Assignment №2

Docker compose

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Almaty, 13.10.2024

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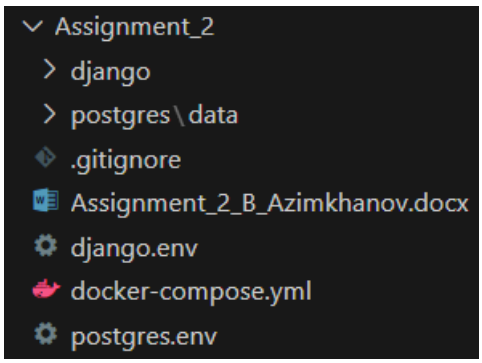
Introduction

The goal of this assignment is to gain hands-on experience with Django and Docker, focusing on Docker Compose, Docker networking, and volumes. Students will set up a Django application within a Docker environment and document the process.



Docker compose

Configuration

```yaml
services:
  django:
    build: django/.
    ports:
      - 8000:8000
    env_file:
      - ./django.env
    command:
    depends_on:
      postgres:
        condition: service_healthy
        restart: true
    networks:
      - net
    volumes:
      - ./django:/usr/src/app

  postgres:
    image: postgres:16.4-bullseye
    ports:
      - 5432:5432
    env_file:
      - ./postgres.env
    healthcheck:
      test: ["CMD-SHELL", "pg_isready -U bauyrzhan -d assignment2"]
      interval: 10s
      retries: 3
      start_period: 30s
      timeout: 10s
    networks:
```

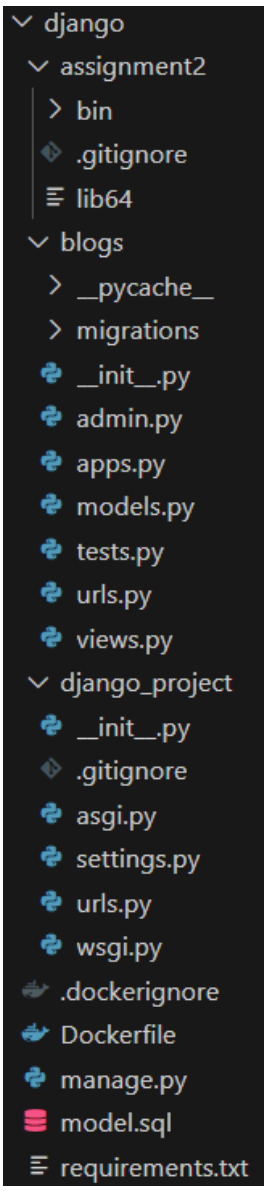
```
      - net
    volumes:
      - ./postgres/data:/var/lib/postgresql/data

networks:
  net:
    driver: bridge
```

This docker-compose.yml file defines a multi-container Docker application with two services: django and postgres. It also sets up a custom network named net.

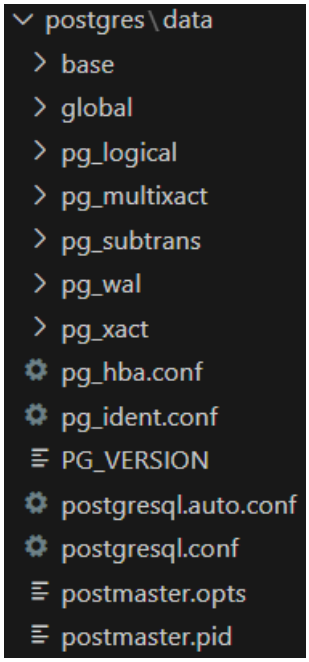
Services

1. **django**
    - **Build context**: The django service is built from the django/ directory.
    - **Ports**: Maps port 8000 on the host to port 8000 in the container.
    - **Environment variables**: Loaded from the ./django.env file.
    - **Dependencies**: Depends on the postgres service being healthy before starting.
    - **Restart Policy**: Always restart the container if it stops.
    - **Networks**: Connected to the net network.
    - **Volumes**: Mounts the ./django directory on the host to /usr/src/app in the container.



