Co-designing DSL Quality Assurance Measures for and with Non-programming Experts
Workshop presentation - DSM’21

Holger Borum, Christoph Seidl, and Peter Sestoft
IT University of Copenhagen

Innovation Fund Denmark
*Projection of Balances and Benefits in Life Insurance (7076-00029B)*
Management Action Language (MAL)
Co-designing with non-programming experts

- How do we design quality assurance (QA) measures that non-programming domain experts deem viable?
Co-designing with non-programming experts

- How do we design quality assurance (QA) measures that non-programming domain experts deem viable?

Our prospective users
Our prospective users

\[
\begin{align*}
\text{d}X(t) &= \text{d}Y_1^{\text{Z(t)}}(t) + Q(t) \text{d}Y_2^{\text{Z(t)}}(t) + V_1^{\text{Z(t)}}(t) \text{d}Q(t) \\
&= r(t)X(t) \text{d}t + dX(t) - b^{\text{Z(t)}}(t, X(t)) \text{d}t - \sum_{k \in Z(t)} \lambda^{\text{Z(t)}}(k, X(t)) \text{d}M_k(t) \\
&- \sum_{k \in Z(t)} \rho^{\text{Z(t)}}(k, X(t(-))) \text{d}t \\
&+ \sum_{k \in Z(t)} \eta^{\text{Z(t)}}(k, X(t(-))) \text{d}M_k(t),
\end{align*}
\]

where

\[
\begin{align*}
\rho^{\text{Z(t)}}(k, X(t(-))) &= \rho_{1k}^b(t) + Q(t) \rho_{2k}^b(t) = \rho_{1k}^b(t) + \frac{X(t(-)}{V_2(t)} \rho_{2k}^b(t), \\
\eta^{\text{Z(t)}}(k, X(t(-))) &= \eta_{1k}^b(t) + Q(t) \eta_{2k}^b(t) = \eta_{1k}^b(t) + \frac{X(t(-)}{V_2(t)} \eta_{2k}^b(t).
\end{align*}
\]

(Bruhn & Lollike (2020))
Our prospective users

(Bruhn & Lollike (2020))
Our prospective users

(Bruhn & Lollike (2020))

\[
dX(t) = dV^{Z(t)}_1(t) + \rho^{Z(t)}_1(t) + V^{Z(t)}_2(t) + V^{Z(t)}_2(t) dQ(t)
\]

\[
= r(t) X(t) dt + dX(t) - b^{Z(t)}_1(t) X(t) dt - \sum_{k,k \neq 1} \rho^{Z(t)}_{k} X(t) dt + \sum_{k,k \neq 1} V^{Z(t)}_{k} X(t) dt
\]

where

\[
\rho^{X(t)}_{k} = \rho_{k}^{X(t)} + Q(t) - V^{X(t)}_{k} V^{X(t)}_{k} \rho_{k}^{X(t)} + \frac{X(t) - V^{X(t)}_{k} V^{X(t)}_{k}}{V^{X(t)}_{k} V^{X(t)}_{k}} b^{X(t)}_{k}.
\]

\[
\rho^{X(t)}_{k} = \rho_{k}^{X(t)} + Q(t) - V^{X(t)}_{k} V^{X(t)}_{k} \rho_{k}^{X(t)} + \frac{X(t) - V^{X(t)}_{k} V^{X(t)}_{k}}{V^{X(t)}_{k} V^{X(t)}_{k}} b^{X(t)}_{k}.
\]

\[
V^{X(t)}_{k} = V_{k}^{X(t)} + Q(t) - V^{X(t)}_{k} V^{X(t)}_{k} \rho_{k}^{X(t)} + \frac{X(t) - V^{X(t)}_{k} V^{X(t)}_{k}}{V^{X(t)}_{k} V^{X(t)}_{k}} b^{X(t)}_{k}.
\]

\[
\text{Assets} \quad \text{Liabilities}
\]

<table>
<thead>
<tr>
<th>Bonds</th>
<th>Reserve for market rate products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stocks and investment association shares</td>
<td>Reserve for average rate products</td>
</tr>
<tr>
<td>Other assets</td>
<td>equity</td>
</tr>
<tr>
<td>Other liabilities</td>
<td>other reserve</td>
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<td>342,360,967</td>
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<td>291,351,453</td>
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<td>124,508,913</td>
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<td>97,318,729</td>
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<td>54,271,385</td>
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<td>58,004,659</td>
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<td>34,650,356</td>
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<td>57,033,083</td>
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<td>45,071,546</td>
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</table>
Our prospective users

