Spatial Data Analysis in R

Deck 2: Scale and Land Cover/Land Use

Eco 697DR – University of Massachusetts, Amherst – Spring 2022
Michael France Nelson

Announcements

- Characteristic Scale Loop section of raster lab is now fixed!
  - Please re-load page
- Let's chat individually about vector lab if you had questions/issues.
- How are you doing on the raster lab?
- Mea culpa – I haven't had time to work on Moodle Wiki. If you have great ideas you want to share, hold on to them. We'll cover the Wiki on Monday.
- Land Use/Land Cover lab is almost ready: it needs a quality check. It's posted, in case you want to get started but be aware there may be some typos. Report questions will be posted soon.

Scale

Fletcher and Fortin Chapter 2

Scale

What is scale?

- What does it mean in different contexts?

Scale concepts

- Two components of scale: grain and extent
- spatial and temporal dimensions
- characteristic scale
- across-scale patterns
- hierarchy theory: levels of organization

From table 2.1: scale = “The spatial or temporal domain of a pattern or process”

Why is scale important?

Why should we think carefully about scale in our research?

- Context dependence:
  - Our research focus
  - Our system's idiosyncrasies
  - Do characteristic scales vary for our covariates?

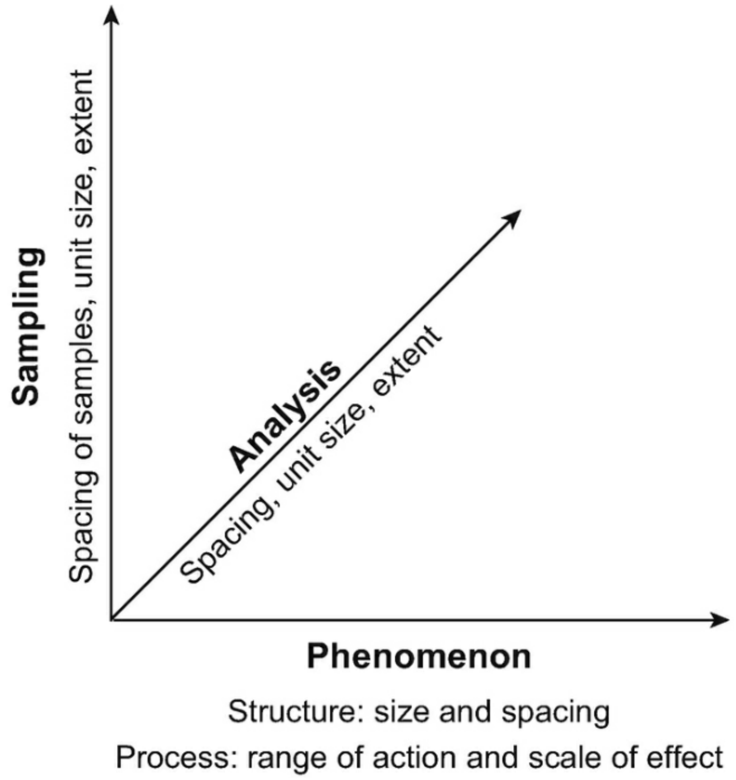
Redstarts and Flycatchers: from Fletcher & Fortin

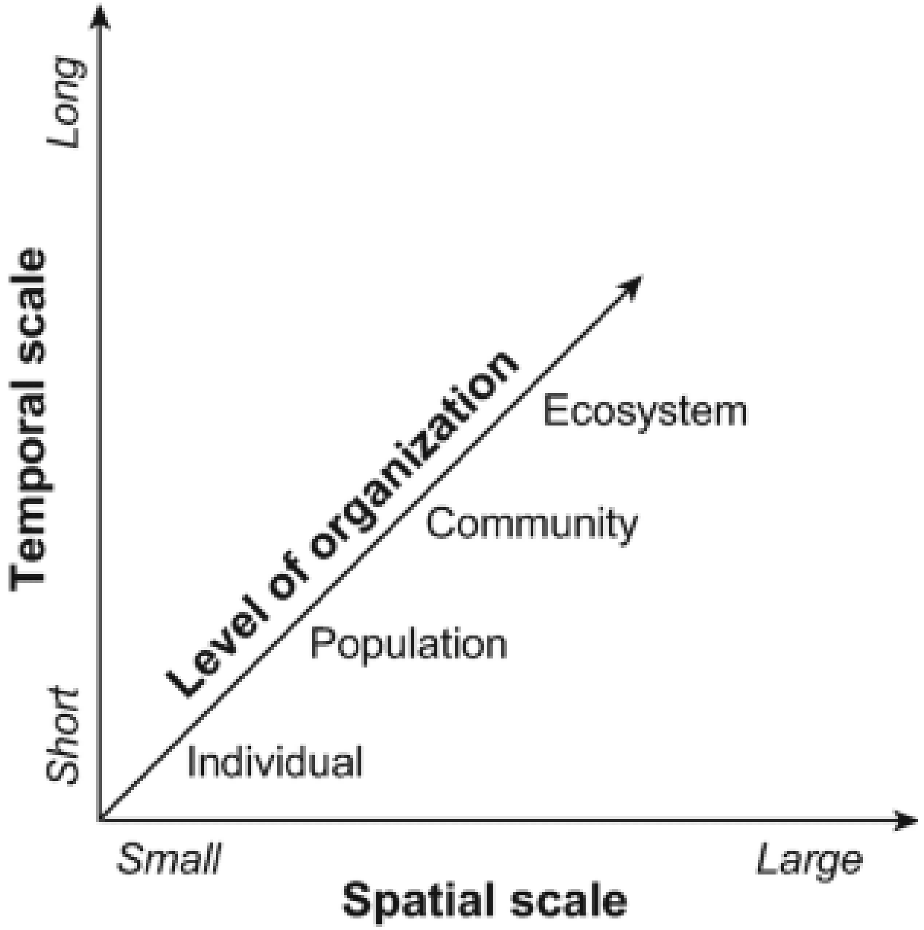
- They share similar habitat
- negative occupancy correlation at ___
- positive occupancy correlation at ___

What is the characteristic scale for flycatcher/redstart system?

Dimensions of scale: A 3D concept (Figure 2.2 in F&F)

The three axes in these figures are perpendicular





Differences among scales

What is different among different scales?

Rates of change tend to covary with spatial scale

Multiscale Concepts: within- and across-scale phenomena

Multiscale open and closed concept: giant kelp

Characteristic Scale

Characteristic Scale: Patches

What is Characteristic Scale?	**How can we determine the characteristic scale?**
Depends on how we define it. Some examples: • Scale at which patches share similar characteristics? • Scale below which patches are different? • Scale at which organisms coexist? • Scale at which organisms compete? • Comparison in scale between presences/absences?	Depends on how we define characteristic scale. Some examples: • Quantify variability landscape metrics (composition) at different spatial scales. • Quantify territory size • Determine size of resource patches • Infer optimal kernel or buffer parameters

Characteristic scale - 5 lined skink example

Which land cover types did they consider?

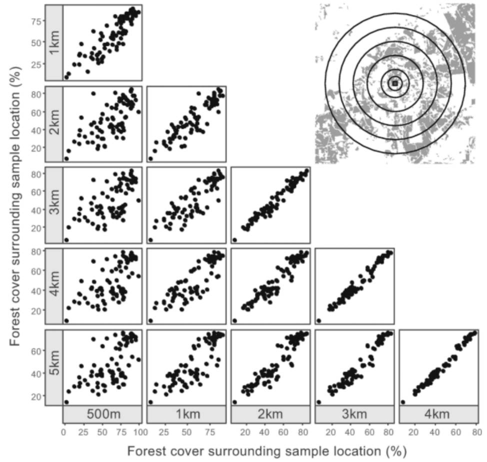
1. Forest types: conifer, deciduous, mixed

2. Why did they remove the sample sites on corn fields?

How did they determine characteristic scale?

- Site Characteristics: graphical approach: Fig 2.9

- Presence/absence: buffer size logistic regressions



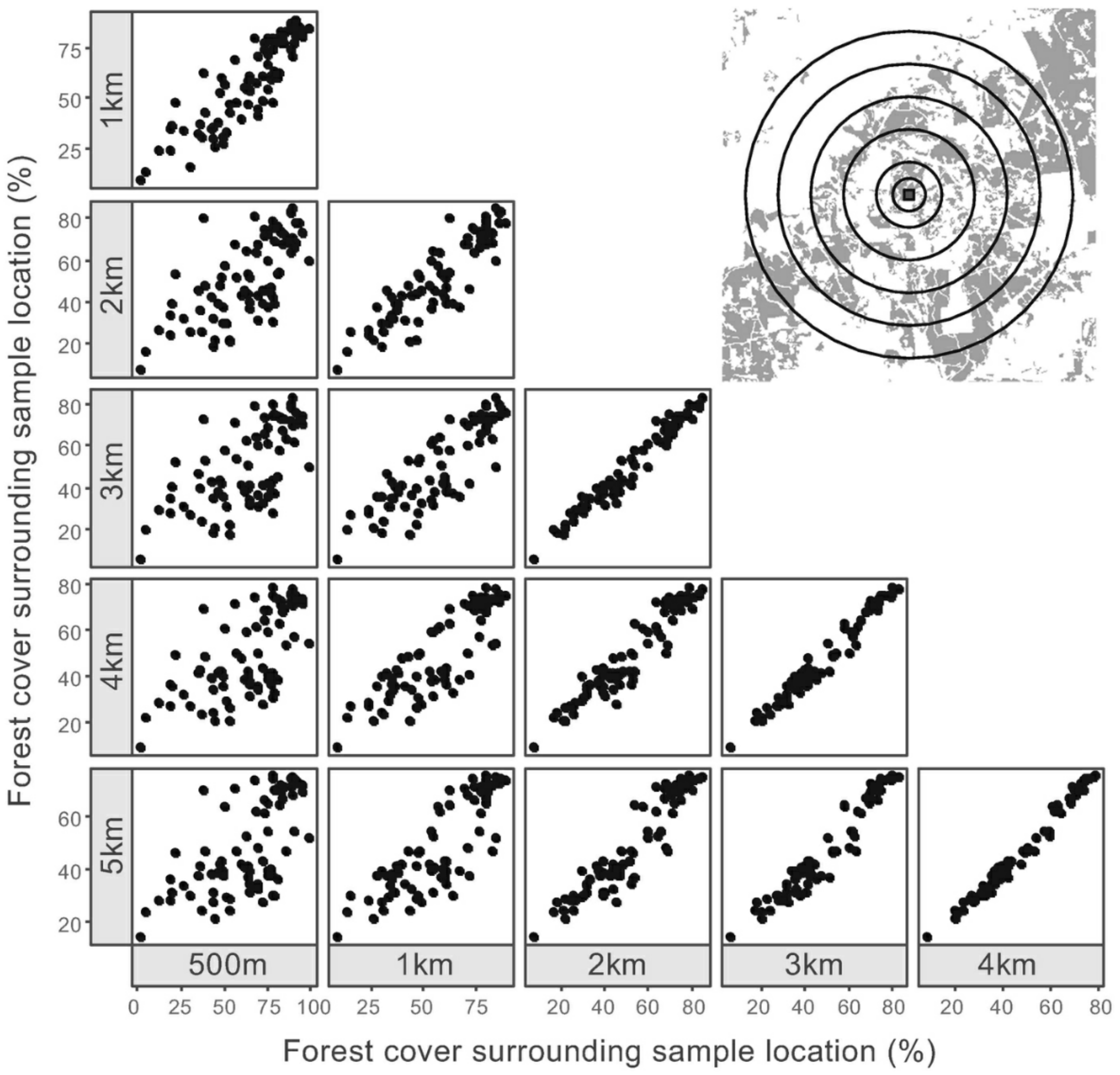
F&F 5-lined skink example: buffers and kernels

Pairwise plots of forest cover at different buffer sizes (fig 2.9):

Figure 2.9 contains a lot of information.

