Towards Green AI
Tracking and Curtailing Carbon Footprint of AI Python Code with CodeCarbon

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tinyurl.com/iiit-codecarbon

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- **International Tech Speaker**
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Flow of the Talk

- Understanding Carbon Footprint
- Carbon Emissions and Compute
- CodeCarbon Package
- CO_2 Equivalents of Python Code
- Visualization and Reporting
- Q/A

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Carbon Footprint

Total Greenhouse Gas Emissions caused by an individual, event, action, organization, service, place or product, expressed as Carbon Dioxide equivalent

Carbon Emissions and Compute

- Organizations are heavily investing in ML/AI Research, Connected Systems, and High Performance Computing
- More computing power ~ More impact on the planet
- Datacenters consume 1%-2% of total energy generated worldwide each year
- Energy used by datacenters has doubled over the past decade and will quadruple within the next decade

Ref. 1

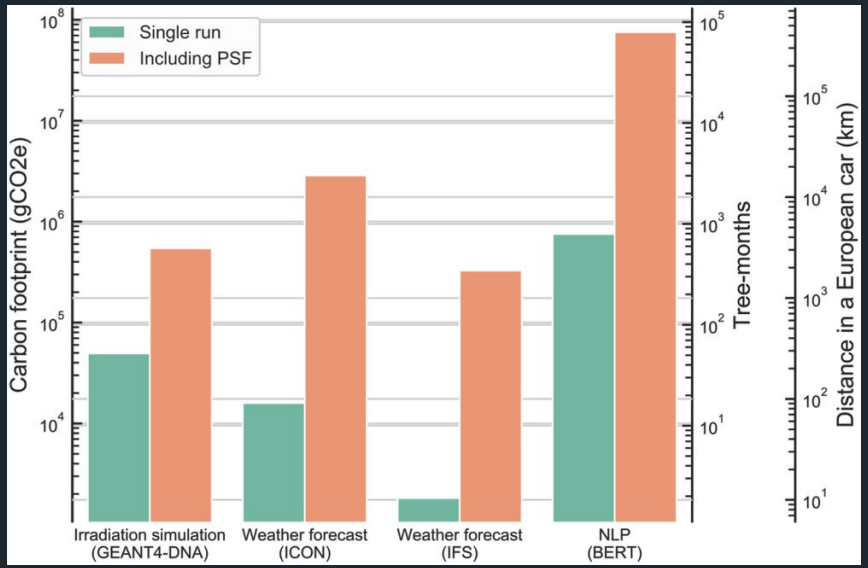
Carbon Intensity

The carbon intensity of computing is directly related to the quantity and source of electricity it uses, measured in grams of CO_2-equivalent (gCO_2e) per kilowatt-hour of power consumed

Factors Influencing Carbon Intensity

- Energy Source(s)
  - Coal, Petroleum, Natural Gas, Tidal/Hydro, Wind, etc.
- Region (even the cloud server region)
- Compute Time
- Hardware
  - CPUs, GPUs, TPUs, etc.

Carbon Emissions and Compute



The figure shows grams (g) of Carbon Dioxide (CO_2) equivalent (e) compared to the amount of carbon sequestered by trees and the emissions from a car.

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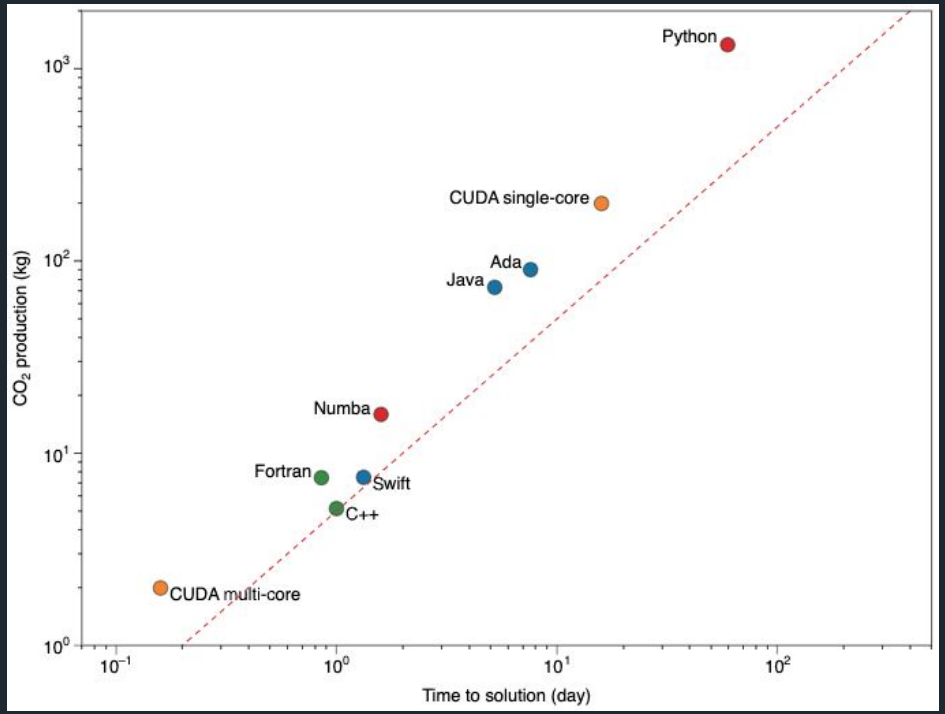
Carbon Emissions and Coding

- Optimized code runs faster and produces fewer emissions
- Carbon Emissions even vary depending on the underlying coding/programming language
- Python, generally takes a longer time to run and produces more emissions than other popular languages, if coded inefficiently

