In this "40 years of formal methods" essay we shall first delineate, Sect. 1, what we mean by method, formal method, computer science, computing science, software engineering, and model-oriented and algebraic methods. Based on this, we shall characterize a spectrum from specification-oriented methods to analysis-oriented methods. Then, Sect. 2, we shall provide a "survey": which are the 'prerequisite works' that have enabled formal methods, Sect. 2.1, and which are, to us, the, by now, classical 'formal methods', Sect. 2.2. We then ask ourselves the question: have formal methods for software development, in the sense of this paper been successful? Our answer is, regretfully, no! We motivate this answer, in Sect. 3.2, by discussing eight obstacles or hindrances to the proper integration of formal methods in university research and education as well as in industry practice. This "looking back" is complemented, in Sect. 3.4, by a "looking forward" at some promising developments-besides the alleviation of the (eighth or more) hindrances! © 2014 Springer International Publishing Switzerland.
Domain Endurants: An Analysis and Description Process Model

We present a summary, Sect. 2, of a structure of domain analysis and description concepts: techniques and tools. And we link, in Sect. 3, these concepts, embodied in domain analysis prompts and domain description prompts, in a model of how a diligent domain analyst cum describer would use them. We claim that both sections, Sects. 2–3, contribute to a methodology of software engineering.

A Survey of Formal Methods in Software Development

The use of formal methods and formal techniques in industry is steadily growing. In this survey we shall characterise what we mean by software development and by a formal method; briefly overview a history of formal specification languages - some of which are: VDM (Vienna Development Method, 1974-..., [1]), Z (Z for Zermelo Fraenkel, 1980-..., [2]), RAISE (Rigorous Approach to Industrial Software Engineering, 1987-..., [3]) Event B (B for Bourbaki, 1990/2000-..., [4]) and Alloy [5]; and outline the basics of a formal development using, for example, RAISE: first developing a domain description D, then a requirements prescription R, and finally a software design S - showing (arguing or formally proving) that S, in the context of D satisfies (is correct with respect to) R. We shall then mention industries in Japan, Europe and USA which, in a number of projects, use formal methods; discuss what it takes for an industry to do so; discuss what education that candidates for these industries need, that is, which courses must be part of a BSc/MSc Software Engineering curriculum. Finally we shall comment on distinctions between formal methods and formal techniques; limitations of mono-language formalisations, hence need for multi-language formalisation (Petri Nets, MSC, StateChart, Temporal Logics); the sociology of university and industry acceptance of formal methods; the inevitability of the use of formal software development methods; while referring to seminal monographs and textbooks on formal methods.
Specifying Geographic Information - Ontology, Knowledge Representation, and Formal Constraints

This thesis deals with the specification of geographic information. On the basis of the role of geographic information as an infrastructure element, a method is developed for the making of specifications which are well-structured and ensure the connection between the data collections being part of a joint infrastructure. The motivation for the presented work is to meet the need for topical geographic information at any time, so that the requirements for data content and quality are fulfilled, and the information can thus form actively part of the task performance in public administration as well as in the private sector. The theoretical background is the establishment of a representational system, which ontologically comprises a representation of notions in the "real world" and notions which include the representation of these. Thus, the thesis leans towards a traditional division between modeling of domains and conceptualization of these. The thesis contributes a formalization of what is understood by domain models and conceptual models, when the focus is on geographic information. Moreover, it is shown how specifications for geographic information are related to this representational system. The starting point of the thesis is an analysis mapping the elements in a specification for geographic information. The basis of this empirical investigation is TOP10DK's data content specification, version 3.2 of the National Survey and Cadastre. The basic idea is to view a specification as a collection of requirements and rules, building on terms from the domain and concept ontologies. In combination with the theoretical basis the analysis is used for developing an underlying model of notions, which defines the individual elements in a specification and the relations between them. In the chapters of the thesis this underlying model is extended to include a number of components, which each contribute to the model being able to form the basis of a strong and productive specification tool for the making and maintenance of specifications for geographic information. These components among others include description of quality requirements and formalization of rules, so that they can be used for verification of produced information. An essential contribution is a formal specification language dedicated to the formulation of formal rules to be observed by the information. The language is based on a formal semantic model which makes translation into other languages possible. In the thesis it is shown how statements can be translated into SQL and thus form the basis of direct implementation in the production environments where the geographic information is procured. To be able to describe requirements for the quality of geographic information is an essential part of a specification. The thesis contributes a structure of quality descriptions by introducing two notions: "Acceptable Quality Levels" (AQL) and "Quality Element Requirements" (QER), which designate respectively the minimum quality requirements for information produced according to a given specification and the requirements for the quality parameters used to describe this information. The two notions are incorporated and related to the developed system of notions for specification for geographic information. It is an important part of an infrastructure for geographic information that there is a connection between the individual data collections. This thesis argues for ensuring the connection by first and foremost describing these as an integrated part of the specification work. The thesis contributes a model which describes relations and dependencies by writing specifications in the context of one or more other specifications. As an illustration of the applications of specifications written in the developed specification language, a concept is developed in the thesis to make possible a decentralized collection and distribution of information about changes to be used for updating geographic information.
A Cloverleaf of Software Engineering

