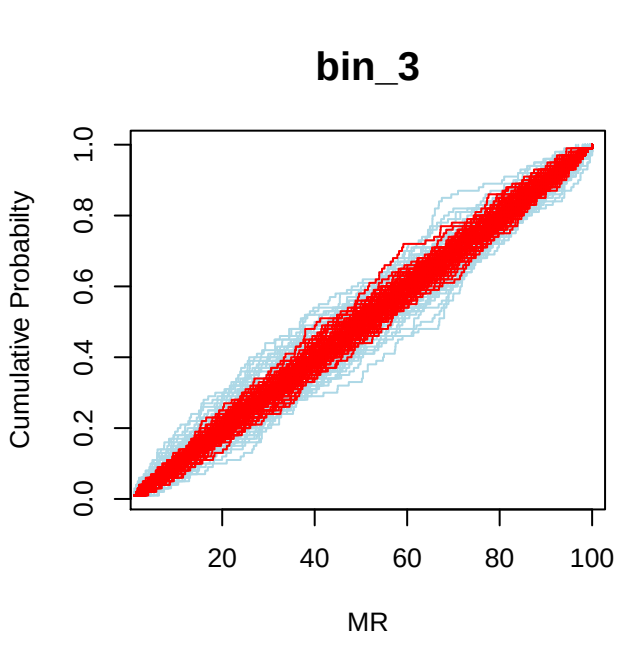
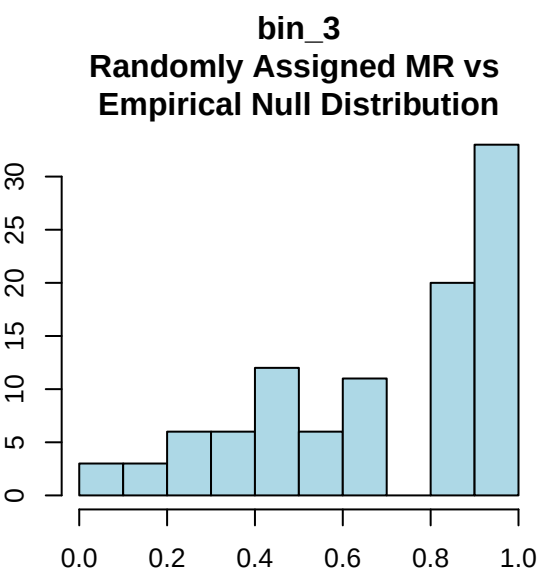
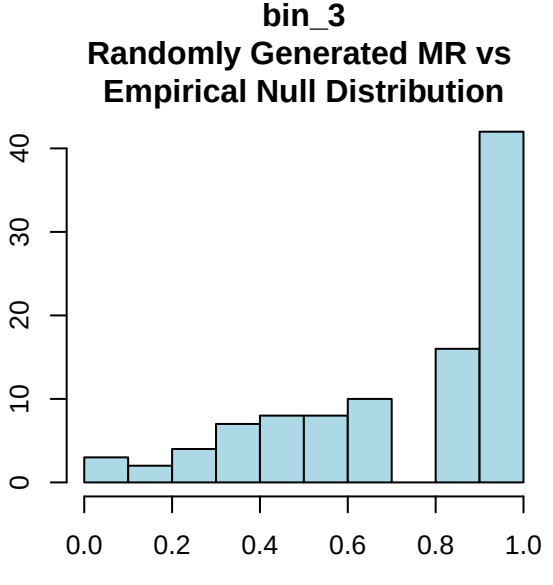
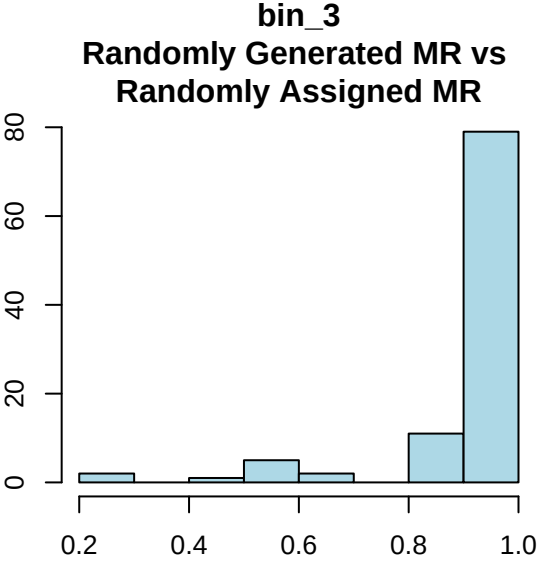
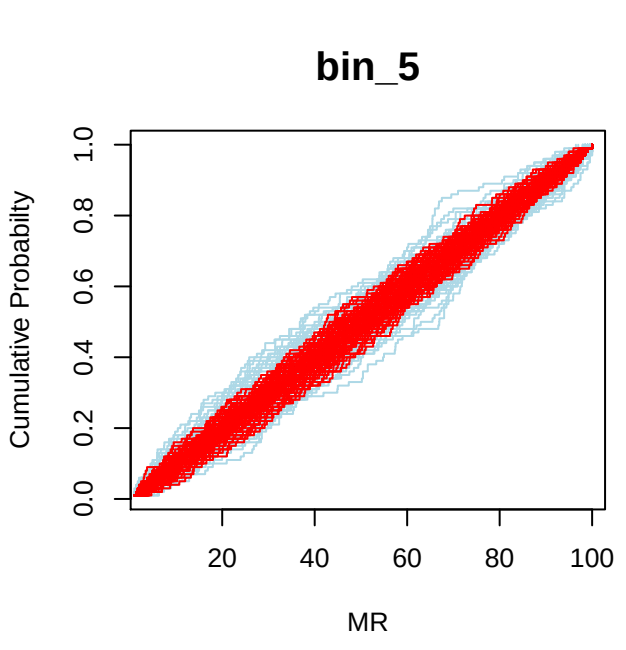
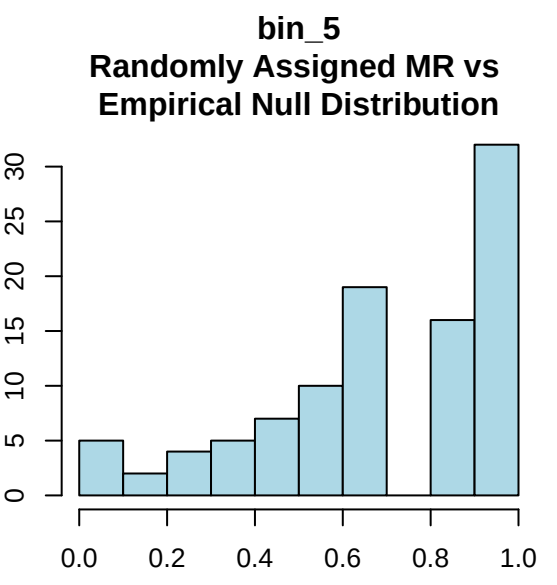

