Differential Evolution

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Introduction

Introduction and Basic Algorithm and relation to the other algorithms in the course so fa

Overview and Terminology

Initialize the population
repeat
    Select *target* vectors from population
    for each target
        Create a *donor* vector
        Combine target and donor to a *trial* vector
    Update population with trial vectors

Overview and Terminology

Initialize the population
repeat

~~Select *target* vectors from population~~

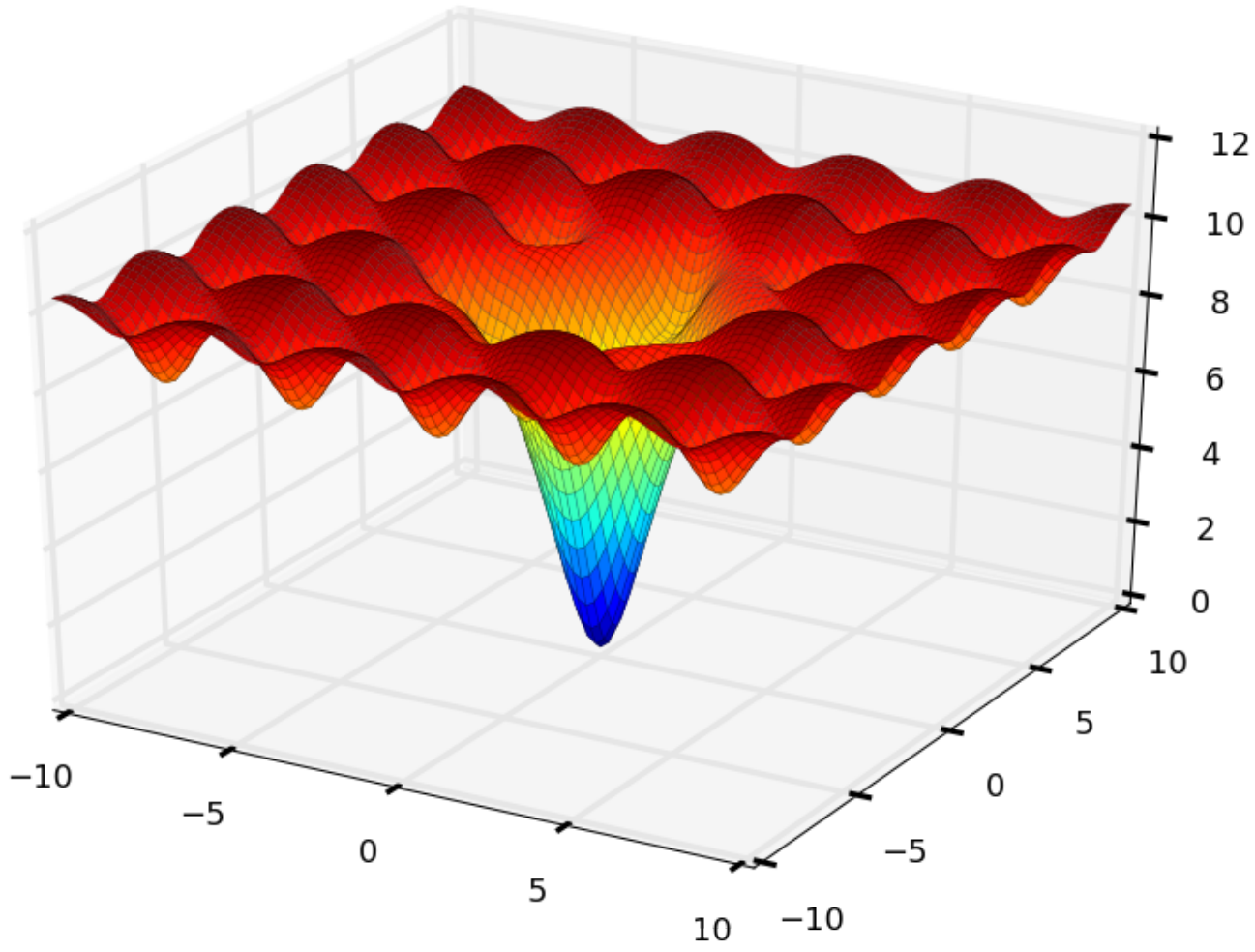
Use the whole population as *targets*

for each target

Create a *donor* vector
Combine target and donor to a *trial* vector

Update population with trial vectors

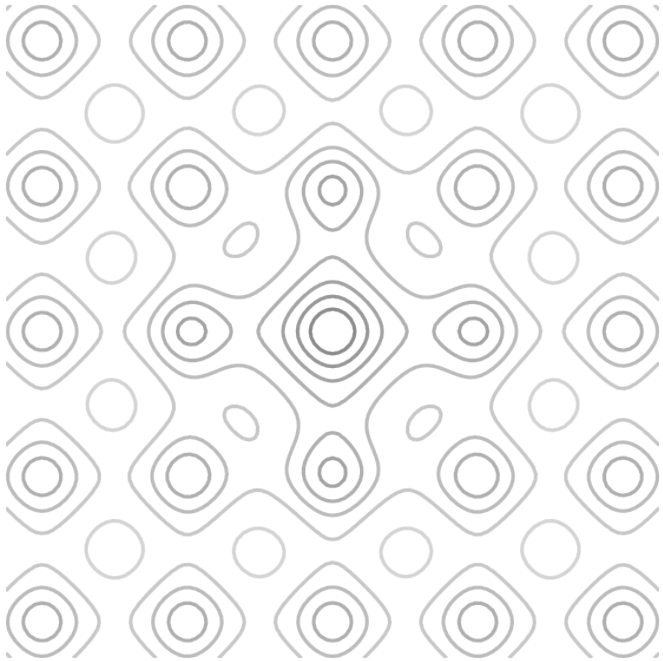
Ackley's function



Initialization

Initialize NP d-dimensional population vectors x:

$$x = (x_1, x_2, ..., x_d) \quad \text{with} \quad x_i \sim PDF_i$$



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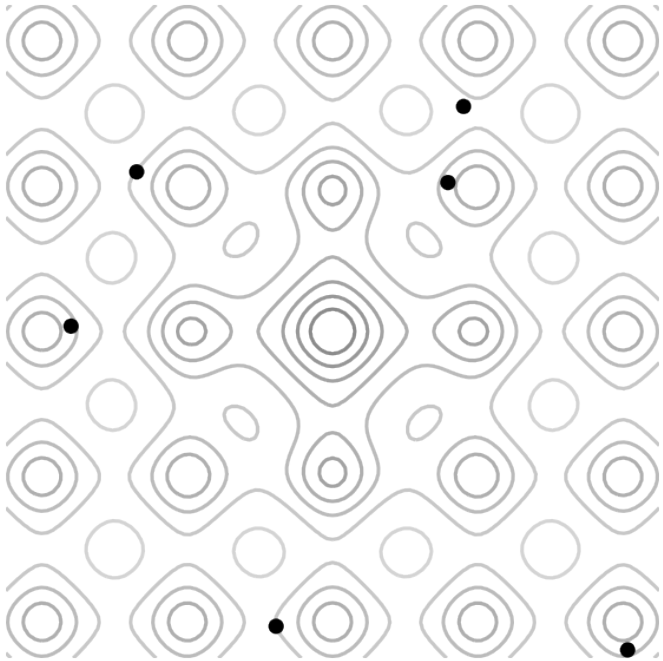
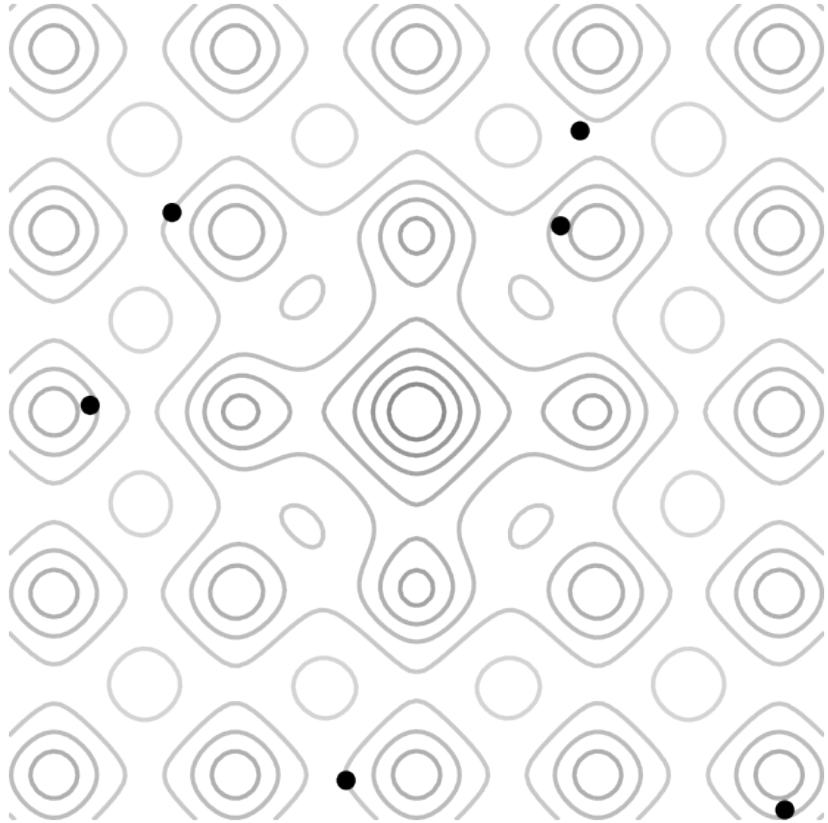


Differential Mutation

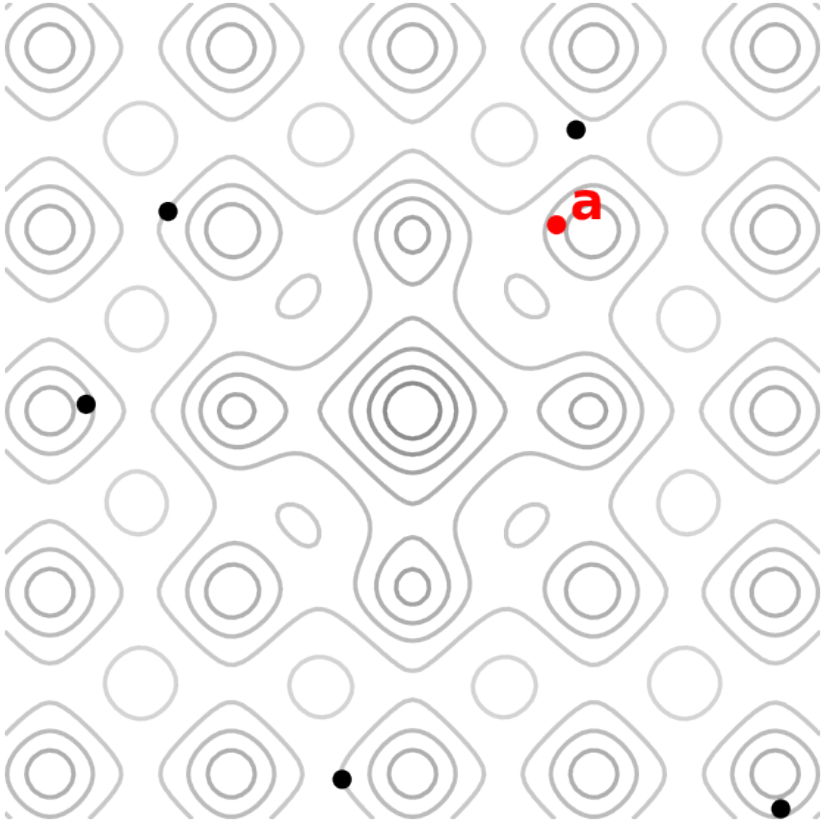
Generate a donor vector y for each target by differential mutation:



Differential Mutation

Generate a donor vector y for each target by differential mutation:

- Select *base* vector a



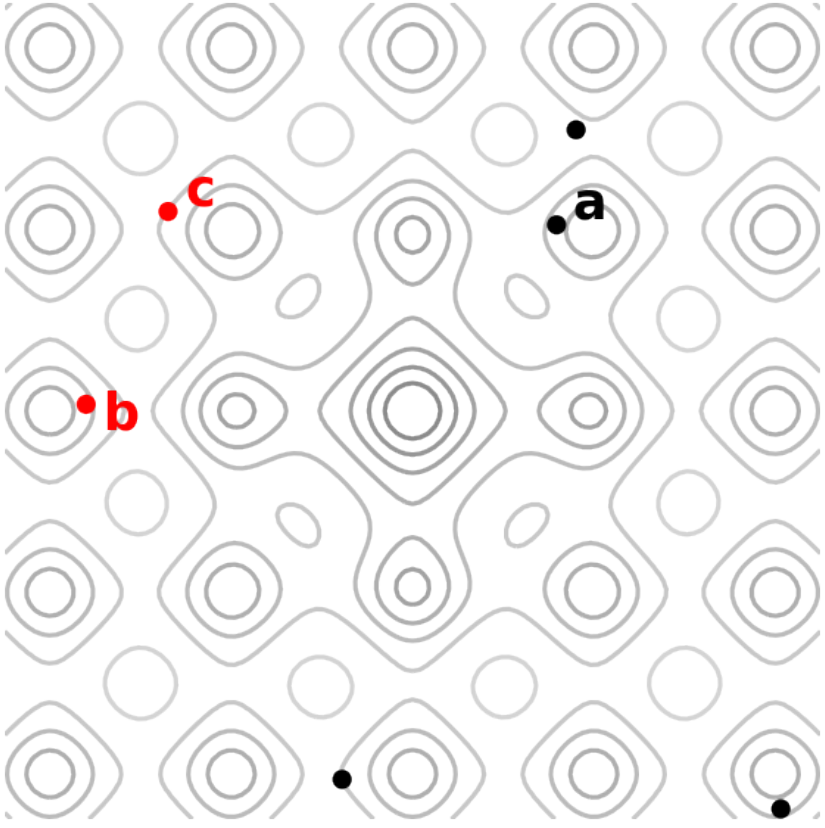
Example

random selection, $a \neq x$

Differential Mutation

Generate a donor vector y for each target by differential mutation:

- Select *base* vector a
- Select two other vectors b, c



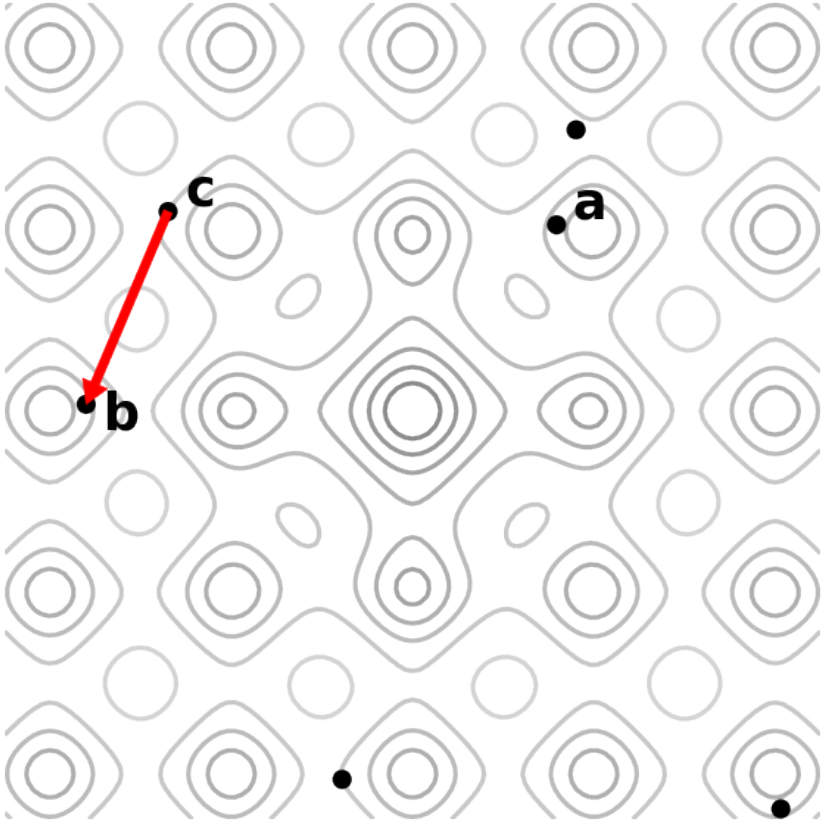
Example

random selection,
$x \neq b \neq a, x \neq c \neq a$

Differential Mutation

Generate a donor vector y for each target by differential mutation:

- Select *base* vector a
- Select two other vectors b, c
- Compute difference $b - c$

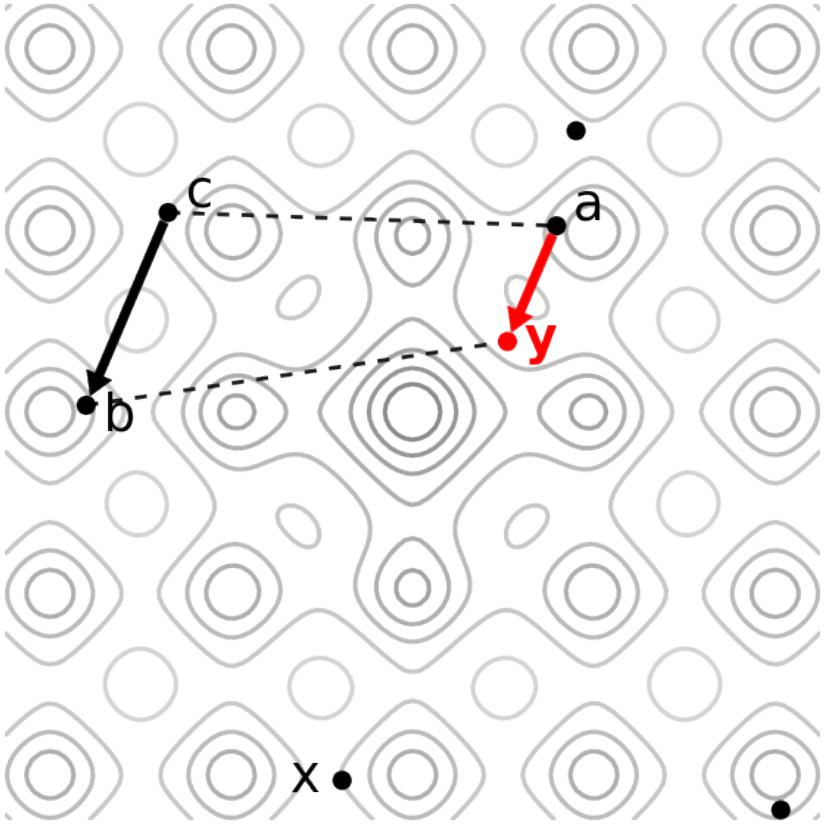


Differential Mutation

Generate a donor vector y for each target by differential mutation:

- Select *base* vector a
- Select two other vectors b, c
- Compute difference $b - c$
- Scale difference and add to base

$$y = a + F(b - c)$$



Example

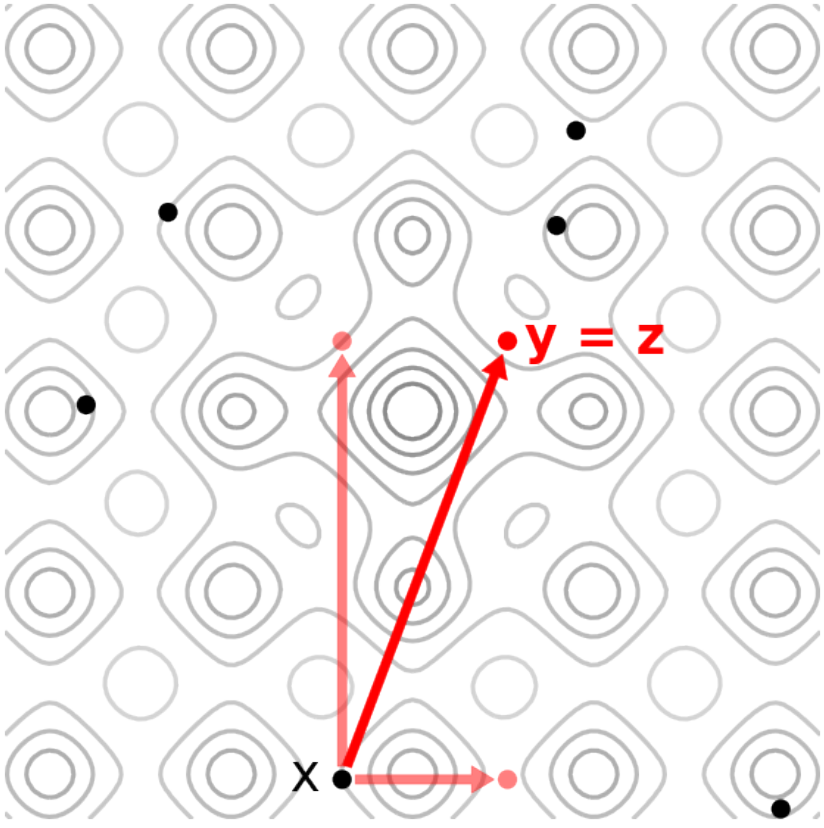
$F = 0.5$, but could be anything > 0

Binomial Crossover

Generate *trial* vector z for each donor y target x:

- Pick random $r \in [1..d]$
- Combine *target* x with *donor* y:

$$z_i = \begin{cases} y_i & \text{if } r \sim \mathcal{U}(0,1) \leq CR \\ y_i & \text{else if } i = r \\ x_i & \text{otherwise} \end{cases}$$



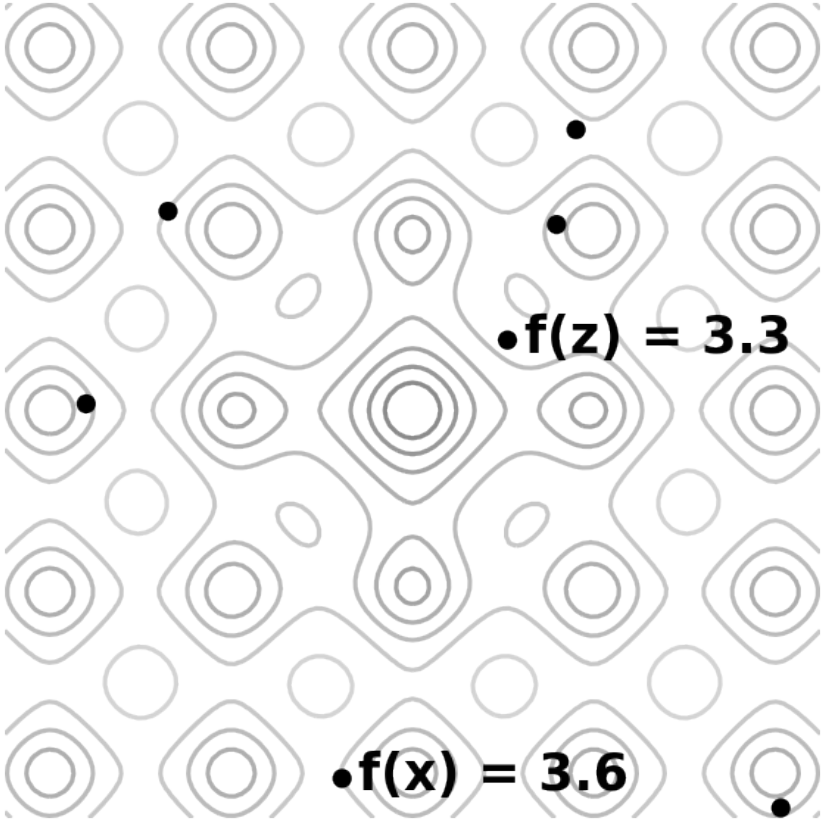
Example

Crossover-rate $CR = 1$, other possibilites transparent

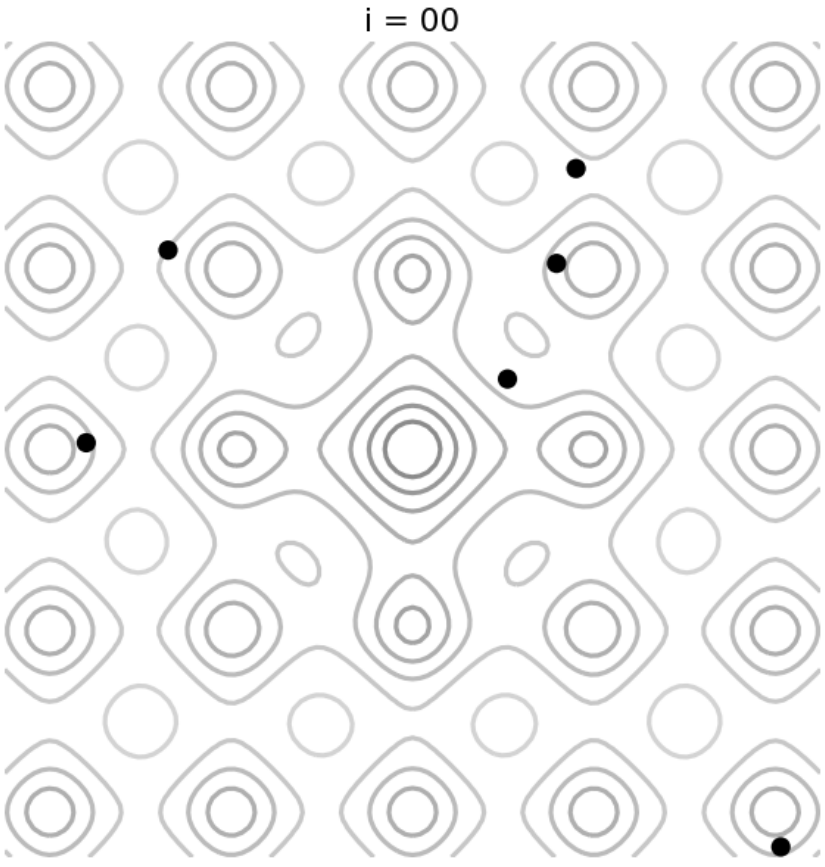
Binomial Crossover

Evaluate objective function for each target and trial:

- Compare $f(x)$ with $f(z)$
- Winner becomes member of next population



Demo



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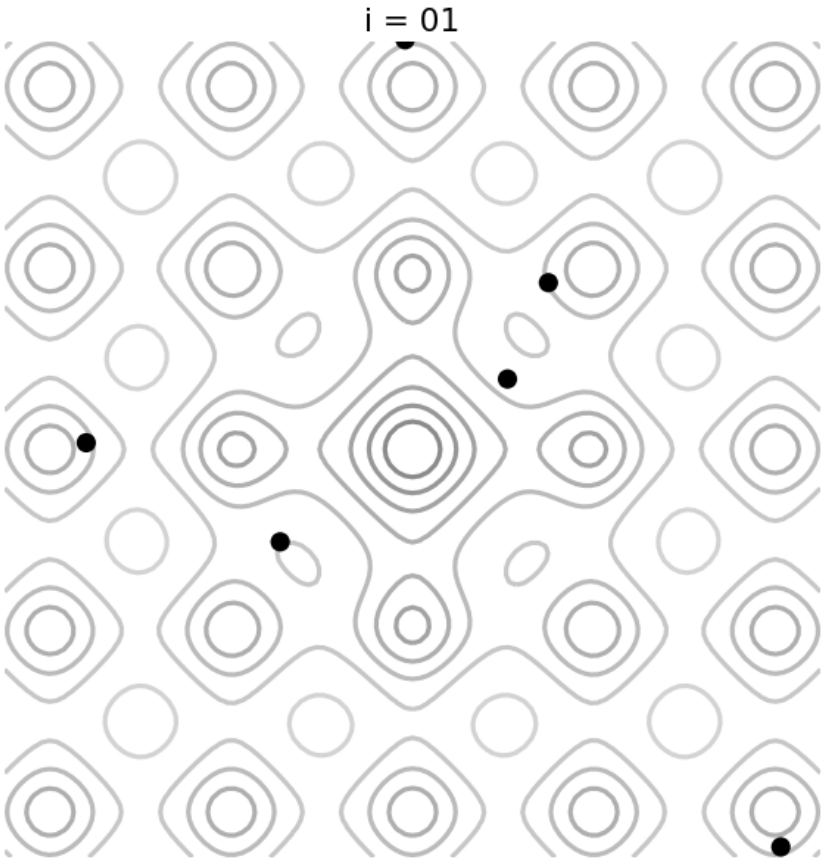

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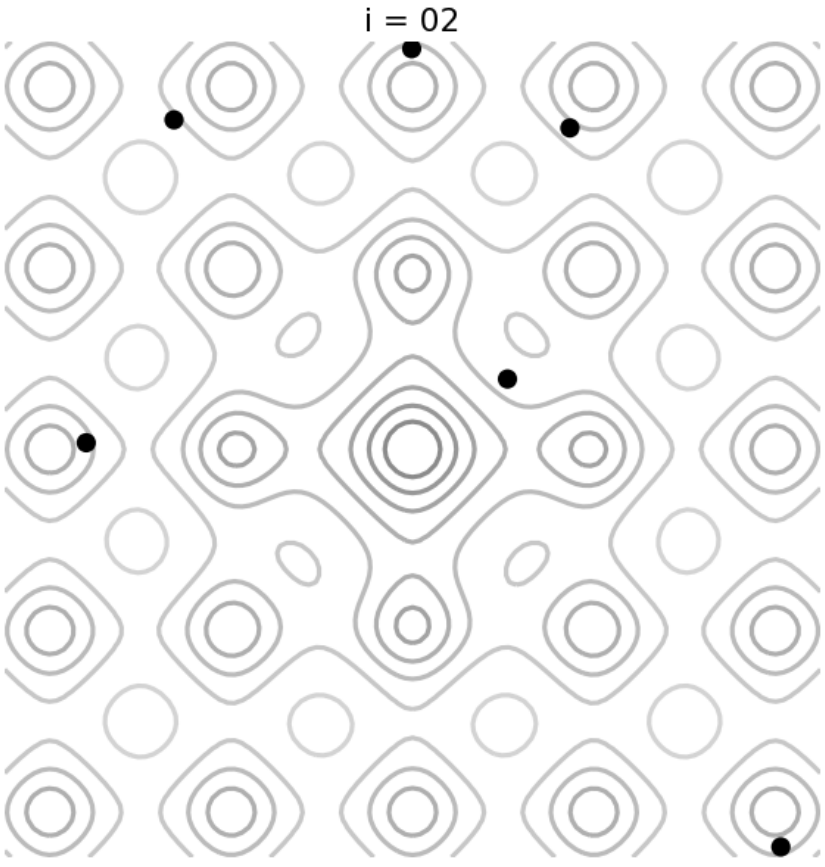

