System Description: MMTTeX
Connecting Content and Narration-Oriented Document Formats

Florian Rabe

Computer Science, University Erlangen-Nürnberg, Germany
LRI, University Paris-Sud, France

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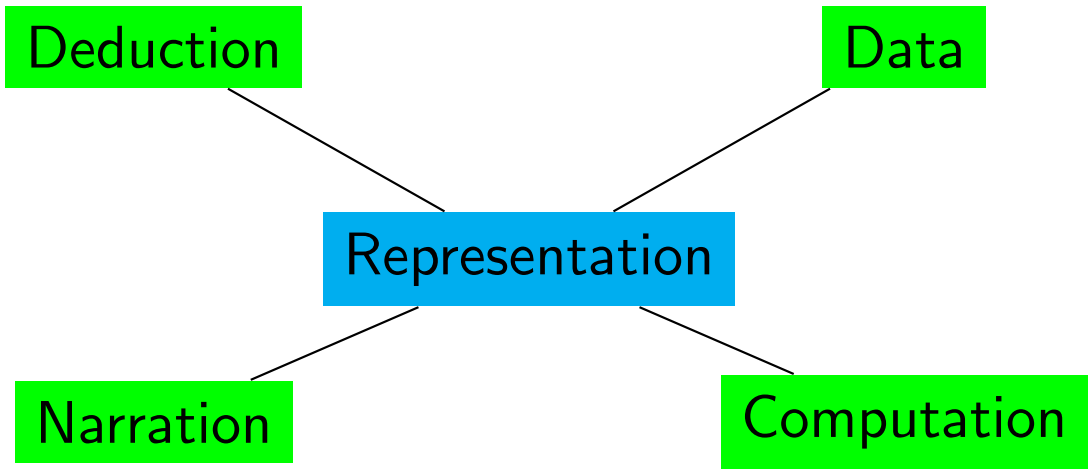
Motivation

Subsume All Aspects of Knowledge

- Narration: informal-but-rigorous math
  needed for human consumption
- Deduction: logic and type systems
  needed for machine understanding
- Computation: data structures and algorithms
  needed for practical applications
- Data: tabulate large sets and functions
  needed for examples, exploration and efficiency