bin_3
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
MR

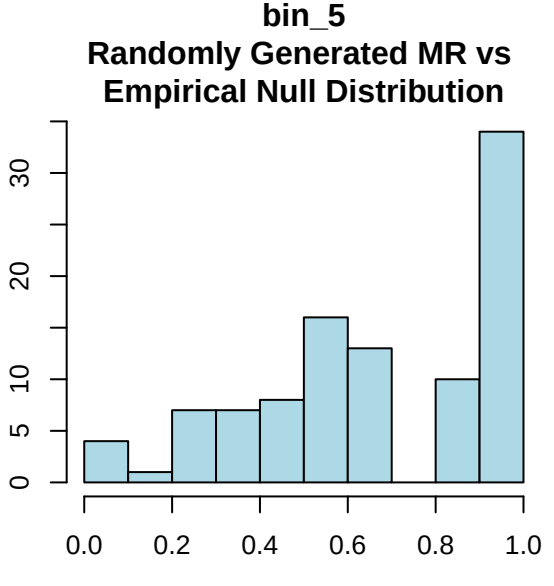

bin_3
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

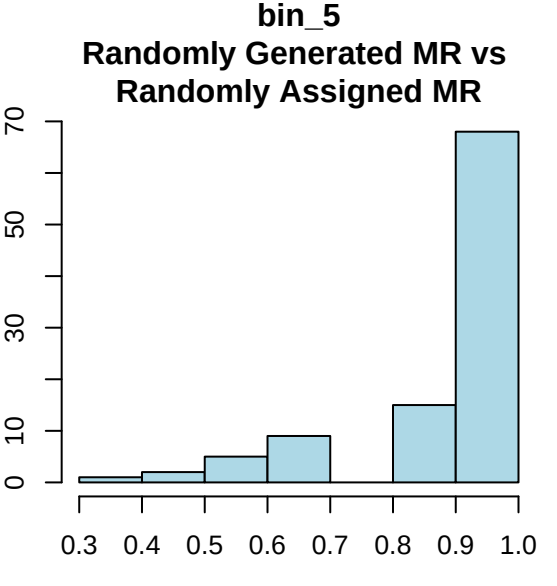

bin_3
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0

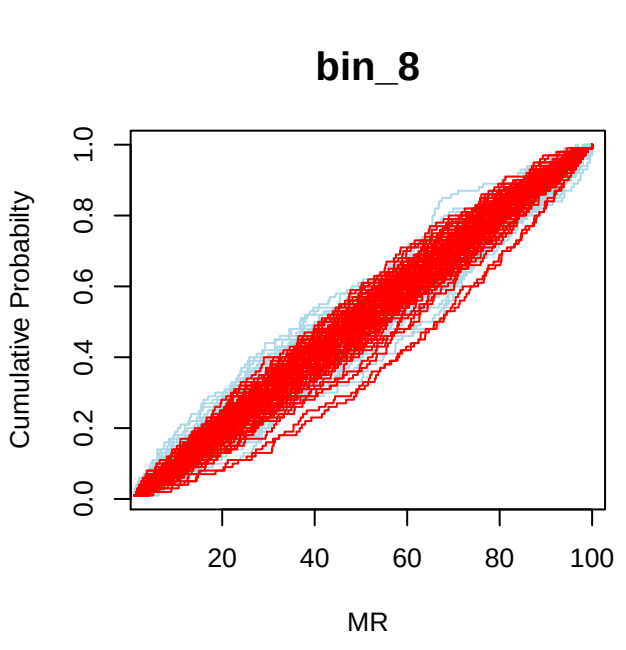

bin_3
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
0.2
0.4
0.6
0.8
1.0

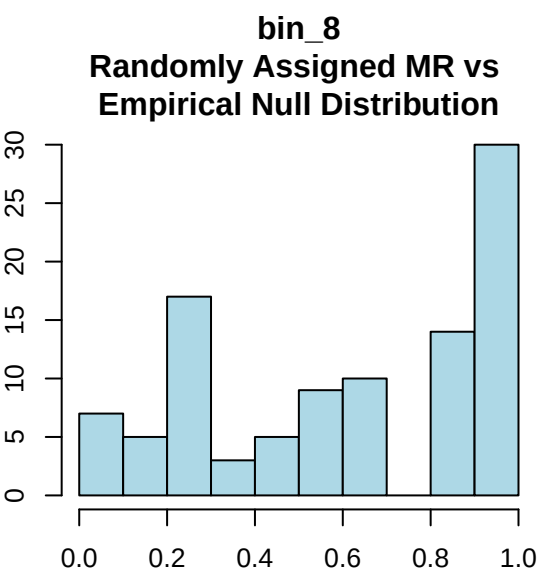