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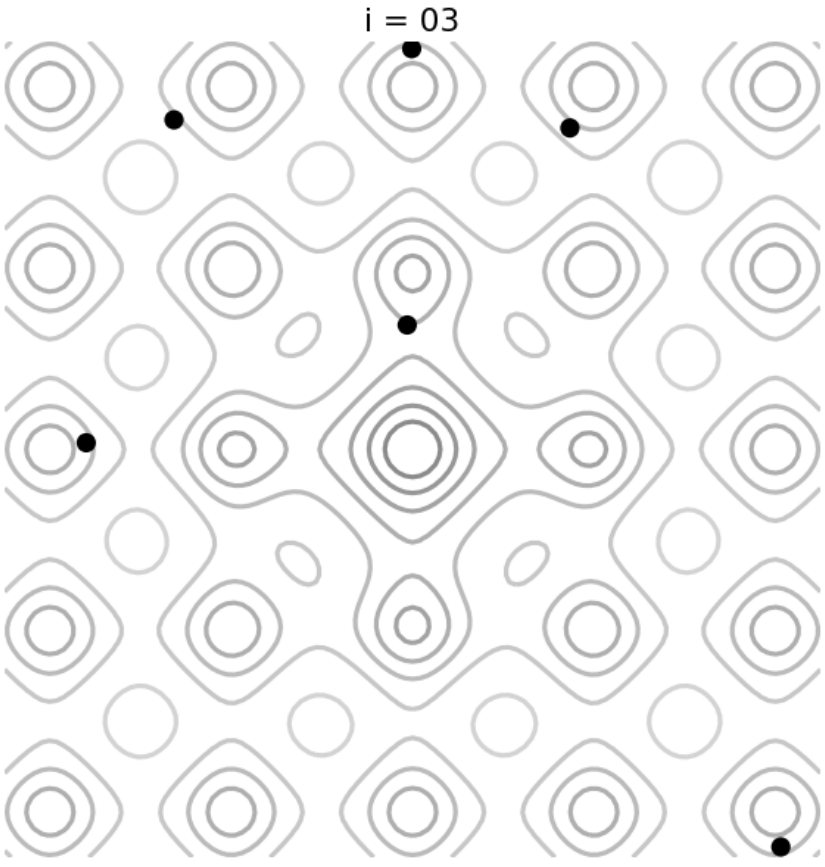

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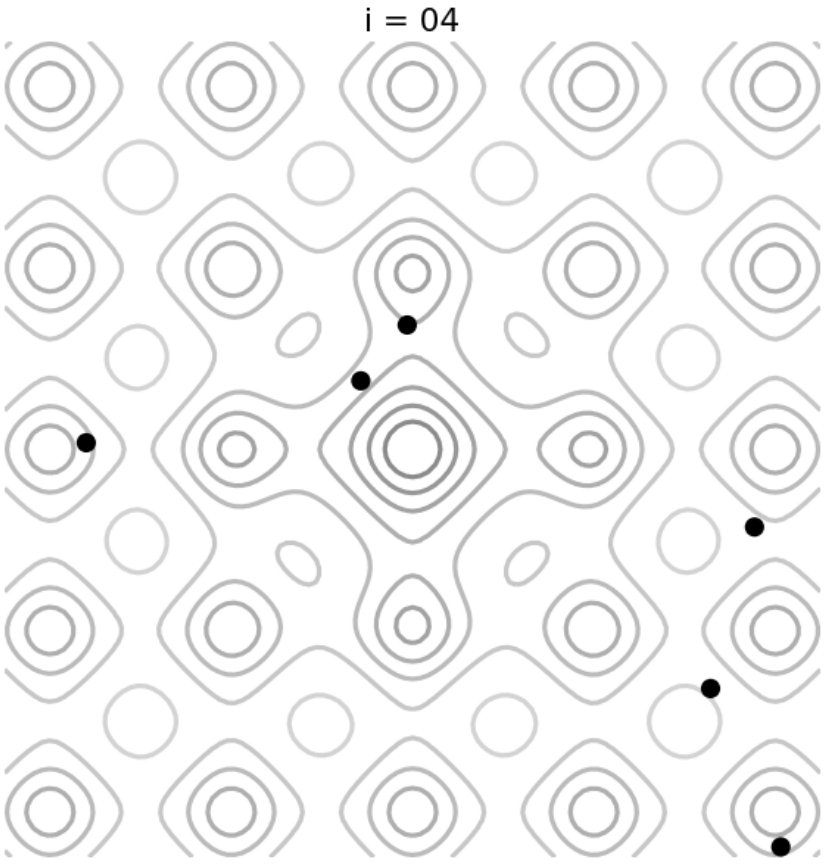

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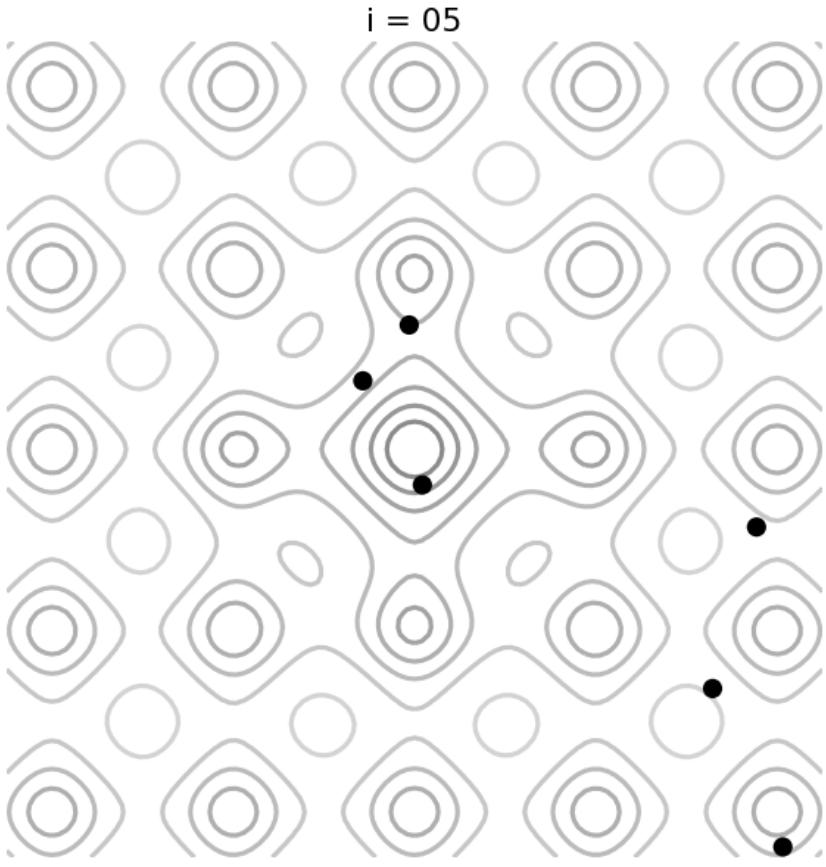

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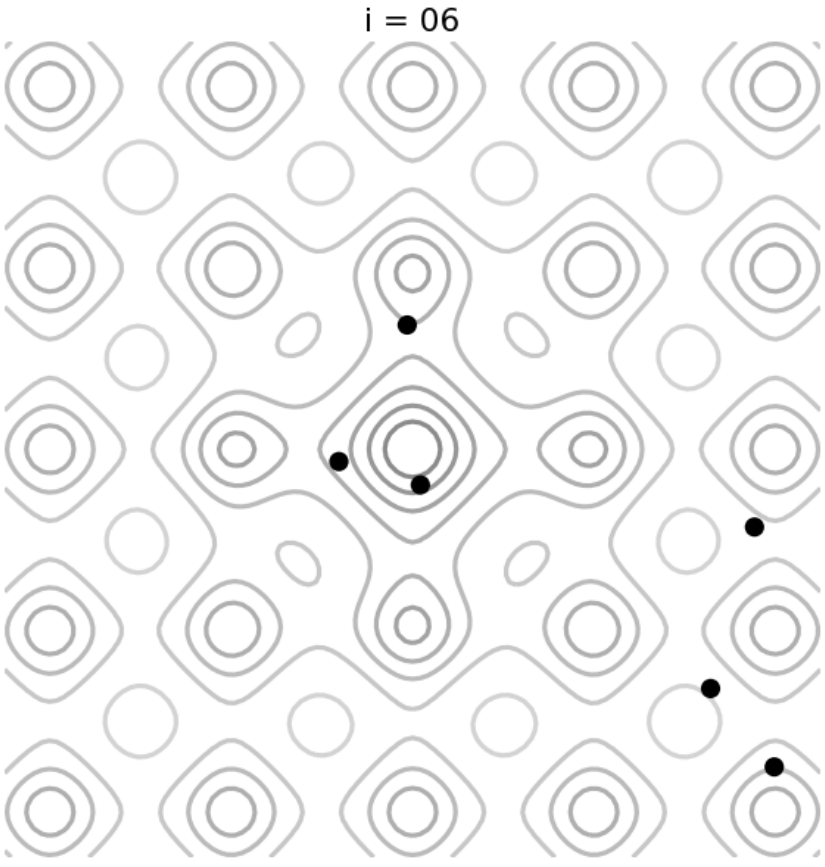

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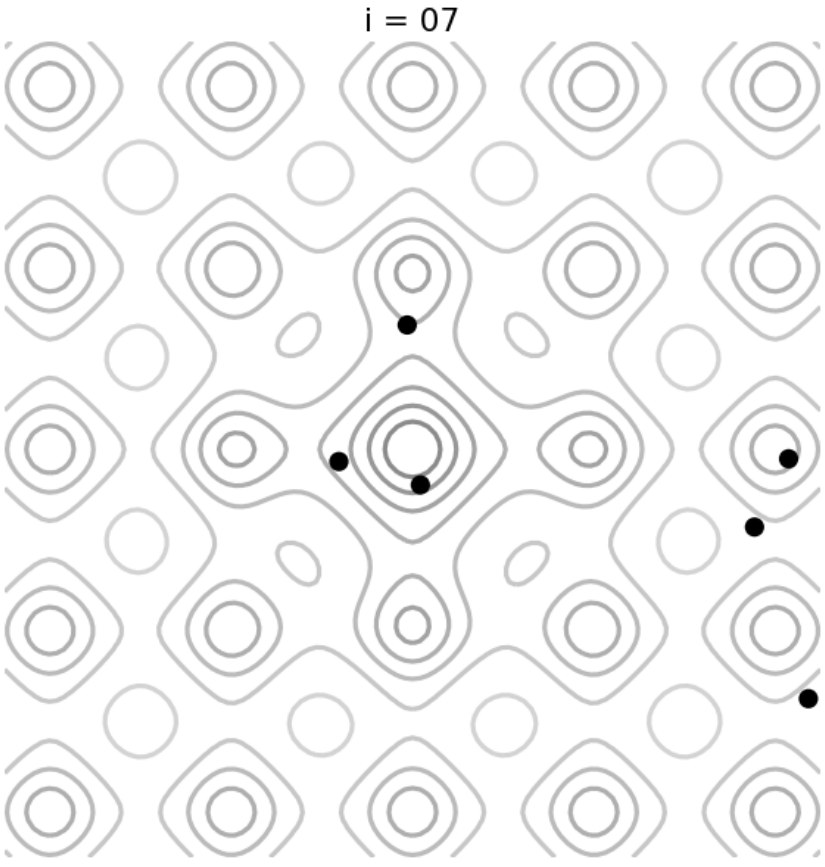

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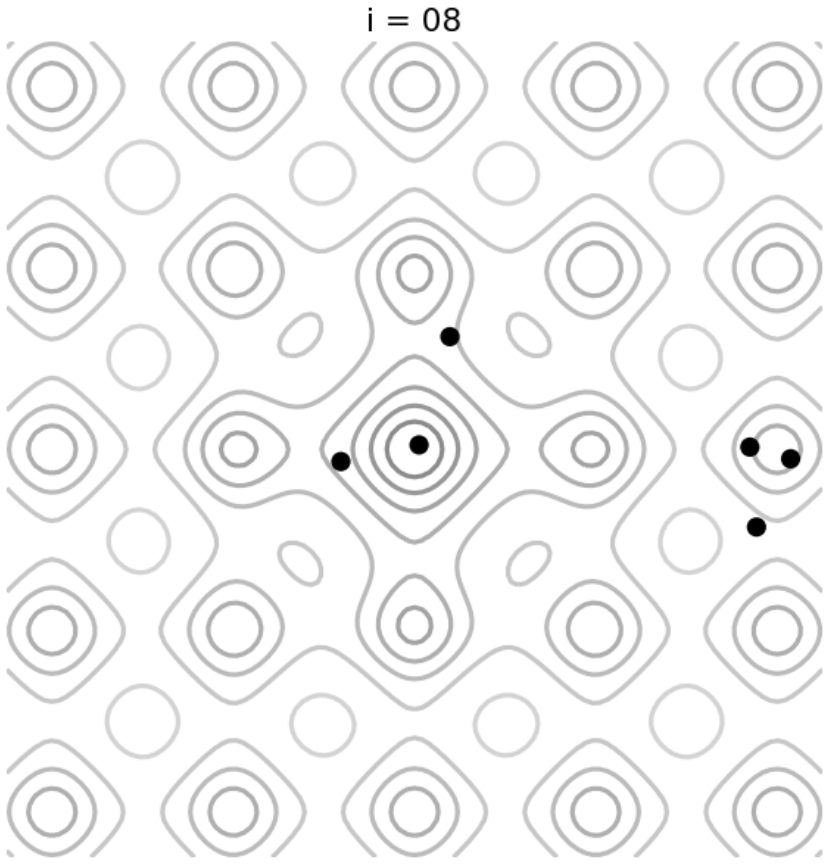

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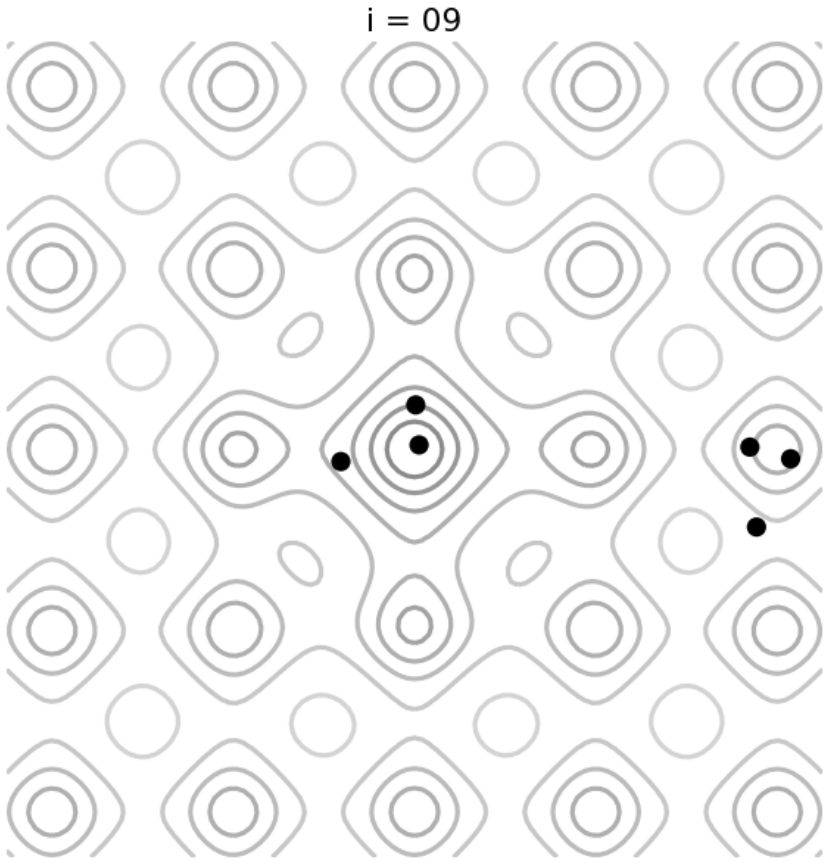

