

# Refactoring Sketcher in FreeCAD

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2<sup>nd</sup> February, 2025  
FOSDEM 2025

View Data  
Tasks  
Close

**Solver messages**  
Under-constrained: [13 DoF\(s\)](#)

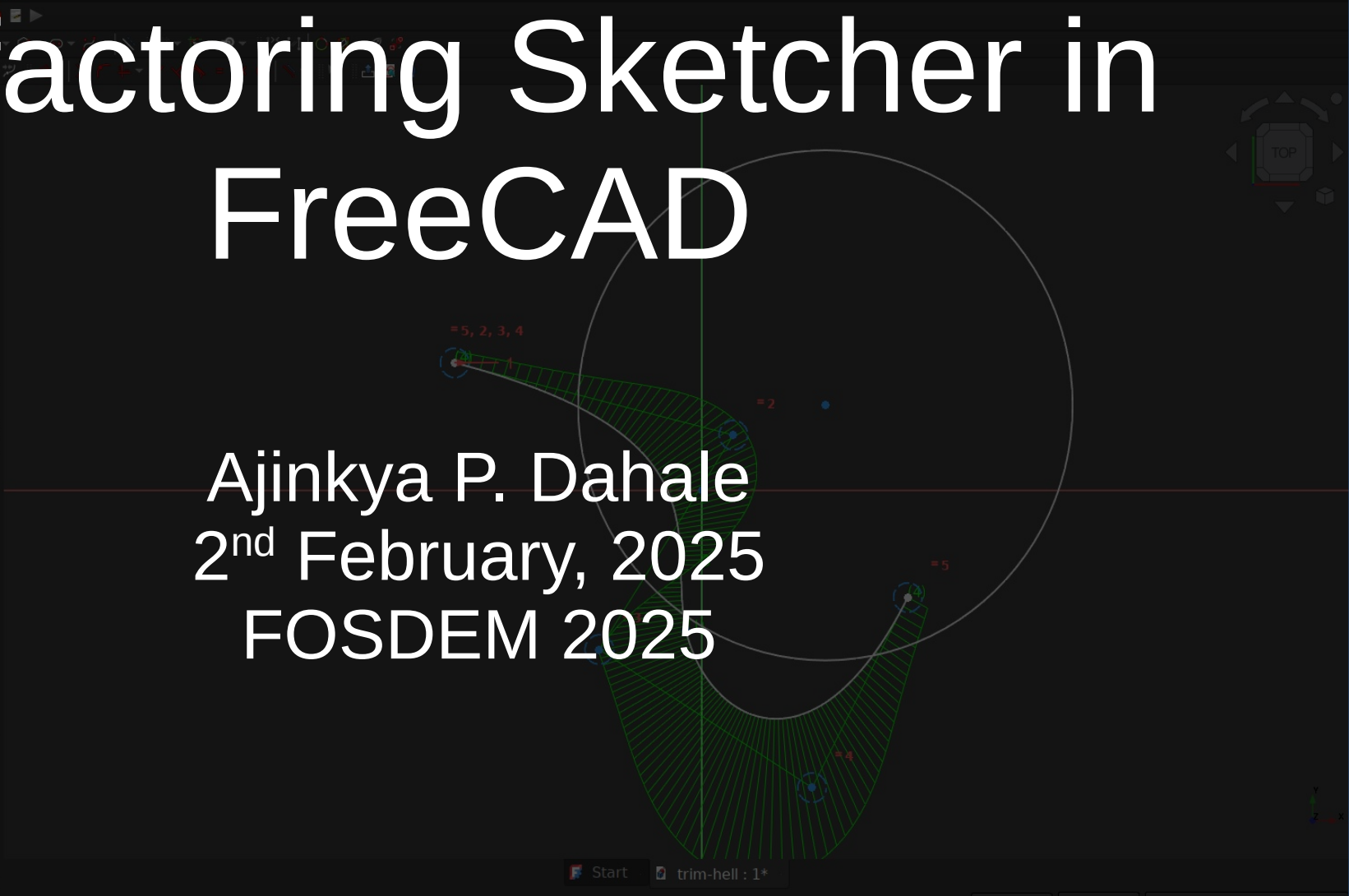
**Advanced solver control**

**Constraints**

- Constraint1 (1)
- Constraint2
- Constraint3
- Constraint4
- Constraint5
- Constraint6
- Constraint7