bin_5
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
MR

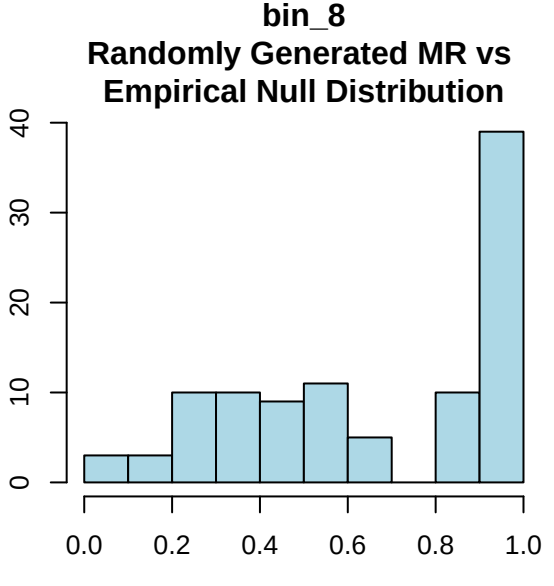

bin_5
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

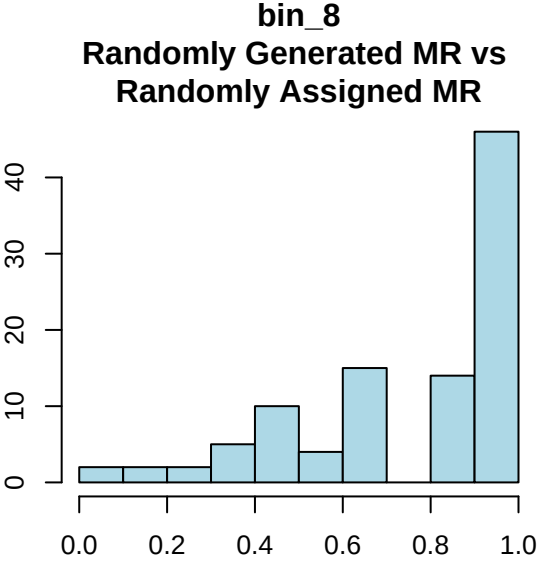

bin_5
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

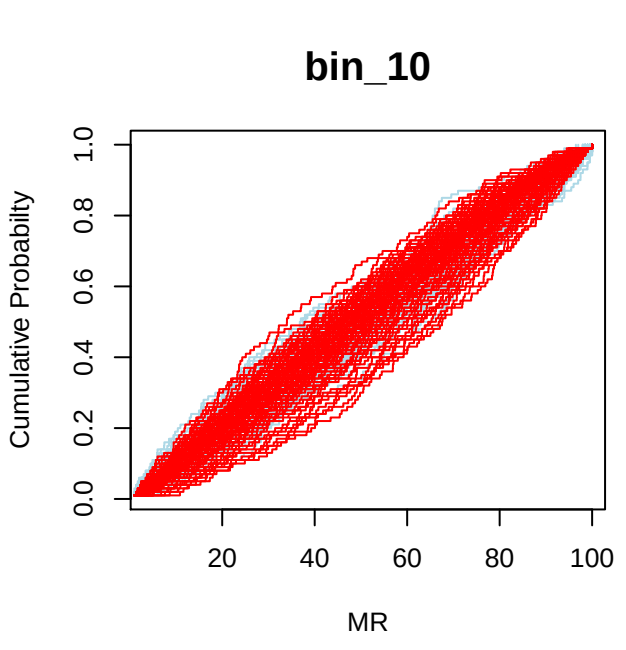

bin_5
Randomly Generated MR vs
Randomly Assigned MR
0
10
30
50
70
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