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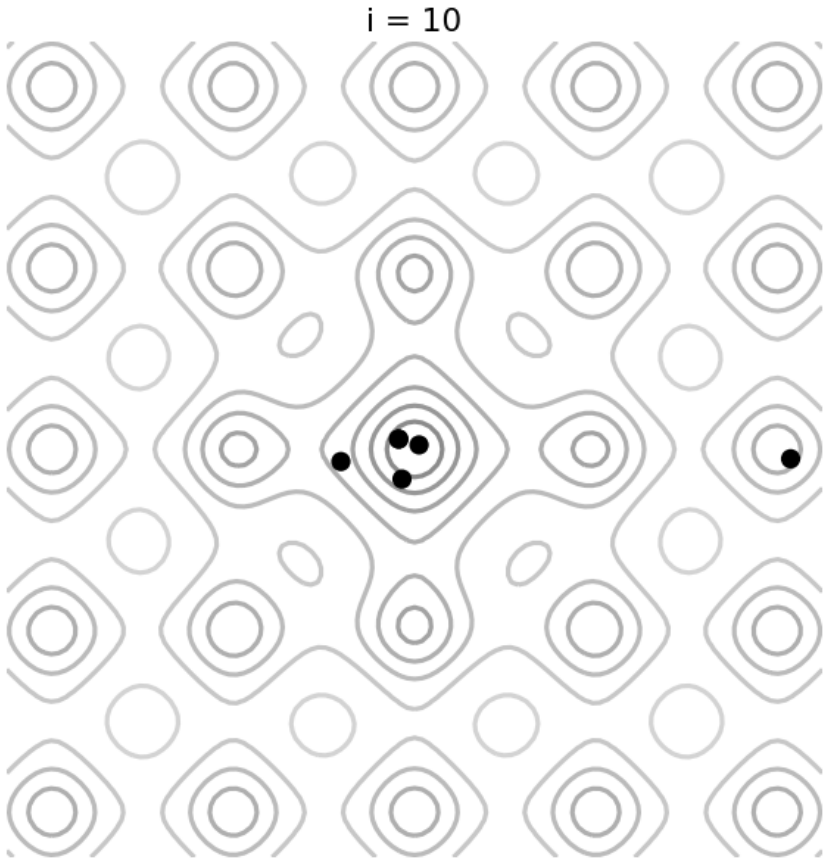

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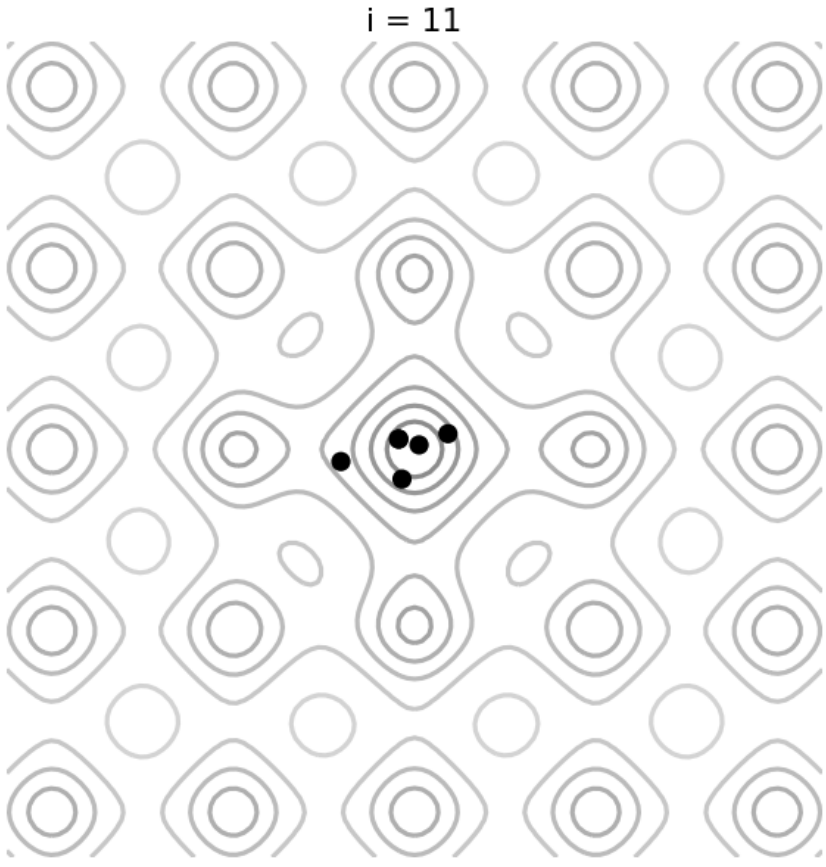

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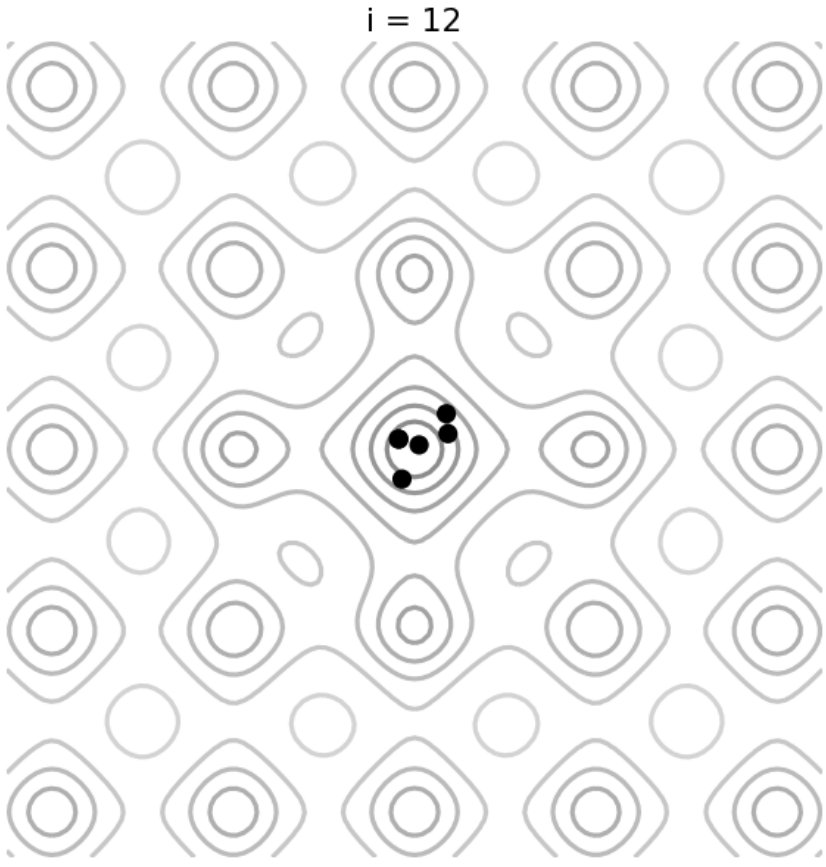

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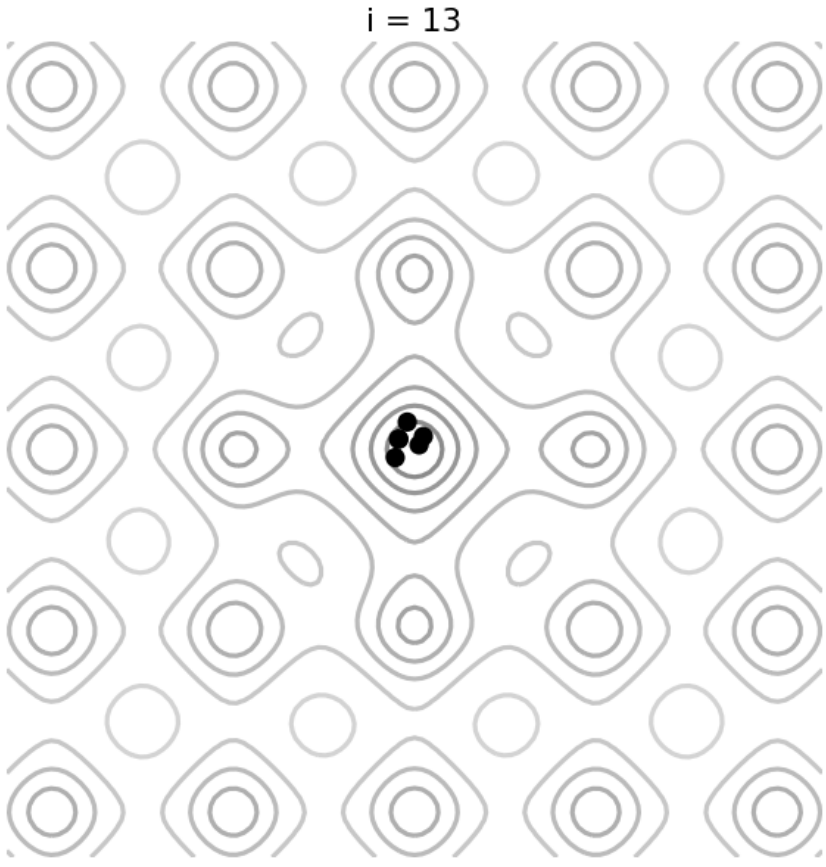

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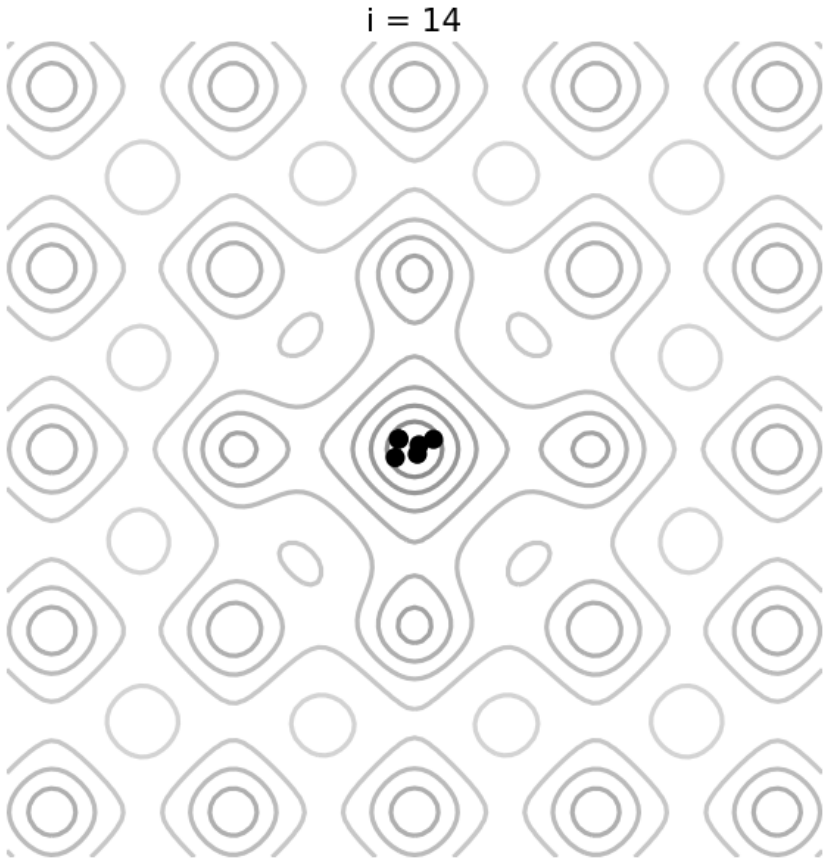

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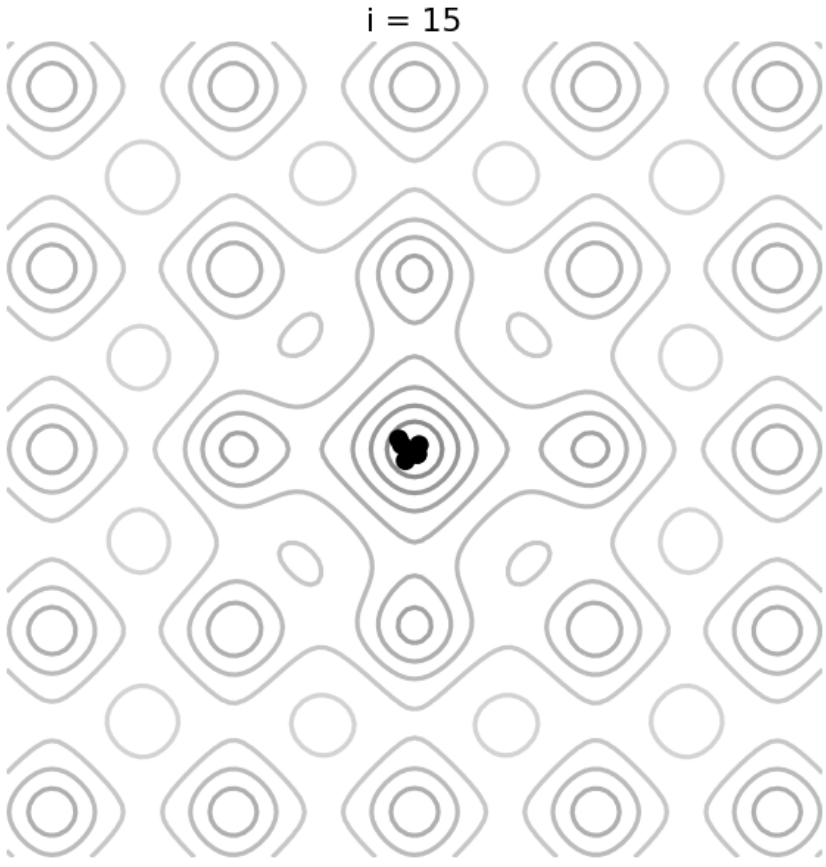

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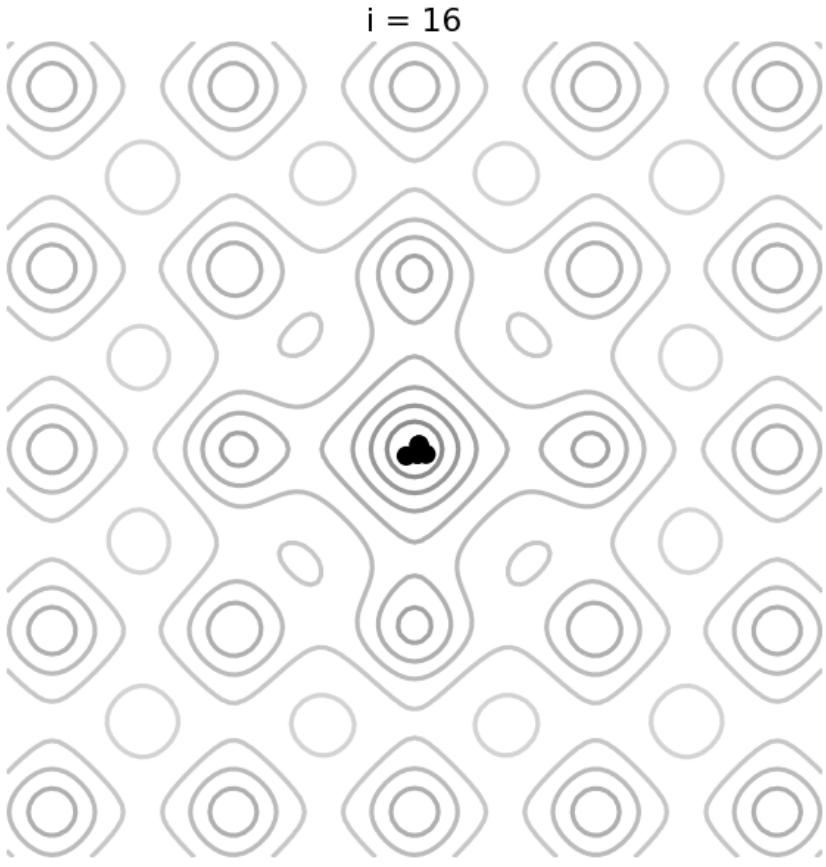

