Modelling Species Distribution in the Great Smoky Mountains National Park

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Agenda

1. Background
2. Research Problems
3. Maximum Entropy Modeling
4. Legacy Data Pipeline
5. New Data Pipeline
6. Live Demo
7. Future Work

Background

- Species Occurrence Data from the Great Smoky Mountains National Park (GRSM)
  - Ecological and Public Research
- Species Distribution Modelling
  - Originally sequential runs
  - Scaled via High Performance Computing in Legacy Pipeline
- New Browser-based Species Mapping
  - Leaflet.js Map Application

Research Problems

1. Learning GRSM's requirements and recommending solutions (consulting)
2. Choosing the maximum number of simultaneous species/colors displayed (data visualization)
3. Learning legacy/new data pipeline (ML, data engineering)
4. Automating new data pipeline (data engineering)
5. Designing Front-end UI/UX (collaboration with UI/UX professor)
   - Researchers
   - General Public (e.g. 8th grade students)

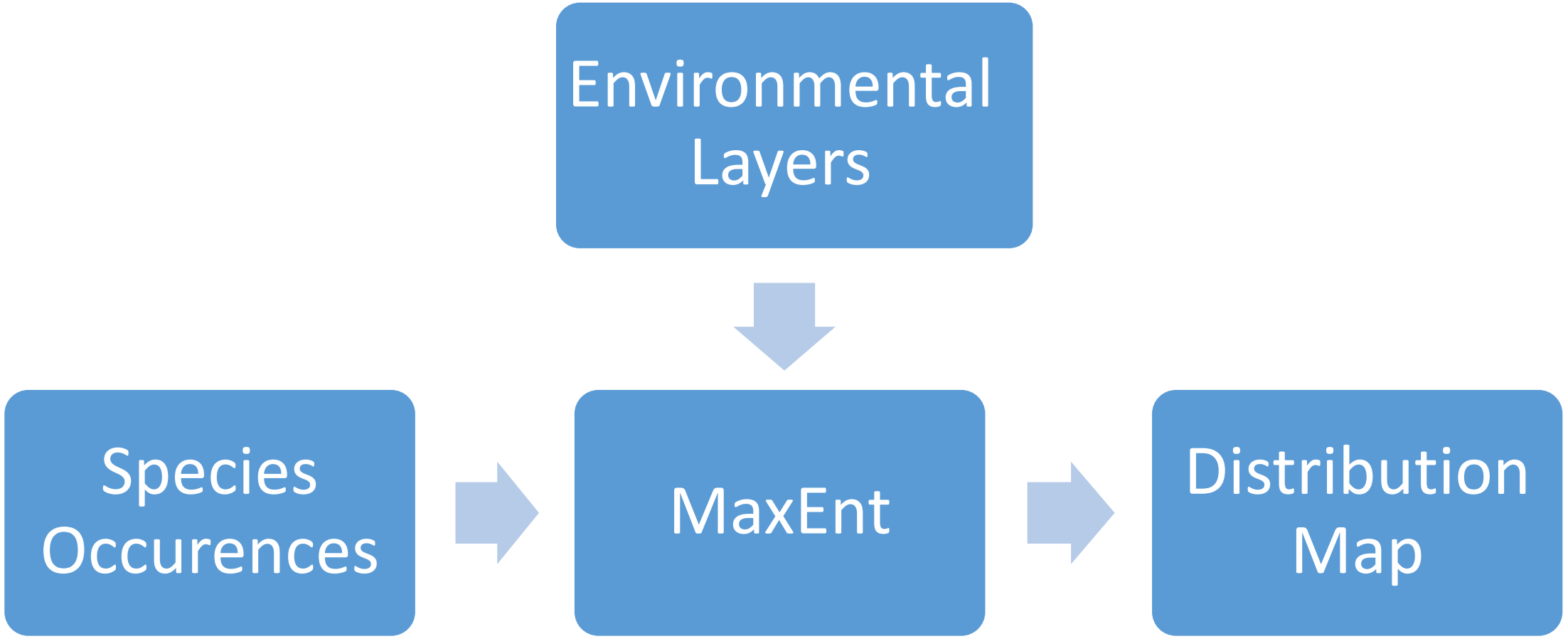
Maximum Entropy Modeling

- “A Maximum Entropy Approach to Species Distribution Modeling” (ICML 2004)
  - Skewed training data: too many positives, not few negatives.
  - “… estimate the target distribution by finding the distribution of maximum entropy … subject to the constraint that the expected value of each feature under this estimated distribution matches its empirical average.”
  - http://rob.schapire.net/papers/maxent_icml.pdf
- Maxent.jar (Java)
  - http://biodiversityinformatics.amnh.org/open_source/maxent/Maxent_tutorial2017.pdf

