

Francy

Framework for Interactive Discrete Mathematics

1.0.4

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Chapter 1

Introduction

1.1 Francy

Francy arose from the necessity of having a lightweight framework for building interactive graphics, generated from GAP, running primarily on the web, primarily in a Jupyter Notebook. An initial attempt to re-use XGAP and port it was made, but the lack of a standardized data exchange format between GAP and the graphics renderer, and the simplistic initial requirements of the project were the basis for the creation of a new GAP package.

1.2 Applications

Francy has potentially many applications and can be used to provide a graphical representation of data structures, allowing one to navigate through and explore properties or relations of these structures. In this way, Francy can be used to enrich a learning environment where GAP provides a library of thousands of functions implementing algebraic algorithms as well as large data libraries of algebraic objects. Example packages using Francy: [FrancyMonoids](#), [SubgroupLattice](#)

1.3 Functionality

Francy provides an interface to draw graphics using objects. This interface is based on simple concepts of drawing and graph theory, allowing the creation of directed and undirected graphs, trees, line charts, bar charts and scatter charts. These graphical objects are drawn inside a canvas that includes a space for menus and to display informative messages. Within the canvas it is possible to interact with the graphical objects by clicking, selecting, dragging and zooming

1.4 Installation

This package requires the GAP packages `JupyterKernel` and `json`, all of which are distributed with GAP. Francy follows a similar installation procedure to `JupyterKernel`, so it requires [Jupyter](#) to be installed on your system. Please note, you need to run the installation command from the same python version [Jupyter](#) is installed on. In order to install Francy, please run the following command to download the latest version available from <https://pypi.org/>:

```
Example  
pip install jupyter_francy -U
```

It is necessary to enable Francy on your [Jupyter](#) installation:

```
Example  
jupyter nbextension enable --py --sys-prefix jupyter_francy
```

1.5 How it works

Francy requires a rendering package to display graphics. Francy uses Renderers based on d3.js and Graphviz, for rendering the semantic representation produced by the GAP package. This library is distributed both as a browser module and as a Jupyter extension. The Jupyter extension can be used in Jupyter Notebooks or Jupyter Lab, using the `JupyterKernel` and the MIME type `application/vnd.francy+json` to render the document. Please check the documentation for more information: [JavaScript Documentation](#).

1.6 Publications

[ICMS 2018](#)

Chapter 2

Francy Callbacks

Callbacks are objects that hold a function, a list of arguments and a trigger event. Callbacks are used to execute GAP code from a remote client using the Trigger Operation.

Callbacks can be added directly to Menus and/or Shapes.

Please see Francy-JS for client implementation.

2.1 Categories

In this section we show the Francy Callback Categories.

2.1.1 IsCallback (for IsFrancyObject)

▷ IsCallback(*arg*) (filter)
Returns: true or false
Identifies Callback objects.

2.1.2 IsRequiredArg (for IsFrancyObject)

▷ IsRequiredArg(*arg*) (filter)
Returns: true or false
Identifies RequiredArg objects.

2.1.3 IsArgType (for IsFrancyTypeObject)

▷ IsArgType(*arg*) (filter)
Returns: true or false
Identifies ArgType objects.

2.1.4 IsTriggerType (for IsFrancyTypeObject)

▷ IsTriggerType(*arg*) (filter)
Returns: true or false
Identifies TriggerType objects.

2.2 Families

In this section we show the Francy Callback Families.

2.3 Representations

In this section we show the Francy Callback Representations.

2.3.1 IsCallbackRep (for IsComponentObjectRep)

- ▷ `IsCallbackRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `Callback` internal representation.

2.3.2 IsRequiredArgRep (for IsComponentObjectRep)

- ▷ `IsRequiredArgRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `RequiredArg` internal representation.

2.3.3 IsArgTypeRep (for IsComponentObjectRep)

- ▷ `IsArgTypeRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `ArgType` internal representation.

2.3.4 IsTriggerTypeRep (for IsComponentObjectRep)

- ▷ `IsTriggerTypeRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `TriggerType` internal representation.

2.4 Operations

In this section we show the Francy Callback Operations.

2.4.1 Callback (for IsTriggerType, IsFunction, IsList)

- ▷ `Callback(IsTriggerType, IsFunction, IsList(object))` (operation)
Returns: `Callback`
 Creates a `Callback` object that holds a function and args to be executed by a trigger based on a trigger type.
Please note, the Function must Return!
 Examples:
 Create a simple `Callback` with no arguments:

Example

```
gap> MyFunction := function() return "Hello World!"; end;
gap> callback := Callback(MyFunction);
gap> Id(callback);
```

Create a Callback with one required argument of type string:

Example

```
gap> MyFunction := function(str) return Concatenation("Hello", " ", str); end;
gap> callback := Callback(MyFunction);
gap> arg := RequiredArg(ArgType.STRING, "Your Name");
gap> Add(callback, arg);
```

Create a Callback with one known argument of type string:

Example

```
gap> MyFunction := function(args) return args; end;
gap> callback := Callback(MyFunction, ["Hello World"]);
```

Create a Callback with one known argument and one required argument of type string:

Example

```
gap> MyFunction := function(a,b) return Concatenation(a, b); end;
gap> callback := Callback(MyFunction, ["Hello "]);
gap> arg := RequiredArg(ArgType.STRING, "Your Name");
gap> Add(callback, arg);
```

Create a Callback with one known argument and one required argument of type string and double click trigger Type:

Example

```
gap> MyFunction := function(a,b) return Concatenation(a, b); end;
gap> callback := Callback(TriggerType.DOUBLE_CLICK, MyFunction, ["Hello "]);
gap> arg := RequiredArg(ArgType.STRING, "Your Name");
gap> Add(callback, arg);
```

In order to see the output of the previous examples, we have to simulate the external call to Trigger operation:

Example

```
gap> MyFunction := function(a,b) return Concatenation(a, b); end;
gap> callback := Callback(TriggerType.DOUBLE_CLICK, MyFunction, ["Hello "]);
gap> arg := RequiredArg(ArgType.STRING, "Your Name");
gap> SetTitle(arg, "Enter your name");
gap> Title(arg);
gap> Add(callback, arg);
gap> SetValue(arg, "Manuel"); # simulate the user input
gap> Value(arg);
gap> Trigger(GapToJsonString(Sanitize(callback))); # simulate the external trigger
```

Create a Noop Callback, useful for Menu holders, where no function is required:

Example

```
gap> callback := NoopCallback();
```

2.4.2 NoopCallback

- ▷ `NoopCallback()` (operation)
Returns: Callback
 Creates an empty Callback object that does nothing. Useful to create menu holders.