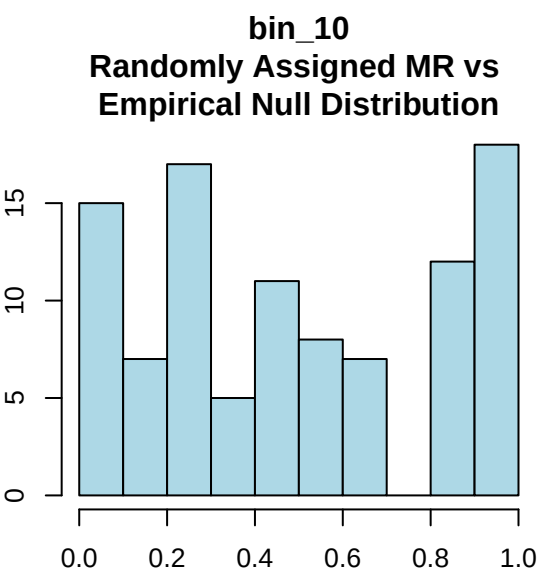

bin_8
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
MR

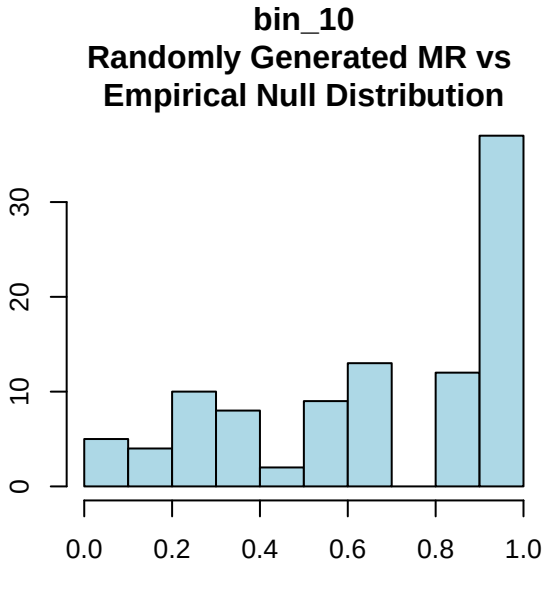

bin_8
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

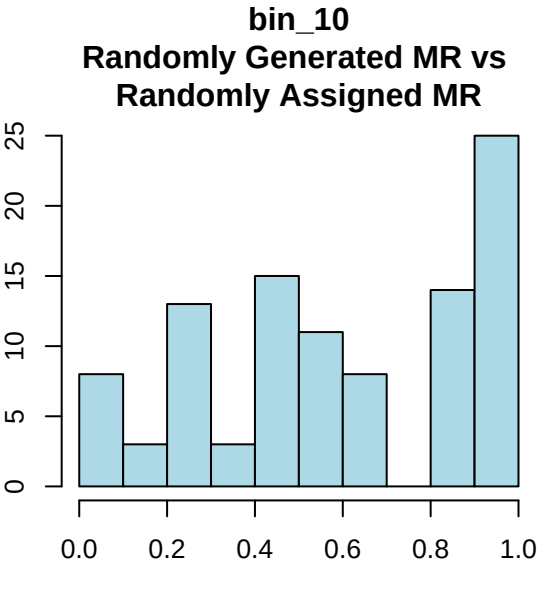

bin_8
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0

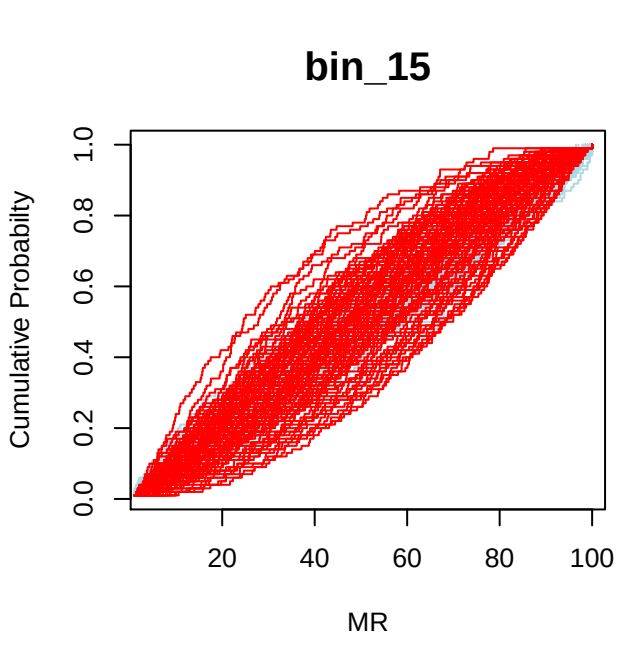

bin_8
Randomly Generated MR vs
Randomly Assigned MR
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0

