Program Verification

Radu Iosif (CR1,CNRS)

Joint work with:

- ➡ Marius Bozga (IR1,CNRS)
- ➡ Filip Konecny (PhD 2008-2012, now at EPFL, Lausanne)
- ➡ Jiri Simacek (PhD 2008-2012, now at NetSuite, Brno)
- ➡ Florent Garnier (PostDoc 2010-2012, now at MathWorks, Paris)

Program Verification Timeline

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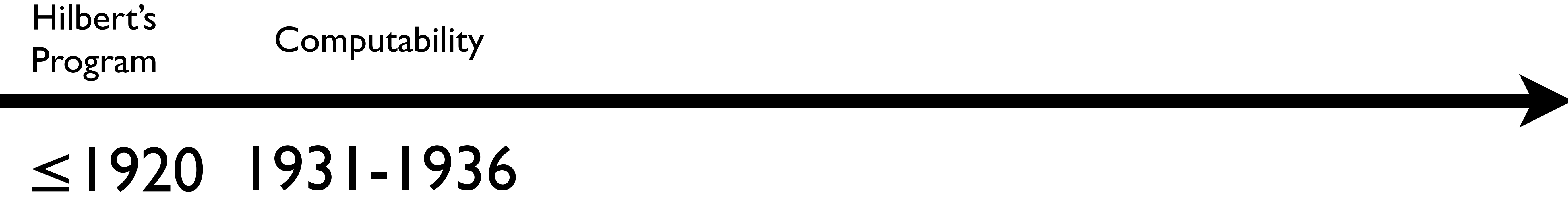
Hilbert's
Program

≤1920

Program Verification Timeline



Hilbert's Program

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Computability

1931-1936

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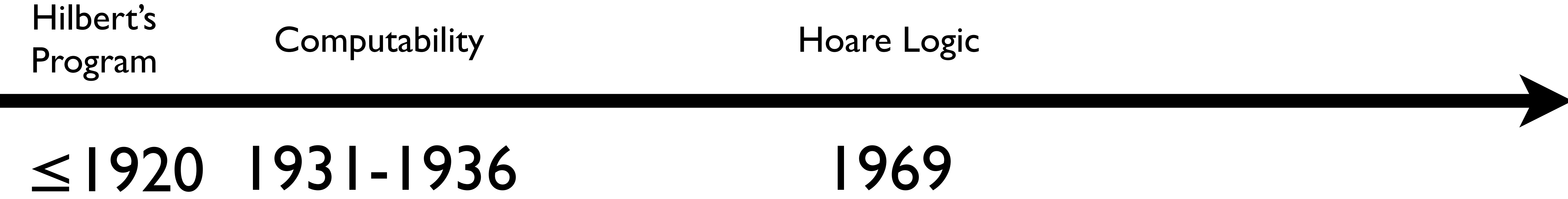

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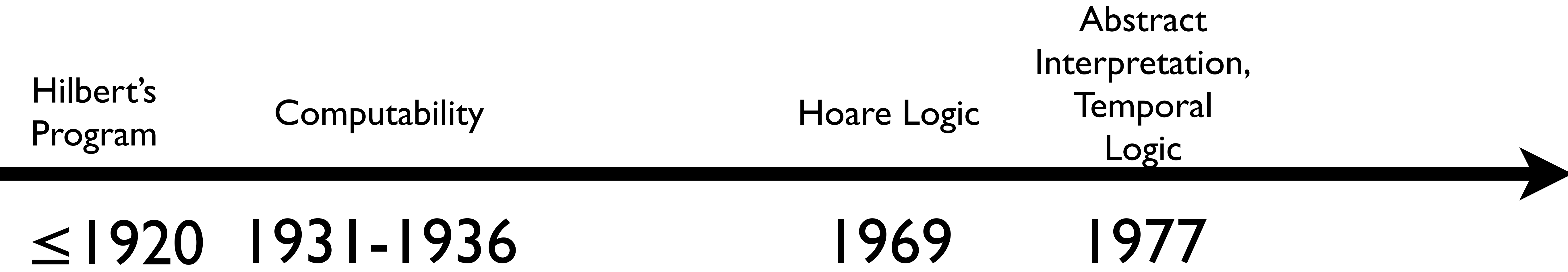

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Abstract Interpretation, Temporal Logic

