A diagram editor to mechanise categorical proofs

Ambroise Lafont (PARTOUT)

23 November 2023

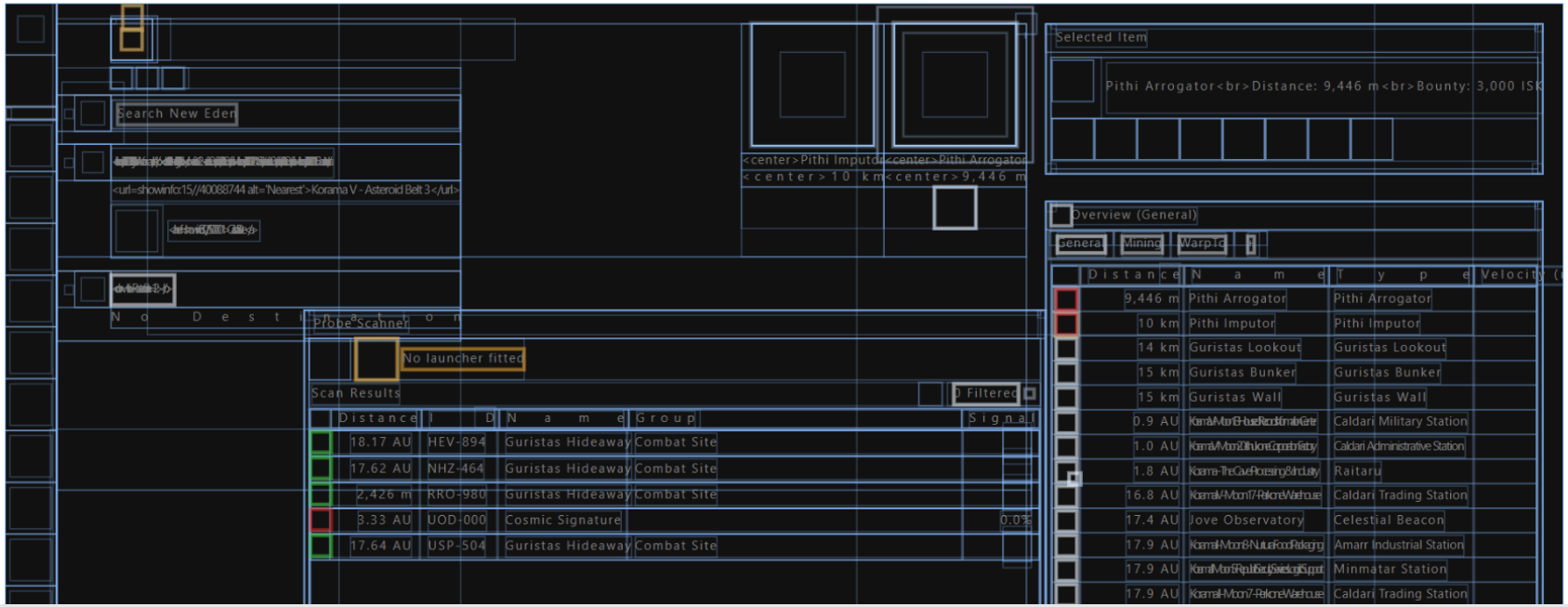
A bit of history

It all started with Covid19.

Sanderling

Sanderling helps you read information from the EVE Online game client using memory reading.

Sanderling is the eyes of bots and monitoring tools. It helps programs see the game client in a structured way, detecting objects and reading information about the game world. It also reads the locations of elements in the game clients' graphical user interface (e.g., in-game windows, overview entries, buttons, etc.). You can use this information to interact with the game client using mouse input.



Releases 39

v2023-01-03 Latest
on Jan 3

+ 38 releases

Packages

No packages published

Contributors 8

Languages

Elm 72.2% C# 27.8%

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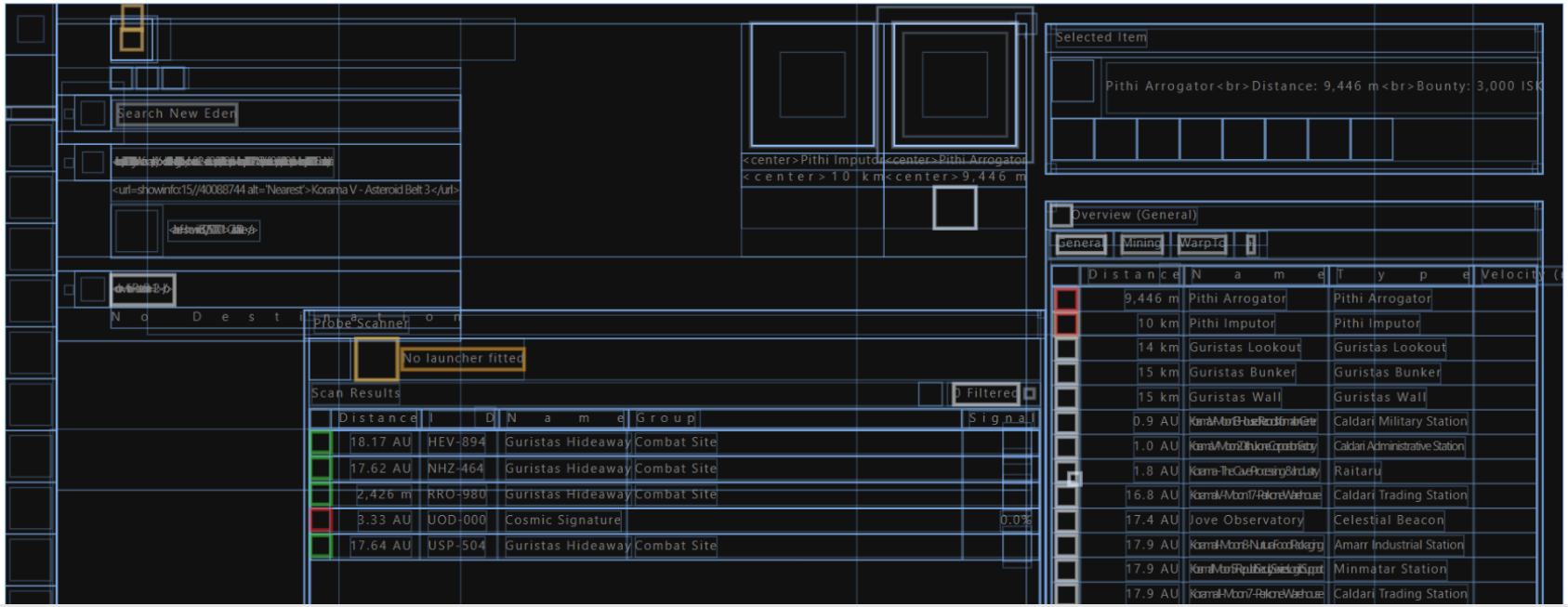

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■THE ELM ARCHITECTURE

```
init : ( Model, Cmd Msg )
update : Msg -> Model -> ( Model, Cmd Msg )
subscriptions : Model -> Sub Msg
view : Model -> Html Msg
```

Afterthoughts:
why you should not program in Elm

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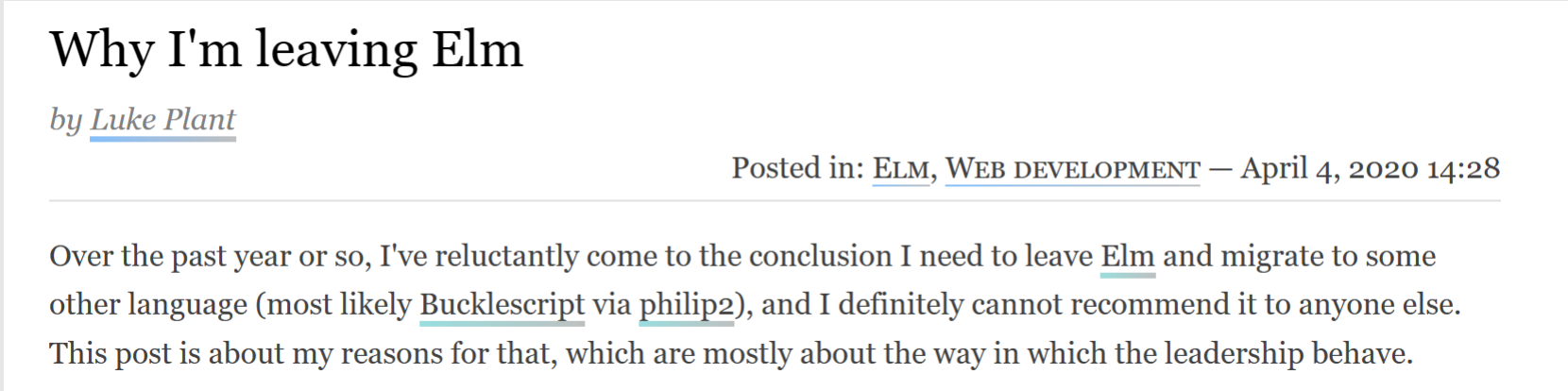

Why I'm leaving Elm

by Luke Plant

Posted in: ELM, WEB DEVELOPMENT — April 4, 2020 14:28

Over the past year or so, I've reluctantly come to the conclusion I need to leave Elm and migrate to some other language (most likely Bucklescript via philip2), and I definitely cannot recommend it to anyone else. This post is about my reasons for that, which are mostly about the way in which the leadership behave.

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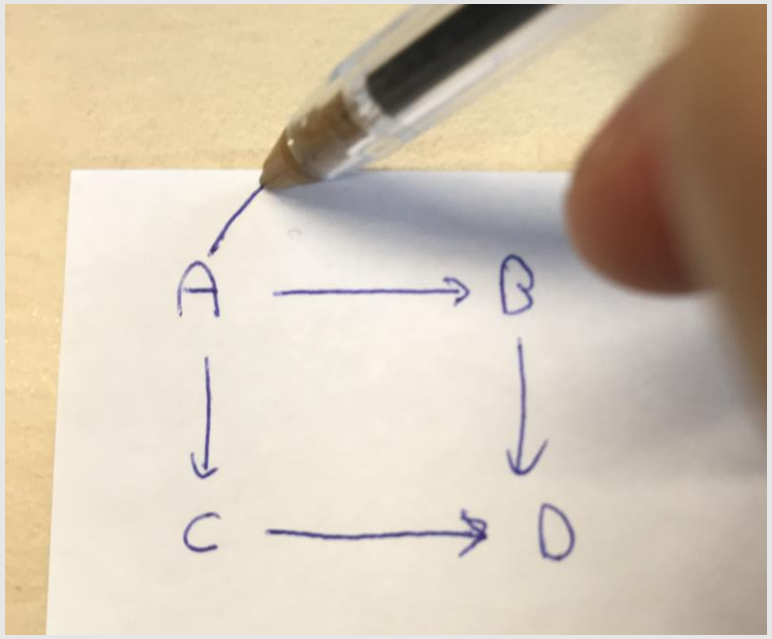

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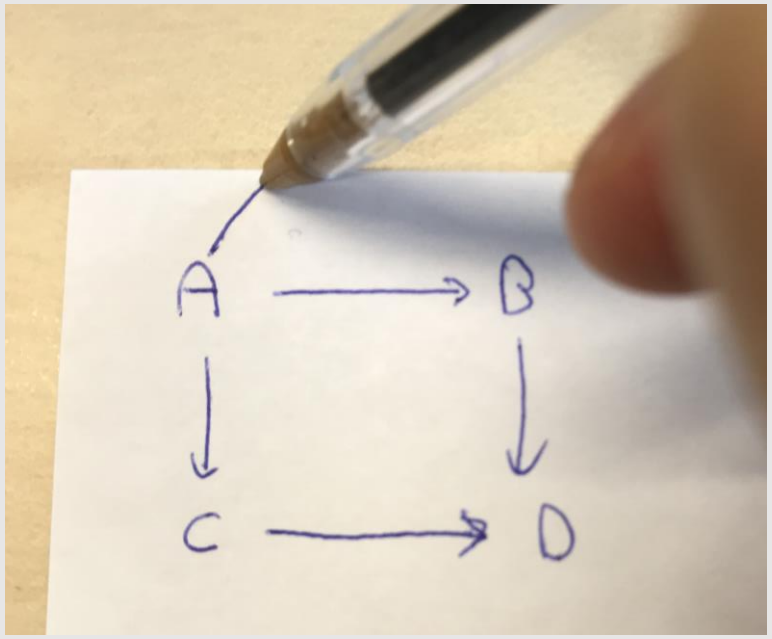
DEMO



How to test the editor

A web app that runs locally in your browser

https://amblafont.github.io/graph-editor/index.html

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A standalone desktop program

- Embeds the web app using electron
- Additional features

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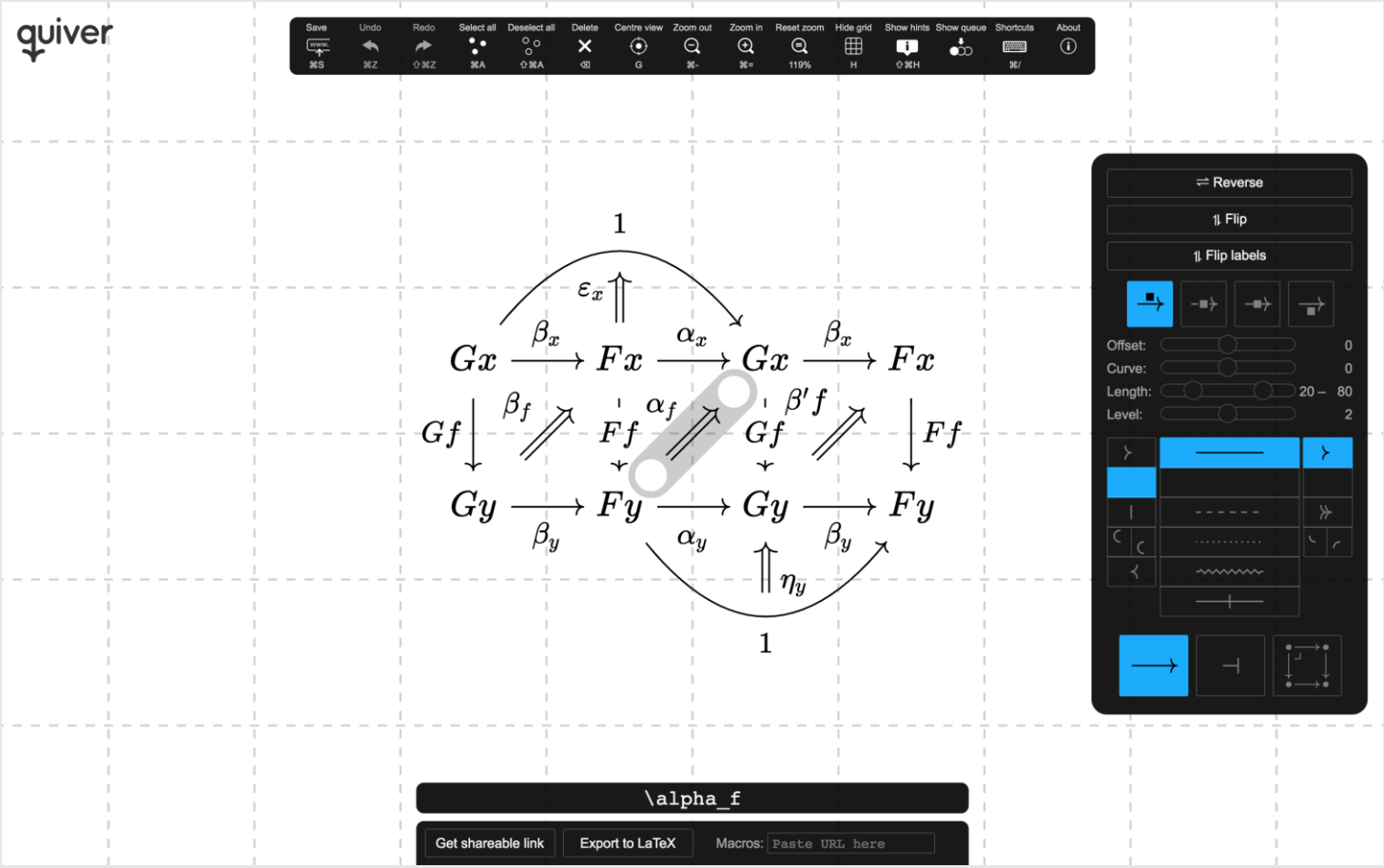

