Human Factors in Modeling HuFaMo – MODELS’2017

VISUAL VARIABLES IN UML: A FIRST EMPIRICAL ASSESSMENT

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Lindholmen dataset

http://oss.models-db.com/
93 648 UML models
24 797 projects
Motivations

State of the art: The visual variables and UML

Design methodology: qualitative and quantitative methods

Obtained results: some statistics!

Discussion & conclusion
COMMUNICATION WITH UML
EXAMPLE: A “SIMPLE” CLASS DIAGRAM

Login
- password: String
- username: String
- blockCount: Integer

getLogin() getLogout() block()

PersonalLoginValidation
- userID: String
- password: String
- isSession: Boolean
- blockCount: Integer

updateBlockCount() getBlockCount() resetBlockCount()

EditProfile
- phone: String
- email: string
- theme: String
- accountNumber: Integer

setPhone() setEmail() addAccount() changeTheme() removeAccount()

MyProfile
- userID: String
- name: String
- address: String
- email: String

getName() getUser() getUsername() getAddress() getEmail() getPhoneNum()

DataBaseConnect
- dataSource: DataSource
- connection: Connection
- statement: Statement
- resultSet: ResultSet
- url: String

executeQuery() updateQuery() createQueryStatement()

Utilities
- moneyTransfer: A2AMoneyTransfer
- c2CTransfer: CardToCardTransfer
- sendMyMoney: SendMoney
- mySearch: Search
- myRequest: Requests

makeTransfer() makeSearch() makeRequest()

Requests
- draftInFavour: String
- draftBy: String
- amount: Integer
- payableAt: String
- chequeBook: Boolean
- newAccount: Boolean
- newAccountType: Integer
- newAccountBalance: Integer

requestNewAccount() requestDraft() requestChequeBook()

Print
- fileToPrint: string

printToPrinter() printToFile() saveAs()

Search
- searchString: String
- dateFrom: Date
- dateUpTo: Date

searchString() searchTransaction() displayResult()
BETTER COMMUNICATION WITH COLORS?
A UML DIAGRAM IN REAL OSS PROJECT

Classes from referenced packages should be marked with (Format->Fill->Pattern: *Downward Diagonal*)

Classes that are the main focus of a diagram should be highlighted with blue (Format->Fill->Fill Color: *Blue*)
- This typically includes any interfaces the class supplies as well
- In unit tests the class under test is usually the main focus

Controller (and its interface) is the focus of this diagram

Agent is referenced from another package

* Names of classes are changed
• Cartography:


Semiology of graphics: A set of 7 visual variables + objective rules to control their effective use.

Fig1: Visual variables: Planar dimensions + retinal variables
Empirical studies focus only on layouts and colors. The other visual means are not yet evaluated.


Several existing empirical studies about UML use in practice


RESEARCH QUESTIONS & THEORETICAL PERSPECTIVES

• Research questions

  • (1) What are the contexts of the use of UML models in the software practitioner’s real situations?

  • (2) What is the state of use of the visual variables in UML?

• Theoretical perspective

  • Studying the benefits of the visual variables in UML.

  • Providing scientific frameworks and effective tools.
QUALITATIVE METHOD:

- **Data collection procedure:** Interviews
- **Focus:** Papyrus tool developers and users community + MDE community
- **Actors:** 8 experts & practitioners of UML
- **Roles of the actors:** requirement manager, software architect, software designer, software engineers
- **Domains:** transportation, aerospace engineering and defense, avionics, telecommunication, E-commerce, insurance, banking.

QUANTITATIVE METHOD: Analysis of +3500 UML diagrams

- 3328 class diagrams, 392 sequence diagrams
- Manual classification
- Diagrams from open source projects in GitHub (http://oss.models-db.com/)

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Qualitative study: Interviews
COMMUNICATION IS THE FIRST PURPOSE OF USING UML

- Coherence with existing empirical researches

CONTEXTUALIZE DIAGRAMS ONLY WITH NON-FAMILIARS WITH UML

Modify diagrams before Comm. With familiar with UML

Yes  No

Modify diagrams before Comm. With non-familiar with UML

Filter info  Adapt the speech  Include textual info.  Does not use UML

2  3  1  1
PRACTITIONERS NEED TO VISUALIZE INFORMATION IN THEIR DIAGRAMS

- **Semantic information** (Search for what is modeled)
  - Input and outputs statements for the requirements
  - The communication in a sequence diagram to understand the logic
  - Functionalities of the system
  - Across functions
  - Interactions of a system
  - Reference for specific signals or events in the model

- **Extra-semantic information** (Something that cannot be described by UML)
  - What has been implemented
  - Bugs in the model
• Semantic information
  • Important features like inheritance, interface
  • Elements that have the same semantic

• Extra-semantic information
  • Specific layers: entities, dataAccessObjects, services.
  • Critical functions: the order
  • Progress of the development
  • Model, View and Controller elements MVC
  • Levels of security
  • Comments: color the text inside
  • My subsystem in the whole system
COLORS IN PRACTICE

Were colors helpful?

- Yes
- Yes, but problems of the tool
- No, but only for communication
KEYS ARE NEEDED

Need for keys when you use colors?

- Yes / I would like to
- No
Do you think that the visual variables are helpful?

- Only for communication: 1
- I would need them, but the tool have to be good: 6
- Problems: 1
Quantitative analysis of UML models

3328 class diagrams, 392 sequence diagrams
Manual classification
Diagrams from open source projects in GitHub (http://oss.models-db.com/)
COLOR IS THE MOST USED VISUAL VARIABLE

6.1: VISUAL VARIATIONS

6.2: SIGNIFICANT VARIATIONS: VISUAL VARIABLES

- Color: 80%
- Brightness: 19%
- Size: 1%
- Texture: 0%
- Orientation: 0%

No visual variations: 11%
DO YOU THINK THAT THE VISUAL VARIABLE ARE HELPFUL?

DIFFERENT IMPLEMENTATIONS OF THE COLORS

COLORS - IMPLEMENTATIONS

- Background: 63%
- Edges: 7%
- Borders: 9%
- Text: 10%
- Head: 6%
- Annotations: 3%
- Combinations: 2%
DO YOU THINK THAT THE VISUAL VARIABLE ARE HELPFUL?

NO KEYS!

PRESENCE OF KEYS WITH SIGNIFICANT VISUAL VARIATIONS
DISCUSSION

• Different usages of UML in different situations
• Need to visualize semantic and extra-semantic information
• Highlighted information using colors are mostly selective
DISCUSSION

- Color is the most used visual variable
- A recurrent non effective use of colors: No keys
- The other visual variables might be helpful in practice
• **Possible improvement to modeling tools**

  • Automatic
  
  • Allows adding keys: interactive keys
  
  • Definition of rules of mappings between the visual variables and the information to highlight
  
  • Subtlety of the visual variations
  
  • Considering large organizations and collaboration
  
  • Different usages of colors in UML elements: background, borders, text, etc: What are the most effective ones?
Thank you for your attention

Questions?

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