2. **postgres**
    - **Image**: Uses the postgres:16.4-bullseye image.
    - **Ports**: Maps port 5432 on the host to port 5432 in the container.
    - **Environment variables**: Loaded from the ./postgres.env file.
    - **Healthcheck**:
        - **Test**: Runs the command "pg_isready -U bauyrzhan -d assignment2" to check if the database is ready.
        - **Interval**: Checks every 10 seconds.
        - **Retries**: Retries up to 3 times before considering the service unhealthy.
        - **Start Period**: Waits 30 seconds before starting health checks.

        - **Timeout**: Each health check command must complete within 10 seconds.
    - **Networks**: Connected to the net network.
    - **Volumes**: Mounts the ./postgres/data directory on the host to /var/lib/postgresql/data in the container.



Networks

- **net**: A custom bridge network used to facilitate communication between the django and postgres services.

This setup ensures that the Django application can communicate with the PostgreSQL database, and the health of the PostgreSQL service is monitored before the Django service starts.

The entire database state is preserved by mounting volumes in the Postgres service. Similarly, mounting helps dynamically apply and reflect changes in the Django project code.

Build and run

After writing Dockerfiles and other code, you need to run the "docker compose build" command, and then the "docker compose up" command.

Docker networking and volumes

1. Custom network setup and its benefits

The docker-compose.yml file defines a custom network named net using the bridge driver. This network facilitates communication between the django and postgres services. Here are the benefits of this setup:

- **Isolation**: The custom network isolates the services from other containers running on the host, enhancing security.
- **Service discovery**: Docker automatically assigns each service a hostname based on the service name, making it easy for services to discover and communicate with each other.
- **Simplified configuration**: By using a custom network, you avoid the need to manually configure IP addresses and ports for inter-service communication.

2. Volumes for data persistence

Volumes are used in the docker-compose.yml file to ensure data persistence for both the django and postgres services:

- **Django service**:
    - The volume ./django:/usr/src/app mounts the ./django directory on the host to /usr/src/app in the container. This allows the Django application code to be accessible and editable from the host machine.
- **Postgres service**:
    - The volume ./postgres/data:/var/lib/postgresql/data mounts the ./postgres/data directory on the host to /var/lib/postgresql/data in the container. This ensures that the PostgreSQL database data is stored persistently on the host, even if the container is stopped or removed.

3. Advantages of using Docker networking and volumes

Using Docker networking and volumes in your application offers several advantages:

- **Networking**:
    - **Enhanced security**: Custom networks isolate containers, reducing the risk of unauthorized access.
    - **Ease of communication**: Services can easily communicate using service names, simplifying the configuration.
    - **Scalability**: Networks can be easily scaled to include more services or containers as needed.
- **Volumes**:

- **Data persistence**: Volumes ensure that data is not lost when containers are stopped or removed.
- **Separation of concerns**: Application code and data are managed separately, making it easier to update and maintain the application.
- **Performance**: Volumes are optimized for performance, providing faster data access compared to bind mounts.

These features make Docker a powerful tool for developing, deploying, and managing applications in a consistent and efficient manner.

Django application setup

Project structure

The Django project is created using two articles from the official Django documentation. Links to both articles are provided in the corresponding section.