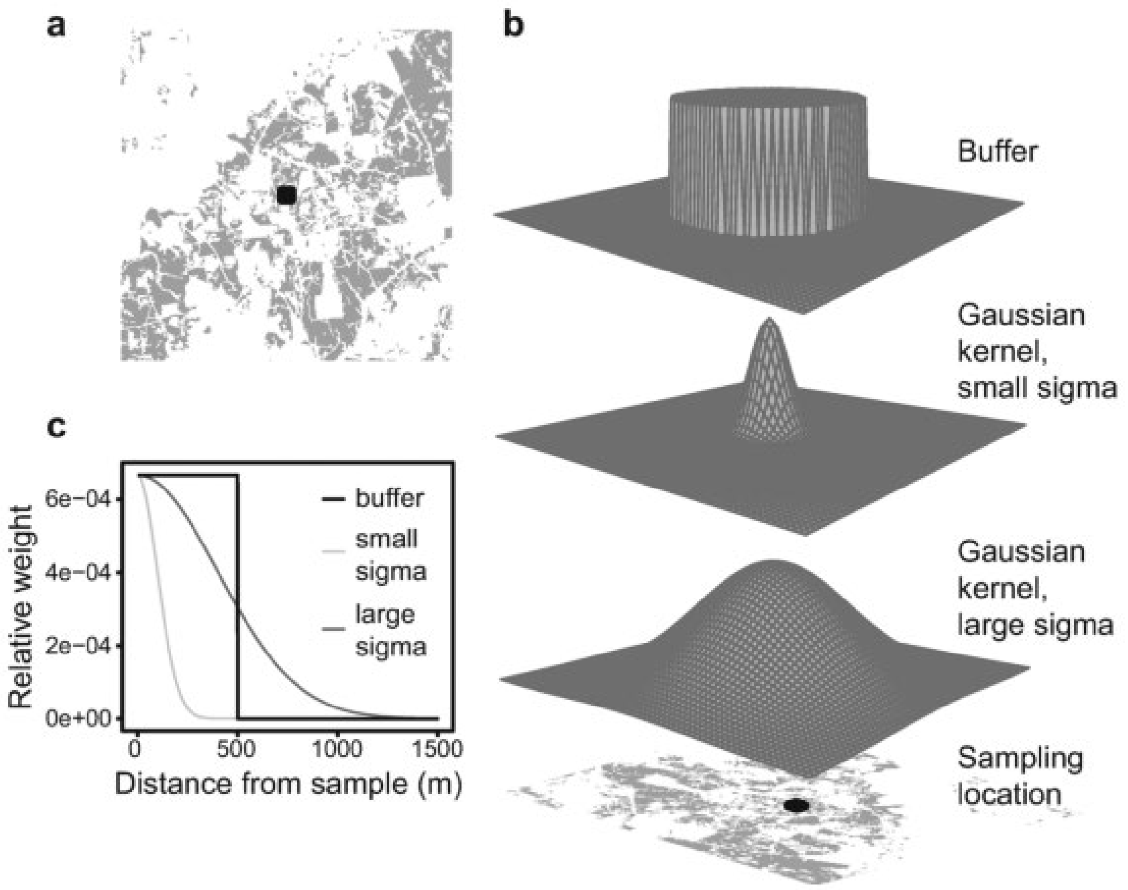
Can we explain the patterns in figure 2.9?

- Is there a characteristic scale for forest cover?
- Does this figure describe *composition*, or *configuration*?



What are buffers and kernels?

- Buffers have sharp edge: you're either inside or outside the buffer
- Kernels have soft edge: points near the center are heavily weighted, far points are downweighted.
  - Weighted average
  - Cutoff point



F&F 5-lined skink example: buffer size

Log-likelihood: how likely are our data given the best-fit model?

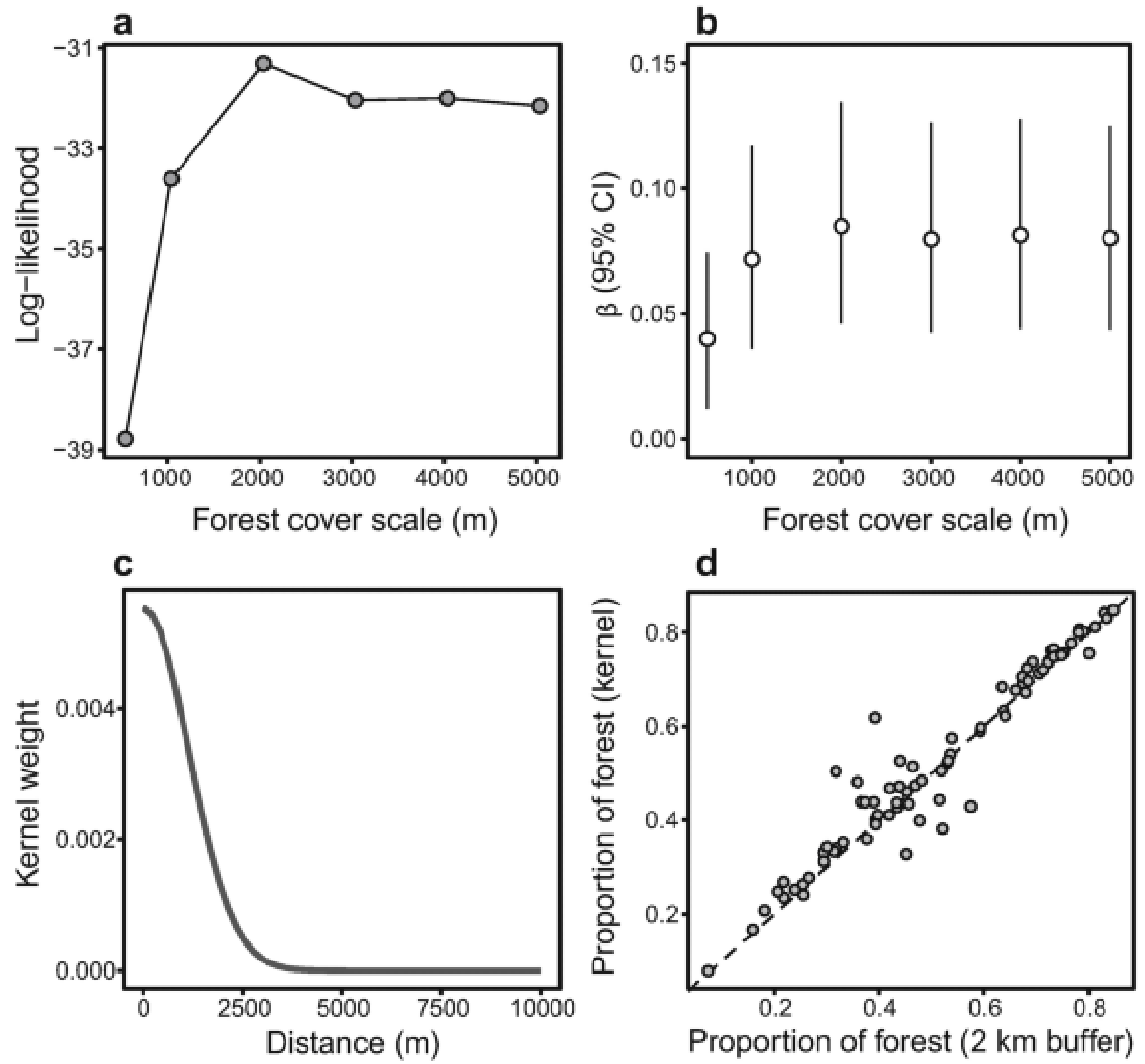
- A measure how well the model fits the data

Logistic regression: presence/absence explained by % forest cover

- β is kind of like our slope in a linear regression
- It is a measure of the strength of association between predictor and response

They conducted a series of regressions with different buffer widths and kernel types

- Buffer: Find best-fit parameters for multiple buffer sizes. Select model with highest overall likelihood.



Land Use/Land Cover

Fletcher and Fortin – Chapter 3

LULC Change Conceptual Models

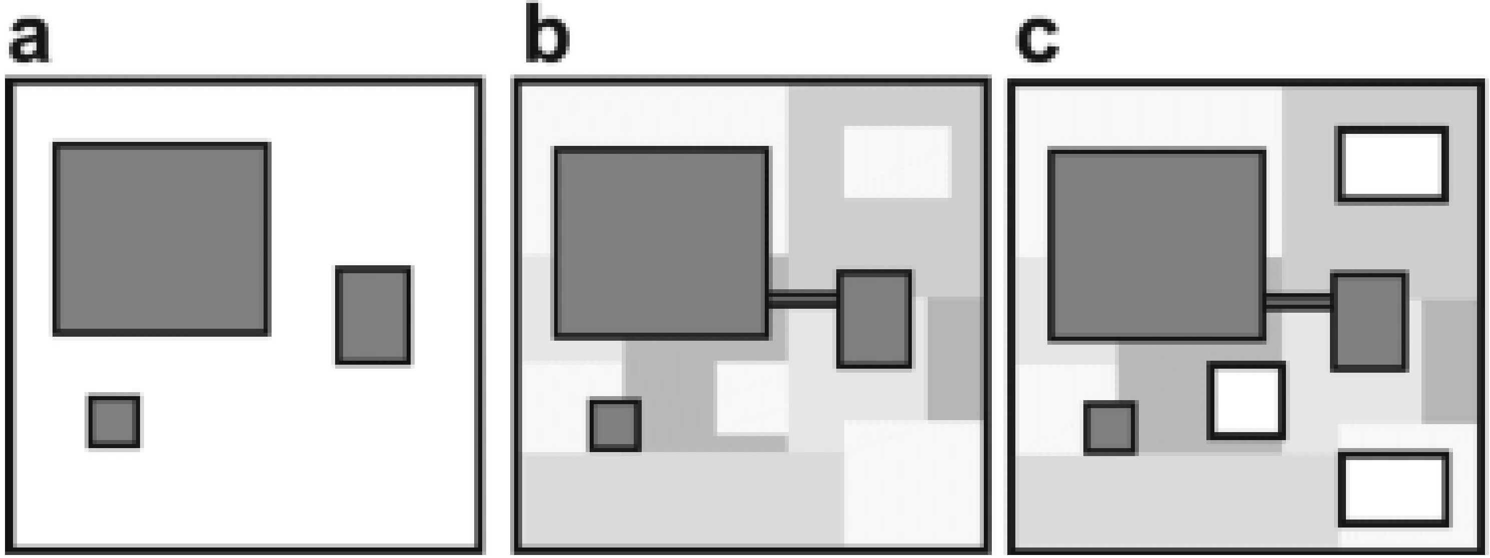
Conceptual models have origins in ecological theoretical concepts of **island biogeography** and **metapopulation dynamics**.