**Elements**

Valid, Internal name: Body



# About FreeCAD

- Complete parametric 3D modeling tool, in development since 2001
- Ability to model physical objects of any size
- For more detail, check out our stand in the AW building (or <https://freecad.org> if watching remotely)

# About Me

- FreeCAD contributor since 2016.
- Mainly focused on Sketcher, Part Design and related topics.
- Presently also working as project staff at FOSSEE, IIT Bombay (<https://fossee.in>)
- Occasionally available on most “professional” social media: just search for “Ajinkya Dahale”

# Motivation

- Freecad is well over 20 years old
- Technical debt accumulates
  - Multiple ad-hoc changes (bug based development)
  - Many developers
  - Spaghetti code: readability limited
  - Changing standards (C++98 to C++20)
- Due for a clean up.
- (Mid-2024) 1.0 release preparations kept the code base stable

File Edit View Tools Macro Sketch Windows Help

Sketcher

Model

trim-hell

Body

Origin

Sketch1

View Data

Tasks

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Solver messages

Under-constrained: 13 DoF(s)

Advanced solver options

Constraints

Filters

x Constraint1 (1)

x Constraint2

x Constraint3

x Constraint4

x Constraint5

x Constraint6

x Constraint7

Elements

Filters

Valid, Internal name: Body

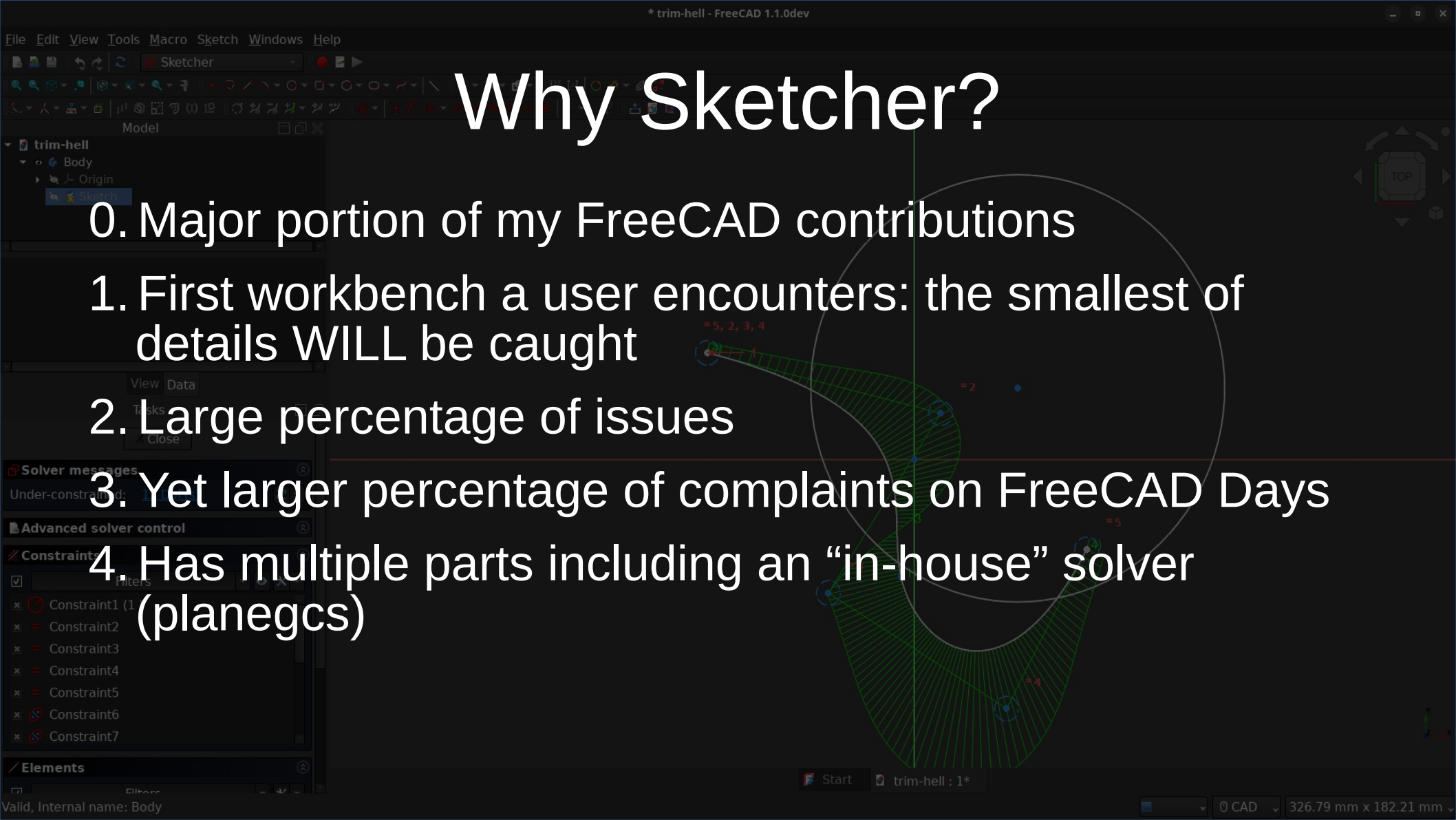
Start trim-hell : 1\*

0 CAD

326.79 mm x 182.21 mm

# Why Sketcher?

0. Major portion of my FreeCAD contributions
1. First workbench a user encounters: the smallest of details WILL be caught
2. Large percentage of issues
3. Yet larger percentage of complaints on FreeCAD Days
4. Has multiple parts including an “in-house” solver (planegcs)



# Method: The Basics

- Need some heuristic to prioritize and measure progress
- Metric used: Cognitive Complexity (developed by SonarSource)
- Mostly following “Refactoring” by Martin Fowler et al and “Clean Code” by Bob Martin

Need some heuristic to prioritize and measure progress

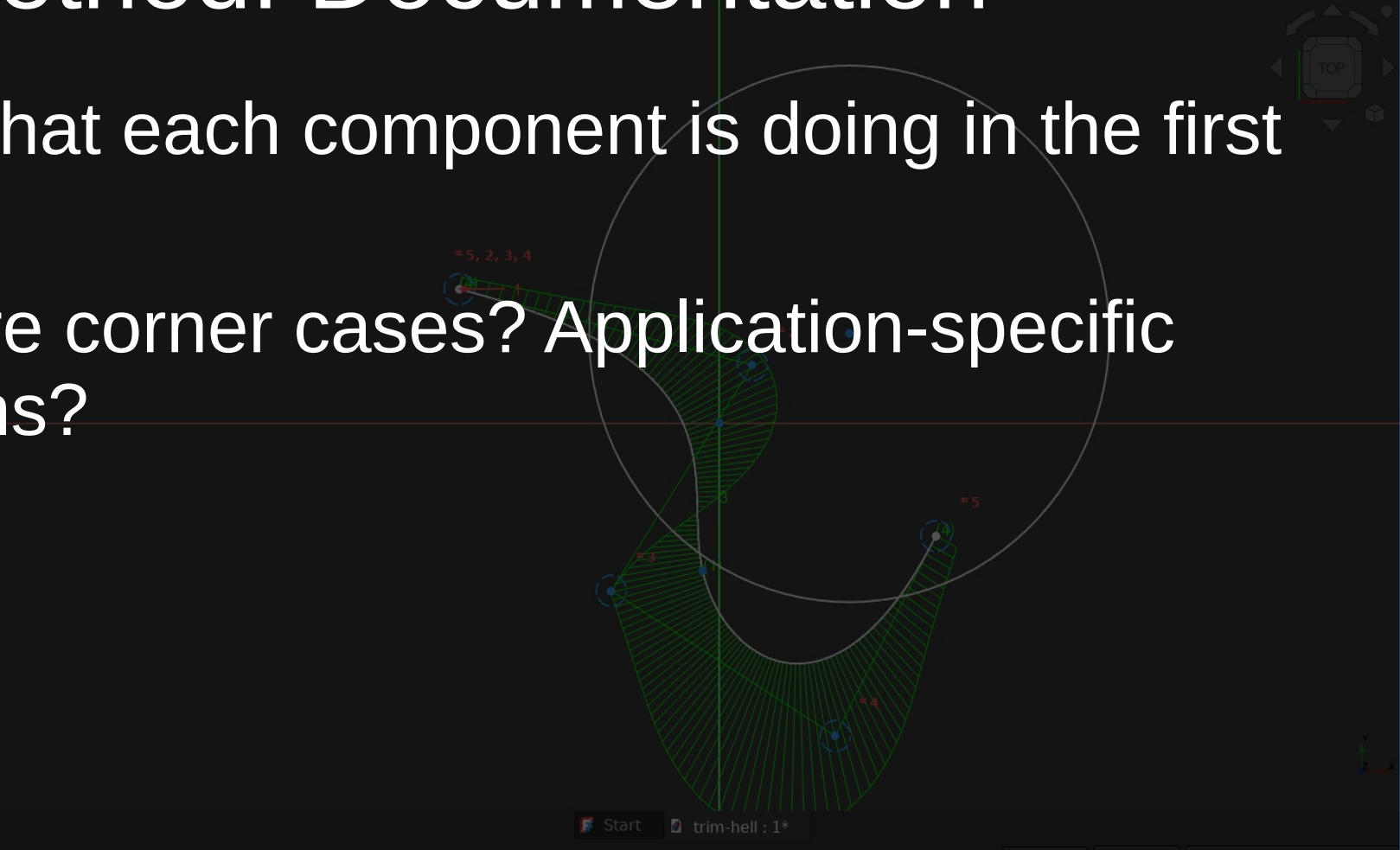
Metric used: Cognitive Complexity (developed by SonarSource)

