argument name="indication" type="String"/>
  <argument name="first-drug" type="String"/>
</function-def>
...
<plan name="propose-second-drug">
  <value-defs>
    <variable-def name="second-drug" type="String"/>
  </value-defs>
  <plan-body>
    <subplans type="sequentially">
      <wait-for>
        <all/>
      </wait-for>
      <plan-activation>
        <plan-schema name="administer-drug">
```

```

    <argument-value name="proposed-drug">
      <function-call name="propose-partner">
        <argument-value name="indication">
          <field-ref field="indication" record="patient-record"/>
        </argument-value>
        <argument-value name="first-drug">
          <field-ref field="first-drug" record="patient-record"/>
        </argument-value>
      </function-call>
    </argument-value>
  </plan-schema>
</plan-activation>
</subplans>
</plan-body>
</plan>
<plan name="administer-drug">
  <explanation text="The proposed drug is $1."/>
  <arguments>
    <argument name="proposed-drug" type="String"/>
  </arguments>
  <plan-body>
    <user-performed/>
  </plan-body>
</plan>

```

## 4.2 Controlling Blood Pressure

The goal of the (new) anti-hypertensive treatment discussed in recommendation (1) is to control blood pressure to

- less than 140/90 mm Hg (systolic BP below 140 mm Hg and diastolic BP below 90 mm Hg).
- For patients with Diabetes Mellitus, the blood pressure should be controlled to below 130/85 mm Hg.
- Blood pressure should be controlled to 125/75 in patients with proteinuria in excess of 1 gram per 24 hours,
- and to 130/85 mm Hg in patients with proteinuria with at most 1 gram per 24 hours with whatever anti-hypertensive therapy is necessary.

This boils down to the following values for the limit between normal and high blood pressure.

Context	Systolic	Diastolic
normal/default	140	90
Diabetes Mellitus	130	85
Proteinuria > 1g/24h	125	75
Proteinuria ≤ 1g/24h	130	85

We therefore defined two `raw-data`-parameters `numerical-x-blood-pressure` which contain the values entered by the user and qualitative abstractions thereof named `x-blood-pressure`. They contain one of only two values: `normal` and `high`. There should also be a `low` value, but this guideline deals with high blood pressure only and we did not investigate limits on our own.

Having abstracted the values for blood pressure, the intention of the overall plan `hypertension-treatment` simply becomes "achieve normal blood pressure (both systolic and diastolic) within one

month". The limit of one month is our guess, various domain experts will assume other temporal limits.

```

<qualitative-scale-def name="blood-pressure">
  <qualitative-entry entry="normal"/>
  <qualitative-entry entry="high"/>
</qualitative-scale-def>
<parameter-group>
  <parameter-def name="numerical-systolic-blood-pressure"
    type="pressure">
    <raw-data-def mode="manual"
      unit="mmHg"
      user-text="Please enter the systolic blood pressure"/>
  </parameter-def>
  <parameter-def name="systolic-blood-pressure"
    type="blood-pressure">
    <qualitative-parameter-def>
      <limits>
        <comment text="for a healthy person"/>
        <context>
          <context-combination operator="and">
            <context-not>
              <context-ref name="diabetes-mellitus"/>
            </context-not>
            <one-of name="proteinuria">
              <value-ref name="none"/>
            </one-of>
          </context-combination>
        </context>
        <limit-entry value="0"/>
        <limit-entry include-limit-value="yes" value="140"/>
        <positive-infinite/>
      </limits>
      <limits>
        <comment text="for Diabetes Mellitus and high Protienuria"/>
        <context>
          <context-combination operator="and">
            <context-ref name="diabetes-mellitus"/>
            <one-of name="proteinuria">
              <value-ref name="high"/>
            </one-of>
          </context-combination>
        </context>
        <limit-entry value="0"/>
        <limit-entry include-limit-value="yes" value="130"/>
        <positive-infinite/>
      </limits>
      <limits>
        <comment text="for low Protienuria"/>
        <context>
          <context-combination operator="and">
            <context-not>
              <context-ref name="diabetes-mellitus"/>
            </context-not>
          </context-combination>
        </context>
      </limits>
    </qualitative-parameter-def>
  </parameter-def>
</parameter-group>

```