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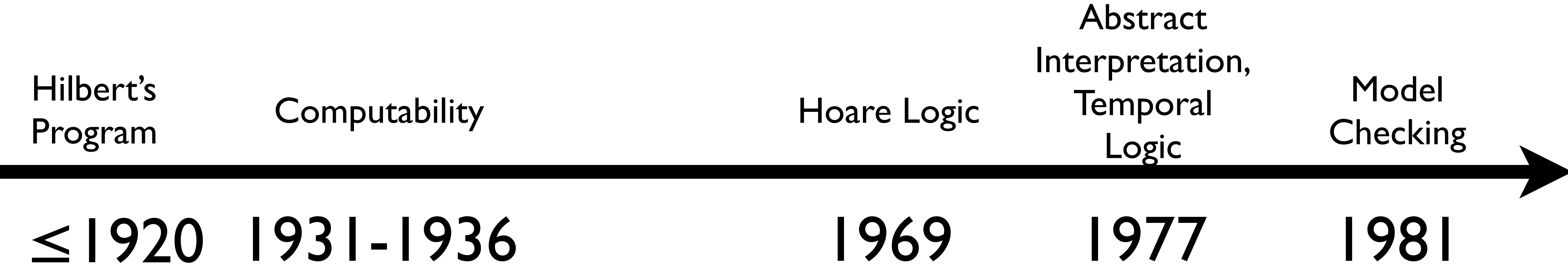

Hilbert's Program

Computability

Hoare Logic

Abstract Interpretation, Temporal Logic

Model Checking

≤1920

1931-1936

1969

1977

1981

Program Verification Timeline

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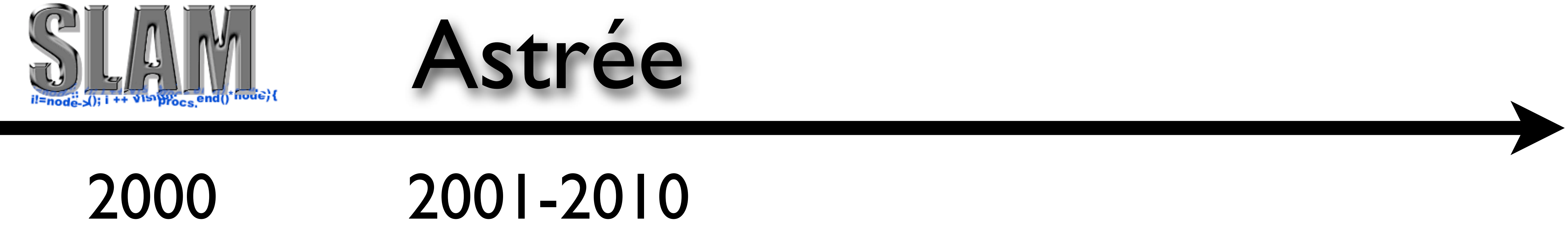
2000

Program Verification Timeline



SLAM

Astrée

2000

2001-2010

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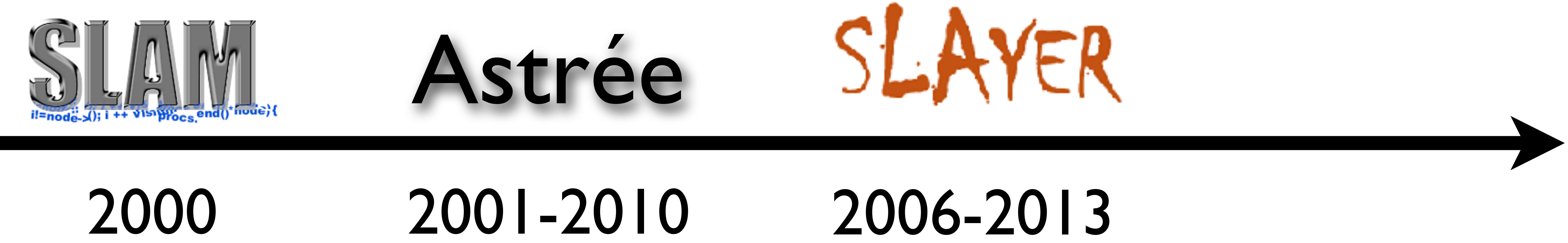

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Reports of 100K to 10 million lines of verified code!

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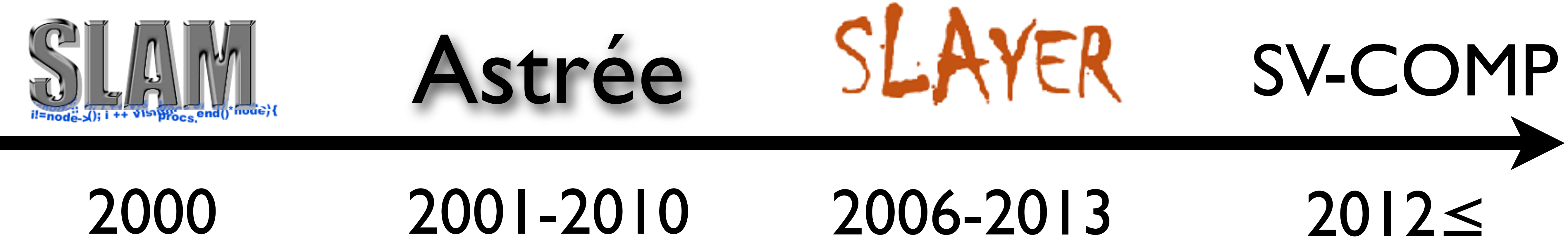

SLAM — 2000

Astrée — 2001-2010

SLAYER — 2006-2013

SV-COMP — 2012≤

Reports of 100K to 10 million lines of verified code!

