

DRASIL

A Knowledge-Based Approach to Scientific Software Development

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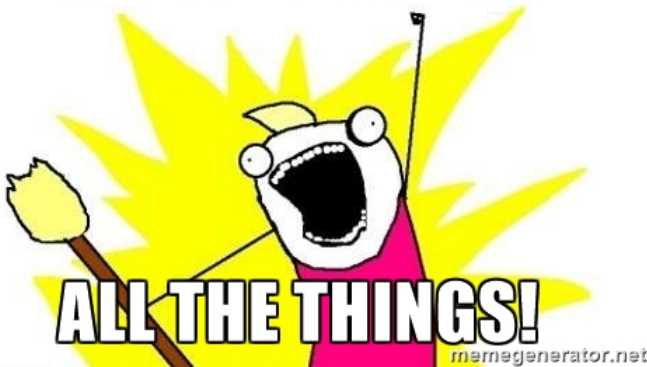
McMaster University

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Background Context

- \exists problems $\in D$ where
- $D = \{ \text{scientific computing, engineering computing} \}$
- Problems = [
 - Inconsistent Software Requirement Specifications (SRS) across D
 - Inconsistency between code and documentation
 - Documentation is annoying to make and maintain
 - Hard to reuse code for different applications]

GENERATE



Purpose of Drasil

- Solve the four problems
- Promote
 - Reusability
 - Examples have fully documented code
 - Data base to build new examples
 - Maintainability
 - Make changes in one place, gets updated everywhere

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- Language and Rendering (Language.Drasil)
 - Code Generation: transition from Drasil to working code
 - Documentation Generation: transition from Drasil to human readable documentation
- Case Studies (Example.Drasil)
 - This part is where you would input equations, requirements, and output code and documentation

- Scientific and engineering computing has the potential to lead other fields of software with its solid knowledge base

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- Drasil is intended to simplify the generation of documentation and code for scientific software
- Facilitate desirable software qualities such as traceability, verifiability, and reproducibility
- Case studies from which structural patterns and implicit relationships can be extracted, data can be captured, and core systems can be tested and implemented

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- Related information should stem from one source (reduces duplication)

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GitHub

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- Git (**when used properly**) prevents catastrophic lose of work

Daily Tasks

- Finding patterns within examples \Rightarrow sentence combinators
- Finding patterns between examples \Rightarrow extraction of common sections, contents, and concepts



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- Code cleanup and bug fixing
- Opening/closing issues

Example

Var	Physical Constraints	Software Constraints	Typical Value	Typical Uncertainty
P_{btol}	$0.0 < P_{btol}$ and $P_{btol} < 1.0$	None	0.008	1.0e-3
TNT	$TNT > 0.0$	None	1	0.1
a	$a > 0.0$ and $\frac{a}{b} > 1.0$	$d_{min} \leq a, a \leq d_{max}$, and $\frac{a}{b} < AR_{max}$	1500.0 m	0.1
b	$b > 0.0$ and $b < a$	$d_{min} \leq b, b \leq d_{max}$, and $\frac{a}{b} < AR_{max}$	1200.0 m	0.1
w	$w \geq 0.0$	$w_{max} \leq w$ and $w \leq w_{min}$	42.0 kg	0.1
SD	$SD > 0.0$	$SD_{min} < SD$ and $SD < SD_{max}$	45.0 m	0.1

