



Flask

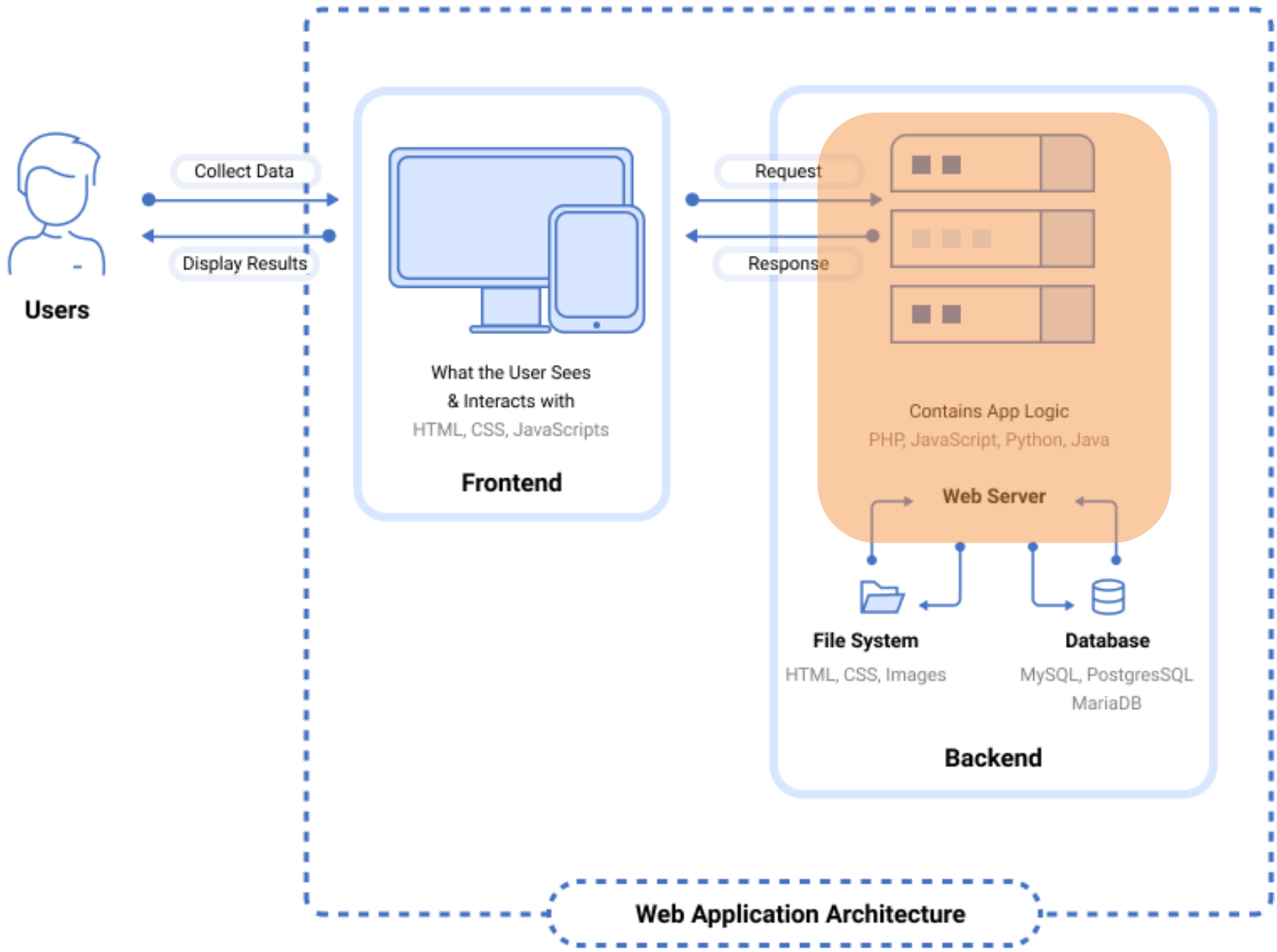
The server side

Luigi De Russis



Goal

- Create web applications
 - In Python
 - Using the learnt front-end technologies
 - On the server side
- Learn a web framework
 - Start simple, minimal
 - Extensible