We shall touch upon four issues of software engineering (SE): domain engineering, formal techniques, SE sociology, and academic software architects. First, before software can be designed one must understand its requirements; but before requirements can be formulated one must understand the domain. So we assume that requirements development is based on first having established models of the (application) domain. We illustrate facets of the railway domain. Second, we touch upon all of the three phases: domain engineering, requirements engineering and software design also being done formally, however "lite". Third, despite 35 years of formal methods, the SE industry, maturity-wise still lags far behind that of other engineering disciplines. So we examine why. Finally, in several areas, in health care, in architecture, and others, we see that major undertakings are primarily spearheaded by senior academic staff. Professors of medicine daily perform specialized surgery and treatments at hospitals. Professors of architecture design new, daring buildings for industry, and professors of civil engineering head the engineering structural design of new, daring bridges. So we speculate what a similar approach would entail for SE. The paper is provocative, it postulates, but most claims are not (but
can and will be) substantiated.

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 75-85
Publication date: 2005

**Host publication information**
Publisher: IEEE
ISBN (Print): 0-7695-2435-4
Main Research Area: Technical/natural sciences
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10.1109/SEFM.2005.2
Source: orbit
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Publication: Research - peer-review › Article in proceedings – Annual report year: 2005

**An Example Railway Domain**

**General information**
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 29-39
Publication date: 2005
Main Research Area: Technical/natural sciences

**Publication information**
Journal: British Computer Society FACTS FACT
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Original language: English
Links:
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Source: orbit
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Publication: Research › Journal article – Annual report year: 2005

**Multimodal Transportation Nets**

**General information**
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Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern), Boca, P. (ed.) (Ekstern)
Pages: 30
Publication date: 2005
Main Research Area: Technical/natural sciences

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Journal: British Computer Society FACS FACT
Issue number: 4
Original language: English
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Source: orbit
Source-ID: 185650
Publication: Research › Journal article – Annual report year: 2005
Construction informatics - Issues in engineering, computer science and ontology

This Ph.D. thesis studies issues in the area of construction informatics. Construction informatics is the theoretical study of formal and conceptual aspects in the domain of civil engineering and design. The thesis is a collection of papers which each treat a specific subject within domain analysis and conceptual modelling of civil engineering and design. Due to the
interdisciplinary content, the first half of the study has been carried out at Department of Civil Engineering (BYG'DTU), The Technical University of Denmark; whereas the second half has been carried out at Informatics and Mathematical Modelling, The Technical University of Denmark. Supervisors have been Prof. Dines Bjørner (IMM) and Per Galle (BYG'DTU). The idea was to initiate the study at a place where engineering issues are discussed on a daily basis, and where the practical and theoretical knowledge of the domain is present. With origin in civil engineering and design issues, the study was directed towards computer science oriented theories in an attempt to introduce such theories in modelling and clarification of the domain. This strategy turned out to be a strength for the study and this thesis. However, it also discovered some problems in carrying out such a truly interdisciplinary Ph.D. study. Per Galle’s and Dines Bjørner’s common background in computer science has been essential for the success of this study. The original title of the Ph.D. project was Design and application of a civil engineering ontology. However, it became clear that there were going to be two main streams in the thesis, and that an actual monograph was not an appropriate format for the thesis. The main streams are both rooted in civil engineering ontology, and they are bound together by the overall issue of how civil engineering concepts relate. The issues of the thesis are treated from three angles: from computer science, from civil engineering and design theory, and from philosophy. It is characteristic for the thesis that these angles are all present in analysis and argumentation. The philosophical aspect is a natural ingredient as construction informatics primarily concerns the fundamental conceptual structures, and how models of these relate to engineering and design practice and reality. The aspect of design has been given high priority because this subject concerns the relation between representation and artefacts - a subject which is also essential in computer science, and which is deeply rooted in philosophy.