Input Data Constraints

Example

```
s6_2_5_table1 = Table [S "Var", S "Physical Cons", S "Software Constraints", S "Typical Value",  
  S "Uncertainty"] (mkTable [(\x -> x!!0), (\x -> x!!1), (\x -> x!!2), (\x -> x!!3),  
  (\x -> x!!4)] [(P $ plate_len ^ . symbol), (P $ plate_len ^ . symbol) +:+ S "> 0 and" +:+  
  (P $ plate_len ^ . symbol) +:+ S "/" +:+ (P $ plate_width ^ . symbol) +:+ S "> 1",  
  (P $ dim_min ^ . symbol) +:+ S "<=" +:+ (P $ plate_len ^ . symbol) +:+ S "<=" +:+  
  (P $ dim_max ^ . symbol) +:+ S "and" +:+ (P $ plate_len ^ . symbol) +:+ S "/" +:+  
  (P $ plate_width ^ . symbol) +:+ S "<" +:+ (P $ ar_max ^ . symbol), S "1500" +:+  
  Sy (unit_symb plate_len), S "10%"], [(P $ plate_width ^ . symbol),  
  (P $ (plate_width ^ . symbol)) +:+ S "> 0 and" +:+ (P $ plate_width ^ . symbol)  
  +:+ S "<" +:+ (P $ plate_len ^ . symbol), (P $ dim_min ^ . symbol) +:+ S "<=" +:+  
  (P $ plate_width ^ . symbol) +:+ S "<=" +:+ (P $ dim_max ^ . symbol) +:+ S "and" +:+  
  (P $ plate_len ^ . symbol) +:+ S "/" +:+ (P $ plate_width ^ . symbol) +:+ S "<" +:+  
  (P $ ar_max ^ . symbol), S "1200" +:+ Sy (unit_symb plate_width), S "10%"],  
  [(P $ pb_tol ^ . symbol), S "0 <" +:+ (P $ pb_tol ^ . symbol) +:+ S "< 1", S "-", S "0.008", S "0.1%"],  
  [(P $ char_weight ^ . symbol), (P $ char_weight ^ . symbol) +:+ S ">= 0", (P $ cWeightMin ^ . symbol)  
  +:+ S "<" +:+ (P $ char_weight ^ . symbol) +:+ S "<" +:+ (P $ cWeightMax ^ . symbol), S "42" +:+  
  Sy (unit_symb char_weight), S "10%"], [(P $ tNT ^ . symbol), (P $ tNT ^ . symbol) +:+  
  S "> 0", S "-", S "1", S "10%"], [(P $ standOffDist ^ . symbol), (P $ standOffDist ^ . symbol)  
  +:+ S "> 0", (P $ sd_min ^ . symbol) +:+ S "<" +:+ (P $ standOffDist ^ . symbol) +:+ S "<" +:+  
  (P $ sd_max ^ . symbol), S "45" +:+ Sy (unit_symb standOffDist), S "10%"]])
```



```
s6_2_5_table1 :: Contents  
s6_2_5_table1 = inDataConstTbl (gbInputDataConstraints)
```

Example

```
plate_len :: UncertQ
plate_len = uqcND "plate_len" (nounPhraseSP "plate length (long dimension)")
  1A metre Real
  [ physc $ \c -> c :> (Dbl 0),
    physc $ \c -> (c / (C plate_width)) :> (Dbl 1),
    sfwrc $ \c -> (C dim_min) :<= c,
    sfwrc $ \c -> c :<= (C dim_max),
    sfwrc $ \c -> (c / (C plate_width)) :< (C ar_max) ] (Dbl 1500) defaultUncrt
```

Figure

```
-- Creates the input Data Constraints Table
inDataConstTbl :: (UncertainQuantity c, SymbolForm c, Constrained c) => [c] -> Contents
inDataConstTbl qlst = Table ([S "Var"] ++ (isPhys $ physC (head qlst) qlst) ++
  (isSfwr $ sfwrC (head qlst) qlst) ++ [S "Typical" ++ titleize value] ++
  (isUnc $ typUnc (head qlst) qlst))
  (map (\x -> fmtInputConstr x qlst) qlst)
  (S "Input Data Constraints") True
  where isPhys [] = []
        isPhys _ = [titleize' physicalConstraint]
        isSfwr [] = []
        isSfwr _ = [titleize' softwareConstraint]
        isUnc [] = []
        isUnc _ = [S "Typical Uncertainty"]
```

Figure

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- Output:
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 - Documentation (Module Guide, Software Requirements Specification)

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- Catching and correcting errors in software:
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 - Easy to spot
 - Once it's fixed, it is also fixed everywhere else

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- GamePhysics
 - Most ambiguous example
 - SRS for a game physics library

For more information about Drasil and LLS visit our github page:
<https://github.com/JacquesCarette/literate-scientific-software>

You can even build a working version yourself!