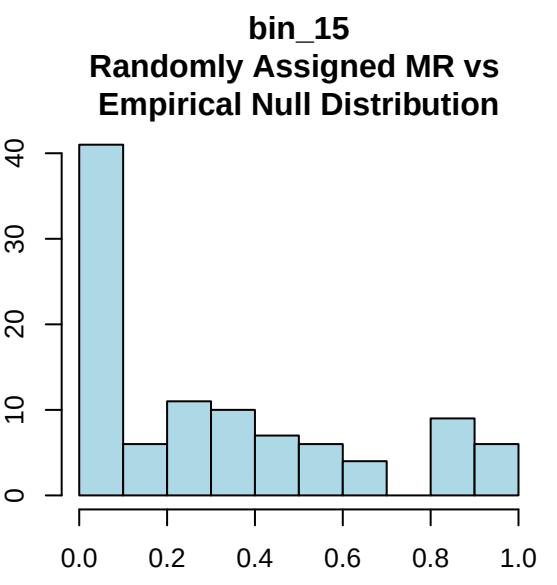

bin_10
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
MR

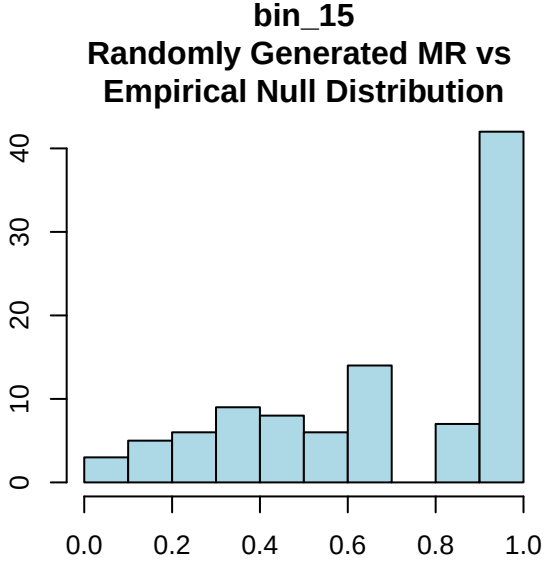

bin_10
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

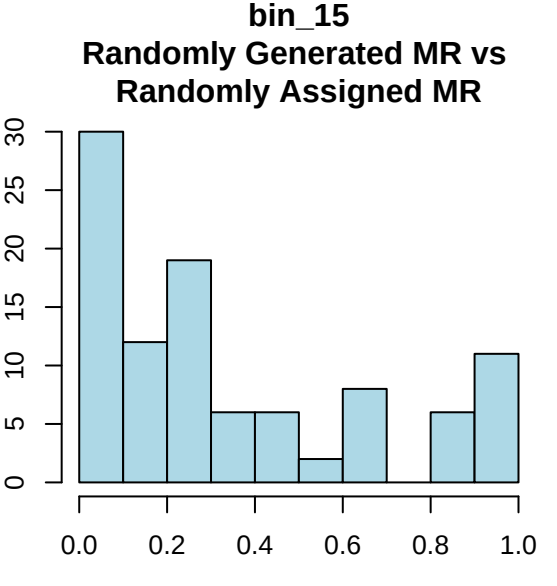

bin_10
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

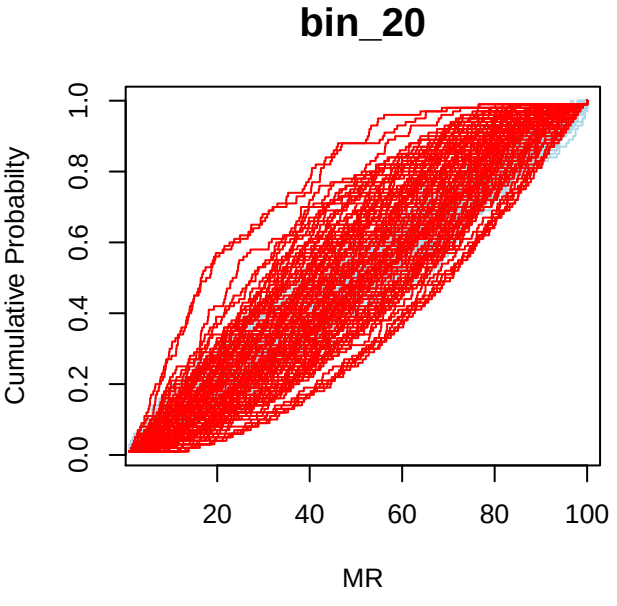

bin_10
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
25
0.0
0.2
0.4
0.6
0.8
1.0

