Package 'sobol'

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Type Package

Title Quasi-Monte Carlo Sobol Sequence Generator

Version 1.0.0

Description Provides a fast and efficient implementation of Sobol sequences for quasi-Monte Carlo methods. The Sobol sequence is a low-discrepancy sequence with the property that for all values of N, its subsequence x1, ..., xN has a low discrepancy. It can be used to generate quasi-random numbers for use in Monte Carlo integration and other simulation methods. This implementation is based on the algorithms described by Bratley and Fox (1988) <doi:10.1145/42288.214372> and uses direction numbers from Joe and Kuo (2008) <doi:10.1145/1358628.1358630>. The package includes both batch and incremental interfaces with support for arbitrary starting indices and reproducible sequences. It uses 'Rcpp' for efficient 'C++' integration.

URL https://alrobles.github.io/sobol/

BugReports https://github.com/alrobles/sobol/issues

Encoding UTF-8

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LinkingTo Rcpp

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RoxygenNote 7.3.3

License GPL (>= 3)

NeedsCompilation yes

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`print.sobol_generator` *Print Method for Sobol Generator*

Description

Print Method for Sobol Generator

Usage

```
## S3 method for class 'sobol_generator'
print(x, ...)
```

Arguments

`x`	A sobol_generator object
`...`	Additional arguments passed to print

Value

Invisibly returns the input object (for chaining)

print.summary.sobol_generator *Print Summary of Sobol Generator*

Description

Print Summary of Sobol Generator

Usage

```
## S3 method for class 'summary.sobol_generator'
print(x, ...)
```

Arguments

x	A summary.sobol_generator object
...	Additional arguments passed to print

Value

Invisibly returns the input object

sobol_design *Generate a Sobol Design for Parameter Exploration*

Description

Creates a Latin hypercube design based on the Sobol low-discrepancy sequence. This function provides an API-compatible alternative to the sobol_design function in the pomp-explore package for generating parameter designs.

Usage

```
sobol_design(lower = numeric(0), upper = numeric(0), nseq)
```

Arguments

lower	Named numeric vector giving the lower bounds of the parameter ranges. Must have the same names as upper.
upper	Named numeric vector giving the upper bounds of the parameter ranges. Must have the same names as lower.
nseq	Integer, the total number of parameter sets (points) to generate.

Details

This function generates a Sobol sequence in the unit hypercube [0,1]^d and then scales each dimension to the specified parameter ranges. The Sobol sequence is generated using the Joe-Kuo direction numbers with Property A enforcement, providing excellent low-discrepancy properties.

Following the recommendation of Joe & Kuo (2003) and the implementation in pomp-explore, this function skips the first k points of the Sobol sequence, where k is the largest power of 2 smaller than nseq. This improves the uniformity properties of the generated design.

The function is designed to be API-compatible with the `sobol_design` function from the pomp-explore package, allowing for easy comparison and drop-in replacement.

Value

A data frame with `nseq` rows and one column for each parameter named in `lower` and `upper`. Each column contains values scaled to the specified range [lower, upper] for that parameter.

References

Bratley, P., & Fox, B. L. (1988). Algorithm 659: Implementing Sobol's quasirandom sequence generator. ACM Transactions on Mathematical Software, 14(1), 88-100.

Joe, S., & Kuo, F. Y. (2008). Constructing Sobol sequences with better two-dimensional projections. SIAM Journal on Scientific Computing, 30(5), 2635-2654.

See Also

`sobol_points` for batch generation without scaling, `sobol_generator` for incremental generation

Examples

```
# Generate 100 parameter sets for two parameters
design <- sobol_design(
  lower = c(a = 0, b = 100),
  upper = c(a = 1, b = 200),
  nseq = 100
)
head(design)

# Plot the design
plot(design$a, design$b, main = "Sobol Design")

# High-dimensional example
params <- paste0("param", 1:10)
design_10d <- sobol_design(
  lower = setNames(rep(0, 10), params),
  upper = setNames(rep(1, 10), params),
  nseq = 1000
)
```

sobol_dimensions *Get Number of Dimensions of a Sobol Generator*

Description

Returns the number of dimensions configured for the generator.

Usage

```
sobol_dimensions(x, ...)
```

Arguments

x	A sobol_generator object created by sobol_generator
...	Additional arguments (currently unused)

Value

An integer representing the number of dimensions.

Examples

```
gen <- sobol_generator(dimensions = 5)
dims <- sobol_dimensions(gen)
print(dims) # 5
```

sobol_generator *Create a Sobol Sequence Generator*

Description

Creates an S3 object that wraps an Rcpp Sobol sequence generator for incremental point generation. The generator maintains internal state and allows for efficient generation of quasi-random sequences.

Usage

```
sobol_generator(dimensions, skip = 0)
```

Arguments

dimensions	Integer, the number of dimensions for the Sobol sequence. Must be a positive integer.
skip	Numeric, the number of initial points to skip (default: 0). This allows starting the sequence from any index for reproducibility.