Island and patch/corridor/matrix models

- Metapopulations and patch mosaics

The world consists of **habitat patches** embedded in a **non-habitat matrix**.

Large habitat patches may be connected by small **corridors** of the patch cover type.



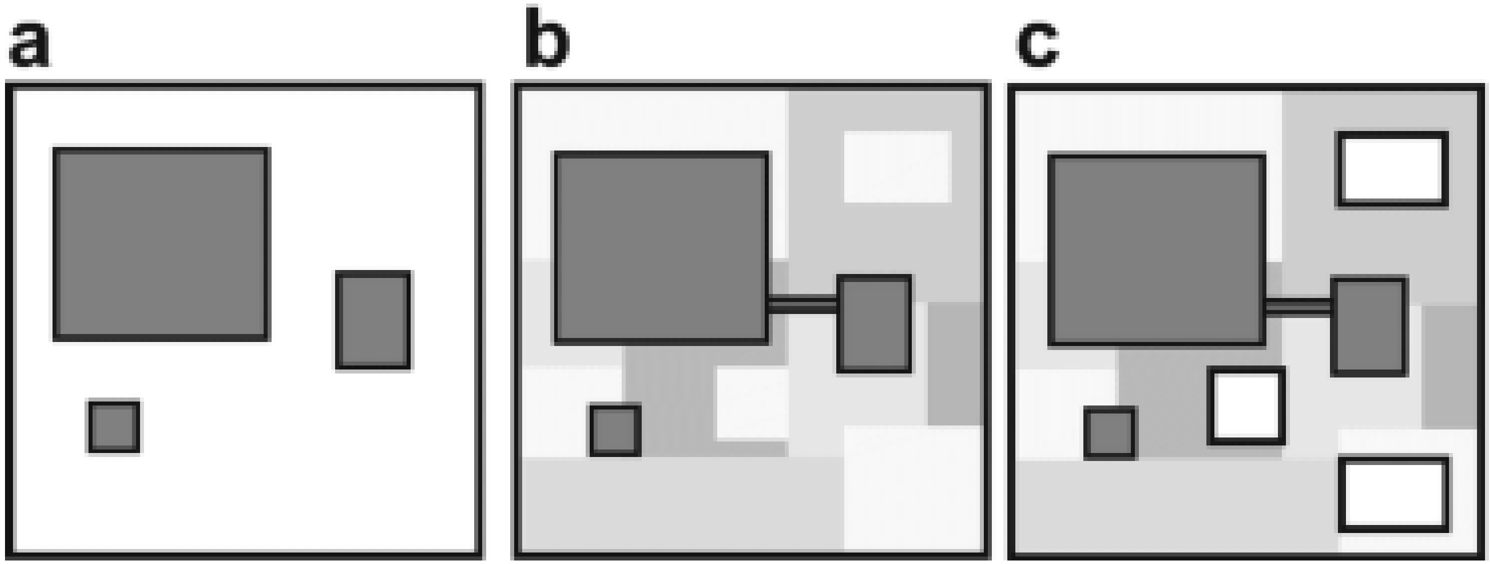
Patches and Matrix

Patch	**Matrix**
Simplifying assumption: patch-internal heterogeneity is *unimportant*. • The criteria for *unimportant* are context-dependent • Sometimes called the **focal** type. Model Thinking: How might you define patches and corridors in your own research?	Simplifying assumption: LULC types that are not the same as the patch (focal) type. * Characteristics of the matrix are *unimportant* Model Thinking: Are there LULC types that you can ignore in your research?

Mosaics: Multiple Focal Types

Mosaic models build upon the focal/non-focal paradigm by considering several focal types. Think NLCD data!

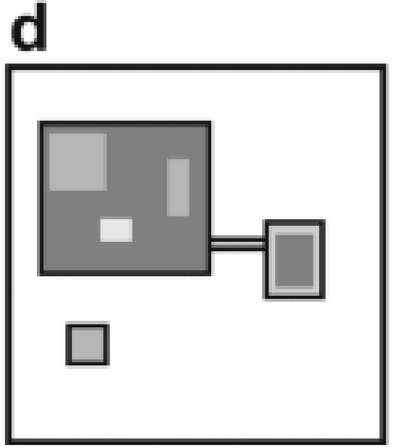
Model Thinking: Does your research need to consider more than 1 habitat/focal type?



Variegation: Continuous Variation in Habitat Quality

Variegation focuses on within-patch differences in habitat quality, from the point of view of the organism.

Model Thinking: Are there within-patch factors that are important to your research?



Disturbances, etc.

- Individual tree senescence
- Tree blow down or insect damage
- Different soil types, topography within patch

Model Thinking

Thinking about your own research context:

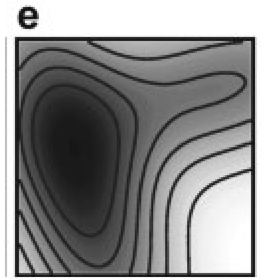
- Consider the simplifying assumptions of the various LULC model paradigms.
- What can you simplify?
- What are the trade-offs between model complexity and simplification in your system?
- How might your expected results change at different spatial (or temporal) scales?

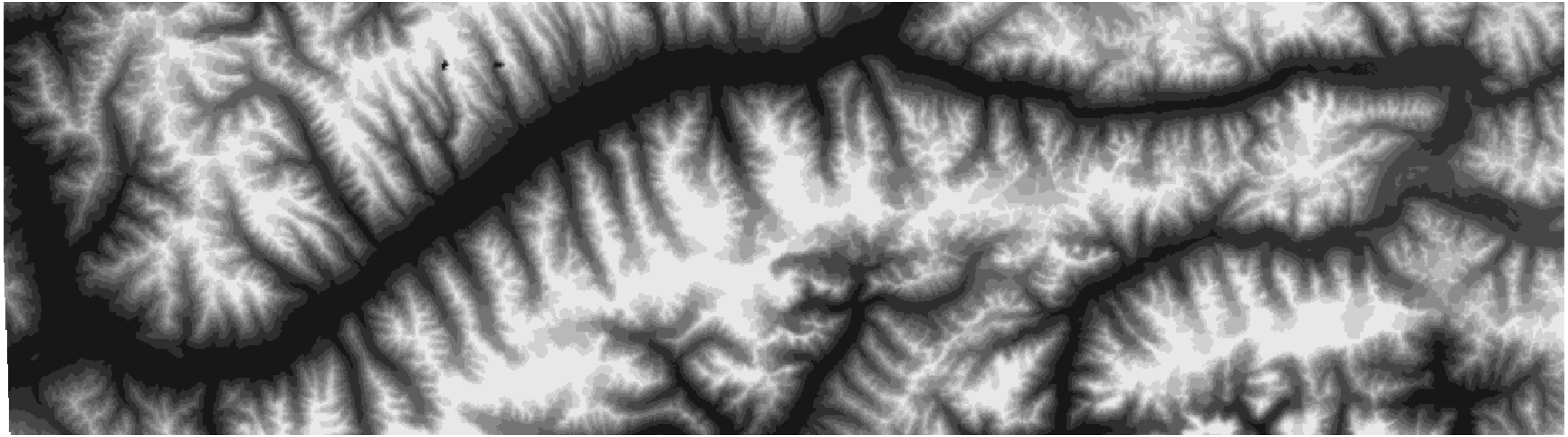
Continuum Models: Process-based models

Continuum models are even more organism-focused.

The habitat concept is similar to niche space.

Species Distribution Models





Describing and Quantifying Pattern and Change

Pattern refers to the spatial arrangement of LULC types.

LULC patterns are quantified via *landscape metrics*.

LULC Change can occur via habitat Loss, intensification, extensification, fragmentation, etc.

What are some possible spatial patterns of habitat loss?

Scale and Patterns

The scale of analysis depends on the research context. Multiple scales may be of interest.

Model Thinking: What scale(s) are relevant to your research?

LULC Patterns

Some important and/or cool pattern concepts include:

- Composition and configuration
- Heterogeneity
- Contrast
- Edge/perimeter
- Fractal dimension
- Aggregation, dispersion, interspersion
- Diversity and evenness
- Neutral landscapes
- Contagion

Selected Metrics and Methods: Patch Delineation - Rasters

Cellular neighborhoods: Moore, Von Neumann, extended.

Note the distinction between cell-wise distance and other distance measures. The example neighborhoods are cell-wise.

- Defining patches in raster data: neighborhood algorithms. These algorithms are analogous to 'flood fill'.

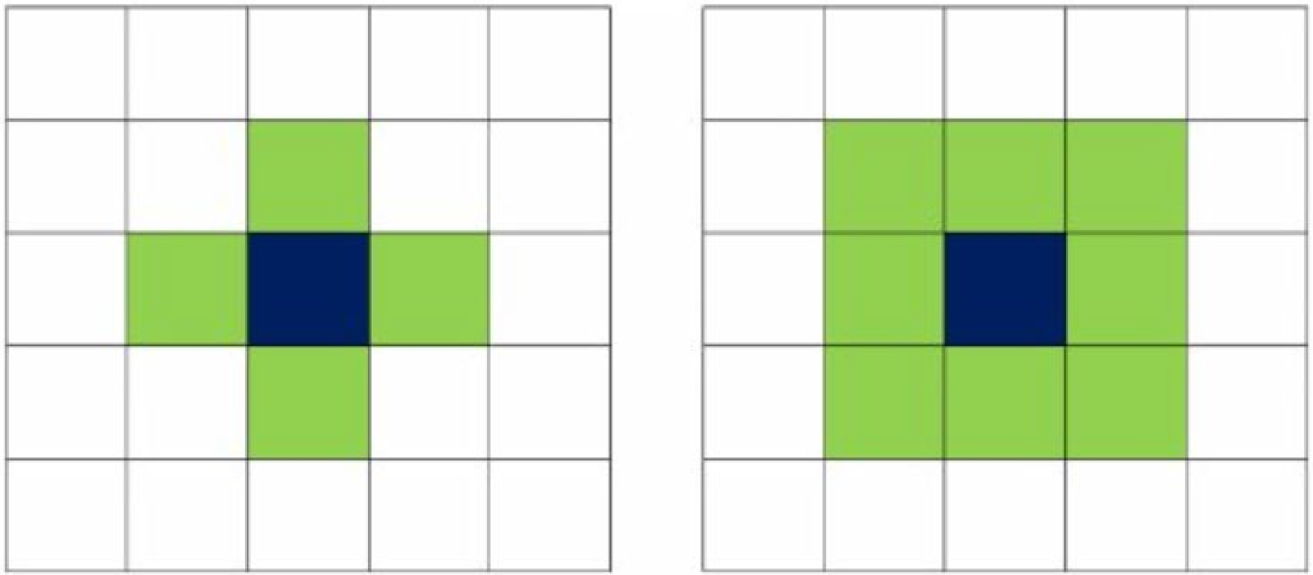


Figure 1 from Tzedakis et al 2015

Selected Metrics and Methods: Aggregation

Aggregation measures the extent to which similar LULC types are nearby (aggregated), or not (dispersed), in space.

