

LABMATE: Supporting Types for MATLAB

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The Problem

- ▶ Much software in science and engineering. written in `MATLAB`
 - ▶ May contain errors and bugs, as with any software.
- ▶ Developers often leave comments about how their data should be interpreted, e.g., units of measure for quantities.
- ▶ However `MATLAB` is oblivious to these high-level comments, and instead performs low-level checks during execution.

Our Plan

Can we do better?

- ▶ Make these developer comments formal.
- ▶ ...and create a tool to make use of them — LABMATE.
 - ▶ Keep existing MATLAB code and toolchains; no need to switch to a new language.
- ▶ Distill the essence of the developer comments in LABMATE's expressive type system.
 - ▶ A set of logical rules that assign domains of admissible values to program expressions.
- ▶ LABMATE is meant to be used while writing the code to get instant feedback and guidance — do not delay until execution.

How does LABMATE Work?

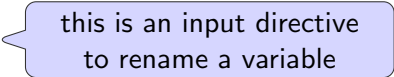
- ▶ LABMATE is a program transducer: reads MATLAB code with formal comments, and outputs a modified version of the input.
- ▶ These formal comments are directives — they start with %<.
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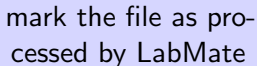
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mark the file as processed by LabMate

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- ▶ We can ask for type information. LabMate can infer the dimensions

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LabMate can point
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LabMate infers type of A
from the annotation on B

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tracks Matlab scope

Dimensions and Quantities

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define some base
set of dimensions

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- ▶ LABMATE has support for arbitrary quantities and a canonical unit of measure
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this is a “magic” response  
that LabMate emits

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%> typeof y
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turn a value of a dimension-  
less type into a quantity

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- ▶ A common scenario when working with matrices of quantities

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- ▶ Work in progress: LABMATE support for such matrices

```
% > A :: [i <- [{ } {`T}]
% x j <- [{ } {`L}]
%] Q({`M * j / i})
A = [2*kg 5*kg*metre
 3*kg/sec 4*kg*metre/sec]
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  - ▶ Quantities are modelled as the free Abelian group over a base set of dimensions.
  - ▶ The typechecker understands nontrivial algebraic properties.

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  - ▶ **Quality of life improvements**: better messages and more readable responses from LABMATE.
- ▶ We want to extend our coverage to loops and conditionals in the future.