A Brief Introduction to λ-calculas

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How to express a function ?

Usually we define a function like this:

$$f(x, y) = x - y$$

$$g(x) = e^x$$

Then use it like this:

$$f(5, 1) = 5 - 1 = 4$$

$$g(0) = e^0 = 1$$

Is the name of a function so important ?

We can define the two functions: $f(x, y) = x - y$ and $g(x) = e^x$ like this:

$$(x, y \to x - y)$$

$$(x \to e^x)$$

and use them like this:

$$(x, y \to x - y)(5, 1) = 5 - 1 = 4$$

$$(x \to e^x)(1) = e$$

Is the ability to define functions with more than one parament necessary?

For function:

$$f(x, y) = x - y$$

We can also define a function like this:

$$(x \to (y \to x - y))$$

The function map x to another function ,which maps y to x - y.
(Now we can see the power to write the function itself as the name of it)

We call $(x \to x - 1)$ an **anonymous function**.

And the method that using

$$(x \to (y \to x - y))$$

to replace the function

$$f(x, y) = x - y$$

is called **Currying**

Let's see the formal definition of λ-calculus

Definition(λ-terms)

Assume there is a sequence of expressions $v_0, v_{00}, v_{000}, \ldots$ called **variables**. The set of expression called λ**-terms** is defined as follows:

- all variables are λ-terms (called **atoms**);
- if M and N are any λ-terms, then (MN) is a λ-term (called an **Application**);
- if M is any λ-term and x is any variable, then $(\lambda x.M)$ is a λ-term (called an **Abstraction**).

Examples of λ-term

If x, y, z are any distinc variables, the following are λ-terms:

1. $(\lambda v_0.(v_0 v_{00}))$
2. $(\lambda x.(xy))$
3. $(x(\lambda x.(\lambda x.x)))$
4. $((\lambda y.y)(\lambda x.(xy)))$
5. $(\lambda x.(yz))$

For simplicity, we omit some unnecessary parentheses.

Original expressions	Shorter expressions
$(\lambda x.(\lambda y.(((yx)a)b)))$	$\lambda x.\lambda y.yxab$
$(((\lambda x.(\lambda y.(yx)))a)b)$	$(\lambda x.\lambda y.yx)ab$
$(\lambda x.(\lambda y.((ab)(\lambda z.z))))$	$\lambda x.\lambda y.ab\lambda z.z$

Introducing Gaia theme

Marp's new slide theme

Created by Yuki Hattori (@yhatt)

> In Greek mythology, **Gaia** also spelled **Gaea**, was the personification of the Earth and one of the Greek primordial deities.
>
> -- *Gaia (mythology) - Wikipedia, the free encyclopedia*

Overview

Gaia is the beautiful presentation theme on Marp!

- **New features**
  1. Title Slides
  2. Highlight
  3. Color scheme

How to use

From menu

Select menu: *View* ➡️ *Theme* ➡️ *Gaia*

Use directive

Set `gaia` theme by `$theme` Global Directive.

```
<!-- $theme: gaia -->
```

Basic example 1

Lorem ipsum dolor *sit* amet, ***consectetur*** adipiscing elit, sed do `eiusmod` tempor incididunt ut labore et dolore ~~magna aliqua~~. 😄

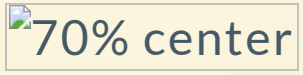
> Stay Hungry. Stay Foolish. *--Steve Jobs (2005)*

- List A
  1. Sub list
  2. Sub list
     - *More Sub list*

Basic example 2

```
document.write('Hello, world!');
```

table	layout	example
align to left	align to center	align to right
⬅ left	⬅ center ➡	right ➡



Introduce new features!!

1. Title Slides

e.g. This page 😋

Apply centering to the page that has only headings!

Useful to title slide. 😆

“ **Tips:**
Apply vertical centering to quote only page too. ”

2. Highlight

Highlight Markup

You can use `==` for highlighting blue.

```
==This is highlight markup.==
```

Notice

Marp would show yellow marker highlight in Markdown view or default slide theme.

3. Color scheme templates

Color scheme templates

Change color scheme *by* `template` *page directive.*

```
<!-- template: default -->
```

- **Default** ⬅️ This page
- Invert
- Gaia (Theme color)

Hello,world

this is bria

$$\sum_{i=1}^{n} i$$

Color scheme templates

Change color scheme *by* `template` *page directive.*

```
<!-- template: invert -->
```

- Default
- **Invert** ⬅️ This page
- Gaia (Theme color)

Color scheme templates

Change color scheme *by* `template` *page directive.*

```
<!-- template: gaia -->
```

- Default
- Invert
- **Gaia** (Theme color) ⬅ This page

Templates can use to per pages!

with using temporally page directive

```
<!-- *template: invert -->
```

That's all!

Let's create beautiful slides with Marp + Gaia theme!

`<!-- $theme: gaia -->` of Marp

https://yhatt.github.io/marp