This application has a blogs app with corresponding views and models. It is connected to the main module (django_project directory) via the urls.py file in blog.

```
from django.contrib import admin
from django.urls import include, path

urlpatterns = [
    path("blogs/", include("blogs.urls")),
    path('admin/', admin.site.urls),
]
```

```
from django.urls import path

from . import views

urlpatterns = [
    path("", views.index, name="index"),
]
```

```
from django.shortcuts import render
from django.http import HttpResponse


def index(request):
    return HttpResponse("Hello, world. You're at the blogs index.")


from django.db import models


class Question(models.Model):
    question_text = models.CharField(max_length=200)
    pub_date = models.DateTimeField("date published")


class Choice(models.Model):
    question = models.ForeignKey(Question, on_delete=models.CASCADE)
    choice_text = models.CharField(max_length=200)
    votes = models.IntegerField(default=0)
```

```
BEGIN;
--
-- Create model Question
--
CREATE TABLE "blogs_question" ("id" bigint NOT NULL PRIMARY KEY GENERATED BY
DEFAULT AS IDENTITY, "question_text" varchar(200) NOT NULL, "pub_date" timestamp
with time zone NOT NULL);
--
-- Create model Choice
--
CREATE TABLE "blogs_choice" ("id" bigint NOT NULL PRIMARY KEY GENERATED BY
DEFAULT AS IDENTITY, "choice_text" varchar(200) NOT NULL, "votes" integer NOT
NULL, "question_id" bigint NOT NULL);
ALTER TABLE "blogs_choice" ADD CONSTRAINT
"blogs_choice_question_id_c774bda9_fk_blogs_question_id" FOREIGN KEY
("question_id") REFERENCES "blogs_question" ("id") DEFERRABLE INITIALLY DEFERRED;
CREATE INDEX "blogs_choice_question_id_c774bda9" ON "blogs_choice"
("question_id");
COMMIT;
```

Database configuration

The PostgreSQL database is integrated with Django via the postgresql-client library in the Django Docker image and the Python3 pip module psycopg2-binary. They are installed at the image build stage (docker compose build) on the 3rd and 10th lines, respectively.

```
FROM python:3.11

RUN apt-get update \
    && apt-get install -y --no-install-recommends \
        postgresql-client \
    && rm -rf /var/lib/apt/lists/*
WORKDIR /usr/src/app
COPY requirements.txt ./

RUN pip install -r requirements.txt
COPY . .

EXPOSE 8000
CMD ["python", "manage.py", "runserver", "0.0.0.0:8000"]
```

Further configuration is performed in the settings.py file in the DATABASES structure (line 89). Data on the database name and other things are taken from the

environment variable of the PostgreSQL container. These variables are set at the Docker compose level (docker compose up) in the env_file fields.

```
DATABASES = {
    'default': {
        'ENGINE': 'django.db.backends.postgresql',
        'NAME': os.environ.get('POSTGRES_NAME'),
        'USER': os.environ.get('POSTGRES_USER'),
        'PASSWORD': os.environ.get('POSTGRES_PASSWORD'),
        'HOST': os.environ.get('POSTGRES_HOST'),
        'PORT': os.environ.get('POSTGRES_PORT')
    }
}
```

Findings

You need to pay close attention to the order of launching containers in Docker compose. Otherwise, errors may occur when starting Django.

To avoid such incidents, you need to declare checks of the state and readiness (healthcheck field in docker-compose.yml) of the container with the database for work. After all, database initialization can take longer than a similar process for the application. Since a ready and running database is required to launch the application (depends_on field in docker-compose.yml), I included the healthcheck field.

Conclusion

Key learnings from the assignment

This assignment highlighted the importance of using Docker Compose to manage multi-container applications. By defining services, networks, and volumes in a single file, we can streamline the setup and deployment process, ensuring consistency across different environments.

Significance of using Docker with Django for application development

Using Docker with Django simplifies the development and deployment process by encapsulating the application and its dependencies in containers. This approach ensures that the application runs consistently, regardless of the underlying environment. It also facilitates easier scaling and management of the application components.

Significance of healthchecks for containers with databases

Implementing healthchecks for containers, especially those running databases, is crucial. Healthchecks ensure that the database service is fully operational before dependent services, like Django, start. This prevents potential errors and ensures a smooth startup process, enhancing the reliability and stability of the application.

