Intent of paper

- Does the visitor pattern have an impact on program comprehension and modification tasks?
- Does the representation of the visitor pattern have an influence?
Visitor Pattern
(canonical representation [1])

[1] Design Patterns – Elements of Reusable Object-Oriented Software
Hypotheses for Comprehension

C1) A class diagram with the Visitor reduces the subjects efforts during program comprehension when compared to one without it.

C2) A class diagram using the canonical representation of the Visitor reduces the subjects efforts during program comprehension when compared to one using the Visitor with another layout.
Hypotheses for Modification

M1) A class diagram with the Visitor reduces the subjects efforts during program modification when compared to one without it.

M2) A class diagram using the canonical representation of the Visitor reduces the subjects efforts during program modification when compared to one using the Visitor with another layout.
Experimental Settings

- 3 open-source applications
  - JHotDraw, JRefactory and PADL

- 24 students
  - 7 post-graduate
  - 17 graduate
Experimental Settings

- Eye-tracker for data collection
  - Tracks movement of eyes
  - Gives fixations and saccades

EyeLink II from SR Research
http://www.eyelinkinfo.com
Experiment Design

• 3 different design alternatives
  • CP: with visitor in canonical representation
  • MP: with visitor in different representation
  • NP: with no visitor

• Questions for comprehension and modification
  • 6 questions for every Subject
Mitigating Variables

- UML knowledge
- Design pattern knowledge
- Questionnaire for every subject
  - After the experiment
Dependent Variables

- ADRF (Average Duration of Relevant Fixations)
  \[
  ADRF = \frac{\sum_{c \in \{\text{Rel. Classes}\}} d(c)}{|\{\text{Rel. Classes}\}|}
  \]

- ADNRF (Average Duration of Non- Relevant Fixations)
  \[
  ADNRF = \frac{\sum_{c \in \{\text{NonRel. Classes}\}} d(c)}{|\{\text{NonRel. Classes}\}|}
  \]

- \(d(c)\) is the total duration of the fixation for class \(c\)
Dependent Variables

• NRRF (Normalized Rate of Relevant Fixations)

\[ NRRF = \frac{\sum_{c \in \{\text{Rel. Classes}\}} f(c)}{\left| \{\text{Rel. Classes}\} \right|} \div \frac{\sum_{c \in \{\text{all Classes}\}} f(c)}{\left| \{\text{all Classes}\} \right|} \]

• \( f(c) \) is the number of fixations for class \( c \)
Experiment Analysis

- **Effect on Comprehension:**

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>MP</th>
<th>NP</th>
<th>$\Delta_1$ (NP, CP)</th>
<th>$\Delta_2$ (NP, MP)</th>
<th>sig. $\Delta_1$</th>
<th>sig. $\Delta_2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADRF</td>
<td>12.8 s</td>
<td>12.3 s</td>
<td>13.3 s</td>
<td>4%</td>
<td>8%</td>
<td>0.807</td>
<td>0.592</td>
</tr>
<tr>
<td>ADNRF</td>
<td>3.4 s</td>
<td>3.6 s</td>
<td>3.4 s</td>
<td>1%</td>
<td>-6%</td>
<td>0.711</td>
<td>0.635</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>MP</th>
<th>NP</th>
<th>p-val. C1</th>
<th>p-val. C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRF</td>
<td>75.7%</td>
<td>78.0%</td>
<td>81.5%</td>
<td>0.221</td>
<td>0.663</td>
</tr>
</tbody>
</table>

- **Significance level $\alpha = 0.05$**
Experiment Analysis

- **Effect on Maintenance:**

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>MP</th>
<th>NP</th>
<th>Δ1 (NP, CP)</th>
<th>Δ2 (NP, MP)</th>
<th>sig. Δ1</th>
<th>sig. Δ2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADRF</td>
<td>12.1 s</td>
<td>13.2 s</td>
<td>18.7 s</td>
<td>35%</td>
<td>30%</td>
<td><strong>0.045</strong></td>
<td>0.076</td>
</tr>
<tr>
<td>ADNRF</td>
<td>4.8 s</td>
<td>4.0 s</td>
<td>4.4 s</td>
<td>-9%</td>
<td>9%</td>
<td>0.672</td>
<td>0.626</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>CP</th>
<th>MP</th>
<th>NP</th>
<th>p-val. M1</th>
<th>p-val. M2</th>
</tr>
</thead>
<tbody>
<tr>
<td>NRRF</td>
<td>72.0%</td>
<td>73.5%</td>
<td>80.2%</td>
<td><strong>0.027</strong></td>
<td>0.725</td>
</tr>
</tbody>
</table>

- **Significance level α = 0.05**
Impact of Mitigation Variables

- 2-way ANOVA test

- UML knowledge:

<table>
<thead>
<tr>
<th>NRRF</th>
<th>Comprehension</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>UML knowledge</td>
<td>0.494</td>
<td>0.061</td>
</tr>
<tr>
<td>Combined</td>
<td>0.471</td>
<td>0.267</td>
</tr>
</tbody>
</table>

- Design pattern (DP) knowledge

<table>
<thead>
<tr>
<th>NRRF</th>
<th>Comprehension</th>
<th>Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>DP knowledge</td>
<td>0.692</td>
<td>0.245</td>
</tr>
<tr>
<td>Combined</td>
<td>0.217</td>
<td>0.546</td>
</tr>
</tbody>
</table>
Threats to Validity

- From the paper
  - All threads addressed
  - Mono-method bias
  - Hypothesis guessing
  - And many more

- From me
  - Only students and only 24
  - Effect of UML knowledge?
Conclusion

- The visitor pattern has a positive impact on program modification tasks.

- The visitor pattern has no impact on program comprehension tasks.
Future Work

- Other variables to confirm results
- Other design pattern
- With professionals
Questions