

Report on KIV formalisation of jaundice protocol

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Plan

- KIV in a nutshell (revisited)
- KIV formalisation of Asbru (revisited)
- The jaundice protocol in KIV
- Conclusions



KIV in a nutshell (revisited)

- Features:
 - modularity, user interaction, management tools
 - language:
 - algebraic+procedural specifications
 - rich set of programming constructs
 - sequential programs: := , SKIP, ABORT, VAR, IF, WHILE
 - parallel programs: $\parallel$, AWAIT, OR, ATOM
- ...with programming constructs for Asbru:
 - BREAK (interrupts)
 - $\parallel$ s (synchronous execution)
 - $\parallel$ a (any order sequential execution)

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KIV formalisation of Asbru

- Based on plan-to-program mapping:
 - mapping of plan conditions:
 - FILTER PRECONDITION ϕ body $\rightarrow$ AWAIT ϕ ; body
 - COMPLETE/ABORT CONDITION ϕ body $\rightarrow$ BREAK body IF ϕ
 - ACTIVATE MODE manual body $\rightarrow$ VAR time0=time, dt=[?] AWAIT time0+dt $\leq$ time; body

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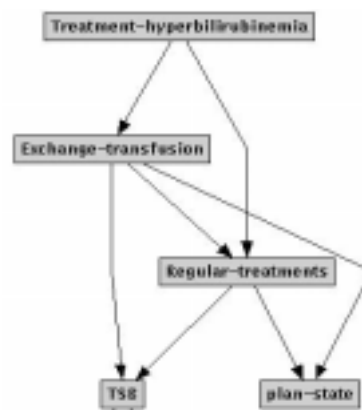
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KIV formalisation of Asbru (cont.)

- mapping of control structure:
 - DO PARALLEL plan1 plan2... → plan1 ??? plan2...
 - DO ANY-ORDER plan1 plan2... → plan1 ||a plan2...
 - DO UNORDERED plan1 plan2... → plan1 ||s plan2...
- mapping of continuation specification:
 - DO ..., WAIT-FOR planN, ... →
VAR planN-completed IN
BREAK ... IF planN-state=completed
- mapping of specific options: *ad hoc* way

The jaundice protocol in KIV the treatment part

- First version, with big-size modules



The jaundice protocol in KIV the treatment part (cont.)

– TSB specification:

- functions&axioms for treatment table, e.g. to derive the appropriate treatment:
 $25 \leq a \wedge a \leq 48 \wedge l < 12 \rightarrow$
`get-bilirubin(set-age-level(tsb,a,l))=observation;`
`...`

– Regular-treatments specification:

- procedures for clinical actions, of automatic activation:
`Prescribe-observation#(VAR time)`
`BEGIN`
`SKIP;`
`VAR time0=time, dt=[?] IN AWAIT time0+dt≤time`
`END`

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The jaundice protocol in KIV the treatment part (cont.)

or manual activation:

```
Prescribe-observation-manual#(VAR time)
BEGIN
  VAR time0=time, dt=[?] IN AWAIT time0+dt≤time;
  SKIP;
  VAR time0=time, dt=[?] IN AWAIT time0+dt≤time
END
```

- procedures using the previous ones:
`Observation#(VAR tsb,time,Observation-st)`
`BEGIN`
`AWAIT get-bilirubin(tsb)=observation;`
`PBREAK BEGIN`
`Prescribe-observation#(;time);`
`Observation-st:=completed`
`END`
`IF get-bilirubin(tsb)≠observation`
`END;`

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The jaundice protocol in KIV the treatment part (cont.)

- and procedure for Regular-treatments

```

Regular-treatments#(VAR tsb,time,Regular-treatments-st,
                    Phototherapy-intensive-act)

BEGIN
  ...
  AWAIT get-bilirubin(tsb)≠transfusion;
  PBREAK BEGIN
    Feeding-alternatives#(time)
    ||s
    VAR Observation-st=considered IN BEGIN
      PBREAK WHILE true do
        BEGIN
          Phototherapy-intensive#(...) OR ...
          OR Observation#(;tsb,time,Observation-st)
        END
        IF Observation-st=completed
        END
      END ...
    END ...
  
```

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The jaundice protocol in KIV the treatment part (cont.)

- Next version, with small-size modules



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The jaundice protocol in KIV the diagnosis part

- With small-size modules



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The jaundice protocol in KIV the diagnosis part (cont.)

– algebraic specification: other-diseases

- predicates to be used in IF statements, e.g. to determine if there could be a hemolytic disease:

$$\text{fam-history} \vee \text{eth-origin} \vee \text{geo-origin} \vee \text{ear-jaundice} \leftrightarrow$$

$$\text{possibility-of-hemolytic-disease}(\text{fam-history}, \text{eth-origin}, \text{geo-origin}, \text{ear-jaundice});$$

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The jaundice protocol in KIV the diagnosis part (cont.)

