

An Extended Systematic Mapping Study on Modeling Languages for Industry 4.0

The data collection

Overview

Slide 2

Total Papers

- Google Scholar: $971 + 606$ papers = 1577
- IEEE Xplore: $151 + 104$ papers = 255
- ACM DL: $104 + 34$ papers = 138
- SpringerLink: $240 + 102$ papers = 342
- Scopus 504 papers
- Web of Science 32 papers
- = 2848 papers

- Removed 561 duplicates = 2287 papers left

- Removed 1369 papers by criteria = 918 papers left

- Read and considered irrelevant 570 papers = 348 papers left


- Yields 348 relevant papers

ACM Digital Library: Restrictions and Query

Slide 3

- Full text search with complex query only possible by editing the Query manually

9"digital%20factory"%20OR%20"digital%20factories"%20OR%20"smart%20factory"%20OR%20"smart%20factories"%20OR%20"factory%20of%20the%20future"...

 RWTH Aachen University [SIGN IN](#) [SIGN UP](#)

Advanced Search

Select items from The ACM Guide to Computing Literature ?

Where Any field matches all of the following words or phrases: - +

[SEARCH](#) [\[clear\]](#)

[\[sign in required to save query\]](#) [\[hide query syntax\]](#)

Edit Query Query syntax is generated automatically; editing below will override this, to revert back, [Reset Query](#)

`content.ftsec:(("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR`

View Full Query Syntax

```
"query": { content.ftsec:(("digital factory" OR "digital factories" OR "smart factory" OR
"smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0")
AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling
language" OR "modelling language")) }
"filter": { owners.owner=GUIDE}
```

[Export query syntax](#)

Saved Queries

To save or access your saved queries please [sign in or create](#) a free Web account

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ACM DL DIGITAL LIBRARY

RWTH Aachen University

Searched for content.ftsec(("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language"))

Searched The ACM Guide to Computing Literature: 2,828,964 records [Limit your search to The ACM Full-Text Collection: 545,112]

Refinements: [remove all] click each refinement below to remove

Published before: 2018

182 results found

Refine by People

- Names ▾
- Institutions ▾
- Authors ▾
- Editors ▾
- Reviewers ▾

Refine by Publications

- Publication Names ▾
- ACM Publications ▾
- All Publications ▾
- Content Formats ▾
- Publishers ▾

Refine by Conferences

- Sponsors ▾
- Events ▾
- Proceeding Series ▾

Refine by Publication Year

Published Since 1984

Result 1 – 20 of 182

1 [Conceiving the model-driven smart factory](#)
Juan Cadavid, Mauricio Alf rez, S bastien G rard, Patrick Tessler
August 2015 ICSSP 2015: Proceedings of the 2015 International Conference
Publisher: ACM
Bibliometrics: Citation Count: 1
Downloads (6 Weeks): 4, Downloads (12 Months): 38,
Full text available: [PDF](#)
Manufacturing processes are undergoing major challenges to achieve the increase systematic processes reuse and improve understandability of con challenges recall closely those of software processes which have been such engineering techniques such as domain-specific modeling languages, mod
Keywords: Model-Driven Engineering, Smart Factories, ISA-95, Process f Manu- facturing Execution Systems, Modeling
[\[result highlights\]](#)

2 [A knowledge-based tool for designing cyber physical production](#)
E. Francalanza, J. Borg, C. Constantinescu
January 2017 Computers in Industry: Volume 84 Issue C, January 2017
Publisher: Elsevier Science Publishers B. V.
Bibliometrics: Citation Count: 0
Changing production systems and product requirements can trace their or evolving product requirements. This dynamic nature of customer requirem constantly moving target, thus presenting a significant challenge for sever deal with this constant and sometimes ...
Keywords: Digital factory, Industry 4.0, Decision making
[\[result highlights\]](#)

Upcoming Conferences

Please note that these and the following figures were created significantly after the submission and hence the illustrated numbers of results do not match exactly.

