CS6

Practical System Skills

Fall 2019 edition

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Midterm results & Logistics

⇒ Midterm I average: 78.8%

⇒ Midterm II average: 83%

⇒ Final project presentations on 15th Dec @ CIT 3pm - 5pm

→ room to be defined
→ 15 min presentation + 10 min questions
→ Your TA is there to help you.

21 Practical Flask

CS6 Practical System Skills

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All examples available at

github.com/browncs6/FlaskExamples

21.01 User logins in flask

⇒ Website often need to authenticate users, there are several packages available to help achieve this in Flask

- **flask_login** helps to guard routes/require user login for them.
- **Werkzeug** tool to help with hashing password.
- **itsdangerous** generates safe tokens, e.g. for account confirmation or expiring links

⇒ Following slides are based on Chapter 8-9, Flask book

21.02 Login system via Flask

How to store user login information? User + passwd?

⇒ Don't store clear passwords!

⇒ Instead store a hash computed via

```
hash(password + salt)
```

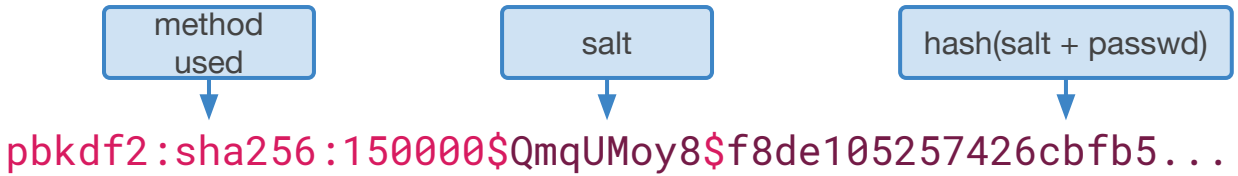
Some crytographic secure hash function (use a well-tested library)

user supplied password

random value, added for each password

21.03 Password hashing via werkzeug

```
from werkzeug.security import generate_password_hash
from werkzeug.security import check_password_hash

h = generate_password_hash('secret password')


# Result h looks similar to this
# pbkdf2:sha256:150000$QmqUMoy8$f8de105257426cbfb533f9db8ecf85921cd544
541ec2df2def8d8ea123b83fc2

check_password_hash(h, 'secret password')
```



21.04 Properties in Python

⇒ Often we want to assign / get values. Not necessarily does a value need to be represented by a member variable always.

⇒ A wide-spread pattern used is a pair of a getter and a setter function.

⇒ using getters/setters allows to use patterns like

1. lazy computation
2. enforcing constraints
3. avoiding redundancy

21.04 Properties in Python

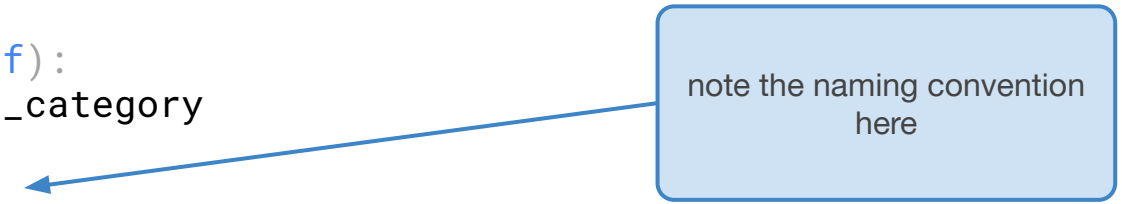
```
class Pokemon:
    def __init__(self, name):
        self.name = name
        self.setCategory('unknown')

    def __repr__(self):
        return '{}[{}]'.format(self.name, self.category)

    def getCategory(self):
        return self._category

    def setCategory(self, category):
        self._category = category

    category = property(getCategory, setCategory)
```

allows us to call the getter/setter via `.category` or `.category = ...`

21.04 Properties in Python with decorators

⇒ instead of using `property(...)`, you can also use `@property` and `@value.setter` to declare them

```
class Pokemon:
    def __init__(self, name):
        self.name = name
        self.category = 'unknown'

    def __repr__(self):
        return '{}[{}]'.format(self.name, self.category)

    @property
    def category(self):
        return self._category

    @category.setter
    def category(self, category):
        self._category = category
```



