Events & Worker Queues

Teacher Version

Software Architecture

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Evan Hughes, Brae Webb & Richard Thomas

> **Aside**
>
> Github Classroom links for this practical can be found on Edstem `https://edstem.org/au/courses/21491/discussion/2429006`

1 This Week

Our goal is to:

- Explore events and worker queues in the context of AWS.

- Deploy our own TaskOverflow container on AWS Elastic Container Registry (ECS).

- Develop an event-based architecture to generate a calendar from tasks in TaskOverflow.

2 Event Processing

As we saw in Event-Driven Architectures [1], event processing enables us to build highly scalable and extensible systems. In this practical we will get our hands dirty with event processing using AWS SQS. AWS SQS is a service which acts as an event broker.

2.1 Technologies

There are other technologies that can be useful in developing an event-based architecture. The following is a non-exhaustive list of services native to AWS.

2.1.1 AWS SQS

AWS provides the Simple Queue Service, SQS, which offers a simple and fully managed message queue service. There are two flavours of SQS to be aware of.

Standard message queues allow for greater scalability by providing higher through-put. However, standard message queues in SQS are not exactly queues, messages are not first in first out, they are best-effort ordered.

FIFO message queues guarantees that messages are First in First Out.

2.1.2 AWS SNS

Amazon Simple Notification Service (Amazon SNS) is a fully managed messaging service for both application-to-application (A2A) and application-to-person (A2P) communication.

The A2A pub/sub functionality provides topics for high-throughput, push-based, many-to-many messaging between distributed systems, microservices, and event-driven serverless applications. Using Amazon SNS topics, your publisher systems can fanout messages to a large number of subscriber systems, including Amazon SQS queues, AWS Lambda functions, HTTPS endpoints, and Amazon Kinesis Data Firehose, for parallel processing. The A2P functionality enables you to send messages to users at scale via SMS, mobile push, and email.[1]

– AWS

2.1.3 AWS MQ / Apache ActiveMQ / RabbitMQ

Amazon MQ is a managed message broker service for Apache ActiveMQ[2] and RabbitMQ[3] that makes it easy to set up and operate message brokers on AWS. Amazon MQ reduces your operational responsibilities by managing the provisioning, setup, and maintenance of message brokers for you. Because Amazon MQ connects to your current applications with industry-standard APIs and protocols, you can easily migrate to AWS without having to rewrite code.

– AWS

> **Aside**
>
> Not available in the Learner Lab environment.

---

[1]Please do not try to create a spam service in your AWS account.
[2]https://activemq.apache.org/
[3]https://www.rabbitmq.com/

2.1.4   AWS MSK (Managed Streaming for Apache Kafka)

Amazon Managed Streaming for Apache Kafka[4] (Amazon MSK) is a fully managed service that enables you to build and run applications that use Apache Kafka to process streaming data. Amazon MSK provides the control-plane operations, such as those for creating, updating, and deleting clusters. It lets you use Apache Kafka data-plane operations, such as those for producing and consuming data It runs open-source versions of Apache Kafka. This means existing applications, tooling, and plugins from partners and the Apache Kafka community are supported without requiring changes to application code. You can use Amazon MSK to create clusters that use any of the Apache Kafka versions listed under Supported Apache Kafka versions.

<div align="right">– AWS</div>

> **Aside**
>
> Not available in the lab environments.

2.1.5   Redis

Redis, which stands for Remote Dictionary Server, is a fast, open source, in-memory, key-value data store. The project started when Salvatore Sanfilippo, the original developer of Redis, wanted to improve the scalability of his Italian startup. From there, he developed Redis, which is now used as a database, cache, message broker, and queue.

Redis delivers sub-millisecond response times, enabling millions of requests per second for real-time applications in industries like gaming, ad-tech, financial services, healthcare, and IoT. Today, Redis is one of the most popular open source engines today, named the "Most Loved" database by Stack Overflow for five consecutive years. Because of its fast performance, Redis is a popular choice for caching, session management, gaming, leaderboards, real-time analytics, geospatial, ride-hailing, chat/messaging, media streaming, and pub/sub apps.

