BRICS & IDIA: Data Analytics Training

Statistical Analysis

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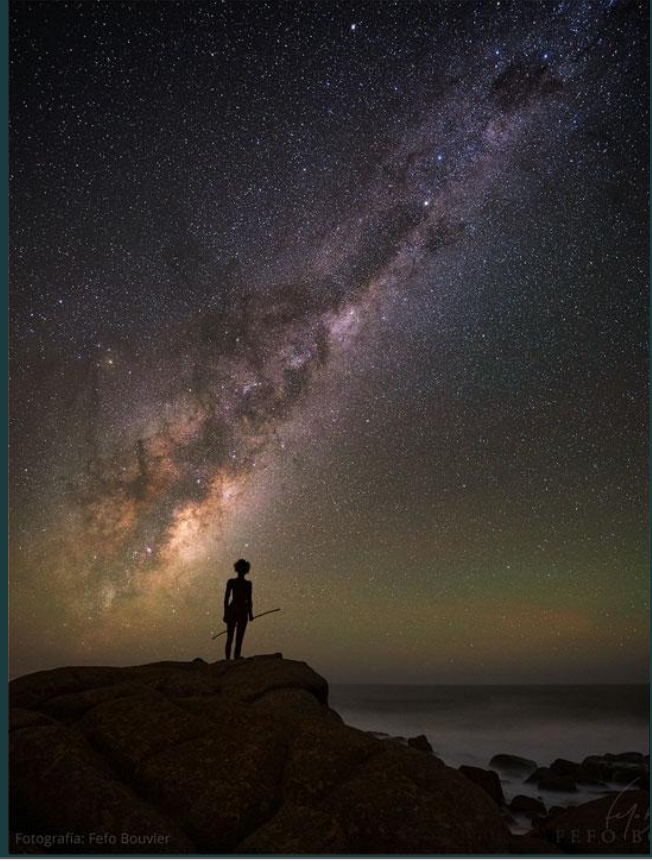

BRICS ASTRONOMY

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IDIA

Content *overview*

Why Python?

Open-source ecosystem: Collaborative, free, and constantly evolving.

Versatility: From data cleaning to machine learning.

Integration: Libraries work seamlessly together.

Community: Widely adopted in academia and industry.

Key Tools Covered:

Pandas: Data manipulation.

NumPy: Numerical computing.

SciPy: Advanced statistics.

Statsmodels: Statistical modeling.

NumPy – The Foundation

What is NumPy?

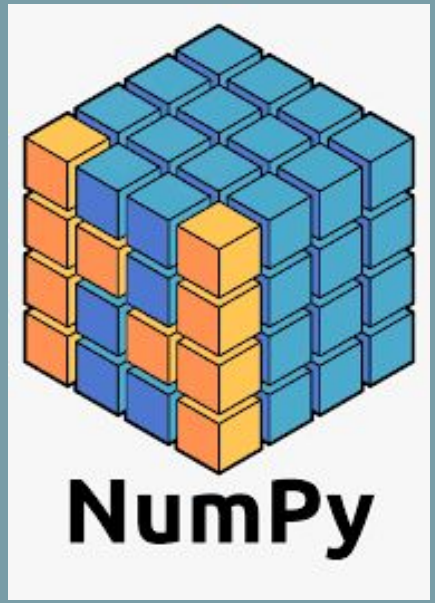
- **Core library** for numerical computing.
- Provides **n-dimensional arrays** (vectors, matrices).

Why It Matters:

- **Efficiency:** Optimized for speed (written in C/Fortran).
- **Universal:** Underpins nearly all scientific Python libraries.
- **Math operations:** Linear algebra, Fourier transforms, random number generation.

Use Cases:

- Handling large datasets (e.g., astronomical measurements).
- Matrix operations for simulations.



Pandas – Data Manipulation

What is Pandas?

- **DataFrame-centric library** for structured data.
- Built on NumPy, optimized for tabular data.

Key Features:

- **Load data:** CSV, Excel, SQL, JSON.
- **Clean data:** Handle missing values, duplicates.
- **Filter/transform:** Subset rows, calculate new columns.
- **Merge datasets:** Combine data from multiple sources.

Why It Matters:

- Simplifies **data wrangling** (80% of data science work).
- Enables reproducible workflows.