Mostly following “Refactoring” by Martin Fowler et al and “Clean Code” by Bob Martin

# Method: Documentation

- Know what each component is doing in the first place
- Are there corner cases? Application-specific decisions?

The image shows the left-hand side of the FreeCAD interface. At the top, the menu bar includes File, Edit, View, Tools, Macro, Sketch, Windows, and Help. Below the menu bar is the 'Model' tree, which shows a hierarchy: trim-hell > Body > Origin > Sketch. The 'Solver messages' panel is open, displaying 'Under-constrained: 13 DoF(s)'. Below that is the 'Advanced solver control' panel. The 'Constraints' panel is also open, showing a list of constraints: Constraint1 (1), Constraint2, Constraint3, Constraint4, Constraint5, Constraint6, and Constraint7. The 'Elements' panel is at the bottom, showing 'Valid, Internal name: Body'.



# Method: Tests

- Need to make sure changes do not break existing behaviour.
- Tests can automate this.
- Add as many tests as needed (possibly dozens per method).

File Edit View Tools Macro Sketch Windows Help

Sketcher

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trim-hell

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Solver messages

Under-constrained: 13

Advanced solver control

Constraints

Filters

x Constraint1 (1)

x Constraint2

x Constraint3

x Constraint4

x Constraint5

x Constraint6

x Constraint7

Elements

Valid, Internal name: Body

Start

trim-hell : 1\*

0 CAD

326.79 mm x 182.21 mm



# Method: Loops and Conditions

- Use modern C++ tools like `range` for and initialization within `if` statements as far as possible
- As far as possible, avoid nesting of `if` statements and `for/while` loops
- This includes the ternary operator `"x?y:z"`
- If needed, do not hesitate to repeat small bits of code (or create a helper function and repeat that)
  - This often comes into picture if one part of the condition is significantly larger than the other, and, after exiting, the method just wraps up and returns.

# Methods: Helper functions

- As lambdas within the method or loose functions outside.
- They also help identify opportunity for reuse.

