

First Committee Meeting

Progress Report

Jason Balaci

McMaster University

Oct. 21st, 2021

Table of Contents

1 Introduction

2 Project

- Drasil
- Goal #1: Typed Expression Language
- Goal #2: Model Discrimination – “ModelKinds”

3 References

Table of Contents

1 Introduction

2 Project

- Drasil
- Goal #1: Typed Expression Language
- Goal #2: Model Discrimination – “ModelKinds”

3 References

Who am I?

Who am I?

- I am **Jason Balaci**



Me, Camping in Massasauga Prov.
Park, Fall 2019

Who am I?

- I am **Jason Balaci**
- Graduate of *McMaster University*, holding...



Me, Camping in Massasauga Prov.
Park, Fall 2019

Who am I?

- I am **Jason Balaci**
- Graduate of *McMaster University*, holding...
 - Hons. Actuarial and Financial Mathematics (B.Sc.)



Me, Camping in Massasauga Prov. Park, Fall 2019

Who am I?

- I am **Jason Balaci**
- Graduate of *McMaster University*, holding...
 - Hons. Actuarial and Financial Mathematics (B.Sc.)
 - Minor in Computer Science



Me, Camping in Massasauga Prov. Park, Fall 2019

Who am I?

- I am **Jason Balaci**
- 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**.



Me, Camping in Massasauga Prov. Park, Fall 2019

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

Course-related progression

- I'm required to complete¹²:

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses
- I've completed:

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses
- I've completed:
 - CAS 701 "Logic & Discrete Mathematics" - Theory course, Fall 2020

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses
- I've completed:
 - CAS 701 "Logic & Discrete Mathematics" - Theory course, Fall 2020
 - CAS 761 "Generative Programming" - Software course, Fall 2020

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses
- I've completed:
 - CAS 701 "Logic & Discrete Mathematics" - Theory course, Fall 2020
 - CAS 761 "Generative Programming" - Software course, Fall 2020
 - CAS 763 "Certified Programming with Dependent Types" - Theory & Software course, Winter 2021

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses
- I've completed:
 - CAS 701 "Logic & Discrete Mathematics" - Theory course, Fall 2020
 - CAS 761 "Generative Programming" - Software course, Fall 2020
 - CAS 763 "Certified Programming with Dependent Types" - Theory & Software course, Winter 2021
 - COMPSCI 6TB3 "Syntax-Based Tools and Compilers" - Systems course, Winter 2021

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Course-related progression

- I'm required to complete¹²:
 - One (1) "Software" course
 - Either of:
 - Two "Theory" courses, and one "Systems" course
 - One "Theory" course, and two "Systems" courses
- I've completed:
 - CAS 701 "Logic & Discrete Mathematics" - Theory course, Fall 2020
 - CAS 761 "Generative Programming" - Software course, Fall 2020
 - CAS 763 "Certified Programming with Dependent Types" - Theory & Software course, Winter 2021
 - COMPSCI 6TB3 "Syntax-Based Tools and Compilers" - Systems course, Winter 2021
- Together, the courses completed satisfies the "Courses Requirement" as mentioned in the academic calendar¹ and the "Regulations for the Computer Science M.Sc. Program" document².

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

²http://www.cas.mcmaster.ca/cas/0files/reg_master_cs_2019a.pdf

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

Thesis/research-related Progression

- Conducted “full-time” research for at least 1 full semester (Spring/Summer 2021), and “part-time” research during courses.

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

Thesis/research-related Progression

- Conducted “full-time” research for at least 1 full semester (Spring/Summer 2021), and “part-time” research during courses.
- Continuing to research “full-time”.

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

Thesis/research-related Progression

- Conducted “full-time” research for at least 1 full semester (Spring/Summer 2021), and “part-time” research during courses.
- Continuing to research “full-time”.
- Attended a thesis defence to learn about what to expect from a thesis defence (and learn about their research).

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

Thesis/research-related Progression

- Conducted “full-time” research for at least 1 full semester (Spring/Summer 2021), and “part-time” research during courses.
- Continuing to research “full-time”.
- Attended a thesis defence to learn about what to expect from a thesis defence (and learn about their research).
- Supervisory committee is formed, and we are currently having our first supervisory committee.
 - *Supervisor:* Dr. Jacques Carette
 - Dr. Spencer Smith
 - Dr. Wolfram Kahl

Table of Contents

1 Introduction

2 Project

- Drasil
- Goal #1: Typed Expression Language
- Goal #2: Model Discrimination – “ModelKinds”

3 References

Preface

What is Drasil?