Aggregation may refer to a single focal LULC type (dispersion) or consider multiple types (interspersion).

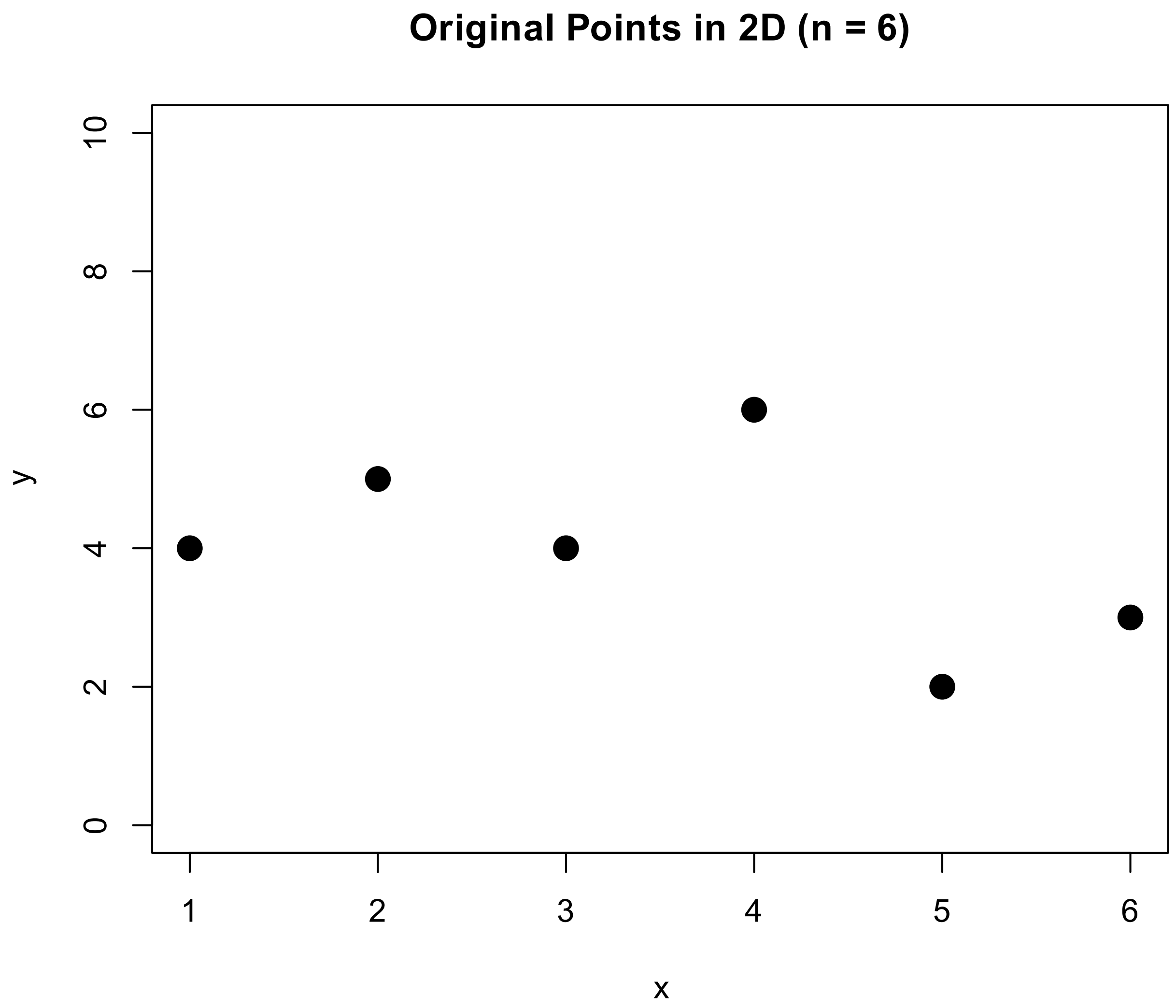
Aggregation Metrics at different scales

- Cell: Spatial point pattern statistics
- Class: Adjacency proportion, aggregation index
- Landscape: aggregation index

Point pattern concepts (next chapter!)

- Complete spatial randomness (CSR)
- Poisson process, homogeneous/inhomogeneous processes
- First- and second-order pattern/process

Raster Resampling Intuition



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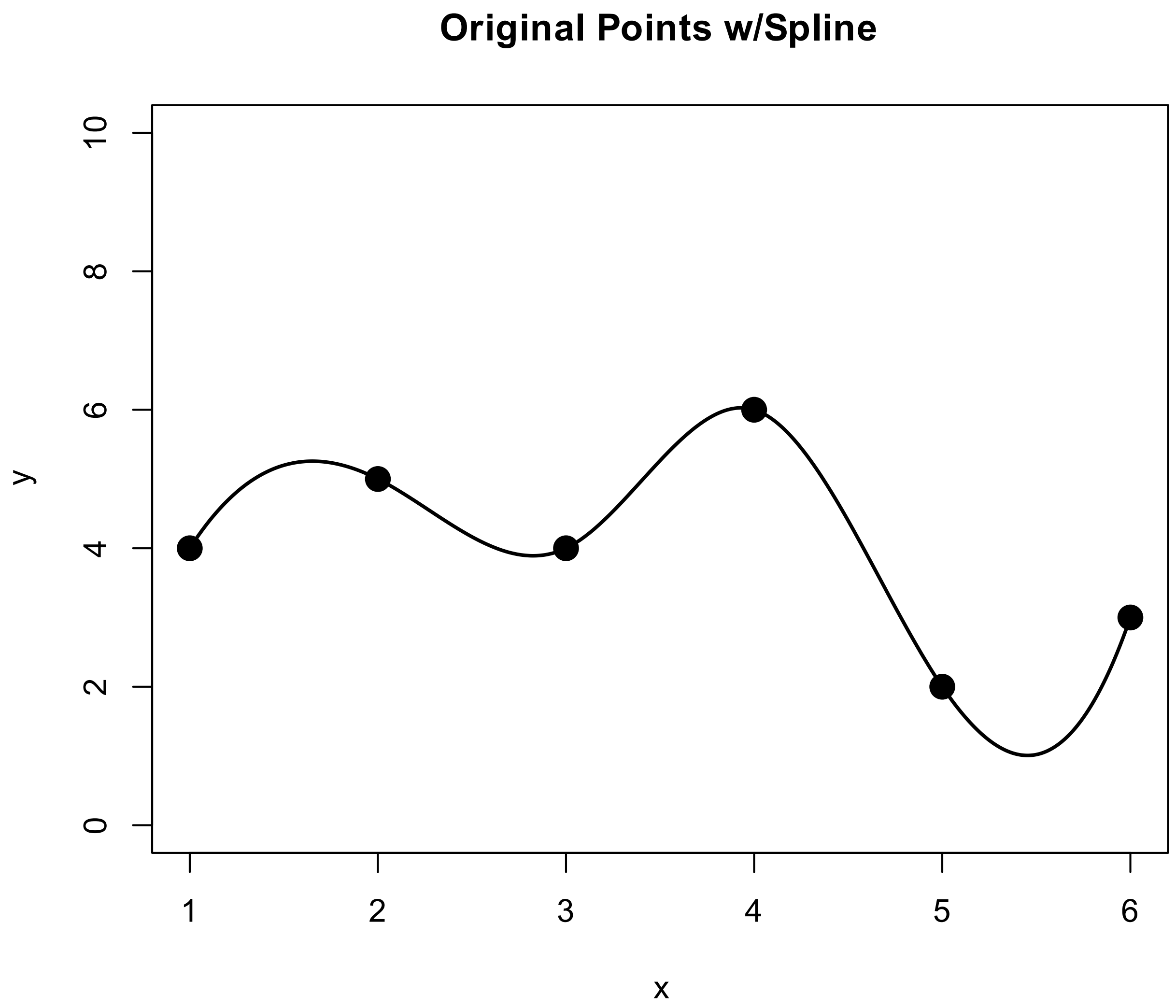

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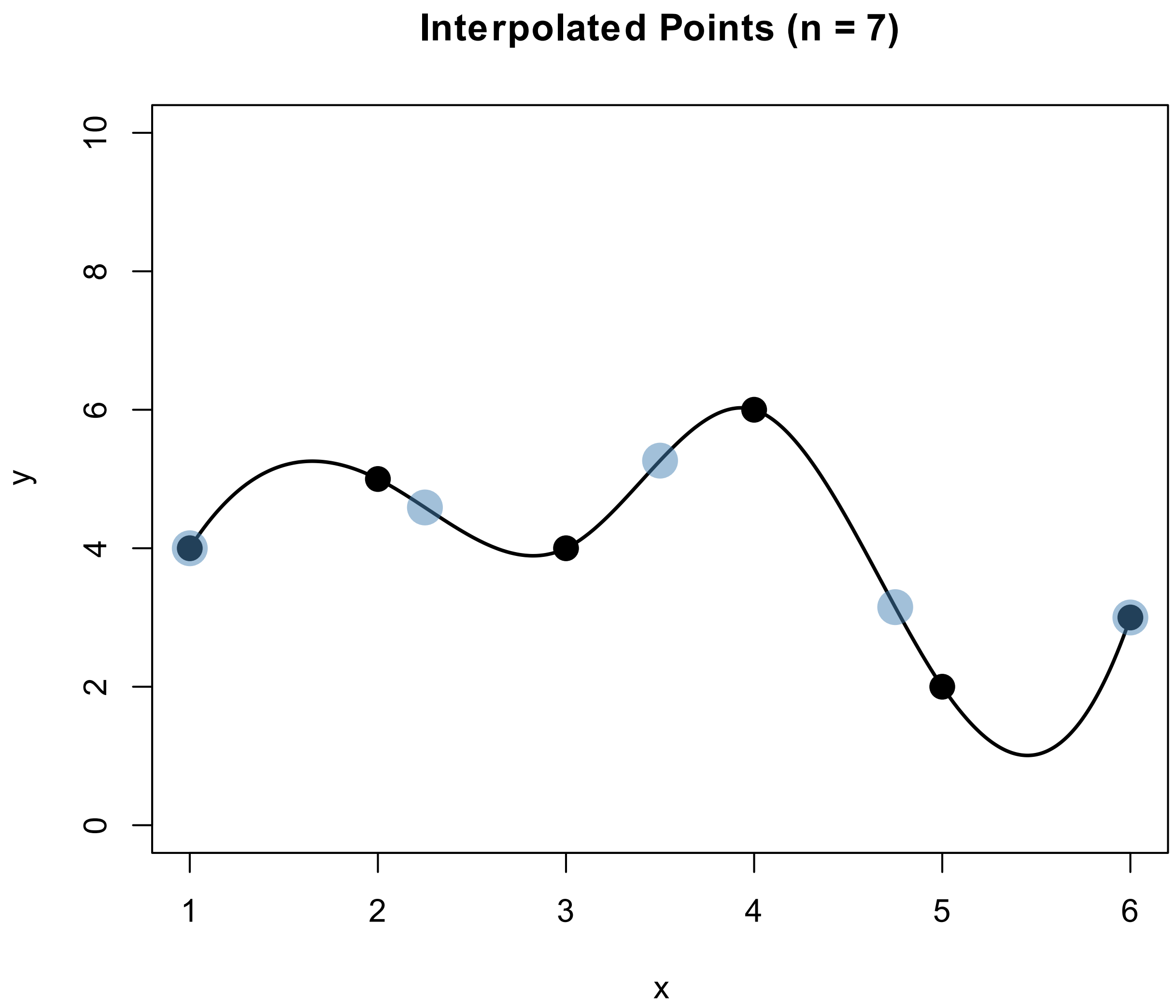