2.4.3 RequiredArg (for IsArgType, IsString)

- ▷ `RequiredArg(IsArgType, IsString(title))` (operation)
Returns: RequiredArg
 Creates a Callback RequiredArg. RequiredArg is user input driven and required for the execution of a Callback This value will be provided by the user.

2.4.4 Trigger (for IsString)

- ▷ `Trigger(IsString(JSON))` (operation)
Returns: the result of the execution of the Callback defined Function
 Triggers a callback function in GAP. Gets a JSON String object representation of the callback to execute.

2.4.5 Add (for IsCallback, IsRequiredArg)

- ▷ `Add(IsCallback[, IsRequiredArg, List(IsRequiredArg)])` (operation)
Returns: Callback
 Adds a RequiredArg to a specific Callback.

2.4.6 Remove (for IsCallback, IsRequiredArg)

- ▷ `Remove(IsCallback[, IsRequiredArg, List(IsRequiredArg)])` (operation)
Returns: Callback
 Removes a RequiredArg from a specific callback.

2.5 Globals

In this section we show the Global Callback Francy Records for multi purpose.

2.6 Attributes

In this section we show the Francy Callback Attributes

2.6.1 Title (for IsRequiredArg)

- ▷ `Title(arg)` (attribute)
Returns: IsString with the title of the object
 A title on a required arg is used to ask the user what is expected from his input.

2.6.2 Title (for `IsRequiredArg`)

▷ `Title(arg1)` (function)

2.6.3 `SetTitle` (for `IsRequiredArg`, `IsString`)

▷ `SetTitle(IsRequiredArg, IsString)` (function)

Sets the title of the required arg.

2.6.4 Value (for `IsRequiredArg`)

▷ `Value(arg)` (attribute)

Returns: `IsString` with the value of the object

A value on a required arg is the actual input to be passed to gap. These values are stored as `String` for convenience, even if the `ArgType` specified for the `RequiredArg` is another. Explicit conversion is required within the `Callbackfunction`.

2.6.5 Value (for `IsRequiredArg`)

▷ `Value(arg1)` (function)

2.6.6 `SetValue` (for `IsRequiredArg`, `IsString`)

▷ `SetValue(IsRequiredArg, IsString)` (function)

Sets the value of the required arg.

2.6.7 `ConfirmMessage` (for `IsCallback`)

▷ `ConfirmMessage(arg)` (attribute)

Returns: `IsString` with the value of the object

A value on a required arg is the actual input to be passed to gap. These values are stored as `String` for convenience, even if the `ArgType` specified for the `RequiredArg` is another. Explicit conversion is required within the `Callbackfunction`.

2.6.8 `ConfirmMessage` (for `IsCallback`)

▷ `ConfirmMessage(arg1)` (function)

2.6.9 `SetConfirmMessage` (for `IsCallback`, `IsString`)

▷ `SetConfirmMessage(IsRequiredArg, IsString)` (function)

Sets the value of the required arg.

Chapter 3

Francy Canvas

A Canvas is an area where the graphics representation of Francy live.
Please see Francy-JS for client implementation.

3.1 Categories

In this section we show the Francy Canvas Categories.

3.1.1 IsCanvas (for IsFrancyObject)

▷ `IsCanvas(arg)` (filter)
Returns: true or false
Identifies Canvas objects.

3.1.2 IsCanvasDefaults (for IsFrancyDefaultObject)

▷ `IsCanvasDefaults(arg)` (filter)
Returns: true or false
Identifies CanvasDefaults objects.

3.2 Families

In this section we show the Francy Canvas Families.

3.3 Representations

In this section we show the Francy Canvas Representations.

3.3.1 IsCanvasRep (for IsComponentObjectRep)

▷ `IsCanvasRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a Canvas internal representation.

3.3.2 IsCanvasDefaultsRep (for IsComponentObjectRep)

- ▷ `IsCanvasDefaultsRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a CanvasDefaults internal representation.

3.4 Operations

In this section we show the Francy Canvas Operations.

3.4.1 Canvas (for IsString, IsCanvasDefaults)

- ▷ `Canvas(IsString(title) [, IsCanvasDefaults])` (operation)
Returns: Callback
 Canvas represents a base element to draw graphics on. Inspired by the HTML canvas tag element which is used to draw graphics, in runtime, via JavaScript. Examples:
 Create a simple Canvas:

Example

```
gap> canvas := Canvas("");
gap> Id(canvas);
gap> SetTitle(canvas, "Quaternion Group Subgroup Lattice");
gap> Title(canvas);
gap> SetHeight(canvas, 400); # default 600
gap> Height(canvas);
gap> SetWidth(canvas, 400); # default 800
gap> Width(canvas);
gap> SetZoomToFit(canvas, false); # default true
gap> ZoomToFit(canvas);
gap> Draw(canvas);
```

3.4.2 Add (for IsCanvas, IsFrancyGraph)

- ▷ `Add(IsCanvas[, IsFrancyGraph, List(IsFrancyGraph)])` (operation)
Returns: Canvas
 Adds a FrancyGraph to a specific Canvas. Well, the api is abstract enough to allow Adding a list of IsFrancyGraph to a canvas, but this results in setting the graph property only to the last IsFrancyGraph in the list.

3.4.3 Remove (for IsCanvas, IsFrancyGraph)

- ▷ `Remove(IsCanvas[, IsFrancyGraph, List(IsFrancyGraph)])` (operation)
Returns: Canvas
 Removes a FrancyGraph from a Canvas.

