The Flask Mega-Tutorial Part IX: Pagination (/post/the-flask-mega-tutorial-part-ix-pagination)

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Posted by Miguel Grinberg (/author/Miguel Grinberg) under Flask (/category/Flask), Python (/category/Python), Programming (/category/Programming), Database (/category/Database).

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This is the ninth installment of the Flask Mega-Tutorial series, in which I'm going to tell you how to paginate lists of database entries.

For your reference, below is a list of the articles in this series.

Note 1: If you are looking for the legacy version of this tutorial, it's here (/post/the-flask-mega-tutorial-part-i-hello-world-legacy).

Note 2: If you would like to support my work on this blog, or just don't have patience to wait for weekly articles, I am offering the complete version of this tutorial packaged as an ebook or a set of videos. For more information, visit courses.miguelgrinberg.com (https://courses.miguelgrinberg.com).

In Chapter 8 (/post/the-flask-mega-tutorial-part-viii-followers) I have made several database changes necessary to support the "follower" paradigm that is so popular with social networks. With that functionality in place, I'm ready to remove the last piece of scaffolding that I have put in place in the beginning, the fake posts. In this chapter the application will start accepting blog posts from users, and also deliver them in the home and profile pages.

The GitHub links for this chapter are: Browse (https://github.com/miguelgrinberg/microblog/tree/v0.9), Zip (https://github.com/miguelgrinberg/microblog/archive/v0.9.zip), Diff (https://github.com/miguelgrinberg/microblog/compare/v0.8...v0.9).

Submission of Blog Posts

Let's start with something simple. The home page needs to have a form in which users can type new posts. First I create a form class:

app/forms.py: Blog submission form.

```
class PostForm(FlaskForm):
    post = TextAreaField('Say something', validators=[
        DataRequired(), Length(min=1, max=140)])
    submit = SubmitField('Submit')
```

Next, I can add this form to the template for the main page of the application:

app/templates/index.html: Post submission form in index template

```
{% extends "base.html" %}

{% block content %}
    <h1>Hi, {{ current_user.username }}!</h1>
    <form action="" method="post">
        {{ form.hidden_tag() }}
        <p>
            {{ form.post.label }}<br>
            {{ form.post(cols=32, rows=4) }}<br>
            {% for error in form.post.errors %}
            <span style="color: red;">[{{ error }}]</span>
            {% endfor %}
        </p>
        <p>{{ form.submit() }}</p>
    </form>
    {% for post in posts %}
    <p>
    {{ post.author.username }} says: <b>{{ post.body }}</b>
    </p>
    {% endfor %}
{% endblock %}
```

The changes in this template are similar to how previous forms were handled. The final part is to add the form creation and handling in the view function:

app/routes.py: Post submission form in index view function.

```
from app.forms import PostForm
from app.models import Post

@app.route('/', methods=['GET', 'POST'])
@app.route('/index', methods=['GET', 'POST'])
@login_required
def index():
    form = PostForm()
    if form.validate_on_submit():
        post = Post(body=form.post.data, author=current_user)
        db.session.add(post)
        db.session.commit()
        flash('Your post is now live!')
        return redirect(url_for('index'))
    posts = [
        {
            'author': {'username': 'John'},
            'body': 'Beautiful day in Portland!'
        },
        {
            'author': {'username': 'Susan'},
            'body': 'The Avengers movie was so cool!'
        }
    ]
    return render_template("index.html", title='Home Page', form=form,
                           posts=posts)
```

Let's review the changes in this view function one by one:

- I'm now importing the `Post` and `PostForm` classes
- I accept `POST` requests in both routes associated with the `index` view function in addition to `GET` requests, since this view function will now receive form data.
- The form processing logic inserts a new `Post` record into the database.
- The template receives the `form` object as an additional argument, so that it can render the text field.

Before I continue, I wanted to mention something important related to processing of web forms. Notice how after I process the form data, I end the request by issuing a redirect to the home page. I could have easily skipped the redirect and allowed the function to continue down into the template rendering part, since this is already the index view function.

So, why the redirect? It is a standard practice to respond to a `POST` request generated by a web form submission with a redirect. This helps mitigate an annoyance with how the refresh command is implemented in web browsers. All the web browser does when you hit the refresh key is to re-issue the last request. If a `POST` request with a form submission returns a regular response, then a refresh will re-submit the form. Because this is unexpected, the browser is going to ask the user to confirm the duplicate submission, but most users will not understand what the browser is asking them. But if a `POST` request is answered with a redirect, the browser is now instructed to send a `GET` request to grab the page indicated in the redirect, so now the last request is not a `POST` request anymore, and the refresh command works in a more predictable way.

