Halton Iterative Partitioning (HIP) Sampling for Polygons

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Introduction

This vignette demonstrates basic Halton Iterative Partitioning (HIP) sampling from a polygon resource.

```
library(SDraw)
```

HIP Sampling

In this example, we will use HIP to draw a spatially balanced sample of 25 points from the state of Washington. Usually, it is recommended to use a fine Halton lattice with $J = (8, 5)$, but for ease of visualization we will use a coarser lattice with $J = (3, 2)$.

```
data("WA")
n <- 25
J <- c(3,2)
S <- sdraw(WA, n, "HIP", J = J)
```

The sample is produced in HIP order.

```
S
```

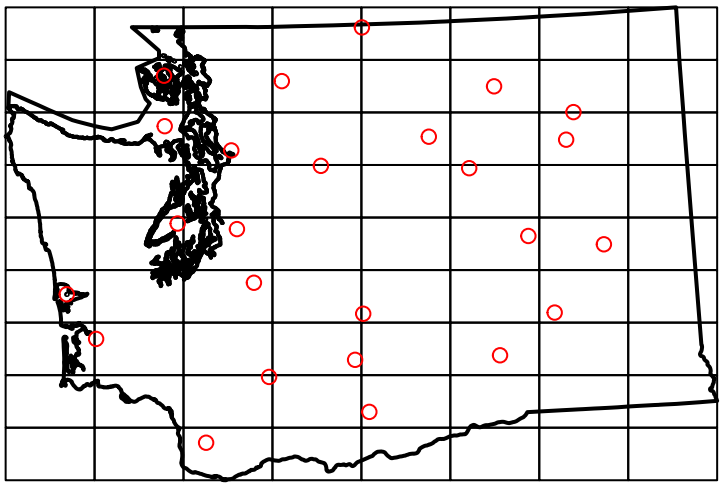
```
##            coordinates sampleID         AREA   PERIMETER STATESP020
## 1  (677120.2, 5102480)        1 1.735938e+05 3865.177367       1265
## 2  (565112.1, 5257083)        2 1.735938e+05 3865.177367       1265
## 3  (849793.9, 5356042)        3 1.735938e+05 3865.177367       1265
## 4  (445997.8, 5164176)        4 1.735938e+05 3865.177367       1265
## 5  (761610.2, 5308612)        5 1.735938e+05 3865.177367       1265
## 6    (421150, 5201948)        6 9.593636e-01    4.081049       1343
## 7  (727437.9, 5335261)        7 1.735938e+05 3865.177367       1265
## 8  (592310.7, 5132032)        8 1.735938e+05 3865.177367       1265
## 9  (875544.7, 5244241)        9 1.735938e+05 3865.177367       1265
## 10   (503409, 5386846)       10 1.511922e+02  112.763854       1276
## 11 (787674.3, 5150334)       11 1.735938e+05 3865.177367       1265
## 12   (636129, 5310603)       12 1.735938e+05 3865.177367       1265
## 13 (671945.3, 5185493)       13 1.735938e+05 3865.177367       1265
## 14 (560336.5, 5323650)       14 1.735938e+05 3865.177367       1265
## 15   (514992, 5261812)       15 1.735938e+05 3865.177367       1265
## 16 (782634.4, 5377877)       16 1.735938e+05 3865.177367       1265
## 17   (665074, 5146504)       17 1.735938e+05 3865.177367       1265
## 18 (579491.4, 5211707)       18 1.735938e+05 3865.177367       1265
## 19 (843609.5, 5332727)       19 1.735938e+05 3865.177367       1265
## 20   (811634, 5251268)       20 1.735938e+05 3865.177367       1265
## 21   (603085, 5382265)       21 1.735938e+05 3865.177367       1265
## 22 (670834.8, 5427696)       22 1.735938e+05 3865.177367       1265
## 23 (539033.3, 5076370)       23 1.735938e+05 3865.177367       1265
## 24 (833901.9, 5186483)       24 1.735938e+05 3865.177367       1265
```

```
## 25 (504015.3, 5344143)       25 7.215719e+03 3267.733217       1263
##         STATE STATE_FIPS ORDER_ADM MONTH_ADM DAY_ADM YEAR_ADM LAND_TYPE
## 1  Washington         53        42  November      11     1889  MAINLAND
## 2  Washington         53        42  November      11     1889  MAINLAND
## 3  Washington         53        42  November      11     1889  MAINLAND
## 4  Washington         53        42  November      11     1889  MAINLAND
## 5  Washington         53        42  November      11     1889  MAINLAND
## 6  Washington         53        42  November      11     1889    ISLAND
## 7  Washington         53        42  November      11     1889  MAINLAND
## 8  Washington         53        42  November      11     1889  MAINLAND
## 9  Washington         53        42  November      11     1889  MAINLAND
## 10 Washington         53        42  November      11     1889    ISLAND
## 11 Washington         53        42  November      11     1889  MAINLAND
## 12 Washington         53        42  November      11     1889  MAINLAND
## 13 Washington         53        42  November      11     1889  MAINLAND
## 14 Washington         53        42  November      11     1889  MAINLAND
## 15 Washington         53        42  November      11     1889  MAINLAND
## 16 Washington         53        42  November      11     1889  MAINLAND
## 17 Washington         53        42  November      11     1889  MAINLAND
## 18 Washington         53        42  November      11     1889  MAINLAND
## 19 Washington         53        42  November      11     1889  MAINLAND
## 20 Washington         53        42  November      11     1889  MAINLAND
## 21 Washington         53        42  November      11     1889  MAINLAND
## 22 Washington         53        42  November      11     1889  MAINLAND
## 23 Washington         53        42  November      11     1889  MAINLAND
## 24 Washington         53        42  November      11     1889  MAINLAND
## 25 Washington         53        42  November      11     1889     OCEAN
```