– procedural specifications:

• Anamnesis-abnormal-signs procedure:

```

PLAN Anamnesis-abnormal-signs #(time, pathologic-reason,
PLAN Anamnesis-abnormal-signs
Anamnesis-abnormal-signs-st)
CONDITIONS
BEGIN
  abort-conditions: pathologic-reason=true
PBREAK
PLAN BODY
  VAR let=[?], apn=[?], tac=[?], ... exc-weight-loss=[?] IN
  do sequentially, wait-for all
  BEGIN
    do any-order, wait-for all
    let:=[?] || a:apn=[?] || a ... || a exc-weight-loss=[?];
    VAR time0=time, dt=[?] IN AWAIT time0+dt≤time;
    ask lethargy;
    ask lethargy;
    pathologic-reason:=possibility-of-other-diseases(let,
    if(lethargy=true exc-weight-loss))
    END
    then possibility-of-other-diseases=true
  IF pathologic-reason=true;
  else possibility-of-other-diseases=false;
  IF pathologic-reason = true;
  if(possibility-of-other-diseases=true)
  THEN Anamnesis-abnormal-signs-st:=aborted
  then pathologic-reason=true
END

```

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The jaundice protocol in KIV the diagnosis part (cont.)

• Blood-tests procedure:

```

PLAN Blood-tests #(time, pathologic-reason, Blood-tests-st)
PLAN BODY
  do sequentially, wait-for optional-subplans=yes, wait-for one
  VAR Check-blood-test-mother-st=considered,
  Check-blood-test-mother
  Perform-blood-test-child-st=considered IN
  BEGIN
    PLAN Check-blood-test-mother
    PLAN BODY
    CONDITIONS
    filter-preconditions: known(blo-mother) and known(rhe-mother)
    and known(ant-mother) and known(time, Check-blood-test-mother-st);
    Perform-blood-test-child#( ; time, pathologic-reason,
    ... Perform-blood-test-child-st)
    PLAN Perform-blood-test-child
    PLAN BODY
    CONDITIONS
    filter-preconditions: not(known(blo-mother)) and known(rhe-mother)
    and known(ant-mother) or ...
    ...
  END...
END

```

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The jaundice protocol in KIV the diagnosis part (cont.)

- Jaundice-determination procedure:

```

Jaundice-determination-procedure
PLAN Anamnesis-abnormal-signs,
PLAN BODY      jaundice-clinically-significant)
BEGIN
do sequentially, wait-for all
  Blanching-skin-with-digital-pressure-test-manual#(; time)
  OR Icterometer-test-manual#(; time)
  OR Transcutaneous-jaundice-meter-test-manual#(; time)
  OR Determine-extent-cephalocaudal-progression-manual#(; time);
  jaundice-clinically-significant := true;
VAR time0=time, determine-extent-cephalocaudal-progression
END;      ask jaundice-clinically-significant

```

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The jaundice protocol in KIV the diagnosis part (cont.)

- ...and Diagnosis-hyperbilirubinemia procedure:

```

Diagnosis-hyperbilirubinemia-procedure
PLAN Anamnesis-abnormal-signs, blo-mother, rhe-mother,
ant-mother, time, jaundice-clinically-significant, pathologic-reaso
PLAN BODY
BEGIN
do sequentially, wait-for all
  VAR Anamnesis-abnormal-signs-st=considered, Blood-tests-st=considered,
  Anamnesis-hemolytic-disease-st=considered IN
  BEGIN
    Anamnesis-abnormal-signs
  PBREAK
    Blood-tests
  BEGIN
    Anamnesis-hemolytic-disease
    pathologic-reason := false;
    jaundice-determination#(; time, pathologic-reason, Anamnesis-a
    Blood-tests#(; blo-mother, rhe-mother, ant-mother, time, pathologi
    Blood-tests-st);
    Anamnesis-hemolytic-disease#(; time, pathologic-reason, Anamnesi
    Jaundice-determination#(; time, jaundice-clinically-significant
  END
  IF Anamnesis-abnormal-signs-st=aborted ∨ Blood-tests-st=aborted
  ∨ Anamnesis-hemolytic-disease-st=aborted
END
END

```

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The jaundice protocol in KIV the top-level plan

– procedural specification:

- Hyperbilirubinemia procedure:

```

PLAN Hyperbilirubinemia
Hyperbilirubinemia( var age, tsb, direct-serum-bilirubin, total-urine-bili
CONDITIONS other, rhe-mother, ant-mother, tsb, time)
BEGIN
  abort-conditions: possibility-of-hemolytic-disease=true
  VAR var-possibility-of-hemolytic-disease=[?], var-possibility-of-chole
PLAN BODY
  Diagnostics+Treatment-hyperbilirubinemia-state=[?] IN
  BEGIN
    no unordered, wait-for Diagnosis+Treatment-hyperbilirubinemia
    PBREAK Check-for-rapid-TSB-increase
    BEGIN
      Check-for-jaundice>2-weeks
      Check-for-rapid-TSB-increase#(; age,tsb,direct-serum-bilirubin
      Check-for-jaundice>3-weeks
      ||s Check-for-jaundice-after-2-weeks#(; tsb,direct-serum-bilir
      ||s Diagnosis+Treatment-hyperbilirubinemia#(; time,var-possibility-o
      ||s Diagnosis+Treatment-hyperbilirubinemia#(; term,age,blo-m
    END
    IF Diagnostics+Treatment-hyperbilirubinemia-state=completed
      v var-possibility-of-hemolytic-disease=true
  END
END
  
```

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Conclusions

- Current state:
 - formalisation of jaundice is complete but not stable
 - open questions in translation of difficult plans
 - still no proper translation for parallel plans
- Conclusion:
 - translation of intermediate Asbru models into KIV is harder than expected
 - Asbru plans are difficult to recognise in KIV

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Conclusions (cont.)

- Next steps
 - study (somehow) general translation rules
 - extend KIV with more Asbru constructs