



Universiteit
Leiden
The Netherlands

An online corpus of UML Design Models : construction and empirical studies

Karasneh, B.H.A.

Citation

Karasneh, B. H. A. (2016, July 7). *An online corpus of UML Design Models : construction and empirical studies*. Retrieved from <https://hdl.handle.net/1887/41339>

Version: Not Applicable (or Unknown)

License: [Licence agreement concerning inclusion of doctoral thesis in the Institutional Repository of the University of Leiden](#)

Downloaded from: <https://hdl.handle.net/1887/41339>

Note: To cite this publication please use the final published version (if applicable).

Cover Page



Universiteit Leiden



The handle <http://hdl.handle.net/1887/41339> holds various files of this Leiden University dissertation.

Author: Karasneh, B.H.A.

Title: An online corpus of UML Design Models : construction and empirical studies

Issue Date: 2016-07-07

Bibliography

- [1] M. Iliev, B. Karasneh, M. R. V. Chaudron, and E. Essenius, "Automated prediction of defect severity based on codifying design knowledge using ontologies," in *1st International Workshop on Realizing Artificial Intelligence Synergies in Software Engineering (RAISE 2012)*, pp. 7–11, June 2012.
- [2] B. Karasneh and M. R. V. Chaudron, "Extracting uml models from images," in *5th International Conference on Computer Science and Information Technology (CSIT2013)*, pp. 169–178, IEEE, 2013.
- [3] B. Karasneh and M. R. V. Chaudron, "Img2uml: A system for extracting uml models from images," in *39th EUROMICRO Conference on Software Engineering and Advanced Applications (SEAA 2013)*, pp. 134–137, IEEE, 2013.
- [4] B. Karasneh and M. R. V. Chaudron, "Online img2uml repository: An online repository for uml models.," in *Proceedings of the 3rd International Workshop on Experiences and Empirical Studies in Software Modeling (EESMOD@MoDELS 2013)*, pp. 61–66, 2013.
- [5] T. Ho Quang, M. R. V. Chaudron, I. Samúelsson, J. Hjaltason, B. Karasneh, and H. Osman, "Automatic classification of uml class diagrams from images," in *Proceedings 21st Asia-Pacific Software Engineering Conference (APSEC 2014)*, 2014.
- [6] B. Karasneh, D. Stikkolorum, E. Larios, and M. R. V. Chaudron, "Quality assessment of uml class diagrams: A study comparing experts and students," in *MoDELS*, 2015.
- [7] D. Stikkolorum, T. Ho Ho Quang, B. Karasneh, and M. R. V. Chaudron, "Uncovering students' common difficulties and strategies during a class diagram design process: an online experiment," in *MoDELS*, 2015.
- [8] B. Karasneh, R. Jolak, and M. R. V. Chaudron, "Using examples for teaching software design," in *Proceedings of the 22st Asia-Pacific Software Engineering Conference (APSEC2015)*, 2015.