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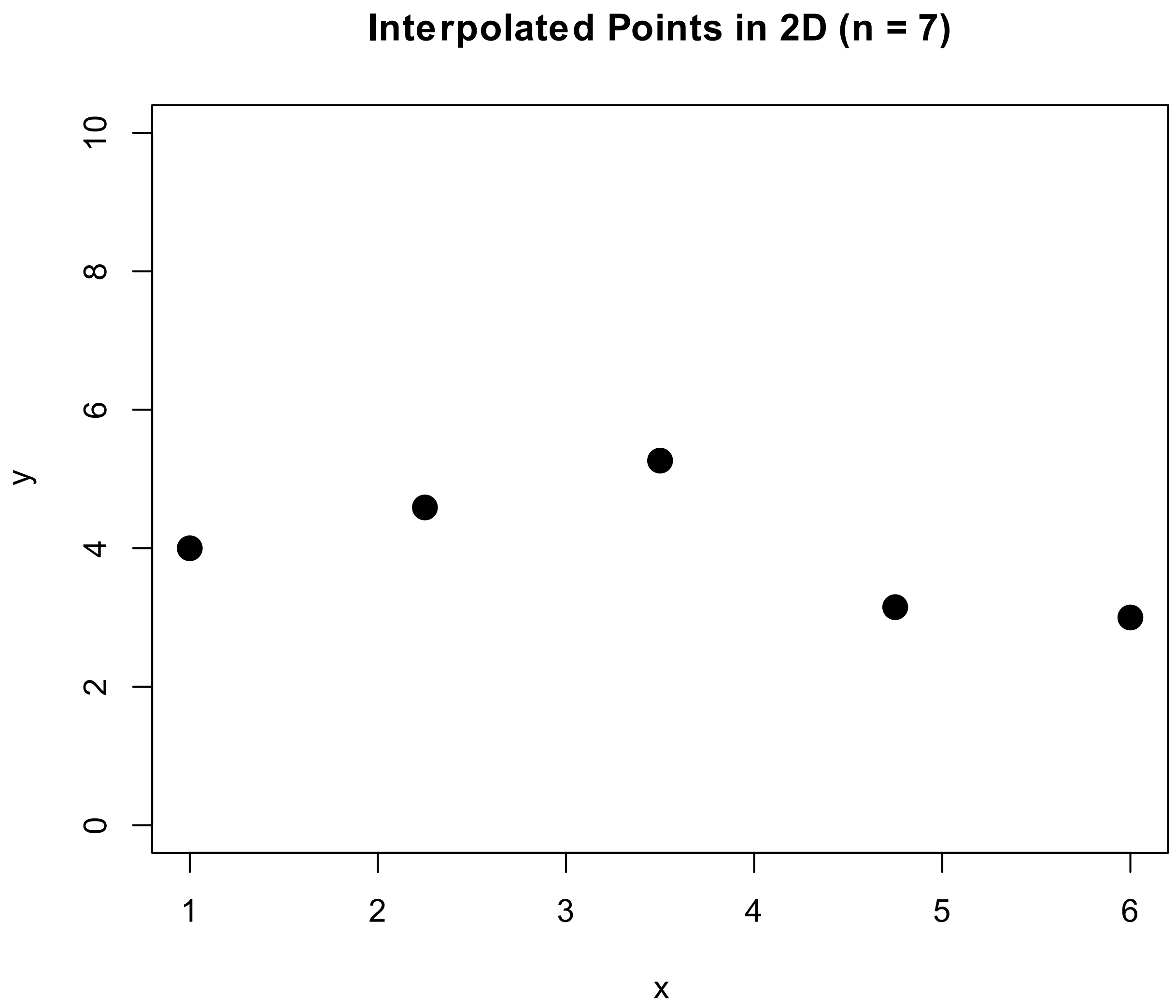

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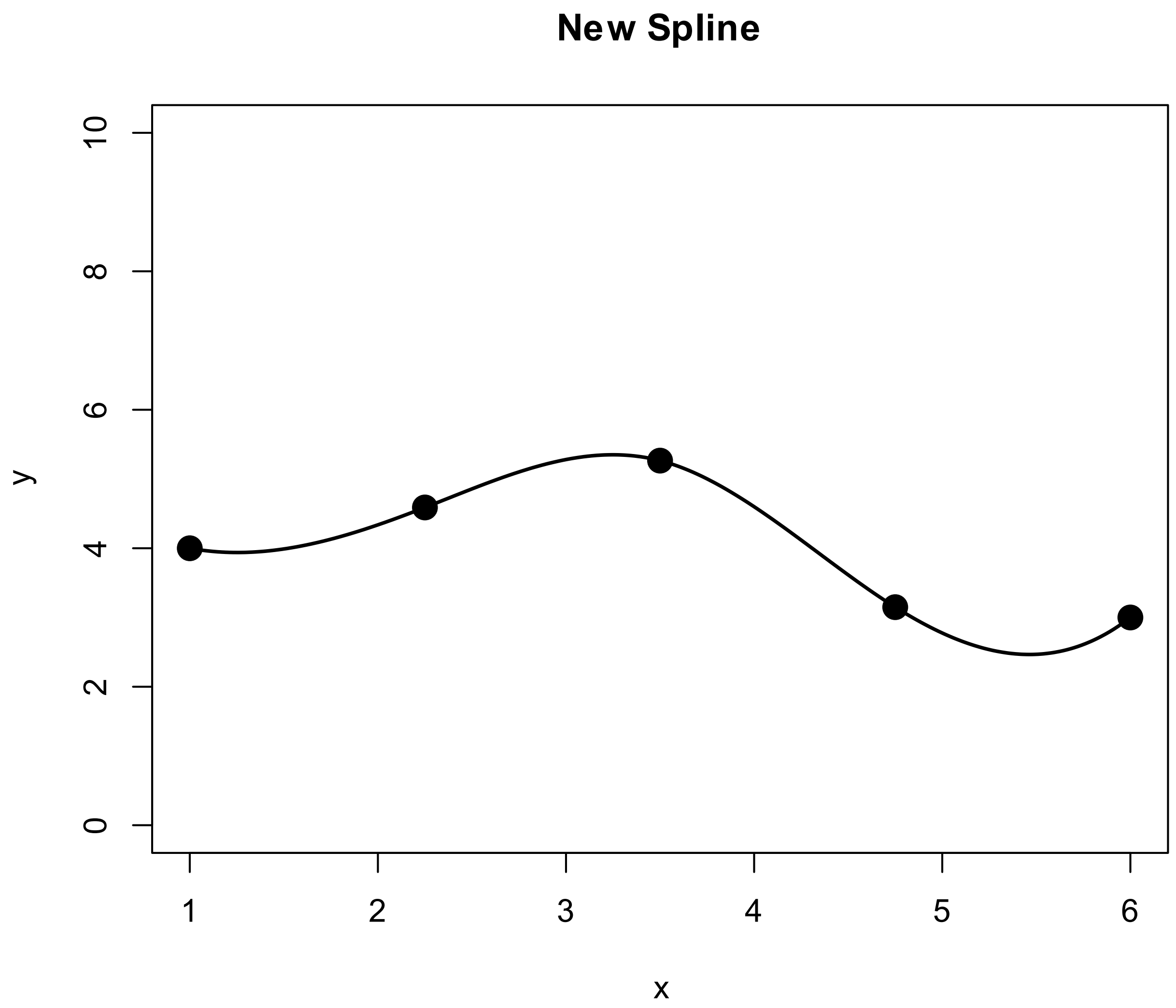

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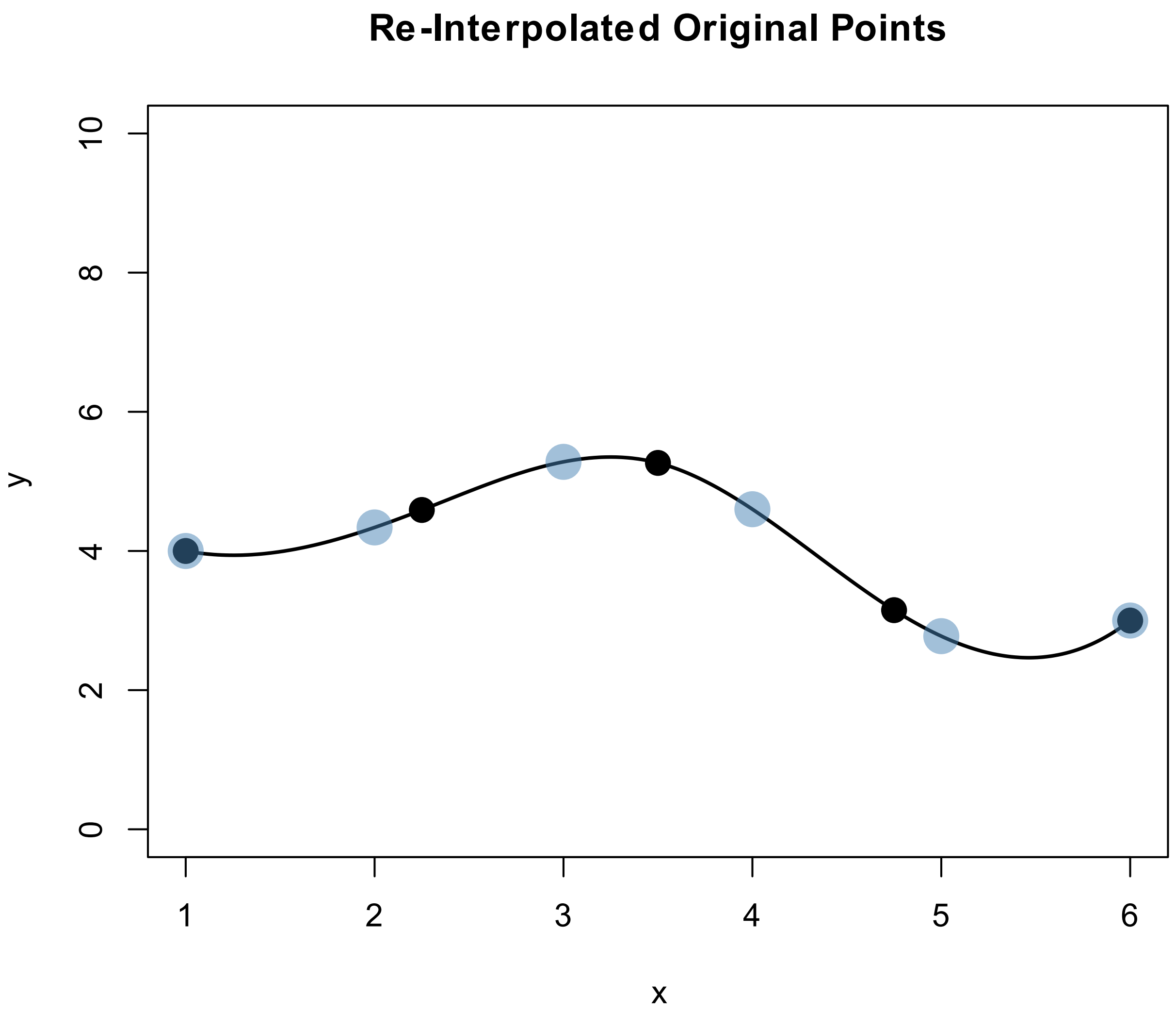