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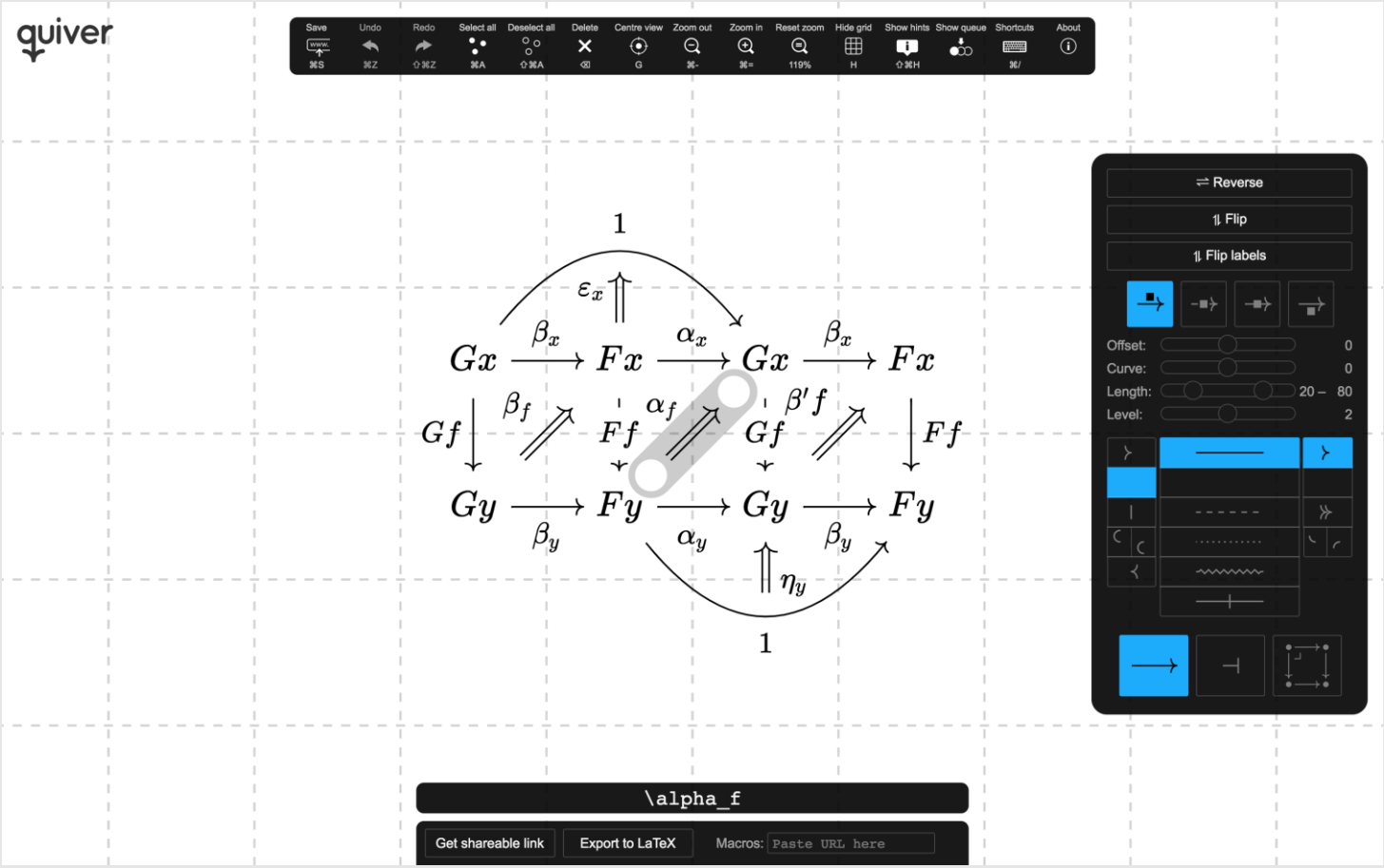

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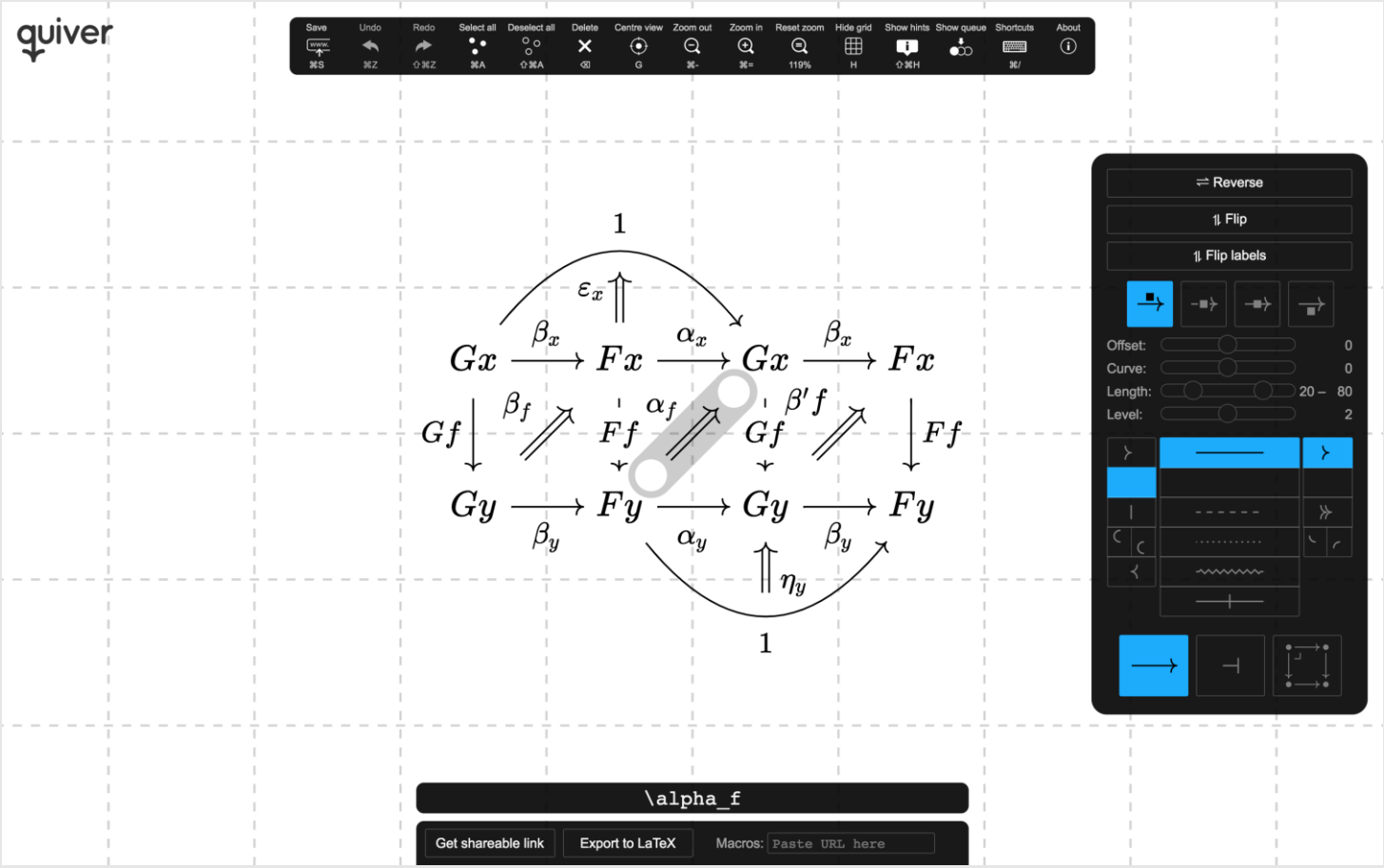

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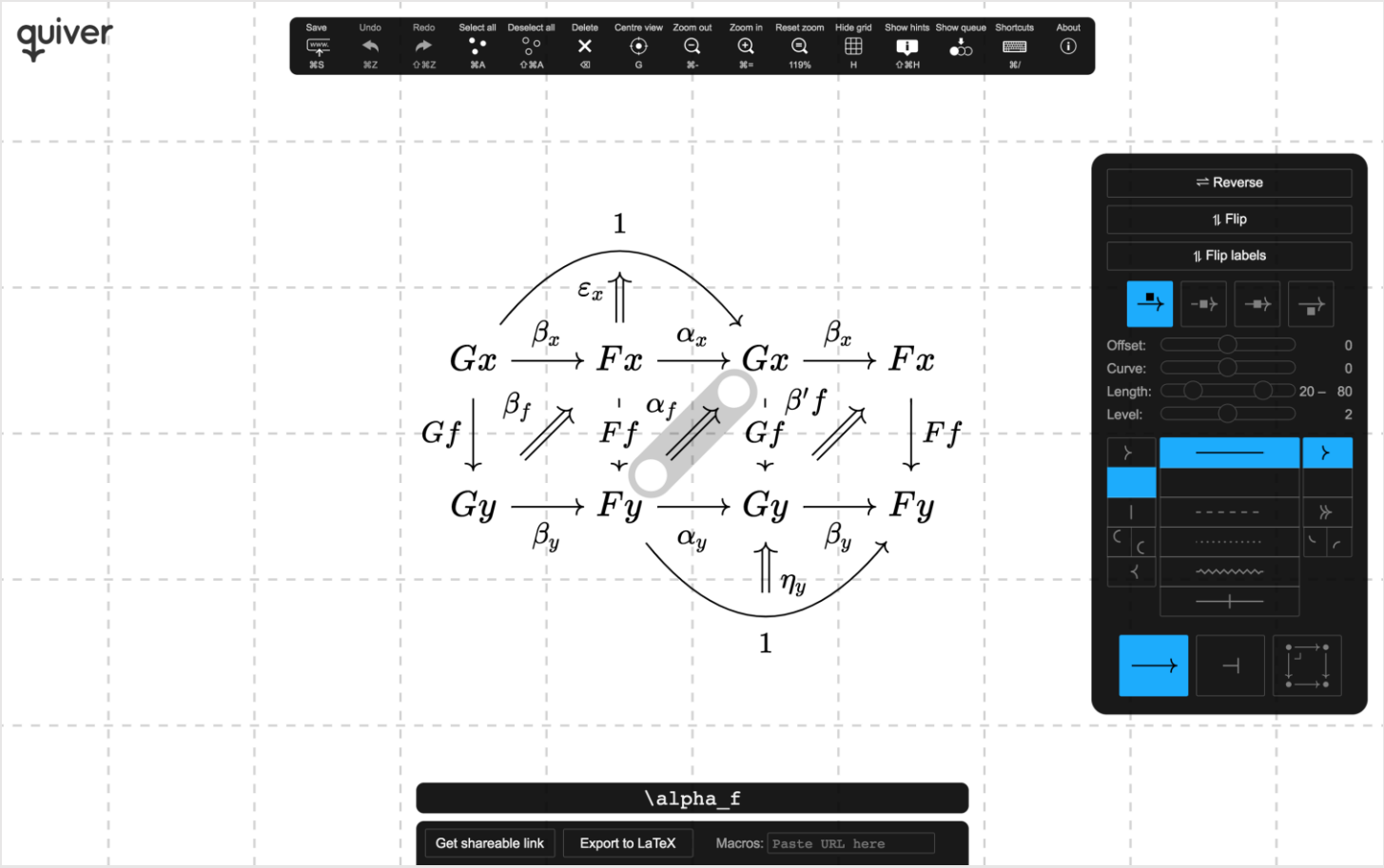

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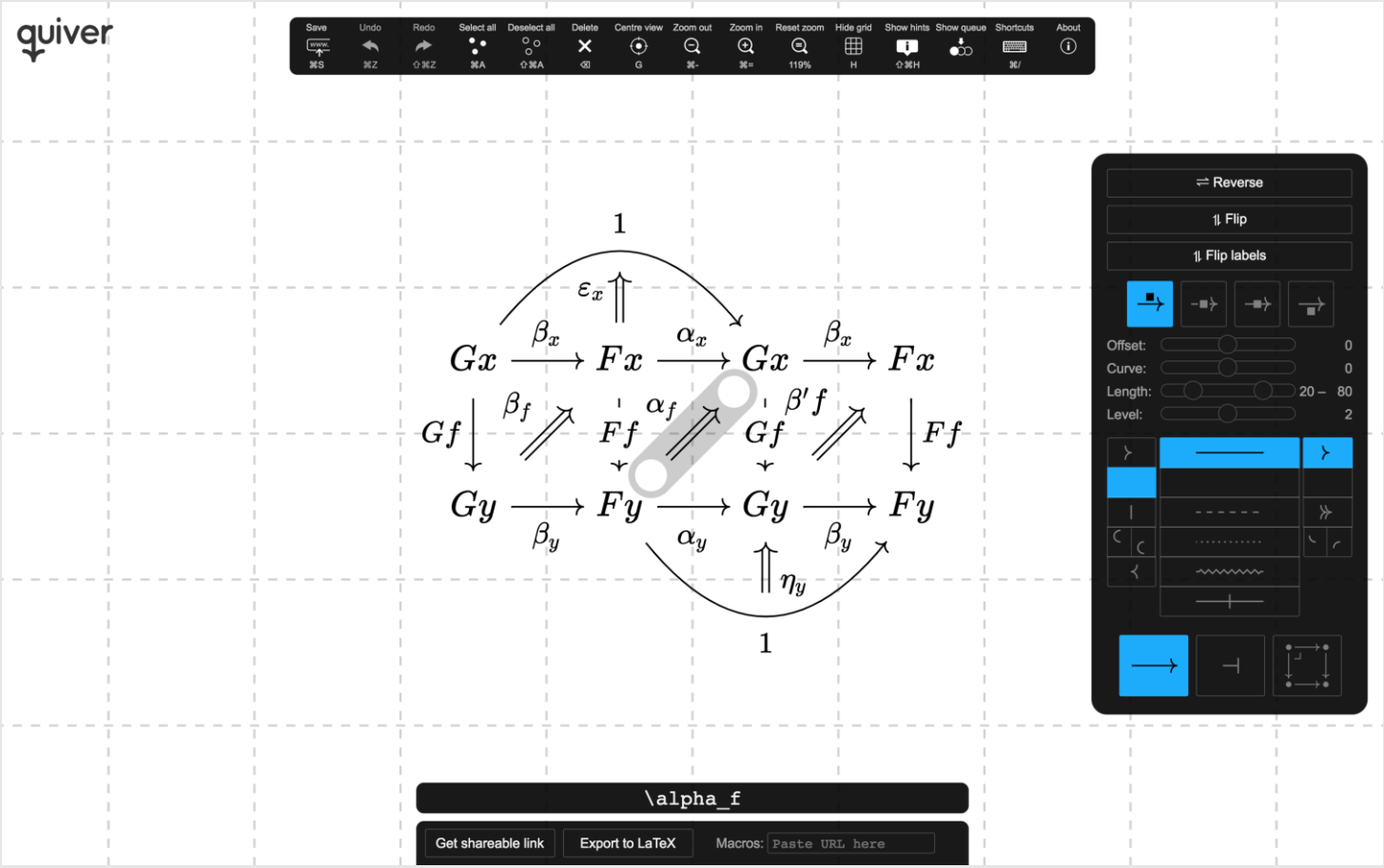

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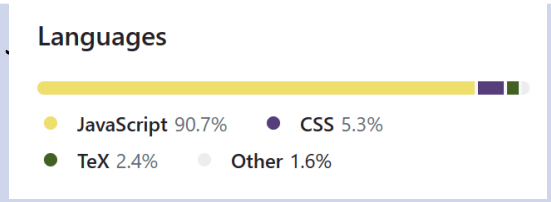
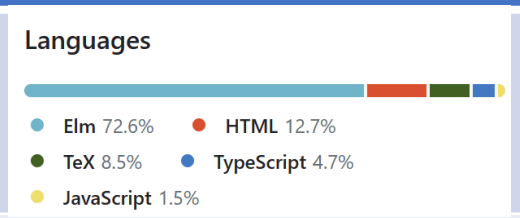
it is implemented in JavaScript 💀

Comparison with quiver

About the same size (around 10k of LoC)

	Quiver	My editor
Programming Languages		
Styling options	+	-
User-friendly	+	-
Editing features	-	+ Tabs, copy & paste, find & replace, expand selection to connected components, …

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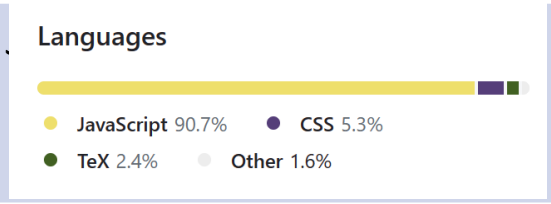
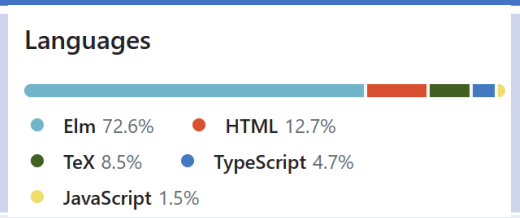
Programming Languages		
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LaTeX export	yes	yes[1]

[1] Implemented by Tom Hirschowitz

Easy editing of LaTeX diagrams

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\node (0) at (9.476190476190476em, -3.3154761904761907em) {$a$} ;
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example.tex