- [9] B. Karasneh, M. R. V. Chaudron, F. Khomh, and Y.-G. Guéhéneuc, "Studying the relation between anti-patterns in models and in source code," in *Proceedings of the 23rd IEEE International Conference on Software Analysis, Evolution, and Reengineering (SANER 2016)*, 2016.
- [10] A. Geraci, F. Katki, L. McMonegal, B. Meyer, and H. Porteous, "Ieee standard computer dictionary," *A Compilation of IEEE Standard Computer Glossaries. IEEE Std*, vol. 610, 1991. (cited on pages 9, 13 and 25).
- [11] ISO/IEC, "ISO/IEC 25010 - Systems and software engineering - Systems and software Quality Requirements and Evaluation (SQuaRE) - System and software quality models," tech. rep., 2010. (cited on pages 10 and 122).
- [12] ISO/IEC, *ISO/IEC 9126. Software engineering – Product quality*. ISO/IEC, 2001. (cited on page 10).
- [13] J. A. McCall, P. K. Richards, and G. F. Walters, "Factors in software quality. volume i. concepts and definitions of software quality," tech. rep., DTIC Document, 1977. (cited on page 10).
- [14] B. W. Boehm, J. R. Brown, and M. Lipow, "Quantitative evaluation of software quality," in *Proceedings of the 2Nd International Conference on Software Engineering, ICSE '76*, (Los Alamitos, CA, USA), pp. 592–605, IEEE Computer Society Press, 1976. (cited on page 10).
- [15] J. Bansiya and C. Davis, "A hierarchical model for object-oriented design quality assessment," *Software Engineering, IEEE Transactions on*, vol. 28, pp. 4–17, Jan 2002. (cited on page 10).
- [16] R. G. Dromey, "A model for software product quality," *IEEE Trans. Softw. Eng.*, vol. 21, pp. 146–162, #feb# 1995. (cited on page 10).
- [17] F. Khomh and Y.-G. Guéhéneuc, "Dequalite: Building design-based software quality models," in *Proceedings of the 15th Conference on Pattern Languages of Programs, PLoP '08*, (New York, NY, USA), pp. 2:1–2:7, ACM, 2008. (cited on page 10).
- [18] C. Lange and M. Chaudron, "Managing model quality in uml-based software development," in *Software Technology and Engineering Practice, 2005. 13th IEEE International Workshop on*, pp. 7–16, 2005. (cited on page 10).
- [19] N. Fenton and J. Bieman, *Software metrics: a rigorous and practical approach*. CRC Press, 2014. (cited on page 11).
- [20] S. Chidamber and C. Kemerer, "A metrics suite for object oriented design," *Software Engineering, IEEE Transactions on*, vol. 20, pp. 476–493, Jun 1994. (cited on page 13).

- [21] A. Janes, M. Scotto, W. Pedrycz, B. Russo, M. Stefanovic, and G. Succi, "Identification of defect-prone classes in telecommunication software systems using design metrics," *Information Sciences*, vol. 176, no. 24, pp. 3711 – 3734, 2006. (cited on page 13).
- [22] R. Shatnawi and W. Li, "The effectiveness of software metrics in identifying error-prone classes in post-release software evolution process," *Journal of Systems and Software*, vol. 81, no. 11, pp. 1868 – 1882, 2008. (cited on page 13).
- [23] Y. Zhou and H. Leung, "Empirical analysis of object-oriented design metrics for predicting high and low severity faults," *Software Engineering, IEEE Transactions on*, vol. 32, pp. 771–789, Oct 2006. (cited on pages 13, 43 and 44).
- [24] C. Catal and B. Diri, "A systematic review of software fault prediction studies," *Expert Syst. Appl.*, vol. 36, pp. 7346–7354, #may# 2009. (cited on page 13).
- [25] I. Group *et al.*, "1044-2009-ieee standard classification for software anomalies," *IEEE, New York*, 2010. (cited on pages ix, 13, 22, 23, 25, 26, 28, 30, 31, 32, 35, 36, 43, 46, 124 and 155).
- [26] T. R. Gruber, "A translation approach to portable ontology specifications," *Knowledge Acquisition*, vol. 5, no. 2, pp. 199 – 220, 1993. (cited on page 14).
- [27] N. F. Noy, D. L. McGuinness, *et al.*, *Ontology development 101: A guide to creating your first ontology*, vol. 15. Stanford knowledge systems laboratory technical report KSL-01-05 and Stanford medical informatics technical report SMI-2001-0880, 2001. (cited on pages 14 and 23).
- [28] L. Dittmann, T. Rademacher, and S. Zelewski, "Performing fmea using ontologies," in *18th International Workshop on Qualitative Reasoning. Evanston USA*, pp. 209–216, 2004. (cited on page 14).
- [29] J. Cardoso, "The semantic web vision: Where are we?," *Intelligent Systems, IEEE*, vol. 22, pp. 84–88, Sept 2007. (cited on pages 15 and 23).
- [30] M. Horridge, S. Jupp, G. Moulton, A. Rector, R. Stevens, and C. Wroe, "A practical guide to building owl ontologies using protégé 4 and co-ode tools edition1. 2," *The University of Manchester*, 2009. (cited on pages 15, 16, 23, 24, 25, 28 and 105).
- [31] J. Rumbaugh, M. Blaha, W. Premerlani, F. Eddy, W. E. Lorensen, *et al.*, *Object-oriented modeling and design*, vol. 199. Prentice-hall Englewood Cliffs, 1991. (cited on page 16).
- [32] G. Booch, *Object Solutions: Managing the Object-oriented Project*. Redwood City, CA, USA: Addison Wesley Longman Publishing Co., Inc., 1995. (cited on page 16).
- [33] I. Jacobson, "Object oriented software engineering: a use case driven approach," 1992. (cited on page 16).