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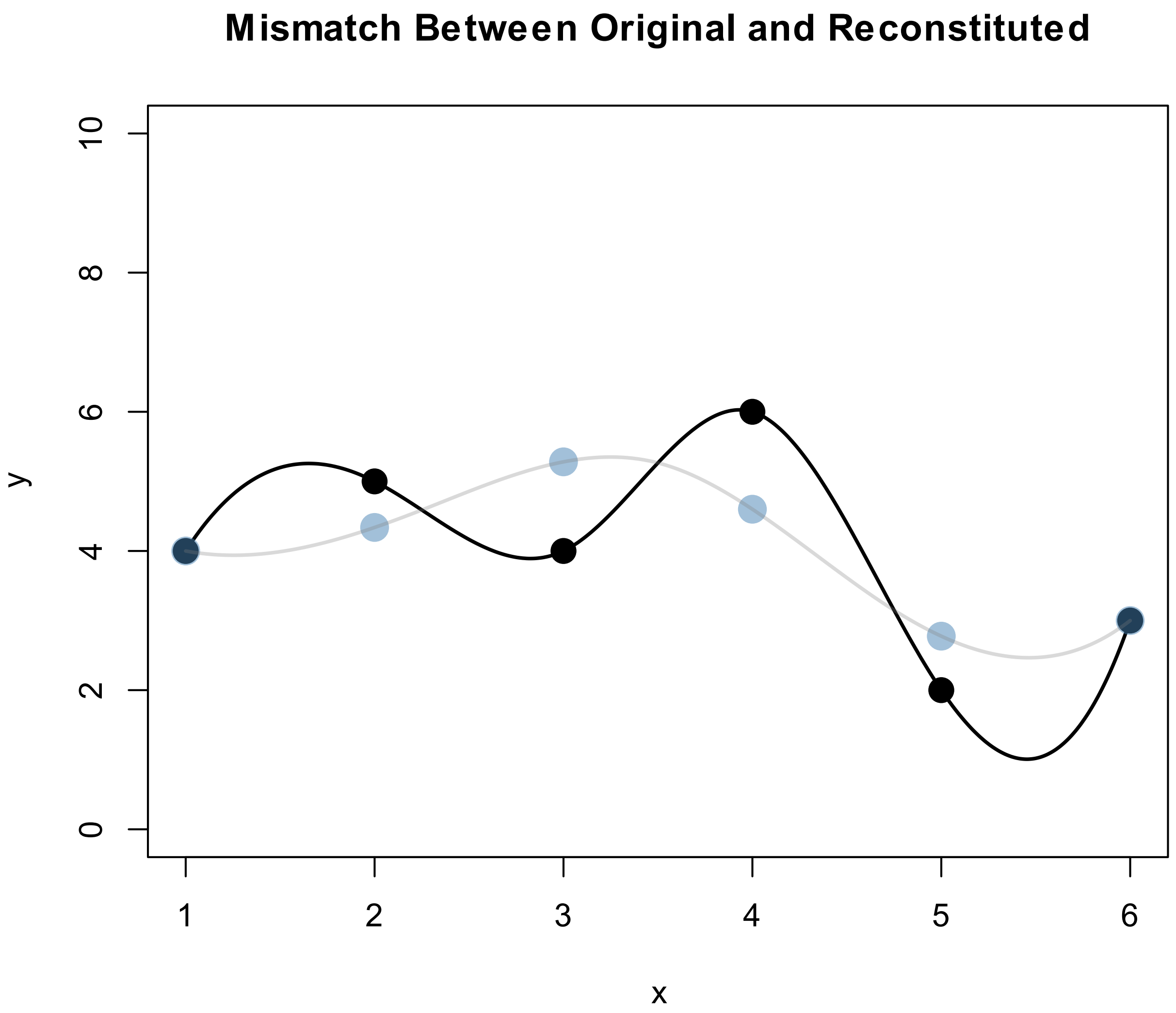

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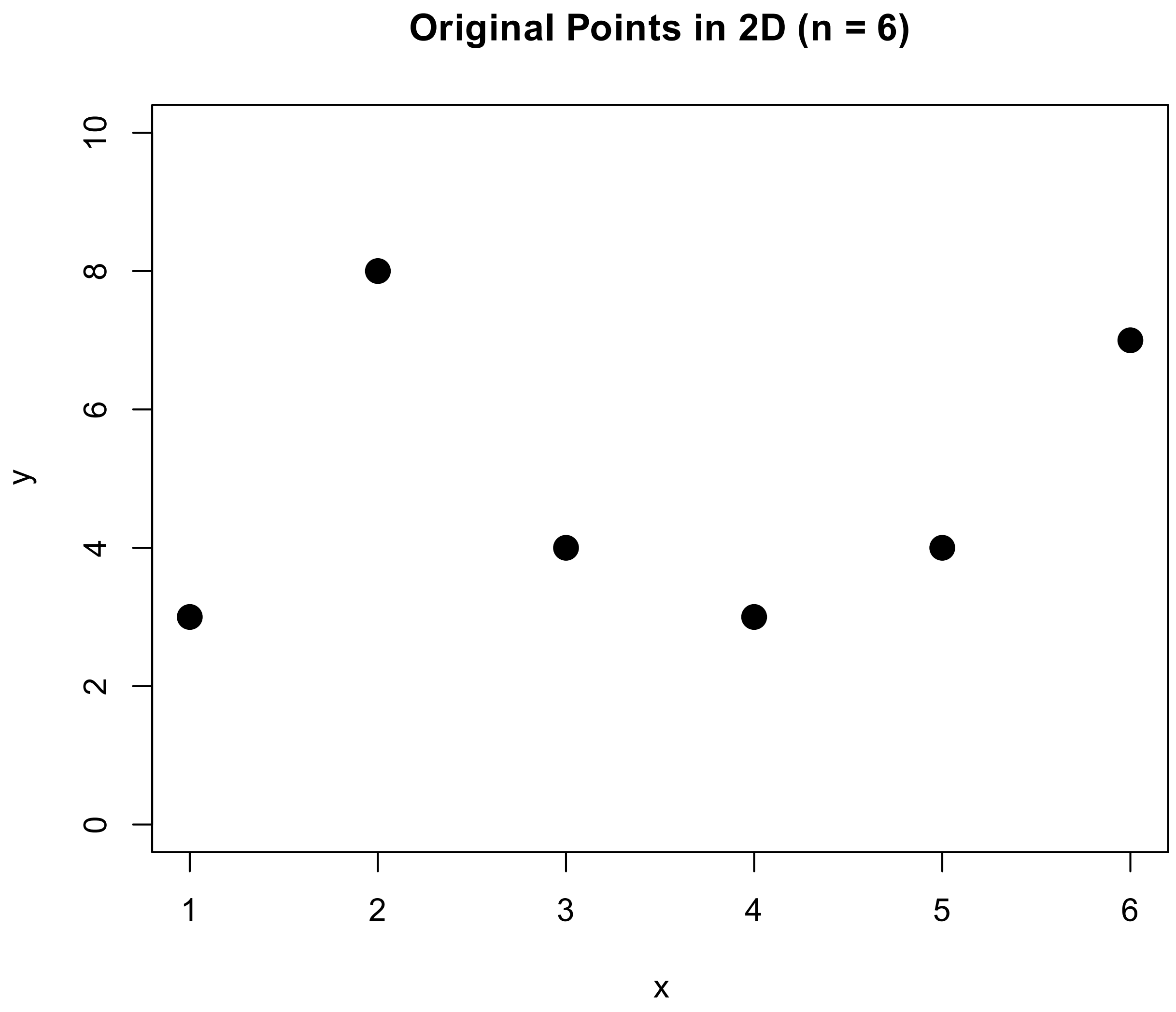