Program Verification Status

Static Analysis

- Lots of false positives
- No automatic refinement

Model Checking

- Infinite state spaces
- No guarantee of termination

What’s wrong ?

- The success criteria are wrong
- The size of a program gives no indication on the complexity of its verification problems
- Empirical success stories (deadly bug found in device driver) are almost impossible to reproduce and trust

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We need better measures of problem complexity than the # of lines, or the # of variables, etc ...

A Personal Timeline

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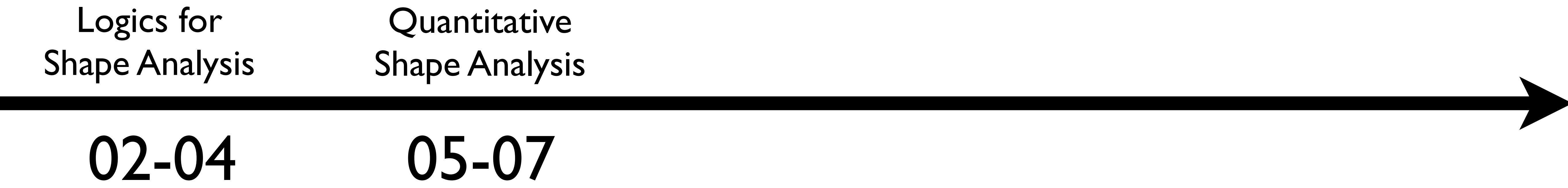
Logics for Shape Analysis

02-04

A Personal Timeline



Logics for Shape Analysis

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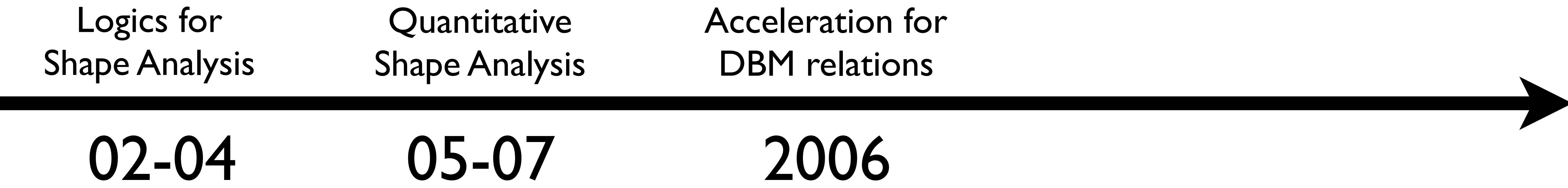
Quantitative Shape Analysis

05-07

A Personal Timeline



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Acceleration for DBM relations

2006

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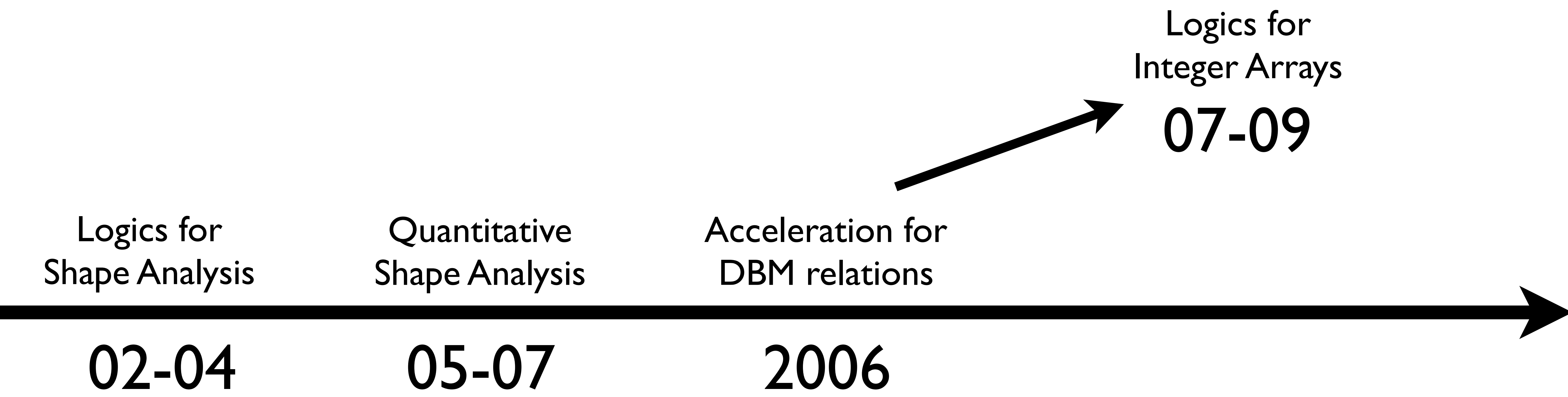