- [34] D. Milicev, "On the semantics of associations and association ends in uml," *Software Engineering, IEEE Transactions on*, vol. 33, pp. 238–251, April 2007. (cited on pages 16 and 122).
- [35] B. Dobing and J. Parsons, "How uml is used," *Communications of the ACM*, vol. 49, no. 5, pp. 109–113, 2006. (cited on page 17).
- [36] R. France, J. Bieman, and B. H. Cheng, "Repository for model driven development (remodd)," in *Models in Software Engineering*, pp. 311–317, Springer, 2007. (cited on pages 17 and 79).
- [37] R. P. Buse and T. Zimmermann, "Information needs for software development analytics," in *Proceedings of the 34th international conference on software engineering*, pp. 987–996, IEEE Press, 2012. (cited on page 17).
- [38] D. Rodriguez, I. Herraiz, and R. Harrison, "On software engineering repositories and their open problems," in *Proceedings of the First International Workshop on Realizing AI Synergies in Software Engineering, RAISE '12*, (Piscataway, NJ, USA), pp. 52–56, IEEE Press, 2012. (cited on pages 19 and 78).
- [39] A. Escórcio and J. Cardoso, "Editing tools for ontology creation," *Semantic Web Services: Theory, Tools and Applications*; IGI Global (former Idea Group). Hersey, Pennsylvania, USA, pp. 71–95, 2007. (cited on page 23).
- [40] M. Iliev, B. Karasneh, M. Chaudron, and E. Essenius, "Automated prediction of defect severity based on codifying design knowledge using ontologies," in *Realizing Artificial Intelligence Synergies in Software Engineering (RAISE), 2012 First International Workshop on*, pp. 7–11, June 2012. (cited on page 30).
- [41] I. H. Witten, E. Frank, and M. A. Hall, *Data Mining: Practical Machine Learning Tools and Techniques*. San Francisco, CA, USA: Morgan Kaufmann Publishers Inc., 3rd ed., 2011. (cited on pages 37 and 59).
- [42] I. Witten and E. Frank, "Credibility: Evaluating what's been learned," *Data mining: Practical machine learning tools and techniques*, p. 173, 2005. (cited on page 38).
- [43] T. Menzies and A. Marcus, "Automated severity assessment of software defect reports," in *Software Maintenance, 2008. ICSM 2008. IEEE International Conference on*, pp. 346–355, Sept 2008. (cited on pages 43 and 44).
- [44] M. D. Mohamed Suffian, "Defect prediction model for testing phase." Masters thesis, Universiti Teknologi Malaysia, 2009. (cited on pages 43 and 44).
- [45] A. M. Hoss, *Ontology-Based Methodology for Error Detection in Software Design*. PhD thesis, 2006. (cited on page 45).
- [46] Y. Kalfoglou, *Deploying Ontologies in Software Design*. PhD thesis, Citeseer, 2000. (cited on page 45).