AWS offers two fully managed services to run Redis. Amazon MemoryDB for Redis is a Redis-compatible, durable, in-memory database service that delivers ultra-fast performance. Amazon ElastiCache for Redis is a fully managed caching service that accelerates data access from primary databases and data stores with microsecond latency. Furthermore, ElastiCache also offers support for Memcached, another popular open source caching engine.

<div align="right">– AWS</div>

> **Aside**
>
> Not available in the lab environments.

3   Talking to the Simple Queue Service (SQS)

> **Info**
>
> This section is intended to be demonstrated by your practical tutor. You may work through it on your own if you wish.

We will demonstrate working with the two queue flavours of AWS SQS. A standard queue, named `csse6400_prac` and a FIFO queue, named `csse6400_prac.fifo`. The Terraform code below can be used to create these two queues.

---

[4]https://kafka.apache.org/

```
⟩ cat q-demo.tf
terraform {
  required_providers {
    aws = {
      source = "hashicorp/aws"
      version = "~> 5.0"
    }
  }
}

provider "aws" {
  region = "us-east-1"
  shared_credentials_files = ["./credentials"]
}

resource "aws_sqs_queue" "our_first_mailbox" {
  name = "csse6400_prac"
}

resource "aws_sqs_queue" "our_first_fifo" {
  name = "csse6400_prac.fifo"
  fifo_queue = true
  content_based_deduplication = true
}

output "mailbox" {
  value = aws_sqs_queue.our_first_mailbox.arn
}

output "fifo" {
  value = aws_sqs_queue.our_first_fifo.arn
}
```
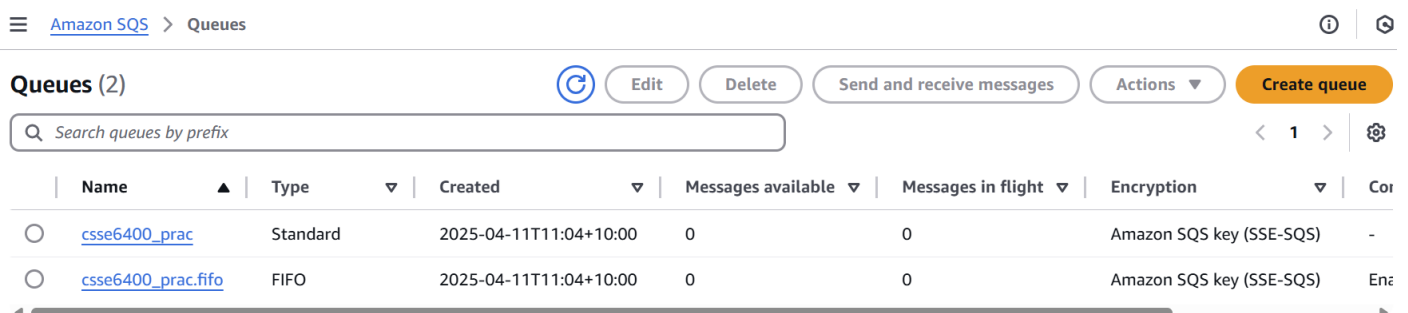
Now that we have provisioned the queues, we can have a look at them in the AWS Console. In the main AWS dashboard you can search for "SQS" to find these queues. You should reach a page like this:

Name	Type	Created	Messages available	Messages in flight	Encryption	Cor
csse6400_prac	Standard	2025-04-11T11:04+10:00	0	0	Amazon SQS key (SSE-SQS)	-
csse6400_prac.fifo	FIFO	2025-04-11T11:04+10:00	0	0	Amazon SQS key (SSE-SQS)	Ena

Like the EC2 and RDS dashboards, we can browse the queue configurations and metrics.

3.1   Queue Command-line Interface

We have provided a small Docker container to demonstrate the difference between the implementations. First we must retrieve our AWS credentials and setup our environment.

Grab the AWS credentials from the Learner Lab, but instead of creating a credentials file we will use environment variables.