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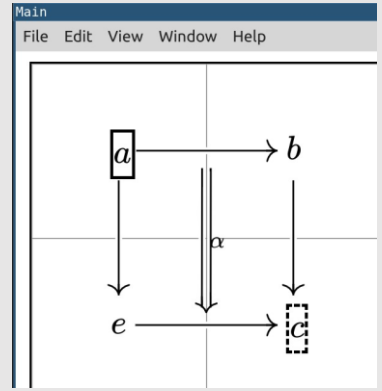

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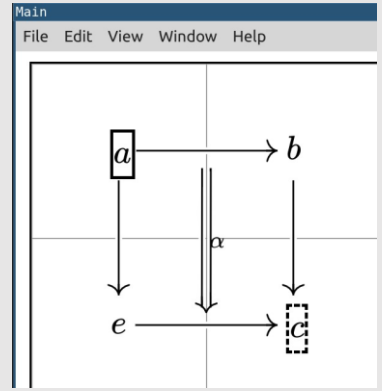

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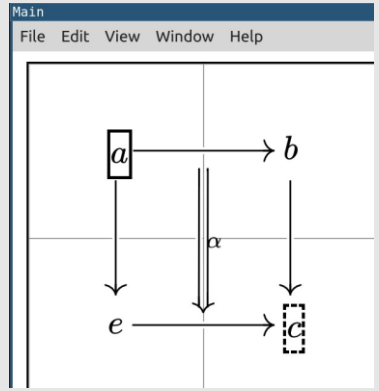

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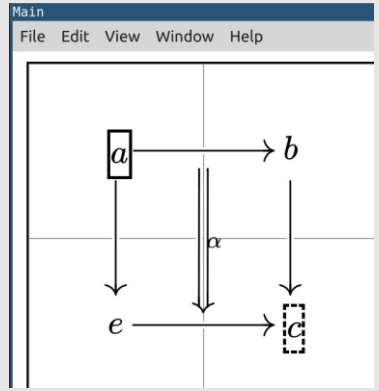

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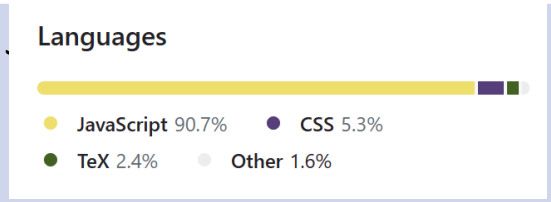
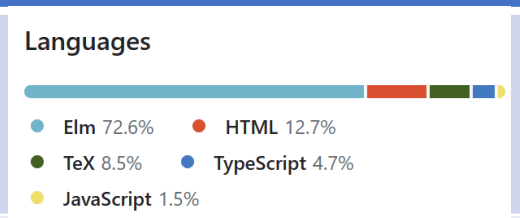
Programming Languages		
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User-friendly	+	-
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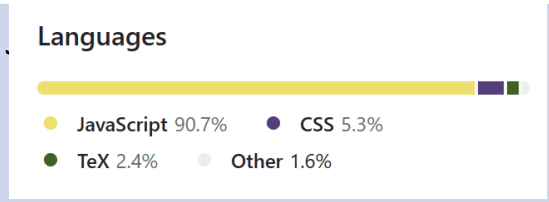
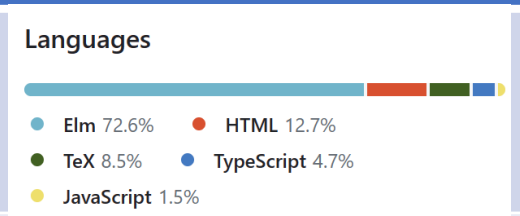
Programming Languages		
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A nice name	+	-

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This is already taken 😵

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README.rst Update information about daily-packages. 10 years ago

README.rst

YADE - Yet Another Dynamic Engine

Extensible open-source framework for discrete numerical models, focused on Discrete Element Method. The computation parts are written in c++ using flexible object model, allowing independent implementation of new algorithms and interfaces. Python is used for rapid and concise scene construction, simulation control, postprocessing and debugging.

Languages

C++ 79.5% Python 18.3%
CMake 2.0% Shell 0.2%

Now I call it Coreact YADE 🤔

Now I call it Coreact YADE 😳

ANR Project[1] (2023 - 2027): Coq-based Rewriting: Towards Executable Applied Category Theory

[1] https://coreact.wiki/

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- Involving (at LIX): myself, S. Mimram, B. Werner, N. Zeilberger.

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The Coq proof assistant

A software to write formal proofs interactively

File editor, e.g., Visual Studio Code + coq-lsp extension

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There is also a web version of Coq (no installation required): https://coq.vercel.app/

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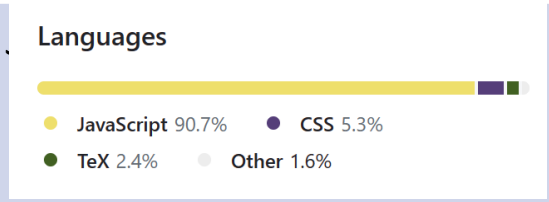
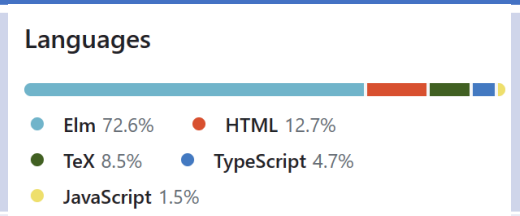
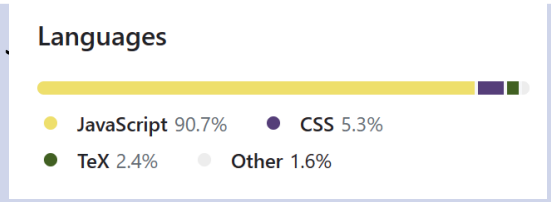
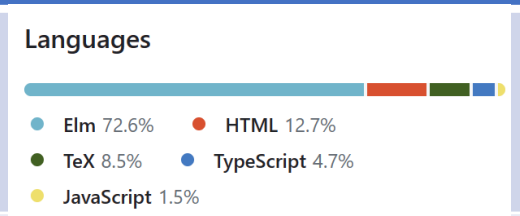
Programming Languages		
Styling options	+	-
User-friendly	+	-
Editing features	-	+ Tabs, Copy & paste, find & replace, expand selection to connected components, …
LaTeX export	yes	yes
A nice name	+	-

Comparison with quiver

	Quiver	My editor
Programming Languages		
Styling options	+	-
User-friendly	+	-
Editing features	-	+ Tabs, Copy & paste, find & replace, expand selection to connected components, …
LaTeX export	yes	yes
A nice name	+	-
Mechanisation features	-	+

Diagrammatic reasoning in category theory

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$\forall f: c_1 \to c_2,$ $\quad Ff \circ \alpha_{c_1} = \alpha_{c_2} \circ Gf$

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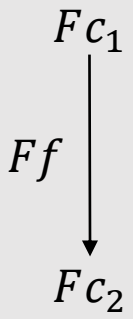

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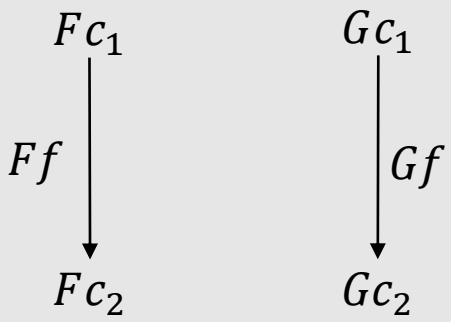

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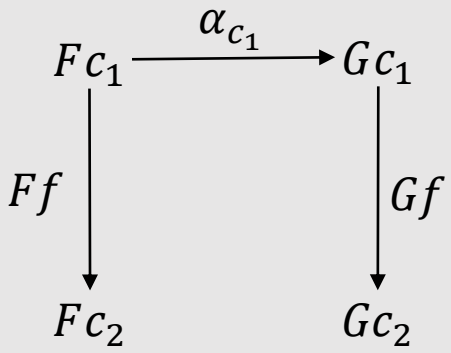

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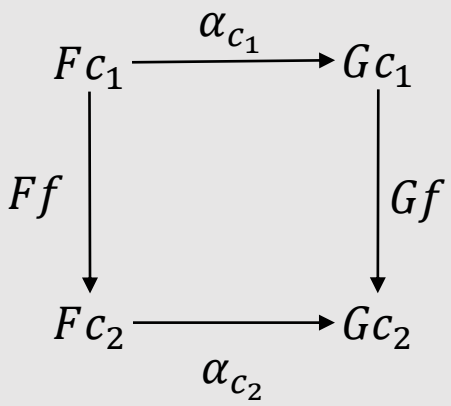

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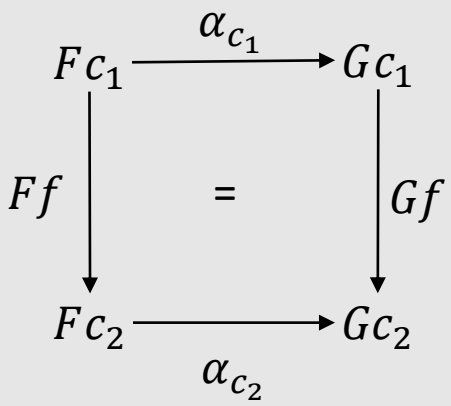

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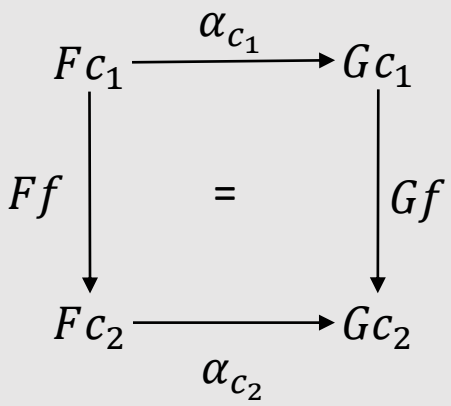

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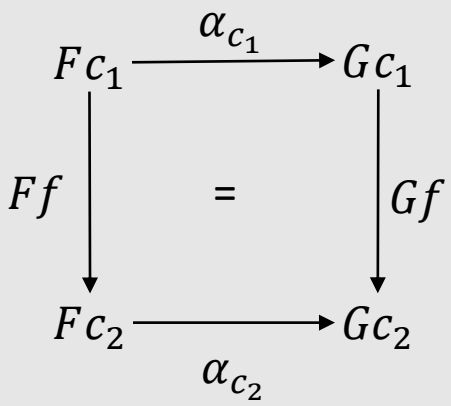

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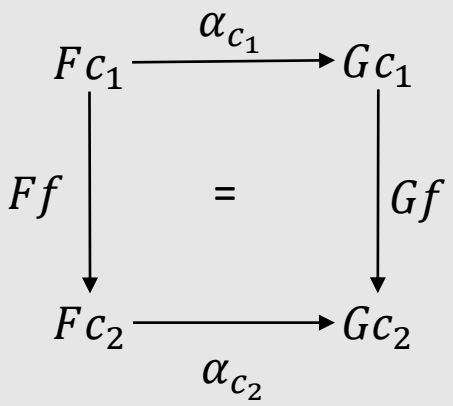


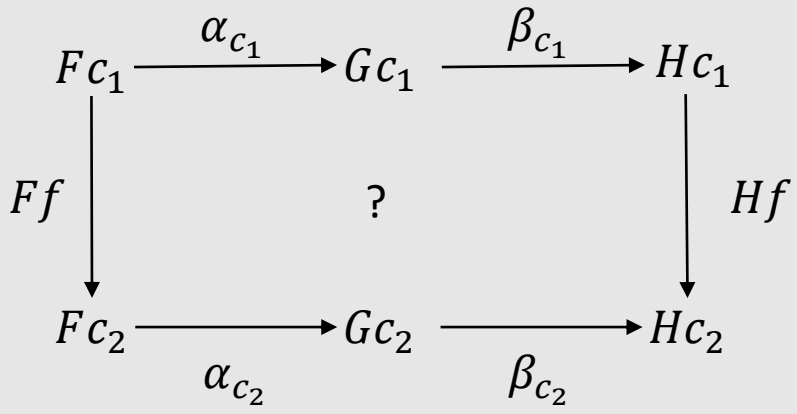
$Gf \circ \alpha_{c_1} = \alpha_{c_2} \circ Ff$

…unless $\circ$ is defined the other way around

Natural transformations compose:

If $\alpha: F \Rightarrow G$ and $\beta: G \Rightarrow H$ are natural, then so is $(\beta_c \circ \alpha_c: Fc \to Hc)_c$

Diagrammatic proof



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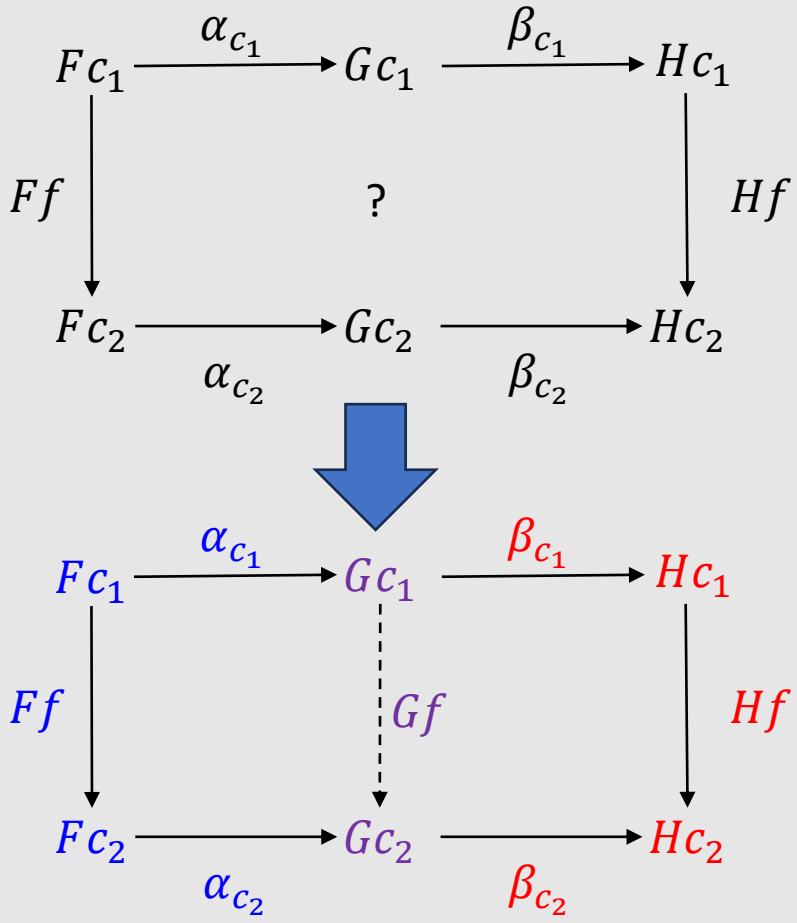

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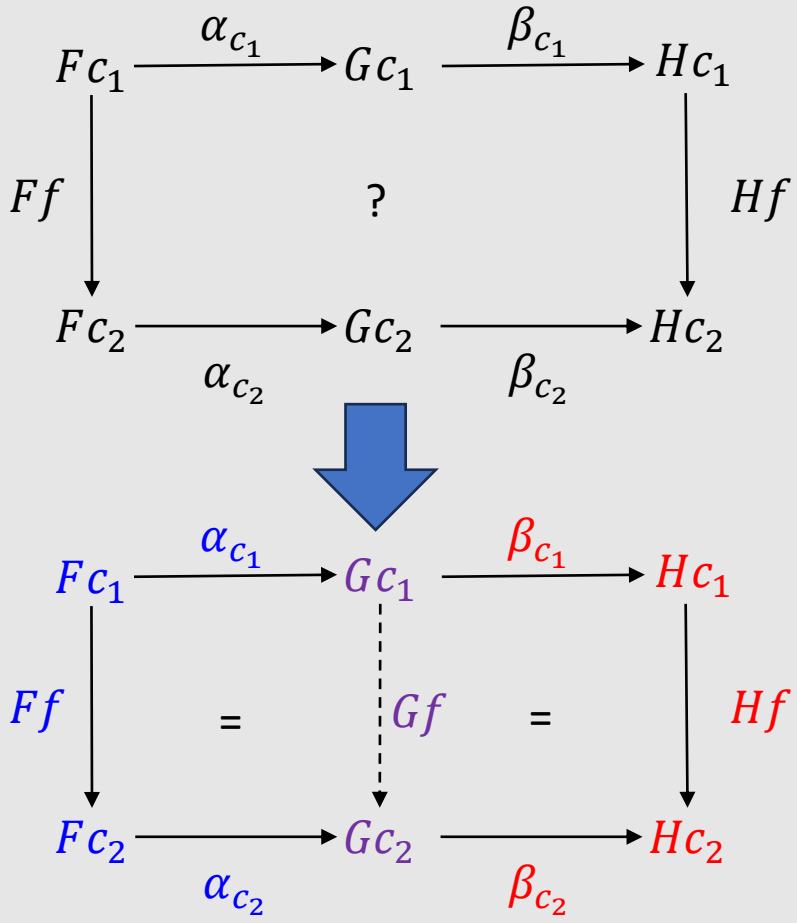

