

# JupyterKernel

Jupyter kernel written in GAP

1.5.1

7 July 2024

**Markus Pfeiffer**

**Manuel Martins**

**Markus Pfeiffer**

Email: [markus.pfeiffer@morphism.de](mailto:markus.pfeiffer@morphism.de)

Homepage: <https://markusp.morphism.de/>

Address: School of Computer Science  
North Haugh  
St Andrews  
Fife  
KY16 9SX  
Scotland

**Manuel Martins**

Email: [manuelmachadomartins@gmail.com](mailto:manuelmachadomartins@gmail.com)

Homepage: <https://github.com/mcmartins>

# Contents

<b>1</b>	<b>Introduction</b>	<b>3</b>
1.1	GAP Jupyter Kernel . . . . .	3
1.2	Installation . . . . .	3
1.3	How it works . . . . .	4
1.4	Code Highlighting and Indentation . . . . .	4
1.5	Known Limitations and Caveats . . . . .	4
1.6	Feedback . . . . .	5
<b>2</b>	<b>Jupyter Kernel</b>	<b>6</b>
2.1	Functions . . . . .	6
<b>3</b>	<b>Jupyter Renderables</b>	<b>7</b>
3.1	Handlers for Jupyter requests . . . . .	7
<b>4</b>	<b>Jupyter Utility Functions</b>	<b>9</b>
4.1	Functions . . . . .	9
4.2	Additional Utility Functions . . . . .	9
	<b>Index</b>	<b>10</b>

# Chapter 1

## Introduction

### 1.1 GAP Jupyter Kernel

This package provides a so-called *kernel* for the [Jupyter](#) interactive document system. This kernel is implemented in GAP.

### 1.2 Installation

This package requires [Jupyter](#) to be installed on your system, which on most Python installations can be achieved by issuing the following command.

Example

```
> pip install --user notebook
```

Further instructions can be found at <https://jupyter.org/install>. This package requires the GAP packages IO, uuid, ZeroMQInterface, crypting, and json, all of which are distributed with GAP, and some of which require compilation. To compile ZeroMQInterface you need to install [ZeroMQ](#), for details please refer to the [ZeroMQInterface manual](#). JupyterKernel itself does not contain any kernel code that needs to be compiled. It is necessary to register JupyterKernel with your [Jupyter](#) installation. Registering the GAP jupyter kernel system-wide works as follows:

Example

```
> pip install .
```

or registering for your user only

Example

```
> pip install . --user
```

If GAP is not in your PATH, then you have to set the environment variable JUPYTER\_GAP\_EXECUTABLE to point to your GAP executable for [Jupyter](#) to be able to execute GAP, and the script jupyter-kernel-gap that is distributed with this package in the directory bin/ needs to be in your path. To start [Jupyter](#) run:

Example

```
> jupyter notebook
```

Then JupyterKernel should show up in your [Jupyter](#) installation as "GAP 4".

## 1.3 How it works

### 1.3.1 Kernel Startup

This section gives a short explanation how the process of executing GAP as a kernel by Jupyter works to help with debugging issues. Jupyter registers kernels using json files in various directories. You can list which kernel specifications are installed by executing the following command

Example

```
> jupyter kernelspec list
Available kernels:
python2          /usr/local/lib/python2.7/site-packages/ipykernel/resources
gap-4            /usr/local/share/jupyter/kernels/gap-4
```

If there is no line containing the gap-4 kernel, something went wrong with setup.py. You can try to manually install the file kernel.json which is in the etc directory of the JupyterKernel package by copying it. Better yet, you should report this issue on the issue tracker giving which operating system you are using, your version of Jupyter and GAP, and which commands you tried to execute. What happens when Jupyter wants to start a GAP kernel is that it tries to execute the small script jupyter-kernel-gap (which is distributed with the JupyterKernel package), which in turn executes GAP, loading the package and then running the kernel. This script currently has to be in your PATH environment variable, too.

### 1.3.2 Kernel operation

The communication between the Jupyter frontend and GAP happens through ZeroMQ streams as documented [here](#), encoded as JSON dicts. After entering code into a cell and instructing Jupyter to execute that code, the jupyter frontend sends the code to the GAP session where it is executed by using the GAP function READ\_ALL\_COMMANDS, resulting values of the execution are rendered using ViewString and sent back to the Jupyter frontend. In principle, rich rendering of content, as exemplified in the function JUPYTER\_DotSplash is possible. Tab-completion is handled by the GAP function JUPYTER\_completion, and inspection is handled by JUPYTER\_Inspect. Changing these functions, one can change the behaviour of Tab-completion and inspection to improve user experience.