Programming the Web with Python

GETTING STARTED WITH FLASK

Python meets the Web

- Python includes a `SimpleHTTPServer` to activate a web server
 - Low-level, not very friendly
- Several libraries and frameworks were developed
 - Different features and complexity
- **Flask** is one of the most popular micro-frameworks
 - Simple and easy to use



<https://wiki.python.org/moin/WebFrameworks>

Flask

- A non-full stack web framework for Python
 - Web server based on Werkzeug (WSGI toolkit, <https://werkzeug.palletsprojects.com>)
 - Application context
 - Conventions and configurations
- Include a template engine
 - Jinja, <https://jinja.palletsprojects.com/>
 - Easy editing of dynamic HTML pages
 - Powerful: operators and inheritance



Flask Resources (recap)

Project Links

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Flask

Welcome to Flask's documentation. Get started with [Installation](#) and then get an overview with the [Quickstart](#). There is also a more detailed [Tutorial](#) that shows how to create a small but complete application with Flask. Common patterns are described in the [Patterns for Flask](#) section. The rest of the docs describe each component of Flask in detail, with a full reference in the [API](#) section.

Flask depends on the Werkzeug WSGI toolkit, the Jinja template engine, and the Click CLI toolkit. Be sure to check their documentation as well as Flask's when looking for information.

User's Guide

Flask provides configuration and conventions, with sensible defaults, to get started. This section of the documentation explains the different parts of the Flask framework and how they can be used, customized, and extended. Beyond Flask itself, look for community-maintained extensions to add even more functionality.