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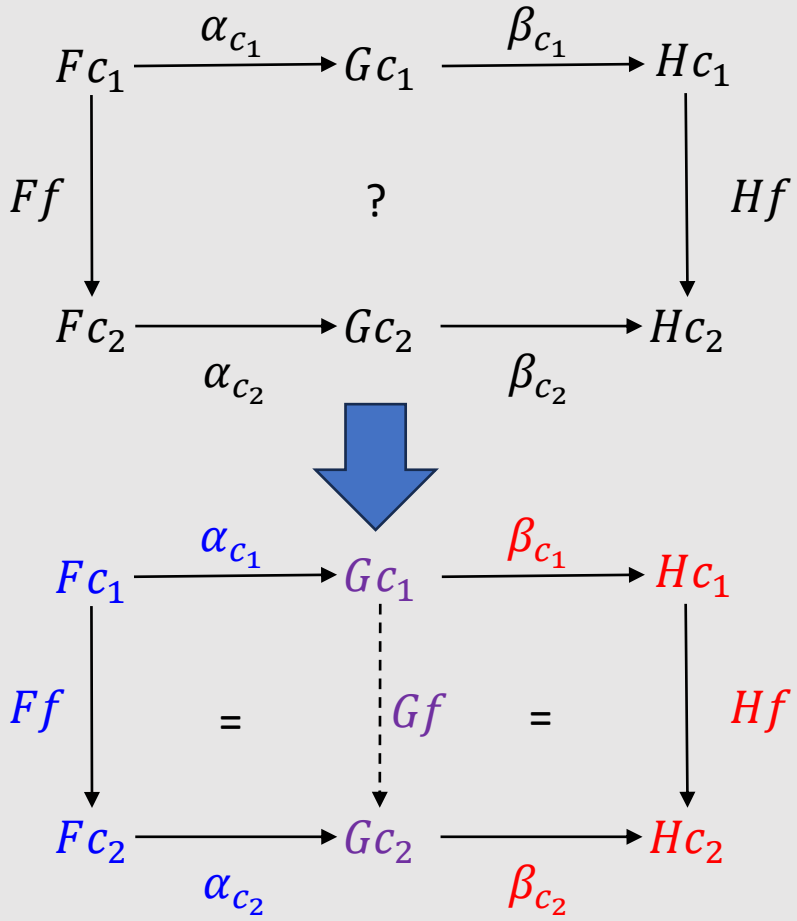

Computer-friendly proof

$$Hf \circ \beta_{c_1} \circ \alpha_{c_1}$$

$$= \beta_{c_2} \circ Gf \circ \alpha_{c_1}$$

$$= \beta_{c_2} \circ \alpha_{c_2} \circ Ff$$

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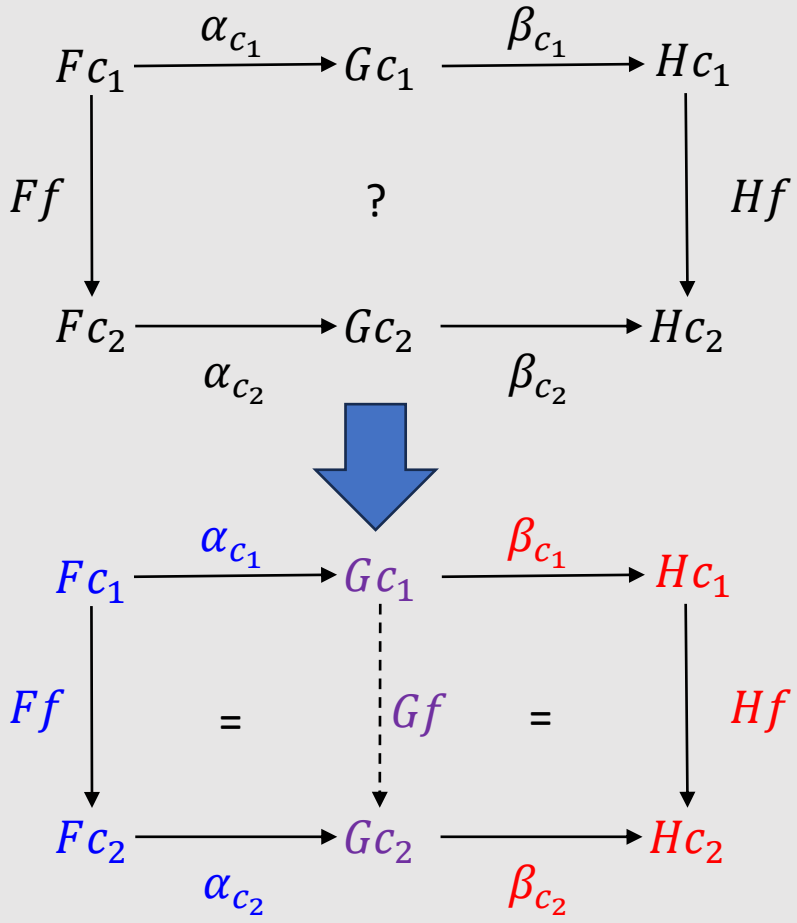

Automatic generation?

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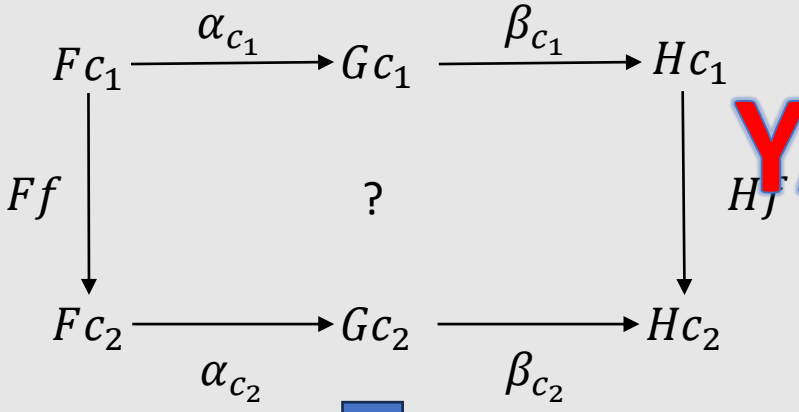

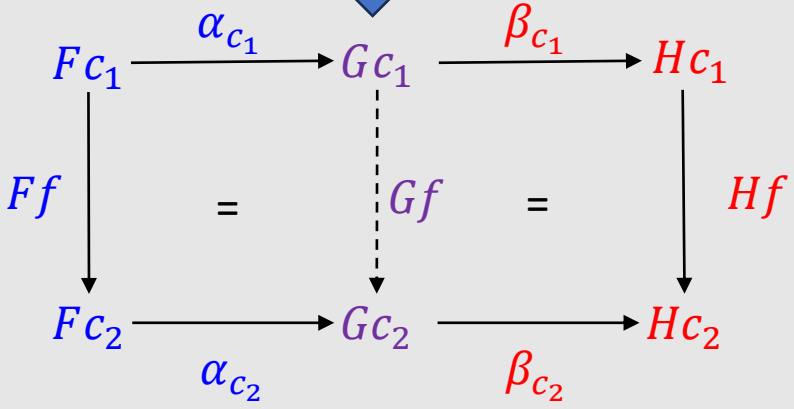

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$$Hf \circ \beta_{c_1} \circ \alpha_{c_1}$$
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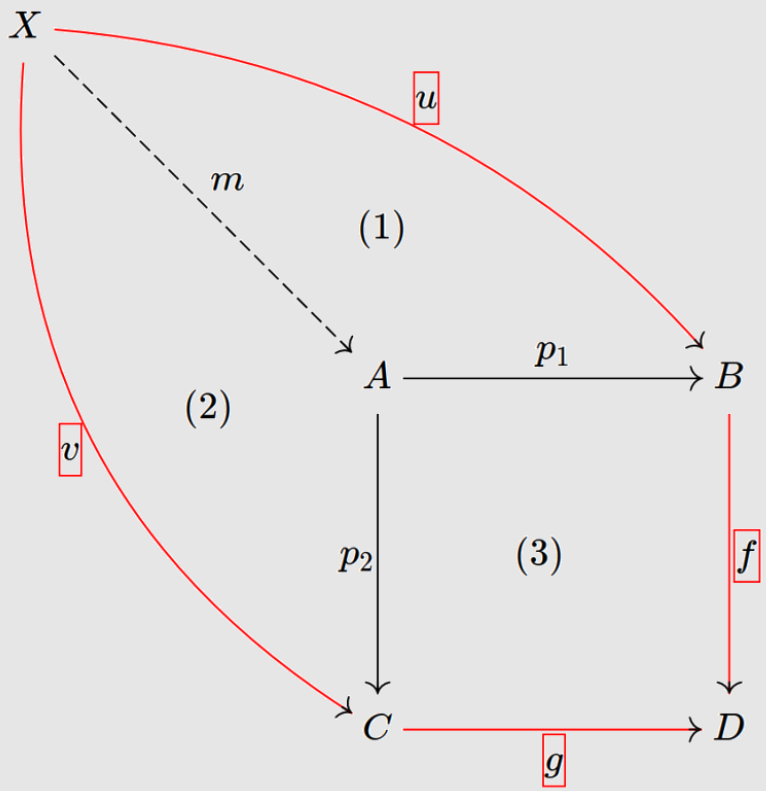
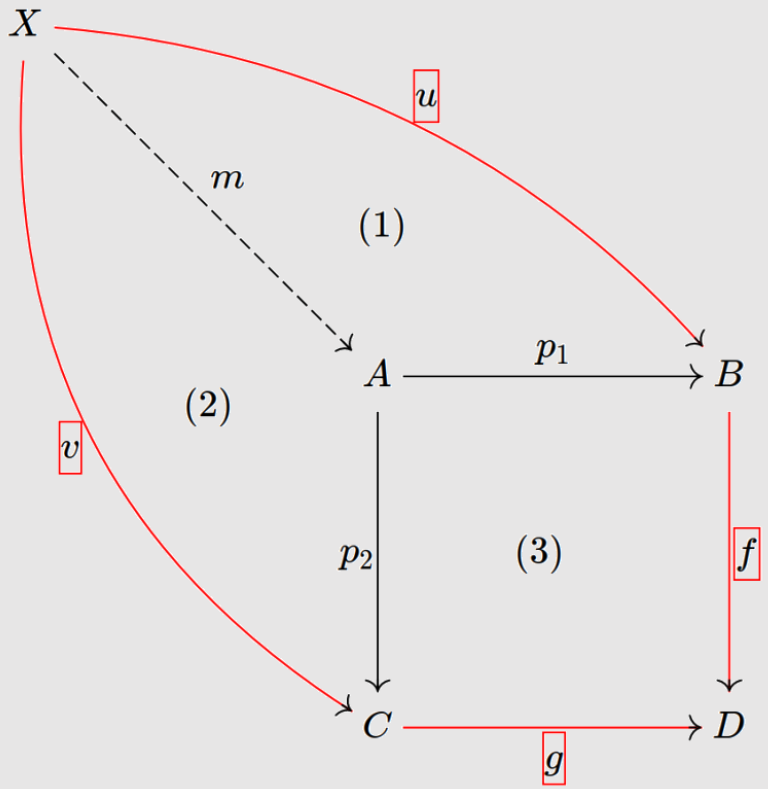
$$= \beta_{c_2} \circ \alpha_{c_2} \circ Ff$$

Proof generation: sketch of the algorithm



Proof generation: sketch of the algorithm

1) Save all subdiagrams as rewrite rules: “top right branch” → “bottom left branch”



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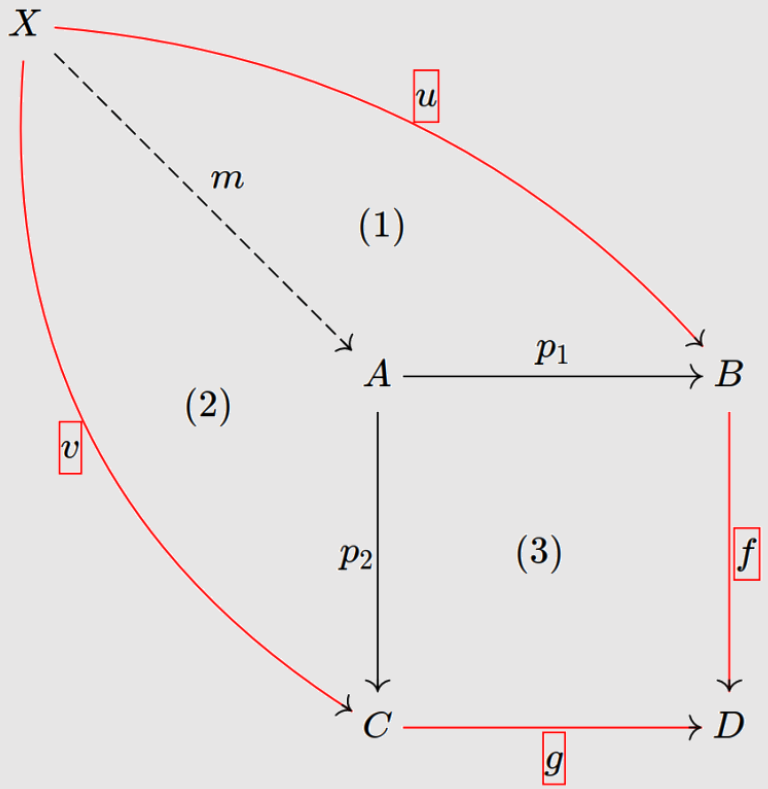
$(1)\ u \to p_1 \circ m$



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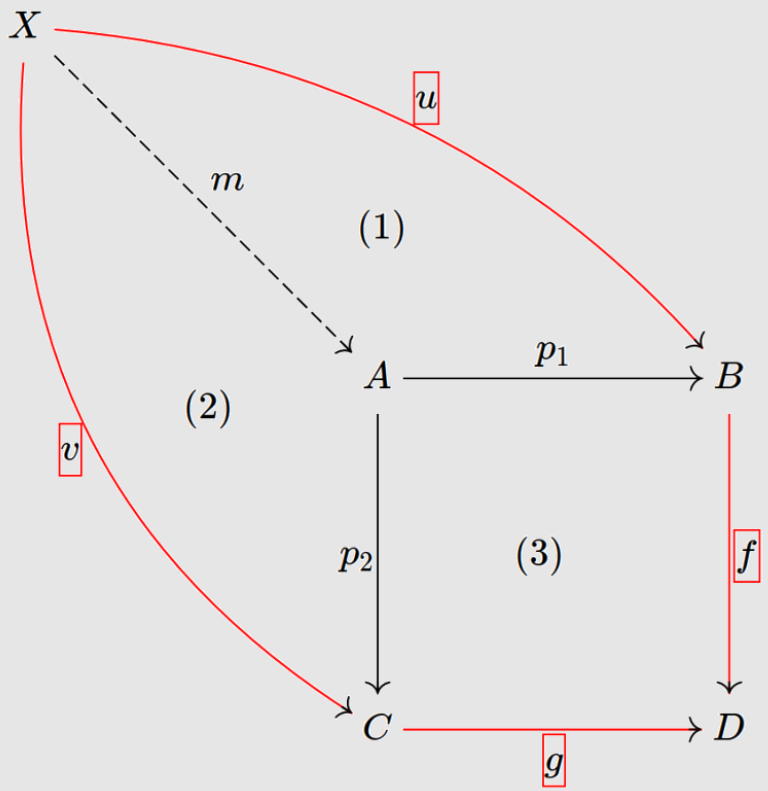
$(1)\ u \to p_1 \circ m$