3.4.4 Add (for IsCanvas, IsChart)

- ▷ `Add(IsCanvas[, IsChart, List(IsChart)])` (operation)
Returns: Canvas

Adds a Chart to a specific Canvas. Well, the api is abstract enough to allow Adding a list of IsChart to a canvas, but this results in setting the graph property only to the last IsChart in the list.

3.4.5 Remove (for IsCanvas, IsChart)

- ▷ `Remove(IsCanvas[, IsChart, List(IsChart)])` (operation)
Returns: Canvas
 Removes a Chart from a Canvas.

3.4.6 Add (for IsCanvas, IsMenu)

- ▷ `Add(IsCanvas[, IsMenu, List(IsMenu)])` (operation)
Returns: Canvas
 Adds a Menu to a specific Canvas.

3.4.7 Remove (for IsCanvas, IsMenu)

- ▷ `Remove(IsCanvas[, IsMenu, List(IsMenu)])` (operation)
Returns: Canvas
 Removes a Menu from a Canvas.

3.4.8 Add (for IsCanvas, IsFrancyMessage)

- ▷ `Add(IsCanvas[, IsFrancyMessage, List(IsFrancyMessage)])` (operation)
Returns: IsCanvas
 Adds a FrancyMessage to a specific IsCanvas.

3.4.9 Remove (for IsCanvas, IsFrancyMessage)

- ▷ `Remove(IsCanvas[, IsFrancyMessage, List(IsFrancyMessage)])` (operation)
Returns: IsCanvas
 Removes a FrancyMessage from a specific IsCanvas.

3.4.10 Draw (for IsCanvas)

- ▷ `Draw(IsCanvas)` (operation)
Returns: rec with json representation of the canvas
 Generates the JSON representation of the canvas and children objects

3.4.11 DrawSplash (for IsCanvas)

- ▷ `DrawSplash(IsCanvas)` (operation)
Returns: rec with html generated
 Generates an HTML page and opens it within the default browser of the system

3.5 Global

In this section we show the Global Francy Canvas Records for multi purpose.

3.6 Attributes

In this section we show the Francy Attributes

3.6.1 Width (for IsCanvas)

- ▷ `Width(arg)` (attribute)
 - Returns:** `IsPosInt`
 - The Width of the canvas in pixels

3.6.2 Width (for IsCanvas)

- ▷ `Width(arg1)` (function)

3.6.3 SetWidth (for IsCanvas, IsPosInt)

- ▷ `SetWidth(IsCanvas, IsPosInt)` (function)
 - Sets the Width of the canvas in pixels

3.6.4 Height (for IsCanvas)

- ▷ `Height(arg)` (attribute)
 - Returns:** `IsPosInt`
 - The Height of the canvas in pixels

3.6.5 Height (for IsCanvas)

- ▷ `Height(arg1)` (function)

3.6.6 SetHeight (for IsCanvas, IsPosInt)

- ▷ `SetHeight(IsCanvas, IsPosInt)` (function)
 - Sets the Height of the canvas in pixels

3.6.7 ZoomToFit (for IsCanvas)

- ▷ `ZoomToFit(arg)` (attribute)
 - Returns:** `IsBool` True if enabled otherwise False
 - `ZoomToFit` is a property that sets the zoom to fit behavior on change in the client implementation.

3.6.8 ZoomToFit (for IsCanvas)

- ▷ `ZoomToFit(arg1)` (function)

3.6.9 SetZoomToFit (for IsCanvas, IsBool)

▷ `SetZoomToFit(IsCanvas, IsBool)` (function)

`ZoomToFit` is a property that sets the zoom to fit behavior on change in the client.

3.6.10 Title (for IsCanvas)

▷ `Title(arg)` (attribute)

Returns: `IsString` with the title of the object

A title on a required arg is used to ask the user what is expected from his input.

3.6.11 Title (for IsCanvas)

▷ `Title(arg1)` (function)

3.6.12 SetTitle (for IsCanvas, IsString)

▷ `SetTitle(IsCanvas, IsString)` (function)

Sets the title of the required arg.

3.6.13 TexTypesetting (for IsCanvas)

▷ `TexTypesetting(arg)` (attribute)

Returns: `IsBool` with the title of the object

Enables Tex typesetting on the client implementation

3.6.14 TexTypesetting (for IsCanvas)

▷ `TexTypesetting(arg1)` (function)

3.6.15 SetTexTypesetting (for IsCanvas, IsBool)

▷ `SetTexTypesetting(IsCanvas, IsBool)` (function)

Sets Tex typesetting on the canvas objects

Chapter 4

Francy Charts

It is possible to build Charts with simple Datasets.
Currently, Francy, supports Bar, Line and Scatter Charts.
Please see Francy-JS for client implementation.

4.1 Categories

In this section we show the Francy Chart Categories.

4.1.1 IsChart (for IsFrancyObject)

- ▷ `IsChart(arg)` (filter)
Returns: true or false
Identifies Chart objects.

4.1.2 IsChartType (for IsFrancyTypeObject)

- ▷ `IsChartType(arg)` (filter)
Returns: true or false
Identifies ChartType objects.

4.1.3 IsChartDefaults (for IsFrancyDefaultObject)

- ▷ `IsChartDefaults(arg)` (filter)
Returns: true or false
Identifies ChartDefaults objects.

4.1.4 IsAxisScaleType (for IsFrancyTypeObject)

- ▷ `IsAxisScaleType(arg)` (filter)
Returns: true or false
Identifies AxisScaleType objects.

4.1.5 IsXAxis (for IsFrancyObject)

- ▷ `IsXAxis(arg)` (filter)
Returns: true or false
Identifies XAxis objects.

4.1.6 IsYAxis (for IsFrancyObject)

- ▷ `IsYAxis(arg)` (filter)
Returns: true or false
Identifies YAxis objects.

4.1.7 IsDataset (for IsFrancyObject)

- ▷ `IsDataset(arg)` (filter)
Returns: true or false
Identifies Dataset objects.

4.2 Families

In this section we show the Francy Chart Families.

4.3 Representations

In this section we show the Francy Chart Representations.