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v. 3.0.x

O'REILLY®



Flask

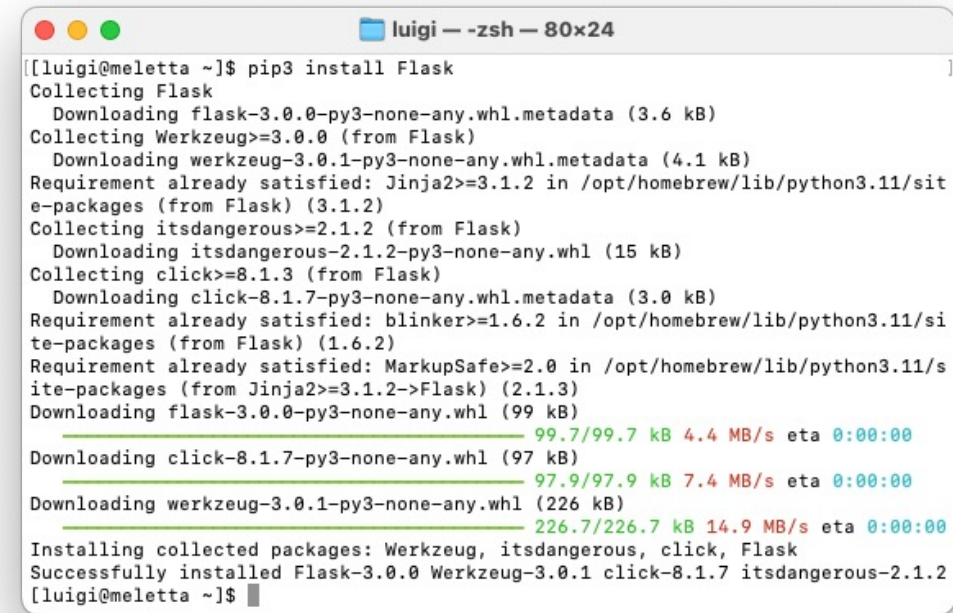
Web Development

DEVELOPING WEB APPLICATIONS WITH PYTHON

Miguel Grinberg

Installation

- Use `pip` (or `pip3`) to install Flask
 - It comes with Werkzeug and Jinja among its dependencies
 - You need Python 3.8 or *higher*
- **Option 1: system-wide installation**
`pip install Flask`



```
[[luigi@meletta ~]$ pip3 install Flask
Collecting Flask
  Downloading flask-3.0.0-py3-none-any.whl.metadata (3.6 kB)
Collecting Werkzeug>=3.0.0 (from Flask)
  Downloading werkzeug-3.0.1-py3-none-any.whl.metadata (4.1 kB)
Requirement already satisfied: Jinja2>=3.1.2 in /opt/homebrew/lib/python3.11/site-packages (from Flask) (3.1.2)
Collecting itsdangerous>=2.1.2 (from Flask)
  Downloading itsdangerous-2.1.2-py3-none-any.whl (15 kB)
Collecting click>=8.1.3 (from Flask)
  Downloading click-8.1.7-py3-none-any.whl.metadata (3.0 kB)
Requirement already satisfied: blinker>=1.6.2 in /opt/homebrew/lib/python3.11/site-packages (from Flask) (1.6.2)
Requirement already satisfied: MarkupSafe>=2.0 in /opt/homebrew/lib/python3.11/site-packages (from Jinja2>=3.1.2->Flask) (2.1.3)
Downloading flask-3.0.0-py3-none-any.whl (99 kB)
 99.7/99.7 kB 4.4 MB/s eta 0:00:00
Downloading click-8.1.7-py3-none-any.whl (97 kB)
 97.9/97.9 kB 7.4 MB/s eta 0:00:00
Downloading werkzeug-3.0.1-py3-none-any.whl (226 kB)
 226.7/226.7 kB 14.9 MB/s eta 0:00:00
Installing collected packages: Werkzeug, itsdangerous, click, Flask
Successfully installed Flask-3.0.0 Werkzeug-3.0.1 click-8.1.7 itsdangerous-2.1.2
[[luigi@meletta ~]$
```


Installation

- **Option 2:** within a virtual environment (project-specific)

```
cd myproject
```

```
python3 -m venv venv
```

```
. venv/bin/activate (on Windows: venv\Scripts\activate)
```

```
pip install Flask
```

deactivate will close
the virtual environment

```
example -- zsh -- 80x24
[[luigi@meletta Desktop]$ cd example
[[luigi@meletta example]$ python3 -m venv venv
[[luigi@meletta example]$ . venv/bin/activate
((venv) [luigi@meletta example]$ pip3 install Flask
Collecting Flask
  Using cached flask-3.0.0-py3-none-any.whl.metadata (3.6 kB)
Collecting Werkzeug>=3.0.0 (from Flask)
  Using cached werkzeug-3.0.1-py3-none-any.whl.metadata (4.1 kB)
Collecting Jinja2>=3.1.2 (from Flask)
  Using cached Jinja2-3.1.2-py3-none-any.whl (133 kB)
Collecting itsdangerous>=2.1.2 (from Flask)
  Using cached itsdangerous-2.1.2-py3-none-any.whl (15 kB)
Collecting click>=8.1.3 (from Flask)
  Using cached click-8.1.7-py3-none-any.whl.metadata (3.0 kB)
Collecting blinker>=1.6.2 (from Flask)
  Using cached blinker-1.7.0-py3-none-any.whl.metadata (1.9 kB)
Collecting MarkupSafe>=2.0 (from Jinja2>=3.1.2->Flask)
  Using cached MarkupSafe-2.1.3-cp311-cp311-macosx_10_9_universal2.whl.metadata (3.0 kB)
Using cached flask-3.0.0-py3-none-any.whl (99 kB)
Using cached blinker-1.7.0-py3-none-any.whl (13 kB)
Using cached click-8.1.7-py3-none-any.whl (97 kB)
Using cached werkzeug-3.0.1-py3-none-any.whl (226 kB)
Using cached MarkupSafe-2.1.3-cp311-cp311-macosx_10_9_universal2.whl (17 kB)
```

A Minimal Flask App

- Calling `Flask()` creates an application object **app**
- Incoming HTTP requests are routed to a function according to its **route** decorator
 - path (mandatory param), e.g., `“/”`
 - options, e.g., `“methods=[POST]”`
- The function bound to a route returns the message we want to display in the browser
 - HTML is the default content type

```
# import module
from flask import Flask

# create the application
app = Flask(__name__)

# define routes and web pages
@app.route('/')
def hello_world():
    return 'Hello, World!'
```

Flask Applications

- One Flask object represents the entire web application

```
from flask import Flask
```

```
app = Flask(__name__)
```

```
## __name__ is a shortcut for the application name
```

