First Committee Meeting

Progress Report

Jason Balaci

McMaster University

Oct. 21^{st}, 2021

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Who am I?

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Me, Camping in Killarney Prov. Park, Fall 2019

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- Graduate of *McMaster University*, holding...
  - Hons. Actuarial and Financial Mathematics (B.Sc.)
  - Minor in Computer Science
- Currently pursuing a thesis-based Master's of Computer Science (M.Sc) at *McMaster University*, under the supervision of **Dr. Jacques Carette**.

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Overview of Progression Towards C.S. M.Sc.

Course-related progression

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[1] https://academiccalendars.romcmaster.ca/preview_program.php?catoid=45&poid=23470&returnto=9166

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- Together, the courses completed satisfies the "Courses Requirement" as mentioned in the academic calendar[1] and the "Regulations for the Computer Science M.Sc. Program" document[2].

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- Supervisory committee is formed, and we are currently having our first supervisory committee meeting.
  - *Supervisor*: Dr. Jacques Carette
  - Dr. Spencer Smith
  - Dr. Wolfram Kahl

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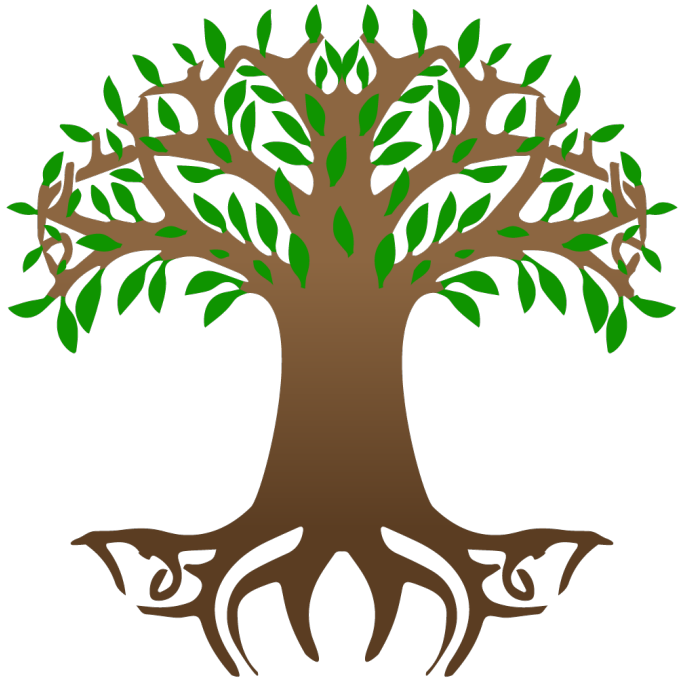
Drasil...



Drasil's Logo
[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

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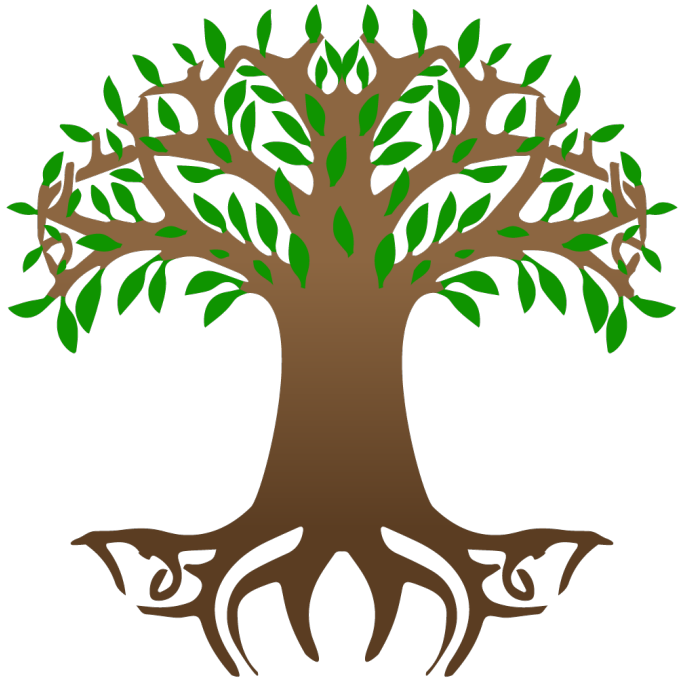

