Reinhard Wilhelm

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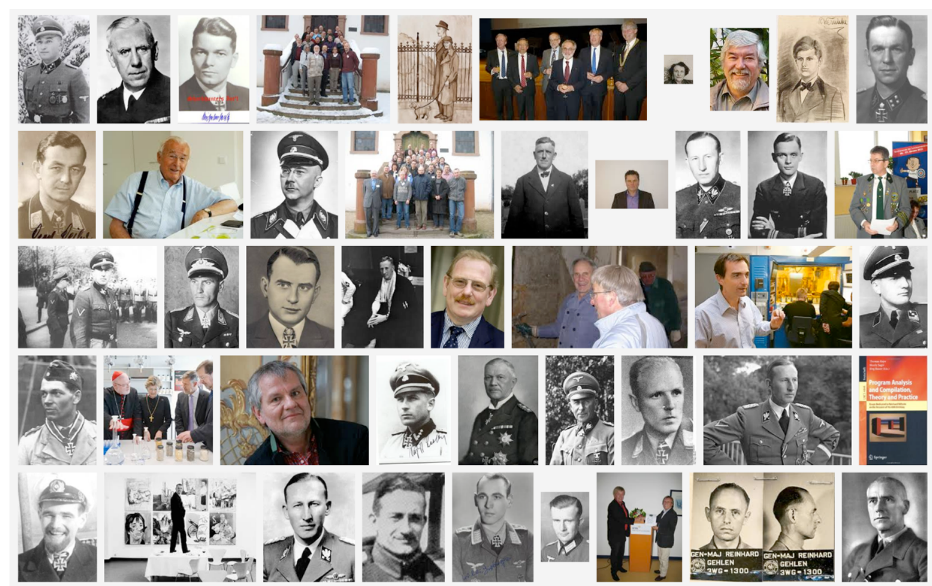
Farewell Colloquium on the Occasion of Reinhard Wilhelm's 68th birthday

Saarbrüchen, November, 28th 2014

You said Reinhard Wilhelm?

But who is Reinhard Wilhelm?

But who is Reinhard Wilhelm?



But who is Reinhard Wilhelm?

1. You have undestood the limitations of ``Big data'' and ``Advanced machine learning''

But who is Reinhard Wilhelm?

1. You have undestood the limitations of ``Big data'' and ``Advanced machine learning''
2. This is THE Reinhard Wilhelm:

Reinhard Wilhelm

Reinhard Wilhelm is a German computer scientist. Wikipedia

Born: June 5, 1946 (age 68), Finnentrop, Germany

Education: University of Münster

But who is Reinhard Wilhelm?

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sorry, this was 2 months ago on Wikipedia, thanks to the true Reinhard Wilhelm for updating his picture last month!

But who is Reinhard Wilhelm?

1. You have undestood the limitations of ``Big data'' and ``Advanced machine learning''
2. This is THE Prof. em. Dr. Dr. h.c. Reinhard Wilhelm:

Reinhard Wilhelm

Reinhard Wilhelm, 2014

Born	5 June 1946 (age 68) Finnentrop, Germany
Fields	Computer Scientist
Institutions	Saarland University
Alma mater	University of Münster, Stanford University, Technical University Munich
Known for	compiler technology
Notable awards	Konrad Zuse Medal (2009) Merit Cross on Ribbon (2010) ACM Distinguished Service Award (2011)

There is only one, the proof is by Google

There is only one, the proof is by Google

Images for Prof. em. Dr. Dr. h.c. Reinhard Wilhelm Report images

More images for Prof. em. Dr. Dr. h.c. Reinhard Wilhelm

And more …

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Reinhard Wilhelm

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- *affiliation:* Saarland University, Compiler Design Lab
- *affiliation:* Schloss Dagstuhl - Leibniz Center for Informatics

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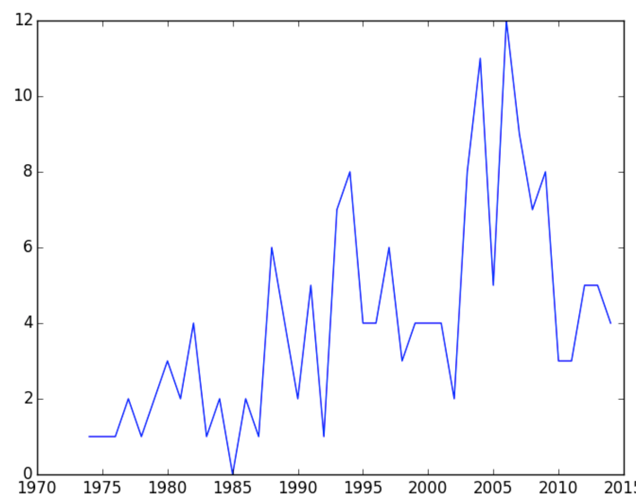
[+] Coauthor Index