Routing: Decorator

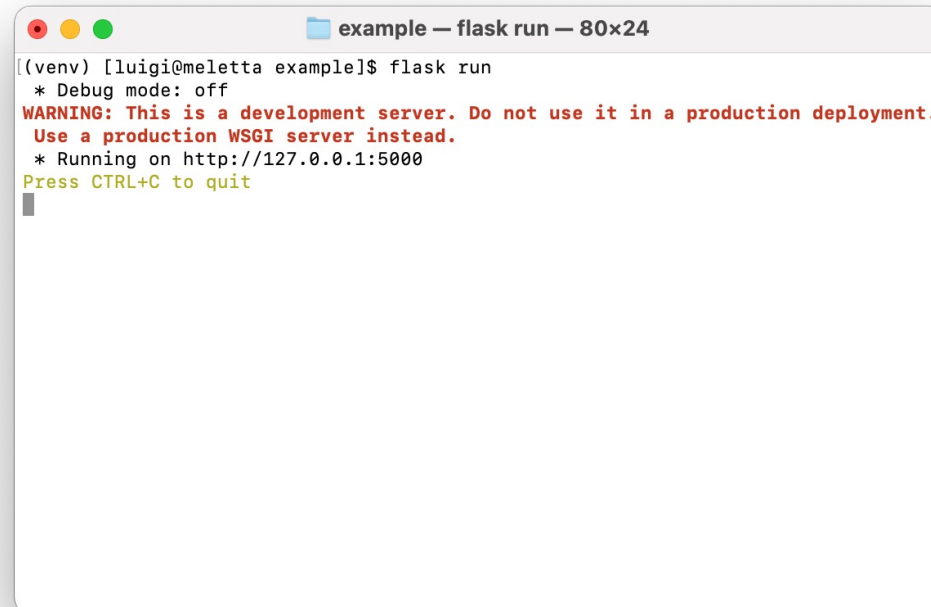
- *Almost* each web page is represented by a decorator (+ a function)
- `@app.route(path, options)`
 - **app**: the Flask object
 - **path**: a string representing a path on the server
 - Matched with the path in the HTTP Request Message
 - options: extra options such as...
 - **methods**: an array of one or more HTTP Request method (GET, POST, PUT, DELETE, ...); if omitted, the default is GET
 - **redirect_to**: a string or a function representing the target of the redirect
 - Other (less frequent) options at <https://werkzeug.palletsprojects.com/en/3.0.x/routing/#werkzeug.routing.Rule>

Routing: Function

- def `index()`:
 return 'Hello, world!'
- `index` is the `name` of the page
- The HTML `content` of the page (e.g., “Hello World”) is in the return statement
- If the decorator declares more HTTP methods, the actually called method is available in the `request.method` variable of the bound function

Running a Flask App

- To run a Flask application:
 - `flask --app main run`
 - where “main” is the name (with the path, without extension) of the Python file
 - **Shortcut:** if the file is called “app.py”, you can just type `flask run`

A terminal window titled "example - flask run - 80x24" showing the output of the command "flask run". The output includes a warning about using a development server and the URL "http://127.0.0.1:5000".

```
[(venv) [luigi@meletta example]$ flask run
* Debug mode: off
WARNING: This is a development server. Do not use it in a production deployment.
Use a production WSGI server instead.
* Running on http://127.0.0.1:5000
Press CTRL+C to quit
```

Flask's (Development) Web Server

- By default, Flask runs a web server at:
 - <http://127.0.0.1:5000/>
 - Accessible by **localhost**, only
 - Running on port 5000
 - Great for **development** and test
- It can be customized with options when launching the application (before “run”):
 - with **debug mode** enabled -> use the `--debug` option
 - **externally-visible server** -> use `--host=0.0.0.0` before “run”
 - use a different **port** -> use `--port=3000` (e.g., to use 3000 as the port)

Alternative Way to Run the Application

- Instead of the Flask CLI, you can start the development server in code

```
if __name__ == "__main__":  
    app.run(host='0.0.0.0', port=3000, debug= True)  
    # or a subset of these options
```

- NEVER use it in **production**
- Then, launch the application as a normal Python program:
python3 app.py

Running a 'Public' Web Server

- Bind to all IP addresses of your machine
 - `host='0.0.0.0'`
- Use a standard port
 - `port=80` (*must be launched as 'root'*)
 - `port=3000` (*>1024, does not require root*)
- Check the firewall, and open the host/port combination for external access

Beware hackers and intruders!