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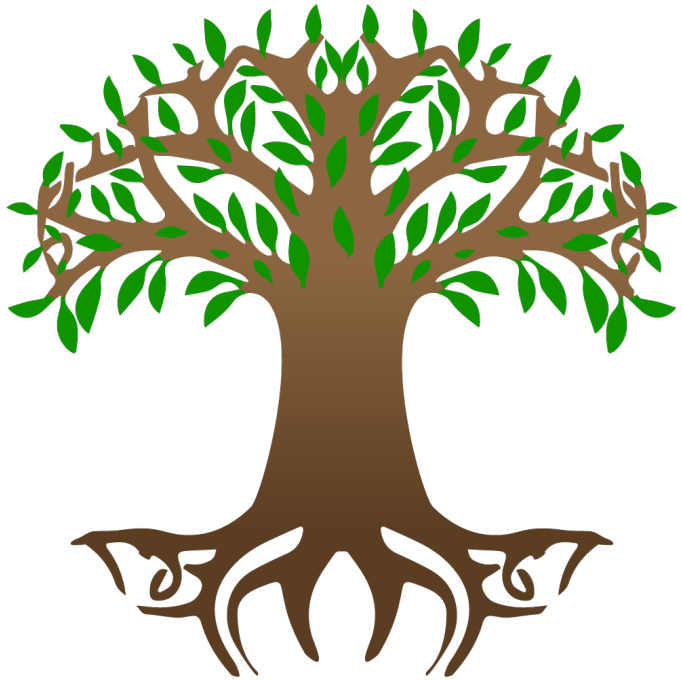

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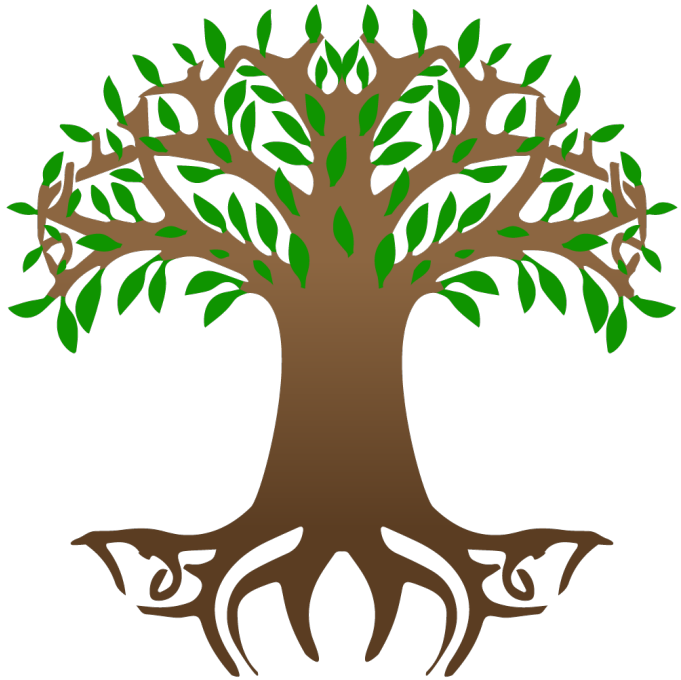

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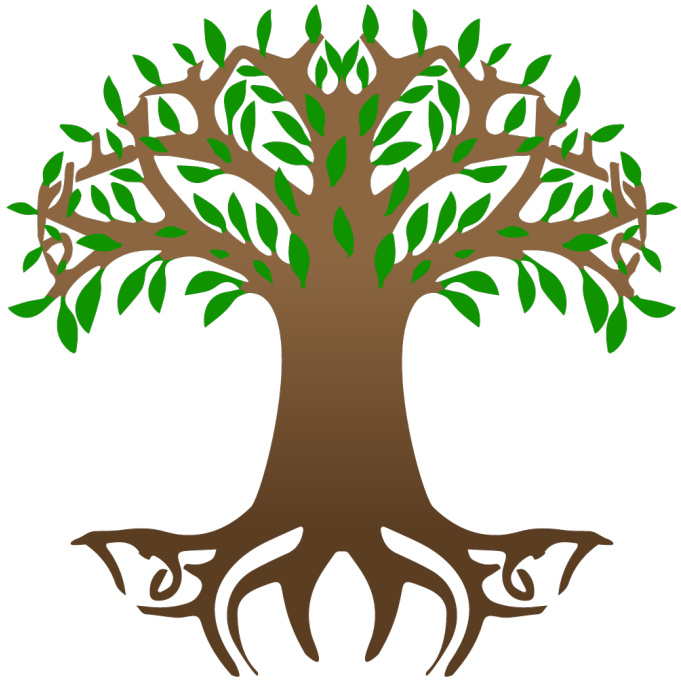

