How to Self-Host LLMs on Your Infrastructure

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Intro

Why Self-Host?

- Data security
- Cost limitations
- **You're a massive nerd**

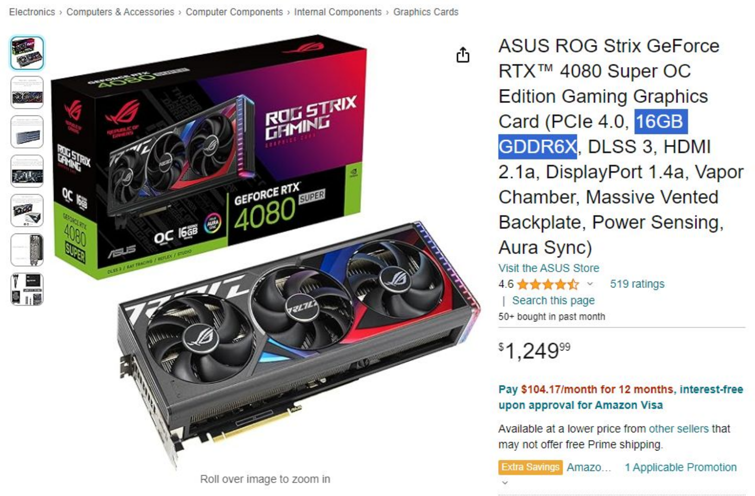
Things to consider:

- Do you have enough compute?
  - In particular, GPU vRAM (or graphics RAM)
- Understand the goals/limitations of your project.
  - Number of requests, frequency, and size (tokens in/out)
  - Observability/auditing requirements

Rough number crunching

- Mistral-7B: 7 Billion Parameters
- Each parameter stored as 16-bit float
- 16 bits = 2 bytes
- 7 Billion x 2 bytes = 14 Billion bytes = 14 Gigabytes

+10% overhead →15.4 GB of vRAM minimum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ASUS ROG Strix GeForce RTX™ 4080 Super OC Edition Gaming Graphics Card (PCIe 4.0, 16GB GDDR6X, DLSS 3, HDMI 2.1a, DisplayPort 1.4a, Vapor Chamber, Massive Vented Backplate, Power Sensing, Aura Sync)

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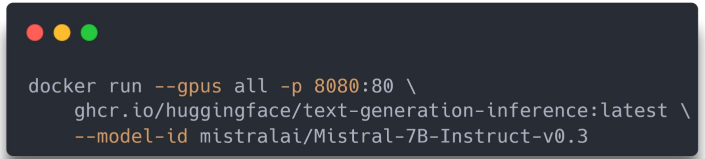
Text Generation Inference (TGI)

➔ **Cool Features**
- Easy to use
- Direct integration with LangChain & LlamaIndex

➔ **Advantages**
- Native support for models from HuggingFace
- Numerous parameters to control inference (quantization, tensor parallelism, etc)
- All dependencies in a single Docker image

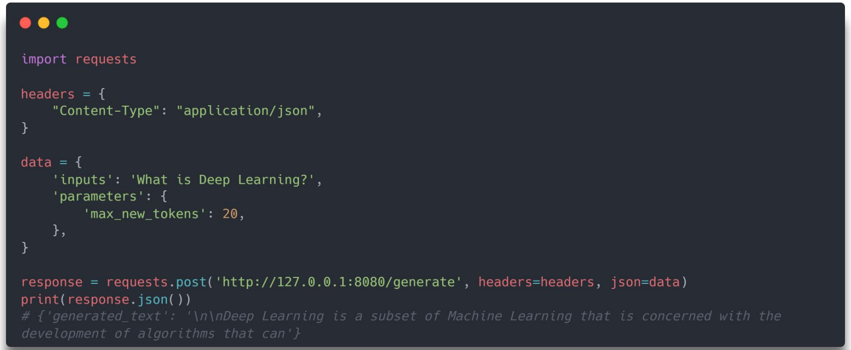
➔ **Limitations**
- Non-standard API
- Scalability

LAUNCH



```
docker run --gpus all -p 8080:80 \
    ghcr.io/huggingface/text-generation-inference:latest \
    --model-id mistralai/Mistral-7B-Instruct-v0.3
```

CONSUME



```python
import requests

headers = {
    "Content-Type": "application/json",
}

data = {
    'inputs': 'What is Deep Learning?',
    'parameters': {
        'max_new_tokens': 20,
    },
}

response = requests.post('http://127.0.0.1:8080/generate', headers=headers, json=data)
print(response.json())
# {'generated_text': '\n\nDeep Learning is a subset of Machine Learning that is concerned with the
development of algorithms that can'}
```

See More: https://huggingface.co/docs/text-generation-inference/

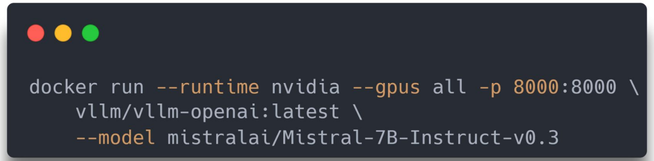
vLLM

➔ **Cool Features**
- Continuous request batching
- Fast and easy to use
- Direct integration with LangChain & LlamaIndex

