CHECKING BUSINESS PROCESS MODELS FOR COMPLIANCE

COMPARING GRAPH MATCHING AND TEMPORAL LOGIC
1. “The process of granting loans encompasses the necessary operational steps up to the loan payout. All factors which are material for assessing the risk shall be analyzed and assessed, taking particular account of the debt-servicing capacity of the borrower or the property/project, with the intensity of the assessment depending on the riskiness of the exposures (e.g., creditworthiness assessment, risk score in the risk classification procedure or an assessment based on a simplified procedure).

2. As a general rule, the value and legal validity of collateral shall be reviewed prior to granting the loan. When reviewing the value of collateral, available collateral values may be relied on if there are no indications of any change in value.

3. If the collateral value depends largely on the situation of a third party (e.g., a guarantee), the third party’s counterparty and credit risk shall be appropriately reviewed.

4. The institution shall define the eligible types of collateral and the procedures for determining the value of this collateral.”

Federal Financial Supervisory Authority - (BaFin)Circular 10/2012: Minimum Requirements for Risk Management (MaRisk BA) - BTO 1.2.1 - Granting of loans
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PROVIDED MODELS
ICEBRICKS MODELLING NOTATION

4-Layer Architecture:

1. Business framework
2. Main processes
3. Detail processes
4. Processbricks

[Diagram of 4-layer architecture]
PROVIDED MODELS
ICEBRICKS MODELLING LANGUAGE AND ICEBRIDGE PLUGIN

Business procedure
Business object

Create offer

✓ Several attributed graphs
✓ Automatic pattern search is possible
"A printed document must not be changed."
PROCESS QUERYING

GRAPH-THEORETICAL POINT OF VIEW

print application

- Activity

- Attribute (procedure)

- Undirected edge

- Attribute (object)

- Directed edge

- Attribute (document)
GRAPHS BASED PATTERN MATCHING
FINDING ELEMENTS OF A SPECIFIC TYPE

- Evaluate function $ElementsOf\text{Type}(E,T)$

\[
e = \{ \text{Advise on savings deposit}, \text{Get financial plan}, \text{Perform demand analysis}, \text{Perform holistic consulting}, \text{Perform cross-selling consulting} \} \]

\[t = "Processbrick"\]

$ElementsOf\text{Type}(e,"Processbrick")$

\[
= \{ \text{Get financial plan}, \text{Perform demand analysis}, \text{Perform holistic consulting}, \text{Perform cross-selling consulting} \} 
\]
GRAPH BASED PATTERN MATCHING

FINDING ELEMENTS WITH SPECIFIC ATTRIBUTE VALUES

- Evaluate $ElementsWithTypeAttributeOfValue(E, T, V)$

\[
e = \{ \text{Process bank transfer}, \lambda, \text{Extract accompanying document}, \text{Release data transmission order} \}
\]

\[t = \text{Caption}\]

\[v = "\text{Process bank transfer}"\]

$ElementsWithTypeAttributeOfValue(e, t, v) = \{ \text{Process bank transfer} \}$
PROCESS QUERYING
TEMPORAL-LOGIC POINT OF VIEW

- Symbolic Model Checking (SMC): Model processes as state-machines

- Computation Tree Logic (CTL): Computations on tree-like structure of all states/paths, where future is nondeterministic
CTL
PATTERN SPECIFICATION

- Linear temporal operators:
  - $G(p)$ — $p$ holds in every state on the path
  - $F(p)$ — $p$ holds in some state on the path
  - ...

