

LABMATE: Supporting Types for MATLAB

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The Problem

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 - ▶ 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.

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Can we do better?

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- ▶ Make these developer comments formal.
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 - ▶ 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.

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- ▶ ...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.

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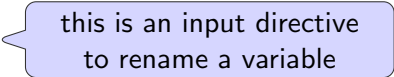
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LabMate response to
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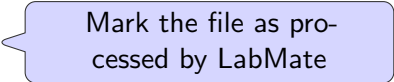
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Mark the file as processed by LabMate

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A = [ 3 4 ]
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%> B :: [ 2 x 4 ] int
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- ▶ We can ask for type information. LabMate can infer the dimensions

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LabMate can point
out an error with D

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function B = f(A)
    %> B :: [ 1 x 3 ] int
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    %> typeof A
    %< A :: [Matrix 1 2 int]
end

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LabMate infers type of A
from the annotation on B

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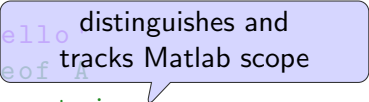
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distinguishes and
tracks Matlab scope

Dimensions and Quantities

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%> dimensions V for Q over `Mass, `Time  
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Dimensions and Quantities

- ▶ LABMATE has support for arbitrary

quantities
define some base
set of dimensions

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Dimensions and Quantities

- ▶ LABMATE has support for arbitrary quantities and a canonical unit of measure
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can be arbitrary group  
expression over V

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this is a “magic” response  
that LabMate emits

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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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%> dimensions V for Q over `L, `M, `T
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- ▶ Work in progress: LABMATE support for such matrices

```
% > A :: [i <- [{ } {`T}]
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The cell type Q depends on i and j

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Index i tells us something about the rows

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- ▶ Work in progress: Index  $j$  disambiguates the columns for such matrices

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% > A := [2*kg 5*kg*metre
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% x j <- [{ } { `L }]
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  - ▶ 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.

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