Universität Trier SCHLOSS DAGSTUHL Leibniz-Zentrum für Informatik

Great sustainable productivity



Too much to read so let's have numbers

Citation indices	All	Since 2009
Citations	7053	3497
h-index	35	27
i10-index	75	41

- The hit parade (even cited before published!):

Title 1–20	Cited by	Year
Parametric shape analysis via 3-valued logic M Sagiv, T Reps, R Wilhelm ACM Transactions on Programming Languages and Systems (TOPLAS) 24 (3), 217-298	1047	2002
The worst-case execution-time problem—overview of methods and survey of tools R Wilhelm, J Engblom, A Ermedahl, N Holsti, S Thesing, D Whalley, ... ACM Transactions on Embedded Computing Systems (TECS) 7 (3), 36	1004	2008
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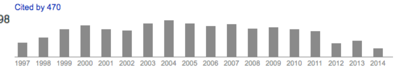

- The flop:

An abstract machine for an object-oriented language with top-level classes C Böschen, C Fecht, AV Hense, R Wilhelm	2	2011

Total citations Cited by 2

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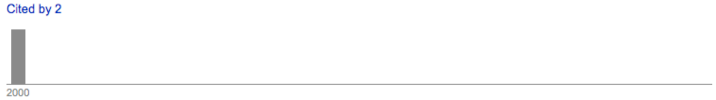


yes, but cited 11 years before the pretend publication date!

Science

Main contributions

Reinhard Wilhelm
Professor of Computer Science, Saarland University
embedded systems, compilers, static program analysis
Verified email at cs.uni-saarland.de

- Coming number one in static analysis, world-wide:

Google label:static_program_analysis

Scholar 1 - 10

Reinhard Wilhelm
Professor of Computer Science, Saarland University
Verified email at cs.uni-saarland.de
Cited by 7053
embedded systems compilers static program analysis

What is static analysis?

Static program analysis

From Wikipedia, the free encyclopedia

Static program analysis is the analysis of computer software that is performed without actually executing programs (analysis performed on executing programs is known as dynamic analysis).

at least the static analyzer must execute!

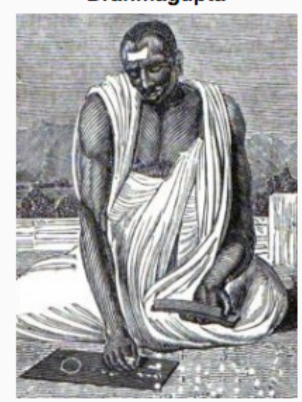
by a computer

A short introduction to static analysis

The very first static analysis

Brahmagupta (Sanskrit: ब्रह्मगुप्त; listen (help·info)) (598–c.670 CE) was an Indian mathematician and astronomer who wrote two important works on Mathematics and Astronomy: the *Brāhmasphuṭasiddhānta* (Extensive Treatise of Brahma) (628), a theoretical treatise, and the *Khaṇḍakhādyaka*, a more practical text.

Brahmagupta



Born	598 CE
Died	c.670 CE
Fields	Mathematics, Astronomy
Known for	Zero, modern Number system

The rule of signs by Brahmagupta (628)

18.30. [The sum] of two positives is positives, of two negatives negative;

The rule of signs by Brahmagupta (628)

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- The abstraction is that you do not (always) need to known the absolute value of the arguments to know the sign of the result;

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- Sometimes imprecise (don't know the sign of the sum of a positive and a negative)

The rule of signs by Brahmagupta (628)

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- Useful in practice (if you know what to do when you don't know the sign)

The rule of signs by Brahmagupta (628)

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- Sometimes imprecise (don't know the sign of the sum of a positive and a negative)
- Useful in practice (if you know what to do when you don't know the sign)
- e.g. in compilation: do not optimize (a division by 2 into a shift when positive(*))

(*) Unless processor uses 2's complement and can shift the sign.

The rule of signs by Brahmagupta (628)

18.30. [The sum] of two positives is positives, of two negatives negative; [...]

18.32. A negative minus zero is negative, a positive [minus zero] positive; zero [minus zero] is zero. When a positive is to be subtracted from a negative or a negative from a positive, then it is to be added.

The rule of signs by Brahmagupta (628)

18.30. [The sum] of two positives is positives, of two negatives negative; [...]