Logics for Integer Arrays

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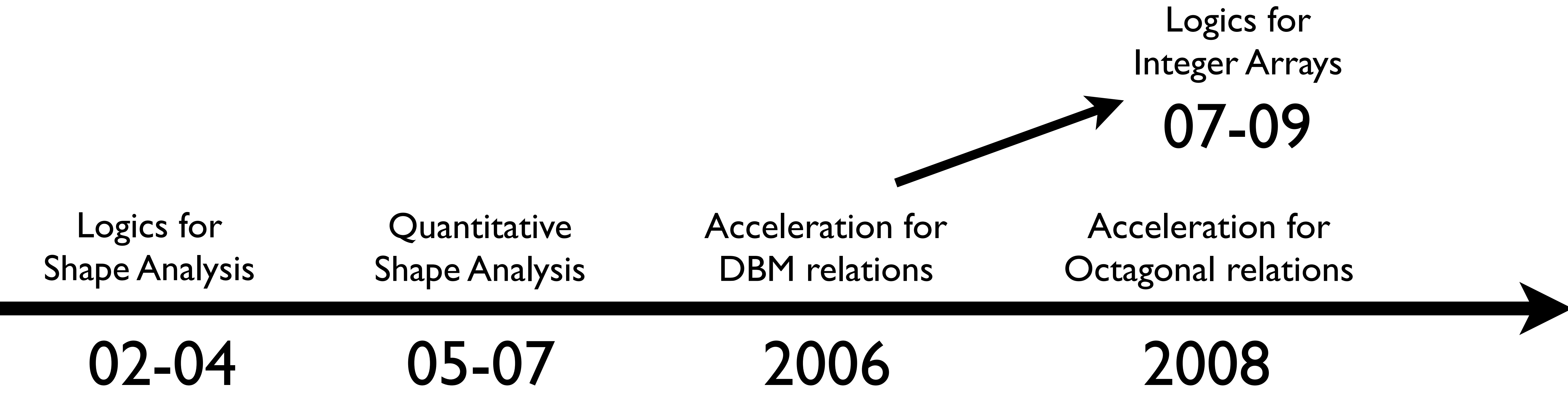

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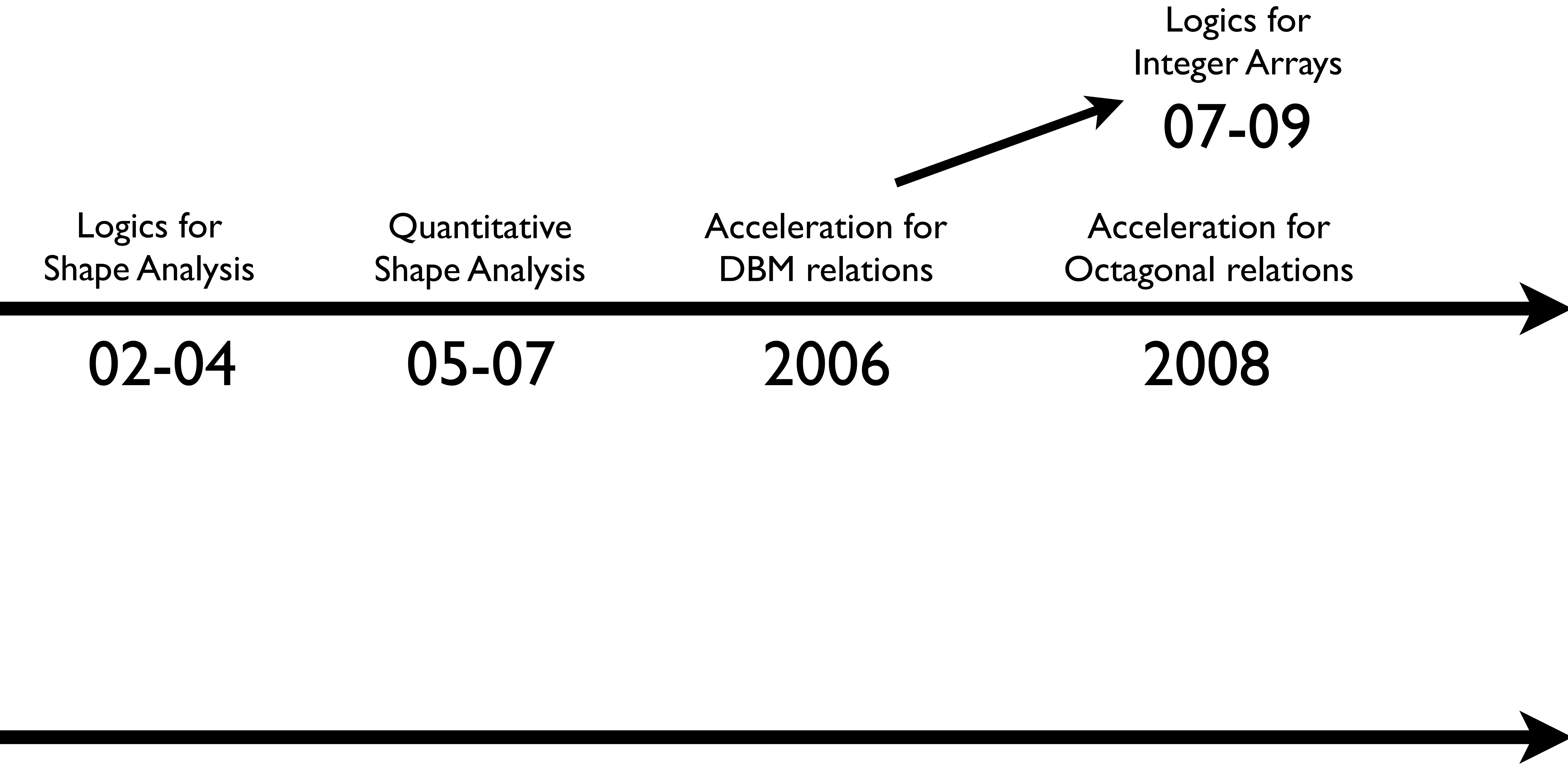