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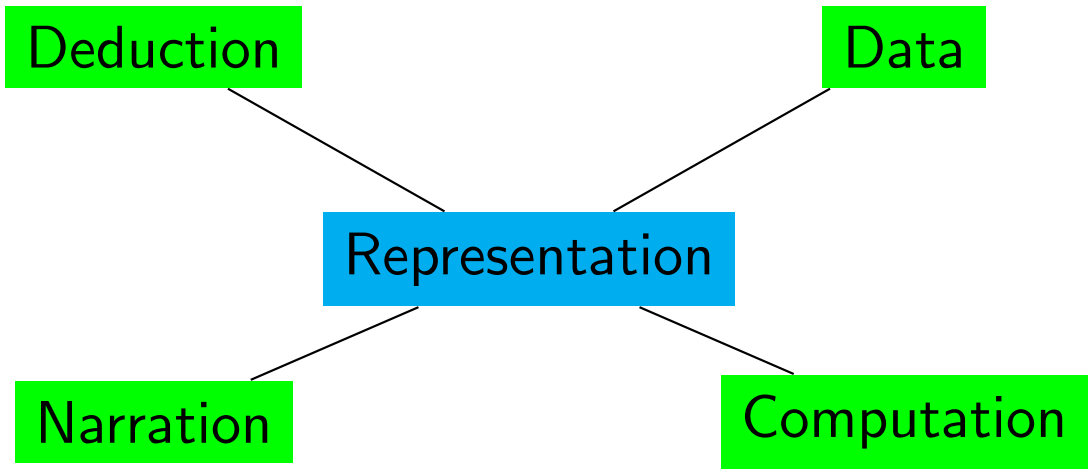
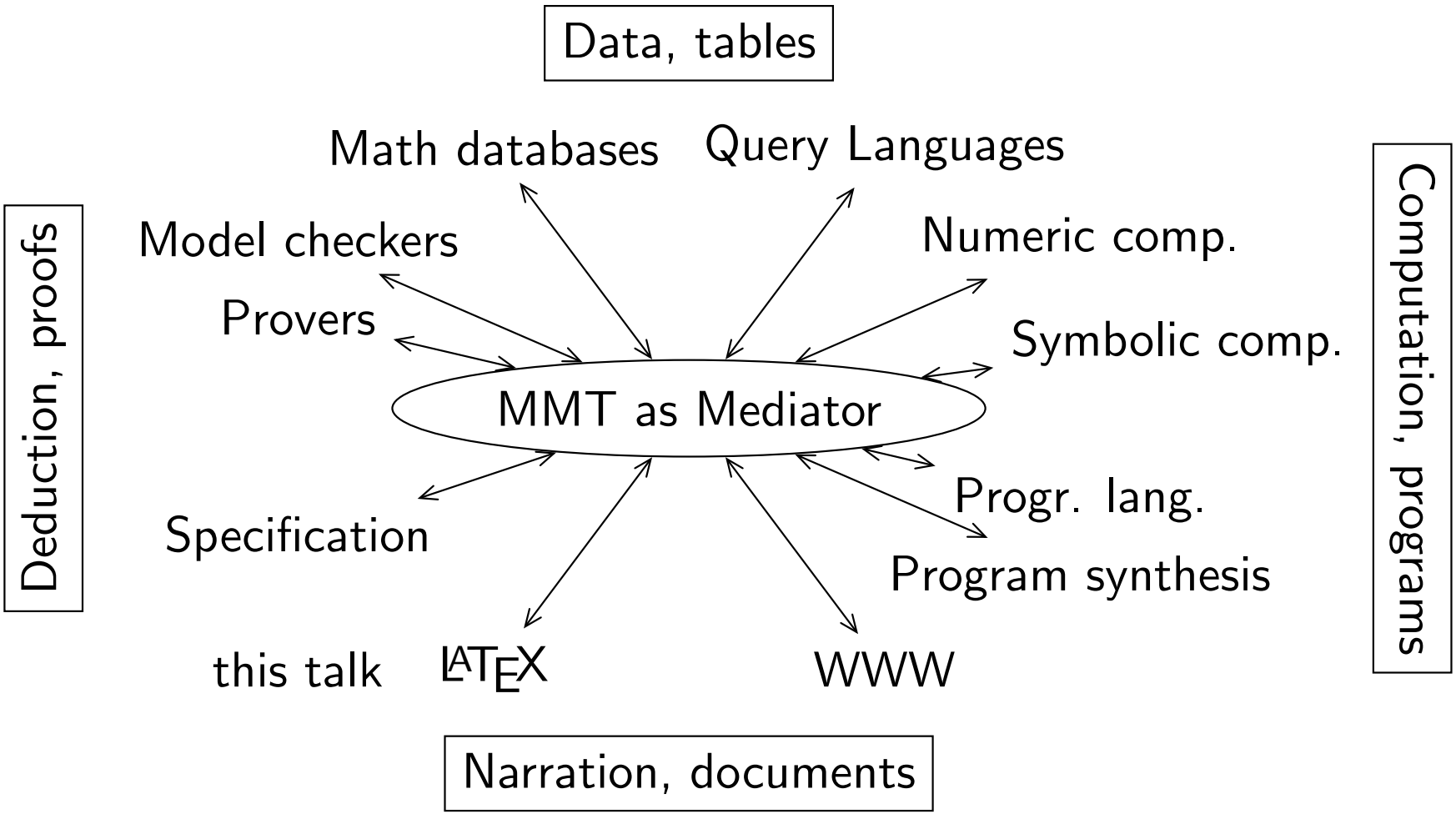
- Universal representation language
  key to universality, inter-operability



MMT as System Integration Platform

All system interfaces formalized in MMT

$\rightarrow$ semantics-aware tool integration while maintaining existing work flows