Use Cases:

- Cleaning messy survey data.
- Aggregating experimental results.

SciPy – Scientific Computing

What is SciPy?

- **Advanced toolbox** for science and engineering.
- Built on NumPy, with specialized submodules.

Key Features:

- Statistics: Distributions, hypothesis testing (t-tests, ANOVA).
- Optimization: Minimize/maximize functions.
- Signal processing: Filtering, Fourier analysis.
- Integration: Solve differential equations.

Why It Matters:

- Provides peer-reviewed algorithms (no reinventing the wheel)
- Bridges gap between theory and application.

Statsmodels – Statistical Modeling

What is Statsmodels?

- **Library for estimating and testing statistical models.**

Key Features:

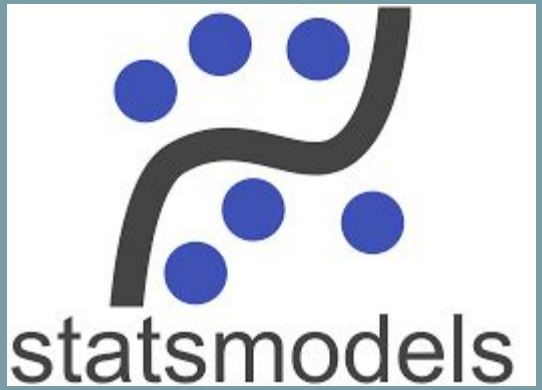
- **Regression:** Linear, logistic, time-series.
- **Hypothesis tests:** T-tests, chi-square, ANOVA.
- **Diagnostics:** Model accuracy, residual analysis.

Why It Matters:

- Provides **interpretable results** (p-values, confidence intervals).
- Essential for **quantitative research.**

Use Cases:

- Predicting galaxy brightness from distance.
- Validating experimental hypotheses.



Workflow Integration

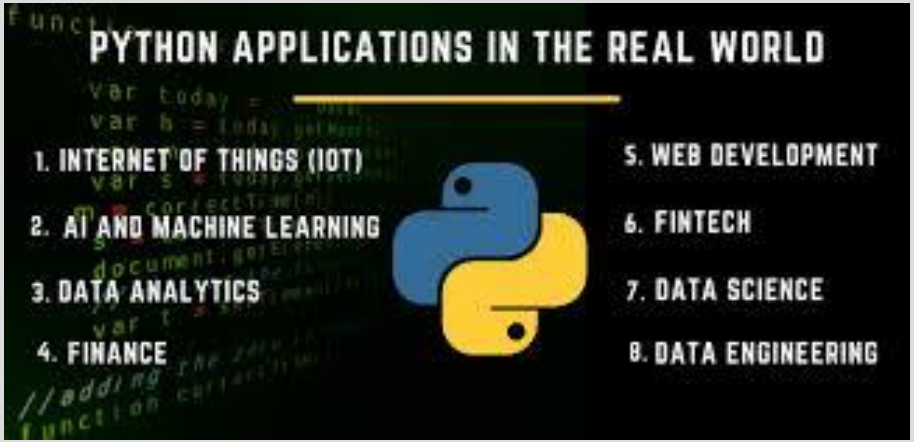
Typical Data Analysis Pipeline:

1. **Load & Clean:** Pandas.
2. **Transform:** NumPy/Pandas.
3. **Analyze:** SciPy/Statsmodels.
4. **Model:** Statsmodels.

Why Integration Matters:

- **End-to-end analysis** in one ecosystem.
- Reduces errors from switching tools.

Real-World Applications



Astronomy

- Filtering Gaia star catalogs (Pandas).
- Testing if bright stars move faster (SciPy t-test).
- Modeling brightness vs. distance (Statsmodels).

Biology

- Cleaning genomic data (Pandas).
- Comparing gene expression (SciPy ANOVA).

Finance

- Predicting stock trends (Statsmodels time-series).

Conclusion

Python's Scientific Ecosystem:

- **NumPy:** Fast arrays.
- **Pandas:** Clean data.
- **SciPy:** Advanced stats.
- **Statsmodels:** Modeling.

Why Learn These Tools?

- **Industry standard** in data-driven fields.
- **Empowers researchers** to focus on science, not coding.

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Thank you

Q & A