References

Links to Django tutorials from official documentation:

1. https://docs.djangoproject.com/en/5.1/intro/tutorial01/
2. https://docs.djangoproject.com/en/5.1/intro/tutorial02/

Link to official Docker documentation:

- https://docs.docker.com/

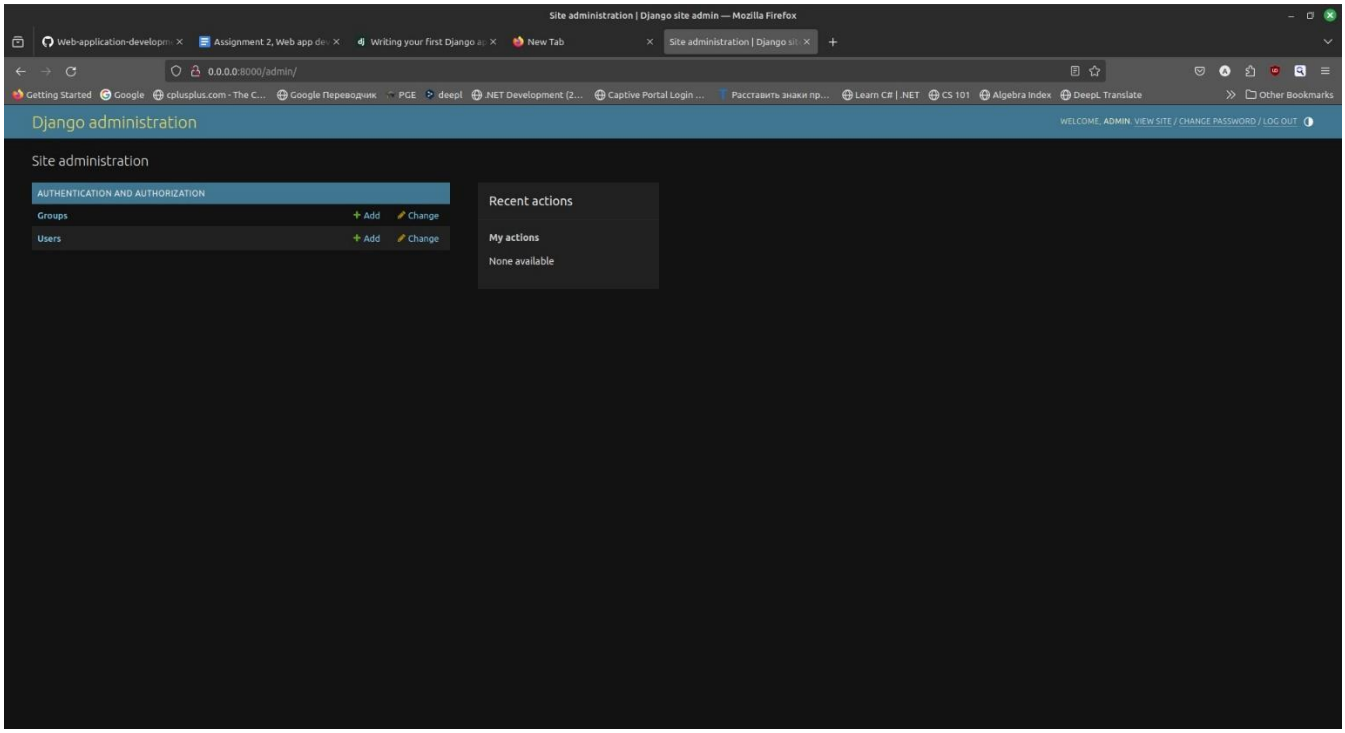
Link to official Docker image registry where from I took base images for compose:

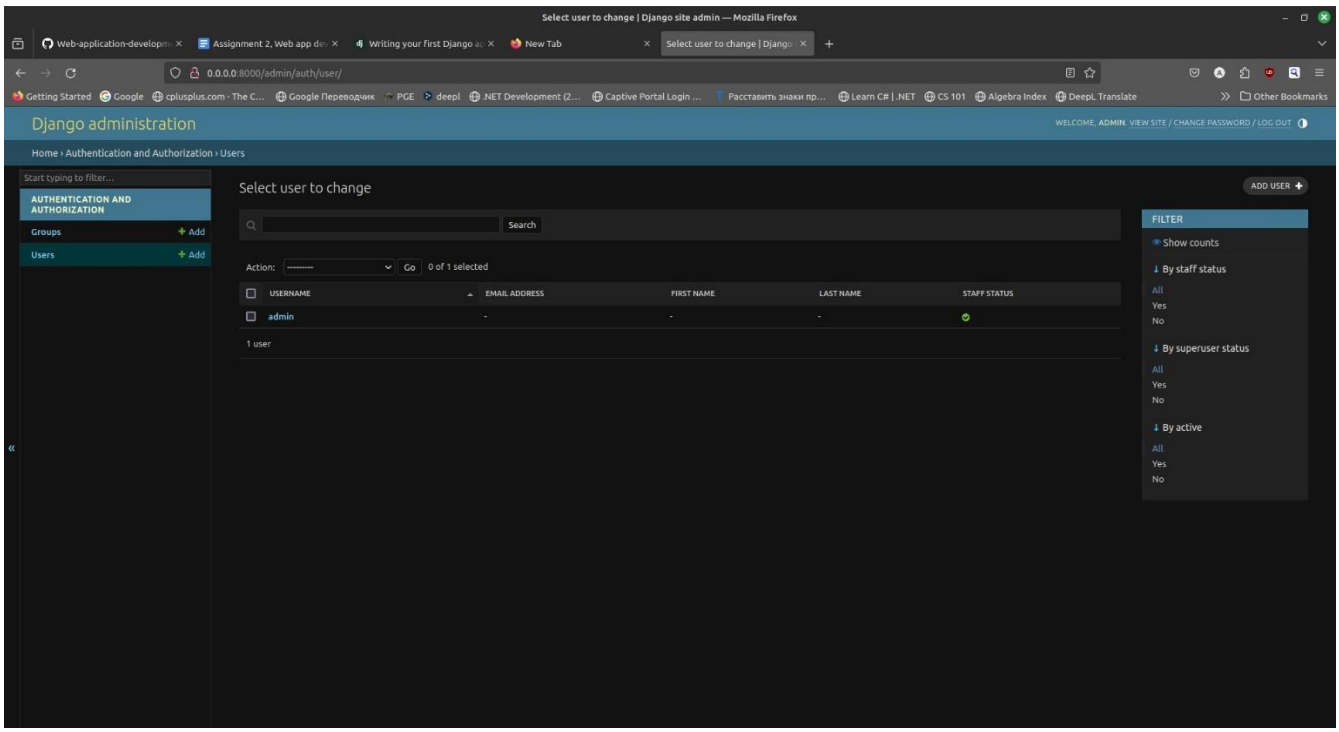
- https://hub.docker.com/

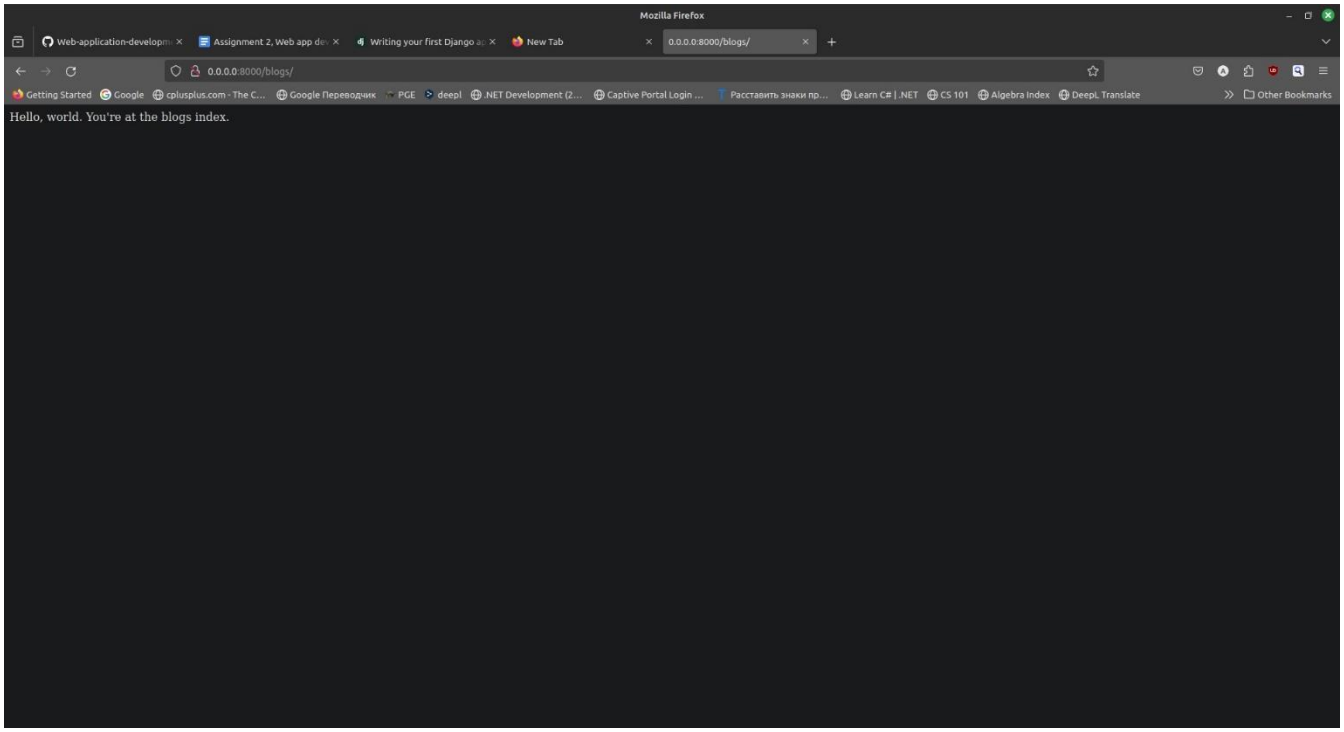
Link to my GitHub repository (screenshots, logs and SQL structure included):

- https://github.com/BauyrzhanAzimkhanov/Web-application-development-MSc-

Screenshots




Select user to change | Django site admin — Mozilla Firefox
0.0.0.0:8000/admin/auth/user/
Django administration
WELCOME, ADMIN. VIEW SITE / CHANGE PASSWORD / LOG OUT
Home › Authentication and Authorization › Users
Start typing to filter...
AUTHENTICATION AND AUTHORIZATION
Groups + Add
Users + Add
Select user to change
ADD USER +
Search
Action: --------- Go 0 of 1 selected
USERNAME
EMAIL ADDRESS
FIRST NAME
LAST NAME
STAFF STATUS
admin
1 user
FILTER
Show counts
By staff status
All
Yes
No
By superuser status
All
Yes
No
By active
All
Yes
No


Mozilla Firefox
0.0.0.0:8000/blogs/
Hello, world. You're at the blogs index.