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State: Published

Organisations: Department of Civil Engineering, Department of Informatics and Mathematical Modeling

Authors: Eir, A. (Intern), Bjørner, D. (Intern), Galle, P. (Intern)

Publication date: Jul 2004

**Publication information**

Original language: English

Main Research Area: Technical/natural sciences

Electronic versions:

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imm3149.zip

Links:


Source: orbit

Source-ID: 154828

Publication: Research › Ph.D. thesis – Annual report year: 2004

**From Railway Resource Planning to Train Operation - a Brief Survey of Complementary Formalisations**

In: Building the Information Society

**General information**

State: Published

Organisations: Department of Informatics and Mathematical Modeling

Authors: Penicka, M. (Intern), Bjørner, D. (Intern), Jacquart, R. (ed.) (Ekstern)

Pages: 629-636

Publication date: 2004

**Host publication information**

Title of host publication: IFIP 18th World Computer Congress, Toulouse, France

Publisher: Kluwer Academic Publishers

Main Research Area: Technical/natural sciences

Conference: IFIP 18th World Computer Congress, Toulouse, France, 01/01/2004

Source: orbit

Source-ID: 200319

Publication: Research - peer-review › Article in proceedings – Annual report year: 2004

**The TRain Topical Day**

**General information**

State: Published

Organisations: Department of Informatics and Mathematical Modeling

Authors: Bjørner, D. (Intern), Jacquart, R. (ed.) (Ekstern)

Pages: 607-611

Publication date: 2004
Towards a Formal Model of CyberRail

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern), Jacquart, R. (ed.) (Ekstern)
Pages: 657-664
Publication date: 2004

UML-ising formal techniques
This invited paper presents a number of correlated specifications of example railway system problems. They use a variety of partially or fully integrated formal specification. The paper thus represents a mere repository of what we consider interesting case studies. The existence of the Unified Modeling Language [10,67,36,20] has caused, for one reason or another, the research community to try formalise one or another facet of UML. In this paper we report on another way to achieve what UML attempts to achieve: Broadness of application, convenience of notation, and multiplicity of views. Whether these different UML views are unified, integrated, correlated or merely co-located is for others to dispute. We also seek to support multiple views, but are also in no doubt that there must be sound, well defined relations between such views. We thus report on ways and means of integrating formal techniques such as RAISE (RSL) [58,59], Petri Nets [56,62,37,61,411], Message and Live Sequence Charts [42,43,44,64,13], Statecharts [23,24,26,27], RAISE with Timing (TRSL) [18,45,46], and TRSL with Duration Calculus (79,30]. In this way one achieves a firm foundation for combined uses of these formal development techniques, one that can be believably deployed for as wide a spectrum, or even a wider spectrum of software (and hardware) development, as, respectively than UML.
An Ontology for a TripTych Formal Software Development

An ontology, i.e., a formalised set of strongly interrelated definitions, is given for an approach to software development that spans domain engineering, requirements engineering and software design - and which is otherwise based on a judicious use of both informal and formal, mathematics-based techniques.


An analysis is presented, in the form both of an informal narrative and a formal model of "The Market" of buyers and sellers, agents, brokers and traders - who inquire about products and services, issue quotations, orders, delivers, receives, accepts, invoices, pays, rejects, returns and gets refund on such products and services. The analysis is "lifted" to apply to intra government, intra business and intra citizen, as well as any pairing of these: G2G, G2B, G2C, B2G, B2B, B2C, C2G, C2B, and C2C.
Dynamics of Railway Nets: On an Interface between Automatic Control and Software Engineering

New Results and Trends in Formal Techniques for the Development of Software for Transportation Systems.