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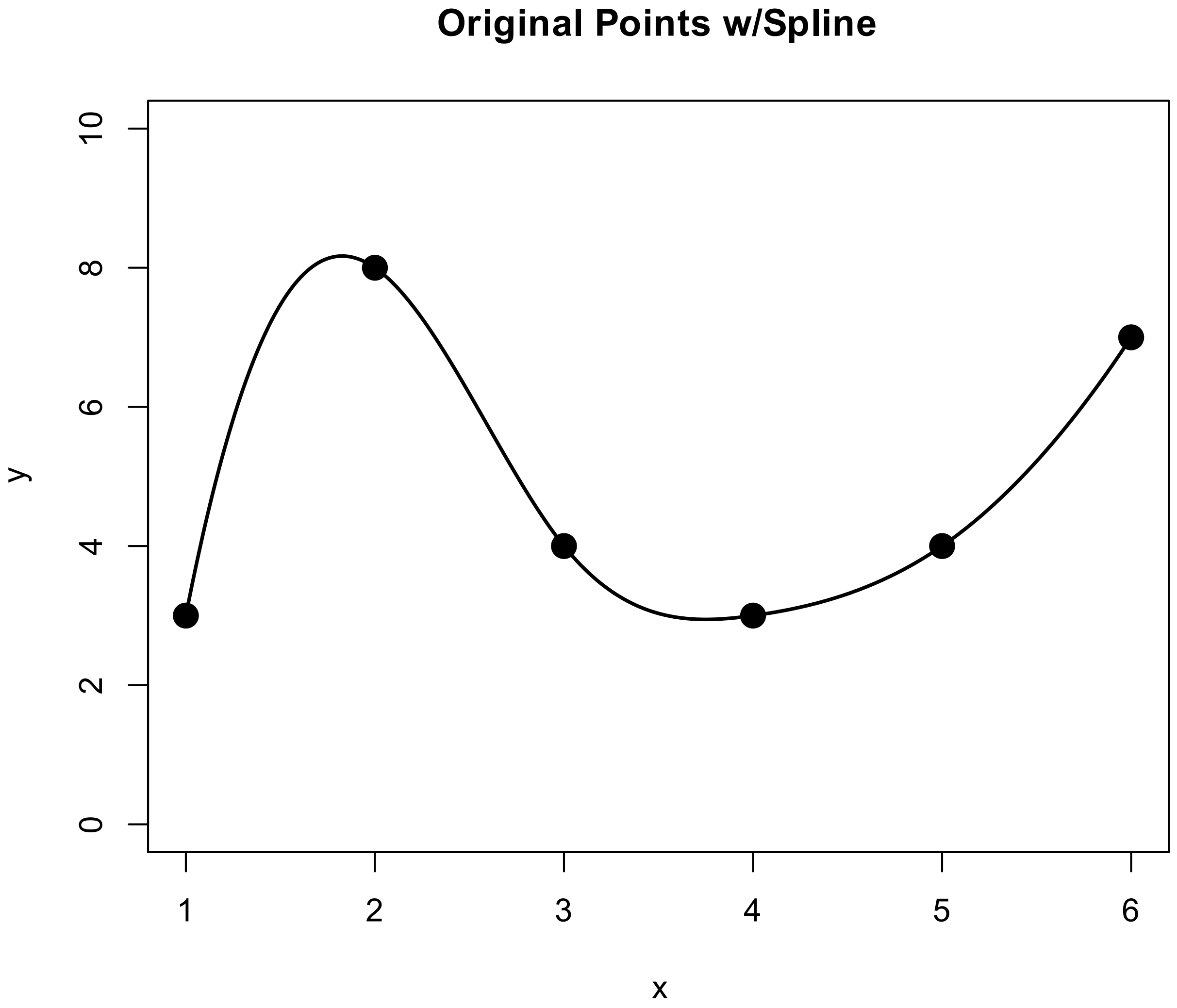

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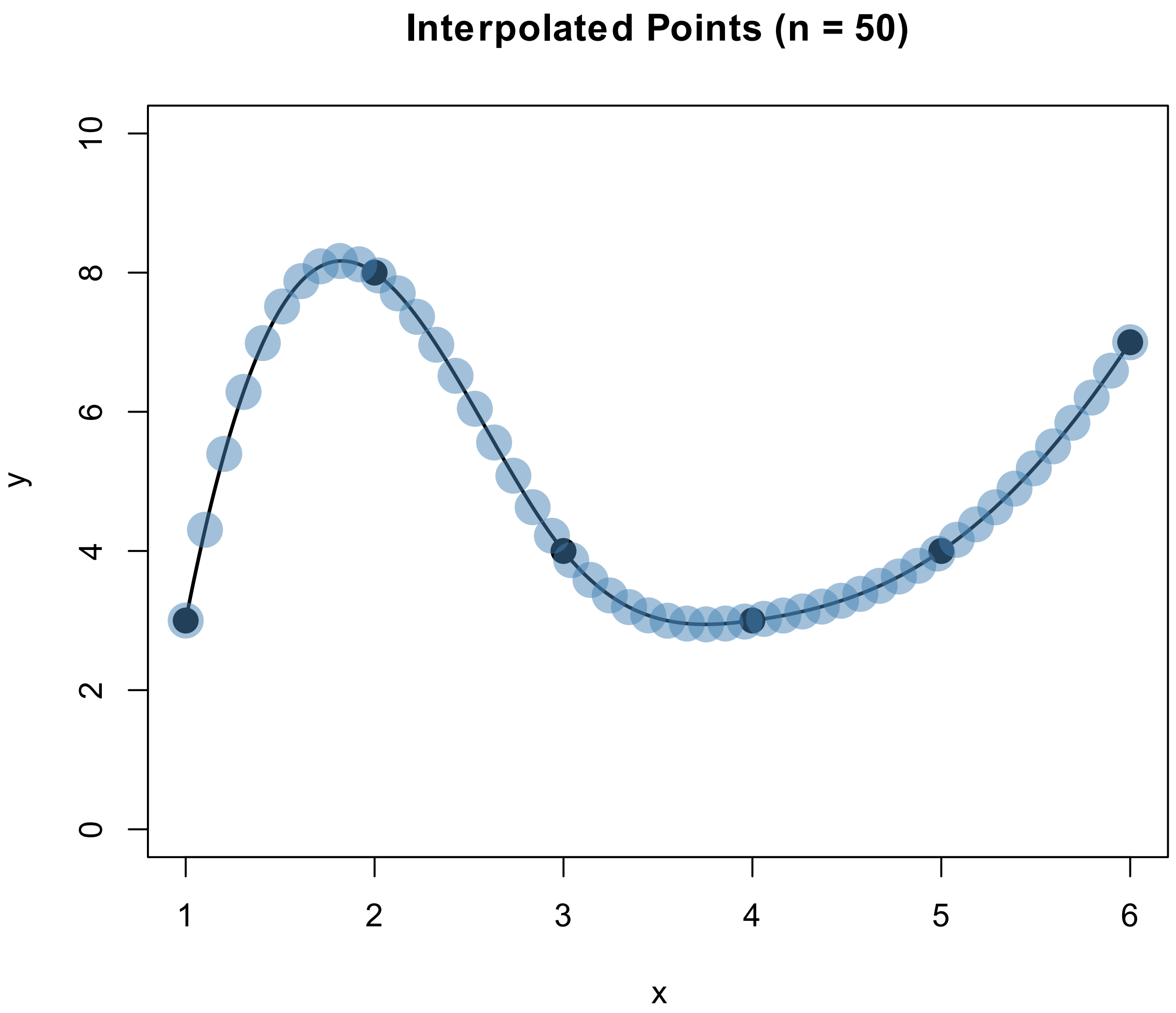

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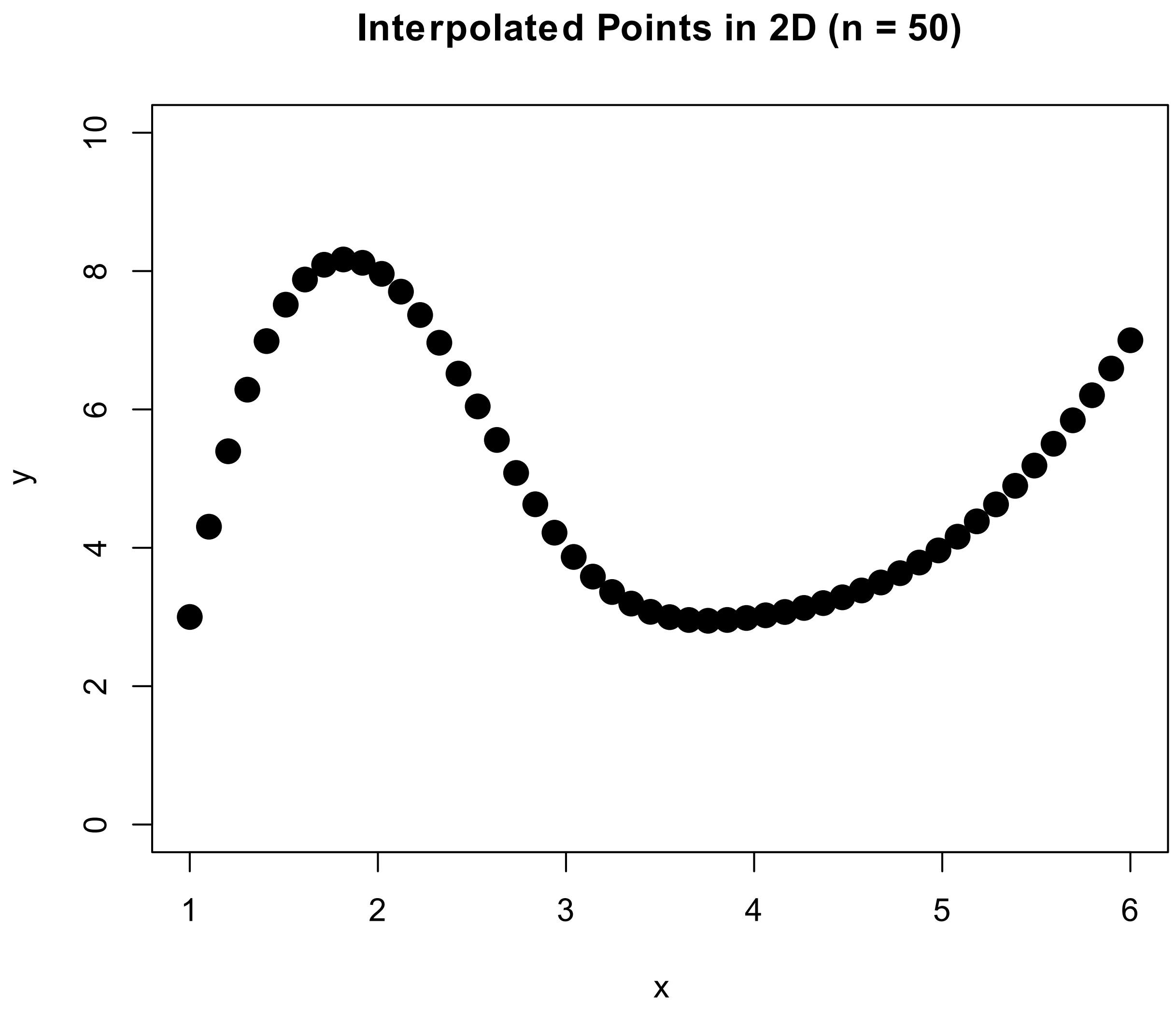