➔ **Advantages**
- Very fast text generation
- OpenAI compatible server

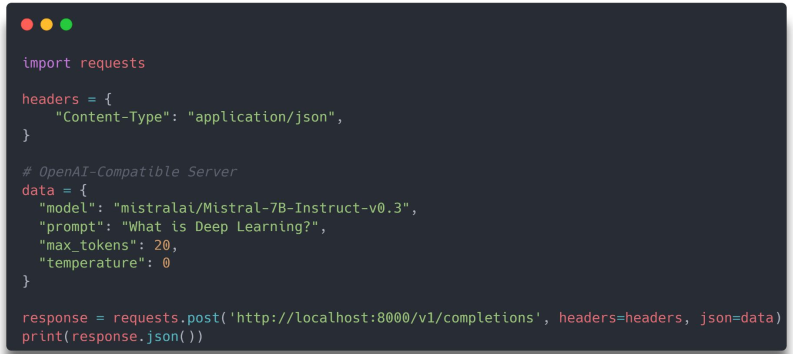
➔ **Limitations**
- Limited, but growing, list of supported models.
- Harder to add custom models.
- Some quantization support
- Scalability

LAUNCH



```
docker run --runtime nvidia --gpus all -p 8000:8000 \
    vllm/vllm-openai:latest \
    --model mistralai/Mistral-7B-Instruct-v0.3
```

CONSUME



```
import requests

headers = {
    "Content-Type": "application/json",
}

# OpenAI-Compatible Server
data = {
  "model": "mistralai/Mistral-7B-Instruct-v0.3",
  "prompt": "What is Deep Learning?",
  "max_tokens": 20,
  "temperature": 0
}

response = requests.post('http://localhost:8000/v1/completions', headers=headers, json=data)
print(response.json())
```

See More: https://docs.vllm.ai/en/stable/index.html

Ray Serve

➔ **Cool Features**

- Monitoring/observability with Prometheus/Grafana
- Autoscaling across replicas w/ zero downtime
- Fractional GPU support

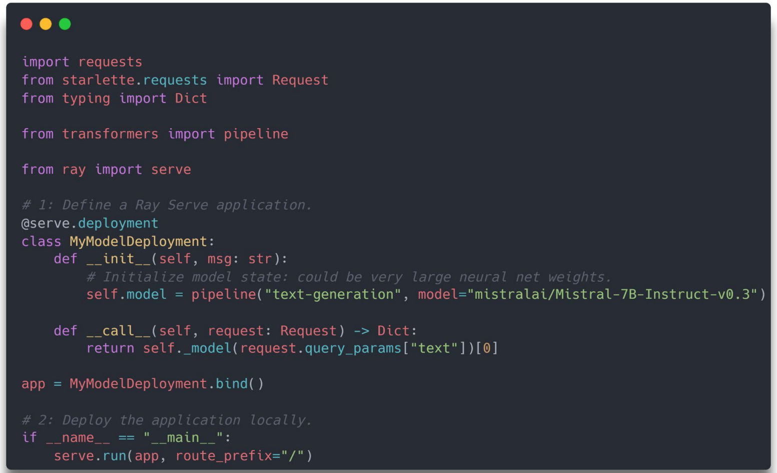
➔ **Advantages**

- Framework/vendor agnostic and flexible
- Integration with Ray ecosystem - most mature framework.
- Extensive documentation/examples

➔ **Limitations**

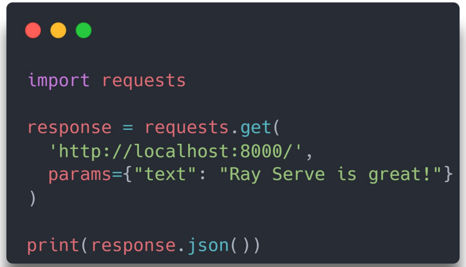
- Require deploying/managing a Ray Cluster
- More code than a single Docker command
- Not focused on LLMs

LAUNCH



```python
import requests
from starlette.requests import Request
from typing import Dict

from transformers import pipeline

from ray import serve

# 1: Define a Ray Serve application.
@serve.deployment
class MyModelDeployment:
    def __init__(self, msg: str):
        # Initialize model state: could be very large neural net weights.
        self.model = pipeline("text-generation", model="mistralai/Mistral-7B-Instruct-v0.3")

    def __call__(self, request: Request) -> Dict:
        return self._model(request.query_params["text"])[0]

app = MyModelDeployment.bind()

# 2: Deploy the application locally.
if __name__ == "__main__":
    serve.run(app, route_prefix="/")
```

CONSUME



```python
import requests

response = requests.get(
  'http://localhost:8000/',
  params={"text": "Ray Serve is great!"}
)

print(response.json())
```

See More: https://docs.ray.io/en/latest/serve/

TL;DR

1. **vLLM**: when you care about speed and the model you want is supported.
2. **TGI**: for native HuggingFace support; great for rapid prototyping
3. **Ray Serve**: for mature production-ready projects.

My favorite option: ***Ray Serve + vLLM together!***

Honorable Mentions:

4. **MLC LLM**: Natively deploy LLMs on the edge (ie Android or iPhone)
5. **CTranslate2**: C++ and Python library for efficient execution
6. **LocalAI**: OpenAI compatible framework optimized for a collection text, audio, and image models