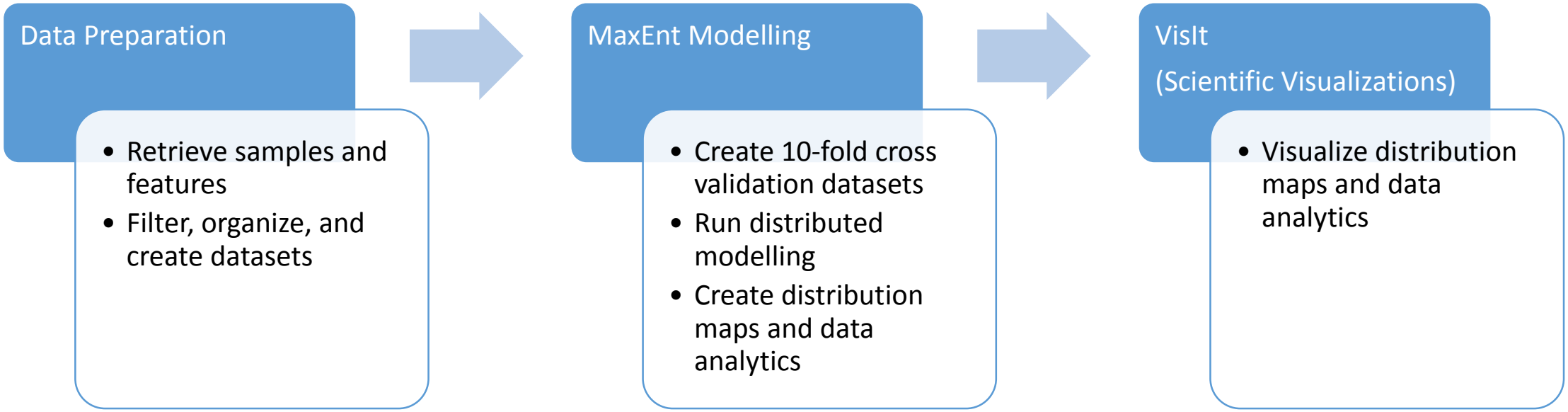
Maximum Entropy Modeling

- Samples: Species Occurrences
  - CSV format: “species name, longitude, latitude”
  - (>= 30) occurrences x ~900 species
- Features: Environmental Layers
  - ASCII Raster Grid format
  - Continuous or Categorical
  - ~50 environmental layers
- Output: Distribution Map
  - ASCII Raster Grid format
  - Pixel color corresponds to predicted distribution value

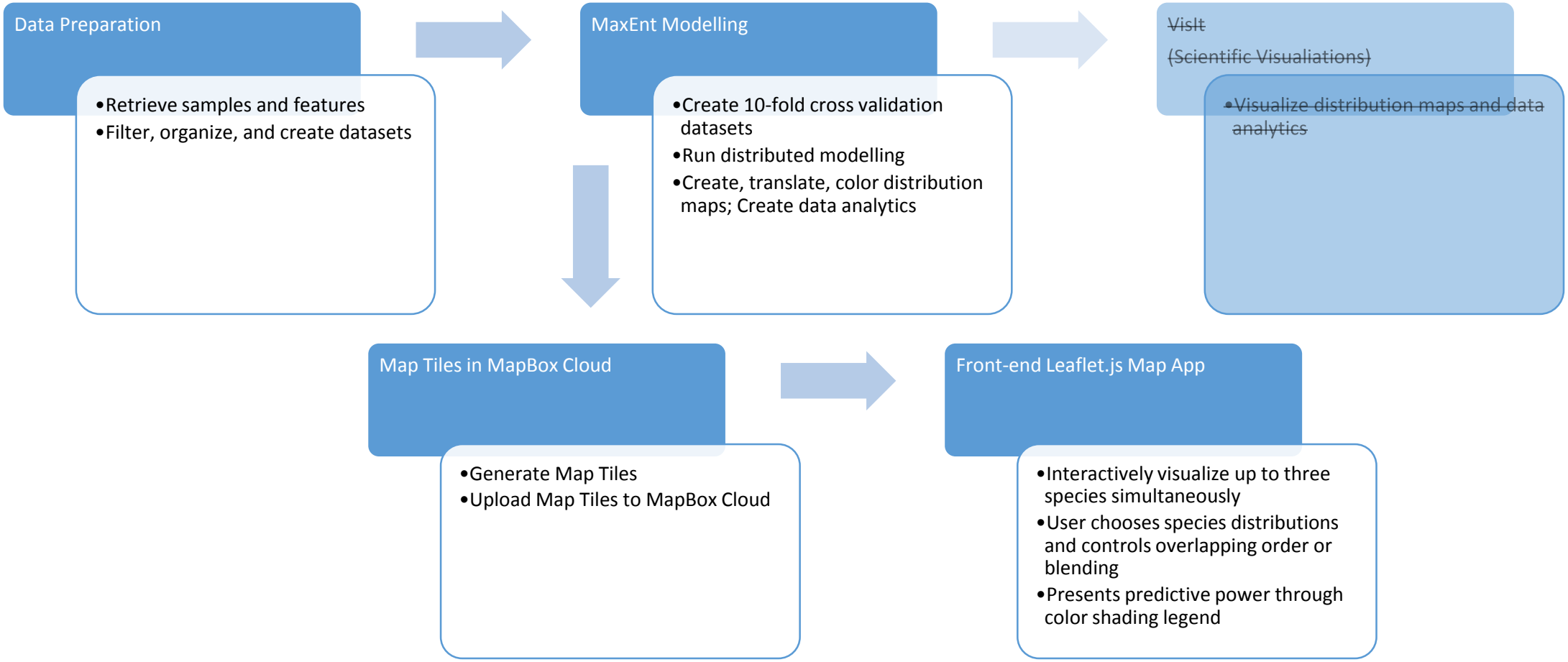
MaxEnt Workflow



Legacy Data Pipeline



New Data Pipeline



Live Demo

- https://science.nature.nps.gov/parks/grsm/species/

Future Work

- NPS Direct Control of Data Pipeline
- Tracking Historical Data
  - Analyzing/Forecasting Trends
- Public Mobile App