To do this, create an environment file for our Docker container to read so that it can access AWS. Create an `aws.env` file in the current directory and edit the contents so that it looks similar to the example below. It is important that the environment variable names are capitalised. The AWS key values will be from the credentials shown in your Learner Lab environment.

```
TERM=xterm-256color
AWS_ACCESS_KEY_ID=...
AWS_SECRET_ACCESS_KEY=...
AWS_SESSION_TOKEN=...
```

```
$ docker run --rm -it --env-file aws.env ghcr.io/csse6400/queue:main --name "test" --
    client-name "Client 1"


  ----------
 |   \XX/   |
 | T. \/ .T |       University of Queensland
 | XX:  :XX |          Faculty of EAIT
 T L' /\ 'J T
  \  /XX\  /        CSSE6400 Queue Prac
@\_ '____' _/@       csse6400.uqcloud.net
\_X\_ __ _/X_/
 \=/\----/\=/




Unable to find a Queue by this name test
```

3.2 SQS Standard

The "standard" offering of SQS does not guarantee order or "only once delivery". We will create a message publisher and a message subscriber.

> **Info**
>
> For the rest of this practical you will require multiple terminals. Make sure these are all in the same folder so we can reuse the `aws.env` file.

To create the subscriber run the following command:

```
$ docker run --rm -it --env-file aws.env ghcr.io/csse6400/queue:main --name "
    csse6400_prac" --client-name "Client 1" --receive
```

```
$ docker run --rm -it --env-file .env ghcr.io/csse6400/queue:main --name "csse6400_prac" --cl
ient-name "hello" --receive


      ----------
     |   \XX/   |
     | T. \/ .T |         University of Queensland
     | XX:   :XX |            Faculty of EAIT
     T L' /\ 'J T
      \  /XX\  /          CSSE6400 Queue Prac
     @\_ '____' _/@       csse6400.uqcloud.net
     \_X\_  __ _/X_/
       \=/\----/\=/

Connected to csse6400_prac
: Waiting for messages...
```

Now start a publisher in another terminal.

```
$ docker run --rm -it --env-file aws.env ghcr.io/csse6400/queue:main --name "
    csse6400_prac" --client-name "Client 1"
```

6

```
$ docker run --rm -it --env-file .env ghcr.io/csse6400/queue:main --name "csse6400_prac" --cl
ient-name "Client 1"


        ----------
       |   \XX/   |
       | T. \/ .T |            University of Queensland
       | XX:  :XX |                 Faculty of EAIT
       T L' /\ 'J T
         \  /XX\  /              CSSE6400 Queue Prac
       @\_ '____' _/@            csse6400.uqcloud.net
       \_X\_ __ _/X_/
        \=/\----/\=/




Connected to csse6400_prac
Sending Messages:
Working...  ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━━  25% 0:00:19
```

When the publisher connects to the queue it will put 100 messages of increasing increment into the queue. On the subscriber we will be able to see the messages being received, an example is provided below:

```
       | T. \/ .T |            University of Queensland
       | XX:  :XX |                 Faculty of EAIT
       T L' /\ 'J T
         \  /XX\  /              CSSE6400 Queue Prac
       @\_ '____' _/@            csse6400.uqcloud.net
       \_X\_ __ _/X_/
        \=/\----/\=/




Connected to csse6400_prac
[11:41:41] Client 1: Message 0                                                       main.py:62
           Client 1: Message 1                                                       main.py:62
[11:41:42] Client 1: Message 2                                                       main.py:62
           Client 1: Message 5                                                       main.py:62
           Client 1: Message 6                                                       main.py:62
[11:41:43] Client 1: Message 8                                                       main.py:62
           Client 1: Message 9                                                       main.py:62
[11:41:44] Client 1: Message 12                                                      main.py:62
           Client 1: Message 13                                                      main.py:62
           Client 1: Message 14                                                      main.py:62
[11:41:46] Client 1: Message 16                                                      main.py:62
```

Hopefully, like our example, you can see that some of the messages arrive out of order. Next, add more publishers and subscribers and experiment with different configurations.

> **Info**
>
> When making multiple publishers, you may want to change the client-name CLI parameter, so you can keep track of when the messages arrived at the subscribers.