(Bruhn & Lollike (2020))

\[
\begin{align*}
\text{d}X(t) &= \text{d}X(t) + V(\text{d}X(t)) + V(\text{d}X(t)) - X(t) + X(t) \\
\text{d}Y(t) &= \text{d}Y(t) + V(\text{d}Y(t)) + V(\text{d}Y(t)) - Y(t) + Y(t)
\end{align*}
\]

where

\[
\begin{align*}
\rho^X(t, X(-)) &= \rho^X(t) + \rho^X(t) \\
\rho^Y(t, X(-)) &= \rho^Y(t) + \rho^Y(t)
\end{align*}
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<tr>
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<td>410,970,916 17.6%</td>
<td>291,301,145 12.5%</td>
<td>20,100,968 9.7%</td>
<td>183,069,673 8.4%</td>
<td>97,318,729 4.2%</td>
<td>64,271,455 4.0%</td>
<td>92,942,264 4.0%</td>
<td>89,600,356 3.9%</td>
<td>68,204,659 2.6%</td>
<td>57,551,603 2.5%</td>
<td>57,255,603 2.5%</td>
<td>48,643,752 2.1%</td>
<td>45,671,546 2.0%</td>
<td>43,952,579 1.8%</td>
<td>43,091,541 1.9%</td>
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<td>60,405,197 3.1%</td>
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<td>51,136,170 3.0%</td>
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<td>48,643,752 2.1%</td>
<td>30,511,152 1.6%</td>
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<td>31,969,615 1.6%</td>
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<td>G N</td>
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<td>40,670,516 2.1%</td>
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<td>26,602,370 1.6%</td>
<td>20,869,111 1.2%</td>
<td>27,069,101 1.0%</td>
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IT UNIVERSITY OF COPENHAGEN
<table>
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<th>Plan</th>
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<tbody>
<tr>
<td>Elicit current approaches to QA</td>
<td></td>
</tr>
<tr>
<td>Identify properties of management actions</td>
<td></td>
</tr>
<tr>
<td>Discuss how to ensures these properties</td>
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1 All quotes are from notes and translated.
**Workshop**

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<tr>
<td>Identify properties of management actions</td>
<td>“I would love to list different properties, but the calculations are so complex that I am simply unable to do so”¹</td>
</tr>
<tr>
<td>Discuss how to ensures these properties</td>
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</table>

¹ All quotes are from notes and translated.
“How do you think we can improve the existing quality assurance?”
“How do you think we can improve the existing quality assurance?”

- Quantity monitors
- Fragment debugging
- Debugging spreadsheets
We proposed the possibility of debugging programs using spreadsheets.
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```plaintext
1 update policy in Policies
2 {
3   let baseFactor = pow(1 + Global.Param.BaseFee, Projection.PeriodLength) - 1
4   policy.Fee = baseFactor * policy.TotalReserve
5 }
```
We proposed the possibility of debugging programs using spreadsheets.

```plaintext
update policy in Policies
{
    let baseFactor = pow(1 + Global.Param.BaseFee, Projection.PeriodLength) - 1
    policy.Fee = baseFactor * policy.TotalReserve
}
```

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Policy 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>let baseFactor =</td>
<td>=POWER(1+C3,D3)-1</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>=POWER(1+C3,D3)-1</td>
<td></td>
<td>1.3</td>
</tr>
<tr>
<td>4</td>
<td>policy.Fee =</td>
<td></td>
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<tr>
<td></td>
<td>=B3*C5</td>
<td></td>
<td>5234.23</td>
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</tbody>
</table>

A formula view of a part of a debugging spreadsheet.
Lessons learned

Perspective of MAL
- Analytical tools important for its prospective users
Lessons learned

Perspective of MAL

- Analytical tools important for its prospective users
- Design of three concrete quality assurance measures
Lessons learned

Perspective of MAL

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Perspective of co-designing DSL

- Non-programming domain experts may be engaged actively in design process
- Workshop facilitator should be prepared, flexible, and ready to improvise

Debugging spreadsheets may be used by other DSLs in similar domains
Lessons learned

**Perspective of MAL**
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Conclusion

We have
- presented MAL be used in asset/liability projections

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Conclusion

We have

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- described an approach to and experiences with co-designing quality assurance measures

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We have
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- described an approach to and experiences with co-designing quality assurance measures
- demonstrated how three concrete quality measures were derived from the co-design workshop

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Conclusion

We have

- presented MAL be used in asset/liability projections
- described an approach to and experiences with co-designing quality assurance measures
- demonstrated how three concrete quality measures were derived from the co-design workshop
- presented debugging spreadsheets as a general quality assurance measure applicable to domains with complex mathematical calculations

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