Drasil...



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.
- originates from the work of Dan Szymczak.



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.
- originates from the work of Dan Szymczak.
 - Originally focused on scientific software (*Literate Scientific Software*).



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.
- originates from the work of Dan Szymczak.
 - Originally focused on scientific software (*Literate Scientific Software*).
 - Focus expanded...



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.
- originates from the work of Dan Szymczak.
 - Originally focused on scientific software (*Literate Scientific Software*).
 - Focus expanded...
- tries to “Generate All The Things”...



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.
- originates from the work of Dan Szymczak.
 - Originally focused on scientific software (*Literate Scientific Software*).
 - Focus expanded...
- tries to “Generate All The Things”...
 - with a focus on research software.



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

Preface

What is Drasil?

Drasil...

- is managed by Dr. Carette & Dr. Smith.
- originates from the work of Dan Szymczak.
 - Originally focused on scientific software (*Literate Scientific Software*).
 - Focus expanded...
- tries to “Generate All The Things”...
 - with a focus on research software.
- has a website¹!



Drasil's Logo

[Carette et al., 2021][Yggdrasil - Wikipedia, 2021]

¹<https://jacquescarette.github.io/Drasil/>

- TODO: here!

Drasil Case Studies

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:
 - **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:
 - **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
 - **Single Pendulum** - Observing the motion of a single pendulum.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:
 - **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
 - **Single Pendulum** - Observing the motion of a single pendulum.
 - **Double Pendulum** - Observing the motion of a double pendulum.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:
 - **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
 - **Single Pendulum** - Observing the motion of a single pendulum.
 - **Double Pendulum** - Observing the motion of a double pendulum.
 - **Game Physics** - Modelling of an open source 2D rigid body physics library used for games.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:
 - **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
 - **Single Pendulum** - Observing the motion of a single pendulum.
 - **Double Pendulum** - Observing the motion of a double pendulum.
 - **Game Physics** - Modelling of an open source 2D rigid body physics library used for games.
 - **Proportional Derivative Controller (PDController)** - Examining the output of a “Power Plant” (Process Variable) over time.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

Drasil Case Studies

- Drasil currently contains a significant amount of Physics-related knowledge.
- As of writing, current case studies¹ are primarily related to physics, including:
 - **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
 - **Single Pendulum** - Observing the motion of a single pendulum.
 - **Double Pendulum** - Observing the motion of a double pendulum.
 - **Game Physics** - Modelling of an open source 2D rigid body physics library used for games.
 - **Proportional Derivative Controller (PDController)** - Examining the output of a “Power Plant” (Process Variable) over time.
 - **Solar Water Heating System (SWHS)** - Modelling of a solar water heating system with phase change material, predicting temperatures and change in heat energy of water and the PCM over time.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

- *cont.d*¹:
 - **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

- *cont.d*¹:
 - **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.
 - **Projectile** - Determining if a launched projectile hits a target, assuming no flight collisions.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

- *cont.d*¹:

- **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.
- **Projectile** - Determining if a launched projectile hits a target, assuming no flight collisions.
- **Slope Stability Analysis (SSP)** - Assessment of the safety of a slope (composed of rock and soil) subject to gravity, identifying the surface most likely to experience slip and an index of its relative stability (factor of safety).

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

- *cont.d*¹:

- **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.
- **Projectile** - Determining if a launched projectile hits a target, assuming no flight collisions.
- **Slope Stability Analysis (SSP)** - Assessment of the safety of a slope (composed of rock and soil) subject to gravity, identifying the surface most likely to experience slip and an index of its relative stability (factor of safety).
- **Heat Transfer Coefficients between Fuel and Cladding in Fuel Rods (HGHC)** - Examining the heat transfer coefficients related to clad.