21.05 A simple password model w. properties

```
class User(db.Model):

    id = db.Column(db.Integer(), primary_key=True)
    password_hash = db.Column(db.String(128))

    @property
    def password(self):
        raise AttributeError('password is write-only')

    @password.setter
    def password(self, password):
        self.password_hash = generate_password_hash(password)

    def verify_password(self, password):
        return check_password_hash(self.password_hash, password)
```

21.06 Flask_login

⇒ Flask extension which helps to protect routes & automate everything related to user authentication

⇒ documentation: https://flask-login.readthedocs.io/en/latest/

⇒ support for remember_me cookies builtin

⇒ protect routes by adding `@login_required` decorator! E.g.,

```
@app.route('/')
@login_required
def index():
    return 'Hello world'
```

21.07 Flask login

⇒ Setup a default path which is displayed to login, via `login_view`

```
from flask_login import LoginManager, login_required, login_user, logout_user

app = Flask(__name__)

login_manager = LoginManager(app)
login_manager.login_view = 'login' # route or function where login occurs...

@app.route('/login')
def login():
    ...
    user = User(...)
    login_user(user, remember=True)
    ...

@app.route('/')
@login_required
def index():
    ...
```

21.07 Flask login user model

⇒ flask login requires a user class to implement several properties/methods:

⇒ derive from UserMixin class to implement useful defaults

`is_authenticated`	True if user has valid credentials, False otherwise
`is_active`	True if user is allowed to login (i.e. use to confirm an account or block it)
`is_anonymous`	False for regular users, True for special anonymous user
`get_id()`	must return a unique identifier for each user, encoded as str

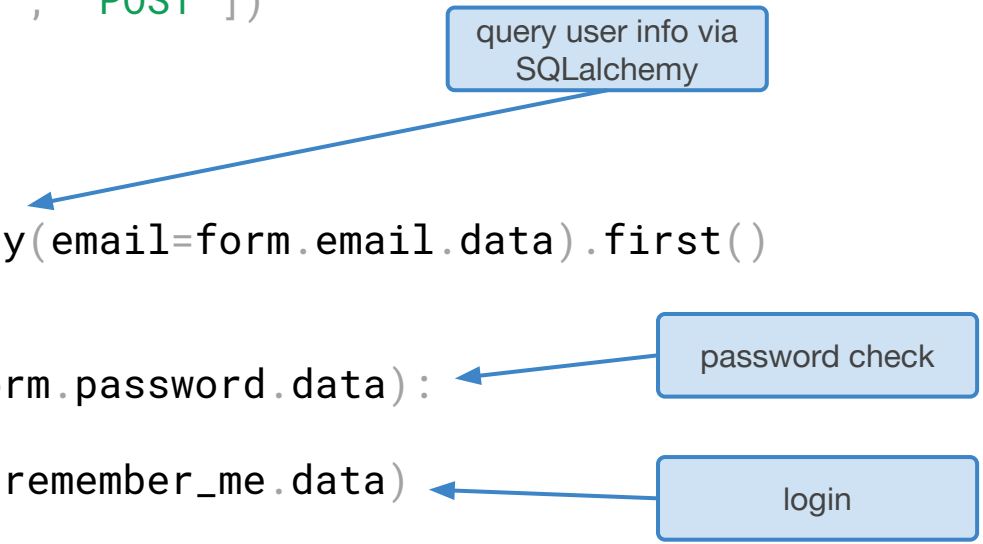
21.07 Flask login user model

```
class User(UserMixin, db.Model):

    id = db.Column(db.Integer(), primary_key=True)
    email = db.Column(db.String(64), unique=True, index=True)
    username = db.Column(db.String(64), unique=True, index=True)
    password_hash = db.Column(db.String(128))

    @property
    def password(self):
        raise AttributeError('password is write-only')

    @password.setter
    def password(self, password):
        self.password_hash = generate_password_hash(password)

    def verify_password(self, password):
        return check_password_hash(self.password_hash, password)
```