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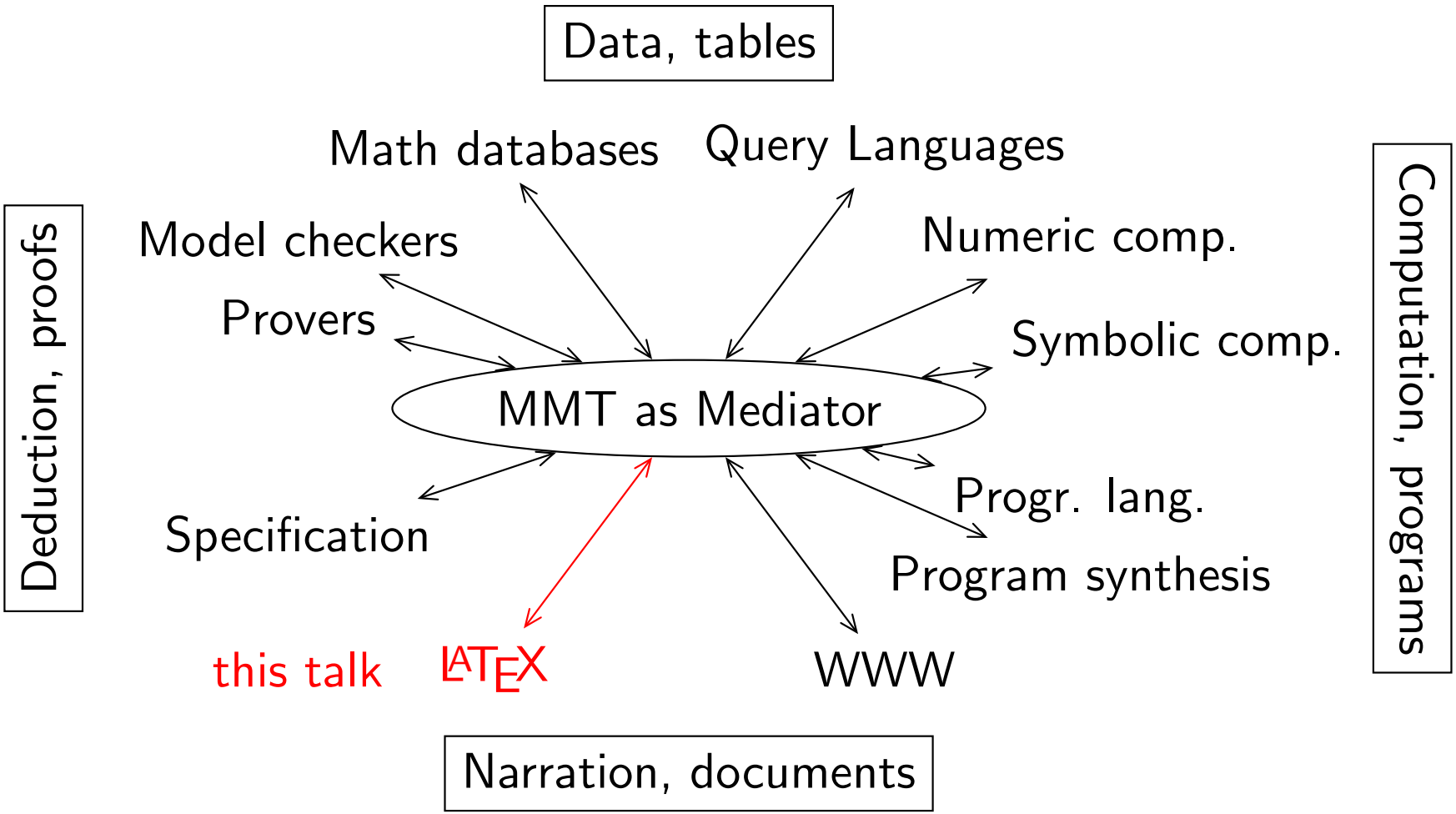

Design

Ideal System

Requirements:

- Author flexibly switches between MMT and LaTeX
  - multiple nesting levels allowed
  - top level can be either format
- Control passes between MMT and LaTeX processor
  - sharing the same context
  - communicating context changes

  e.g., introduce name in MMT chunk, use it in LaTeX chunk
- Produces OMDoc, pdf, HTML, etc.