4.3.1 IsChartRep (for IsComponentObjectRep)

- ▷ `IsChartRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a Chart internal representation.

4.3.2 IsChartDefaultsRep (for IsComponentObjectRep)

- ▷ `IsChartDefaultsRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a ChartDefaults internal representation.

4.3.3 IsChartTypeRep (for IsComponentObjectRep)

- ▷ `IsChartTypeRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a ChartType internal representation.

4.3.4 IsAxisScaleTypeRep (for IsComponentObjectRep)

- ▷ `IsAxisScaleTypeRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `AxisScaleType` internal representation.

4.3.5 IsAxisRep (for IsComponentObjectRep)

- ▷ `IsAxisRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `AxisRep` internal representation.

4.3.6 IsDatasetRep (for IsComponentObjectRep)

- ▷ `IsDatasetRep(arg)` (filter)
Returns: true or false
 Checks whether an `Object` has a `DatasetRep` internal representation.

4.4 Operations

In this section we show the Francy Chart Operations.

4.4.1 Chart (for IsChartType, IsChartDefaults)

- ▷ `Chart(IsChartType[, IsChartDefaults])` (operation)
Returns: `Chart`
 Every object to draw will be a subclass of this object. This will allow all the objects to contain the same base information.
 Examples:

Create a simple Chart of type `ChartType.BAR`:

Example

```
gap> chart:=Chart(ChartType.BAR);
gap> SetAxisXTitle(chart, "X Axis");
gap> AxisXTitle(chart);
gap> SetAxisXDomain(chart, ["domain1", "domain2", "domain3", "domain4", "domain5"]); # default []
gap> AxisXDomain(chart);
gap> SetAxisYTitle(chart, "Y Axis");
gap> AxisYTitle(chart);
gap> data1 := Dataset("data1", [100,20,30,47,90]);
gap> data2 := Dataset("data2", [51,60,72,38,97]);
gap> data3 := Dataset("data3", [50,60,70,80,90]);
gap> Add(chart, [data1, data2, data3]);
gap> Remove(chart, data1);
gap> Add(chart, data1);
gap> Remove(chart, [data2, data3]);
gap> Length(RecNames(chart!.data)) = 1;
```

Create a simple Chart of type `ChartType.LINE`:

Example

```
gap> chart:=Chart(ChartType.LINE);
gap> SetAxisXTitle(chart, "X Axis");
gap> SetAxisYTitle(chart, "Y Axis");
gap> data1 := Dataset("data1", [100,20,30,47,90]);
gap> Add(chart, data1);
```

Create a simple Chart of type `ChartType.SCATTER`:

Example

```
gap> chart:=Chart(ChartType.SCATTER);
gap> SetAxisXTitle(chart, "X Axis");
gap> SetAxisYTitle(chart, "Y Axis");
gap> data1 := Dataset("data1", [100,20,30,47,90]);
gap> Add(chart, data1);
```

4.4.2 Add (for `IsChart`, `IsDataset`)

- ▷ `Add(IsChart[, IsDataset, List(IsDataset)])` (operation)
Returns: `Chart`
 Adds a Dataset to a specific Chart.

4.4.3 Remove (for `IsChart`, `IsDataset`)

- ▷ `Remove(IsChart[, IsDataset, List(IsDataset)])` (operation)
Returns: `Chart`
 Removes a Dataset from a specific Chart.

4.4.4 Dataset (for `IsString`, `IsList`)

- ▷ `Dataset(IsString(title), IsList(data))` (operation)
Returns: `Dataset`
 Creates a dataset.

4.4.5 DefaultAxis (for `IsChartType`)

- ▷ `DefaultAxis(IsChartType)` (operation)
Returns: `rec`
 Returns the default settings for a `ChartType`

4.4.6 XAxis (for `IsAxisScaleType`, `IsString`, `IsList`)

- ▷ `XAxis(IsAxisScaleType, IsString(title), IsList(domain))` (operation)
Returns: `XAxis`
 Creates a `XAxis`

4.4.7 YAxis (for `IsAxisScaleType`, `IsString`, `IsList`)

- ▷ `YAxis(IsAxisScaleType, IsString(title), IsList(domain))` (operation)
Returns: `YAxis`
 Creates a `YAxis`

4.5 Global

In this section we show the Global Chart Francy Records for multi purpose.

4.6 Attributes

In this section we show the Francy Attributes

4.6.1 ShowLegend (for IsChart)

- ▷ `ShowLegend(arg)` (attribute)
 - Returns:** `IsBool` True if enabled otherwise False
 - ShowLegend is a property that enables or disables the legend in the client implementation.

4.6.2 ShowLegend (for IsChart)

- ▷ `ShowLegend(arg1)` (function)

4.6.3 SetShowLegend (for IsChart, IsBool)

- ▷ `SetShowLegend(IsChart, IsBool)` (function)

ShowLegend is a property that enables or disables the legend in the client implementation.

4.6.4 AxisXTitle (for IsChart)

- ▷ `AxisXTitle(arg)` (attribute)
 - Returns:** `IsString` with the title of the object
 - This title is used to display the X Axis Title in the client implementation.

4.6.5 AxisXTitle (for IsChart)

- ▷ `AxisXTitle(arg1)` (function)

4.6.6 SetAxisXTitle (for IsChart, IsString)

- ▷ `SetAxisXTitle(IsChart, IsString)` (function)

This title is used to display the X Axis Title in the client implementation.

4.6.7 AxisYTitle (for IsChart)

- ▷ `AxisYTitle(arg)` (attribute)
 - Returns:** `IsString` with the title of the object
 - This title is used to display the Y Axis Title in the client implementation.

4.6.8 AxisYTitle (for IsChart)

▷ `AxisYTitle(arg1)` (function)

4.6.9 SetAxisYTitle (for IsChart, IsString)

▷ `SetAxisYTitle(IsChart, IsString)` (function)

This title is used to display the Y Axis Title in the client implementation.

4.6.10 AxisXDomain (for IsChart)

▷ `AxisXDomain(arg)` (attribute)

Returns: `IsList`

This is the domain of the X Axis values in the client implementation.