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18.33. The product of a negative and a positive is negative, of two negatives positive, and of positives positive; the product of zero and a negative, of zero and a positive, or of two zeros is zero.

The rule of signs by Brahmagupta (628)

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18.33. The product of a negative and a positive is negative, of two negatives positive, and of positives positive; the product of zero and a negative, of zero and a positive, or of two zeros is zero.

18.34. A positive divided by a positive or a negative divided by a negative is positive; a zero divided by a zero is zero; a positive divided by a negative is negative; a negative divided by a positive is [also] negative.

wrong

The rule of signs by Michel Sintzoff (1972)

For example, a×a+b×b yields the value 25 when a is 3 and b is -4, and when + and × are the arithmetic multiplication and addition. But a×a+b×b yields always the object "pos" when a and b are the objects "pos" or "neg", and when the valuation is defined as follows :

pos+pos=pos	pos×pos=pos
pos+neg=pos,neg	pos×neg=neg
neg+pos=pos,neg	neg×pos=neg
neg+neg=neg	neg×neg=pos
V(p+q)=V(p)+V(q)	V(p×q)=V(p)×V(q)

V(0)=V(1)=...=pos
V(-1)=V(-2)=...=neg

The valuation of a×a+b×b yields "pos" by the following computations :

V(a)=pos,neg	V(b)=pos,neg
V(a×a)=pos×pos,neg×neg	V(b×b)=pos×pos,neg×neg
=pos,pos=pos	=pos,pos=pos

V(a×a+b×b)=V(a×a)+V(b×b)=pos+pos=pos

This valuation proves that the result of a×a+b×b is always positive and hence allows to compute its square root without any preliminary dynamic test on its sign. On the other hand, the

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pos+pos=pos	pos×pos=pos
pos+neg=pos,neg	pos×neg=neg
neg+pos=pos,neg	neg×pos=neg
neg+neg=neg	neg×neg=pos
V(p+q)=V(p)+V(q)	V(p×q)=V(p)×V(q)

V(0)=V(1)=...=pos
V(-1)=V(-2)=...=neg

The valuation of a×a+b×b yields "pos" by the following computations :

V(a)=pos,neg	V(b)=pos,neg
V(a×a)=pos×pos,neg×neg	V(b×b)=pos×pos,neg×neg
=pos,pos=pos	=pos,pos=pos

V(a×a+b×b)=V(a×a)+V(b×b)=pos+pos=pos

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neg+pos=pos,neg	neg×pos=neg
neg+neg=neg	neg×neg=pos
V(p+q)=V(p)+V(q)	V(p×q)=V(p)×V(q)

wrong

0∈pos x -1∈neg
= 0∉neg

V(0)=V(1)=...=pos
V(-1)=V(-2)=...=neg

The valuation of a×a+b×b yields "pos" by the following computations :

V(a)=pos,neg	V(b)=pos,neg
V(a×a)=pos×pos,neg×neg	V(b×b)=pos×pos,neg×neg
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The rule of signs by Reinhard Wilhelm (2012/13)

http://www.rw.cdl.uni-saarland.de/teaching/dses12/slides/lecture6_static_analysis.pdf

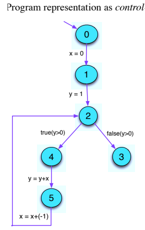
2 Example — Rules-of-Sign Analysis

Problem: Determine at each program point the sign of the values of all variables of numeric type.

Example program:

```
1: x = 0;
2: y = 1;
3: while (y > 0) do
4:     y = y + x;
5:     x = x + (-1);
```

Program representation as *control-flow graphs*



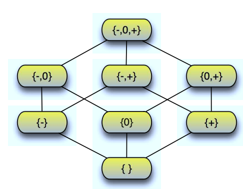
8

9

All the ingredients:

- a set of information elements, each a set of possible signs,
- a partial order, "$\sqsubseteq$", on these elements, specifying the "relative strength" of two information elements,
- these together form the abstract domain, a lattice,
- functions describing how signs of variables change by the execution of a statement, abstract edge effects,
- these need an abstract arithmetic, an arithmetic on signs.

We construct the abstract domain for single variables starting with the lattice $Signs = 2^{\{-,0,+\}}$ with the relation "$\sqsubseteq$" = "$\subseteq$".



The analysis should "bind" program variables to elements in *Signs*.

So, the abstract domain is $\mathbb{D} = (Vars \to Signs)_\perp$, a Sign-environment.

$\perp \in \mathbb{D}$ is the function mapping all arguments to $\{\}$.