Google Scholar via Harzingers “Publish or Perish”: Restrictions and Query

Slide 5

- 256 Character limit → Replace “AND “ with “&” and “ OR “ with “|”
- ((("digital factory"|"digital factories"|"smart factory"|"smart factories"|"factory of the future"|"factories of the future"|"Industry 4.0") & ("metamodel"|"DSL"|"UML"|"domain-specific language"|"modeling language"|"modelling language"))

google scholar character limit

Alle Bilder News Shopping Videos Mehr

Ungefähr 36.100.000 Ergebnisse (0,60 Sekunden)

Google Scholar has 256 **character limit**, lacking truncation and nesting of search subexpressions for more than 1 level. 11.06.2014

8 surprising things I learnt about Google Scholar | musingsaboutlibrarianship.blogspot.com/2014/06/8-surprising-th

The screenshot shows two browser windows side-by-side. The left window displays Google Scholar search results for the query "cat" | "dog", showing approximately 4,860,000 results. The right window shows the same search results for the query "cat" OR "dog", also showing approximately 4,860,000 results. Below the browser windows is the Harzingers Publish or Perish software interface. The 'My queries' list shows a query for "cat" | "dog" with 760 papers and 9898 citations. The 'Google Scholar query' section shows the query: ((("digital factory"|"digital factories"|"smart factory"|"smart factories"|"factory of the future"|"factories of the future"|"Industry 4.0") & ("metamodel"|"DSL"|"UML"|"domain-specific language"|"modeling language"|"modelling language"))

Harzingers Publish or Perish

Scholar 2017

My queries

Saved queries

New Folder

Trash

Query	Source	Papers	Cites	Cites/y...	h
✓ ("digital factory" "digital facto...	Google Sc...	760	9898	291.12	48

Google Scholar query

Authors:

Publication/Journal:

All of the words:

Any of the words:

None of the words:

The phrase:

factories"|"factory of the future"|"factories of the future"|"Industry 4.0")&("metamodel"|"DSL"|"UML"|"domain-spec

Metrics

Help

	Cites	Per year	Rank	Authors	Title
Publication years: 1985-2017	✓ h 60	15.00*	1	D Karagiannis	Agile modeling method engineer
Citation years: 34 (1985-2019)	✓ 9	2.25	2	J Cadavid, M Alfér...	Conceiving the model-driven sm
Papers: 760	✓ 20	2.86	3	P Arnold, S Rudolph	Bridging the gap between produc
Citations: 9898	✓ h 54	13.50*	4	R Seiger, C Keller, ...	Modelling complex and flexible p
Cites/year: 291.12	✓ h 62	5.64	5	M Wieland, P Kacz...	Context integration for smart wor
Cites/paper: 13.02	✓ 9	1.29	6	Y Sun, J Gray, K Bu...	A model-driven approach to sup.
Cites/author: 4348.87	✓ 13	4.33	7	D Tchoffa, N Figay...	Digital factory system for dynami
Papers/author: 380.97	✓ 20	2.50	8	N Cipriani, M Wiel...	Tool support for the design and ..
Authors/paper: 2.84	✓ 7	2.33	9	C Büscher, H Voet...	Semantic information modelling
h-index: 48	✓ 38	9.50	10	AAF Saldivar, Y Li, ...	Industry 4.0 with cyber-physical i
g-index: 84	✓ h 112	9.33	11	M Wieland, O Kop...	Towards context-aware workflow
hI,norm: 30	✓ 45	4.50	12	T Kjellberg, A von ...	The machine tool model—A core
hI,annual: 0.88					
*Count: 35					

Google Scholar query

Ungefähr 773 Ergebnisse (0,0 Sek.)

Agile modeling method engineering

D Karagiannis - Proceedings of the 19th Panhellenic Conference on ..., 2015 - dl.acm.org

egy, these three levels are provided by three different modeling languages supporting different ...

pdf [6]. European Factories of the Future Association, Factories of the Future Roadmap, http ... A

domain-specific language for modelling method definition: from requirements to grammar ...