Logs

```
bauyrzhan@bauyrzhan-laptop:~/Desktop/web-dev/Web-application-development-MSc-
/Assignment_2$ docker compose up
[+] Running 2/0
 ✓ Container assignment_2-postgres-
1  Created
                                        0.0s
 ✓ Container assignment_2-django-
1    Recreated
                                          0.0s
Attaching to django-1, postgres-1
postgres-1  |
postgres-1  | PostgreSQL Database directory appears to contain a database;
Skipping initialization
postgres-1  |
postgres-1  | 2024-10-11 14:18:16.365 UTC [1] LOG:  starting PostgreSQL 16.4
(Debian 16.4-1.pgdg110+2) on x86_64-pc-linux-gnu, compiled by gcc (Debian 10.2.1-
6) 10.2.1 20210110, 64-bit
postgres-1  | 2024-10-11 14:18:16.366 UTC [1] LOG:  listening on IPv4 address
"0.0.0.0", port 5432
postgres-1  | 2024-10-11 14:18:16.366 UTC [1] LOG:  listening on IPv6 address
"::", port 5432
postgres-1  | 2024-10-11 14:18:16.368 UTC [1] LOG:  listening on Unix socket
"/var/run/postgresql/.s.PGSQL.5432"
postgres-1  | 2024-10-11 14:18:16.372 UTC [30] LOG:  database system was
interrupted; last known up at 2024-10-10 11:52:06 UTC
postgres-1  | 2024-10-11 14:18:16.891 UTC [30] LOG:  database system was not
properly shut down; automatic recovery in progress
postgres-1  | 2024-10-11 14:18:16.894 UTC [30] LOG:  redo starts at 0/19F39A0
postgres-1  | 2024-10-11 14:18:16.895 UTC [30] LOG:  invalid record length at
0/19F4428: expected at least 24, got 0
postgres-1  | 2024-10-11 14:18:16.895 UTC [30] LOG:  redo done at 0/19F43F0
system usage: CPU: user: 0.00 s, system: 0.00 s, elapsed: 0.00 s
postgres-1  | 2024-10-11 14:18:16.901 UTC [28] LOG:  checkpoint starting: end-of-
recovery immediate wait
postgres-1  | 2024-10-11 14:18:16.915 UTC [28] LOG:  checkpoint complete: wrote 8
buffers (0.0%); 0 WAL file(s) added, 0 removed, 0 recycled; write=0.004 s,
sync=0.005 s, total=0.016 s; sync files=7, longest=0.002 s, average=0.001 s;
distance=2 kB, estimate=2 kB; lsn=0/19F4428, redo lsn=0/19F4428
postgres-1  | 2024-10-11 14:18:16.922 UTC [1] LOG:  database system is ready to
accept connections
django-1    | Watching for file changes with StatReloader
django-1    | Performing system checks...
django-1    |
django-1    | System check identified no issues (0 silenced).
django-1    | October 11, 2024 - 14:18:22
django-1    | Django version 5.1.1, using settings 'django_project.settings'
django-1    | Starting development server at http://0.0.0.0:8000/
django-1    | Quit the server with CONTROL-C.
django-1    |
```

```
django-1    | Not Found: /
django-1    | [11/Oct/2024 14:18:28] "GET / HTTP/1.1" 404 2312
django-1    | [11/Oct/2024 14:18:34] "GET /admin/ HTTP/1.1" 200 5852
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/js/theme.js HTTP/1.1" 200
1653
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/css/dark_mode.css
HTTP/1.1" 200 2804
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/css/dashboard.css
HTTP/1.1" 200 441
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/css/base.css HTTP/1.1"
200 22092
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/css/nav_sidebar.css
HTTP/1.1" 200 2810
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/js/nav_sidebar.js
HTTP/1.1" 200 3063
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/css/responsive.css
HTTP/1.1" 200 17972
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/img/icon-changelink.svg
HTTP/1.1" 200 380
django-1    | [11/Oct/2024 14:18:34] "GET /static/admin/img/icon-addlink.svg
HTTP/1.1" 200 331
django-1    | [11/Oct/2024 14:20:53] "GET /admin/auth/user/ HTTP/1.1" 200 11051
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/css/base.css HTTP/1.1"
304 0
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/theme.js HTTP/1.1" 304
0
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/css/dark_mode.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/css/nav_sidebar.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/nav_sidebar.js
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/css/changelists.css
HTTP/1.1" 200 6878
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/jquery.init.js
HTTP/1.1" 200 347
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/core.js HTTP/1.1" 200
6208
django-1    | [11/Oct/2024 14:20:53] "GET