File Edit View Tools Macro Sketch Windows Help

Model

trim-hell

Body

Origin

Sketch

Solver messages

Under-constrained: 13 DoF(s)

Advanced solver control

Constraints

Constraint1 (1)

Constraint2

Constraint3

Constraint4

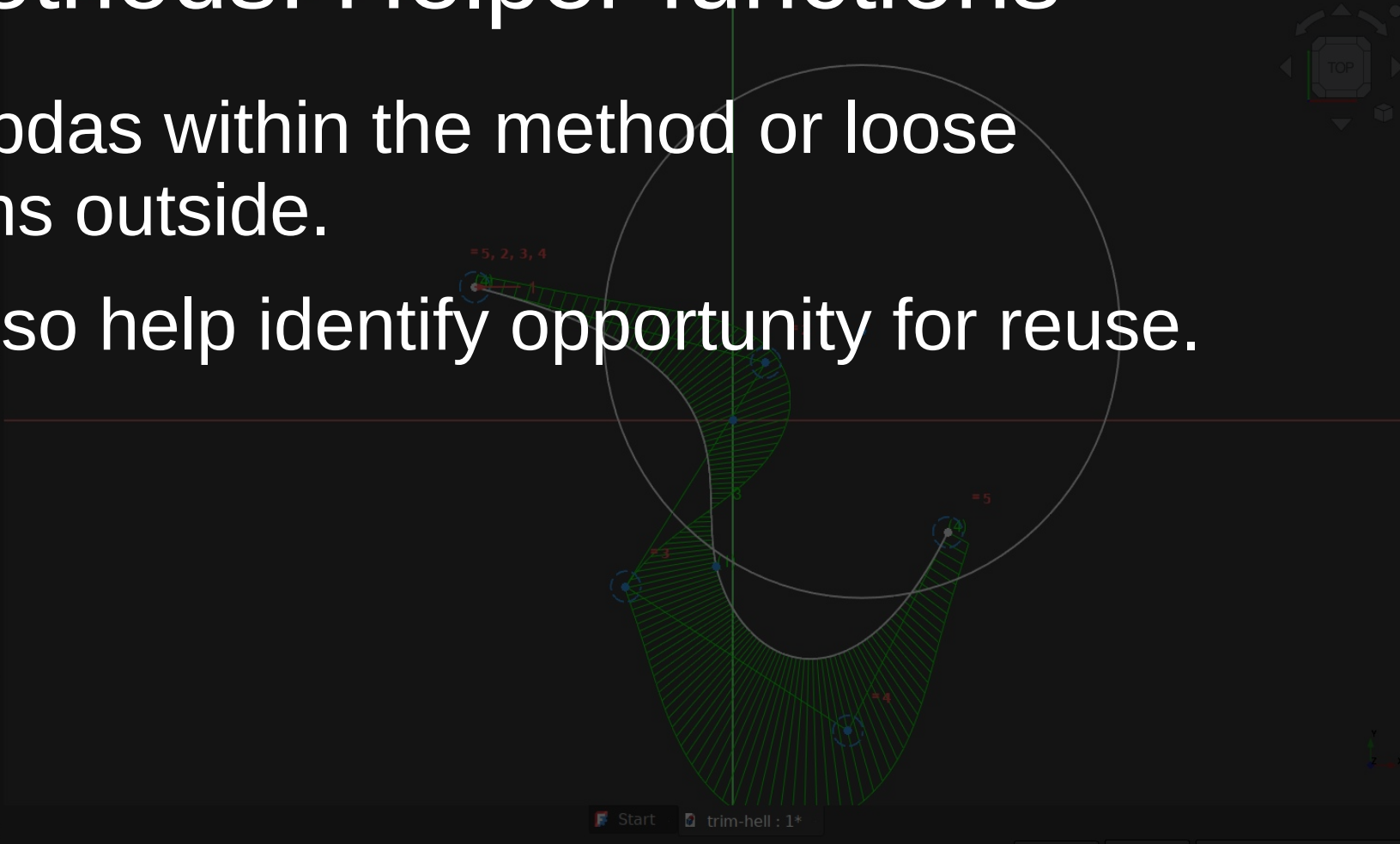
Constraint5

Constraint6

Constraint7

Elements

Valid, Internal name: Body



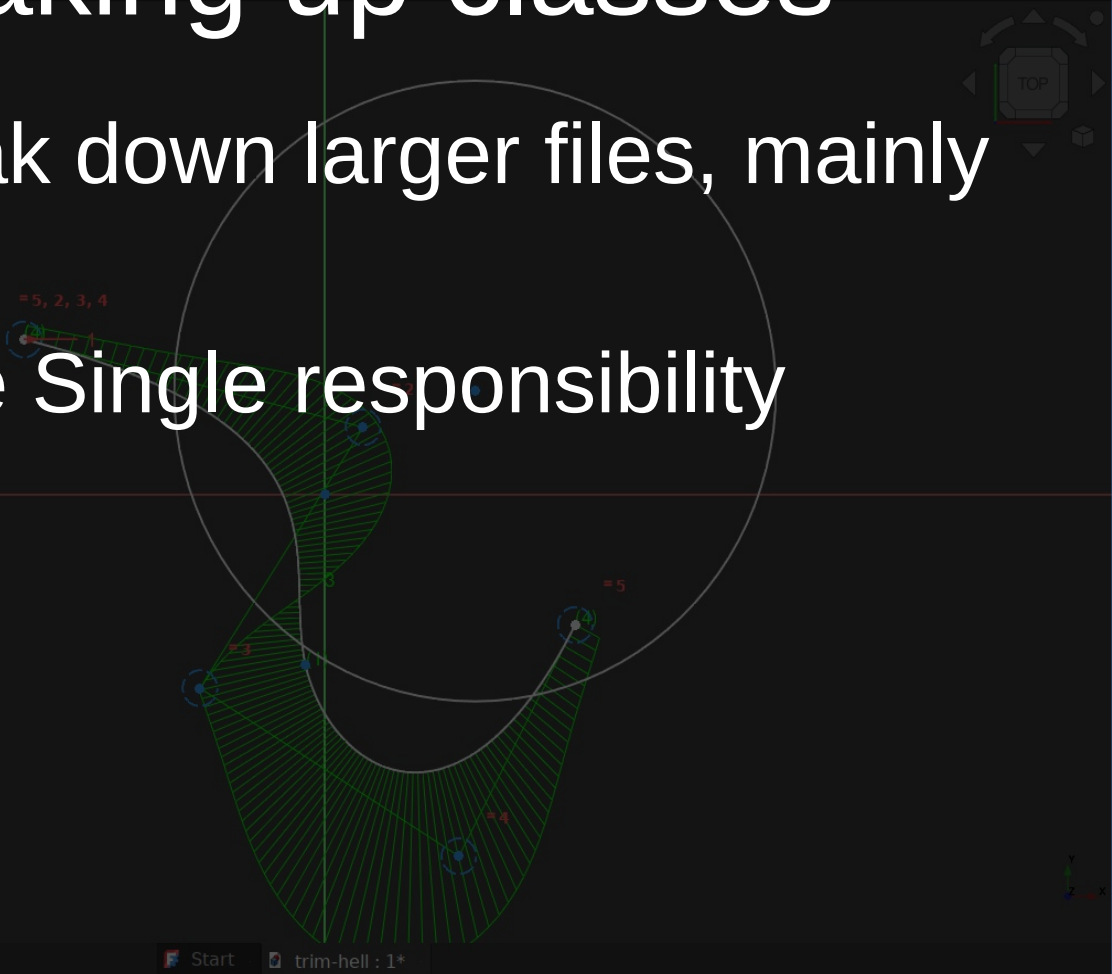
# Methods: Use algorithm library

- As far as possible, use the algorithm library in C++ to replace combinations of loops and conditionals.
- Some examples: `copy_if`, `(all/any/none)_of`, `move`, `transform`, `(min/max)_element`, `sort`, `partition`
- Even a `for_each` can be useful
  - These methods also directly convey the intent
  - Possible opportunity to parallelize