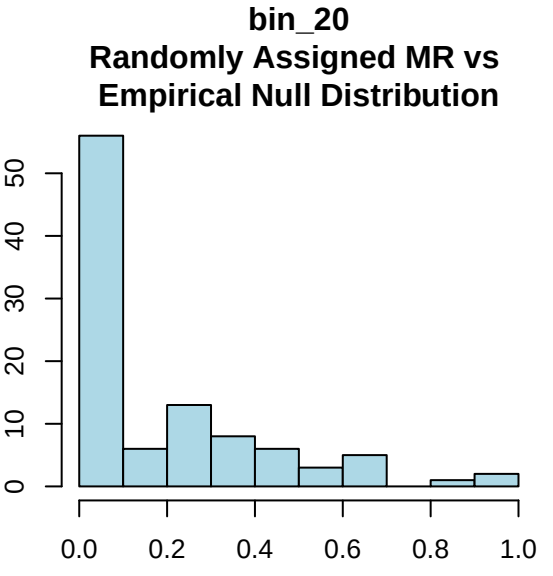

bin_15
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
MR

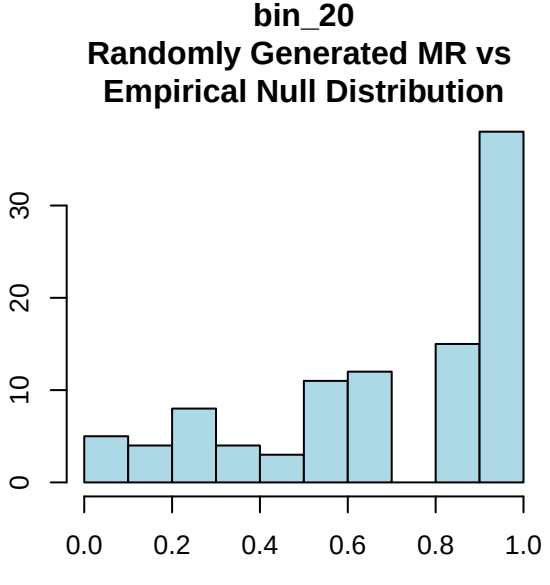

bin_15
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0


bin_15
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0


bin_15
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0


bin_20
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