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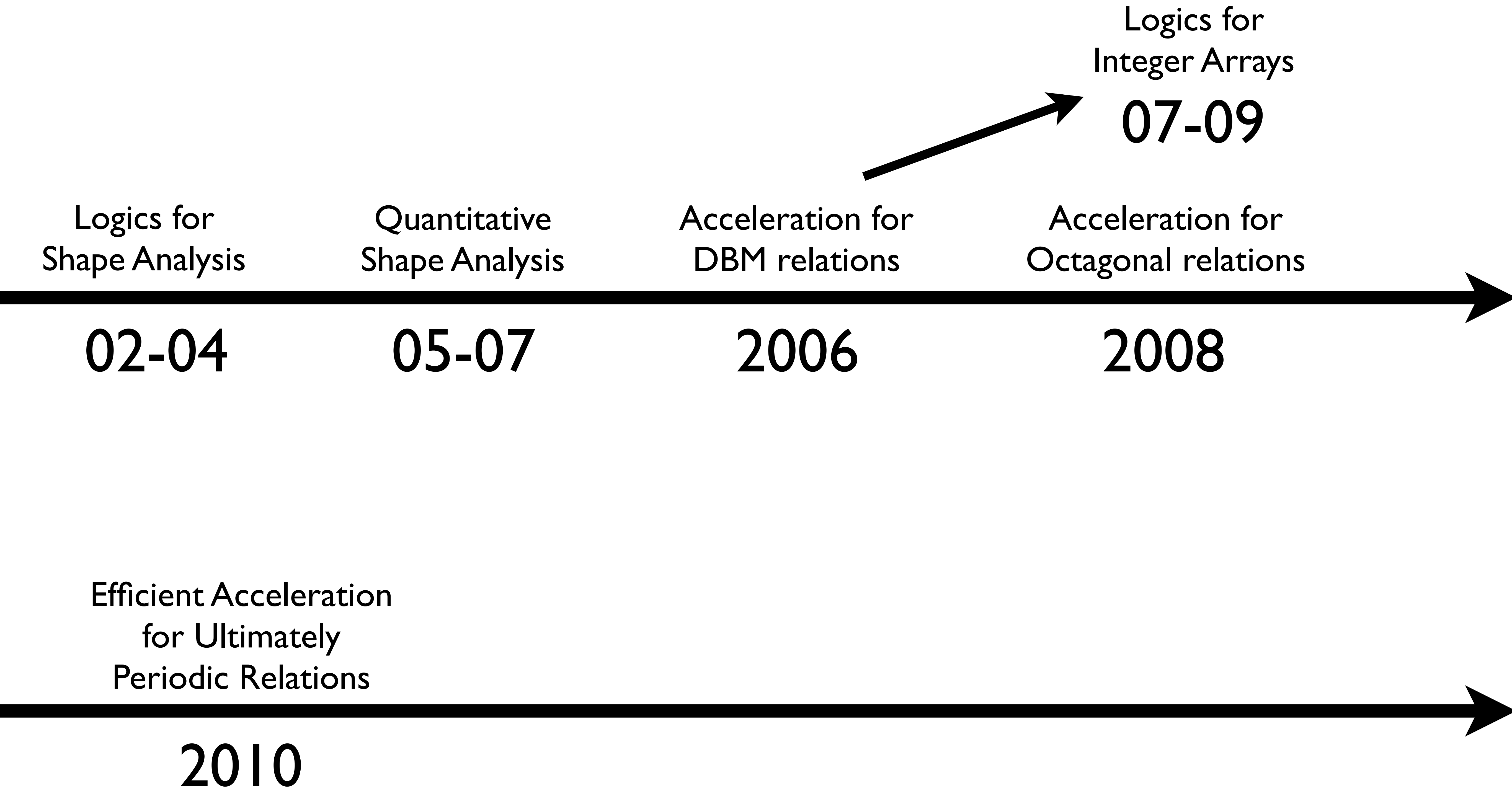