3.3 SQS FIFO

Now we will experiment with the FIFO based service offered by SQS. Like before, we will start a subscriber but make sure the name of the queue matches the FIFO queue we created in Terraform.

```
$ docker run --rm -it --env-file aws.env ghcr.io/csse6400/queue:main --name "
    csse6400_prac.fifo" --client-name "Client 1" --receive
```

Now start a publisher in another terminal.

```
$ docker run --rm -it --env-file aws.env ghcr.io/csse6400/queue:main --name "
    csse6400_prac.fifo" --client-name "Client 1"
```

```
^[[D$ docker run --rm -it --env-file .env ghcr.io/csse6400/queue:main --name "csse6400_prac.f
ifo" --client-name "Client 2"


     ----------
    |   \XX/   |
    | T. \/ .T |        University of Queensland
    | XX:  :XX |            Faculty of EAIT
    T L' /\ 'J T
     \  /XX\  /         CSSE6400 Queue Prac
    @\_ '____' _/@      csse6400.uqcloud.net
    \_X\_ __ _/X_/
     \=/\----/\=/

           I

Connected to csse6400_prac.fifo
Sending Messages:
Working...  ━━━━━━━━━━━━━━━━━━━━━━━━━━━━━  100% 0:00:00
$
```

On the subscriber we now see the messages arriving in the order which is expected.

8

```
$ docker run --rm -it --env-file .env ghcr.io/csse6400/queue:main --name "csse6400_prac.fifo"
  --client-name "hello" --receive



      ----------
     |   \XX/   |
     | T. \/ .T |         University of Queensland
     | XX:  :XX |            Faculty of EAIT
      T L' /\ 'J T
       \  /XX\  /          CSSE6400 Queue Prac
      @\_ '____' _/@       csse6400.uqcloud.net
      \_X\_ __ _/X_/
        \=/\----/\=/



Connected to csse6400_prac.fifo
[11:57:28] Client 1: Message 0                                          main.py:62
[11:57:29] Client 1: Message 1                                          main.py:62
           Client 1: Message 2                                          main.py:62
[11:57:30] Client 1: Message 3                                          main.py:62
           Client 1: Message 4                                          main.py:62
```

If we re-run the publisher though, we may not see any new messages make it to the consumer. This is because we have asked AWS to de-duplicate messages where it can. You can see this in FIFO queue's dashboard Monitoring tab. The queue test code has a CLI parameter which prepends a string to the message. Re-run the test code using `-prepend "A-"` to send non-duplicate messages.

As before try experimenting with different publisher / subscriber configurations to see how they behave.

> **Info**
>
> When making multiple publishers, you may want to change the client-name CLI parameter, so you can keep track of when the messages arrived at the subscribers.

> **Warning**
>
> **Please remember to** `terraform destroy` **to delete your resources!**

4   Worker Queues

One good use case for queues is for distributing work to scale to demand. In this exercise we encourage you to have a look at these widely used libraries to see how you could integrate them into a distributed system.

- Python: Celery[5]

- Java: RabbitMQ[6]

The two libraries above are integrated into many popular application frameworks. Today we will use Celery to create a simple worker queue for TaskOverflow.

---

[5]https://docs.celeryq.dev/en/stable/
[6]https://www.rabbitmq.com/tutorials/tutorial-one-java

4.1 Celery

Celery is a Python library which allows you to create a worker queue. It is popular and used in many large scale applications. It is also relatively easy to use and has comprehensive documentation.

5 Task Calendar

TaskOverflow will use Celery to distribute the work of generating a calendar view of tasks, as this could be a time-intensive task.[7] This will be done by a worker which will run in a separate container. The TaskOverflow server will place job requests on the Celery queue. The worker will pick-up jobs and generate the calendar. The webserver can then serve the calendar to the user.

Calendar generation occurs asynchronously with this architecture. The user will not have to wait for the calendar view to be generated and the web server can handle other requests.

5.1 API Extension

We will extend our existing API with the following endpoints.

POST /todos/ical Create an asynchronous calendar generation job.[8]

GET /todos/ical/{task_id}/status Check the status of the generation job.

GET /todos/ical/{task_id}/result Download the generated iCal file when it is ready.