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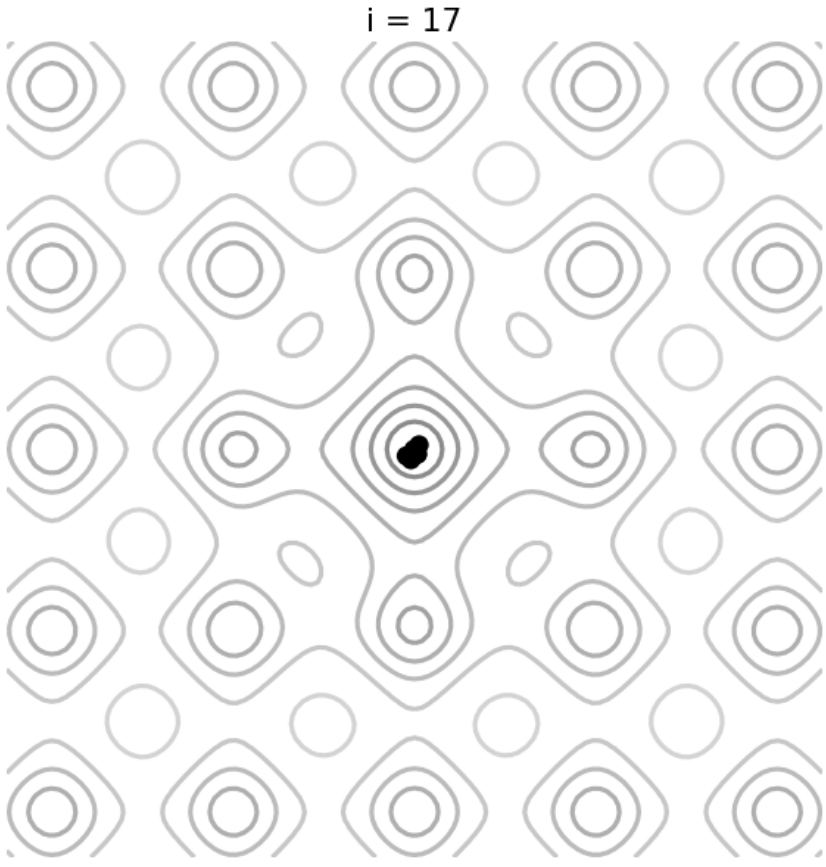

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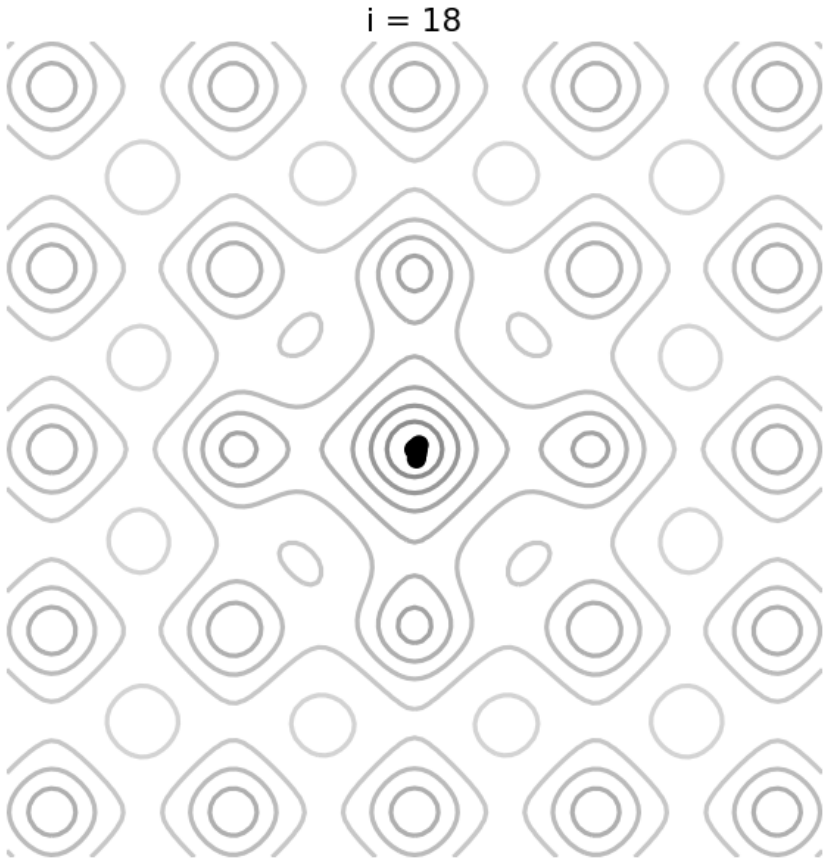

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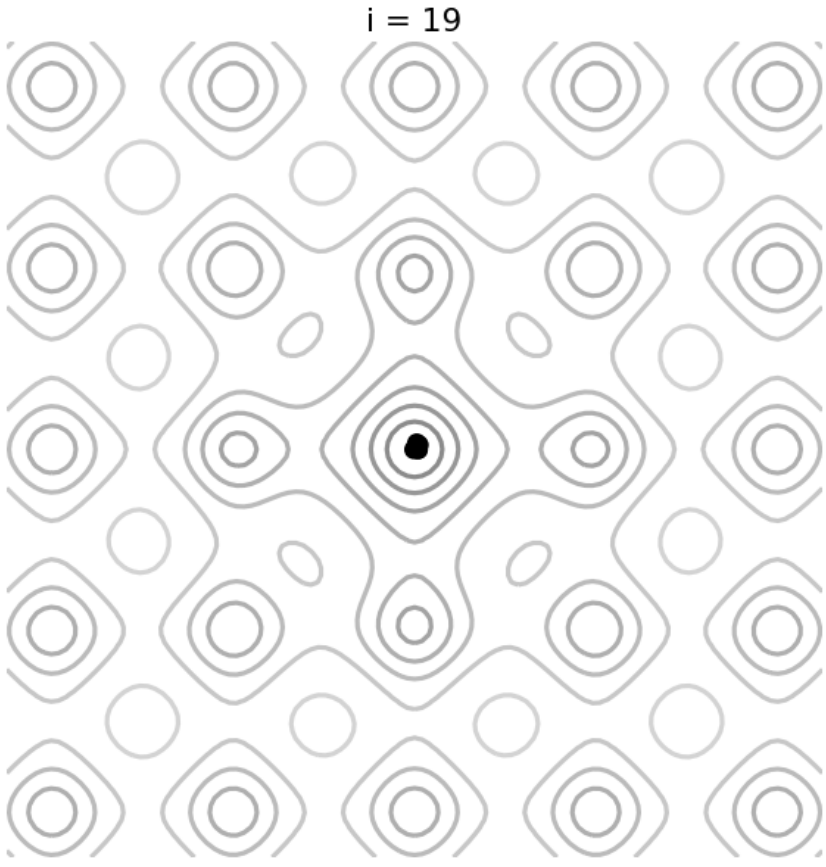

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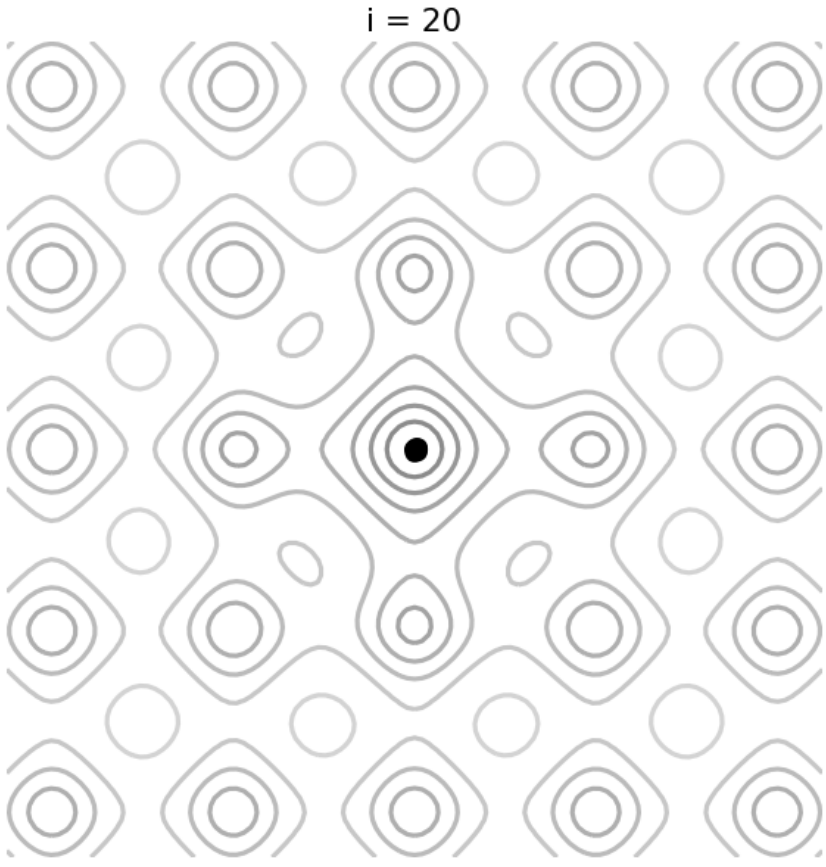
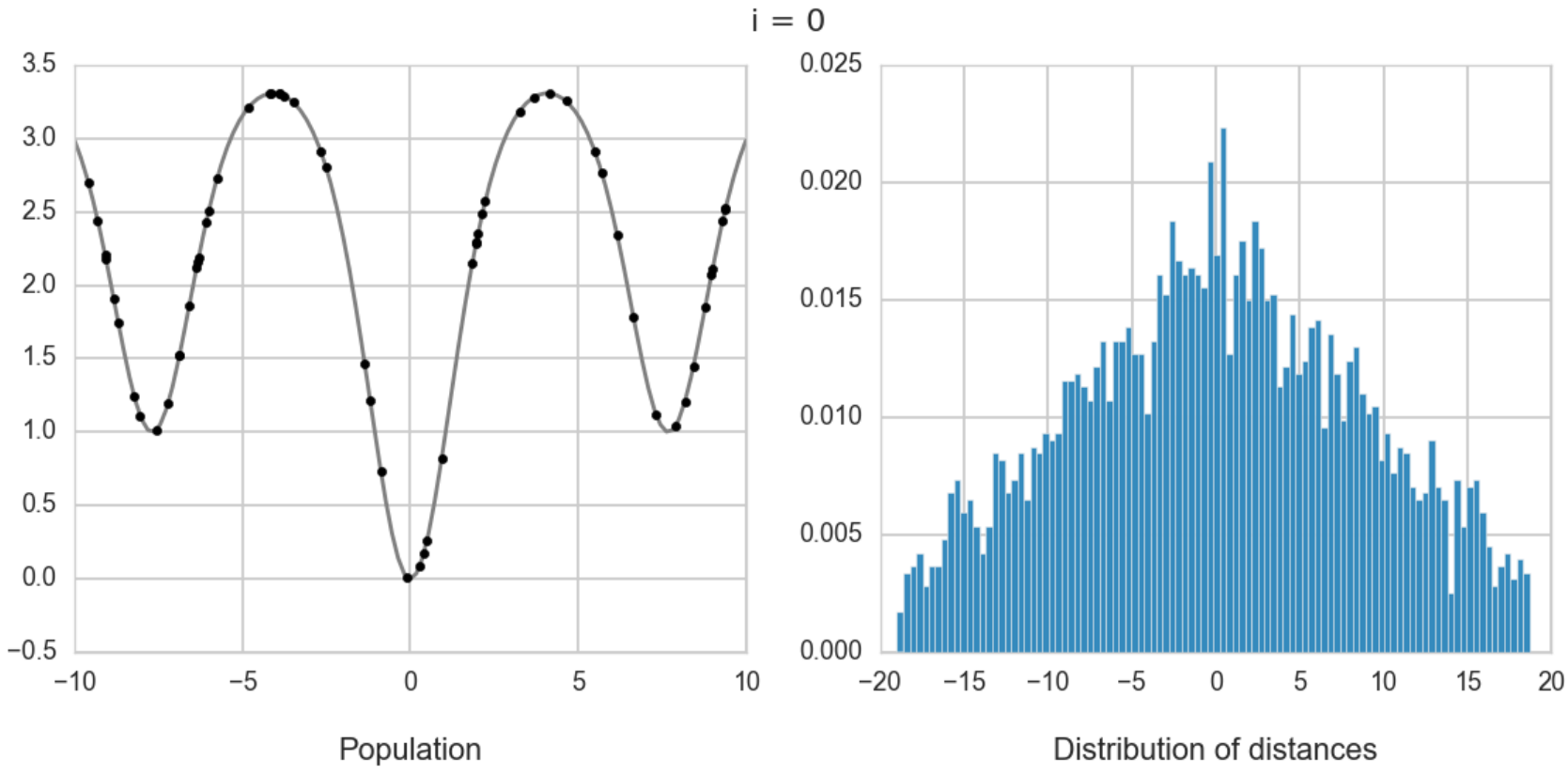


Contour Matching



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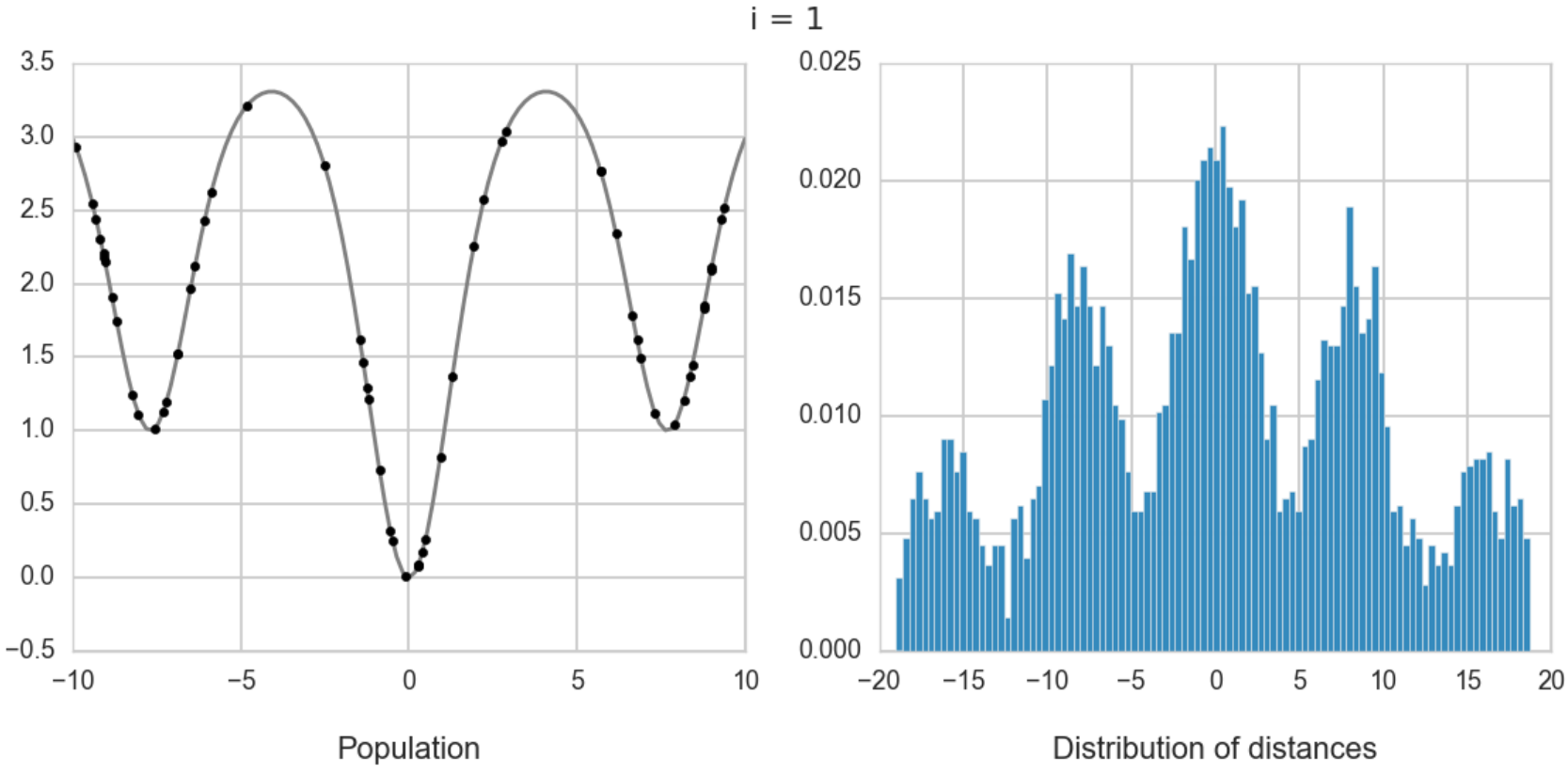