This simple trick is called the Post/Redirect/Get (https://en.wikipedia.org/wiki/Post/Redirect/Get) pattern. It avoids inserting duplicate posts when a user inadvertently refreshes the page after submitting a web form.

Displaying Blog Posts

If you recall, I created a couple of fake blog posts that I've been displaying in the home page for a long time. These fake objects are created explicitly in the `index` view function as a simple Python list:

```
    posts = [
        {
            'author': {'username': 'John'},
            'body': 'Beautiful day in Portland!'
        },
        {
            'author': {'username': 'Susan'},
            'body': 'The Avengers movie was so cool!'
        }
    ]
```

But now I have the `followed_posts()` method in the `User` model that returns a query for the posts that a given user wants to see. So now I can replace the fake posts with real posts:

app/routes.py: Display real posts in home page.

```
@app.route('/', methods=['GET', 'POST'])
@app.route('/index', methods=['GET', 'POST'])
@login_required
def index():
    # ...
    posts = current_user.followed_posts().all()
    return render_template("index.html", title='Home Page', form=form,
                           posts=posts)
```

The `followed_posts` method of the `User` class returns a SQLAlchemy query object that is configured to grab the posts the user is interested in from the database. Calling `all()` on this query triggers its execution, with the return value being a list with all the results. So I end up with a structure that is very much alike the one with fake posts that I have been using until now. It's so close that the template does not even need to change.

Making It Easier to Find Users to Follow

As I'm sure you noticed, the application as it is does not do a great job at letting users find other users to follow. In fact, there is actually no way to see what other users are there at all. I'm going to address that with a few simple changes.

I'm going to create a new page that I'm going to call the "Explore" page. This page will work like the home page, but instead of only showing posts from followed users, it will show a global post stream from all users. Here is the new explore view function:

app/routes.py: Explore view function.

```
@app.route('/explore')
@login_required
def explore():
    posts = Post.query.order_by(Post.timestamp.desc()).all()
    return render_template('index.html', title='Explore', posts=posts)
```

Did you notice something odd in this view function? The `render_template()` call references the *index.html* template, which I'm using in the main page of the application. Since this page is going to be very similar to the main page, I decided to reuse the template. But one difference with the main page is that in the explore page I do not want to have a form to write blog posts, so in this view function I did not include the `form` argument in the template call.

To prevent the *index.html* template from crashing when it tries to render a web form that does not exist, I'm going to add a conditional that only renders the form if it is defined:

app/templates/index.html: Make the blog post submission form optional.

```
{% extends "base.html" %}

{% block content %}
    <h1>Hi, {{ current_user.username }}!</h1>
    {% if form %}
    <form action="" method="post">
        ...
    </form>
    {% endif %}
    ...
{% endblock %}
```

I'm also going to add a link to this new page in the navigation bar:

app/templates/base.html: Link to explore page in navigation bar.

```
        <a href="{{ url_for('explore') }}">Explore</a>
```

Remember the *_post.html* sub-template that I have introduced in Chapter 6 (/post/the-flask-mega-tutorial-part-vi-profile-page-and-avatars) to render blog posts in the user profile page? This was a small template that was included from the user profile page template, and was separate so that it can also be used from other templates. I'm now going to make a small improvement to it, which is to show the username of the blog post author as a link:

app/templates/_post.html: Show link to author in blog posts.

```
    <table>
        <tr valign="top">
            <td><img src="{{ post.author.avatar(36) }}"></td>
            <td>
                <a href="{{ url_for('user', username=post.author.username) }}">
                    {{ post.author.username }}
                </a>
                says:<br>{{ post.body }}
            </td>
        </tr>
    </table>
```

I can now use this sub-template to render blog posts in the home and explore pages:

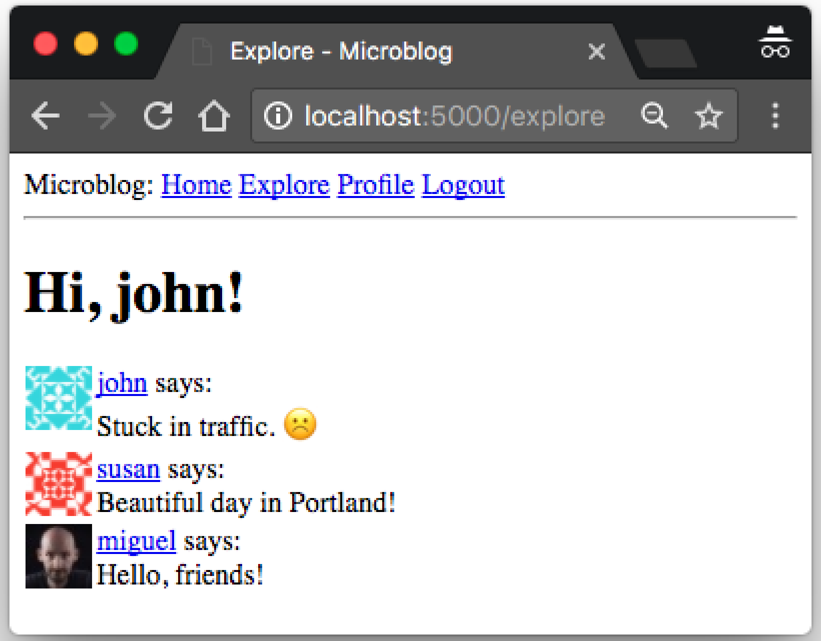
app/templates/index.html: Use blog post sub-template.

```
    ...
    {% for post in posts %}
        {% include '_post.html' %}
    {% endfor %}
    ...
```

The sub-template expects a variable named `post` to exist, and that is how the loop variable in the index template is named, so that works perfectly.

With these small changes, the usability of the application has improved considerably. Now a user can visit the explore page to read blog posts from unknown users and based on those posts find new users to follow, which can be done by simply clicking on a username to access the profile page. Amazing, right?

At this point I suggest you try the application once again, so that you experience these last user interface improvements.



Microblog: Home Explore Profile Logout

Hi, john!

john says:
Stuck in traffic. ☹

susan says:
Beautiful day in Portland!

miguel says:
Hello, friends!

Pagination of Blog Posts

The application is looking better than ever, but showing all of the followed posts in the home page is going to become a problem sooner rather than later. What happens if a user has a thousand followed posts? Or a million? As you can imagine, managing such a large list of posts will be extremely slow and inefficient.

To address that problem, I'm going to *paginate* the post list. This means that initially I'm going to show just a limited number of posts at a time, and include links to navigate through the entire list of posts. Flask-SQLAlchemy supports pagination natively with the `paginate()` query method. If for example, I want to get the first twenty followed posts of the user, I can replace the `all()` call that terminates the query with:

```
>>> user.followed_posts().paginate(1, 20, False).items
```

The `paginate` method can be called on any query object from Flask-SQLAlchemy. It takes three arguments:

- the page number, starting from 1
- the number of items per page

- an error flag. If `True` , when an out of range page is requested a 404 error will be automatically returned to the client. If `False` , an empty list will be returned for out of range pages.

The return value from `paginate` is a `Pagination` object. The `items` attribute of this object contains the list of items in the requested page. There are other useful things in the `Pagination` object that I will discuss later.

Now let's think about how I can implement pagination in the `index()` view function. I can start by adding a configuration item to the application that determines how many items will be displayed per page.

config.py: Posts per page configuration.

```
class Config(object):
    # ...
    POSTS_PER_PAGE = 3
```

It is a good idea to have these application-wide "knobs" that can change behaviors in the configuration file, because then I can go to a single place to make adjustments. In the final application I will of course use a larger number than three items per page, but for testing it is useful to work with small numbers.

Next, I need to decide how the page number is going to be incorporated into application URLs. A fairly common way is to use a *query string* argument to specify an optional page number, defaulting to page 1 if it is not given. Here are some example URLs that show how I'm going to implement this:

- Page 1, implicit: *http://localhost:5000/index*
- Page 1, explicit: *http://localhost:5000/index?page=1*
- Page 3: *http://localhost:5000/index?page=3*

To access arguments given in the query string, I can use the Flask's `request.args` object. You have seen this already in Chapter 5 (/post/the-flask-mega-tutorial-part-v-user-logins), where I implemented user login URLs from Flask-Login that can include a `next` query string argument.