- [47] K. Tombre and B. Lamiroy, "Graphics recognition - from re-engineering to retrieval," in *Document Analysis and Recognition, 2003. Proceedings. Seventh International Conference on*, pp. 148–155 vol.1, Aug 2003. (cited on page 50).
- [48] L. Fu and L. B. Kara, "From engineering diagrams to engineering models: Visual recognition and applications," *Comput. Aided Des.*, vol. 43, pp. 278–292, #mar# 2011. (cited on pages 50 and 75).
- [49] *Image Search Developer's Guide of Google*, web-site: <https://developers.google.com/image-search/v1/devguide/>. (cited on page 51).
- [50] J. Han, M. Kamber, and J. Pei, *Data mining: concepts and techniques: concepts and techniques*. Elsevier, 2011. (cited on page 57).
- [51] M. A. Hall, *Correlation-based feature selection for machine learning*. PhD thesis, The University of Waikato, 1999. (cited on page 57).
- [52] B. Karasneh and M. R. Chaudron, "Img2uml: A system for extracting uml models from images," in *Software Engineering and Advanced Applications (SEAA), 2013 39th EUROMICRO Conference on*, pp. 134–137, IEEE, 2013. (cited on pages 61 and 137).
- [53] B. Karasneh and M. Chaudron, "Extracting uml models from images," in *Computer Science and Information Technology (CSIT), 2013 5th International Conference on*, pp. 169–178, March 2013. (cited on pages 61 and 137).
- [54] L. Surhone, M. Tennoe, and S. Henssonow, "Aforge .net: Artificial intelligence, computer vision, .net framework," 2013. (cited on pages 62 and 68).
- [55] V. Vashisht, T. Choudhury, and T. Prasad, "Sketch recognition using domain classification," *arXiv preprint arXiv:1211.2742*, 2012. (cited on page 62).
- [56] *Sparx Enterprise Architect 11*, web-site: <http://www.sparxsystems.com/>. (cited on pages 72 and 79).
- [57] V. Paradigm, "Visual paradigm for uml," *Visual Paradigm for UML-UML tool for software application development*, 2013. (cited on pages 72 and 79).
- [58] M. Lee, H. Kim, J. Kim, and J. Lee, "Staruml 5.0 developer guide," *The Open Source UML/MDA Platform*. (cited on pages 72 and 139).
- [59] D. Lucr dio, R. P. d. M. Fortes, and J. Whittle, "Moogole: A model search engine," in *Model Driven Engineering Languages and Systems*, pp. 296–310, Springer, 2008. (cited on page 74).
- [60] D. Lu and Q. Weng, "A survey of image classification methods and techniques for improving classification performance," *International journal of Remote sensing*, vol. 28, no. 5, pp. 823–870, 2007. (cited on page 75).
- [61] J. A. Shine and D. B. Carr, "A comparison of classification methods for large imagery data sets," *JSM*, pp. 3205–3207, 2002. (cited on page 75).

- [62] A. Mishchenko and N. Vassilieva, "Model-based chart image classification," in *Advances in Visual Computing*, pp. 476–485, Springer, 2011. (cited on page 75).
- [63] Y. Yu, A. Samal, and S. C. Seth, "A system for recognizing a large class of engineering drawings," *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, vol. 19, no. 8, pp. 868–890, 1997. (cited on page 75).
- [64] B. T. Messmer and H. Bunke, "Automatic learning and recognition of graphical symbols in engineering drawings," in *Graphics recognition methods and applications*, pp. 123–134, Springer, 1996. (cited on page 75).
- [65] S. V. Ablameyko and S. Uchida, "Recognition of engineering drawing entities: Review of approaches," *International Journal of Image and Graphics*, vol. 7, no. 04, pp. 709–733, 2007. (cited on page 75).
- [66] Q. Chen, J. Grundy, and J. Hosking, "Sumlow: early design-stage sketching of uml diagrams on an e-whiteboard," *Software: Practice and Experience*, vol. 38, no. 9, pp. 961–994, 2008. (cited on page 75).
- [67] T. Hammond and R. Davis, "Tahuti: A geometrical sketch recognition system for uml class diagrams," in *ACM SIGGRAPH 2006 Courses*, p. 25, ACM, 2006. (cited on page 75).
- [68] E. Lank, J. Thorley, S. Chen, and D. Blostein, "On-line recognition of uml diagrams," in *Document Analysis and Recognition, 2001. Proceedings. Sixth International Conference on*, pp. 356–360, IEEE, 2001. (cited on page 75).
- [69] E. Lank, J. S. Thorley, and S. J.-S. Chen, "An interactive system for recognizing hand drawn uml diagrams," in *Proceedings of the 2000 conference of the Centre for Advanced Studies on Collaborative research*, p. 7, IBM Press, 2000. (cited on page 75).
- [70] L. Qiu, "Sketchuml: The design of a sketch-based tool for uml class diagrams," in *World Conference on Educational Multimedia, Hypermedia and Telecommunications*, vol. 2007, pp. 986–994, 2007. (cited on page 75).
- [71] M. Scott, "Wordsmith tools version 7," 2016. (cited on page 78).
- [72] J. Di Rocco, D. Di Ruscio, L. Iovino, and A. Pierantonio, "Collaborative repositories in model-driven engineering [software technology]," *IEEE Software*, no. 3, pp. 28–34, 2015. (cited on page 79).
- [73] F. Basciani, J. Di Rocco, D. Di Ruscio, L. Iovino, and A. Pierantonio, "Model repositories: Will they become reality ?," in *CloudMDE Workshop at MoDELS 2015, Ottawa, Canada*, 2015. (cited on page 79).
- [74] M. Lanza and R. Marinescu, *Object-oriented metrics in practice: using software metrics to characterize, evaluate, and improve the design of object-oriented systems*. Springer Science & Business Media, 2007. (cited on page 80).

