SSA 200
Strategic Use of Data

Lecture slides, activities, and additional supplementary materials are available online at:
ssa200.auburn.edu

What is a model?

The purpose of modeling

- Statistical analysis of data
- Use statistical analysis to predict the future
- Explaining variation
- Using data analysis to understand ecological processes
- Predict patterns in the future
- Evaluate competing hypothesis about how the system works

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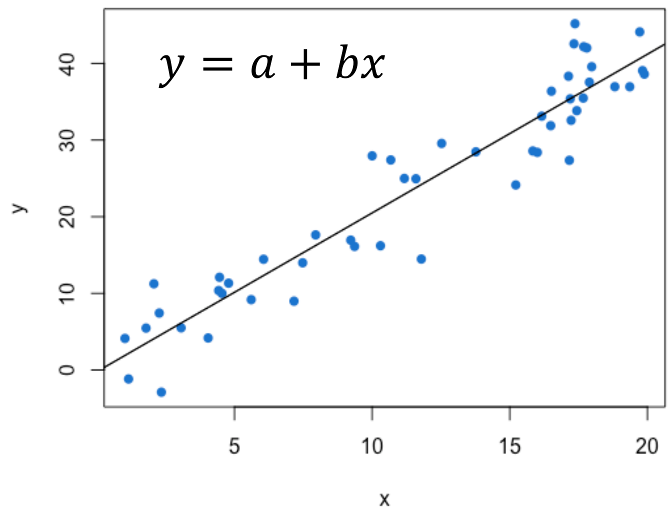
Statistical distributions

Name	Continuous or Discrete	Bounds	Common applications	Shape	Notes
Normal	Continuous	-∞, ∞	Linear regression		
Binomial	Discrete	0 or 1	Occupancy Survival		
Multinomial	Discrete	0, ∞	State transitions		
Poisson	Discrete	0, ∞	Count data		
Negative Binomial	Discrete	0, ∞	Counts with many zeros		
Log-normal	Continuous	0, ∞	Population-level productivity (projections)		
Beta	Continuous	0, 1	Population rates (projections)		
Uniform	Continuous	User-defined	Variety of applications (projections)		

Linear regression and AIC

General linear model – response variable (y) has a Normal distribution

Generalized linear model – response variable (y) has some other distribution
- **Logistic** regression – Binomial distribution
- **Poisson** regression – Poisson distribution



Parameter	Estimate	SE	*t*	p-value
Intercept	-0.22	1.29	-0.169	0.866
b	2.07	0.0978	21.16	< 0.0001

Model	AIC	ΔAIC	Np	w_i
Int + Covariate 1 + Covariate 3	345.8	0	3	0.82
Int + Covariate 1 + Covariate 2 + Covariate 3	349.1	3.1	4	0.18
Int	359.8	14.0	2	0
Int + Covariate 2	361.1	15.3	1	0

Types of uncertainty

Partial controllability – We are unable to control the exact management actions taken in a system.

Examples:
- Setting management goals – we may intend to fully restore a habitat, but may not be able to implement the exact management goals due to other logistical constraints

Observational uncertainty – We are unable to perfectly observe the state of natural systems.

Examples:
- Count data – in almost all cases, we cannot count every individual present at a specific location, but instead assume there is some probability of detecting individuals

Environmental variation – Stochastic environmental fluctuations mean that conditions typically vary randomly from year to year.

Examples:
- Predicting effects of temperature – we may estimate a relationship between temperature and survival probability that we can use to predict survival under future temperature conditions, but temperature will likely vary in a stochastic way from year to year.

Ecological uncertainty – We have an imperfect understanding of how ecological systems work.

Examples:
- Metapopulation dynamics – we think a set of populations function as a metapopulation, but have not conducted studies to explicitly estimate immigration among sites, and therefore we are unsure to what extent immigration plays a role in measured population growth rate at each site.