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Efficient Acceleration
for Ultimately
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2010

from 10 var/hour to 10 var/sec

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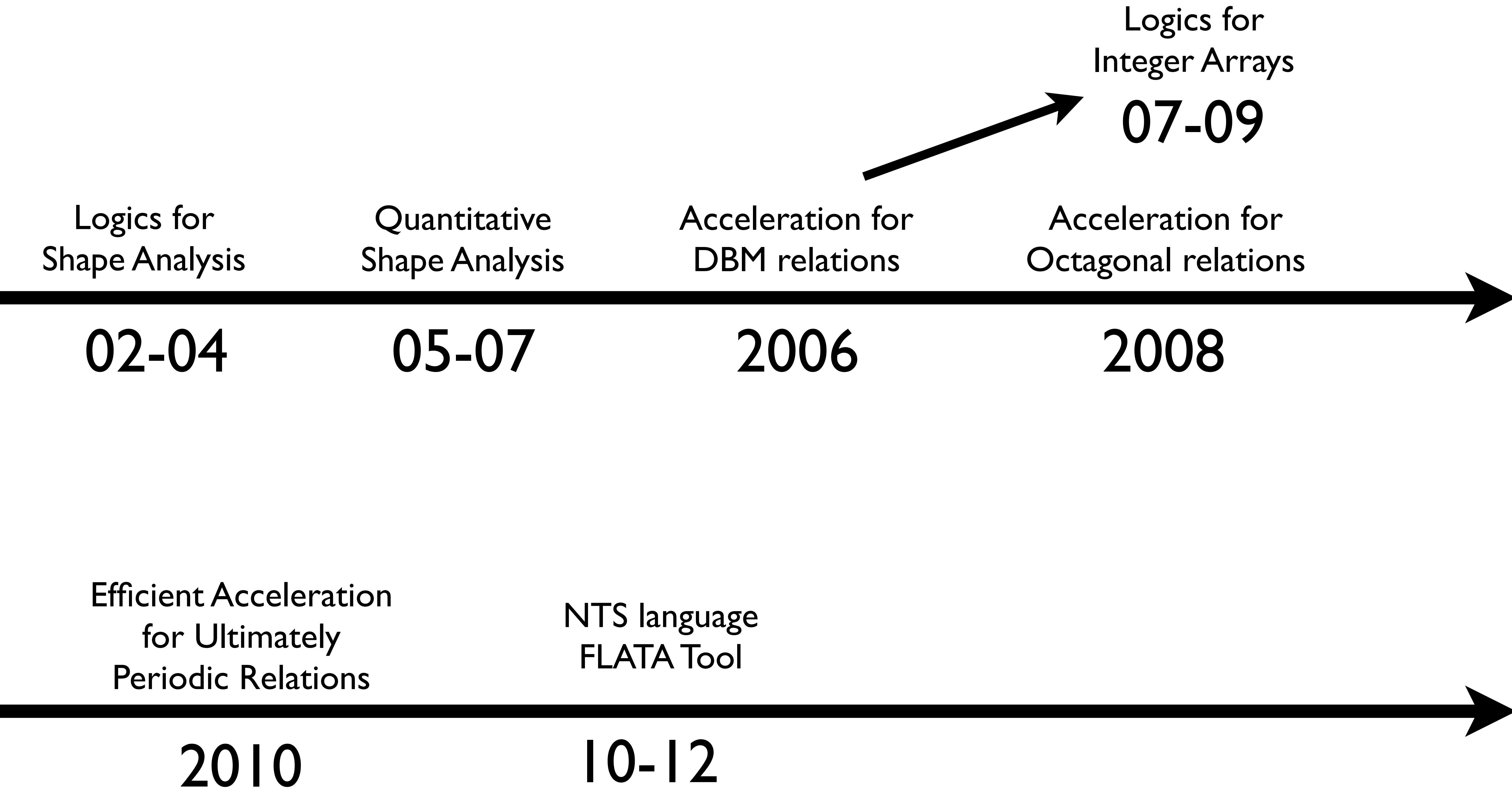