☆ 99 Zitiert von: 60 Ähnliche Artikel Alle 2 Versionen »

Conceiving the model-driven smart factory

J Cadavid, M Alférez, S Gérard, P Tessier - Proceedings of the 2015 ..., 2015 - dl.acm.org

... ISA-95, Modeling, Process Modeling, Business Modeling, Model-Driven Engineering, Smart

Factories, BPMN, Manu ... The factory of the future will create technologies specifi- cally targeted

at humans to ensure ... the ISA-95 levels 3 and 4) to Smart Factory processes (characterized ...

☆ 99 Zitiert von: 9 Ähnliche Artikel Alle 3 Versionen »

[PDF] Bridging the gap between product design and product manufacturing by

means of graph-based design languages

P Arnold, S Rudolph - TMCE 2012 Symposium, Karlsruhe, 2012 - isd.uni-stuttgart.de

... nisms (so-called lightweight and heavyweight exten- sions) to extend the UML with domain specific

as- pects ... method of graph-based design lan- guages will be applied to the digital factory to try ...

One language has been build to generate the exterior skin of the airplane for use in ...

☆ 99 Zitiert von: 20 Ähnliche Artikel Alle 4 Versionen »

Modelling complex and flexible processes for smart cyber-physical

environments

R Seiger, C Keller, F Niebling, T Schlegel - Journal of Computational ..., 2015 - Elsevier

Smart workflows, Process modelling, Cyber-physical systems, Smart factory, Flexible processes

Scholar 2018

google.de/scholar?start=900&q=((("digital+factory"%7C"digital+factories"%7C"smart+factory"%7C"smart+factories"%7C"factory+of+the+future"%7C"factory of the future"%7C"factory of the future")("digital factory")("digital factories")("smart factory")("smart factories")("factory of the future")("factory of the future")("factory of the future"))

Seite 91 von 956 Ergebnissen (0,83 Sek.)

Harzing's Publish or Perish 6.33.6259.6749

File Edit Query Tools Help

My queries
Saved queries
New Folder
Trash

Query	Source	Papers	Cites	Cites/y...	h	g	hI,no...	hI,ann...	*C...	Query date	Cache date	Las...
✓(("digital factory")("digital factories")("smart factory")("smart factories")("factory of the future")("factory of the future")("factory of the future"))	Google Sc...	956	10269	302.03	48	85	30	0.88	39	28.01.2019	28.01.2019	0

Google Scholar query

How to search with Google Scholar

Authors:

Publication/Journal:

All of the words:

Any of the words:

None of the words:

The phrase:

Metrics

Publication years: 1985-2018

Citation years: 34 (1985-2019)

Papers: 956

Citations: 10269

Cites/year: 302.03

Cites/paper: 10.74

Cites/author: 4448.03

Papers/author: 469.15

Authors/paper: 2.88

h-index: 48

g-index: 85

hI norm: 30

✓	h	Cites	Per year	Rank	Authors	Title	Year	Publication	Publisher	Type
✓	h	417	83.40*	632	O Vermesan, P Fri...	Internet of things-from research ...	2014		researchgate.net	BOOK
✓	h	325	14.13*	625	MP Bender, JP Mc...	Icon based process design and co...	1996	US Patent 5,576,946	Google Patents	
✓	h	264	37.71*	467	F Puppe	Systematic introduction to expert...	2012		books.google.com	BOOK
✓	h	253	13.32*	538	A Kusiak	Computational intelligence in de...	2000		books.google.com	BOOK
✓	h	222	13.88*	486	I Crnkovic, U Askl...	Implementing and integrating pr...	2003		books.google.com	BOOK
✓	h	213	23.67*	555	S Terzi, A Bouras, ...	Product lifecycle management-fr...	2010	International Journal of ...	academia.edu	PDF
✓	h	207	69.00*	557	J Mineraud, O Ma...	A gap analysis of Internet-of-Thi...	2016	Computer Communicatio...	Elsevier	
✓	h	192	21.33*	634	PG Maropoulos, D...	Design verification and validation...	2010	CIRP Annals-Manufacturi...	Elsevier	
✓	h	192	8.35	883	DH Sebastian	Concurrent engineering design t...	1996	US Patent 5,552,995	Google Patents	
✓	h	160	84.50*	450	S Jecelke, C Brach	Industrial internet of things and c...	2017	Industrial Internet of	Springer	