4.6.11 AxisXDomain (for IsChart)

▷ `AxisXDomain(arg1)` (function)

4.6.12 SetAxisXDomain (for IsChart, IsList)

▷ `SetAxisXDomain(IsList, IsList)` (function)

This is the domain of the X Axis values in the client implementation.

Chapter 5

Francy Core

Francy is responsible for generating JSON metadata which allows external tools / libraries / frameworks to add a visual representation. This JSON representation defines the contract between this package (server) and a GUI framework (client), this enables complete SoC (Separation of Concerns). Francy can be used to provide a graphical interactive environment on existing GAP packages.

A JSON schema is present and can be used to produce clients for this package. *See [schema/francy.json](#)*

To map required / optional attributes from the schema into GAP code, the implementation follows the following criteria:

- Object creation requests mandatory attributes, i.e. required with no default value, e.g. `canvas:=Canvas("Title")`
- Object creation accepts an object of defaults, i.e. default values for mandatory fields but that might repeat throughout the creation of multiple similar objects, e.g. `defaults:=DefaultCanvas; defaults!.zoomToFit:=false; canvas:=Canvas("Title",defaults);` Where `DefaultCanvas` contains defaults for width (800) and height (600)
- Attributes associated with the object that can be set, i.e. optional with no defaults, e.g. `canvas:=Canvas("Title"); SetTexTypesetting(canvas,true);`

The API follows a common convention and adding objects to other objects is done using `Add(objectHolder,object)`

Although Francy has the concept of a Graph, it does not implement any Mathematics Graphs Theory.

Please see Francy-JS for client implementation.

5.1 Categories

In this section we show the Francy Core Categories.

5.1.1 IsFrancyObject (for IsObject)

- ▷ `IsFrancyObject(arg)` (filter)
Returns: true or false
Identifies all Objects in Francy.

5.1.2 IsFrancyDefaultObject (for IsObject)

- ▷ `IsFrancyDefaultObject(arg)` (filter)
Returns: true or false
Identifies all Default records in Francy.

5.1.3 IsFrancyTypeObject (for IsObject)

- ▷ `IsFrancyTypeObject(arg)` (filter)
Returns: true or false
Identifies all Type records in Francy.

5.2 Families

In this section we show the Francy Core Families.

5.3 Global

In this section we show the Francy Core Types

5.4 Attributes

In this section we show the Francy Core Attributes

5.4.1 FrancyId (for IsFrancyObject)

- ▷ `FrancyId(arg)` (attribute)
Returns: `IsString` with the id of the object
All Objects created in Francy have a generated identifier.

5.4.2 FrancyId (for IsFrancyObject)

- ▷ `FrancyId(arg1)` (function)
Returns: `IsString` with the id of the object
Prints the object unique identifier.

5.4.3 SetFrancyId (for IsFrancyObject, IsString)

- ▷ `SetFrancyId(o, s)` (function)

Use with care! Changing the unique ID might be useful in certain cases, but bare in mind it might cause unexpected behavior if you're not sure about!

Chapter 6

Francy Graphs

It is possible to build Graphs, direct or indirect.

Please see examples section.

Please see Francy-JS for client implementation.

6.1 Categories

In this section we show the Francy Graph Categories.

6.1.1 IsFrancyGraph (for IsFrancyObject)

- ▷ `IsFrancyGraph(arg)` (filter)
Returns: true or false
Identifies Graph objects.

6.1.2 IsFrancyGraphType (for IsFrancyObject)

- ▷ `IsFrancyGraphType(arg)` (filter)
Returns: true or false
Identifies GraphType objects.

6.1.3 IsFrancyGraphDefaults (for IsFrancyDefaultObject)

- ▷ `IsFrancyGraphDefaults(arg)` (filter)
Returns: true or false
Identifies GraphDefaults objects.

6.1.4 IsShape (for IsFrancyObject)

- ▷ `IsShape(arg)` (filter)
Returns: true or false
Identifies Shape objects.

6.1.5 IsShapeType (for IsFrancyObject)

- ▷ `IsShapeType(arg)` (filter)
Returns: true or false
Identifies ShapeType objects.

6.1.6 IsShapeDefaults (for IsFrancyDefaultObject)

- ▷ `IsShapeDefaults(arg)` (filter)
Returns: true or false
Identifies ShapeDefaults objects.

6.1.7 IsLink (for IsFrancyObject)

- ▷ `IsLink(arg)` (filter)
Returns: true or false
Identifies Link objects.

6.1.8 IsLinkDefaults (for IsFrancyDefaultObject)

- ▷ `IsLinkDefaults(arg)` (filter)
Returns: true or false
Identifies LinkDefaults objects.

6.2 Families

In this section we show the Francy Graph Families.

6.3 Representations

In this section we show the Francy Graph Representations.

6.3.1 IsFrancyGraphRep (for IsComponentObjectRep)

- ▷ `IsFrancyGraphRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a Graph internal representation.

6.3.2 IsFrancyGraphDefaultsRep (for IsComponentObjectRep)

- ▷ `IsFrancyGraphDefaultsRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a GraphDefaults internal representation.

6.3.3 IsFrancyGraphTypeRep (for IsComponentObjectRep)

- ▷ `IsFrancyGraphTypeRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a GraphType internal representation.

6.3.4 IsShapeRep (for IsComponentObjectRep)

- ▷ `IsShapeRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a Shape internal representation.

6.3.5 IsShapeDefaultsRep (for IsComponentObjectRep)

- ▷ `IsShapeDefaultsRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a ShapeDeafults internal representation.

6.3.6 IsShapeTypeRep (for IsComponentObjectRep)

- ▷ `IsShapeTypeRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a ShapeType internal representation.

6.3.7 IsLinkRep (for IsComponentObjectRep)

- ▷ `IsLinkRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a Link internal representation.

6.3.8 IsLinkDefaultsRep (for IsComponentObjectRep)

- ▷ `IsLinkDefaultsRep(arg)` (filter)
Returns: true or false
 Checks whether an Object has a LinkDeafults internal representation.