Railway Staff Rostering
The SE Book: Principles and Techniques of Software Engineering or An ABZ of The Theory & Practice of Software Engineering

This "epos" emphasises (1) software development from both a formal and an informal approach; (2) the use of mathematics, logic and algebras, as well as discrete mathematics: Sets, Cartesians, lists, functions, maps; (3) property as well as model-oriented specifications; (4) semiotics in the form of formalisable syntax and semantics and in-formalisable pragmatics; abstraction and modelling techniques such as (5) hierarchies and compositions; (6) denotations and computations; (7) configurations as contexts and states; (8) time, space and space/time; (9) various modal logics; (10) description theory; (11) the TripTych of domain analysis, requirements engineering and software design -- and much much more. It relates all aspects of (12) platform technologies, (13) legal issues of software, (14) quality assurance, and (15) project and product management to the above (1-11 incl.). Highlights of the book series are: (A) Emphasis on design: Literally a thousand development examples are given; and on "Calculi" of (B) domain and (C) requirements engineering: Domain facet "operators" like: (d.1) Instrinsics, (d.2) support technology, (d.3) management & organisation, (d.4) rules & regulations, (d.5) human behaviour, and (d.6) domain specific script languages, as well as domain requirements operators such as (c.1) projection, (c.2) determination, (c.3) instantiation, (c.4) extension, (c.5) fitting, and (c.6) initialisation. The concepts of objects and components likewise receive an altogether new and simpler treatment.

Towards Design Calculi for Requirements Engineering and Software Design

Train Maintenance Routing
What is a method? An Essay on some aspects of software engineering.
We examine some methodological principles and techniques of modeling such domain facets as: Intrinsics, support technologies, management & organisation, rules & regulations, and human behaviour. for some of these we give example (formal) descriptions; for others we formalise the principles and techniques.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 175-203
Publication date: 2003

Computing Systems for Railways - A Role for Domain Engineering. Relations to Requirements Engineering and Software for Control Applications

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern), George, C. W. (Ekstern), Prehn, S. (Intern)
Publication date: 2002

Domain Models of "The Market" - in Preparation for E-Transaction Systems

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
What is an Infrastructure? Towards an Informatics Answer
Infrastructure components - such as transportation, health care, public administration, financial services, logistics - constitute large, man-made systems. Very large software systems have been and are being commissioned and requirements put forward without, we claim, the necessary documentation of the underlying domain being present. In this paper we examine what it takes to do so: To create theoris of application domains.

Danske infra-strukturer: Menneskeskabte systemer og deres IT

Domain modelling: resource management strategics, tactics and operations, decision support and algorithmic software
Informatics Models of Infrastructure Domains

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 13-73
Publication date: 2001

Host publication information
Title of host publication: Computer Science and Information Technologies
Publisher: Institute for Informatics and Automation Problems
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 57825
Publication: Research - peer-review › Article in proceedings – Annual report year: 2001

On formal techniques in protocol engineering - example challenges

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 395-420
Publication date: 2001

Host publication information
Title of host publication: IFIP WG6.1 Formal Techniques for Networked and Distributed Systems
Main Research Area: Technical/natural sciences
Links:
Source: orbit
Source-ID: 57824
Publication: Research - peer-review › Article in proceedings – Annual report year: 2001

On teaching software engineering based on formal techniques

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 641-667
Publication date: 2001
Main Research Area: Technical/natural sciences

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Journal: Journal of Universal Computer Science
Volume: 7
Issue number: 8
ISSN (Print): 0948-695X
Ratings:
BFI (2018): BFI-level 1
BFI (2017): BFI-level 1
Web of Science (2017): Indexed Yes
BFI (2016): BFI-level 1
Scopus rating (2016): SJR 0.307 SNIP 0.743 CiteScore 0.98
BFI (2015): BFI-level 1
Scopus rating (2015): SJR 0.371 SNIP 0.82 CiteScore 0.95
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**Perspectives of System Informatics, IV**

**General information**

State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern), Broy, M. (ed.) (Ekstern), Zamulin, A. V. (ed.) (Ekstern)
Publication date: 2001

**Publication information**

Publisher: Springer Verlag
Original language: English
Main Research Area: Technical/natural sciences
Links:

**Systematic use of E/S-commerce by governments**

An informatics science and technology view of an infrastructure component.