Below you can see how I added pagination to the home and explore view functions:

app/routes.py: Followers association table

```
@app.route('/', methods=['GET', 'POST'])
@app.route('/index', methods=['GET', 'POST'])
@login_required
def index():
    # ...
    page = request.args.get('page', 1, type=int)
    posts = current_user.followed_posts().paginate(
        page, app.config['POSTS_PER_PAGE'], False)
    return render_template('index.html', title='Home', form=form,
                           posts=posts.items)

@app.route('/explore')
@login_required
def explore():
    page = request.args.get('page', 1, type=int)
    posts = Post.query.order_by(Post.timestamp.desc()).paginate(
        page, app.config['POSTS_PER_PAGE'], False)
    return render_template("index.html", title='Explore', posts=posts.items)
```

With these changes, the two routes determine the page number to display, either from the `page` query string argument or a default of 1, and then use the `paginate()` method to retrieve only the desired page of results. The `POSTS_PER_PAGE` configuration item that determines the page size is accessed through the `app.config` object.

Note how easy these changes are, and how little code is affected each time a change is made. I am trying to write each part of the application without making any assumptions about how the other parts work, and this enables me to write modular and robust applications that are easier to extend and to test, and are less likely to fail or have bugs.

Go ahead and try the pagination support. First make sure you have more than three blog posts. This is easier to see in the explore page, which shows posts from all users. You are now going to see just the three most recent posts. If you want to see the next three, type *http://localhost:5000/explore?page=2* in your browser's address bar.

Page Navigation

The next change is to add links at the bottom of the blog post list that allow users to navigate to the next and/or previous pages. Remember that I mentioned that the return value from a `paginate()` call is an object of a `Pagination` class from Flask-SQLAlchemy? So far, I have used the `items` attribute of this object, which contains the list of items retrieved for the selected page. But this object has a few other attributes that are useful when building pagination links:

- `has_next` : True if there is at least one more page after the current one
- `has_prev` : True if there is at least one more page before the current one

- `next_num` : page number for the next page
- `prev_num` : page number for the previous page

With these four elements, I can generate next and previous page links and pass them down to the templates for rendering:

app/routes.py: Next and previous page links.

```
@app.route('/', methods=['GET', 'POST'])
@app.route('/index', methods=['GET', 'POST'])
@login_required
def index():
    # ...
    page = request.args.get('page', 1, type=int)
    posts = current_user.followed_posts().paginate(
        page, app.config['POSTS_PER_PAGE'], False)
    next_url = url_for('index', page=posts.next_num) \
        if posts.has_next else None
    prev_url = url_for('index', page=posts.prev_num) \
        if posts.has_prev else None
    return render_template('index.html', title='Home', form=form,
                           posts=posts.items, next_url=next_url,
                           prev_url=prev_url)

 @app.route('/explore')
 @login_required
 def explore():
    page = request.args.get('page', 1, type=int)
    posts = Post.query.order_by(Post.timestamp.desc()).paginate(
        page, app.config['POSTS_PER_PAGE'], False)
    next_url = url_for('explore', page=posts.next_num) \
        if posts.has_next else None
    prev_url = url_for('explore', page=posts.prev_num) \
        if posts.has_prev else None
    return render_template("index.html", title='Explore', posts=posts.items,
                          next_url=next_url, prev_url=prev_url)
```

The `next_url` and `prev_url` in these two view functions are going to be set to a URL returned by `url_for()` only if there is a page in that direction. If the current page is at one of the ends of the collection of posts, then the `has_next` or `has_prev` attributes of the `Pagination` object will be `False` , and in that case the link in that direction will be set to `None` .