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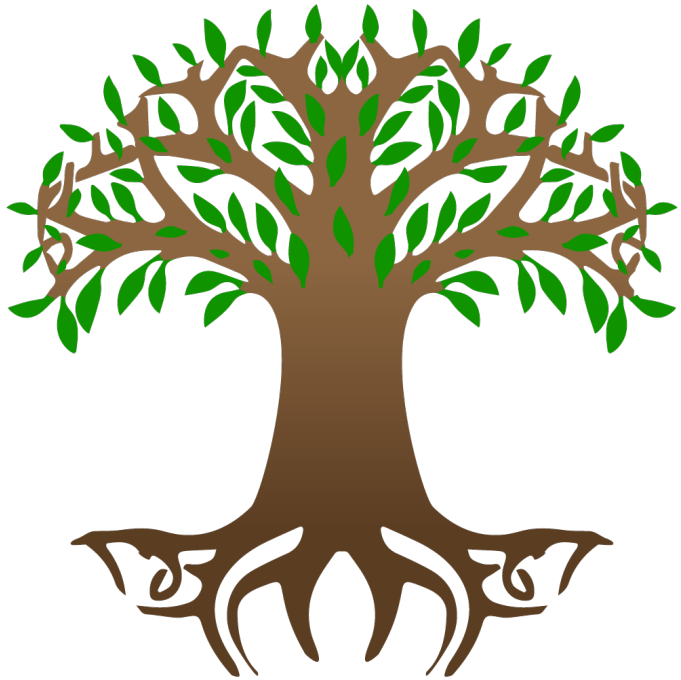

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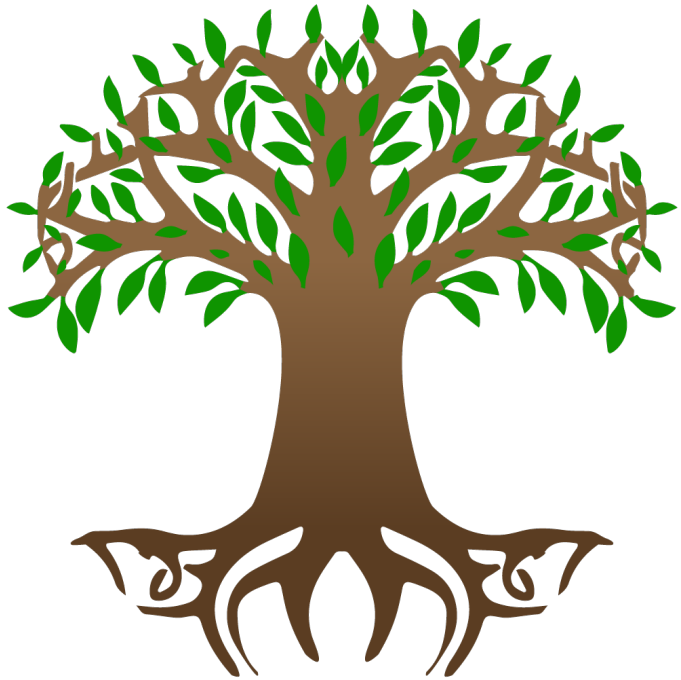

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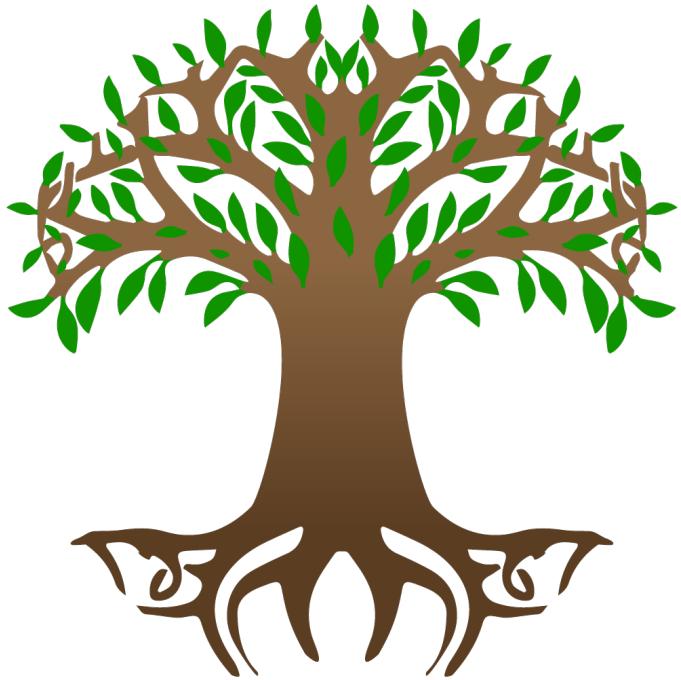
- has a website[1]!