$(2)\ p_2 \circ m \to v$



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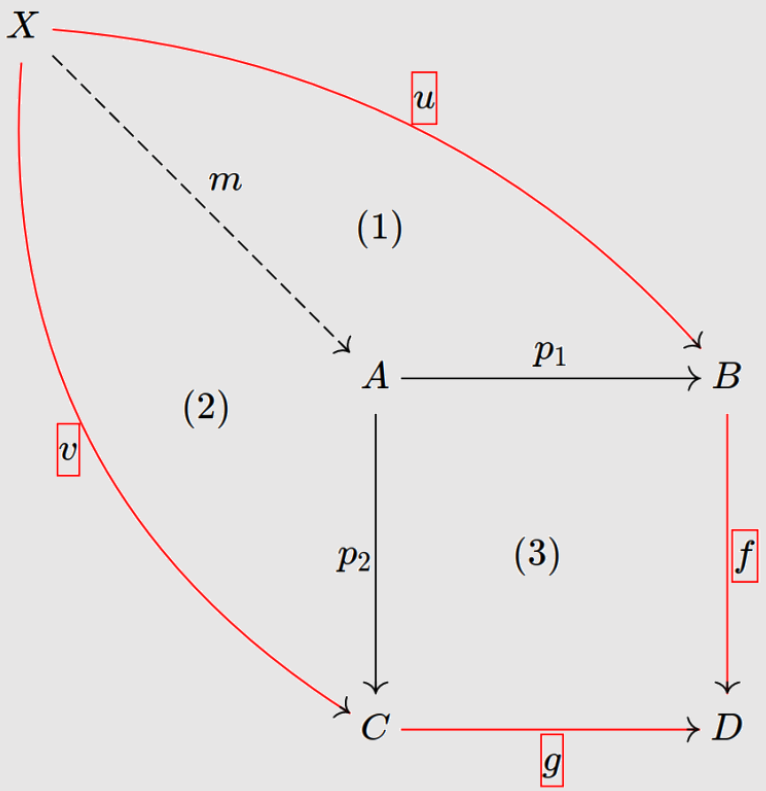
$$(1)\ u \to p_1 \circ m$$
$$(2)\ p_2 \circ m \to v$$
$$(3)\ f \circ p_1 \to g \circ p_2$$



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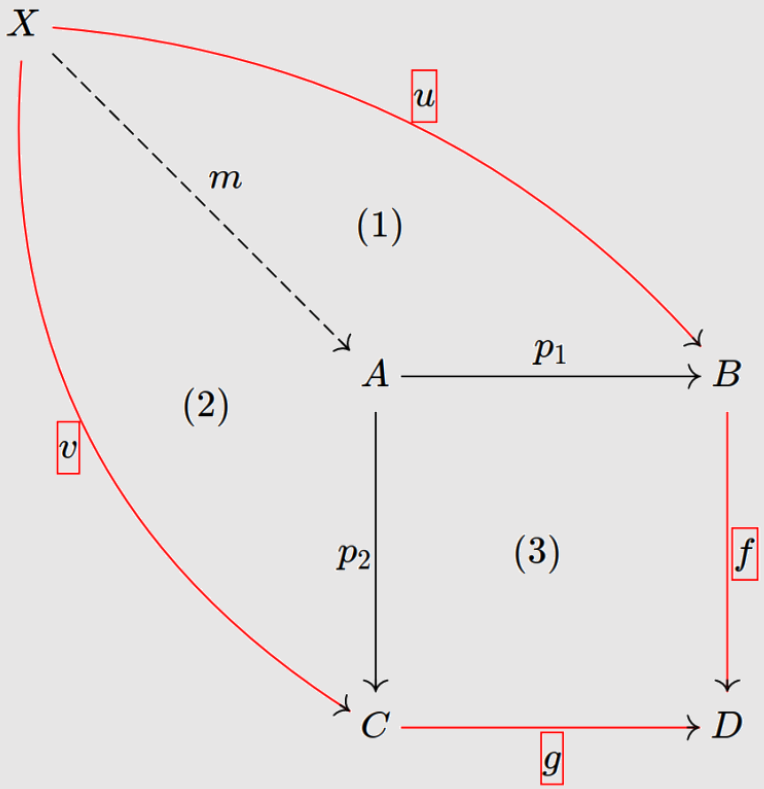
2) Identify the top right branch of the outer diagram.



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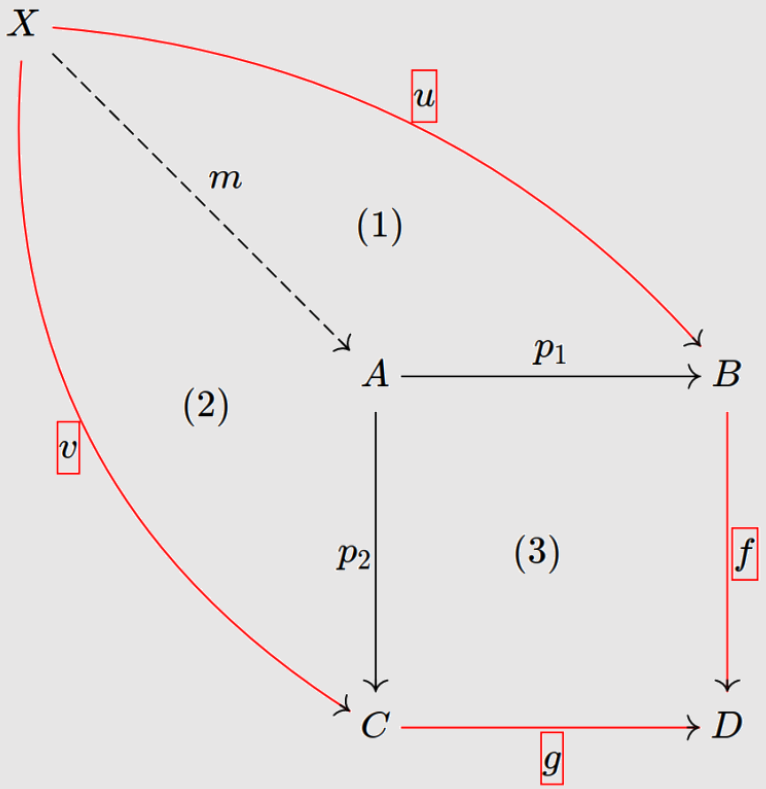

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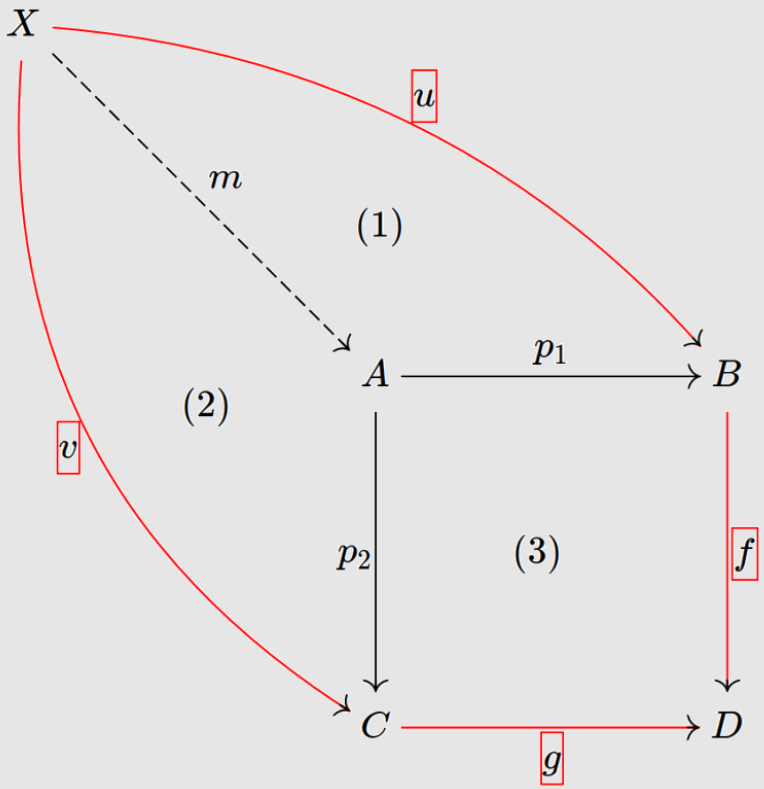
$$f \circ u$$

3) Use greedily the rewrite rules until reaching the bottom left branch



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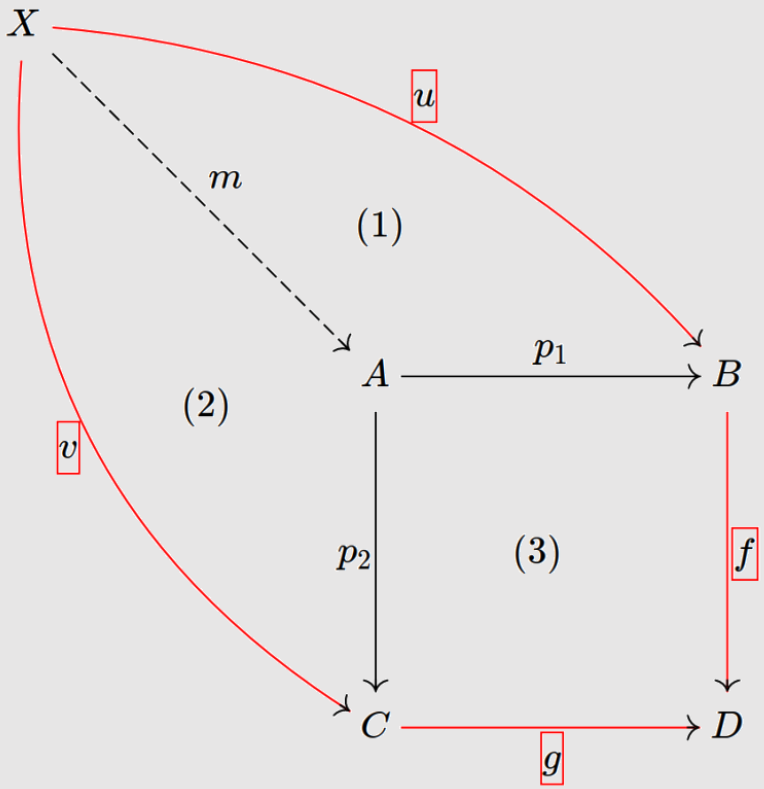
$$f \circ u \to^{(1)} f \circ p_1 \circ m \to^{(3)} g \circ p_2 \circ m \to^{(2)} g \circ v$$



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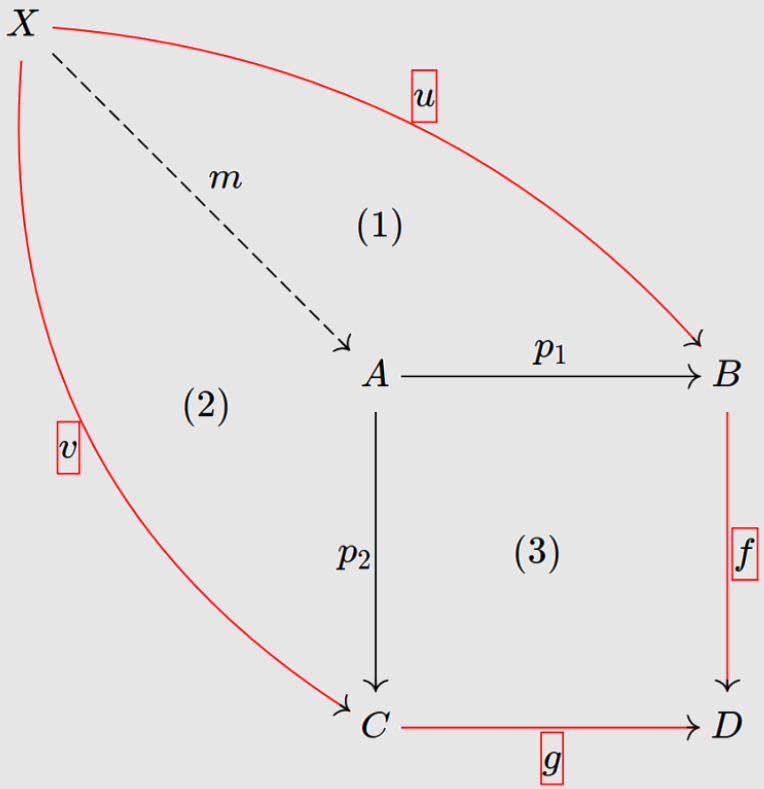
4) Remember the rewrite steps and generate the coq proof script accordingly.



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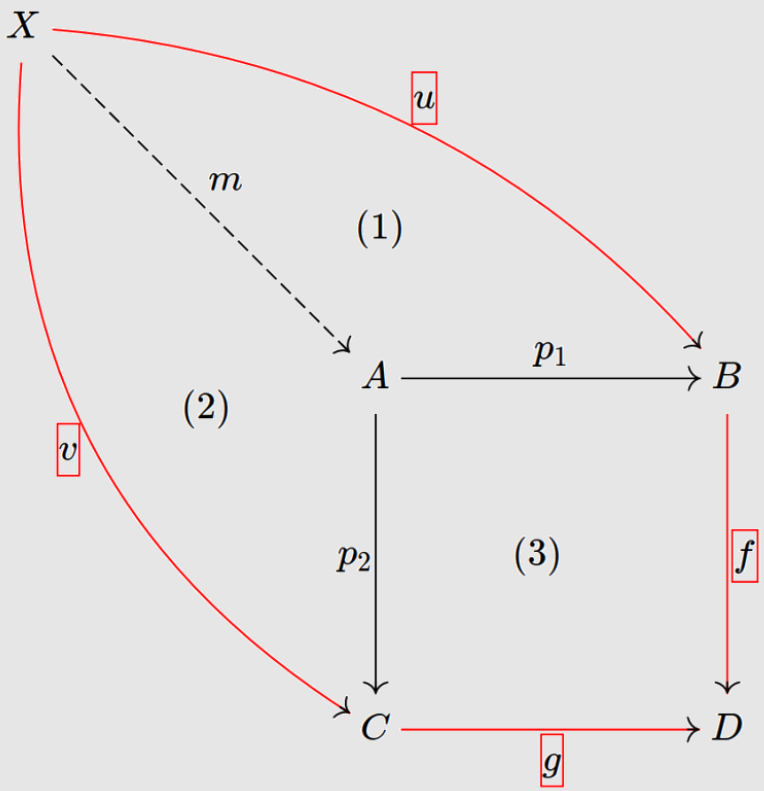

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3) Use greedily the rewrite rules until reaching the bottom left branch

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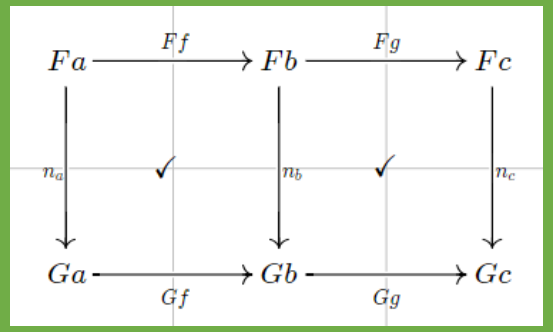
4) Remember the rewrite steps and generate the coq proof script accordingly.
If a Coq proof is provided inside a subdiagram, use it to justify the rewrite step.