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NTS language
FLATA Tool

10-12

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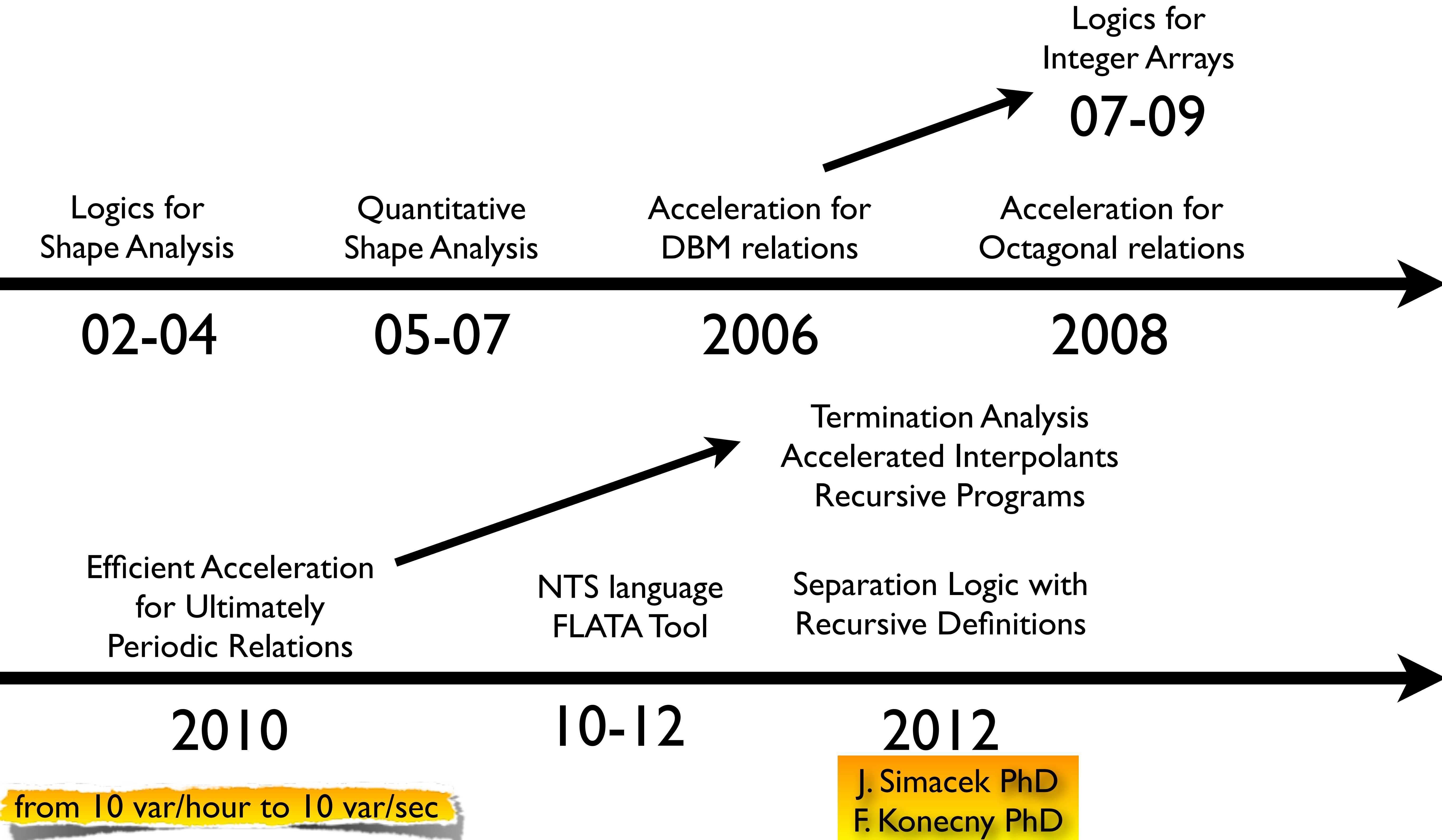

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Termination Analysis
Accelerated Interpolants
Recursive Programs

Efficient Acceleration for Ultimately Periodic Relations

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Separation Logic with Recursive Definitions