- [75] A. Maraee and M. Balaban, "Efficient recognition of finite satisfiability in uml class diagrams: Strengthening by propagation of disjoint constraints," in *Model-Based Systems Engineering, 2009. MBSE'09. International Conference on*, pp. 1–8, IEEE, 2009. (cited on page 80).
- [76] C. Secchi, C. Fantuzzi, and M. Bonfe, "On the use of uml for modeling physical systems," in *Robotics and Automation, 2005. ICRA 2005. Proceedings of the 2005 IEEE International Conference on*, pp. 3990–3995, April 2005. (cited on page 81).
- [77] K. C. Thramboulidis, "Using uml in control and automation: a model driven approach," in *Industrial Informatics, 2004. INDIN'04. 2004 2nd IEEE International Conference on*, pp. 587–593, IEEE, 2004. (cited on page 81).
- [78] J. Wust, "Sdmetrics: The software design metrics tool for uml," 2014. (cited on page 81).
- [79] T. Ho-Quang, M. Chaudron, I. Samuelsson, J. Hjaltason, B. Karasneh, and H. Osman, "Automatic classification of uml class diagrams from images," in *Software Engineering Conference (APSEC), 2014 21st Asia-Pacific*, vol. 1, pp. 399–406, Dec 2014. (cited on page 82).
- [80] J. Cohen, *Statistical power analysis for the behavioral sciences*. Academic press, 2013. (cited on page 100).
- [81] D. Radjenović, M. Heričko, R. Torkar, and A. Živkovič, "Software fault prediction metrics: A systematic literature review," *Information and Software Technology*, vol. 55, no. 8, pp. 1397 – 1418, 2013. (cited on page 103).
- [82] B. Venners, "How to use design patterns. a conversation with erich gamma, part i," *Leading-Edge Java*, 2005. (cited on page 104).
- [83] W. H. Brown, R. C. Malveau, and T. J. Mowbray, "Antipatterns: refactoring software, architectures, and projects in crisis," 1998. (cited on page 104).
- [84] N. Moha, Y.-G. Gueheneuc, L. Duchien, and A.-F. Le Meur, "Decor: A method for the specification and detection of code and design smells," *Software Engineering, IEEE Transactions on*, vol. 36, no. 1, pp. 20–36, 2010. (cited on pages 104, 107 and 117).
- [85] A. Maiga, N. Ali, N. Bhattacharya, A. Sabane, Y.-G. Guéhéneuc, and E. Aimeur, "Smurf: A svm-based incremental anti-pattern detection approach," in *Reverse Engineering (WCRE), 2012 19th Working Conference on*, pp. 466–475, IEEE, 2012. (cited on pages 104, 107 and 117).
- [86] M. Tufano, F. Palomba, G. Bavota, R. Oliveto, M. Di Penta, A. De Lucia, and D. Poshyvanyk, "When and why your code starts to smell bad," in *Software Engineering (ICSE), 2015 IEEE/ACM 37th IEEE International Conference on*, vol. 1, pp. 403–414, May 2015. (cited on pages 104, 105 and 117).