UserMixin adds required properties to User class so it can be used with login_user and logout_user

21.07 Writing the login logic

```
@app.route('/login', methods=['GET', 'POST'])
def login():
    form = LoginForm()

    if form.validate_on_submit():
        user = User.query.filter_by(email=form.email.data).first()

        if user is not None and \
           user.verify_password(form.password.data):

            login_user(user, form.remember_me.data)

            return redirect(url_for('secret_page'))
        flash('invalid username or password.')

    return render_template('login.html', form=form)
```



Demo!

Deploying Flask

21.08 Why do we care?

```
* Serving Flask app "login" (lazy loading)
* Environment: production
  WARNING: Do not use the development server in a
production environment.
  Use a production WSGI server instead.
* Debug mode: on
* Running on http://127.0.0.1:5000/ (Press CTRL+C to quit)
* Restarting with stat
```

⇒ Flask's builtin webserver is provided **for development purposes only**.

⇒ Serves one request at a time. What about multiple ones?

21.06 WSGI

WSGI = Web Server Gateway Interface (pronounce: whiskey)

⇒ There are multiple python frameworks
(e.g. Flask, Django, Tornado, …)
and multiple options for production servers
(e.g. Gunicorn, uWSGI, Gevent, Twisted Web, …)

⇒ WSGI is a standard protocol/interface for a production web server to communicate with your web application.

21.06 Web production serves

⇒ There exist multiple production webservers for a web application written in Python, we'll be using gunicorn (Green unicorn)

⇒ easiest way to deploy flask, is to run

```
gunicorn project:app
```

name of your application, e.g. here `project.py` or `project/`

the app object created via `Flask(__name__)`

More information: flask.palletsprojects.com/en/1.1.x/deploying/wsgi-standalone/

21.06 Gunicorn - options

⇒ Gunicorn provides many options (check via `-h` / `--help`), most important are

`-w 4`	specify how many worker processes to use Formula: `2 * CPU cores + 1` (long option: `--worker`)
`-b 127.0.0.1:4000`	specify to which address/port to bind (long option: `--bind`)
`-e key=value`	set environment variable key to value (long option: `--env`)

21.07 The pain of actual deployment

When trying to deploy an actual application, it's a pain because

- Multiple frameworks, multiple versions, …
- different compiler versions, OS versions, ...

⇒ How to package, how to deploy?

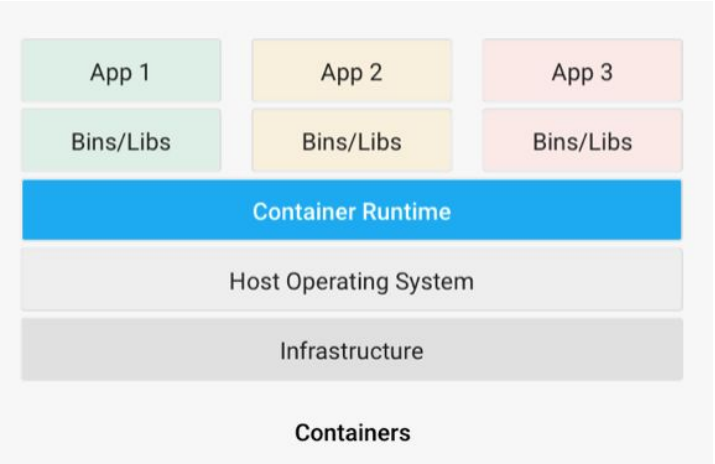
⇒ two popular solutions

- Virtual Machines
- Containers → we'll be using containers!

