INDUCTIVA

FOAM@IBERIA 2024

Easily Deploy OpenFOAM Applications with Python and Cloud HPC

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www.inductiva.ai

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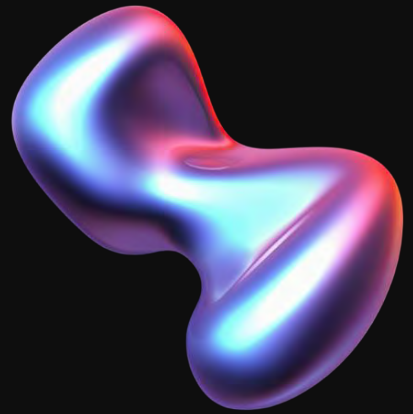
About Inductiva

We are a cloud-based **High-Performance Computing (HPC) platform** designed to make running large-scale simulations easy, fast, and cost-effective.

With our flexible **Python API**, you can run simulations seamlessly—without worrying about complex infrastructure.

With our **streamlined, user-friendly platform**, Inductiva empowers you to focus on innovation and research while cutting costs and speeding up your work.



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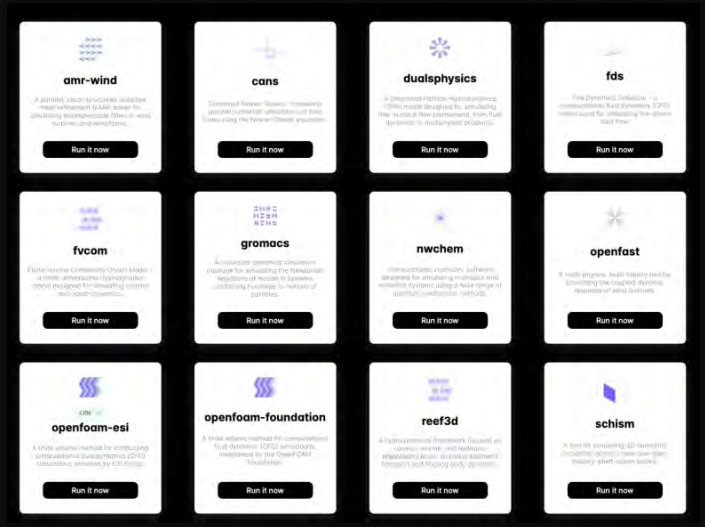
What Makes Inductiva.AI Special?

We are Open Source

Inductiva is built on open-source principles, providing transparency and flexibility.

Our API also includes a variety of **open-source simulators**, such as OpenFOAM, DualSPHysics, and Reef3D, with more being added regularly.



INDUCTIVA.AI/SIMULATORS

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What Makes Inductiva.AI Special?

We are Transparent

Inductiva allows you to track your simulations with ease through an intuitive **Web console**.

Gain clearer insights into your simulation and platform usage with updated dashboards, offering a detailed overview of task performance, disk usage, and active machine groups.

CONSOLE.INDUCTIVA.AI

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What Makes Inductiva.AI Special?

We are Cost Effective

Inductiva helps you reduce computational costs and scale resources as needed through:

Preemptible machines: Take advantage of cheaper, short-term computing resources.
Flexible execution: Choose to run simulations on the cloud or locally.
Elastic Machine Groups: Automatically scale resources based on demand.
MPI clusters: Distribute workloads efficiently for faster, cost-effective simulations.
Checkpointing: Save your progress and resume simulations without starting over. (soon)

```
import inductiva
machine_group = inductiva.resources.MachineGroup(
    machine_type="c2-standard-16",
    num_machines=2,
    data_disk_gb=100,
    spot=True)
```

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What Makes Inductiva.AI Special?

We are Easy to Use

Inductiva is designed with an **API-first approach.**

Build your simulations directly on top of our API, integrating seamlessly with your existing workflows.

No need to manage complex infrastructure—focus on your simulations, not the backend.

```
# Set the simulation commands
commands = [
 "runApplication surfaceFeatures",
 "runApplication blockMesh",
 "runApplication decomposePar -copyZero",
 "runParallel snappyHexMesh -overwrite",
 "runParallel potentialFoam",
 "runParallel simpleFoam",
 "runApplication reconstructParMesh -constant",
 "runApplication reconstructPar -latestTime"
]
```

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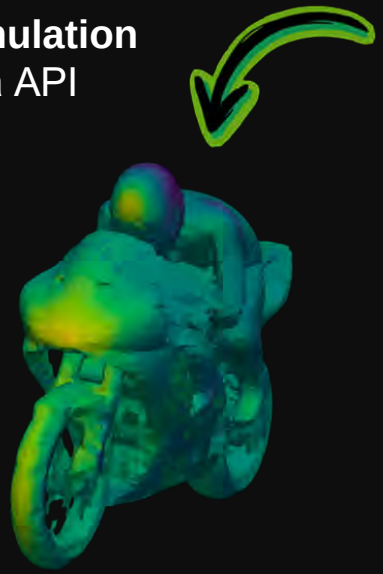
Simulations **Made Easy**