Architecture

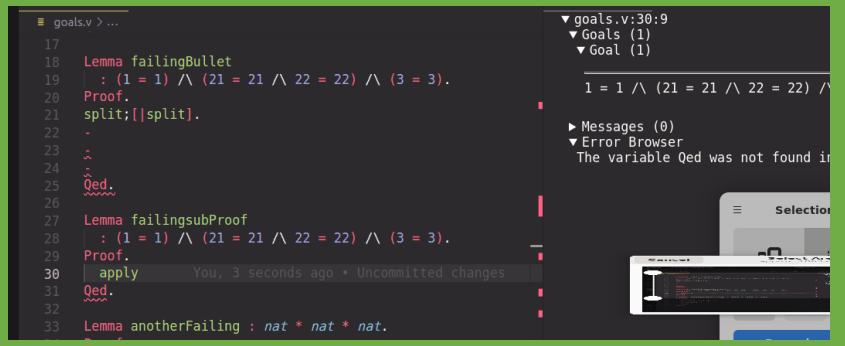
Diagram editor
(standalone version)



Generate proofs

Custom vscode extension (building upon coq-lsp)

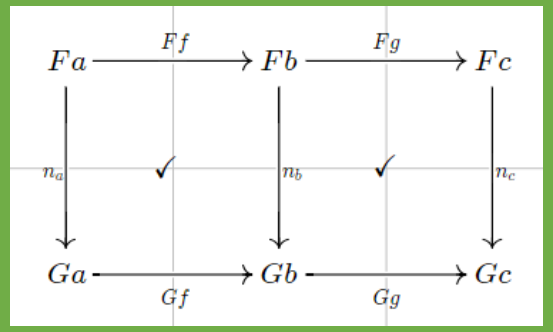
Visual Studio Code



(+ Coq library for custom notations)

Architecture

Diagram editor
(standalone version)

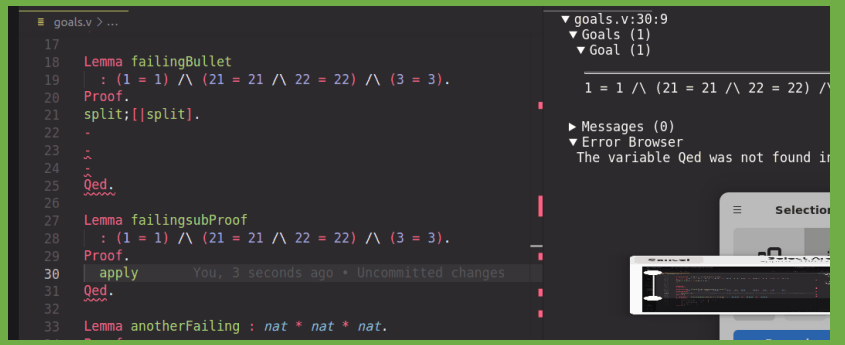


Generate proofs

Show diagram under cursor

Custom vscode extension (building upon coq-lsp)

Visual Studio Code



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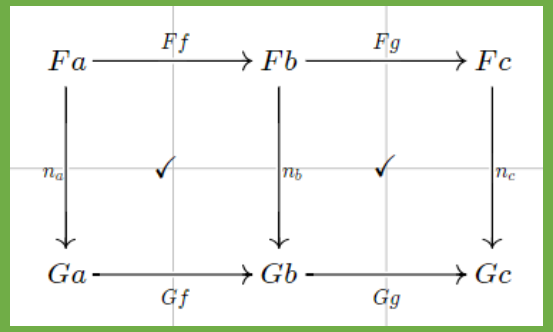
Architecture

Diagram editor
(standalone version)



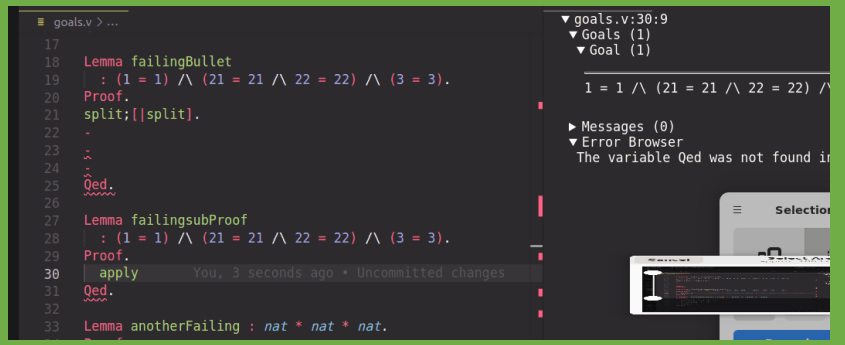
Generate proofs

Show diagram under cursor

Construct diagrams step by step

Custom vscode extension (building upon coq-lsp)

Visual Studio Code



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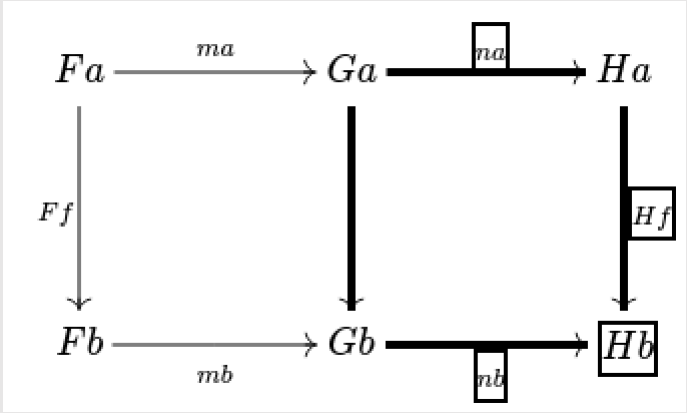
Construction of a diagrammatic proof with Coq + YADE

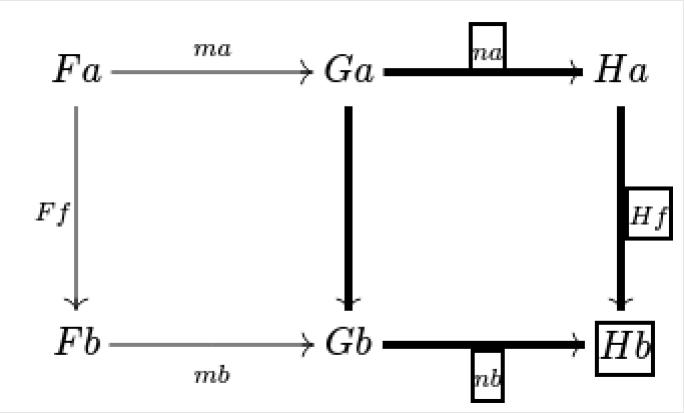
1) Select a subdiagram



Construction of a diagrammatic proof with Coq + YADE

1) Select a subdiagram

2) Execute the export command in the diagram editor



Construction of a diagrammatic proof with Coq + YADE

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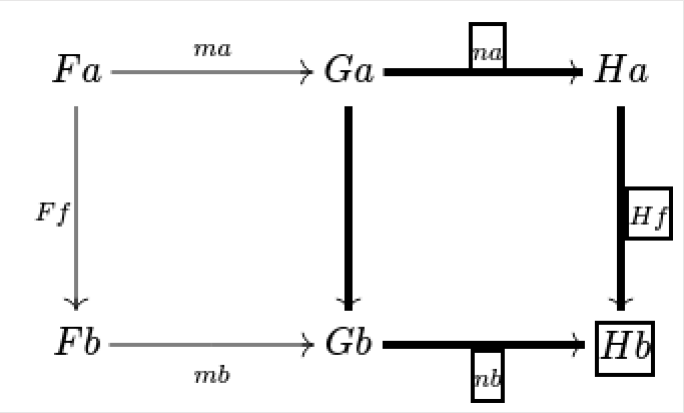
⇒ vscode asks for a Coq proof of equality



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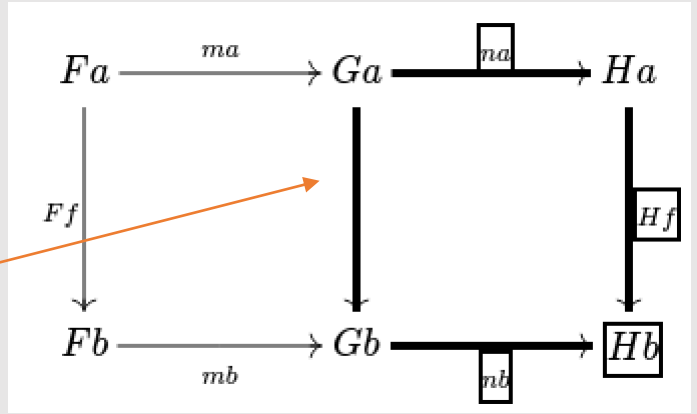
unnamed arrow




```
eassert (yade : { {n a} · H f = {_} · {n b} }).
{
(* Coq proof to be written here by the user *)
}
```

Construction of a diagrammatic proof with Coq + YADE

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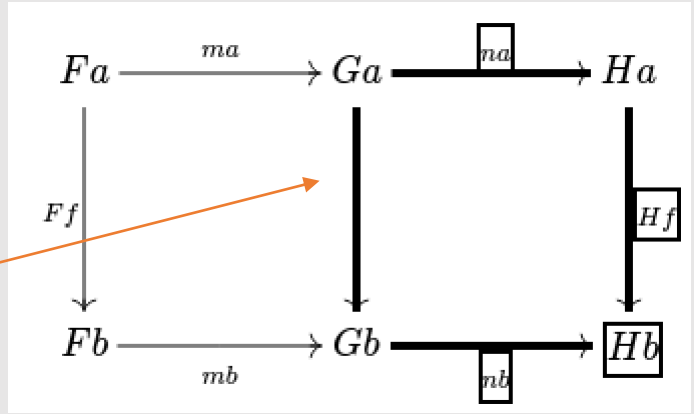

4) Complete the proof (here, by invoking naturality of n)

Construction of a diagrammatic proof with Coq + YADE

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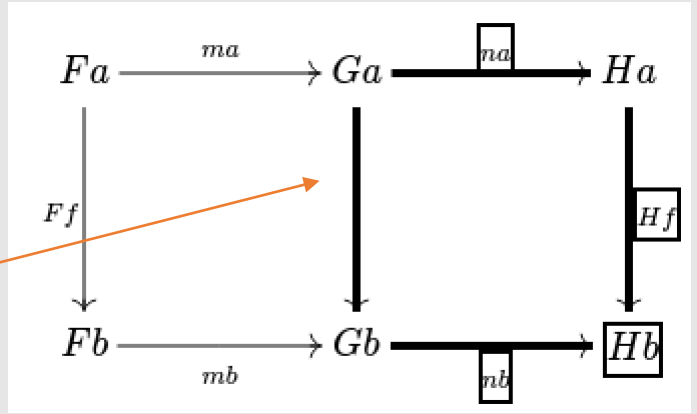


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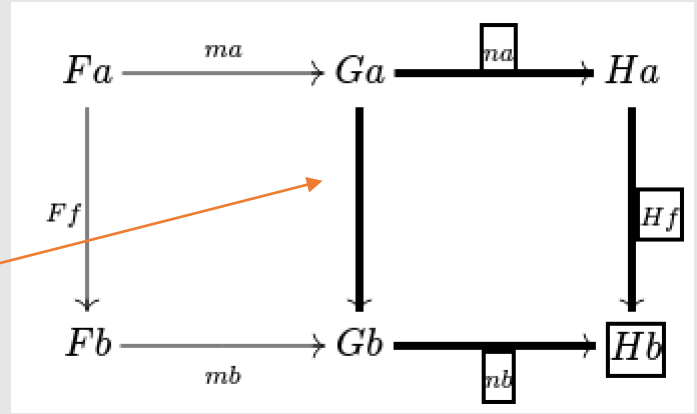

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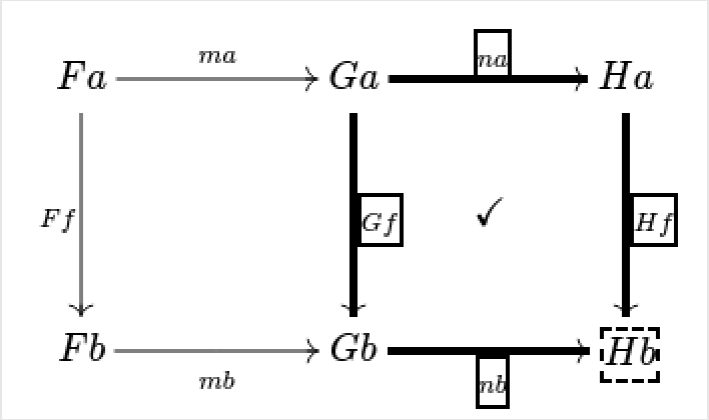
⇒ The diagram gets completed in the editor window:



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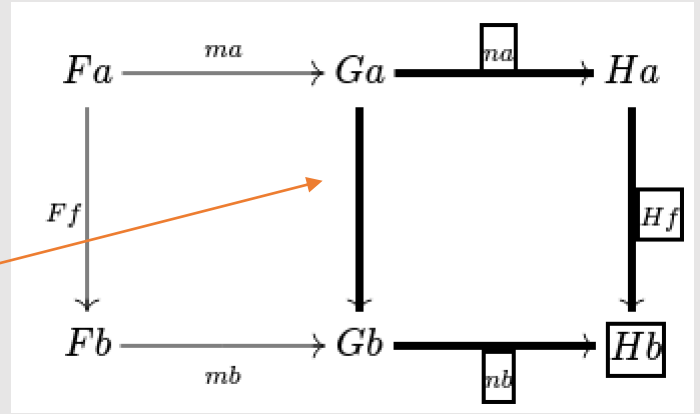

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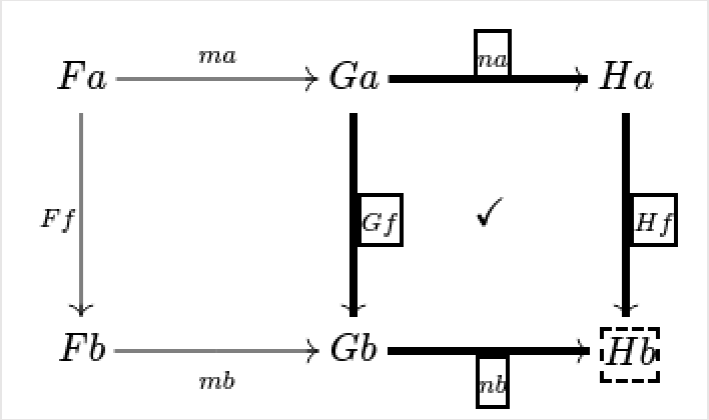
⇒ The diagram gets completed in the editor window:

- The label of the unnamed arrow is inferred



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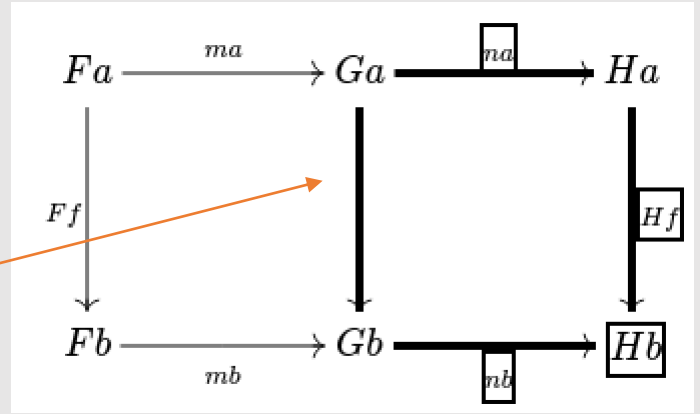

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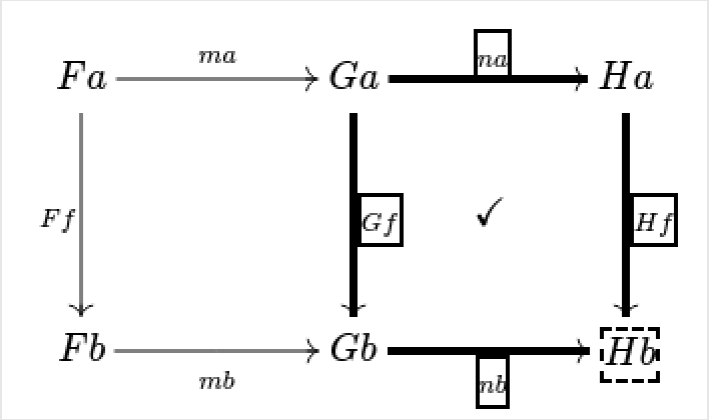
4) Complete the proof (here, by invoking naturality of n)

5) Execute the export command in vscode

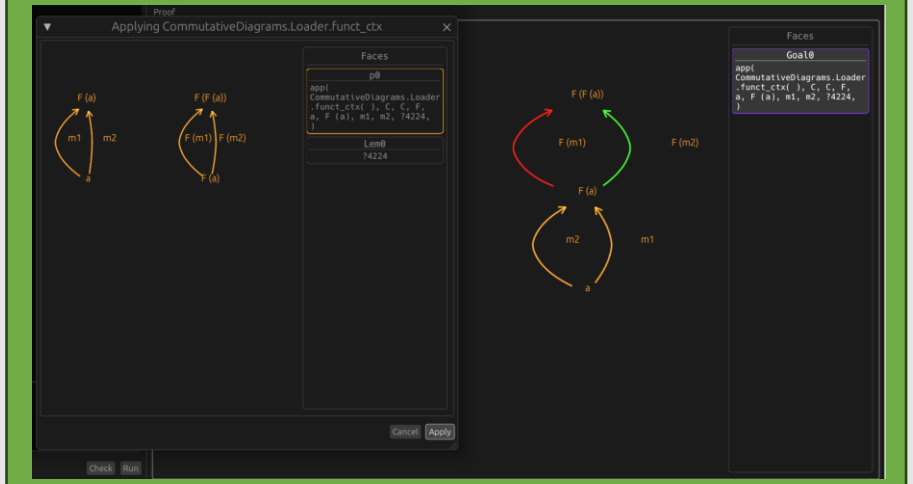
⇒ The diagram gets completed in the editor window:

- The label of the unnamed arrow is inferred
- The Coq proof is saved in the diagram (indicated by ✓)



Another related software for mechanisation: Luc Chabassier's interface for diagrammatic proofs

Graphical interface
(standalone program,
implemented in Rust)



Coq
plugin
(ocaml)