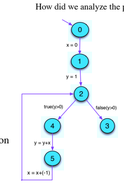
The partial order on $\mathbb{D}$ is $D_1 \sqsubseteq D_2$ iff

$D_1 = \perp$ or

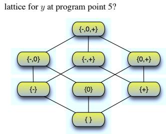
$D_1\, x \subseteq D_2\, x \quad (x \in Vars)$

Intuition?

How did we analyze the program?



In particular, how did we walk the lattice for y at program point 5?



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$D_1 = \perp$ or

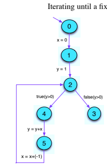
$D_1\, x \subseteq D_2\, x \quad (x \in Vars)$

Intuition?

D_1 is at least as precise as D_2 since D_2 admits at least as many signs as D_1

How is a solution found?

Iterating until a fixed-point is reached



15

0		1		2		3		4		5	
x	y	x	y	x	y	x	y	x	y	x	y

17

Idea:

- We want to determine the sign of the values of expressions.
- For some sub-expressions, the analysis may yield $\{+,-,($ which means, it couldn't find out.

Idea:

- We want to determine the signs of the values of expressions.
- For some sub-expressions, the analysis may yield $\{+,-,0\}$, which means, it couldn't find out.
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The rule of signs by Reinhard Wilhelm (2012/13)

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$$[\![e]\!]^\sharp \;:\; (Vars \to Signs) \to Signs$$

Determining the sign of expressions in a Sign-environment works as follows:

$$
\begin{array}{lcl}
[\![c]\!]^\sharp\, D & = & \begin{cases} \{+\} & \text{if } c > 0 \\ \{-\} & \text{if } c < 0 \\ \{0\} & \text{if } c = 0 \end{cases} \\
[\![v]\!]^\sharp & = & D(v) \\
[\![e_1 \Box e_2]\!]^\sharp\, D & = & [\![e_1]\!]^\sharp\, D \,\Box^\sharp\, [\![e_2]\!]^\sharp\, D \\
[\![\Box e]\!]^\sharp\, D & = & \Box^\sharp [\![e]\!]^\sharp\, D
\end{array}
$$

Abstract operators working on signs (Addition)

$+^\#$	{0}	{+}	{-}	{-, 0}	{-, +}	{0, +}	{-, 0, +}
{0}	{0}	{+}					
{+}							
{-}							
{-, 0}							
{-, +}							
{0, +}							
{-, 0, +}	{-, 0, +}						

Abstract operators working on signs (Multiplication)

$\times^\#$	{0}	{+}	{-}	{-, 0}	{-, +}	{0, +}	{-, 0, +}
{0}	{0}	{0}					
{+}							
{-}							
{-, 0}							
{-, +}							
{0, +}							
{-, 0, +}	{0}						

Abstract operators working on signs (unary minus)

$-^\#$	{0}	{+}	{-}	{-, 0}	{-, +}	{0, +}	{-, 0, +}
	{0}	{-}	{+}	{+, 0}	{-, +}	{0, -}	{-, 0, +}

Working an example: $D = \{x \mapsto \{+\}, y \mapsto \{+\}\}$

$$
\begin{array}{lcl}
[\![x+7]\!]^\sharp\, D & = & [\![x]\!]^\sharp\, D \;+^\sharp\; [\![7]\!]^\sharp\, D \\
& = & \{+\} \;+^\sharp\; \{+\} \\
& = & \{+\} \\
[\![x+(-y)]\!]^\sharp\, D & = & \{+\} \;+^\sharp\; (-^\sharp [\![y]\!]^\sharp\, D) \\
& = & \{+\} \;+^\sharp\; (-^\sharp\{+\}) \\
& = & \{+\} \;+^\sharp\; \{-\} \\
& = & \{+,-,0\}
\end{array}
$$

Thus, we obtain the following effects of edges $[\![lab]\!]^\sharp$:

$$
\begin{array}{lcl}
[\![;]\!]^\sharp\, D & = & D \\
[\![\text{true}\,(e)]\!]^\sharp\, D & = & D \\
[\![\text{false}\,(e)]\!]^\sharp\, D & = & D \\
[\![x = e;]\!]^\sharp\, D & = & D \oplus \{x \mapsto [\![e]\!]^\sharp\, D\} \\
[\![x = M[e];]\!]^\sharp\, D & = & D \oplus \{x \mapsto \{+,-,0\}\} \\
[\![M[e_1] = e_2;]\!]^\sharp\, D & = & D
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$$

... whenever $D \neq \bot$

Attention to details

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{+}							
{-}							
{-, 0}							
{-, +}							
{0, +}							
{-, 0, +}	{-, 0, +}						

Abstract operators working on signs (Multiplication)

$\times^\#$	{0}	{+}	{-}	{-, 0}	{-, +}	{0, +}	{-, 0, +}
{0}	{0}	{0}					
{+}							
{-}							
{-, 0}							
{-, +}							
{0, +}							
{-, 0, +}	{0}						

Abstract operators working on signs (unary minus)

$-^\#$	{0}	{+}	{-}	{-, 0}	{-, +}	{0, +}	{-, 0, +}
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Attention to details

if the program does not terminate isn't it correct to say that x is 0 upon its termination?