Example



/

/about.html

MangiaTO - Informazioni

Il sito è stato progettato durante il corso di Introduzione alle Applicazioni Web del Politecnico di Torino.

Questo esempio è stato creato nell'anno accademico 2023/2024.

[Torna alla home](#)

Solution 1

```
from flask import Flask
```

```
app = Flask(__name__)
```

```
@app.route('/')
```

```
def index():
```

```
    return """<html><head><title>MangiaT0 - Home</title></head>
    <body><h1>MangiaT0</h1>
    <p>Benvenuto sul sito della mensa del Politecnico di Torino.</p>
    <p></p>
    <p>&copy; <a href="about.html">Introduzione alle Applicazioni Web</a></p>
    </body></html>
    """
```

```
@app.route('/about.html')
```

```
def about():
```

```
    return """<html><head><title>MangiaT0 - Sul sito</title></head>
    <body><h1>MangiaT0 - Informazioni</h1>
    <p>Il sito &grave; stato progettato durante il corso di Introduzione alle Applicazioni Web del Politecnico di Torino.</p>
    <p>Questo esempio &grave; stato creato nell'anno accademico 2023/2024.</p>
    <p><a href="/">Torna alla home</a></p>
    </body></html>
    """
```

Generate URLs

- **Bad:** encode destination URL a strings! ☹️
 - Why?
- **Good:** Python generates the appropriate URL for a function!

```
url_for('<function_name>')
```

- You can use it for static files (images, CSS, ...), too

```
url_for('static', filename='image.jpg')
```

- **Beware:** the subfolder must be called “static”

Solution 2

```
from flask import Flask, url_for

app = Flask(__name__)

@app.route('/')
def index():
    return ('<html><head><title>MangiaTO - Home</title></head>' +
           '<body><h1>MangiaTO</h1>' +
           '<p>Benvenuto sul sito della mensa del Politecnico di Torino.</p>' +
           '<p></p>' +
           '<p>&copy; <a href="' + url_for('about') + '">Introduzione alle Applicazioni Web</a></p>' +
           '</body></html>')

@app.route('/about.html')
def about():
    return ('<html><head><title>MangiaTO - Sul sito</title></head>' +
           '<body><h1>MangiaTO - Informazioni</h1>' +
           '<p>Il sito &egrave; stato progettato durante il corso di Introduzione alle Applicazioni Web del Politecnico di Torino.</p>'
           +
           '<p>Questo esempio &egrave; stato creato nell'anno accademico 2023/2024.</p>' +
           '<p><a href="' + url_for('index') + '">Torna alla home</a></p>' +
           '</body></html>')
```



JINJA TEMPLATES

Templating

- Embedding HTML in Python strings is
 - Ugly
 - Error prone
 - Complex (i.e., must follow HTML escaping rules and Python quoting rules)
 - Did I say **ugly**?
- **Templating** comes to help
 - separating the (fixed) structure of the HTML text (template) from the variable parts (interpolated Python variables)
- Flask supports the **Jinja** templating engine out of the box

Jinja Basics

- Flask looks for templates in the `./templates` subfolder
- Templates are HTML files, with `.html` extension
- Templates can interpolate **passed-by values**:
 - `{{ parameter }}`, `{{ expression }}`
- Templates can include **programming statements**:
 - `{% statement %}`
- Templates can have **comments** (not included in the final output):
 - `{# comment #}`
- Templates can access some **implicit objects**
 - `request`, `session`, `g`
- Templates are processed when requested by the Flask page

```
return render_template('hello.html', name=name)
```


Solution 3 - app.js

```
from flask import Flask, render_template
```

```
app = Flask(__name__)
```

```
@app.route('/')
```

```
def index():
```

```
    return render_template('index.html')
```

```
@app.route('/about.html')
```

```
def about():
```

```
    return render_template('about.html')
```