IEEE Xplore: Restrictions and Query

Slide 8

- 40 Search terms (no issue)

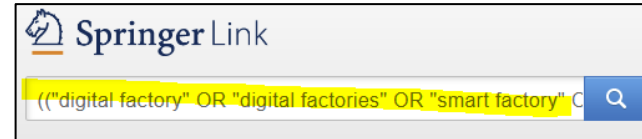
This screenshot shows the 'Advanced Search Options' page on the IEEE Xplore Digital Library. The page has a dark blue header with navigation links: 'Browse', 'My Settings', and 'Get Help'. Below the header, there are tabs for 'Advanced Keyword/Phrases', 'Command Search', 'Citation Search', and 'Preferences'. The 'Command Search' tab is selected. The main content area is titled 'ENTER KEYWORDS, PHRASES, OR A BOOLEAN EXPRESSION' and includes a note about using drop-down lists to generate correct operator and data field codes. A search bar contains the query: 'Search : @Metadata Only @ Full Text & Metadata'. Below the search bar, there are two dropdown menus: 'Data Fields' and 'Operators'. A text area contains a complex boolean search string: '("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")'. To the right of the text area, there are 'SEARCH GUIDELINES' and a note that there is a maximum of 40 search terms. At the bottom right, there are 'Reset All' and 'SEARCH' buttons.

This block contains two screenshots of the IEEE Xplore search results page, illustrating the effect of increasing the number of search terms. Both screenshots show the same search query: '("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")'. The top screenshot shows 'Displaying results 1-25 of 247 for' and 'Filters Applied: 1985 - 2017'. The bottom screenshot shows 'Displaying results 1-25 of 385 for' and 'Filters Applied: 1985 - 2018'. The search results are displayed in a table format with columns for 'All', 'Advanced Search', and 'Other Search Options'. The search bar at the top of each screenshot contains the query: 'Enter keywords or phrases (Note: Searches metadata only by default. A search for 'smart grid' = 'smart AND grid')'. The search results are displayed in a table format with columns for 'All', 'Advanced Search', and 'Other Search Options'. The search results are displayed in a table format with columns for 'All', 'Advanced Search', and 'Other Search Options'.

SpringerLink: Restrictions and Query

Slide 9

- No restrictions: copied and pasted query into search field



Springer Link

Search query: ("digital factory" OR "digital factories" OR "smart factory" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")

281 Result(s) for the query within 1985 - 2017

Content Type:

Content Type	Count
Chapter	241
Conference Paper	126
Article	40

Sort By: Relevance

Show documents published between 1985 and 2017

Springer Link

Search query: ("digital factory" OR "digital factories" OR "smart factory" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")

398 Result(s) for the query within 1985 - 2018

Content Type:

Content Type	Count
Chapter	324
Conference Paper	177
Article	72
Reference Work Entry	2

Sort By: Relevance

Show documents published between 1985 and 2018

Scopus: Restrictions and Query

Slide 10

- No restrictions

The screenshot displays the Scopus search interface. At the top, the Scopus logo is on the left, and navigation links for Search, Sources, Alerts, Lists, and Help are on the right. Below this is a dark blue header with the text "Advanced search". Underneath, there are tabs for Documents, Authors, Affiliations, and Advanced, with the Advanced tab currently selected. To the right of these tabs is a link for "Search tips". The main search area contains a text input field with the query: "Enter query string" followed by "ALL(("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language"))". A green circular icon with a 'G' is located to the right of the query. At the bottom right, there are links for "Outline query", "Add Author name / Affiliation", "Clear form", and a blue "Search Q" button.