Carbon Emissions and Coding



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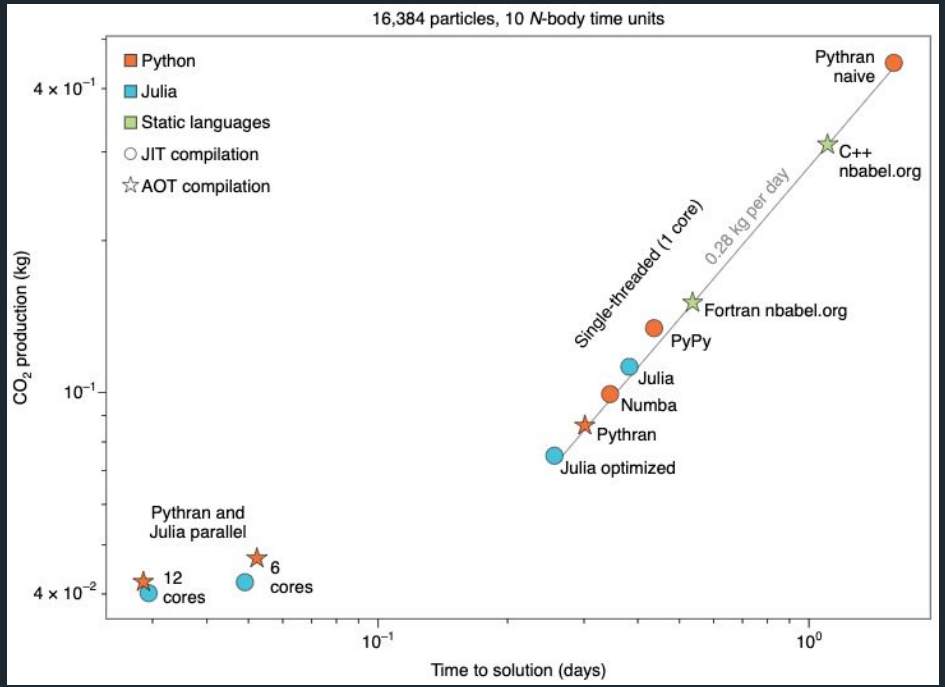
Ref. 1 | Ref. 2

Carbon Emissions after Optimizations



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Ref. 1

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CodeCarbon

- Open Source Python PIP Package
- Carbon emission tracking based on power consumption and location-dependent Carbon Intensity
- Seamless integration into Python code
- Estimation for both Cloud and On-premise (private) computing resources

Getting Started with CodeCarbon

- Install the CodeCarbon Package
- Checkout the official documentation
- Embed CodeCarbon in the Python codebase
- Run the code and let CodeCarbon do the tracking
- Visualize the carbon emissions using the dashboards and reports
- Follow recommendations and perform optimizations

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Online #1: Embedding CodeCarbon

```python
from codecarbon import EmissionsTracker

tracker = EmissionsTracker()
tracker.start()

# GPU Intensive code goes here

tracker.stop()
```

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Online #2: CodeCarbon Decorator

```python
from codecarbon import track_emissions

@track_emissions
def training_loop():
    # GPU Intensive code goes here

if __name__ == "__main__":
    training_loop()
```

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Online #3: CodeCarbon Context Mngr.

```python
from codecarbon import EmissionsTracker

with EmissionsTracker() as tracker:
    # GPU Intensive code goes here
```

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Offline #1: Embedding CodeCarbon

```python
from codecarbon import OfflineEmissionsTracker

tracker = OfflineEmissionsTracker(country_iso_code="CAN")
tracker.start()

# GPU Intensive code goes here

tracker.stop()
```

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Offline #2: CodeCarbon Decorator

```python
from codecarbon import track_emissions

@track_emissions(offline=True, country_iso_code="CAN")
def training_loop():
    # GPU Intensive code goes here

if __name__ == "__main__":
    training_loop()
```

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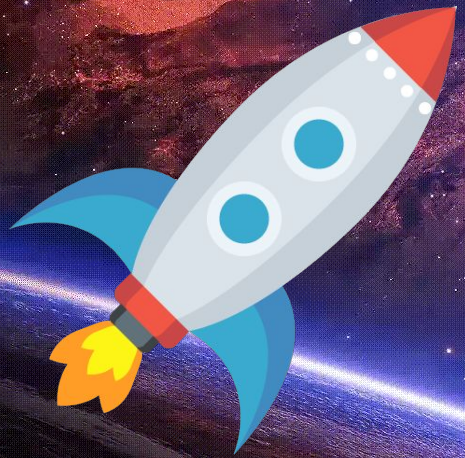

Demo: Tracking and Visualizing Carbon Emissions of MNIST

(tinyurl.com/iiit-codecarbon)

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Noteworthy Points

- CodeCarbon only writes the CSV format outputs for the carbon emissions in the directory where the code is executing
  - The CSV file gets written once the complete code execution is done
- ***flush()*** mechanism can be used to register carbon emissions related intermediate data while running for long running code

Key Takeaways

- Inefficient coding can cost a fortune *(not only money but the planet itself)*
  - Operations optimization is must
- Measure and report carbon footprint of algorithms to make sustainable choices through optimizations
  - CodeCarbon provides *ESTIMATES*
- Choose cloud server regions wisely
- Spread a word in the community to curb Carbon Footprint

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Happy Green Coding!

tinyurl.com/iiit-codecarbon

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#CodeCarbon
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