Solution 3 - Templates

templates/index.html

```
<html>
  <head>
    <title>MangiaTO - Home</title>
  </head>
  <body>
    <h1>MangiaTO</h1>
    <p>Benvenuto sul sito della mensa del
    Politecnico di Torino.</p>
    <p>
      
    </p>
    <p>&copy; <a href="{{ url_for('about')
    }}">Introduzione alle Applicazioni Web</a></p>
  </body>
</html>
```

templates/about.html

```
<html>
  <head>
    <title>MangiaTO - Sul sito</title>
  </head>
  <body>
    <h1>MangiaTO - Informazioni</h1>
    <p>Il sito &grave; stato progettato durante il
    corso di Introduzione alle Applicazioni Web del
    Politecnico di Torino.</p>
    <p>Questo esempio &grave; stato creato
    nell'anno accademico 2023/2024.</p>
    <p><a href="{{ url_for('index') }}">Torna alla
    home</a></p>
  </body>
</html>
```

Jinja Main Programming Statements

- **For** – loop over items in a sequence (list, dictionary)

```
{% for variable in List %} ... {% endfor %}
```

- **If** – test a variable against a condition

```
{% if condition %} ... {% elif another_condition %}  
... {% else %} ... {% endif %}
```

Example: For Statement

app.js

```
...
@app.route('/')
def index():
    first_plates =
        [{'id': 1, 'name': 'Pasta al
tonno'},
        {'id': 2, 'name': 'Lasagne'},
        {'id': 3, 'name': 'Pasta al
sugo'}]
    return
        render_template('index.html',
            first=first_plates)
...
```

templates/index.html

```
...
<h2>Menu</h2>
<ul>
{% for plate in first %}
    <li>{{ plate.name | e }}</li>
{% endfor %}
</ul>
...
```

Escaping: if the variable **may** include any of >, <, &, or " you SHOULD escape it. If you are 100% sure that the variable contains well-formed and trusted HTML, you can skip the escaping.

Statements vs. Expressions

- A {% statement %} controls the flow of execution in a template
 - <https://jinja.palletsprojects.com/en/3.1.x/templates/>
- An {{ expression }} evaluates the variable (or the expression) and “prints” the results in the HTML file
 - <https://jinja.palletsprojects.com/en/3.1.x/templates/#expressions>

Template Inheritance

- In our examples so far, we have **duplicated** HTML code (e.g., `<html>`, part of the title)
- In more complex web applications, various pages have many common elements, for instance:
 - Navigation bar(s)
 - Footers
 - Page layout
 - ...
- Jinja has **blocks** and **template inheritance** to help
- No changes are required in the Python application file!

Main Template Inheritance Tags

- `{% block <block_name> %}...{% endblock %}`
 - Defines a block, a reusable HTML component, within a template
 - `block_name` must be unique within a given template
- `{% extends "filename.html" %}`
 - Extends a parent template so that a child template can use it
 - `filename.html` can be within the same folder of the child template or in a different one, e.g., `'layout/filename.html'`

Example - Base Template

templates/base.html

```
<!DOCTYPE html>
<html>
  <head>
    <title>MangiaTO - {% block title %}{% endblock
%}</title>
  </head>
  <body>
    {% block content %}{% endblock %}
  </body>
</html>
```


Example - Child Templates

templates/index.html

```
{% extends "base.html" %}
{% block title %}Home{% endblock %}
{% block content %}
  <h1>MangiaTO</h1>
  <p>Benvenuto sul sito della mensa del Politecnico di
  Torino.</p>
  <p>
    
  </p>
<hr/>
  <h2>Menu</h2>
  <ul>
    {% for plate in first %}
      <li>{{ plate.name | e }}</li>
    {% endfor %}
  </ul>
  <p>&copy; <a href="{{ url_for('about') }}">Introduzione
  alle Applicazioni Web</a></p>
{% endblock %}
```

templates/about.html

```
{% extends "base.html" %}
{% block title %}Sul sito{% endblock %}
{% block content %}
  <h1>MangiaTO - Informazioni</h1>
  <p>Il sito &grave; stato progettato
  durante il corso di Introduzione alle
  Applicazioni Web del Politecnico di
  Torino.</p>
  <p>Questo esempio &grave; stato creato
  nell'anno accademico 2023/2024.</p>
  <p><a href="{{ url_for('index') }}">Torna
  alla home</a></p>
{% endblock %}
```

Super Blocks

- It is possible to render the content of the parent block by calling `super()`
- For instance, if the parent template defines:

```
<head>
  {% block head %}
  <link rel="stylesheet" href="style.css" />
  <title>MangiaTO - {% block title %}{% endblock %}</title>
  {% endblock %}
</head>
```