- [87] S. Vaucher, F. Khomh, N. Moha, and Y.-G. Guéhéneuc, "Tracking design smells: Lessons from a study of god classes," in *Reverse Engineering, 2009. WCRE'09. 16th Working Conference on*, pp. 145–154, IEEE, 2009. (cited on pages 104, 105, 111 and 117).
- [88] A. Chatzigeorgiou and A. Manakos, "Investigating the evolution of bad smells in object-oriented code," in *Quality of Information and Communications Technology (QUATIC), 2010 Seventh International Conference on the*, pp. 106–115, Sept 2010. (cited on page 104).
- [89] F. Khomh, M. Di Penta, Y.-G. Guéhéneuc, and G. Antoniol, "An exploratory study of the impact of antipatterns on class change-and fault-proneness," *Empirical Software Engineering*, vol. 17, no. 3, pp. 243–275, 2012. (cited on pages 105 and 117).
- [90] Y.-G. Gueheneuc and G. Antoniol, "Demima: A multilayered approach for design pattern identification," *IEEE Transactions on Software Engineering*, vol. 34, no. 5, pp. 667–684, 2008. (cited on page 107).
- [91] G. Y-G, H. Sahraoui, and F. Zaidi, "Fingerprinting design patterns," in *Reverse Engineering, 2004. Proceedings. 11th Working Conference on*, pp. 172–181, Nov 2004. (cited on page 107).
- [92] J. Q. Wilson and G. L. Kelling, "Broken windows-the police and neighborhood safety (1982)," *Atlantic Monthly*, vol. 29, p. 31. (cited on page 114).
- [93] J. Q. Wilson and G. L. Kelling, "Broken windows-the police and neighborhood safety (1982)," *Atlantic Monthly*, vol. 29, p. 31. (cited on page 116).
- [94] R. K. Yin, *Case study research: Design and methods*. Sage publications, 2013. (cited on page 117).
- [95] L. Craig, "Applying uml and patterns," *Tredje upplagan, Prentice Hall*, 2002. (cited on page 122).
- [96] R. W. Hasker, "Umlgrader: an automated class diagram grader," *Journal of Computing Sciences in Colleges*, vol. 27, no. 1, pp. 47–54, 2011. (cited on page 122).
- [97] R. W. Hasker and M. Rowe, "Umlint: Identifying defects in uml diagrams," in *American Society for Engineering Education*, American Society for Engineering Education, 2011. (cited on page 122).
- [98] L. B. Christensen, B. Johnson, and L. A. Turner, *Research methods, design, and analysis*. Allyn & Bacon, 2011. (cited on page 123).
- [99] D. C. Montgomery, *Design and analysis of experiments*. John Wiley & Sons, 2008. (cited on page 123).
- [100] W. F. Tichy, "Hints for reviewing empirical work in software engineering," *Empirical Software Engineering*, vol. 5, no. 4, pp. 309–312, 2000. (cited on page 123).

- [101] D. I. Sjøberg, J. E. Hannay, O. Hansen, V. B. Kampenes, A. Karahasanovic, N.-K. Liborg, and A. C. Rekdal, "A survey of controlled experiments in software engineering," *Software Engineering, IEEE Transactions on*, vol. 31, no. 9, pp. 733–753, 2005. (cited on page 123).
- [102] J. Boustedt, "Students' different understandings of class diagrams," *Computer Science Education*, vol. 22, no. 1, pp. 29–62, 2012. (cited on page 123).
- [103] N. H. Ali, Z. Shukur, and S. Idris, "A design of an assessment system for uml class diagram," in *Computational Science and its Applications, 2007. ICCSA 2007. International Conference on*, pp. 539–546, IEEE, 2007. (cited on page 123).
- [104] G. Hoggarth and M. Lockyer, "An automated student diagram assessment system," in *ACM SIGCSE Bulletin*, vol. 30, pp. 122–124, ACM, 1998. (cited on page 123).
- [105] S. Kaneda, A. Ida, and T. Sakai, "Understanding of class diagrams based on cognitive linguistics for japanese students," in *Knowledge-Based Software Engineering*, pp. 77–86, Springer, 2014. (cited on page 124).
- [106] D. Aguilera, C. Gómez, and A. Olivé, "A complete set of guidelines for naming uml conceptual schema elements," *Data & Knowledge Engineering*, vol. 88, pp. 60–74, 2013. (cited on page 124).
- [107] B. Selic, "The pragmatics of model-driven development," *IEEE software*, no. 5, pp. 19–25, 2003. (cited on page 124).
- [108] *Supplemental materials for the controlled experiment*, 2015. http://www.models-db.com/Models2015_SupplementalMaterial.aspx. (cited on pages 126 and 140).
- [109] B. Efron and R. J. Tibshirani, *An introduction to the bootstrap*. CRC press, 1994. (cited on page 126).
- [110] I. Spss, "Ibm spss statistics version 21," *Boston, Mass: International Business Machines Corp*, 2012. (cited on page 126).
- [111] B. Karasneh and M. R. Chaudron, "Online img2uml repository: An online repository for uml models," in *EESSMOD@ MoDELS*, pp. 61–66, 2013. (cited on pages 136 and 137).
- [112] *UML Repository, web-site: www.models-db.com*, 2013. (cited on pages 136 and 137).
- [113] T. Van Gog, L. Kester, and F. Paas, "Effects of worked examples, example-problem, and problem-example pairs on novices' learning," *Contemporary Educational Psychology*, vol. 36, no. 3, pp. 212–218, 2011. (cited on page 137).
- [114] R. L. Goldstone and J. Y. Son, "The transfer of scientific principles using concrete and idealized simulations," *The Journal of the Learning Sciences*, vol. 14, no. 1, pp. 69–110, 2005. (cited on page 137).