20
40
60
80
100
MR


bin_20
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0


bin_20
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

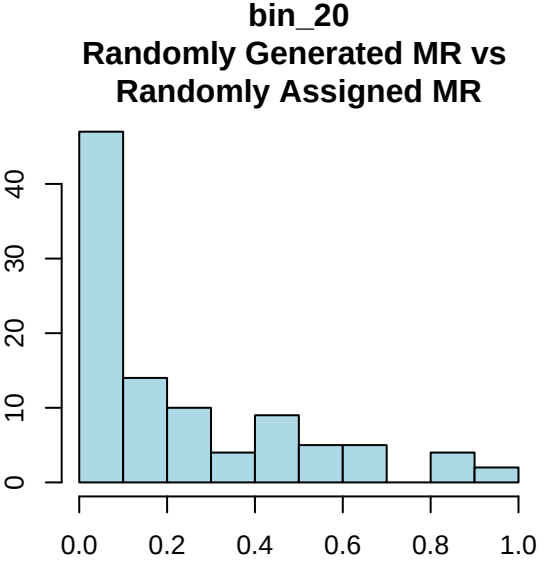
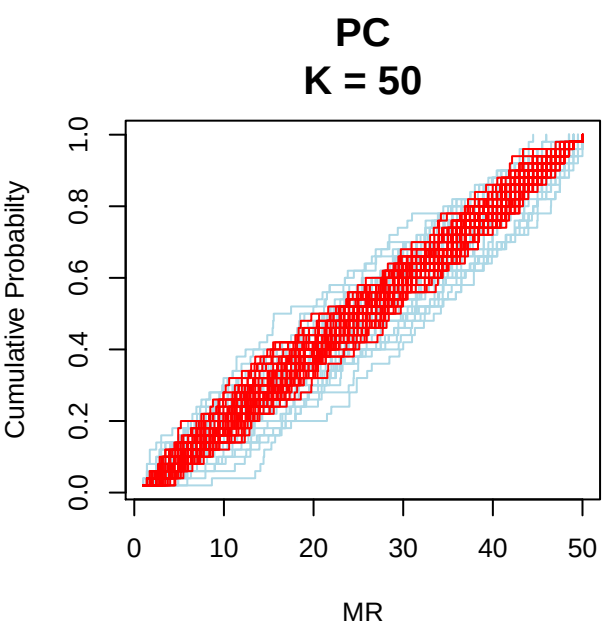
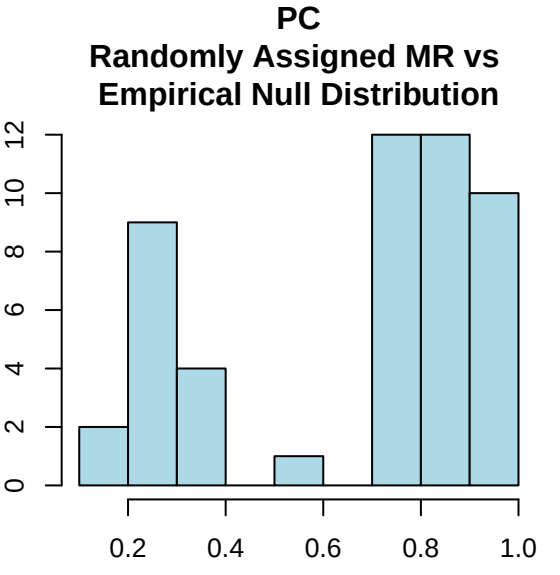
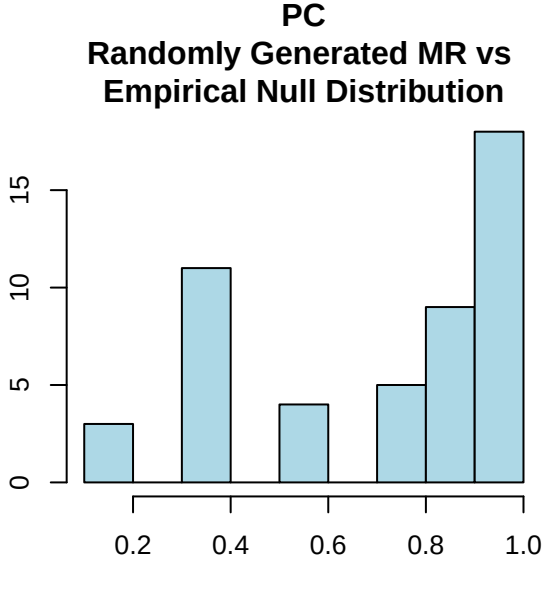
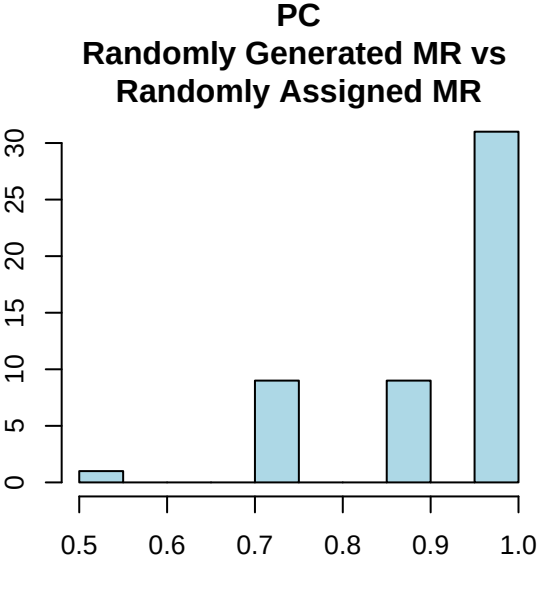