6.4 Operations

In this section we show the Francy Graph Operations.

6.4.1 Graph (for IsFrancyGraphType, IsFrancyGraphDefaults)

- ▷ `Graph(IsFrancyGraphType[, IsFrancyGraphDefaults])` (operation)
Returns: Graph
 Every object to draw will be a subclass of this object. This will allow all the objects to contain the same base information.
 Examples:
 Create a simple Graph of type GraphType.DIRECTED and simple Shapes connected with Links:

Example

```
gap> graph := Graph(GraphType.DIRECTED);
gap> SetSimulation(graph, false);
gap> shape1 := Shape(ShapeType.SQUARE);
gap> shape1!.layer := 1;
gap> shape2 := Shape(ShapeType.TRIANGLE);
gap> shape2!.layer := 3;
gap> link := Link(shape1, shape2);
gap> Add(graph, link);
gap> Add(graph, [shape1, shape2]);
```

Create a simple Graph of type `GraphType.UNDIRECTED` and a simple Shape with a `TriggerEvent.RIGHT_CLICK` Callback:

Example

```
gap> graph := Graph(GraphType.UNDIRECTED);
gap> shape := Shape(ShapeType.SQUARE);
gap> MyFunction := function() Add(graph, Shape(ShapeType.Circle)); return graph; end;
gap> callback := Callback(TriggerType.RIGHT_CLICK, MyFunction);
gap> Add(shape, callback);
gap> Add(graph, shape);
```

6.4.2 UnsetNodes (for IsFrancyGraph)

▷ `UnsetNodes(arg)` (operation)

Removes all nodes from gaph

6.4.3 UnsetLinks (for IsFrancyGraph)

▷ `UnsetLinks(arg)` (operation)

Removes all nodes from gaph

6.4.4 Add (for IsFrancyGraph, IsLink)

▷ `Add(IsFrancyGraph[, IsLink, List(IsLink)])` (operation)

Returns: Graph

Add `IsLink` to a specific Graph.

6.4.5 Remove (for IsFrancyGraph, IsLink)

▷ `Remove(IsFrancyGraph[, IsLink, List(IsLink)])` (operation)

Returns: Graph

Remove `IsLink` from a specific Graph.

6.4.6 Add (for IsFrancyGraph, IsShape)

▷ `Add(IsFrancyGraph[, IsShape, List(IsShape)])` (operation)

Returns: Graph

Add `IsShape` to a specific Graph.

6.4.7 Remove (for IsFrancyGraph, IsShape)

- ▷ `Remove(IsFrancyGraph[, IsShape, List(IsShape)])` (operation)
Returns: Graph
 Remove IsShape from a specific Graph.

6.4.8 Shape (for IsShapeType, IsString, IsShapeDefaults)

- ▷ `Shape(IsShapeType[, IsString(title), IsShapeDefaults])` (operation)
Returns: Shape
 Every object to draw will be a subclass of this object. This will allow all the objects to contain the same base information.

6.4.9 GetShape (for IsFrancyGraph, IsString)

- ▷ `GetShape(IsFrancyGraph, IsString)` (operation)
Returns: Shape
 Gets a Shape node from a graph by ID.

6.4.10 GetShapes (for IsFrancyGraph)

- ▷ `GetShapes(IsFrancyGraph, IsString)` (operation)
Returns: List(Shape)
 Gets a Shape node from a graph by ID.

6.4.11 Add (for IsShape, IsMenu)

- ▷ `Add(IsShape[, IsMenu, List(IsMenu)])` (operation)
Returns: Shape
 Add Menu to a specific Shape.

6.4.12 Remove (for IsShape, IsMenu)

- ▷ `Remove(IsShape[, IsMenu, List(IsMenu)])` (operation)
Returns: Shape
 Remove Menu from a specific Shape.

6.4.13 Add (for IsShape, IsCallback)

- ▷ `Add(IsShape[, IsCallback, List(IsCallback)])` (operation)
Returns: Shape
 Add Callback to a specific Shape.

6.4.14 Remove (for IsShape, IsCallback)

- ▷ `Remove(IsShape[, IsCallback, List(IsCallback)])` (operation)
Returns: Shape
 Remove Callback from a specific Shape.

6.4.15 Add (for IsShape, IsFrancyMessage)

- ▷ `Add(IsShape[, IsFrancyMessage, List(IsFrancyMessage)])` (operation)
Returns: Shape
Add Callback to a specific Shape.

6.4.16 Remove (for IsShape, IsFrancyMessage)

- ▷ `Remove(IsShape[, IsFrancyMessage, List(IsFrancyMessage)])` (operation)
Returns: Shape
Remove Callback from a specific Shape.

6.4.17 Link (for IsShape, IsShape, IsLinkDefaults)

- ▷ `Link(IsShape, IsShape)` (operation)
Returns: Link
Creates a Link between the two Shape.

6.4.18 Links (for IsList, IsList, IsLinkDefaults)

- ▷ `Links(List(IsShape), List(IsShape))` (operation)
Returns: List(Link)
Creates a Link between the Shape of the first list and the second list.

6.4.19 GetLink (for IsFrancyGraph, IsString)

- ▷ `GetLink(IsFrancyGraph, IsString)` (operation)
Returns: Link
Gets a Link from a graph by ID.

6.4.20 GetLinks (for IsFrancyGraph)

- ▷ `GetLinks(IsFrancyGraph, IsString)` (operation)
Returns: List(Link)
Gets a Link from a graph.

6.5 Global

In this section we show the Global Callback Francy Records for multi purpose.

6.6 Attributes

In this section we show the Francy Core Attributes

6.6.1 Title (for IsShape)

▷ `Title(arg)` (attribute)

Returns: `IsString` with the title of the object

Sets the title on the Shape. Supports LaTeX syntax that gets translated, if enabled on the client.

6.6.2 Title (for IsShape)

▷ `Title(arg1)` (function)

6.6.3 SetTitle (for IsShape, IsString)

▷ `SetTitle(IsRequiredArg, IsString)` (function)

Sets the title of the Shape.