Value

An S3 object of class "sobol_generator" containing:

`generator`	The underlying Rcpp reference class object
`dimensions`	Number of dimensions
`initial_skip`	Initial skip value used at construction

Examples

```
# Create a 3-dimensional Sobol generator
gen <- sobol_generator(dimensions = 3)

# Generate a single point
point <- sobol_next(gen)

# Generate multiple points
points <- sobol_next_n(gen, n = 100)

# Skip to a specific index
sobol_skip_to(gen, 1000)

# Create a generator starting from index 50
gen2 <- sobol_generator(dimensions = 2, skip = 50)
```

`sobol_index` *Get Current Index of a Sobol Generator*

Description

Returns the current index of the generator, which is the index of the next point that will be generated.

Usage

```
sobol_index(x, ...)
```

Arguments

`x`	A sobol_generator object created by `sobol_generator`
`...`	Additional arguments (currently unused)

Value

A numeric value representing the current index (0-based).

Examples

```
gen <- sobol_generator(dimensions = 2)
sobol_next(gen)
sobol_next(gen)
idx <- sobol_index(gen)
print(idx) # 2
```

---

sobol_next *Generate the Next Point from a Sobol Generator*

Description

Generates a single point from the Sobol sequence and advances the internal state of the generator.

Usage

```
sobol_next(x, ...)
```

Arguments

x	A sobol_generator object created by sobol_generator
...	Additional arguments (currently unused)

Value

A numeric vector of length equal to the number of dimensions, containing the next point in the Sobol sequence. Values are in [0, 1).

Examples

```
gen <- sobol_generator(dimensions = 3)
point <- sobol_next(gen)
print(point) # e.g., [0.5, 0.5, 0.5]
```

sobol_next_n *Generate Multiple Points from a Sobol Generator*

Description

Generates n consecutive points from the Sobol sequence and advances the internal state of the generator.

Usage

```
sobol_next_n(x, n, ...)
```

Arguments

x	A sobol_generator object created by sobol_generator
n	Integer, the number of points to generate. Must be non-negative.
...	Additional arguments (currently unused)

Value

A numeric matrix with n rows and dimensions columns, where each row represents a point in the Sobol sequence. Values are in [0, 1). If n = 0, returns a 0 x dimensions matrix.

Examples

```
gen <- sobol_generator(dimensions = 2)
points <- sobol_next_n(gen, n = 10)
print(dim(points)) # [1] 10  2
```

sobol_points *Generate a Batch of Sobol Points*

Description

Efficiently generates a matrix of Sobol sequence points. This is a convenience function that does not maintain state between calls. For incremental generation, use sobol_generator instead.

Arguments

n	Integer, the number of points to generate. Must be non-negative.
dim	Integer, the number of dimensions for each point. Must be a positive integer.
skip	Numeric, the number of initial points to skip (default: 0). This allows generating subsequences of the Sobol sequence.

Details

This function is implemented directly in C++ via Rcpp and is more efficient than creating a generator and calling `sobol_next_n` when you know in advance how many points you need.

The skip parameter allows you to start from any point in the sequence, which is useful for:

- Reproducibility: generating the same subsequence across runs
- Parallelization: different workers can generate non-overlapping segments
- Continuation: extending a previous sequence without regenerating early points

Value

A numeric matrix with n rows and dim columns, where each row represents a point in the Sobol sequence. Values are in [0, 1). If n = 0, returns a 0 x dim matrix.

See Also

`sobol_generator` for incremental generation with state

Examples

```
# Generate 1000 points in 5 dimensions
points <- sobol_points(n = 1000, dim = 5)
dim(points) # [1] 1000    5

# Skip the first 100 points
points_skipped <- sobol_points(n = 100, dim = 2, skip = 100)

# Empty result
empty <- sobol_points(n = 0, dim = 3)
dim(empty) # [1] 0 3
```

`sobol_skip_to` *Skip to a Specific Index in a Sobol Generator*

Description

Jumps the internal state of the generator to a specific index in the Sobol sequence. This allows for reproducible subsequences and parallel generation strategies.

Usage

```
sobol_skip_to(x, index, ...)
```

Arguments

x	A sobol_generator object created by sobol_generator
index	Numeric, the index to skip to. Must be a non-negative integer. The next call to sobol_next will return the point at this index.
...	Additional arguments (currently unused)

Value

Invisibly returns the sobol_generator object (for chaining). The primary purpose is the side effect of updating the internal state.

Examples

```
gen <- sobol_generator(dimensions = 2)
sobol_skip_to(gen, 100)
point <- sobol_next(gen) # This is the 100th point (0-indexed)
```

---

summary.sobol_generator

Summary Method for Sobol Generator

Description

Summary Method for Sobol Generator

Usage

```
## S3 method for class 'sobol_generator'
summary(object, ...)
```

Arguments

object	A sobol_generator object
...	Additional arguments passed to summary

Value

A list with class "summary.sobol_generator" containing summary information

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