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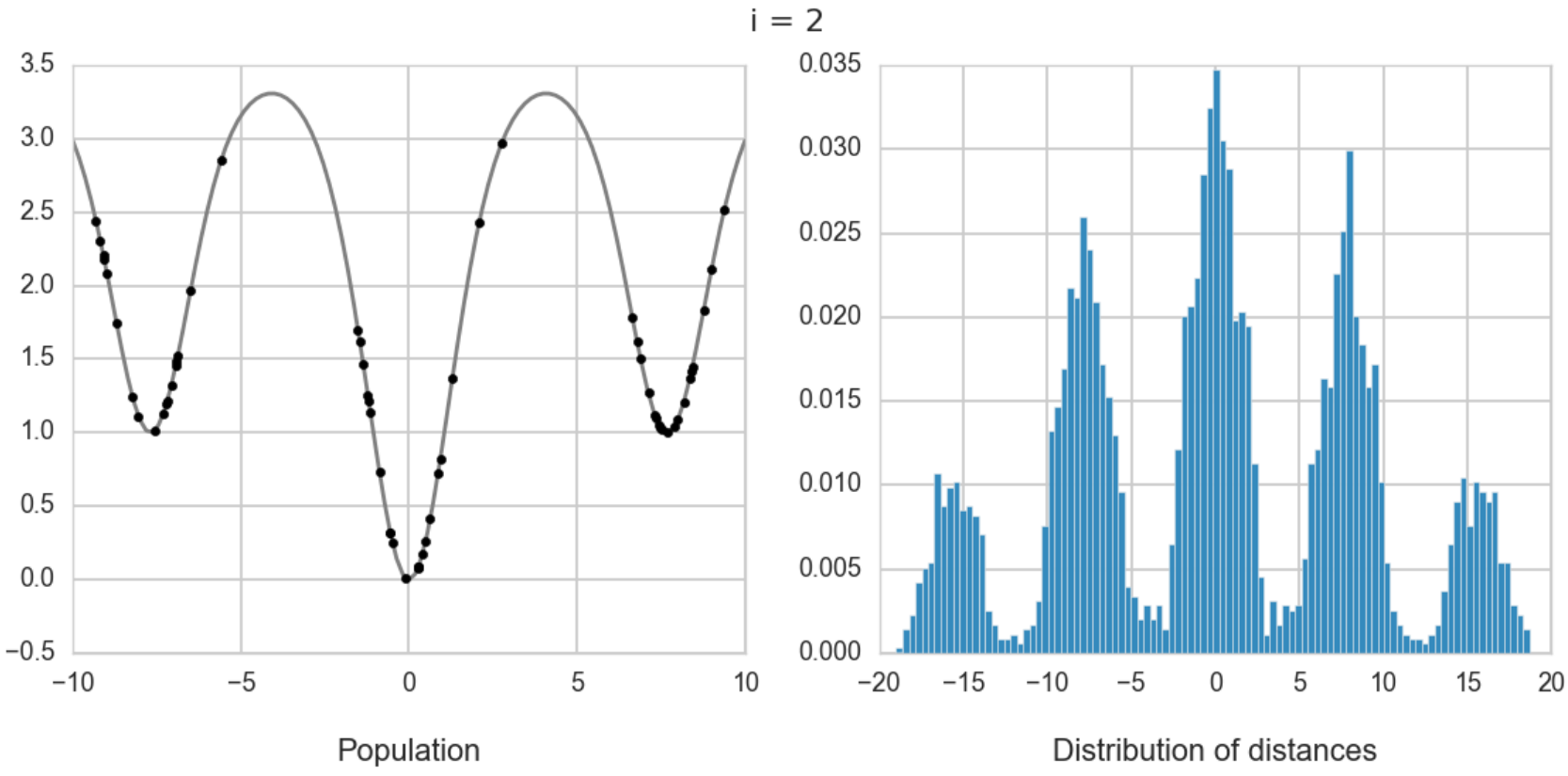

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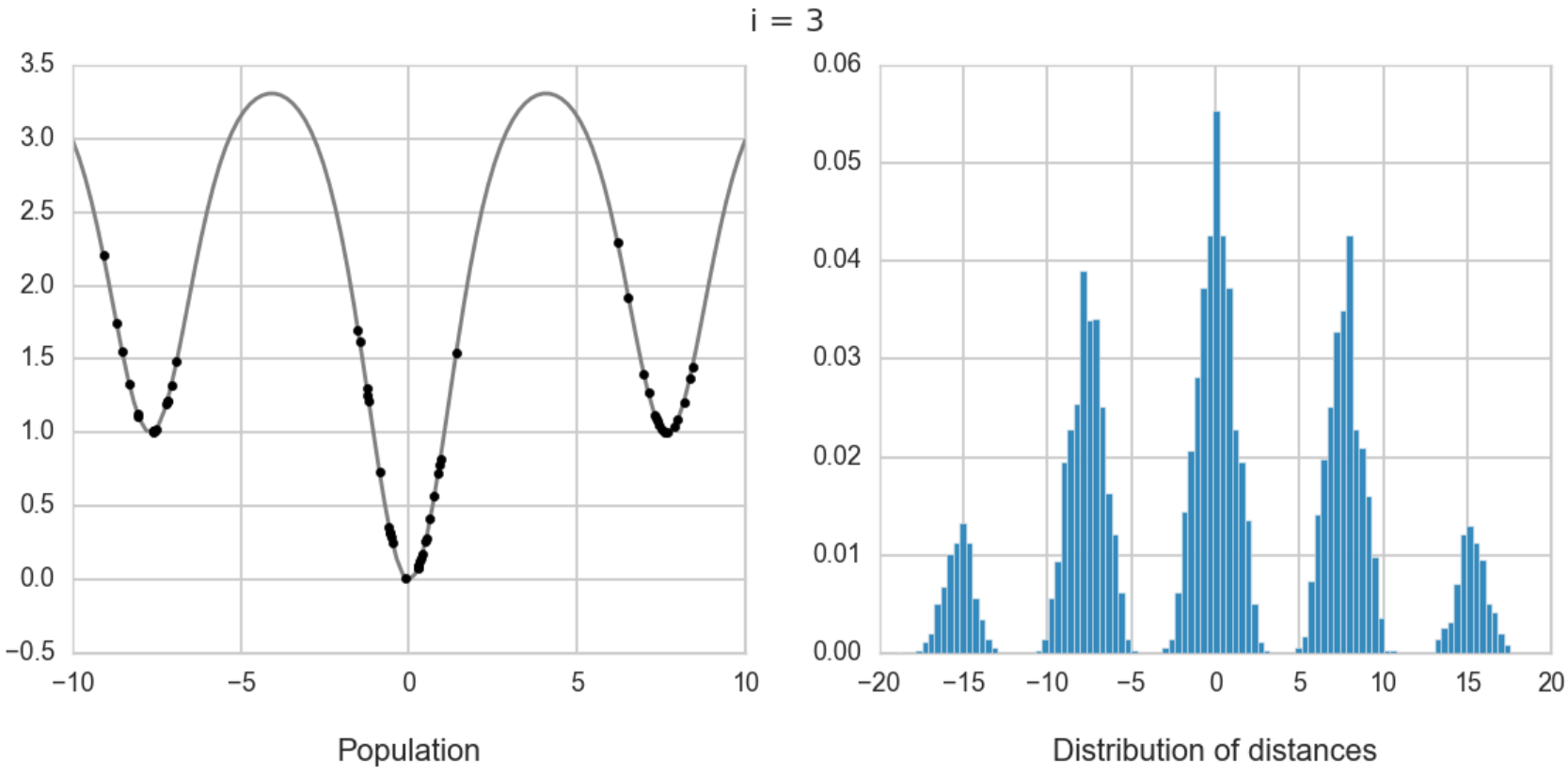

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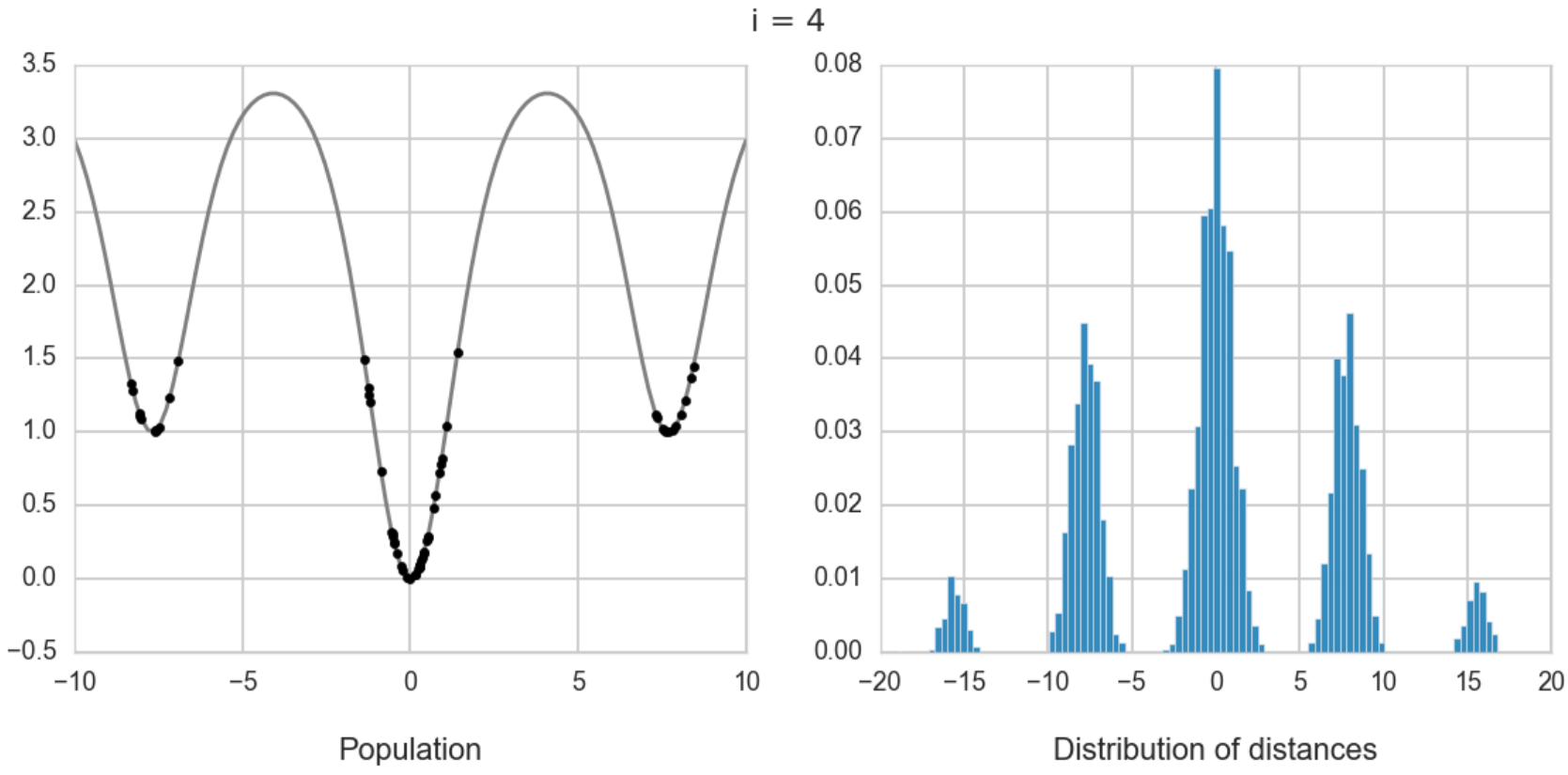

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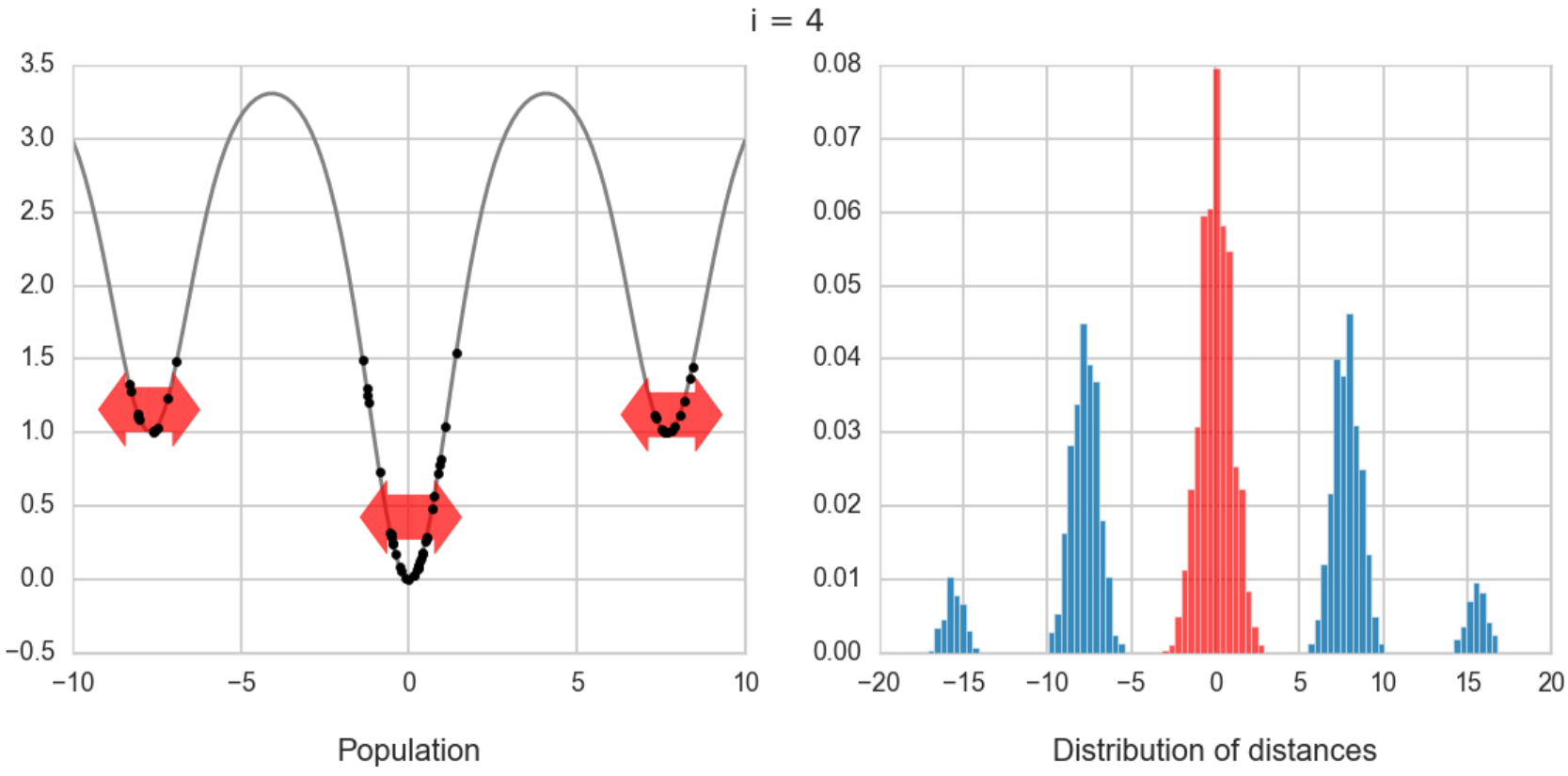