# Methods: Breaking up classes

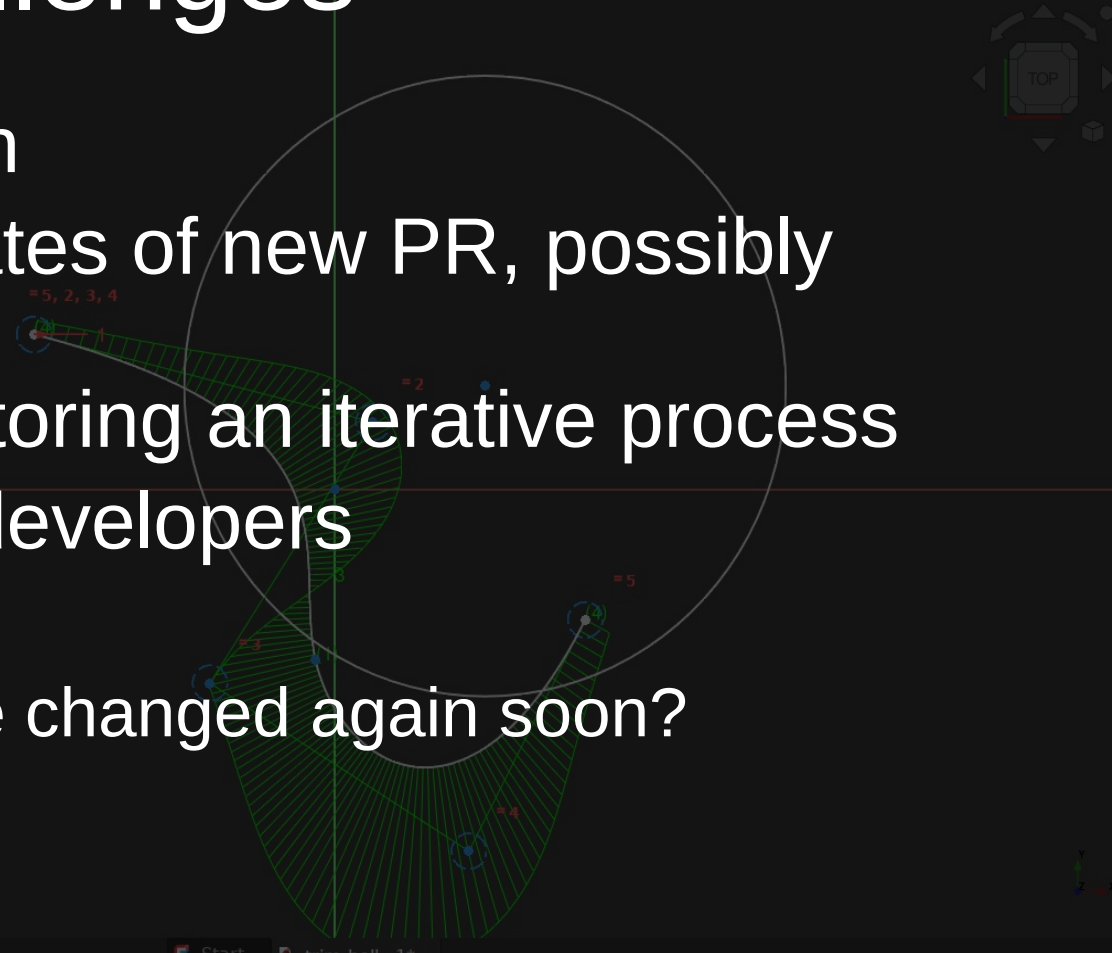
- Ongoing work to break down larger files, mainly SketchObject.
- Towards following the Single responsibility principle.

The screenshot shows the FreeCAD interface with the Sketcher tool active. The top menu bar includes File, Edit, View, Tools, Macro, Sketch, Windows, and Help. The left sidebar shows the model tree with 'trim-hell' and 'Body' selected. The bottom panel displays solver messages, advanced solver control, constraints, and elements. The constraints list includes Constraint1 (1) through Constraint7. The elements list shows 'Valid, Internal name: Body'.



# Challenges

- Limited Documentation
- Release done: floodgates of new PR, possibly causing conflicts
- All of this makes refactoring an iterative process
- Also best done by all developers
- Know when to stop
  - Is this code going to be changed again soon?



trim-hell

- Body
- Origin
- Sketch

View Data

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Solver messages

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# Thank you!