/static/admin/js/admin/RelatedObjectLookups.js HTTP/1.1" 200 9097
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/actions.js HTTP/1.1"
200 8076
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/urlify.js HTTP/1.1"
200 7887
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/prepopulate.js
HTTP/1.1" 200 1531
django-1    | [11/Oct/2024 14:20:53] "GET /admin/jsi18n/ HTTP/1.1" 200 3342
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/js/filters.js HTTP/1.1"
200 978
django-1    | [11/Oct/2024 14:20:53] "GET
/static/admin/js/vendor/jquery/jquery.js HTTP/1.1" 200 285314
```

```
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/css/responsive.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:20:53] "GET
/static/admin/js/vendor/xregexp/xregexp.js HTTP/1.1" 200 325171
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/img/icon-yes.svg
HTTP/1.1" 200 436
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/img/search.svg HTTP/1.1"
200 458
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/img/icon-addlink.svg
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/img/tooltag-add.svg
HTTP/1.1" 200 331
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/img/icon-viewlink.svg
HTTP/1.1" 200 581
django-1    | [11/Oct/2024 14:20:53] "GET /static/admin/img/sorting-icons.svg
HTTP/1.1" 200 1097
django-1    | [11/Oct/2024 14:21:32] "GET /admin/auth/user/1/change/ HTTP/1.1"
200 21815
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/css/nav_sidebar.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/css/base.css HTTP/1.1"
304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/theme.js HTTP/1.1" 304
0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/nav_sidebar.js
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/css/dark_mode.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET
/static/admin/js/vendor/jquery/jquery.js HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/jquery.init.js
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/css/forms.css HTTP/1.1"
200 8710
django-1    | [11/Oct/2024 14:21:32] "GET
/static/admin/js/admin/DateTimeShortcuts.js HTTP/1.1" 200 19319
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/core.js HTTP/1.1" 304
0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/calendar.js HTTP/1.1"
200 9141
django-1    | [11/Oct/2024 14:21:32] "GET
/static/admin/js/admin/RelatedObjectLookups.js HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /admin/jsi18n/ HTTP/1.1" 200 3342
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/SelectBox.js HTTP/1.1"
200 4530
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/actions.js HTTP/1.1"
304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/css/responsive.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/urlify.js HTTP/1.1"
304 0
```

```
django-1    | [11/Oct/2024 14:21:32] "GET
/static/admin/js/vendor/xregexp/xregexp.js HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/prepopulate.js
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/SelectFilter2.js
HTTP/1.1" 200 15502
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/change_form.js
HTTP/1.1" 200 606
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/js/prepopulate_init.js
HTTP/1.1" 200 586
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/css/widgets.css HTTP/1.1"
200 11564
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/icon-addlink.svg
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/icon-calendar.svg
HTTP/1.1" 200 1086
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/search.svg HTTP/1.1"
304 0
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/icon-unknown.svg
HTTP/1.1" 200 655
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/icon-unknown-alt.svg
HTTP/1.1" 200 655
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/icon-clock.svg
HTTP/1.1" 200 677
django-1    | [11/Oct/2024 14:21:32] "GET /static/admin/img/selector-icons.svg
HTTP/1.1" 200 3291
django-1    | [11/Oct/2024 14:21:37] "GET /admin/ HTTP/1.1" 200 5852
django-1    | [11/Oct/2024 14:21:37] "GET /static/admin/css/dashboard.css
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:37] "GET /static/admin/img/icon-changelink.svg
HTTP/1.1" 304 0
django-1    | [11/Oct/2024 14:21:42] "GET /blogs/ HTTP/1.1" 200 40
```