- Path quantifiers:
  - $A$: for all paths from a state
  - $E$: for some path(s) from a state

- Combining: AG, EG, AF, EF
CTL

PATTERN SPECIFICATION

- $\text{AG}(p)\quad p$ holds on every path in every state
- $\text{EG}(p)\quad p$ holds on some path in every state

CTL

PATTERN SPECIFICATION

- $\text{AF}(p)$ — $p$ holds on every path in some state
- $\text{EF}(p)$ — $p$ holds on some path in some state

PRE-TRANSFORMATION OF MODELS
ICEBRICKS EXECUTION SEMANTICS
FOUR EXEMPLARY PATTERNS

- Infringement Pattern
- Too Many Routing Paths per Element
- Check Documents Repetitively
- Observe Iteration Efficiency
„Before account transactions are made, the legal documents have to be handed out to the customer.“

GMQL pattern from Becker et al. (2013)
INFRINGEMENT PATTERN

DPNCE (  
  UNION (EWAOV (O,'Caption','Consult customer'),  
    EWAOV (O,'Caption','Talk to customer')),  
  UNION (EWAOV (O,'Caption','Make account transaction'),  
    EWAOV (O,'Caption','Perform account transaction')),  
  UNION (UNION (  
    EWAOV (O,'Caption','Hand out contract'),  
    EWAOV (O,'Caption','Hand out documents')),  
    EWAOV (O,'Caption','Hand out preliminary contract'))))

M, s0 |= AG ("Consult customer" \lor "Talk to customer" →  
  AG (  
    EG (¬"Make account transaction" \land ¬"Perform account transaction") \lor  
    A [¬"Make account transaction" \land ¬"Perform account transaction") U  
    ("Hand out contract" \lor "Hand out documents" \lor "Hand out preliminary contract")})

GMQL pattern from Becker et al. (2013)
„For each process split there should be no more than three routing paths.“
TOO MANY ROUTING PATHS PER ELEMENT

\[
\text{COMPLEMENT } (O, \\
\quad \text{UNION } ( \\
\quad \quad \text{UNION } (\text{EWNSR } (O, 0), \text{EWNSR } (O, 1)), \\
\quad \quad \text{EWNSR } (O, 2)))
\]

Not possible, because counting pre- or succeeding elements is not supported by CTL.

Textual pattern from Delfmann & Höhenberger (2015)
„Documents should not be repetitively checked and analysed in a loop.“
CHECK DOCUMENTS REPETITIVELY

DLCE (O,
    UNION (    
        EWAOV (O,'Caption','Check document'),
        EWAOV (O,'Caption','Analyse document'))) 

\[ M, s0 \models AG (("Check document" \lor "Analyse document") \rightarrow AG (\neg "Check document" \land \neg "Analyse document")) \]
„Iterations should be efficient, i.e., in an exception handling loop it should not be checked again if an exception needs to be handled.“
OBSERVE ITERATION EFFICIENCY

DLNCE (O,
   UNION (  
     EWAOV (O, 'Caption', 'Check if exception handling necessary'),
     EWAOV (O, 'Caption', 'Check for exception handling')))

Not possible, because the pattern requires the identification of loops as a basis to check the other conditions, which is not supported by CTL.
## COMPARISON OF THE APPROACHES

<table>
<thead>
<tr>
<th>Criterion</th>
<th>GMQL</th>
<th>CTL</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approach-specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Need for model transformation</td>
<td>Transformation to graph</td>
<td>Transformation to automata</td>
</tr>
<tr>
<td>Visualization of query results</td>
<td>Graphical visualization</td>
<td>None</td>
</tr>
<tr>
<td><strong>Query-specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Specification of queries</td>
<td>Set-based operations</td>
<td>Logical formulas</td>
</tr>
<tr>
<td>Attributes for model elements</td>
<td>Directly supported</td>
<td>Need to be modelled as labels</td>
</tr>
<tr>
<td>Result of query execution</td>
<td>Number of pattern occurrences</td>
<td>Boolean result (true/false)</td>
</tr>
<tr>
<td><strong>Feature-specific</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Count ingoing or outgoing edges</td>
<td>Supported</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Differ between directed and undirected edges</td>
<td>Supported</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Identify loops with additional constraints</td>
<td>Supported</td>
<td>Not Supported</td>
</tr>
</tbody>
</table>