**General information**
Towards the E-Market: To understand the E-Market we must first understand "The Market"

Domain Engineering - A Software Engineering discipline in Need of Research
Before software can be developed its requirements must be stated. Before requirements can be expressed the application domain must be understood. In this paper we outline some of the basic facets of domain engineering. Domains seem, it is our experience, far more stable than computing requirements, and these again seem more stable than software designs. Thus, almost like the universal laws of physics, it pays off to first develop theories of domains. But domain engineering, as in fact also requirements engineering, really is in need of thoroughly researched development principles, techniques and tools. The aim of this paper is to advocate: that researchers study these development method components, and that universities focus their education on basing well-nigh any course on the use of formal techniques: Specification and verification, and that software engineers take heed: Start applying formal techniques. A brief example of describing stakeholder perspectives will be given - on the background of which we then proceed to survey the notions of domain intrinsics, domain support technologies, domain management & organisation, domain rules & regulations, domain human behaviour, etc. We show elsewhere how to "derive" requirements from domain descriptions. Domain requirements: by domain projection, instantiation, extension and initialisation; interface requirements: multi-media, dialogue, etc.; and machine requirements: performance, dependability (reliability, availability, accessibility, safety, etc.), and maintainability (adaptability, perfectability and correctability). The current paper presents work-in-progress. The text of the paper is therefore very schematic.
Informatics: A Truly Interdisciplinary Science Prospects for an Emerging World

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State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 2000

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Place of publication: Bangkok, Thailand
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 176458
Publication: Research - peer-review › Article in proceedings – Annual report year: 2000

Pinnacles of Software Engineering: 25 Years of Formal Methods

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern), Yi, W. (Ekstern), Patel, D. (Ekstern)
Pages: 11-66
Publication date: 2000
Main Research Area: Technical/natural sciences

Publication information
Journal: Annals of Software Engineering
Volume: 10
ISSN (Print): 1022-7091
Ratings:
BFI (2012): BFI-level 1
BFI (2008): BFI-level 1
Scopus rating (2005): SJR 0.597 SNIP 2.499
Scopus rating (2004): SJR 0.366 SNIP 1.42
Scopus rating (2003): SJR 0.428 SNIP 1.536
Scopus rating (2002): SJR 0.442 SNIP 0.791
Scopus rating (2001): SJR 0.287 SNIP 0.763
Scopus rating (2000): SJR 0.317 SNIP 0.98
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.241 SNIP 0.513
Original language: English
Links:
http://www2.imm.dtu.dk/pubdb/p.php?936
Source: orbit
Source-ID: 199512
Publication: Research - peer-review › Journal article – Annual report year: 2000

A Triptych Software Development Paradigm: Domain, Requirements and Software

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Computing from Unconventional Viewpoints

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Pages: 87-114
Publication date: 1999

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Title of host publication: Informatics - The Future of Information Society
Place of publication: Takatsuki, Osaka, Japan
Publisher: School of Informatics, Kansai Univ.
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 172176
Publication: Research - peer-review › Book chapter – Annual report year: 1999

Where do Software Architectures come from ?: Systematic Development from Domains and Requirements. A Re-assessment of Software Engineering?

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling
Authors: Bjørner, D. (Intern)
Pages: 3-13
Publication date: 1999
Main Research Area: Technical/natural sciences

Publication information
Journal: South African Journal of Computer Science
Volume: 22
Original language: English
Links:
http://www2.imm.dtu.dk/pubdb/p.php?931
Source: orbit
Source-ID: 172174
Publication: Research - peer-review › Journal article – Annual report year: 1999

Challenges in Domain Modelling: Algebraic or Otherwise

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1998

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Title of host publication: The CafeOBJ Workshop
Place of publication: Kanazawa, Japan
Challenges in Domain Modelling - Algebraic or Otherwise

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1998

Host publication information
Title of host publication: CafeOBJ Workshop
Place of publication: Kanazawa, Japan
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Main Research Area: Technical/natural sciences
Conference: CafeOBJ Workshop, 27-29 April, Numazu, Shizuoka, Japan, 01/01/1998
Source: orbit
Source-ID: 167701
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Domains as a Prerequisite for Requirements and Software: Doain Perspectives and Facets, Requirements Aspects and Software Views