```

        <one-of name="proteinuria">
            <value-ref name="low"/>
        </one-of>
    </context-combination>
</context>
<limit-entry value="0"/>
<limit-entry include-limit-value="yes" value="125"/>
<positive-infinite/>
</limits>
<parameter-ref name="numeric-systolic-blood-pressure"/>
</qualitative-parameter-def>
</parameter-def>
<parameter-def name="numerical-diastolic-blood-pressure" type="pressure">
    <raw-data-def mode="manual"
        unit="mmHg"
        user-text="Please enter the diastolic blood pressure"/>
</parameter-def>
<parameter-def name="diastolic-blood-pressure" type="blood-pressure">
    <qualitative-parameter-def>
        <limits>
            <comment text="for a healthy person"/>
            <context>
                <context-combination operator="and">
                    <context-not>
                        <context-ref name="diabetes-mellitus"/>
                    </context-not>
                    <one-of name="proteinuria">
                        <value-ref name="none"/>
                    </one-of>
                </context-combination>
            </context>
            <limit-entry value="0"/>
            <limit-entry include-limit-value="yes" value="90"/>
            <positive-infinite/>
        </limits>
        <limits>
            <comment text="for Diabetes Mellitus and high Protienuria"/>
            <context>
                <context-combination operator="and">
                    <context-ref name="diabetes-mellitus"/>
                    <one-of name="proteinuria">
                        <value-ref name="high"/>
                    </one-of>
                </context-combination>
            </context>
            <limit-entry value="0"/>
            <limit-entry include-limit-value="yes" value="85"/>
            <positive-infinite/>
        </limits>
        <limits>
            <comment text="for low Protienuria"/>
            <context>
                <context-combination operator="and">
                    <context-not>

```

```

        <context-ref name="diabetes-mellitus"/>
    </context-not>
    <one-of name="proteinuria">
        <value-ref name="low"/>
    </one-of>
</context-combination>
</context>
<limit-entry value="0"/>
<limit-entry include-limit-value="yes" value="75"/>
<positive-infinite/>
</limits>
<parameter-ref name="numeric-diastolic-blood-pressure"/>
</qualitative-parameter-def>
</parameter-def>
</parameter-group>
...
</domain>
</domain-defs>
<plans>
    <plan-group>
        <plan name="hypertension-treatment">
            <intentions>
                <intention type="overall-state" verb="achieve">
                    <parameter-proposition parameter-name="systolic-blood-pressure">
                        <value-description type="equal">
                            <qualitative-constant value="normal"/>
                        </value-description>
                        <context>
                            <any/>
                        </context>
                        <time-annotation>
                            <time-range>
                                <starting-shift>
                                    <latest>
                                        <numerical-constant unit="month" value="1">
                                            <comment text="This is only our guess ;-)" />
                                        </numerical-constant>
                                    </latest>
                                </starting-shift>
                            </time-range>
                            <self/>
                        </time-annotation>
                    </parameter-proposition>
                </intention>
                <intention type="overall-state" verb="achieve">
                    <parameter-proposition parameter-name="diastolic-blood-pressure">
                        <value-description type="equal">
                            <qualitative-constant value="normal"/>
                        </value-description>
                        <context>
                            <any/>
                        </context>
                        <time-annotation>
                            <time-range>

```

```
    <starting-shift>
      <latest>
        <numerical-constant unit="month" value="1">
          <comment text="This is only our guess ;-)" />
        </numerical-constant>
      </latest>
    </starting-shift>
  </time-range>
  <self />
</time-annotation>
</parameter-proposition>
</intention>
</intentions>
</plan>
</plan-group>
</plans>
</plan-library>
```

## References

- [21] Friedman-Hill, E.J.: Jess, The Java Expert System Shell. See <http://herzberg.ca.sandia.gov/jess/>.
- [22] Lackner, M., Trummer, M.: Jess Markup Language, Vienna University of Technology, Institute of Software Technology, Vienna, Technical Report, Asgaard-TR-2000-4, 2000, available at <http://www.ifs.tuwien.ac.at/asgaard/Technical-Reports/Asgaard-TR-2000-4.pdf>