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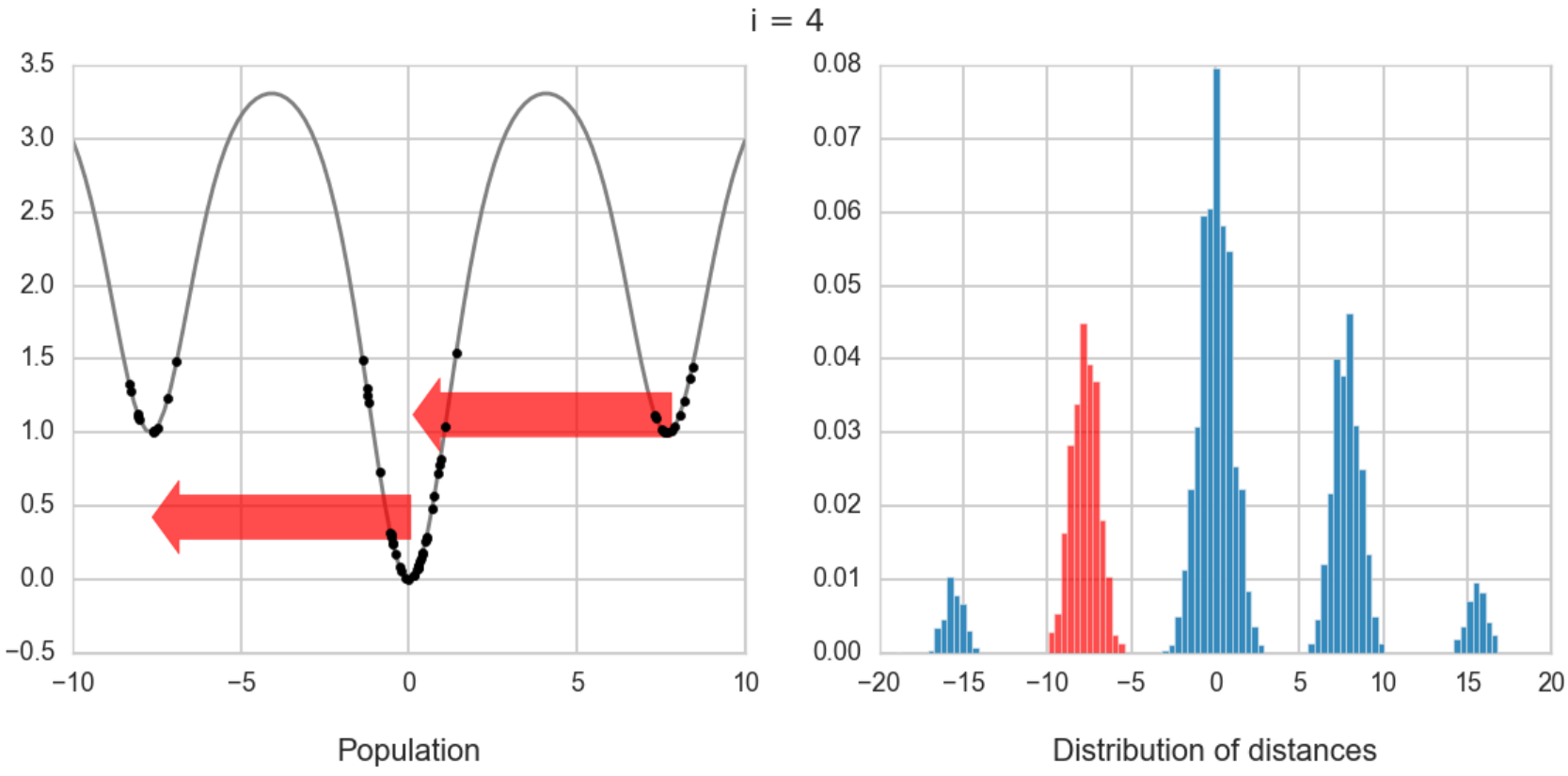

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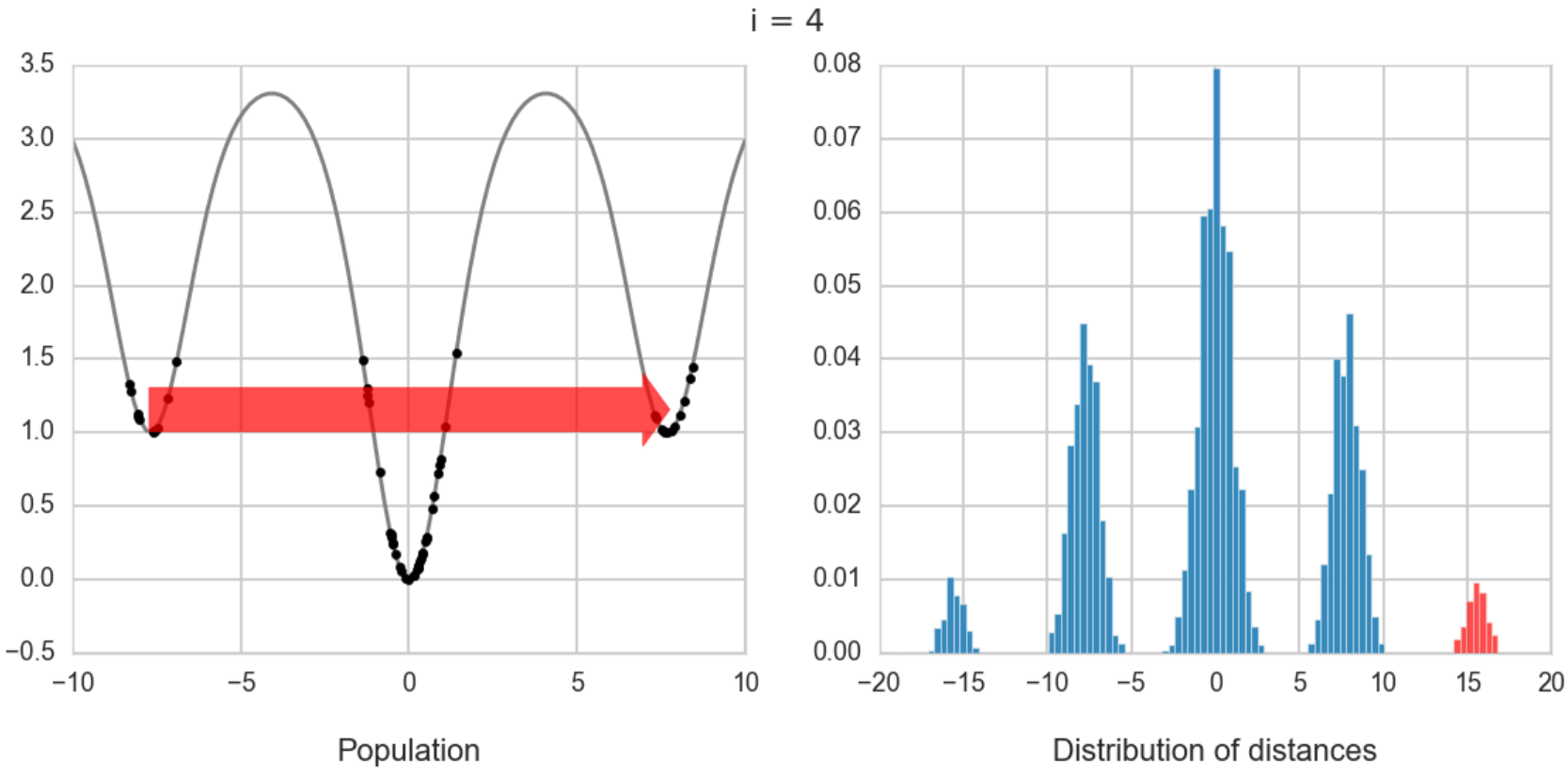

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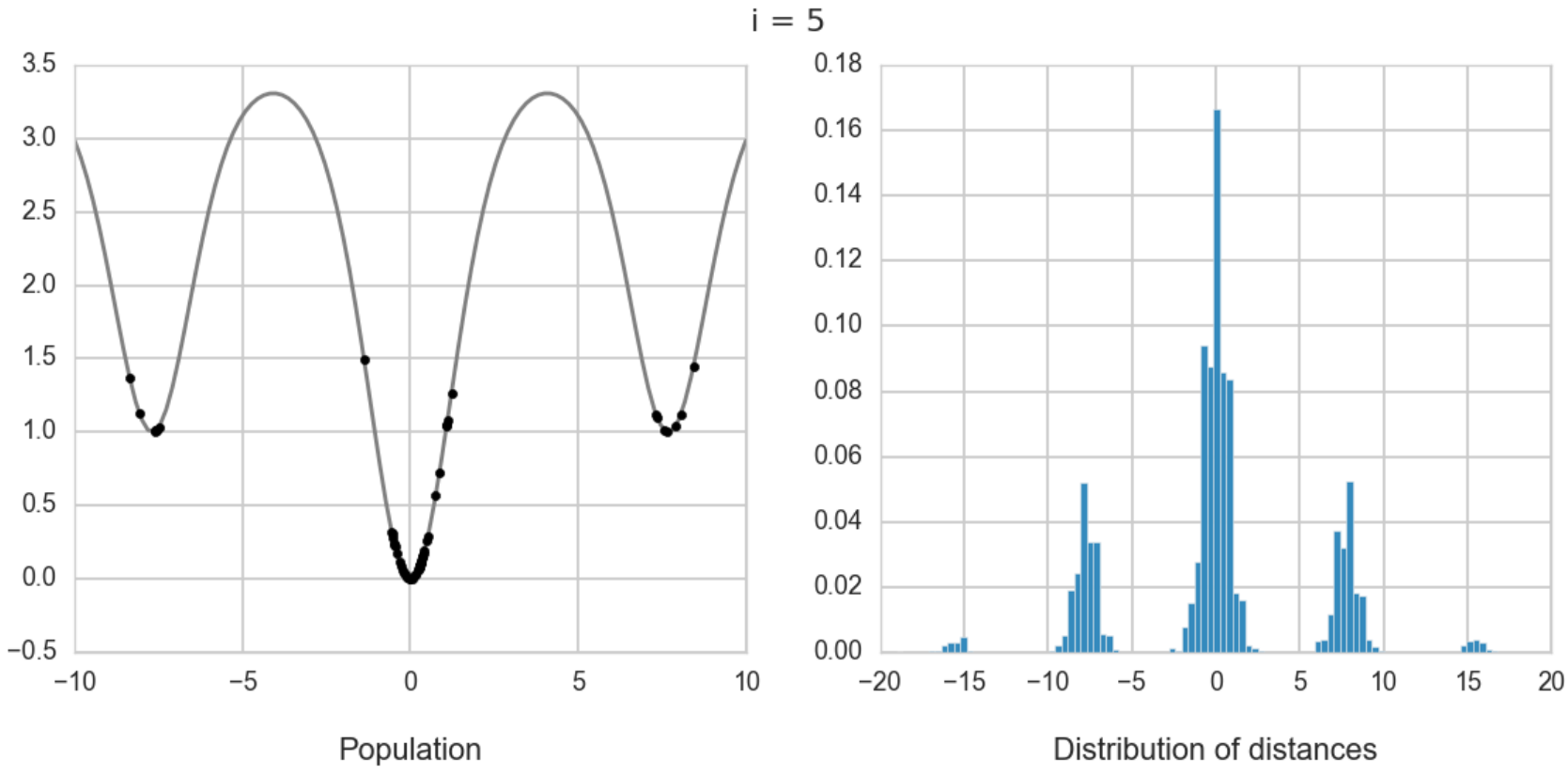

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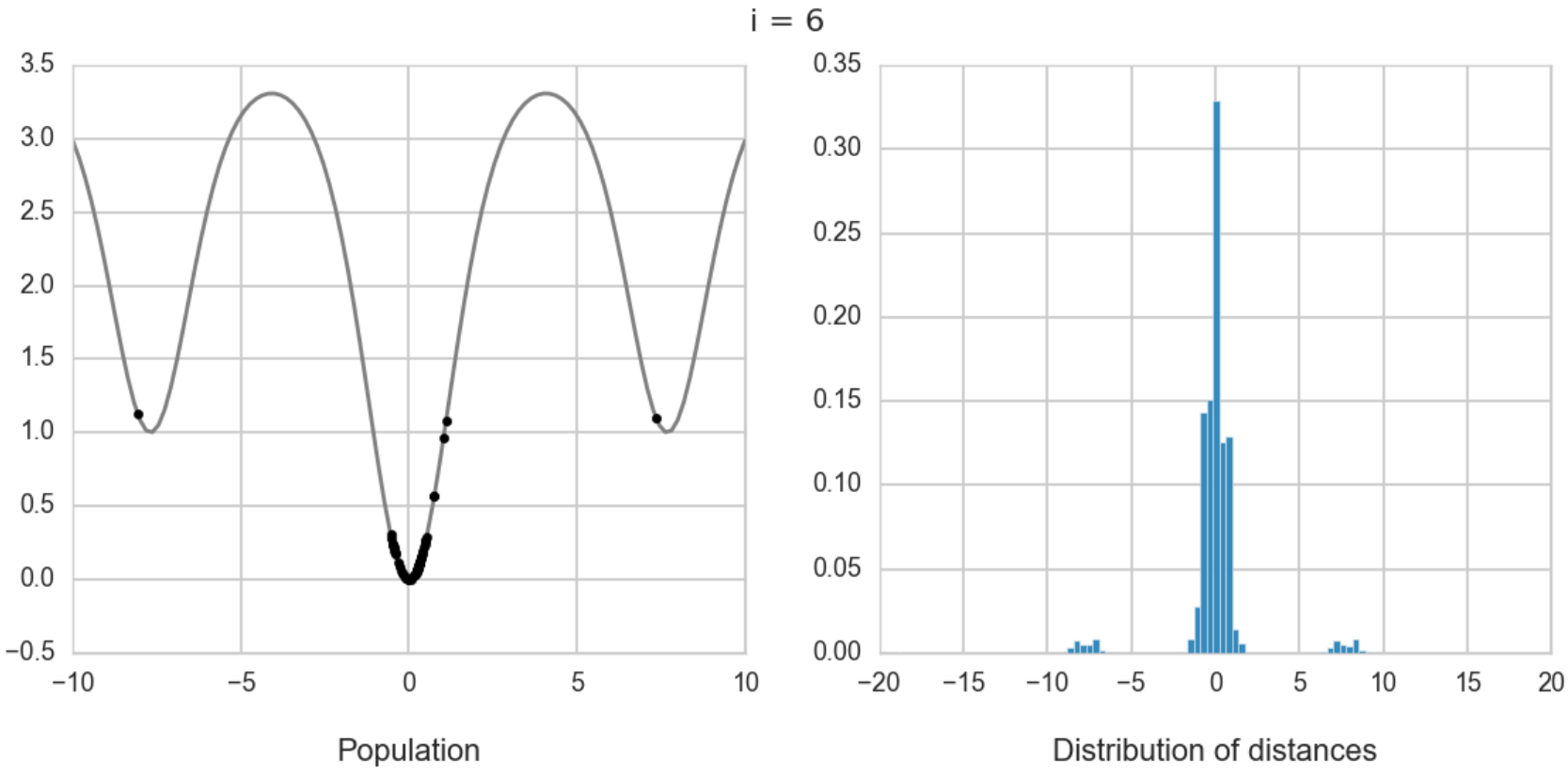