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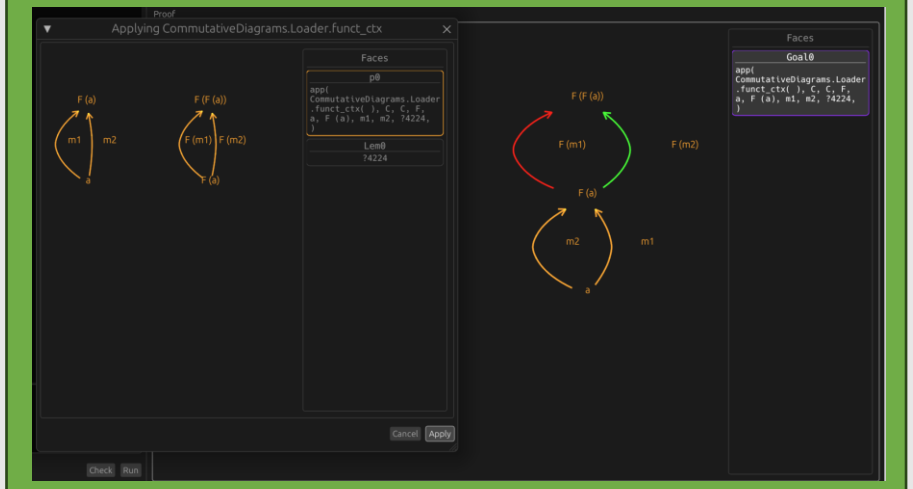

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```
Lemma …
Proof.
  …
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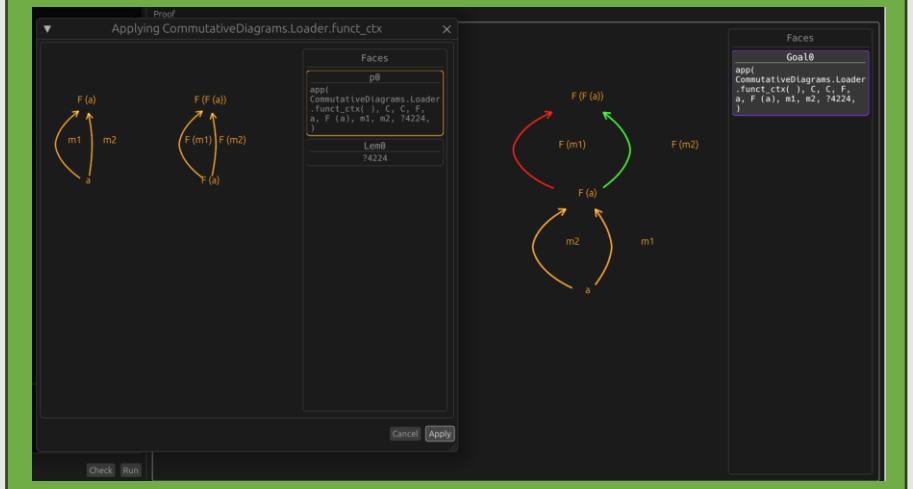

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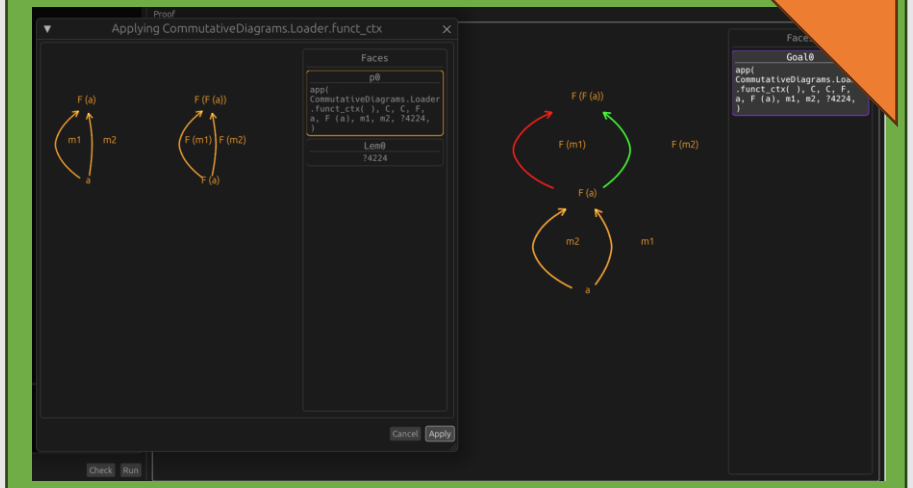

Goal, assumptions, lemmas

Coq plugin (ocaml)

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Lemma …
Proof.
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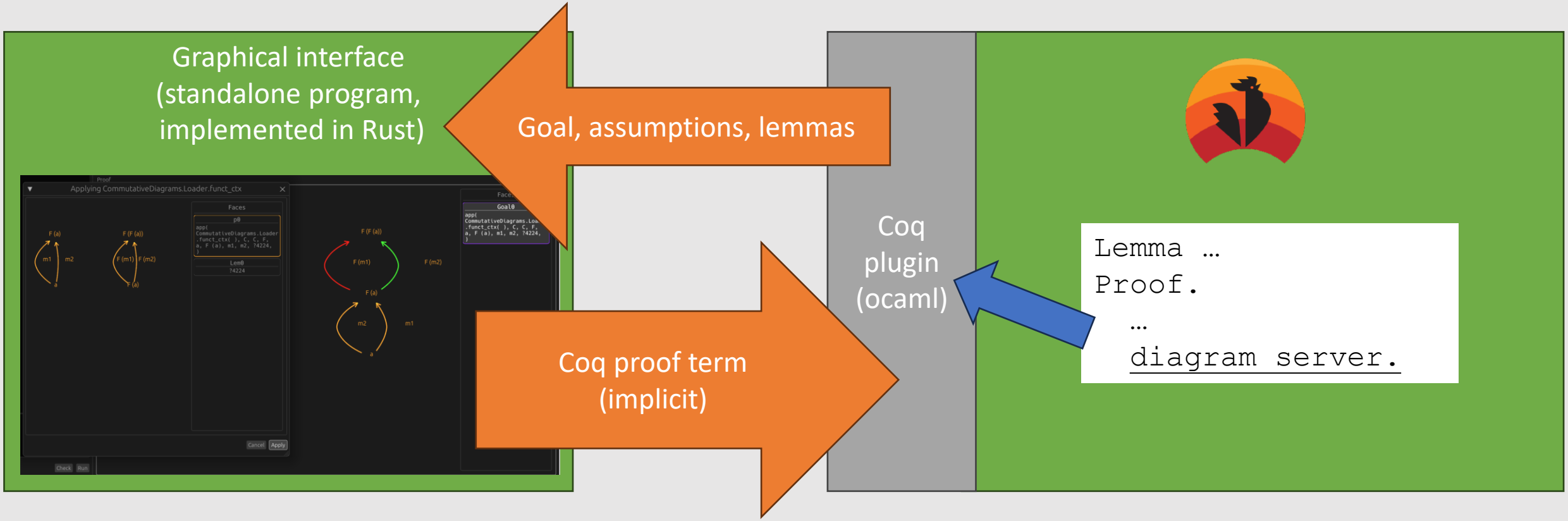

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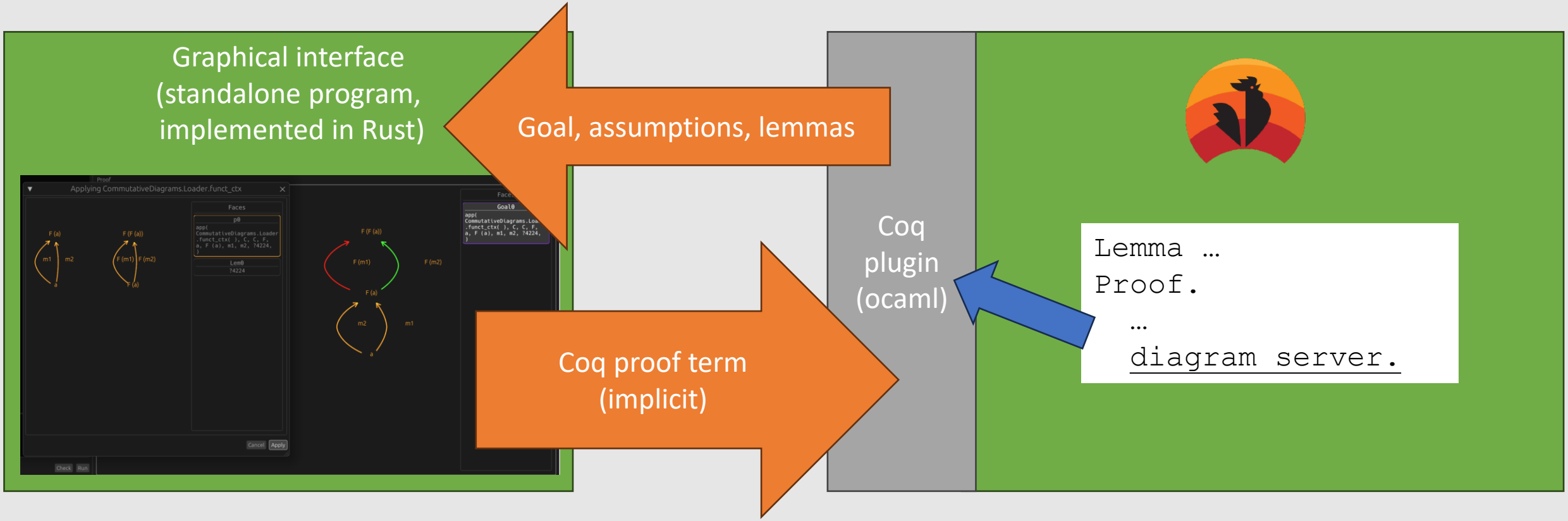

- Automatic layout (limited manual editing)

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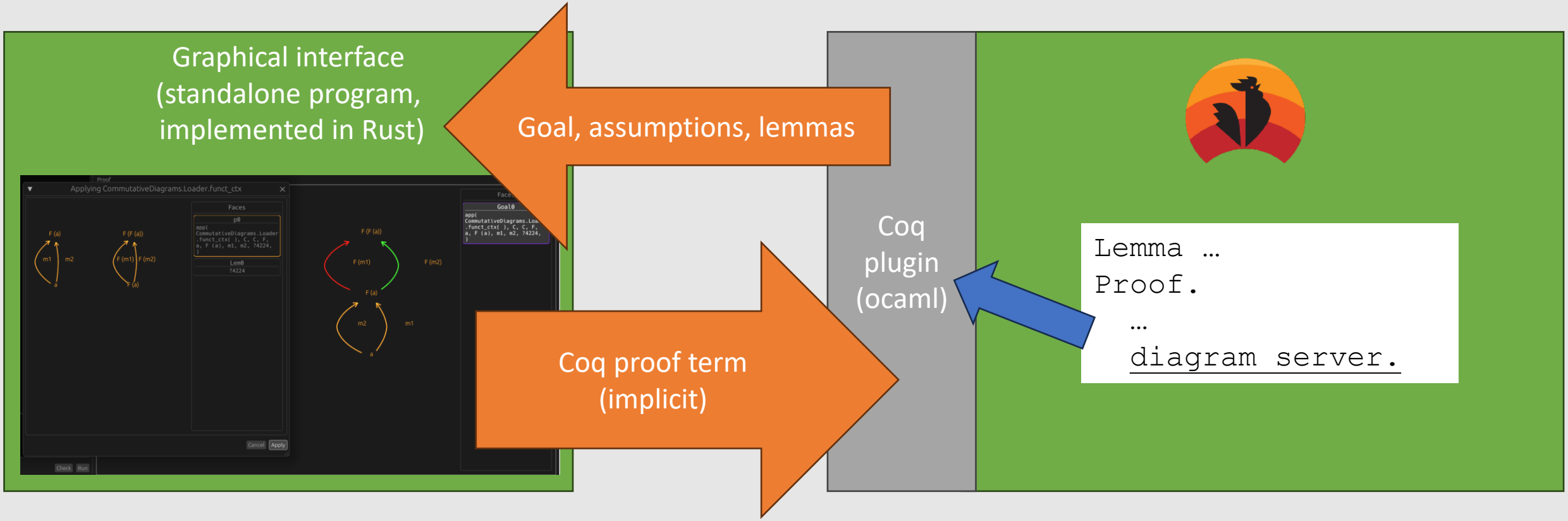

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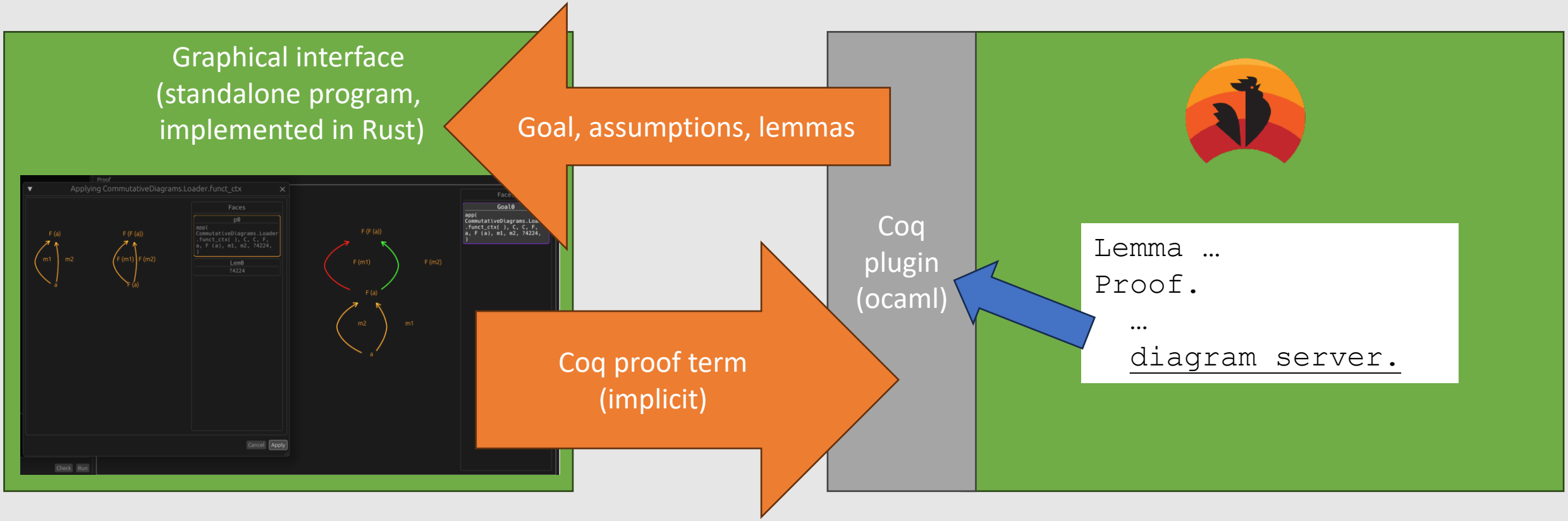

- Automatic layout (limited manual editing)
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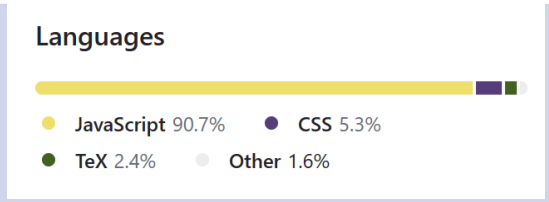
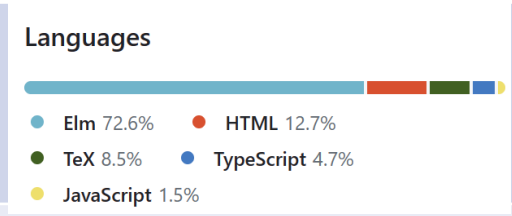
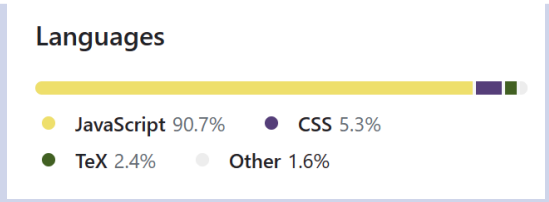
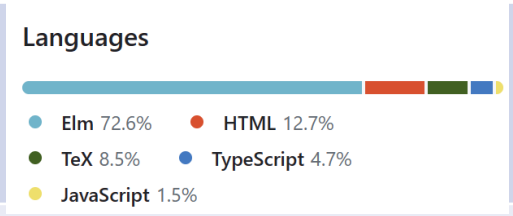
I plan to use his plugin in the future
(to apply Coq lemmas directly in the editor)

Comparison with quiver

	Quiver	YADE
Programming Languages		
Styling options	+	-
User-friendly	+	-
Editing features	-	+ Tabs, Copy & paste, find & replace, expand selection to connected components, …
LaTeX export	yes	yes
A nice name	+	-
Mechanisation features	-	+

Comparison with quiver

	Quiver	YADE
Programming Languages		
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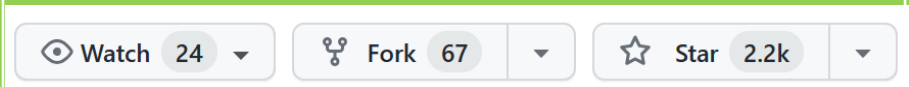
Mechanisation features	-	+
Popularity	+++ 	

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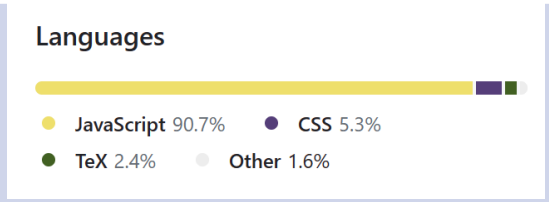
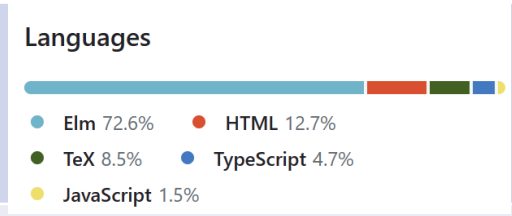
Programming Languages		
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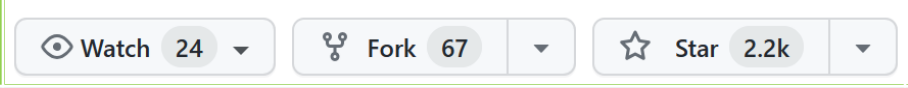
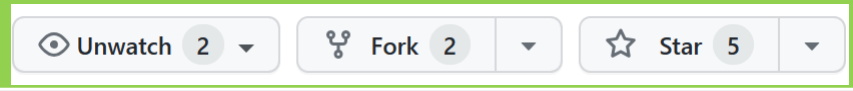
Popularity	+++ 	Two users: me and Tom Hirschowitz 

Some future plans

- Improve the process for building diagrams using Coq + YADE

(I still find it tedious)

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- Formalise categorical results.