Plotting

For HIP sampling, SDraw has a special plotting function for overlaying the Halton lattice on the polygon.

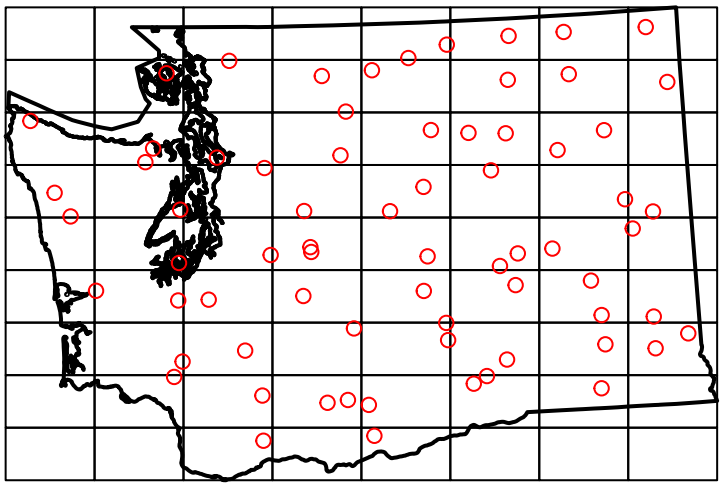
```
hip.plot.lattice(WA, J = J, sample = S)
```



Note that boxes completely outside the state of Washington polygon cannot contain points. When the sample size (n = 25 in this case) is substantially less than the number of boxes with area in the polygon (68 Halton boxes overlap the state of Washington), each Halton box that contains a point will only contain one point because the sequence does not "cycle". As the number of points increases, eventually some boxes will have more than one point and it is possible for some boxes to contain zero points. Some boxes have more than one point, or zero points, because the randomly selected point falls outside the polygon of interest, and the sequence goes on to the next box.

The next figure shows a sample of size 70. Note that some boxes have two points while some have zero. Squares with zero points tend to be those with little area inside the state of Washington.

```
n <- 70
J <- c(3,2)
S <- sdraw(WA, n, "HIP", J = J)
hip.plot.lattice(WA, J = J, sample = S)
```



References

Robertson BL, McDonald T, Price CJ, Brown JA (2017) Halton iterative partitioning: spatially balanced sampling via partitioning. Environ Ecol Stat 25:305-323