An example interaction with the API might look like:

```
$ curl -X POST http://localhost:6400/api/v1/todos/ical
{
  "task_id": "2e80aefd-4a69-4a94-b23a-45f2b8110988",
  "task_url": "http://localhost:6400/api/v1/todos/ical/2e80aefd-4a69-4a94-b23a-45
     f2b8110988/status"
}
$ curl -X GET http://localhost:6400/api/v1/todos/ical/2e80aefd-4a69-4a94-b23a-45
    f2b8110988/status
{
  "result_url": "http://localhost:6400/api/v1/todos/ical/2e80aefd-4a69-4a94-b23a-45
     f2b8110988/result",
  "task_id": "2e80aefd-4a69-4a94-b23a-45f2b8110988",
  "task_status": "PENDING"
}
$ curl -X GET http://localhost:6400/api/v1/todos/ical/2e80aefd-4a69-4a94-b23a-45
    f2b8110988/status
{
  "result_url": "http://localhost:6400/api/v1/todos/ical/2e80aefd-4a69-4a94-b23a-45
     f2b8110988/result",
  "task_id": "2e80aefd-4a69-4a94-b23a-45f2b8110988",
  "task_status": "SUCCESS"
```

---

[7]In reality it is not, but this is an example of a common use case for asynchronous tasks — file generation such as PDFs or videos which do take time.

[8]Ideally a POST procedural endpoint should use a verb like `/generate`.

```
}
$ curl -X GET http://localhost:6400/api/v1/todos/ical/2e80aefd-4a69-4a94-b23a-45
   f2b8110988/result
BEGIN:VCALENDAR
VERSION:2.0
PRODID:-//Taskoverflow Calendar//mxm.dk//
BEGIN:VEVENT
SUMMARY:Project Proposal
DTSTART:20230403T140000
UID:1
DESCRIPTION:CSSE6400 Project Proposal Due
END:VEVENT
END:VCALENDAR
```

We will stub out the implementation of these endpoints for now.

```
» cat todo/views/routes.py

@api.route('/todos/ical', methods=['POST'])
def create_ical():
    pass


@api.route('/todos/ical/<task_id>/status', methods=['GET'])
def get_task(task_id):
    pass


@api.route('/todos/ical/<task_id>/result', methods=['GET'])
def get_calendar(task_id):
    pass
```

5.2 Queue and Workers

Next we will modify our `docker-compose.yml` to include a local queuing service called Redis. Later we will use AWS SQS, but as Celery supports multiple queues, we can use this to make the local development easier.

```
» cat docker-compose.yml

 redis:
   image: redis:latest
   restart: always
   ports:
     - "6379:6379"
```

Now that we have a queue, we will create the worker that accepts jobs from the queue. We will create this worker in `todo/tasks/ical.py`.

```
 » cat todo/tasks/ical.py
import os

from celery import Celery

celery = Celery(__name__)
celery.conf.broker_url = os.environ.get("CELERY_BROKER_URL")
celery.conf.result_backend = os.environ.get("CELERY_RESULT_BACKEND")
celery.conf.task_default_queue = os.environ.get("CELERY_DEFAULT_QUEUE", "ical")

@celery.task(name="ical")
def create_ical(tasks):
    return "Hello World"
```

Note that we are getting a URL from the environment variables: `CELERY_BROKER_URL` and `CELERY_RESULT_BACKEN`
We need to remember to set these variables in whichever environment the service is run.

   We need to install Celery. We will do this in the same poetry environment as the Flask server, as we
will later require our Flask server to use Celery to put jobs into the task queue.

```
$ poetry add celery redis celery[sqs] boto3
```

The above will install the Celery core and Redis and AWS SQS drivers for communication.
   We will now start our local Redis queue and our worker to ensure that they can communicate.

```
$ docker compose up redis
```

```
$ export CELERY_BROKER_URL=redis://localhost:6379
$ export CELERY_RESULT_BACKEND=redis://localhost:6379
$ poetry run python3 -m celery --app todo.tasks.ical worker --loglevel=info
```