- The child block can add its own custom CSS file with:

```
{% block title %}Sul sito{% endblock %}
{% block head %}
  {{ super() }}
  <link rel="stylesheet" href="about.css" />
{% endblock %}
```

DYNAMIC ROUTES

Dynamic Routes

- A route can be dynamic
- It can include a **<parameter>** passed as a function argument

```
@app.route('/users/<username>')  
def show_profile(username):  
    return 'User %s' % username
```

- In this example, this route will be called with /users/luigidr, /users/jpsaenz, ...
- Parameter are considered as **string** in the function

Dynamic Routes

- Parameters are considered as string in the function
- Automatic conversion is obtained by specifying the parameter type in the decorator

```
@app.route('/posts/<int:id>')  
def show_post(id):  
    return 'Post %d' % id # this is an integer
```

- Parameter type can be:
 - int, float
 - path (string that might include slashes)
 - missing (default to string)

Generating URLs With Parameters

- `url_for` accepts parameters
- Encoded as variable URLs, **if** the route is **dynamic**

```
@app.route('/users/<username>')  
def show_profile(username):  
    return 'User %s' % username
```

```
url_for('show_profile', username='luigidr')
```

```
→ /users/luigidr
```

Generating URLs With Parameters

- Instead, **if** the route is **static**, it is encoded as a GET parameters
 - Or if the route does not contain a named param

```
@app.route('/about')  
def about():  
    ...
```

```
url_for('about') → /about
```

```
url_for('about', username='luigidr')  
→ /about?username=luigidr
```

FLASK EXTENSIONS

Flask Extensions

- Web applications share
 - A generally standardized architecture
 - Many common and repetitive actions
 - Many security risks associated with user input and database interactions
 - ...
- Many extensions are available to automate most of the most boring or most risky tasks
 - <https://flask.palletsprojects.com/en/3.0.x/extensions/>

Some Useful Flask Extensions

- **Flask-WTF:** Integration with WTForms (form creation, validation, regeneration)
- **Flask-SQLAlchemy:** Integration with SQLAlchemy, and object-relational mapping for database storage
- **Bootstrap-Flask:** Help render Flask-related data and objects to Bootstrap markup HTML more easily. [Suggested now!](#)
- **Flask-Login:** Management of user sessions for logged-in users
- **Flask-Session:** Add support for Server-side Session to a Flask application
- **Flask-RESTful:** Tools for building RESTful APIs
- **Flask-Mail:** Adds SMTP mail sending to a Flask application

Bootstrap-Flask

- Bootstrap-Flask packages Bootstrap 4 or 5 into an extension that can help render components in Flask.
- Package available at
 - <https://pypi.org/project/Bootstrap-Flask/>
 - Install with pip
- Documentation available at
 - <https://bootstrap-flask.readthedocs.io/en/stable/>

How To Use (I)

- Import and initialize it

```
from flask_bootstrap import Bootstrap5
from flask import Flask

app = Flask(__name__)
bootstrap = Bootstrap5(app)
```

- Use `{{ bootstrap.load_css() }}` and `{{ bootstrap.load_js() }}` to load Bootstrap's resources in the template
- Create a base template such as <https://bootstrap-flask.readthedocs.io/en/stable/basic/#starter-template>

How To Use (II)

- Use the pre-defined blocks you need
- For instance, a sample navbar can be:

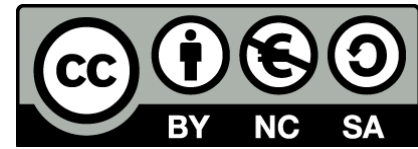
```
{% from 'bootstrap5/nav.html' import render_nav_item %}

<nav class="navbar navbar-expand-lg navbar-light bg-light">
  <div class="navbar-nav mr-auto">
    {{ render_nav_item('index', 'Home') }}
    {{ render_nav_item('explore', 'Explore') }}
    {{ render_nav_item('about', 'About') }}
  </div>
</nav>
```

- where the `render_nav_item()` renders a navigation item according to the Bootstrap style

Next Steps

- A list of all the pre-defined block, with code examples, is available at
 - <https://bootstrap-flask.readthedocs.io/en/stable/macros/>
- The extension works nicely with other extensions:
 - Flask-WTF for form handling
 - Flask-SQLAlchemy for database access



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