## 1.4 Code Highlighting and Indentation

JupyterKernel provides a GAP mode with code highlighting and indentation. This mode is installed as a notebook extension and registers 'text/x-gap' as a MIME type.

## 1.5 Known Limitations and Caveats

Currently the support of the GAP system for alternative frontends is a work in progress. In particular, certain outputs that are printed by GAP cannot be captured by the Jupyter frontend and will not show up. At current, the output of the function Exec (**Reference: Exec**) will print output in the terminal, rather than the Jupyter notebook it is currently executing in. Some objects are also not JupyterRenderable (3.1.3), and as such are not working in the current version of JupyterKernel. The function LogTo (**Reference: LogTo**) does also currently not work in the current version of

JupyterKernel. The variables `last`, `last2` and `last3` (see **Reference: Main Loop**) are also unsupported in the current version. If you happen to notice problems of this kind, feel free to report them on the [issue tracker](#). or suggest a solution via a pull-request.

## 1.6 Feedback

For bug reports, feature requests and suggestions, please use our [issue tracker](#).

## Chapter 2

# Jupyter Kernel

A Jupyter Kernel is an object that can handles the Jupyter Protocol.

### 2.1 Functions

#### 2.1.1 JUPYTER\_LogProtocol

▷ `JUPYTER_LogProtocol(filename)` (function)

Opens a file that is used to log all jupyter protocol messages.

#### 2.1.2 JUPYTER\_UnlogProtocol

▷ `JUPYTER_UnlogProtocol(arg)` (function)

Closes the protocol log.

## Chapter 3

# Jupyter Renderables

A `JupyterRenderable` is an object that can be rendered by Jupyter. `JupyterRenderables` are component object that have to contain at least the components data and metadata.

These components are themselves GAP records which can contain different representations of an object to be rendered. The record component name is the MIME-Type of the representation and the content is the representation itself.

Example

```
render := JupyterRenderable(
  rec( text/plain := "Integers",
        text/html := "$\mathbb{Z}$" )
  , rec( ) );

render2 := JupyterRenderable(
  rec( "image/svg+xml" := "<svg></svg>"
        , rec( "image/svg+xml" := rec( width := 500, height := 500 ) ) );
```

### 3.1 Handlers for Jupyter requests

#### 3.1.1 IsJupyterRenderable (for IsObject)

▷ `IsJupyterRenderable(arg)` (filter)  
**Returns:** true or false  
JupyterRenderable

#### 3.1.2 (for IsComponentObjectRep and IsJupyterRenderable)

▷ `(arg)` (filter)  
**Returns:** true or false

#### 3.1.3 JupyterRenderable (for IsObject, IsObject)

▷ `JupyterRenderable(data, metadata)` (operation)  
**Returns:** A new JupyterRenderable  
Basic constructor for JupyterRenderable

### 3.1.4 JupyterRender (for IsObject)

▷ `JupyterRender(arg)` (operation)

Method that provides rich viewing experience if code used inside Jupyter

### 3.1.5 JupyterRenderableData (for IsJupyterRenderable)

▷ `JupyterRenderableData(arg)` (attribute)

Accessor for data in a JupyterRenderable

### 3.1.6 JupyterRenderableMetadata (for IsJupyterRenderable)

▷ `JupyterRenderableMetadata(arg)` (attribute)

Accessor for metadata in a JupyterRenderable



## Chapter 4

# Jupyter Utility Functions

### 4.1 Functions

#### 4.1.1 JUPYTER\_print

▷ `JUPYTER_print(arg)` (function)

Jupyter printing

#### 4.1.2 JUPYTER\_Complete

▷ `JUPYTER_Complete(arg)` (function)

This function is called when the user presses Tab in a code cell and produces a list of possible completions. It is passed the current code in the cell, and the cursor position inside the code.

### 4.2 Additional Utility Functions

#### 4.2.1 ISO8601Stamp

▷ `ISO8601Stamp(arg)` (function)

Current date and time as ISO8601 timestamp. Don't trust this function.

# Index

IsJupyterRenderable  
    for IsObject, [7](#)  
ISO8601Stamp, [9](#)  
  
JupyterRender  
    for IsObject, [8](#)  
JupyterRenderable  
    for IsObject, IsObject, [7](#)  
JupyterRenderableData  
    for IsJupyterRenderable, [8](#)  
JupyterRenderableMetadata  
    for IsJupyterRenderable, [8](#)  
JUPYTER\_Complete, [9](#)  
JUPYTER\_LogProtocol, [6](#)  
JUPYTER\_print, [9](#)  
JUPYTER\_UnlogProtocol, [6](#)