   You should see something like the below. This indicates that the worker has successfully subscribed to
the queue and is ready to accept events.

```
 -------------- celery@uqrthoxx-8811 v5.5.1 (immunity)
--- ***** -----
-- ******* ---- Windows-11-10.0.26100-SP0 2025-04-11 14:02:30
- *** --- * ---
- ** ---------- [config]
- ** ---------- .> app: todo.tasks.ical:0x11c87792210
- ** ---------- .> transport: redis://localhost:6379//
- ** ---------- .> results: redis://localhost:6379/
- *** --- * --- .> concurrency: 8 (prefork)
-- ******* ---- .> task events: OFF (enable -E to monitor tasks in this worker)
```

```
--- ***** -----
 ------------- [queues]
             .> ical exchange=ical(direct) key=celery


[tasks]
  . ical

[2025-04-11 14:02:30,382: INFO/MainProcess] Connected to redis://localhost:6379//
[2025-04-11 14:02:30,388: INFO/MainProcess] mingle: searching for neighbors
[2025-04-11 14:02:31,428: INFO/MainProcess] mingle: all alone
[2025-04-11 14:02:31,506: INFO/MainProcess] celery@uqrthoxx-8811 ready.
...
```

Finally, we will run Celery inside a new container. For this we will modify our `docker-compose.yml` file.

```
 » cat docker-compose.yml

 worker:
   build:
     context: .
     dockerfile: Dockerfile.dev
   restart: always
   environment:
     CELERY_BROKER_URL: redis://redis:6379
     CELERY_RESULT_BACKEND: redis://redis:6379
   command: poetry run celery --app todo.tasks.ical worker --loglevel=info
```

Note that we are re-using the same image development image as the Flask server. This makes sense since it shares very similar dependencies. It would make sense to separate the dependencies between the two containers as they grow larger.

We are overriding the command to run when the container starts to use the celery command. We have also remembered to set the environment variables appropriately. We have to use the domain name of the redis image instead of the localhost because redis is not running on our localhost. Earlier we were able to pretend it was because the redis port, 6379, was being forwarded from our localhost to our redis container.

5.3   Creating Tasks

We will now return to our Flask server. We will modify our new endpoints to use Celery to create tasks and add them to the task queue.

```
 » cat todo/views/routes.py

from celery.result import AsyncResult
from todo.tasks import ical


...
```

```python
@api.route('/todos/ical', methods=['POST'])
def create_ical():
    todos = Todo.query.order_by(Todo.created_at.desc()).all()
    todo_input = []
    for todo in todos:
        todo_input.append(todo.to_dict())

    task = ical.create_ical.delay(todo_input)

    result = {
        'task_id': task.id,
        'task_url': f'{request.host_url}api/v1/todos/ical/{task.id}/status'
    }

    return jsonify(result), 202

@api.route('/todos/ical/<task_id>/status', methods=['GET'])
def get_task(task_id):
    task_result = AsyncResult(task_id)
    result = {
        "task_id": task_id,
        "task_status": task_result.status,
        "result_url": f'{request.host_url}api/v1/todos/ical/{task_id}/result'
    }
    return jsonify(result), 200

@api.route('/todos/ical/<task_id>/result', methods=['GET'])
def get_calendar(task_id):
    task_result = AsyncResult(task_id)
    if task_result.status == 'SUCCESS':
        return task_result.result, 200, {'Content-Type': 'text/calendar'}
    else:
        return jsonify({'error': 'Task not finished'}), 404
```

The variable that we create as tasks and pass to the delay method is the JSON data that is stored with the event. It is then deserialized from JSON and passed as a variable to the `create_ical` function. Celery is able to create impressive abstractions so that message passing over a task queue looks almost like regular function calls.

Before we can successfully use this endpoint to get our important "Hello World" result, we need to configure the server to talk to our Redis container. Add the Celery environment variables to the `app`'s `environment` in `docker-compose.yml`.

```
» cat docker-compose.yml

environment:
  CELERY_BROKER_URL: redis://redis:6379
  CELERY_RESULT_BACKEND: redis://redis:6379
```

You should now be able to start the server and worker with `docker compose`.

```
$ docker compose up
```

You can now send a POST request to the `/api/v1/todos/ical` endpoint to start a job and follow the subsequent URLs to see the result of the job.