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1998

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Title of host publication: Requirements Targeting Software and Systems Engineering
Place of publication: Heidelberg
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: Requirements Targeting Software and Systems Engineering, Bernried am Staarnberger See, Bavaria, Germany, 01/01/1997
Source: orbit
Source-ID: 167284
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998

Formal Methods in the 21'st Century: An Assessment of Today - Predictions for the Future

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1998

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Title of host publication: ICSE'98: Intl. Conf. on Software Engineering
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Publisher: IEEE Computer Society Press
Main Research Area: Technical/natural sciences
Conference: ICSE'98: Intl. Conf. on Software Engineering, Kyoto, Japan, 01/01/1997
Source: orbit
Source-ID: 167702
Publication: Research › Article in proceedings – Annual report year: 1998
Issues in International Cooperative Research: Why not African, Asian and Latin American 'Esprits'?

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1998

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Title of host publication: Asia Pacific Forum on Software Engineering
Place of publication: Tokyo
Publisher: SEA: Software Engineering Association of Japan
Main Research Area: Technical/natural sciences
Conference: Asia Pacific Forum on Software Engineering, ICSE’98 Workshop, 20-21 April, Kyoto, Japan, 01/01/1998
Source: orbit
Source-ID: 167294
Publication: Research - peer-review › Article in proceedings – Annual report year: 1998


General information
State: Published
Organisations: Department of Information Technology, Siemens Research, Munich
Authors: Bjørner, D. (Intern), Cuellar, J. R. (Ekstern)
Publication date: 1998
Main Research Area: Technical/natural sciences

Publication information
Journal: Annals of Software Engineering
ISSN (Print): 1022-7091
Ratings:
BFI (2012): BFI-level 1
BFI (2008): BFI-level 1
Scopus rating (2005): SJR 0.597 SNIP 2.499
Scopus rating (2004): SJR 0.366 SNIP 1.42
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Scopus rating (2002): SJR 0.442 SNIP 0.791
Scopus rating (2001): SJR 0.287 SNIP 0.763
Scopus rating (2000): SJR 0.317 SNIP 0.98
Web of Science (2000): Indexed yes
Scopus rating (1999): SJR 0.241 SNIP 0.513
Original language: English
Source: orbit
Source-ID: 172173
Publication: Research - peer-review › Journal article – Annual report year: 1998

Where do software architectures come from?: The Devt. of an Airline Time-table System

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1998

Host publication information
Title of host publication: The JSSST Annual Conference
Place of publication: Tokyo, Japan
Publisher: Japan Society for Software Science and technology
Main Research Area: Technical/natural sciences
Conference: JSSST Annual Conference, Tokyo, Japan, 01/01/1998
Source: orbit
Source-ID: 172178
Publication: Research - peer-review › Book chapter – Annual report year: 1998
A Formal Software Engineering Paradigm: From Domains via Requirements to Software. Formal Specification and Design Calculi

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Pages: 219-248
Publication date: 1997

Host publication information
Title of host publication: SOFSEM'97: Theory and Practice of Informatics
Place of publication: Heidelberg
Publisher: Springer Verlag
Main Research Area: Technical/natural sciences
Conference: SOFSEM'97: Software Seminar, Milovy, Czech Republic, 01/01/1997
Source: orbit
Source-ID: 167326
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

A Normative Model of Concrete Banking Operations

General information
State: Published
Organisations: Department of Information Technology
Authors: Bjørner, D. (Intern)
Publication date: 1997

Publication information
Original language: English
Main Research Area: Technical/natural sciences
Links:
http://www.it.dtu.dk/~db/bancs/bancs.html
Source: orbit
Source-ID: 167297
Publication: Research - peer-review › Report – Annual report year: 1997

Michael Jackson's Frame Problems

General information
State: Published
Organisations: Department of Information Technology, IAI, CIT
Authors: Bjørner, D. (Intern), Koussoube, S. (Ekstern), Noussi, R. (Ekstern), Satchok, G. (Ekstern)
Publication date: 1997