An Example: Run a Wind Tunnel Simulation

1. **Submit your simulation** with the Inductiva API
1. Get your **result**



```python
import inductiva

# Instantiate machine group
machine_group = inductiva.resources.MachineGroup('c2-standard-4')
machine_group.start()

# Set simulation input directory
input_dir = inductiva.utils.download_from_url(
 "https://storage.googleapis.com/inductiva-api-demo-files/"
 "openfoam-input-example.zip", unzip=True

# Initialize the Simulator
openfoam = inductiva.simulators.OpenFOAM(distribution="foundation")

# Run simulation with config files in the input directory
task = openfoam.run(input_dir=input_dir,
 commands=commands,
 n_vcpus=4,
 on=machine_group)

task.wait()
task.download_outputs()

machine_group.terminate()
```

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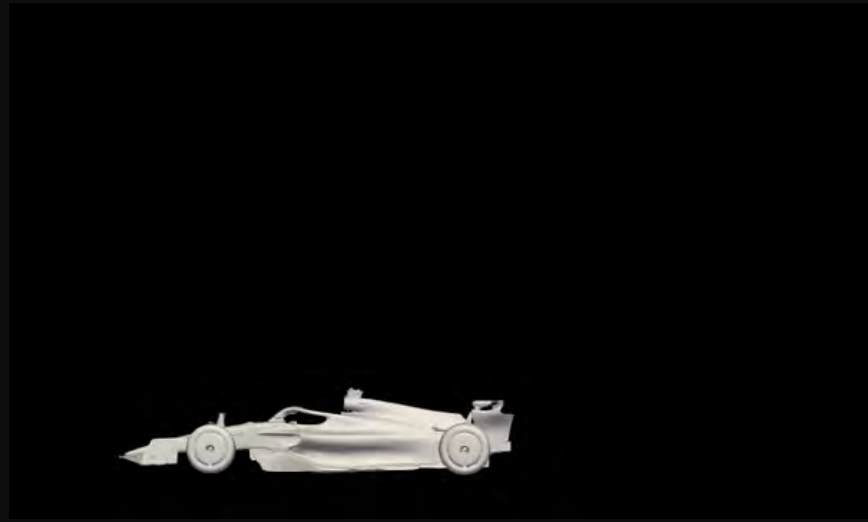
From a Simulation Workflow to a **Simulation App**

An Example: Build a Wind Tunnel App

1. Define **OpenFOAM Input Files.**
2. Make relevant **parameters configurable.**
3. Define a **Python interface** with the Inductiva API.



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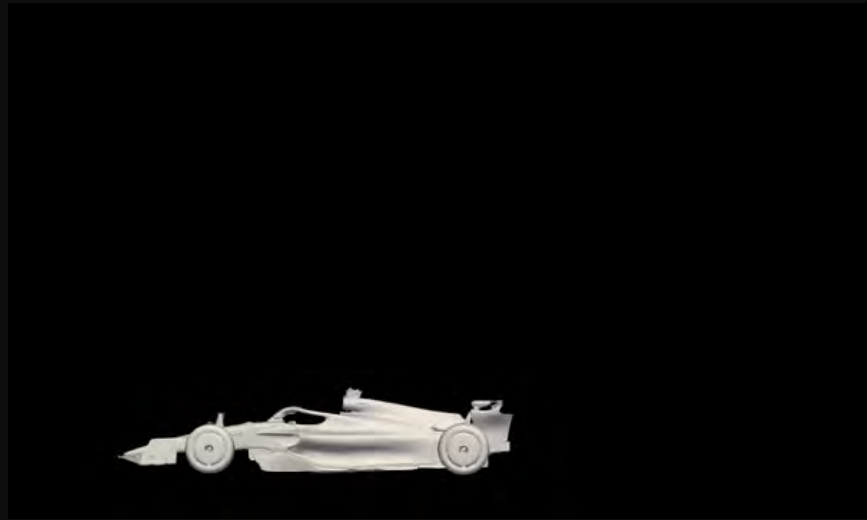
An Example: Build a Wind Tunnel App

Step 1: Define **OpenFOAM Input Files.**

Gather all the required input files for OpenFOAM and place them in a directory.

For the wind tunnel simulation, you'll need the **0**, **constant**, and **system sub-directories**, each containing the appropriate initial and boundary conditions, physical properties, and solver settings.



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An Example: Build a Wind Tunnel App

Step 2: Make relevant **parameters configurable.**

Modify the OpenFOAM input files so that key simulation parameters become variables.