Problems:

- No way to get LaTeX processor to interact flexibly
- No way to write a new LaTeX processor for the occasion

Realistic Options

Symmetric

- new document format with new processor
- interspersed MMT and LaTeX chunks
- generate `.tex` and `.mmt` files, process separately, merge the outputs into OMDoc

failed 201? CICM submission

MMT-led

- .mmt file processed by MMT
- interspersed LaTeX chunks
- MMT generates `.tex` file

LaTeX-led

- .tex file processed by LaTeX
- interspersed MMT chunks
- LaTeX generates `.mmt` file

this talk

Work flow

2 components using BibTeX model

- `mmttex.sty` package for LaTeX
  - first run: writes out MMT chunks to `d.tex.mmt`
  - second run: replaces MMT chunks with code from `d.tex.sty`
- `latex-mmt` plugin for MMT
  - processes `d.tex.mmt` as usual
  - generates `d.tex.sty` with special LaTeX code

	Input	Processor	Output
Step 1	`d.tex`	LaTeX	`d.pdf` `d.tex.mmt`
Step 2	`d.tex.mmt`	MMT	`d.tex.omdoc` `d.tex.sty`
Step 3	Run LaTeX again		

Advantages

Semantics-aware formula processing

- MMT parsing and type-checking
- semantic errors in MMT content produce LaTeX compilation errors
- formulas enriched with inferred information

  implicit arguments, omitted types

Semantically enriched formulas in `.pdf`

- tooltips on symbols
- hyper-references from usage to definition
- whatever else we can get the pdf viewers to support

  e.g., JavaScript barely supported

3 kinds of MMT content

Kind	defined in	function
Pres.-rel. chunks	LaTeX document	payload
Pres.-irrel. chunks		needed by payload
Backgr. Knowledge	elsewhere	

- Presentation-**relevant** MMT chunks
  - formulas defined in MMT instead of LaTeX syntax
  - produce semantically enriched formulas in the `.pdf` file

  e.g., $2 + 2 = 4$
- Presentation-**irrelevant** MMT chunks
  - provide context for the pres.-rel. chunks
  - part of `.tex` file
  - no effect on `.pdf` file

  e.g., definition of $+$
- Background knowledge
  - available in MMT independent of LaTeX document
  - define formal language(s) used in `tex` file

  e.g., formalization of logic, including $=$

Example and Demo

Game Plan

- Background knowledge: typed first-order logic in MMT
- Write a LaTeX document using MMTTeX

  these slides themselves!

  1. define theory of groups
     - informally as usual
     - additional pres.-irrel. chunks for formalization
  2. write formulas about groups in formal MMT syntax

Groups

A group consists of

- a set U,
- an operation $U \to U \to U$, written as infix $*$,
- an element e of U called the unit
- an inverse element function $U \to U$, written as postfix $'$ and with higher precedence than $*$.

We omit the axioms.

Consider group elements a and b.
Then we define the division of a by b as $a * b'$.

Division

We extend the theory of groups with a defined operation for division written as a fraction.

Now we can prove $\forall[x]\frac{x}{x}\doteq e$.

Conclusion

Call for Help

How do I make LaTeX forward a Unicode symbol inside an MMT formula unchanged to the generated `.mmt`?

I have a macro `\toMMT{#1}` that

- appends `#1` to the `.mmt` file
- does not produce anything in the `.pdf` file

But it goes haywire if `#1` contains Unicode characters.

Current workaround:

- avoid Unicode in MMT chunks
- if required by background knowledge, add parsing rules
  e.g., have MMT parse `->` or `\rightarrow` as $\rightarrow$

Prior Attempts

- CICM 201?: with M. Iancu, D. Ginev
  - tried to have a single LaTeX run only
  - LaTeX talked to MMT dynamically via HTTP

    requires LaTeX flag
- CICM 201?: with M. Iancu, M. Kohlhase
  - symmetric design
  - general infrastructure
  - arbitrary nesting of MMT and LaTeX
  - MMT and LaTeXML output merged into OMDoc

Summary

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