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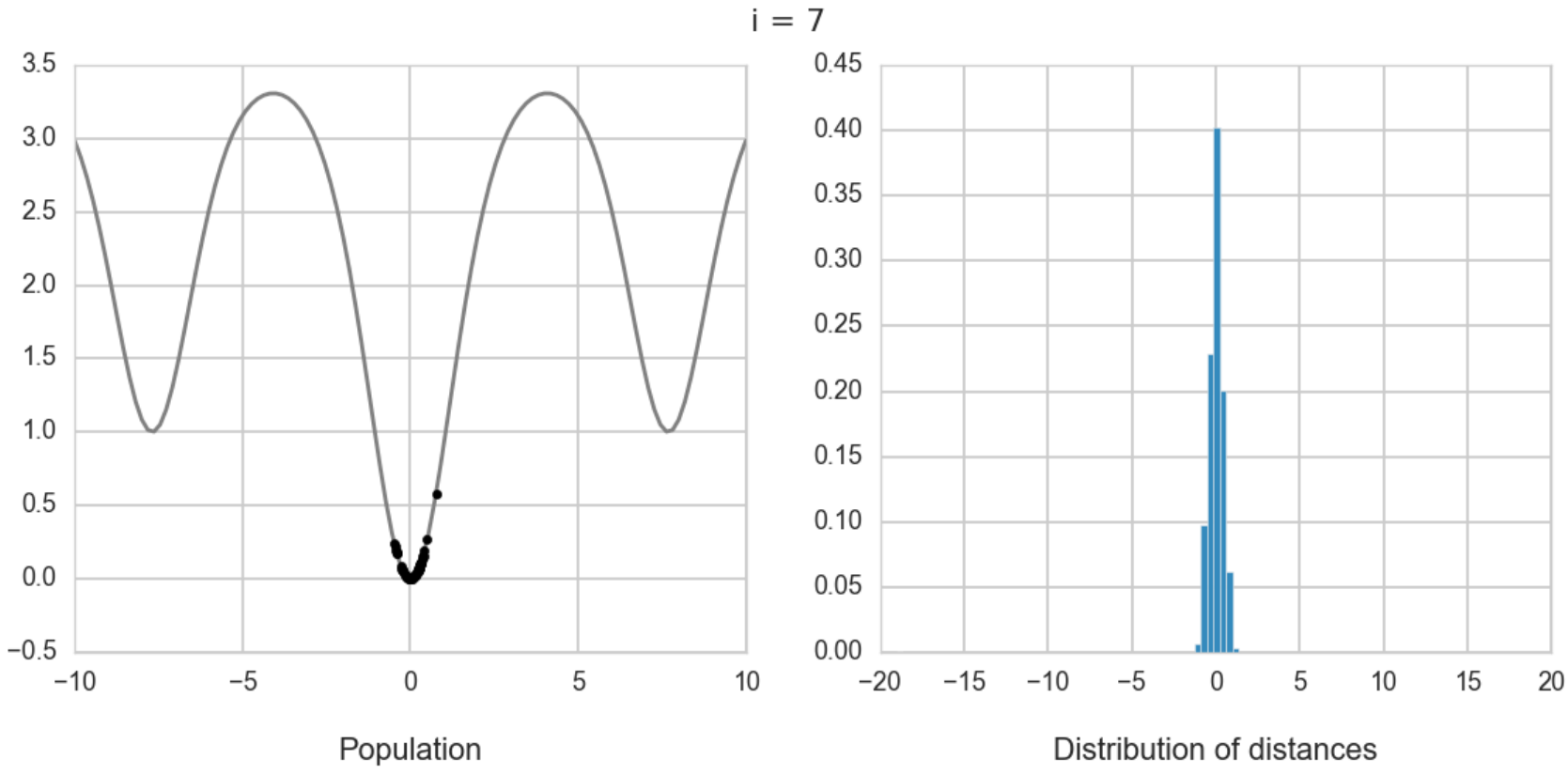

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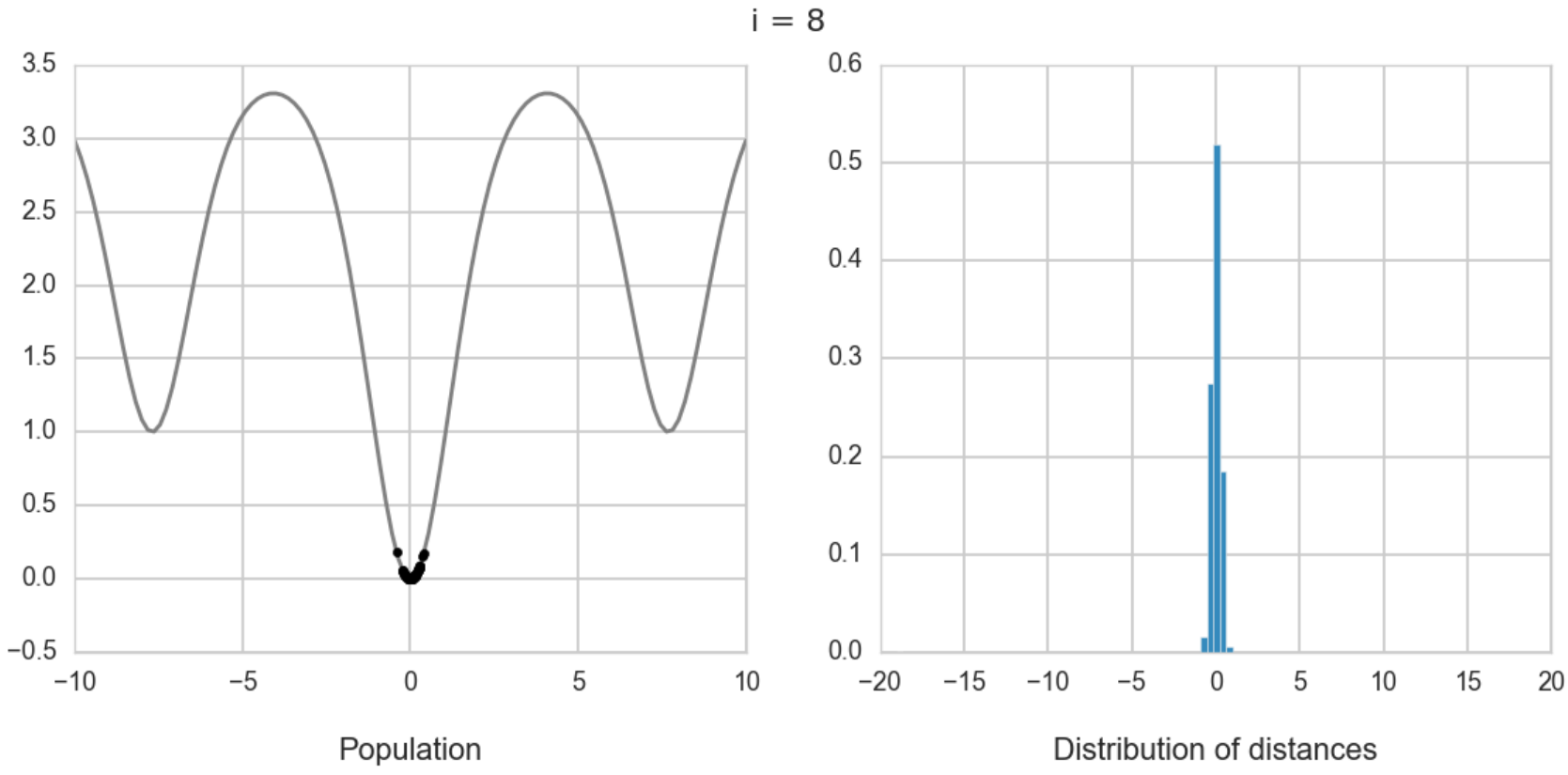

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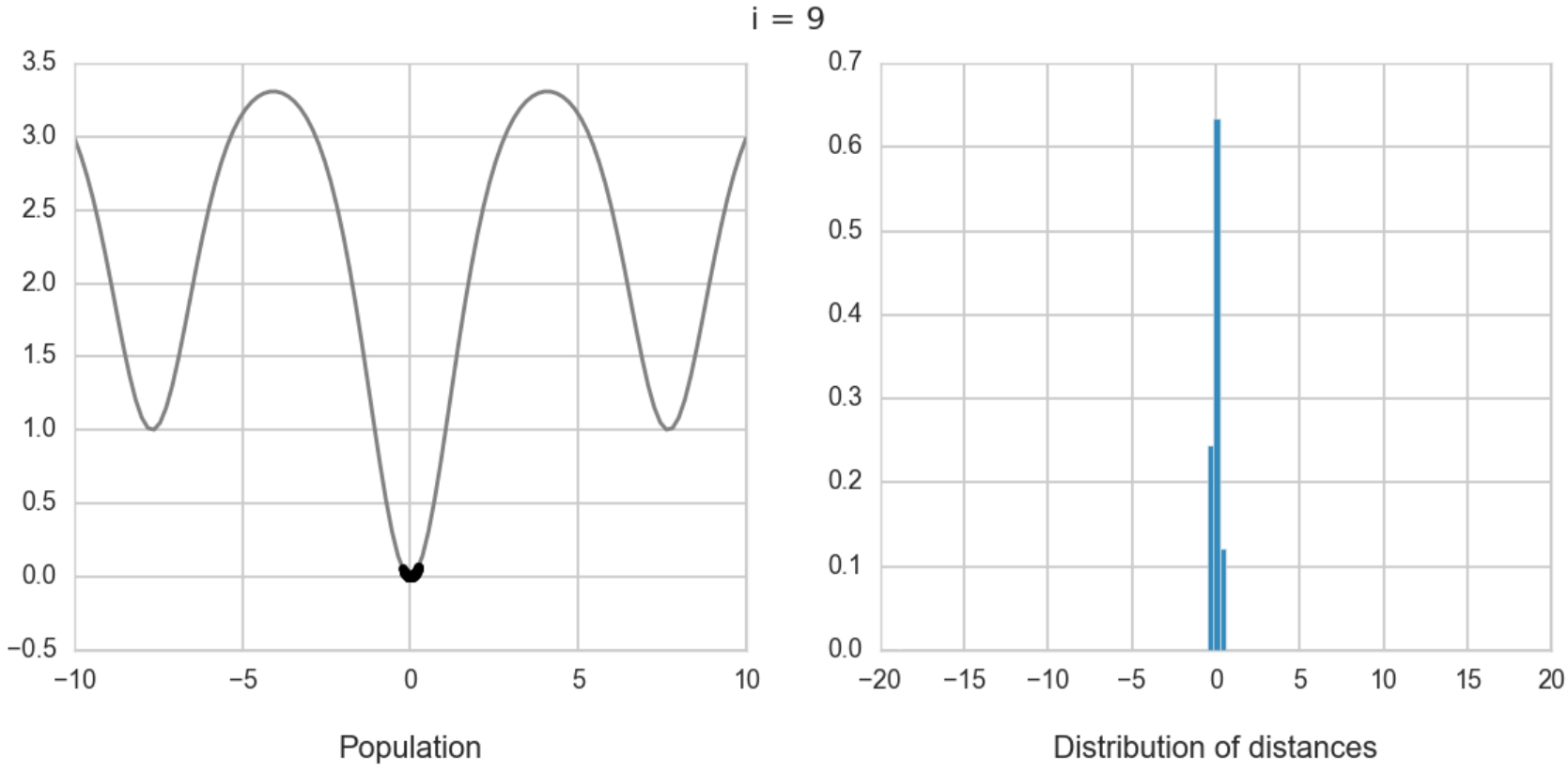

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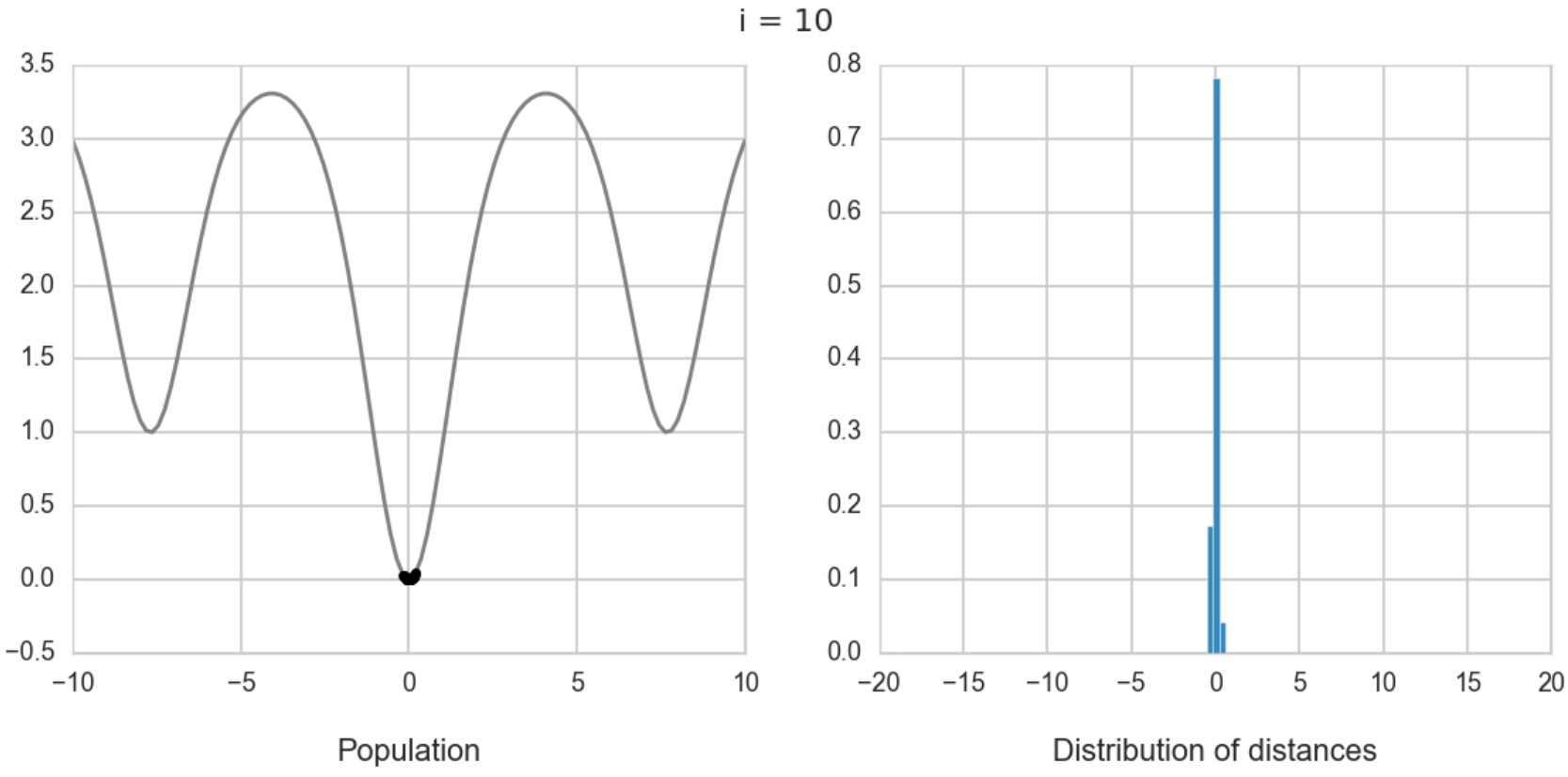

Shalalal