→ ↻ https://www.scopus.com/search/form.uri?sort=plf-f&src=s&nlo=&nlr=&nls=&sid=76d4ed2841e98afadcffc1bb244abc2&sot=a&sdt=a&sl=274&s=ALL%28%28"digital+factory"+OR+"digital+factories"+OR

Scopus [Search](#) Sources Alerts Lists Help

Advanced search

Documents Authors Affiliations Advanced [Search tips ?](#)

Enter query string

ALL(("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language"))

[Outline query](#) [Add Author name / Affiliation](#) [Clear form](#) [Search Q](#)

Scopus: Results of 2017 and 2018

Slide 11

Scopus

[Search](#) [Sources](#) [Alerts](#) [Lists](#) [Help](#) [SciVal](#) [Register](#) [Login](#)

303 document results

[View secondary documents](#) [View 10 patent results](#)

ALL(("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")) AND (EXCLUDE(PUBYEAR, 2019)) AND (EXCLUDE(PUBYEAR, 2018))

495 document results

[View secondary documents](#) [View 21 patent results](#)

ALL(("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")) AND (EXCLUDE(PUBYEAR, 2019))

Web of Science

Slide 12

apps.webofknowledge.com/WOS_GeneralSearch_input.do?product=WOS&search_mode=GeneralSearch&SID=D1Rfp82QFsVRzqkGZ5&preferencesSaved=

Web of Science InCites Journal Citation Reports Essential Science Indicators EndNote Publons Kopernio Sign In Help English

Web of Science

Clarivate Analytics

Tools Searches and alerts Search History Marked List

Select a database Web of Science Core Collection

Get one-click access to full-text

Basic Search Cited Reference Search Advanced Search + More

("digital factory" OR "digital factories" OR "smart factory" OR "smart factories")

All Fields

Search Search tips

+ Add row

Web of Science

Slide 13

Web of Science

Clarivate Analytics

Search

Tools ▾ Searches and alerts ▾ Search History Marked List

Results: 32
(from Web of Science Core Collection)

You searched for: ALL FIELDS: (("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")) ...More

Sort by: Date Times Cited Usage Count Relevance More ▾

◀ 1 of 4 ▶

☐ Select Page

5K

Save to EndNote online ▾

Add to Marked List

Analyze Results

Create Citation Report

Times Cited: 1
(from Web of Science Core Collection)

Usage Count ▾

☐ 1. IFC Monitor - An IFC schema extension for modeling structural health monitoring systems

By: Theiler, Michael; Smarsly, Kay
Conference: 24th EG-ICE International Workshop on Intelligent Computing in Engineering (EG-ICE) Location: Nottingham, ENGLAND Date: JUL 10-12, 2017
Sponsor(s): European Grn Intelligent Comn Engr

Web of Science

Web of Science

Clarivate Analytics

Search

Tools ▾ Searches and alerts ▾ Search History Marked List

Results: 22
(from Web of Science Core Collection)

You searched for: ALL FIELDS: (("digital factory" OR "digital factories" OR "smart factory" OR "smart factories" OR "factory of the future" OR "factories of the future" OR "Industry 4.0") AND ("metamodel" OR "DSL" OR "UML" OR "domain-specific language" OR "modeling language" OR "modelling language")) ...More

Sort by: Date Times Cited Usage Count Relevance More ▾

◀ 1 of 3 ▶

☐ Select Page

5K

Save to EndNote online ▾

Add to Marked List

Analyze Results

Create Citation Report

Times Cited: 1
(from Web of Science Core Collection)

Usage Count ▾

☐ 1. Using Properties as a Semantic Base for Interoperability

By: Eppele, Ulrich; Mertens, Martin; Palm, Florian; et al.
IEEE TRANSACTIONS ON INDUSTRIAL INFORMATICS Volume: 13 Issue: 6 Pages: 3411-3419 Published: DEC 2017

View Abstract ▾