2012

J. Simacek PhD
F. Konecny PhD

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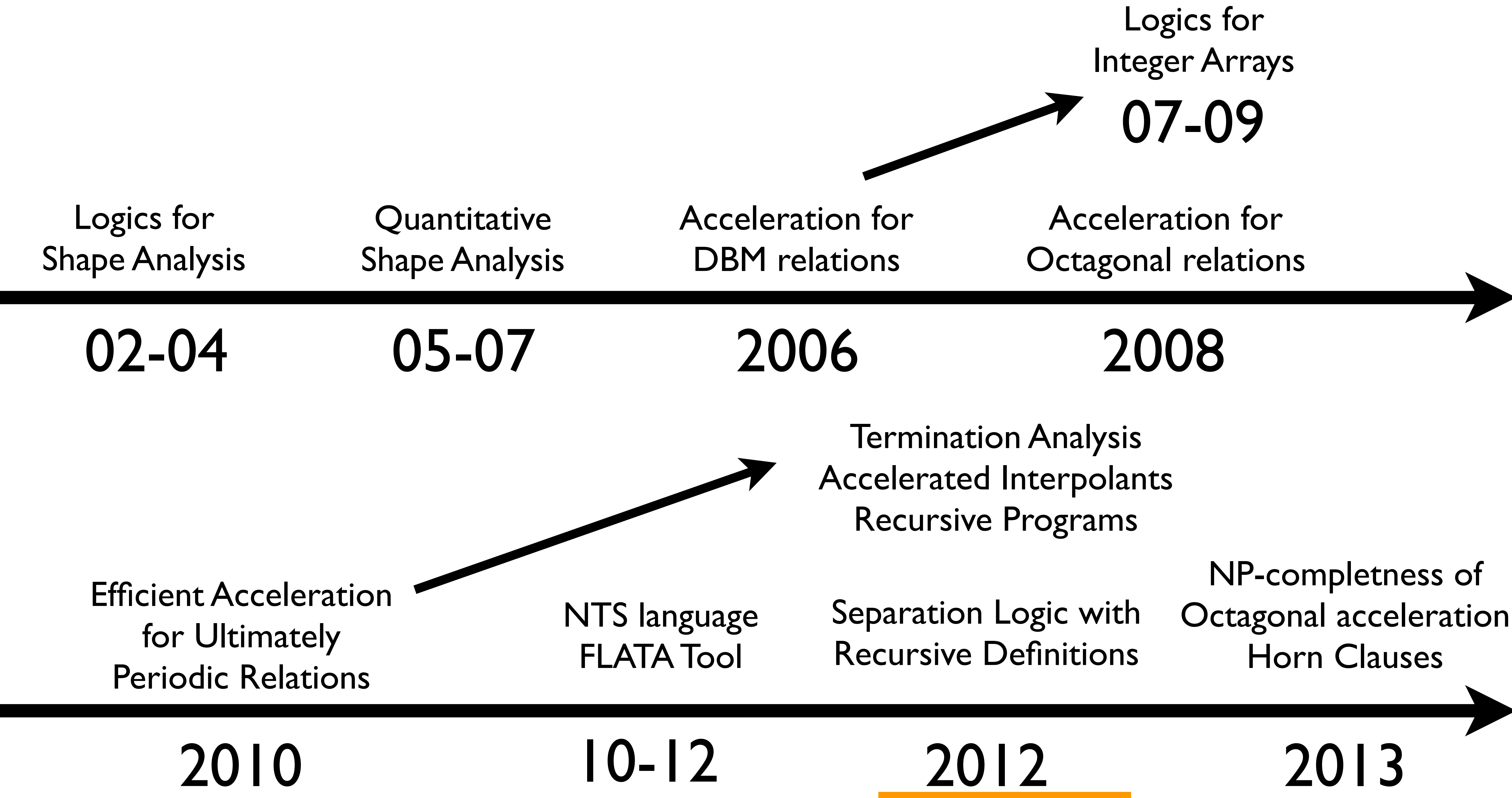

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NP-completness of Octagonal acceleration
Horn Clauses
2013

from 10 var/hour to 10 var/sec

J. Simacek PhD
F. Konecny PhD

Future Projects

- Study the complexity of discrete systems from a different perspective (algorithmic entropy)
- Computational complexity of temporal logic for discrete infinite state systems
- Compositional shape analysis based on Separation Logic
- Multi-level program analysis (axiomatic vs. imperative)

Projects and Collaborations

- AVERILES (RNTL 2006-2009)
- VERIDYC (ANR SEGI 2009-2013)
- ADEPT (ANR INS - decision pending)

- LIAFA Paris (Equipe Modelisation et Verification)
- Brno University of Technology (VeriFIT group)
- IMDEA Madrid (Pierre Ganty)
- EPFL Lausanne (LARA group), TUM (Rybalchenko group), MSR (Bjorner, Qadeer)