These variables can be dynamically filled by the **Inductiva TemplateManager**, allowing for customized simulations.

```
1    dragDir          (1 0 0);
2    CofR             (1 0 0);  // Axle midpoint on ground
3    pitchAxis        (0 1 0);
4    magUInf          {{ wind_speed }};    // Wind-speed
5    lRef             {{ length }};        // Wheelbase length
6    Aref             {{ area }};          // Object projection area
```

Detail view of the system/forceCoeffs configuration file.

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An Example: Build a Wind Tunnel App

Step 3: Define a **Python interface** with the Inductiva API.

```python
import inductiva
class WindTunnel:

    def __init__(self, dimensions: tuple[int, int, int] = (20, 10, 8)):
        ...

    def set_object(self,
                   object_path: str,
                   rotate_z_degrees: float = 0,
                   normalize: bool = True,
                   center: bool = True):
        ...

    def simulate(self,
                 wind_speed_ms: float,
                 num_iterations: int,
                 resolution: int,
                 machine_group_name: str = None,
                 inputs_dir: str = "./inductiva_input"):
        ...
```

Creating python package

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What Can You Do with Your New **Wind Tunnel App?**

Run a Simulation and Share the App

You can easily share your Python package with your team or collaborators, and use it to submit simulations—all through a **simple Python interface**.

```python
from windtunnel import WindTunnel

wind_tunnel = WindTunnel(dimensions=(20, 10, 8))

wind_tunnel.set_object(object_path="tractor.obj")
task = wind_tunnel.simulate(wind_speed_ms=20, num_iterations=300, resolution=5)
```

Submitting a Simulation Using Your Python Package

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What Can You Do with Your New **Wind Tunnel App?**

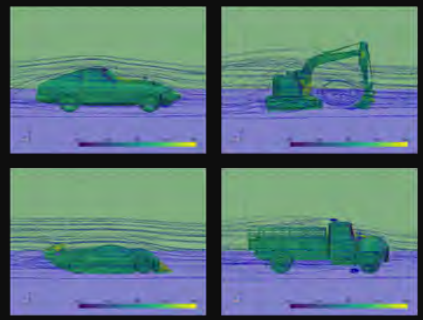
Run Multiple Simulations in Parallel

```python
from windtunnel import WindTunnel

wind_tunnel = WindTunnel(dimensions=(20, 10, 8))

for fname in ["car", "excavator", "race_car", "truck"]:
  wind_tunnel.set_object(object_path=f"assets/{fname}.obj")

  for wind_speed_ms in [10, 30, 50]:
    task = wind_tunnel.simulate(
      wind_speed_ms=wind_speed_ms, num_iterations=300, resolution=5
    )
```



Running Multiple Simulations in Parallel
Using Your Python Package

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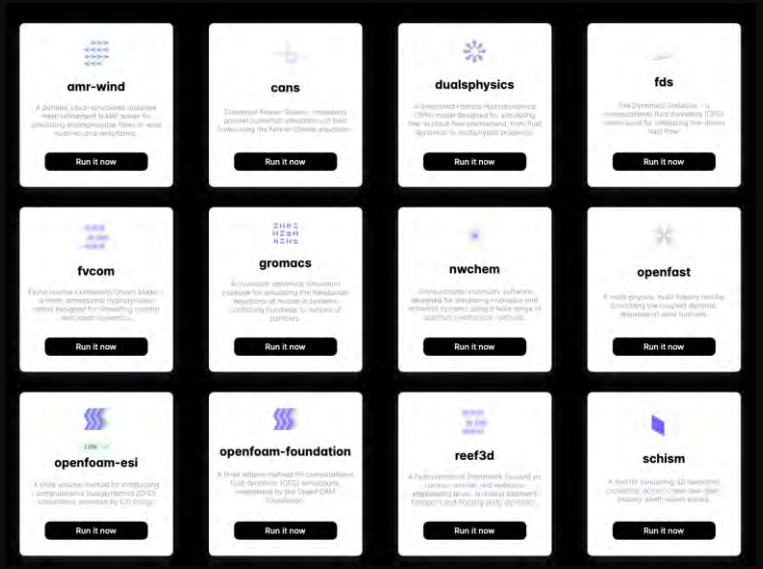
Use Our API—No Matter the Domain

You can apply the same recipe across different domains, from fluid and coastal dynamics to structural mechanics and even molecular dynamics

- ➔ Choose from a variety of built-in, ready-to-use **open-source simulators**, no setup headaches required
- ➔ Build your own app using **the same simple approach**.



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We Generated a 20k Wind Tunnel Dataset

Using the Inductiva API and our wind tunnel package, we generated a dataset of automobile-like objects:

- ➔ The dataset is **open source** with **20,000 samples**.
- ➔ It includes **force coefficients**, **pressure maps**, and **streamlines**.
- ➔ And best of all? It's **free to download!**

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Thank You!

Any questions?

Get in Touch

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