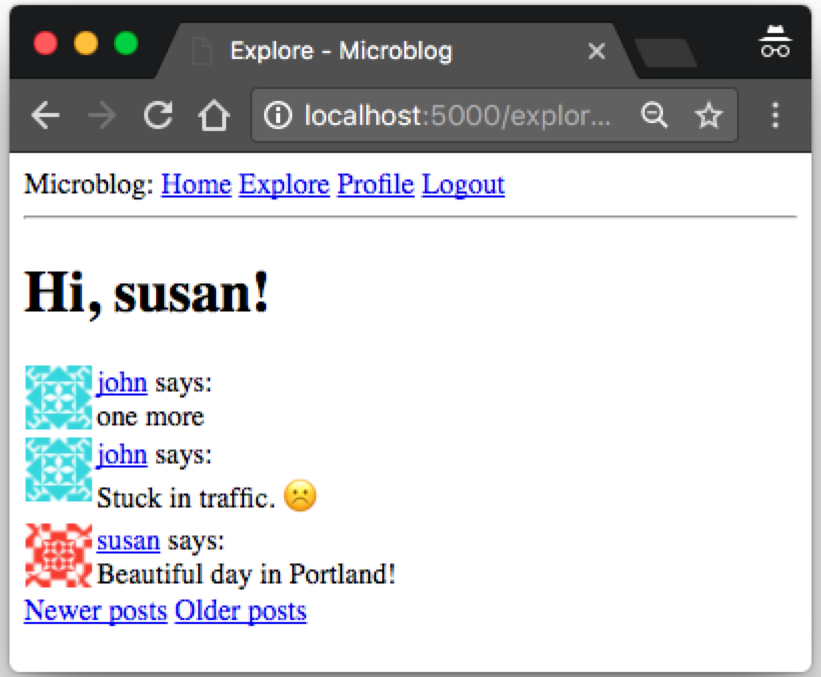
One interesting aspect of the `url_for()` function that I haven't discussed before is that you can add any keyword arguments to it, and if the names of those arguments are not referenced in the URL directly, then Flask will include them in the URL as query arguments.

The pagination links are being set to the *index.html* template, so now let's render them on the page, right below the post list:

app/templates/index.html: Render pagination links on the template.

```
    ...
    {% for post in posts %}
        {% include '_post.html' %}
    {% endfor %}
    {% if prev_url %}
    <a href="{{ prev_url }}">Newer posts</a>
    {% endif %}
    {% if next_url %}
    <a href="{{ next_url }}">Older posts</a>
    {% endif %}
    ...
```

This change adds two links below the post list on both the index and explore pages. The first link is labeled "Newer posts", and it points to the previous page (keep in mind I'm showing posts sorted by newest first, so the first page is the one with the newest content). The second link is labeled "Older posts" and points to the next page of posts. If any of these two links is `None`, then it is omitted from the page, through a conditional.



Microblog: Home Explore Profile Logout

Hi, susan!

john says:
one more
john says:
Stuck in traffic. 😟
susan says:
Beautiful day in Portland!
Newer posts Older posts

Pagination in the User Profile Page

The changes for the index page are sufficient for now. However, there is also a list of posts in the user profile page, which shows only posts from the owner of the profile. To be consistent, the user profile page should be changed to match the pagination style of the index page.

I begin by updating the user profile view function, which still had a list of fake post objects in it.

app/routes.py: Pagination in the user profile view function.

```
@app.route('/user/<username>')
@login_required
def user(username):
    user = User.query.filter_by(username=username).first_or_404()
    page = request.args.get('page', 1, type=int)
    posts = user.posts.order_by(Post.timestamp.desc()).paginate(
        page, app.config['POSTS_PER_PAGE'], False)
    next_url = url_for('user', username=user.username, page=posts.next_num) \
        if posts.has_next else None
    prev_url = url_for('user', username=user.username, page=posts.prev_num) \
        if posts.has_prev else None
    form = EmptyForm()
    return render_template('user.html', user=user, posts=posts.items,
                           next_url=next_url, prev_url=prev_url, form=form)
```

To get the list of posts from the user, I take advantage of the fact that the `user.posts` relationship is a query that is already set up by SQLAlchemy as a result of the `db.relationship()` definition in the `User` model. I take this query and add a `order_by()` clause so that I get the newest posts first, and then do the pagination exactly like I did for the posts in the index and explore pages. Note that the pagination links that are generated by the `url_for()` function need the extra `username` argument, because they are pointing back at the user profile page, which has this username as a dynamic component of the URL.

Finally, the changes to the *user.html* template are identical to those I made on the index page:

app/templates/user.html: Pagination links in the user profile template.

```
    ...
    {% for post in posts %}
        {% include '_post.html' %}
    {% endfor %}
    {% if prev_url %}
    <a href="{{ prev_url }}">Newer posts</a>
    {% endif %}
    {% if next_url %}
    <a href="{{ next_url }}">Older posts</a>
    {% endif %}
```

After you are done experiment with the pagination feature, you can set the `POSTS_PER_PAGE` configuration item to a more reasonable value:

config.py: Posts per page configuration.

```
class Config(object):
    # ...
    POSTS_PER_PAGE = 25
```

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