Host publication information
Title of host publication: ICFEM'97: Intl. Conf. on Formal Engineering Methods
Place of publication: Los Alamitos, Calif., USA
Publisher: IEEE CS Press
Main Research Area: Technical/natural sciences
Conference: ICFEM'97: Intl. Conf. on Formal Engineering Methods, Hiroshima, Japan, 01/01/1997
Source: orbit
Source-ID: 167291
Publication: Research - peer-review › Article in proceedings – Annual report year: 1997

Scheduling and rescheduling of trains

General information
State: Published
Organisations: Department of Information Technology, United Nations University International Institute for Software Technology, CRI A/S
Authors: Bjørner, D. (Intern), George, C. W. (Ekstern), Prehn, S. (Ekstern)
Formal, Model-oriented Software Development Methods - From VDM to ProCoS & from RAISE to LaCoS

The first author has been invited to reminisce over almost 20 years of his research into and application of formal methods in software development. The paper deals with model-oriented methods. The title of this paper mentions two methods: VDM (Vienna Development Method) and RAISE (Rigorous Approach to Industrial Software Engineering), the latter derived from the former, and two projects: ProCoS (Provably Correct Systems) and LaCoS (Large-scale Correct Systems). LaCoS is a follow-up on RAISE. ProCoS adheres to the same principles as VDM as VDM and RAISE, but with a twist! The paper will outline the technical/scientific essence of the VDM and RAISE methods, and explain the ProCoS and LaCoS project structures. The paper will first outline five central roles of software developers: problem domain specialists, programmers, software engineers, resident computation scientists and managers. We will briefly illustrate examples of specifications in VDM and RAISE. The aim of the paper is to record that formal methods in software development are now well-developed and broadly accepted in Europe.
Formalization of Database Models

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Bjørner, D. (Intern), Løvengreen, H. H. (Intern)
Pages: 379-442
Publication date: 1982

Host publication information
Title of host publication: Formal Specification and Software Development
Main Research Area: Technical/natural sciences
Source: orbit
Source-ID: 200628
Publication: Research - peer-review › Book chapter – Annual report year: 1982

Formalization of Database Systems -- and a Formal Definition of (IMS)
Drawing upon an analogy between Programming Language Systems and Database Systems we outline the requirements that architectural specifications of database systems must fulfill, and argue that only formal, mathematical definitions may satisfy these. Then we illustrate some aspects and touch upon some of the exiting literature on formal definitions of database systems. The emphasis will be on constructive definitions in the denotational semantics style of the VCM: Vienna Development Nethd. The role of formal definitions in international standardization efforts is briefly mentioned.

General information
State: Published
Organisations: Department of Informatics and Mathematical Modeling, Computer Science and Engineering
Authors: Bjørner, D. (Intern), Løvengreen, H. H. (Intern)
Pages: 334-347
Publication date: 1982

Host publication information
Title of host publication: Eighth International Conference on Very Large Data Bases
Main Research Area: Technical/natural sciences
Conference: Eighth International Conference on Very Large Data Bases, 01/01/1982
Source: orbit
Source-ID: 199976
Publication: Research - peer-review › Article in proceedings – Annual report year: 1982
On a Formal Model of the Tasking Concepts of Ada

General information
State: Published
Organisations: Computer Science and Engineering, Department of Informatics and Mathematical Modeling
Pages: 213-222
Publication date: 1980

Host publication information
Title of host publication: ACM SIGPLAN Symposium on the Ada Programming Language
Main Research Area: Technical/natural sciences
Conference: ACM SIGPLAN Symposium on the Ada Programming Language, 01/01/1980
Source: orbit
Source-ID: 200209
Publication: Research - peer-review › Article in proceedings – Annual report year: 1980

Projects:

Geodata-Infrastruktur
Department of Informatics and Mathematical Modeling
Period: 01/02/2002 → 01/08/2007
Number of participants: 8
Phd Student:
Christensen, Jesper Vinther (Intern)
Supervisor:
Bjørner, Dines (Intern)
Frederiksen, Poul (Intern)
Jacobi, Ole Illum (Intern)
Main Supervisor:
Nilsson, Jørgen Fischer (Intern)
Examiner:
Villadsen, Jørgen (Intern)
Andreasen, Troels (Ekstern)
Östman, Anders (Ekstern)