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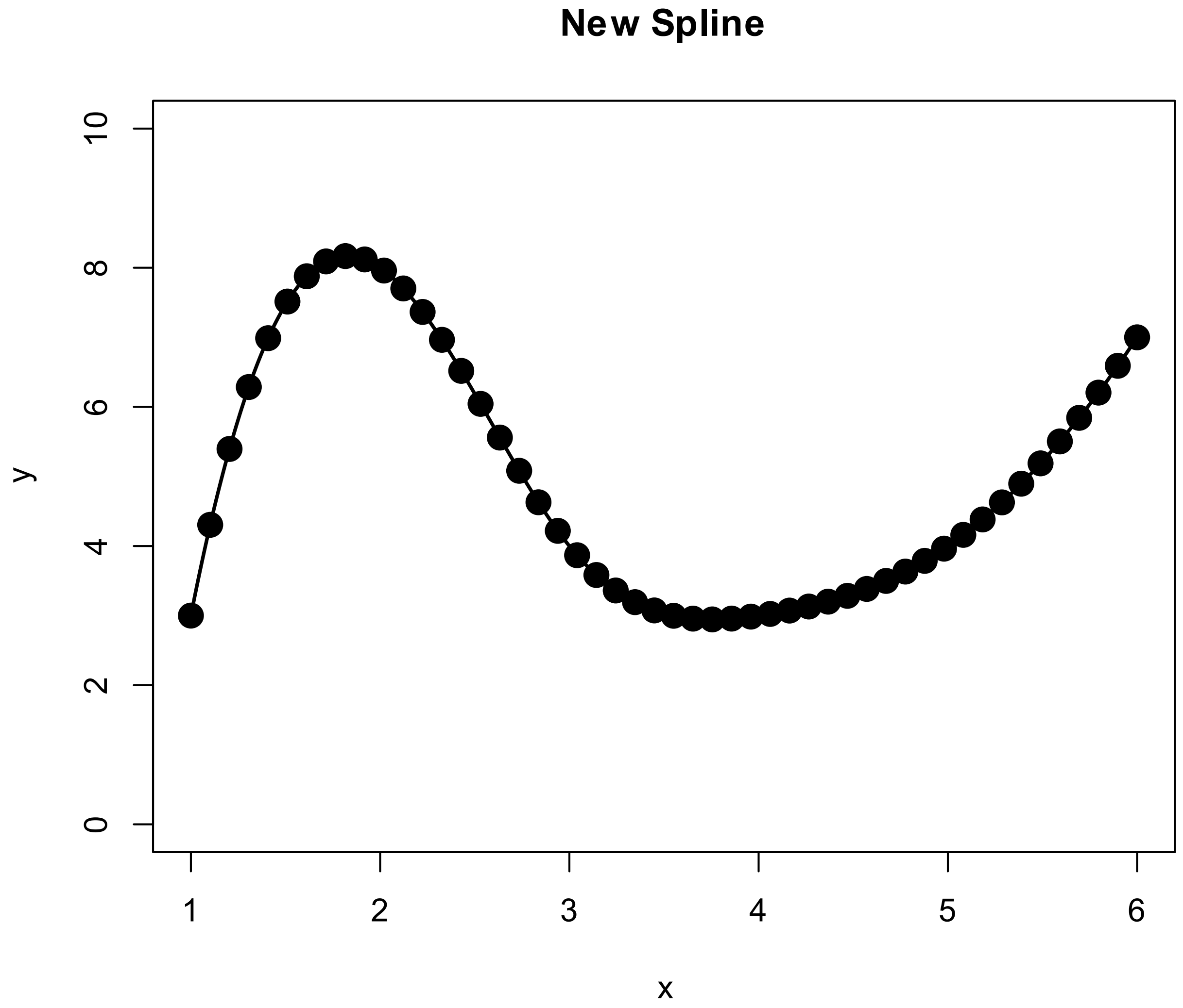

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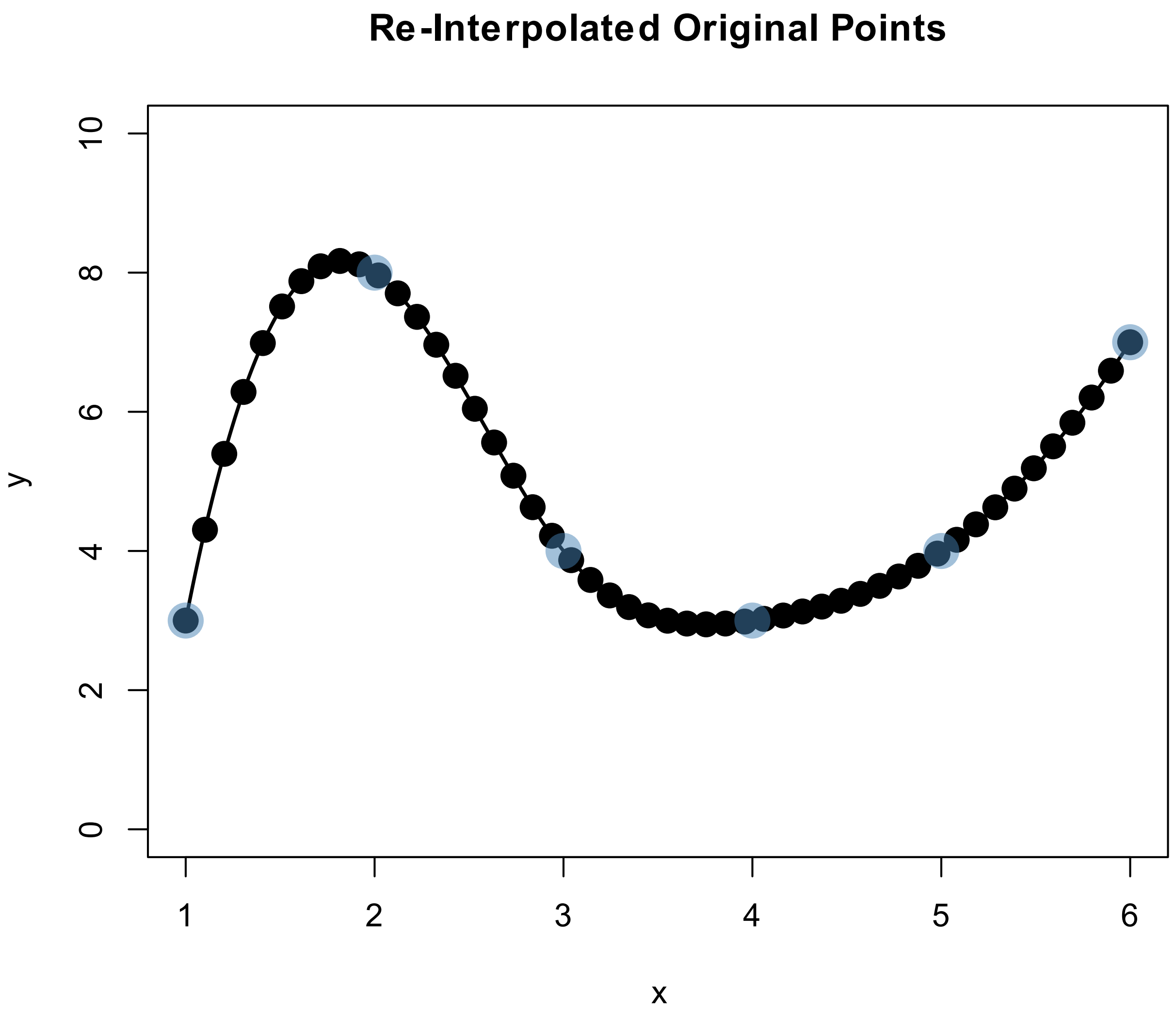

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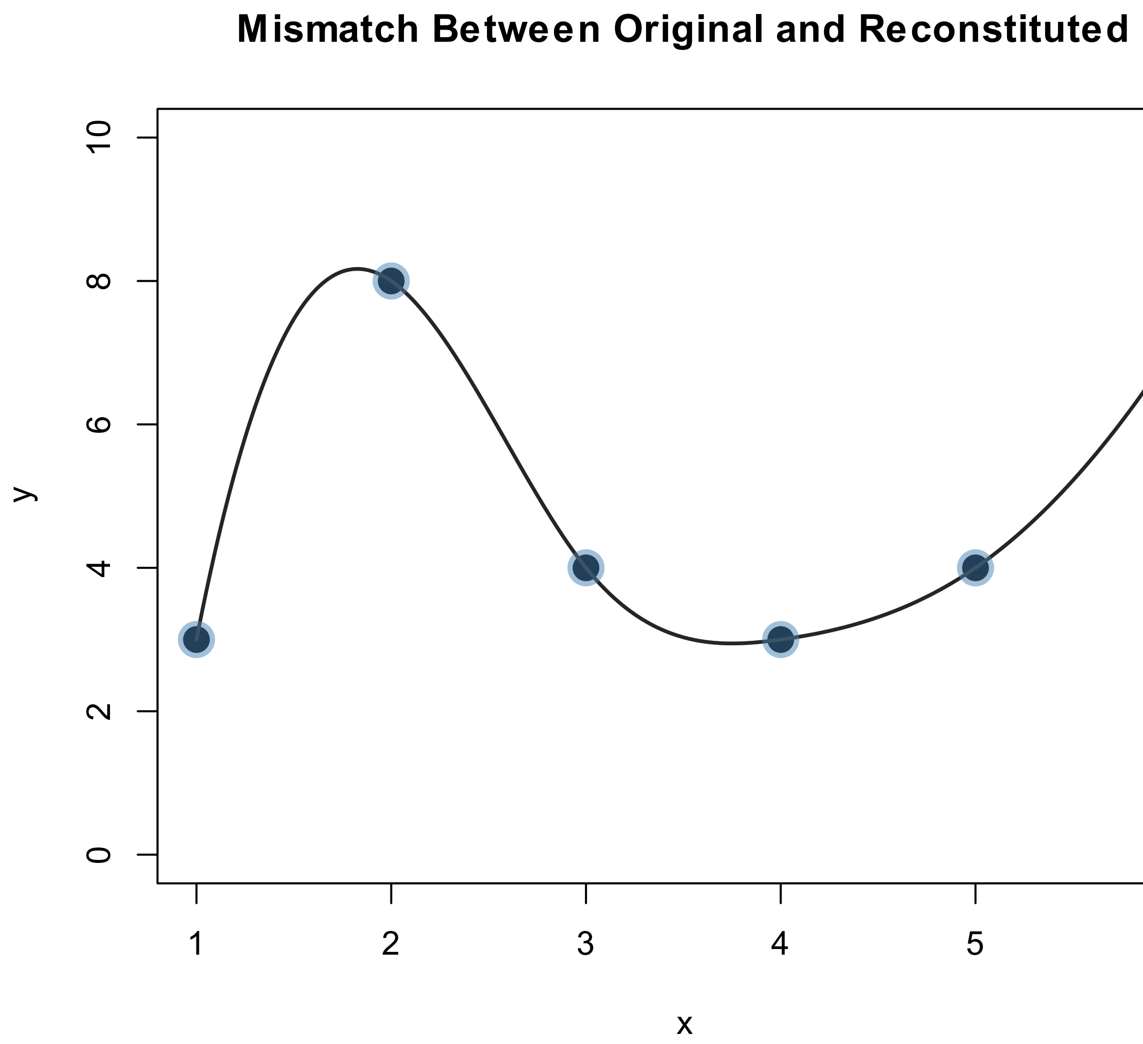

Let’s commit changes and push to GitHub!

Eliminate Large Files

- GitHub won't allow you to upload files greater than 100 megabytes.
  - That's why we went through the trouble to compress the book's NLCD data
- Important: verify that you've zipped the nlcd2011SE folder.
- It's crucially important that you've also deleted the original, unzipped, folder.