- [115] R. M. Seater, *Core extraction and non-example generation: Debugging and understanding logical models*. PhD thesis, Massachusetts Institute of Technology, 2004. (cited on page 137).
- [116] M. L. Gick and K. J. Holyoak, "Schema induction and analogical transfer," *Cognitive psychology*, vol. 15, no. 1, pp. 1–38, 1983. (cited on page 137).
- [117] K. Bąk, D. Zayan, K. Czarnecki, M. Antkiewicz, Z. Diskin, A. Wąsowski, and D. Rayside, "Example-driven modeling: model= abstractions+ examples," in *Proceedings of the 2013 International Conference on Software Engineering*, pp. 1273–1276, IEEE Press, 2013. (cited on page 137).
- [118] D. Zayan, M. Antkiewicz, and K. Czarnecki, "Effects of using examples on structural model comprehension: a controlled experiment," in *Proceedings of the 36th International Conference on Software Engineering*, pp. 955–966, ACM, 2014. (cited on page 137).
- [119] B. Sharif and J. I. Maletic, "An eye tracking study on the effects of layout in understanding the role of design patterns.," in *ICSM*, pp. 1–10, 2010. (cited on page 137).
- [120] H. Storrle, "On the impact of layout quality to understanding uml diagrams: Diagram type and expertise," in *Visual Languages and Human-Centric Computing (VL/HCC), 2012 IEEE Symposium on*, pp. 49–56, IEEE, 2012. (cited on page 137).
- [121] H. Störrle, "On the impact of layout quality to understanding uml diagrams: Size matters," in *Model-Driven Engineering Languages and Systems*, pp. 518–534, Springer, 2014. (cited on page 137).
- [122] A. Nugroho, "Level of detail in uml models and its impact on model comprehension: A controlled experiment," *Information and Software Technology*, vol. 51, no. 12, pp. 1670–1685, 2009. (cited on page 137).
- [123] N. Juristo and A. M. Moreno, *Basics of software engineering experimentation*. Springer Publishing Company, Incorporated, 2010. (cited on pages 138 and 141).
- [124] S. S. Shapiro and M. B. Wilk, "An analysis of variance test for normality (complete samples)," *Biometrika*, pp. 591–611, 1965. (cited on page 141).
- [125] H. B. Mann and D. R. Whitney, "On a test of whether one of two random variables is stochastically larger than the other," *The annals of mathematical statistics*, pp. 50–60, 1947. (cited on page 141).
- [126] R. C. Team, "The r project for statistical computing," *R Foundation for Statistical Computing web-site. www.R-project.org*. Accessed June, vol. 9, 2014. (cited on page 141).
- [127] R. Wirfs-Brock and A. McKean, *Object design: roles, responsibilities, and collaborations*. Addison-Wesley Professional, 2003. (cited on page 156).