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

- *cont.d*¹:

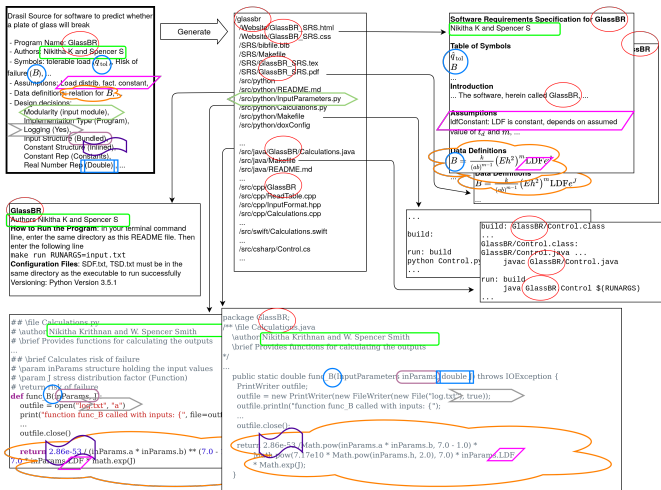
- **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.
- **Projectile** - Determining if a launched projectile hits a target, assuming no flight collisions.
- **Slope Stability Analysis (SSP)** - Assessment of the safety of a slope (composed of rock and soil) subject to gravity, identifying the surface most likely to experience slip and an index of its relative stability (factor of safety).
- **Heat Transfer Coefficients between Fuel and Cladding in Fuel Rods (HGHC)** - Examining the heat transfer coefficients related to clad.

The Drasil website is also generated by Drasil!

¹<https://jacquescarette.github.io/Drasil/#Sec:Examples>

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

Which case studies currently generate code?

- **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.

Which case studies currently generate code?

- **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
- **Proportional Derivative Controller (PDController)** - Examining the output of a “Power Plant” (Process Variable) over time.

Which case studies currently generate code?


- **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
- **Proportional Derivative Controller (PDController)** - Examining the output of a “Power Plant” (Process Variable) over time.
- **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.

Which case studies currently generate code?

- **GlassBR** - Predicting whether or not a glass slab is likely to resist a specified blast.
- **Proportional Derivative Controller (PDController)** - Examining the output of a “Power Plant” (Process Variable) over time.
- **SWHS without Phase Change Material (NoPCM)** - Modelling of a solar water heating system without phase change material, predicting temperatures and change in heat energy of water and the PCM over time.
- **Projectile** - Determining if a launched projectile hits a target, assuming no flight collisions.

Why don't all case studies generate software artifacts?

Where will I be contributing?

¹Terminology is currently being changed, but is not reflected in many documents yet. 

Why don't all case studies generate software artifacts?

Where will I be contributing?

After all,


¹Terminology is currently being changed, but is not reflected in many documents yet.

Why don't all case studies generate software artifacts?

Where will I be contributing?

After all,

- They're all “well-understood”!


¹Terminology is currently being changed, but is not reflected in many documents yet. 

Why don't all case studies generate software artifacts?

Where will I be contributing?

After all,

- They're all “well-understood”!
- The SRS documents are generated!

¹Terminology is currently being changed, but is not reflected in many documents yet. 


Why don't all case studies generate software artifacts?

Where will I be contributing?

After all,

- They're all “well-understood”!
- The SRS documents are generated!

A few, notable, blocking problems:

¹Terminology is currently being changed, but is not reflected in many documents yet. 

Why don't all case studies generate software artifacts?


Where will I be contributing?

After all,

- They're all “well-understood”!
- The SRS documents are generated!

A few, notable, blocking problems:

- Confidently generating usable software artifacts without strong type information places significant stress on developers, resulting in a higher likelihood of bugs in artifacts.

¹Terminology is currently being changed, but is not reflected in many documents yet. 

Why don't all case studies generate software artifacts?

Where will I be contributing?

After all,

- They're all “well-understood”!
- The SRS documents are generated!

A few, notable, blocking problems:

- 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.

¹Terminology is currently being changed, but is not reflected in many documents yet.

Acknowledgements

Fin.
Thank you!

Table of Contents

1 Introduction

2 Project

- Drasil
- Goal #1: Typed Expression Language
- Goal #2: Model Discrimination – “ModelKinds”

3 References

References I



Carette, J., Smith, S., Balaci, J., Hunt, A., Wu, T.-Y., Crawford, S., Chen, D., Szymczak, D., MacLachlan, B., Scime, D., and Niazi, M. (2021).

Drasil.



Yggdrasil - Wikipedia (2021).

Yggdrasil.