5.4 Creating the Calendar

Once we have confirmed that the task queue can communicate with our worker, we can return to the calendar generation. We will use the `icalendar` library for this.

```
$ poetry add icalendar
```

```
» cat todo/tasks/ical.py
import icalendar
import time
import datetime

...

def create_ical(tasks):
    cal = icalendar.Calendar()
    cal.add("prodid", "-//Taskoverflow Calendar//mxm.dk//")
    cal.add("version", "2.0")

    time.sleep(50)

    for task in tasks:
        event = icalendar.Event()

        event.add("uid", task["id"])
        event.add("summary", task["title"])
        event.add("description", task["description"])
        event.add("dtstart", datetime.datetime.strptime(task["deadline_at"], "%Y-%m-%
            dT%H:%M:%S"))

        cal.add_component(event)

    return cal.to_ical().decode("utf-8")
```

Now you should be able to test your application.

1. Start it with `docker compose`.

```
      $ docker compose up --build
```

2. Open the user interface on `http://localhost:6400` and create some tasks.

3. Follow the cURL interaction from Section 5.1 to generate an appropriate iCal.

6   Deploying with SQS

First we will modify our worker so that it can run locally and connect to an SQS queue. We need to create an appropriate SQS queue.

```
$ cat sqs.tf
terraform {
  required_providers {
    aws = {
      source = "hashicorp/aws"
      version = "~> 5.0"
    }
  }
}

provider "aws" {
  region = "us-east-1"
  shared_credentials_files = ["./credentials"]
}

resource "aws_sqs_queue" "ical_queue" {
    name = "ical"
}
```

> **Info**
>
> Celery will automatically create a queue if it does not exist, however, we want to manage it with Terraform so it is easier to destroy.

Now we need to tell our worker to use our SQS queue. To do this we will use the `sqs://` broker URL. This tells Celery to use SQS. Celery will then attempt to find appropriate AWS credentials to use to authenticate.

6.1   Environment Variables

We can pass the credentials in as environment variables, using the `aws.env` file we created in section 3.1.

```
$ cat docker-compose.yml
  volumes:
    - ./todo:/app/todo
  env_file: "aws.env"
  environment:
    CELERY_BROKER_URL: sqs://
```

Ensure that you update both the worker and the server (app).

6.2 Credentials File

It is also possible to mount the `credentials` file that already exists within our container.

```
» cat docker-compose.yml

volumes:
  - ./todo:/app/todo
  - ./credentials:/root/.aws/credentials
environment:
  CELERY_BROKER_URL: sqs://
```

Note that we are using `/root` since the container is run as the root user and Celery will therefore look at `~/.aws/credentials`.

6.3 Tracking Jobs

We can use the SQS queue in this state to create tasks and our workers will pick it up. This is often sufficient, however, in our implementation we have made use of Celery's built-in functionality to track jobs with a persistent data store. This is by use of the `AsyncResult` class. If we tried to go to the status or result page for a task we submitted, we would receive an error.

To work around this issue, we will use our existing PostgreSQL database as our persistent store to track tasks.

We can update our `docker-compose.yml` as below to allow Celery to use our PostgreSQL database.

```
» cat docker-compose.yml

environment:
  CELERY_RESULT_BACKEND: db+postgresql://administrator:
    verySecretPassword@database:5432/todo
```

This is the same as the `SQLALCHEMY_DATABASE_URI`, except for `db+` at the start to help Celery identify the type of data store.

7 Deploying with ECS

Now we have a

1. SQS queue on AWS,

2. Celery worker container running locally,

3. Flask server container running locally, and

4. PostgreSQL database running locally.

In the week 5 practical we demonstrated how to host a container on ECR, and how to use that hosted image to deploy containers on ECS. In that practical we also deployed a PostgreSQL database on RDS [2]. We strongly encourage you to try and deploy all components of the TaskOverflow application on AWS infrastructure. This will be excellent practice for the final stage of the cloud infrastructure assignment.

Hints

1. ECS/EC2 containers will automatically authenticate with your AWS account, so the `credentials` file is not required.

2. Attempt to test each component is deployed correctly individually, e.g. deploy RDS and ensure the system works, then deploy the server and ensure the system works, etc.

References

[1] R. Thomas, "Event-driven architecture," March 2023. `https://csse6400.uqcloud.net/handouts/event.pdf`.

[2] E. Hughes, B. Webb, and R. Thomas, "Database & container deployment," vol. 5 of *CSSE6400 Practicals*, The University of Queensland, March 2025. `https://csse6400.uqcloud.net/practicals/week05.pdf`.