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Drasil

"Generate All The Things!"

- An exploration in software-related artifact generation for "well understood" domains through strong knowledge capture.
  - By unifying knowledge into a single framework with deeply reusable composable units of knowledge, we eliminate code duplication.
  - Knowledge organization and capture is of utmost importance in Drasil, as it is the pathway for interpreters and Domain-Specific Languages (DSLs) to make appropriate usage of the knowledge captured.
  - By creating different kinds of "printers", we can use a stable knowledge-base to easily generate software that solves well understood problems.
- Drasil currently focuses on building research software, with Software Requirement Specification documents (SRS) in both LaTeX and HTML (with MathJaX), code to solve a problem, README files, Makefiles, graphs, etc.

Excerpts from unpublished, blinded paper:
`https://github.com/JacquesCarette/Drasil/blob/NIER2021/Papers/WellUnderstood/wu.pdf`.

Drasil Case Studies

[1] https://jacquescarette.github.io/Drasil/#Sec:Examples

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Drasil Case Studies

- *cont.d*[1]:
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The Drasil website is also generated by Drasil!

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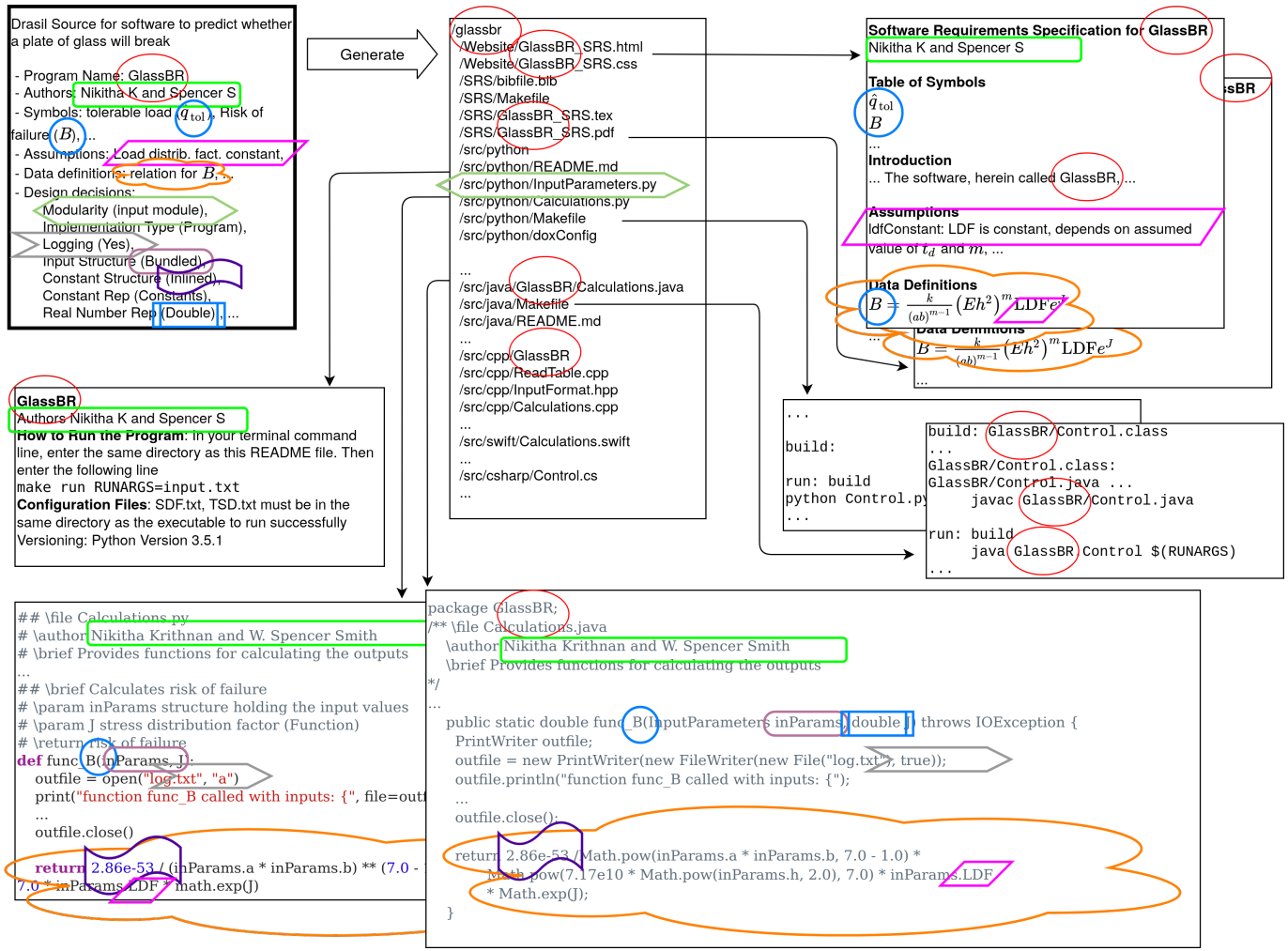
Taking a closer look at one of the examples: GlassBR