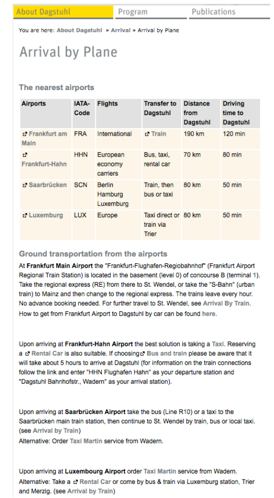
That's where you recognize a great scientist: make simple what is complicated!

Suggestions for an happy retirement

Have ambitious objectives!

Have ambitious objectives!

- Move Dagstuhl close to an airport (or an airport close to Dagstuhl)



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Arrival by Plane

The nearest airports

Airports	IATA-Code	Flights	Transfer to Dagstuhl	Distance from Dagstuhl	Driving time to Dagstuhl
Frankfurt am Main	FRA	International	Train	190 km	120 min
Frankfurt-Hahn	HHN	European economy carriers	Bus, taxi, rental car	70 km	80 min
Saarbrücken	SCN	Berlin Hamburg Luxemburg	Train, then bus or taxi	80 km	50 min
Luxemburg	LUX	Europe	Taxi direct or train via Trier	80 km	50 min

Ground transportation from the airports

At **Frankfurt Main Airport** the "Frankfurt-Flughafen-Regiobahnhof" (Frankfurt Airport Regional Train Station) is located in the basement (level 0) of concourse B (terminal 1). Take the regional express (RE) from there to St. Wendel, or take the "S-Bahn" (urban train) to Mainz and then change to the regional express. The trains leave every hour. No advance booking needed. For further travel to St. Wendel, see Arrival By Train.
How to get from Frankfurt Airport to Dagstuhl by car can be found here.

Upon arriving at **Frankfurt-Hahn Airport** the best solution is taking a Taxi. Reserving a Rental Car is also suitable. If choosing Bus and train please be aware that it will take about 5 hours to arrive at Dagstuhl (for information on the train connections follow the link and enter "HHN Flughafen Hahn" as your departure station and "Dagstuhl Bahnhofstr., Wadern" as your arrival station).

Upon arriving at **Saarbrücken Airport** take the bus (Line R10) or a taxi to the Saarbrücken main train station, then continue to St. Wendel by train, bus or local taxi. (see Arrival by Train)
Alternative: Order Taxi Martin service from Wadern.

Upon arriving at **Luxembourg Airport** order Taxi Martin service from Wadern.
Alternative: Take a Rental Car or come by bus & train via Luxemburg station, Trier and Merzig. (see Arrival by Train)

Remain active in science!

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- Start working on cyberimbedded systems

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- Consider dynamic methods for static analysis

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- Write a book on decompilation

Remain active in science!

- Start working on cyberimbedded systems
- Consider dynamic methods for static analysis
- Write a book on decompilation, by duality

Time for a serious conclusion

Thanks a lot for 30 years of friendship

Thanks a lot for 30 years of friendship, with lots of problems!

Thanks a lot for 30 years of friendship, with lots of problems!

shared scientific

The End, thank you

The beginning, thank you

of retirement

The beginning, thank you

of retirement

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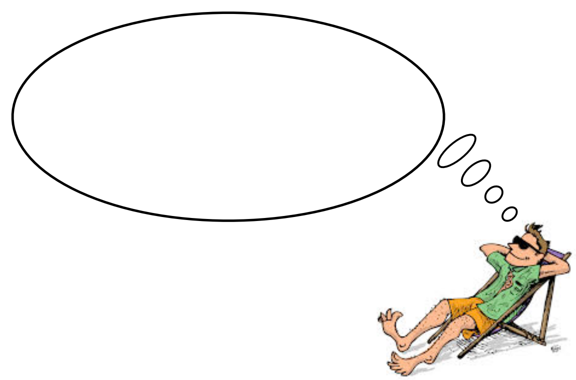

of retirement

The beginning, thank you