21.08 Docker

⇒ allows to package applications with all dependencies into an image

⇒ run via "lightweight virtual machine", however uses less space and memory than a real VM because OS is shared amongst multiple containers



21.09 Creating a container

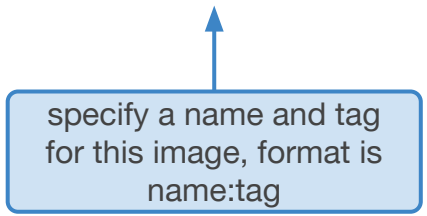
⇒ containers/images are defined via a Dockerfile

⇒ general usage: `docker COMMAND PARAMS`

→ `docker COMMAND --help` to get help for `COMMAND`

⇒ to create image from a Dockerfile stored in . use

```
docker build -t login:latest .
```



21.10 Listing & running images

⇒ to get an overview of created images, use

```
docker images
```

⇒ to start an image use `docker run IMAGE`

→ there are multiple helpful options when starting a container

→ quit via `Ctrl + C` or `docker stop CONTAINER`

→ to get list of running containers, use `docker ps`

21.11 Running containers

`--rm`	remove container when stopped (else you need to use `docker rm IMAGE`)
`--env ENV / -e ENV`	pass environment variable to container **⇒ use this for passwords, config etc.**
`-p <local_port>:<container_port>` `--publish <local_port>:<container_port>`	map local_port to container_port
`--name NAME`	give container a name
`-v <local_path>:<container_path>` `--volume <local_path>:<container_path>`	mount a volume, i.e. make local_path available within container under container_path

21.12 Starting a shell to work within a container

Sometimes it is useful, to "login" to a container.

⇒ use `docker exec -it CONTAINER bash` to start an interactive shell session for a specific container

⇒ get `CONTAINER` via `docker ps`

21.12 Running postgresql in a container

⇒ Dockerhub provides many prebuilt images, you can get them after registering & logging in via `docker pull`

→ if you want, you can also push your images with `docker push`

→ Note: DO NOT STORE passwords in your Dockerfiles/images!

→ run `docker pull postgres` to get postgres image

To start a postgres database:

1. `mkdir db-data # create dir where to store data`
2.
```
docker run --name postgres -e POSTGRES_PASSWORD=docker \
           --rm -p 5432:5432 -v db-data:/var/lib/postgresql/data postgres
```

⇒ connect via `postgresql://postgres:docker@localhost/postgres`

⇒ more info on the postgres image: https://hub.docker.com/_/postgres

21.13 Packaging a flask app in a docker file

```
FROM python:3.7

# install requirements as root
COPY requirements.txt requirements.txt
RUN pip3 install -r requirements.txt

# make this availabe for e.g. flask shell use
ENV FLASK_APP login.py

# run web app as web user
RUN adduser --disabled-password --gecos '' web
USER web

WORKDIR /home/web

COPY login.py login.py
COPY templates templates
COPY run.sh ./

# runtime
EXPOSE 5000
ENTRYPOINT ["./run.sh"]
```

→ `FROM` allows to use a base image

→ `COPY` includes files from the build directory into the image

→ `RUN` allows to run any shell commands (as root)

→ `EXPOSE` makes port 5000 available (i.e. where flask app is run per default)

→ `ENTRYPOINT` specifies which command should run at container startup (i.e. when `docker run` is invoked)

→ `WORKDIR` sets cwd for any commands that follow to some path

21.14 Running Flask & PostgreSQL

1.) Start postgresql container

...

2.) Start flask container & link to postgresql container

```
docker run --name login -p 8000:5000 \
--link postgres:dbserver \
-e DBURI='postgresql://postgres:docker@dbserver/postgres'
-e APP_SECRET='test' \
--rm login:latest
```


HAPPY
thanksgiving

End of lecture.

Next class 3rd Dec: Tue, 4pm @ CIT 477