6.6.4 Color (for IsShape)

▷ `Color(arg)` (attribute)

Returns: `IsInt`

The Color of the current shape.

6.6.5 Color (for IsShape)

▷ `Color(arg1)` (function)

6.6.6 SetColor (for IsShape, IsString)

▷ `SetColor(IsShape, IsString)` (function)

Sets the Color value.

6.6.7 PosX (for IsShape)

▷ `PosX(arg)` (attribute)

Returns: `IsInt`

The Position in the X Axis of the Shape in the Canvas in pixels

6.6.8 PosX (for IsShape)

▷ `PosX(arg1)` (function)

6.6.9 SetPosX (for IsShape, IsInt)

▷ `SetPosX(IsShape, IsInt)` (function)

Sets the Position in the X Axis of the Shape in the Canvas in pixels

6.6.10 PosY (for IsShape)

▷ `PosY(arg)` (attribute)

Returns: `IsInt`

The Position in the Y Axis of the Shape in the Canvas in pixels

6.6.11 PosY (for IsShape)

▷ `PosY(arg1)` (function)

6.6.12 SetPosY (for IsShape, IsInt)

▷ `SetPosY(IsShape, IsInt)` (function)

Sets the Position in the Y Axis of the Shape in the Canvas in pixels

6.6.13 Size (for IsShape)

▷ `Size(arg)` (attribute)

Returns: `IsPosInt`

The Size of the Shape

6.6.14 Size (for IsShape)

▷ `Size(arg1)` (function)

6.6.15 SetSize (for IsShape, IsPosInt)

▷ `SetSize(IsShape, IsPosInt)` (function)

Sets the Size of the Shape

6.6.16 Layer (for IsShape)

▷ `Layer(arg)` (attribute)

Returns: `IsInt`

The Layer in which the node will be placed. This property is also used to apply a color based on a scale

6.6.17 Layer (for IsShape)

▷ `Layer(arg1)` (function)

6.6.18 SetLayer (for IsShape, IsInt)

▷ `SetLayer(IsShape, IsInt)` (function)

Sets the Layer number.

6.6.19 ParentShape (for IsShape)

▷ `ParentShape(arg)` (attribute)

Returns: `IsShape`

The `ParentShape` in which the node will be placed. This property is also used to apply a color based on a scale

6.6.20 ParentShape (for IsShape)

▷ `ParentShape(arg1)` (function)

6.6.21 SetParentShape (for IsShape, IsShape)

▷ `SetParentShape(IsShape, IsShape)` (function)

Sets the `ParentShape`.

6.6.22 Simulation (for IsFrancyGraph)

▷ `Simulation(arg)` (attribute)

Returns: `IsBool` True if enabled otherwise False

`Simulation` is a property that sets the simulation behavior by applying forces to organize the graphics, without the need to provide custom positions, in the client implementation.

6.6.23 Simulation (for IsFrancyGraph)

▷ `Simulation(arg1)` (function)

6.6.24 SetSimulation (for IsFrancyGraph, IsBool)

▷ `SetSimulation(IsCanvas, IsBool)` (function)

Sets the `Simulation` behavior.

6.6.25 Collapsed (for IsFrancyGraph)

▷ `Collapsed(arg)` (attribute)

Returns: `IsBool` True if enabled otherwise False

`Collapsed` is a property that sets to collapsed the graphic structure by default

6.6.26 Collapsed (for IsFrancyGraph)

▷ `Collapsed(arg1)` (function)

6.6.27 SetCollapsed (for IsFrancyGraph, IsBool)

▷ `SetCollapsed(IsCanvas, IsBool)` (function)

Sets the `Collapsed` behavior.

6.6.28 Selected (for IsShape)

▷ `Selected(arg)` (attribute)

Returns: `IsBool` True if enabled otherwise False

`Collapsed` is a property that sets to collapsed the graphic structure by default

6.6.29 Selected (for IsShape)

▷ `Selected(arg1)` (function)

6.6.30 SetSelected (for IsShape, IsBool)

▷ `SetSelected(IsCanvas, IsBool)` (function)

Sets the `Collapsed` behavior.

6.6.31 ConjugateId (for IsShape)

▷ `ConjugateId(arg)` (attribute)

Returns: `IsBool` True if enabled otherwise False

`Collapsed` is a property that sets to collapsed the graphic structure by default

6.6.32 ConjugateId (for IsShape)

▷ `ConjugateId(arg1)` (function)

6.6.33 SetConjugateId (for IsShape, IsInt)

▷ `SetConjugateId(IsCanvas, IsBool)` (function)

Sets the Collapsed behavior.

6.6.34 Weight (for IsLink)

▷ `Weight(arg)` (attribute)

Returns: `IsInt`

The Weight of the current link.

6.6.35 Weight (for IsLink)

▷ `Weight(arg1)` (function)

6.6.36 SetWeight (for IsLink, IsInt)

▷ `SetWeight(IsLink, IsInt)` (function)

Sets the Weight value.

6.6.37 Length (for IsLink)

▷ `Length(arg)` (attribute)

Returns: `IsInt`

The Length of the current link.

6.6.38 Length (for IsLink)

▷ `Length(arg1)` (function)

6.6.39 SetLength (for IsLink, IsInt)

▷ `SetLength(IsLink, IsInt)` (function)

Sets the Length value.

6.6.40 Invisible (for IsLink)

▷ `Invisible(arg)` (attribute)

Returns: `IsBoolean`

The Invisible of the current link.

6.6.41 Invisible (for IsLink)

▷ Invisible(*arg1*) (function)

6.6.42 SetInvisible (for IsLink, IsBool)

▷ SetInvisible(*IsLink*, *IsBool*) (function)

Sets the Invisible value.

6.6.43 Color (for IsLink)

▷ Color(*arg*) (attribute)

Returns: IsInt

The Color of the current link.

6.6.44 Color (for IsLink)

▷ Color(*arg1*) (function)

6.6.45 SetColor (for IsLink, IsString)

▷ SetColor(*IsShape*, *IsString*) (function)

Sets the Color value.