Financing sources
Source: Internal funding (public)
Name of research programme: Ansat eksternt
Project: PhD

Design og Anvendelse af en byggeontologi - Design and Application of a civil engineering Ontology
Department of Informatics and Mathematical Modeling
Period: 01/02/2001 → 05/07/2004
Number of participants: 6
Phd Student:
Eir, Asger (Intern)
Supervisor:
Galle, Per (Intern)
Main Supervisor:
Bjørner, Dines (Intern)
Examiner:
Hansen, Bo Stig (Intern)
Pedersen, Stig Andur (Intern)
Turk, Ziga (Ekstern)
Financing sources
Source: Internal funding (public)
Name of research programme: DTU-lønnet stipendie
Project: PhD

AMORE

Department of Information Technology
Department of Informatics and Mathematical Modeling
University of Rome
University of Konstanz
University of Patras
Swiss Federal Institute of Technology
University of L'Aquila
Centrum Wiskunde & Informatica
Period: 01/04/2000 → 31/03/2003
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)

Financing sources
Source: Unknown
Name of research programme: Ukendt
Amount: 1,100,000.00 Danish Kroner

FMERail (ESPRIT Project EP26538)
This dissemination project aims at promoting the adoption of formal methods in the railway domain. The approach of the project is to arrange a series of workshops to show how different formal method technologies can be applied to railway problems.

Department of Information Technology
Department of Informatics and Mathematical Modeling
Instituttet for Anvendt Datateknik
TERMA Elektronik A/S
Formal Systems (Europe) Ltd.
Steria Méditerranée
Period: 01/01/1998 → 30/09/1999
Number of participants: 3
Project participant:
Bjørner, Dines (Intern)
Haxthausen, Anne Elisabeth (Intern)
Project Manager, organisational:
Hansen, Bo Stig (Intern)

Financing sources
Source: Overhead/overskud
Name of research programme: Overhead/overskud
Amount: 201,000.00 Danish Kroner

Domain and Requirements Engineering
Department of Information Technology
Period: 02/09/1997 → 01/07/2000
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)

Project

RaCoSy: Railway Computing Systems
Domain Models of entire Railway Systems: Nets, Lines, Stations; Routes; Time-tables; Timetables; Train Traffic; Marshalling; Ticketing; Development of New Services (new lines, new traffic, etc.)

Department of Information Technology
Period: 02/09/1997 → 01/09/2000
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)

Project

ATM'2000 - Air Traffic Management 2000
Domain Models, Requirements and Software Architectures for Air Traffic Systems: Monitoring & Control, Simulation and Training.

Department of Information Technology
Period: 02/07/1997 → 01/07/2000
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)

Project

BanCS - Banking Computing Systems
Domain Models of the Financial Service Industries: Banks, Insurance Companies, Securities (Brokers & Traders, Exchanges, etc.), Portofolio Mgt., etc.

Department of Information Technology
Period: 02/07/1997 → 01/07/2000
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)

Project

MiTraS: Metropolitan Transport Systems
Domain models, requirements and software architectures for metropolitan transport systems: busses, metros, taxis: net development, traffic scheduling, monitoring & control, resource allocation, new services (development etc.), etc.

Department of Information Technology
Period: 02/07/1997 → 01/07/2000
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)

Project

Software Architecture and Program Organisation
Specification and Design Techniques for the Derivation of Software Architectures from Requirements and Program Organisation Structures from Requirements and Software Architecture Design. See the Domain & Requirements Engineering Project.

Department of Information Technology
Period: 02/07/1997 → 01/07/2000
Number of participants: 1
Project Manager, organisational:
Bjørner, Dines (Intern)
Programudviklingsmodeller i et hypertextbaseret informationssystem

Department of Informatics and Mathematical Modeling
Period: 01/07/1990 → ...
Number of participants: 2
Phd Student: Lange, Danny B (Intern)
Main Supervisor: Bjørner, Dines (Intern)

Financing sources
Source: Internal funding (public)
Name of research programme: ATV- Gammel ordning
Project: PhD

ProCoS - Provably Correct Systems

Department of Information Technology
Period: 01/09/1989 → 28/02/1992
Number of participants: 1
Project Manager, organisational: Bjørner, Dines (Intern)
Project