Some key terms

Response/dependent variable – in a statistical model, the variable that you are interested in better understanding or predicting (the "y" variable)

Predictor/independent variable – in a statistical model, the variable(s) that explain some of the observed variation in the response variable (the "x" variables)

Covariate – an environmental or ecological quantity that usually represents a stressor or species need and is included in a model as a predictor variable

Parameter – statistical quantities that are estimated to explain the relationship between predictor and response variables. Can also be used to refer to demographic vital rates of interest

Collinearity – occurs when two predictor variables in the same model are correlated with each other

Overfitting – occurs when too many predictor variables are included in the model, resulting in a model that is not very useful for prediction

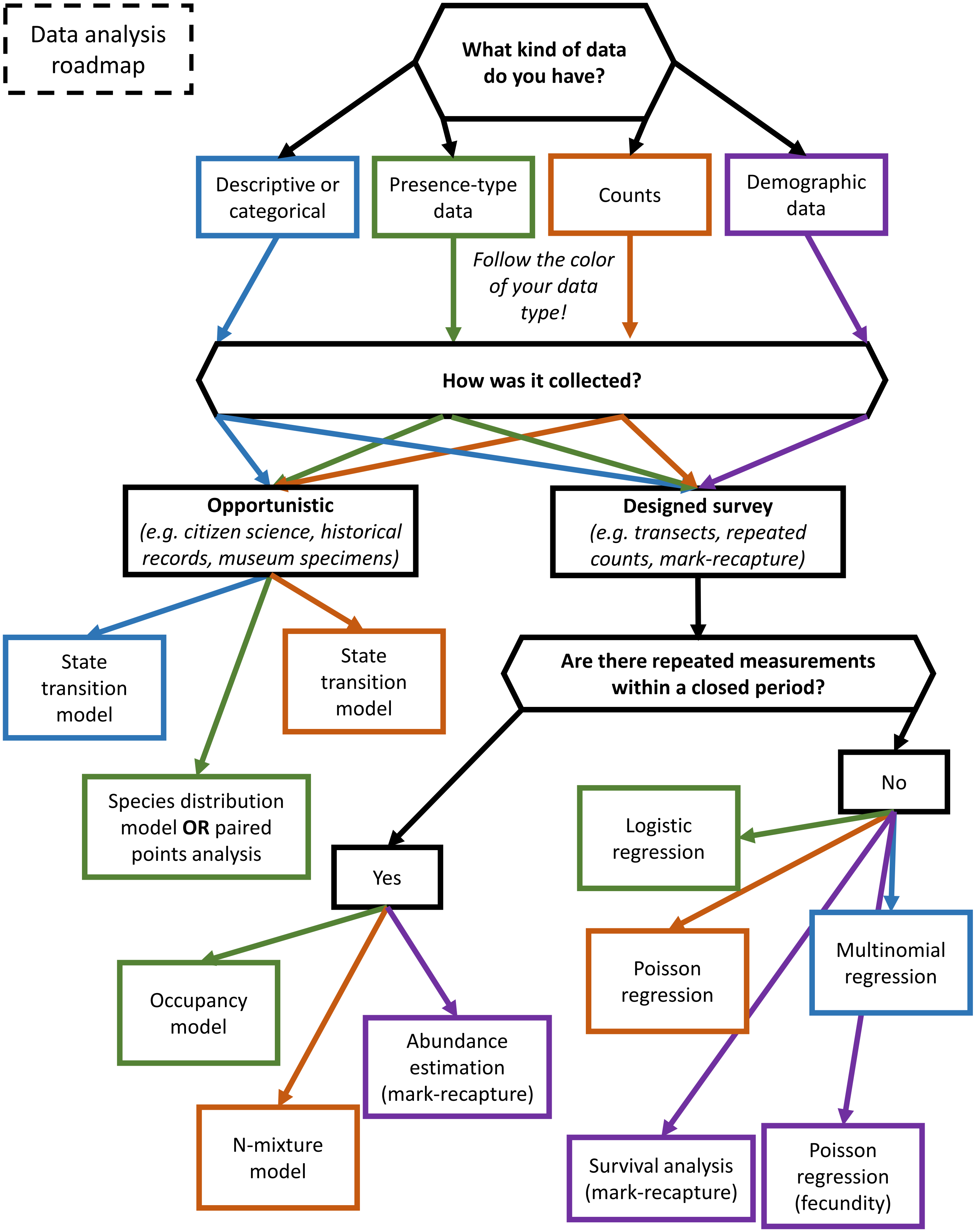
AIC – stands for Aikaike's Information Criterion – a metric used to rank models based on how well they fit the data with a penalty for the number of covariates in the model (to avoid overfitting)

Intercept – the theoretical value of the response variable if all predictors were equal to zero

Null model – the "intercept-only" model that does not include any covariates

Global model – the most complex model in the model set that includes all covariates

Population closure – an important concept for occupancy and abundance estimation, a population is considered "closed" when there are no births, deaths, immigration, or emigration



This roadmap is to serve as a general guide and is not an exhaustive list of all analysis options. Also, ***always check the specific assumptions of your planned modeling approach!***