GlassBR Generates Code!



Knowledge flow from "knowledge-base"/source to artifacts, by Dr. Spencer Smith

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- Confidently generating usable software artifacts without strong type information places significant stress on developers, resulting in a higher likelihood of bugs in artifacts.
- Existing "theories"/"*Models"[1] don't expose enough information. They must be enriched, so that we can better interact with, and understand them.

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- We want to ease developer cognitive load when writing expressions, as they will need to ensure their expressions are coherent, or else a type error can occur at runtime.

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- Allows GOOL code generator to also become typed!

Goal #1: Typed Expression Language

What makes up a "good" solution?

- Catches, within reason, all possible scenarios where an expression goes awry.
- Allows GOOL code generator to also become typed!
- Add extra functionality to existing expression languages safely, allowing for new data types to be introduced.

Goal #1: Typed Expression Language

Current Progression

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  - "CodeExpr" is a clone of 'Expr', with a few extra functionalities for GOOL.

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    - Theories that rely on discussion of terms only found "ModelExpr" may only have code generated for them if we have rich enough data (see goal #2).
  - "CodeExpr" is a clone of 'Expr', with a few extra functionalities for GOOL.
  - Created a typed tagless final[Carette et al., 2009] smart constructor encoding for writing expressions in "Expr" (or, optionally, ModelExpr).

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- Moving literals from "Expr" & "ModelExpr" into their own small language, so that areas that want *strictly* literals can also have stronger restrictions on allowed data.

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- Adjusting containers to allow for expressions with a type variable.

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- Continue moving inadmissible terms from "Expr" into "ModelExpr".
- Moving literals from "Expr" & "ModelExpr" into their own small language, so that areas that want *strictly* literals can also have stronger restrictions on allowed data.
- Adjusting containers to allow for expressions with a type variable.
- Adding the final type signatures, using Haskell GADT syntax.

Goal #2: Theory Discrimination – "ModelKinds"

The Problem

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- Previously, "RelationConcepts" were heavily used in both displaying expressions, and code generation. They are essentially "Relation"s ("Expr"s) with a natural language description of them.

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The Problem

- Previously, "RelationConcepts" were heavily used in both displaying expressions, and code generation. They are essentially "Relation"s ("Expr"s) with a natural language description of them.
- "RelationConcept"s don't contain enough information on their own to be a core component usable in general code generation.

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The Problem

- Previously, "RelationConcepts" were heavily used in both displaying expressions, and code generation. They are essentially "Relation"s ("Expr"s) with a natural language description of them.
- "RelationConcept"s don't contain enough information on their own to be a core component usable in general code generation.
- If the "shape" of the expressions are not uniform, then writing more "interpreters"/"views"/code generators for them required difficult pattern analysis. It's also not a total-conversion.

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What makes up a "good" solution?

- A good solution involves making the "Relation"s a "view" of a more data-rich specialized container for each kind of "Theory"/"*Model".
- "ModelKinds"
- By constructing our final data views through "more steps" (e.g., with more depth), we obtain a better understanding of our "theories", allowing us to do more with them.

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- Considerable number of "theories"/"*Models" have been restructured, but there are still many that are pending classification.
  - Most are best to be done once we have a typed expression language (so that we can better handle expressions that involve collections of sorts), and the rest are differential equation-related models (primarily Dong's domain).

Goal #2: Theory Discrimination – "ModelKinds"

What are the next steps?

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What are the next steps?

- Understanding what kinds of needs we have for "collections", pushing this information back into the typed expression language (once that is fully typed), and then creating model containers for these models.

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What are the next steps?

- Understanding what kinds of needs we have for "collections", pushing this information back into the typed expression language (once that is fully typed), and then creating model containers for these models.
- For the differential equation-related models, we will need to build appropriate models for each kind.

Fin.

Thank you!

Table of Contents

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