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(requires a lot of engineering)

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(I still find it tedious)

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- A collaborative online version the editor

(requires a lot of engineering)

- Support for mechanisation of 2-categorical diagrams, string diagrams

How to try Coreact-YADE

Requirements for the full example available on github[1]

[1] https://github.com/amblafont/vscode-yade-example

How to try Coreact-YADE

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Packaged as .deb (Debian amd64)
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Coreact-YADE

Coq

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Coq

Visual Studio Code

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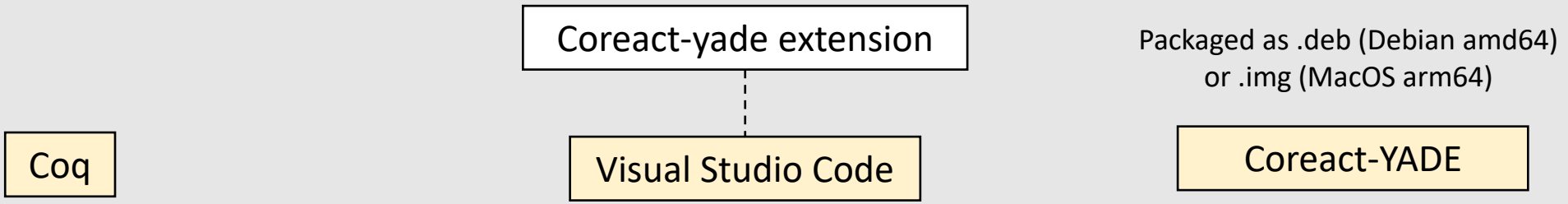

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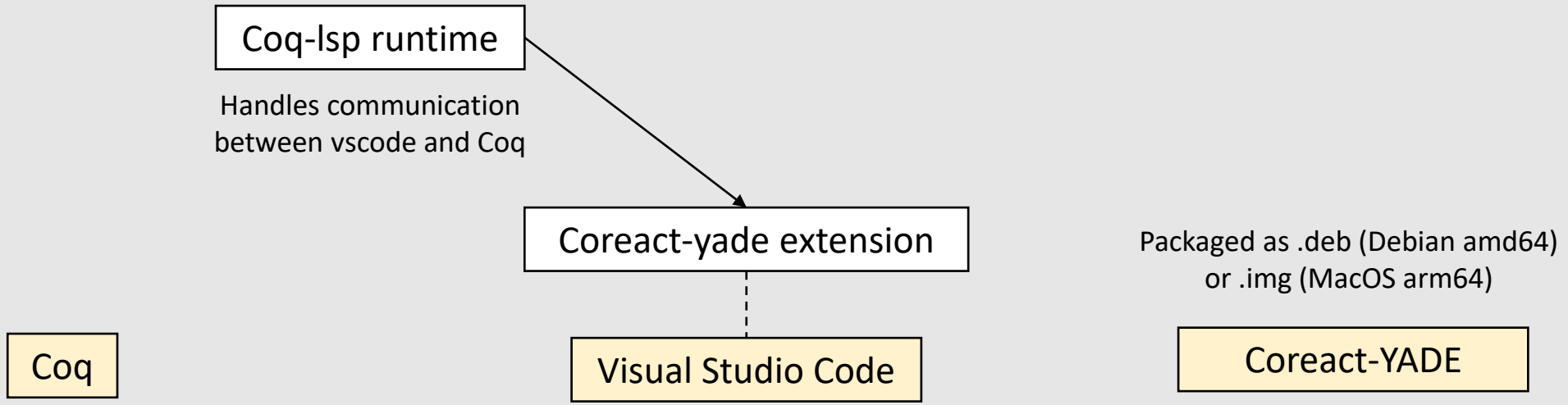

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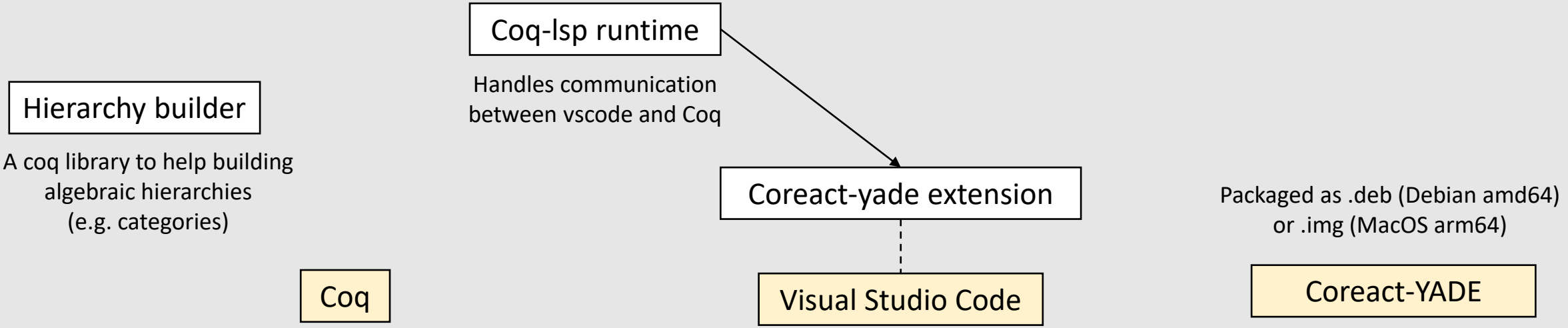

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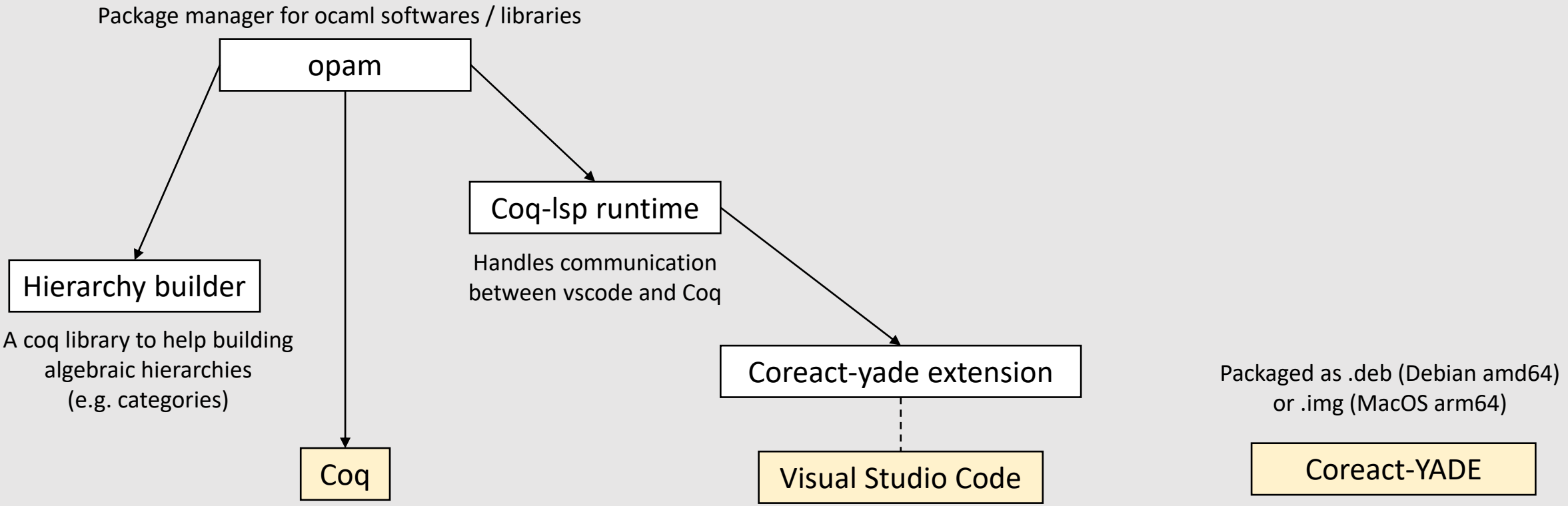

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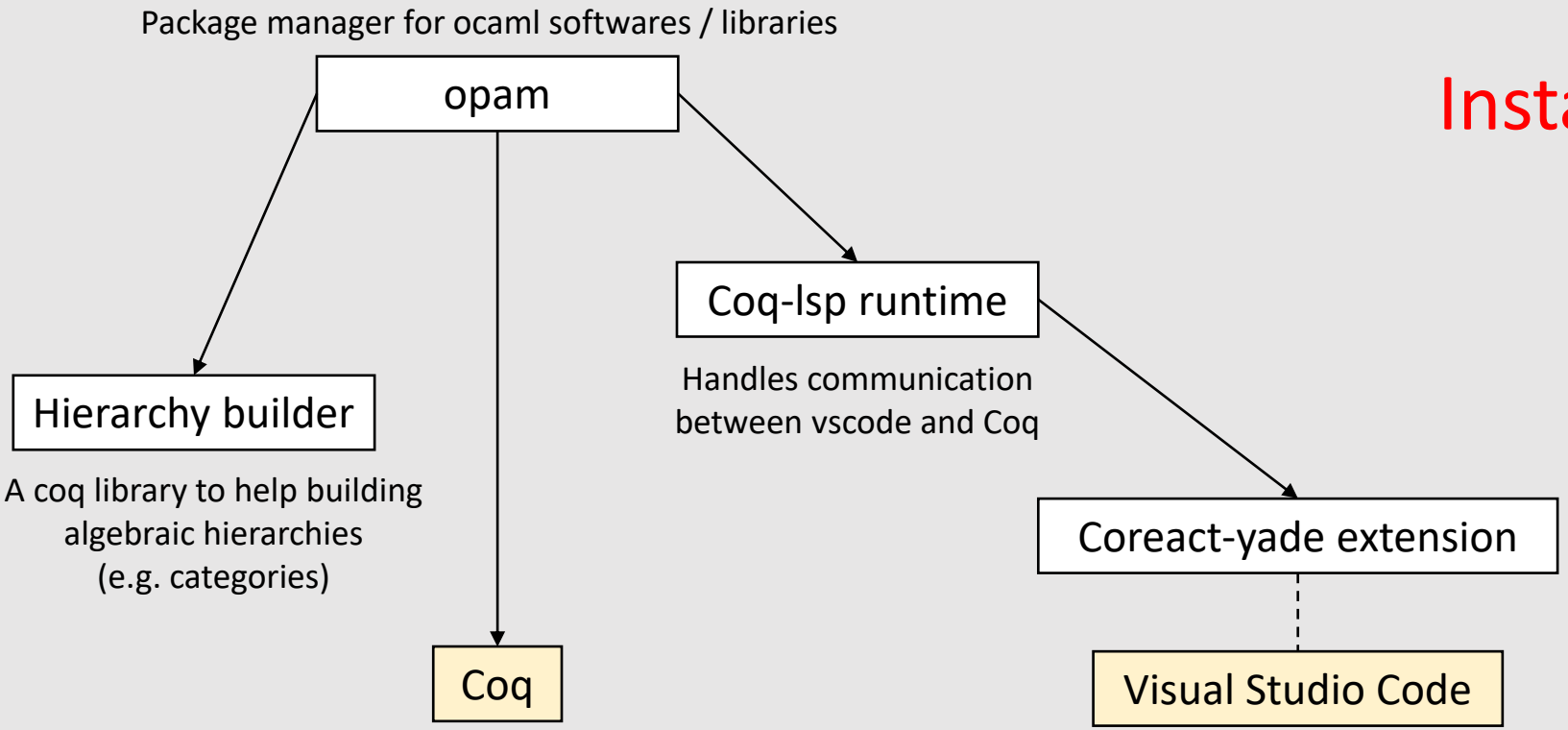

Installation is a bit tedious.

Packaged as .deb (Debian amd64) or .img (MacOS arm64)

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Docker

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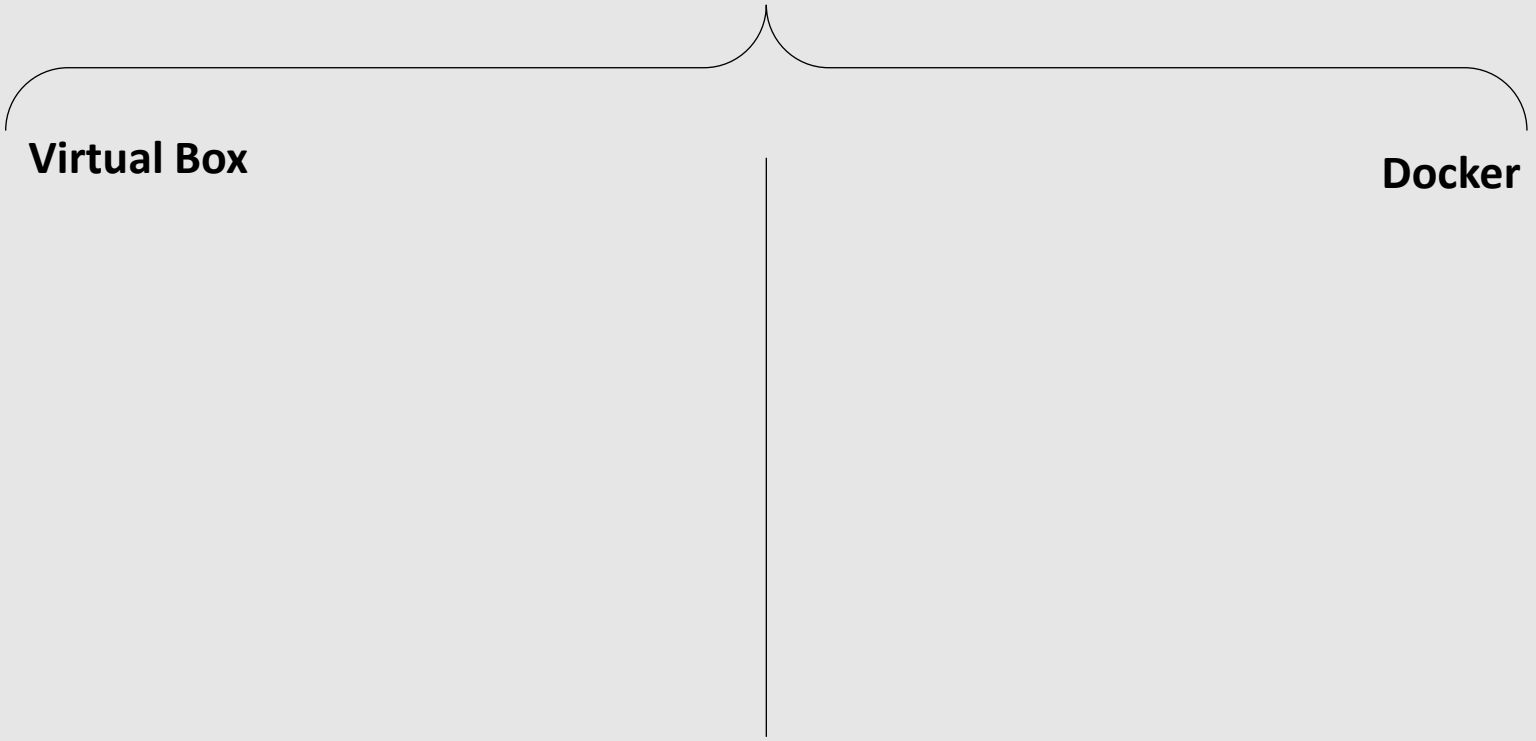

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