6.6.46 Title (for IsLink)

▷ Title(*arg*) (attribute)

Returns: IsInt

The Title of the current link.

6.6.47 Title (for IsLink)

▷ Title(*arg1*) (function)

6.6.48 SetTitle (for IsLink, IsString)

▷ SetTitle(*IsShape*, *IsString*) (function)

Sets the Title value.

Chapter 7

Francy Menus

Menus are agregators of actions that are represented here by `Callbacks`. Menus can have `SubMenus`, and are constituted by a `Title` and a `Callback`.

Please see `Francy-JS` for client implementation.

7.1 Categories

In this section we show the Francy Menu Categories.

7.1.1 `IsMenu` (for `IsFrancyObject`)

▷ `IsMenu(arg)` (filter)
Returns: `true` or `false`
Identifies Menu objects.

7.2 Families

In this section we show the Francy Menu Families.

7.3 Representations

In this section we show the Francy Menu Representations.

7.3.1 `IsMenuRep` (for `IsComponentObjectRep`)

▷ `IsMenuRep(arg)` (filter)
Returns: `true` or `false`
Checks whether an `Object` has a Menu internal representation.

7.4 Operations

In this section we show the Francy Menu Operations.

7.4.1 Menu (for IsString, IsCallback)

▷ `Menu(IsString(title)[, IsCallback])` (operation)

Returns: Menu

Creates a Menu for a Callback Is up to the client implementation to sort out the Menu and invoke the Callback

7.4.2 Add (for IsMenu, IsMenu)

▷ `Add(IsMenu[, IsMenu, List(IsMenu)])` (operation)

Returns: Menu

Add Menu to a specific Menu creating a Submenu. Is up to the client implementation to handle this.

7.4.3 Remove (for IsMenu, IsMenu)

▷ `Remove(IsMenu[, IsMenu, List(IsMenu)])` (operation)

Returns: Menu

Remove Menu from a specific Menu. The client should be able to handle this.

7.5 Attributes

In this section we show the Francy Core Attributes

7.5.1 Title (for IsMenu)

▷ `Title(arg)` (attribute)

Returns: IsString with the title of the object

A title on a Menu is used to identify the menu entry.

7.5.2 Title (for IsMenu)

▷ `Title(arg1)` (function)

7.5.3 SetTitle (for IsMenu, IsString)

▷ `SetTitle(IsMenu, IsString)` (function)

Sets the title of the Menu.

Chapter 8

Francy Messages

FrancyMessage is an object that holds a message.

These messages can be used to provide information to users in the form of SUCCESS, INFO, WARNING, ERROR. Please see Francy-JS for client implementation.

8.1 Categories

In this section we show the Francy FrancyMessage Categories.

8.1.1 IsFrancyMessage (for IsFrancyObject)

- ▷ IsFrancyMessage(*arg*) (filter)
Returns: true or false
Identifies FrancyMessage objects.

8.1.2 IsFrancyMessageType (for IsFrancyObject)

- ▷ IsFrancyMessageType(*arg*) (filter)
Returns: true or false
Identifies MessageType objects.

8.2 Families

In this section we show the Francy FrancyMessage Families.

8.3 Representations

In this section we show the Francy FrancyMessage Representations.

8.3.1 IsFrancyMessageRep (for IsComponentObjectRep)

- ▷ IsFrancyMessageRep(*arg*) (filter)
Returns: true or false
Checks whether an Object has a FrancyMessage internal representation.

8.3.2 IsFrancyMessageTypeRep (for IsComponentObjectRep)

- ▷ `IsFrancyMessageTypeRep(arg)` (filter)
Returns: true or false
Checks whether an Object has a FrancyMessage internal representation.

8.4 Operations

In this section we show the Francy FrancyMessage Operations.

8.4.1 FrancyMessage (for IsFrancyMessageType, IsString, IsString)

- ▷ `FrancyMessage(IsString, IsString)` (operation)
Returns: FrancyMessage
Adds an info label with the format label: value

8.5 Global

In this section we show the Global Callback Francy Records for multi purpose.

8.6 Attributes

In this section we show the Francy Core Attributes

8.6.1 Title (for IsFrancyMessage)

- ▷ `Title(arg)` (attribute)
Returns: IsString with the title of the object
A title on a FrancyMessage is used to display the title information to the user.

8.6.2 Title (for IsFrancyMessage)

- ▷ `Title(arg1)` (function)

8.6.3 SetTitle (for IsFrancyMessage, IsString)

- ▷ `SetTitle(IsFrancyMessage, IsString)` (function)
Sets the title of the FrancyMessage.

8.6.4 Value (for IsFrancyMessage)

- ▷ `Value(arg)` (attribute)
Returns: IsString with the title of the object
A value on a FrancyMessage is used to display the information to the user.

8.6.5 Value (for IsFrancyMessage)

▷ `Value(arg1)` (function)

8.6.6 SetValue (for IsFrancyMessage, IsString)

▷ `SetValue(IsFrancyMessage, IsString)` (function)

Sets the actual message of the `FrancyMessage`.

Chapter 9

Francy Util

9.1 Operations

In this section we show the Francy Util Operations. Contains utility methods to handle Object printing/viewing, Sanitizing, etc.

9.1.1 JUPYTER_ViewString (for IsObject)

▷ `JUPYTER_ViewString(arg)` (operation)

Returns: `String`

This method will pretty print in jupyter environment.

9.1.2 Sanitize (for IsObject)

▷ `Sanitize(IsObject)` (operation)

Returns: `rec`

This method will clone a `Object` and return a sanitized record, traversing all the components and sanitizing when appropriate. Sanitizing in this context means, replace everything with it's string representation that can't be converted into JSON!

9.1.3 MergeObjects (for IsFrancyObject, IsFrancyObject)

▷ `MergeObjects(IsFrancyObject, IsFrancyObject)` (operation)

Returns: `rec`

This method will merge the properties of 2 `IsFrancyObjects` into one `rec`.

9.1.4 GenerateID

▷ `GenerateID()` (operation)

Returns: `IsString`

This method will generate a sequential ID for use as object identifier.

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