

Graduate Certificate in Machine Learning in Conservation Biology

## Species Distribution Modeling

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Species Distribution Modeling (SDM), also known as habitat modeling or niche modeling, is a method used in conservation biology and ecology to predict the spatial distribution of a species based on environmental variables. SDM is a valuable tool for understanding the ecological requirements of a species, identifying suitable habitats, and assessing the potential impacts of climate change and land use change on species distributions.

Related Terms: Habitat modeling, Niche modeling, Ecological niche modeling, MaxEnt, ENFA, GAM, Random Forest, Boosted Regression Trees, Species distribution, Conservation biology, Ecology, Climate change, Land use change.

Explanation: Species Distribution Modeling uses statistical and machine learning techniques to analyze the relationship between species occurrence data and environmental variables such as temperature, precipitation, elevation, land cover, and soil characteristics. By quantifying these relationships, SDM can generate maps that predict where a species is likely to occur, providing valuable information for conservation planning, ecological research, and management decisions.

Example: For example, a researcher studying the distribution of a rare orchid species may collect occurrence data at different locations and then use SDM to predict suitable habitats based on factors such as temperature, precipitation, and soil pH. This information can help identify areas where the orchid is most at risk and guide conservation efforts to protect its habitat.

Practical Applications: Species Distribution Modeling has a wide range of practical applications in conservation biology, ecology, and natural resource management. Some common applications include:

- Identifying suitable habitats for endangered species
- Assessing the potential impacts of climate change on species distributions
- Prioritizing areas for conservation based on species richness and rarity
- Designing protected areas and wildlife corridors to enhance biodiversity
- Monitoring changes in species distributions over time

Challenges: While Species Distribution Modeling is a powerful tool, it also has several challenges and limitations that researchers need to consider:

- Data quality: SDM relies on high-quality occurrence data and accurate environmental variables. Incomplete or biased data can lead to inaccurate predictions.
- Model selection: There are many different modeling techniques available, each with its strengths and weaknesses. Choosing the right model for a given dataset can be challenging.
- Overfitting: Overfitting occurs when a model is too complex and captures noise in the data rather than the

underlying patterns. Regularization techniques can help prevent overfitting.

- Extrapolation: SDM models are trained on existing data, so extrapolating predictions to new areas or future conditions can be risky. Careful validation and uncertainty analysis are essential.

Overall, Species Distribution Modeling is a valuable tool for understanding and predicting species distributions, but researchers must be mindful of its limitations and uncertainties when interpreting results and making management decisions.