bin_20
Randomly Generated MR vs
Randomly Assigned MR
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0

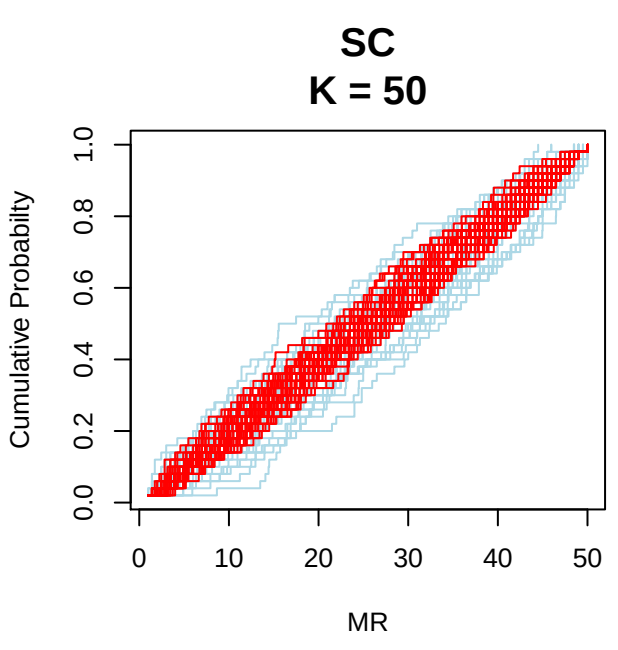
Figure S1. Empirical cumulative density functions of $\widetilde{\mathbf{MR}}^{\mathcal{M}}_{\mathbf{100\times100}}(\boldsymbol{i},\cdot)$ versus the empirical null distribution of $\widehat{\mathbf{MR}}_{\mathbf{100\times100}}$ for the co-expression associated computed by MI with bin0=3, 5, 8, 10, 15, and 20. 100 randomly generated cumulative density functions of $\widetilde{\mathrm{MR}}^{\mathcal{M}}_{\mathrm{K\times K}}(i,\cdot)$ and empirical null distributions of $\widehat{\mathrm{MR}}_{\mathrm{K\times K}}$ are colored by red and light blue in each plot (top-left figure), in which x-axis and y-axis represent the MR values in increasing order and the empirical cumulative probability, respectively. P values of the KS tests among the simulated $\widetilde{\mathrm{MR}}^{\mathcal{M}}_{\mathrm{K\times K}}(i,\cdot)$ ($\widetilde{\mathrm{MR}}$), $\widehat{\mathrm{MR}}^{\mathcal{M}}_{\mathrm{K\times K}}(i,\cdot)$ ($\widehat{\mathrm{MR}}$), and the empirical distribution of $\widehat{\mathrm{MR}}_{\mathrm{K\times K}}$ (N) are shown.

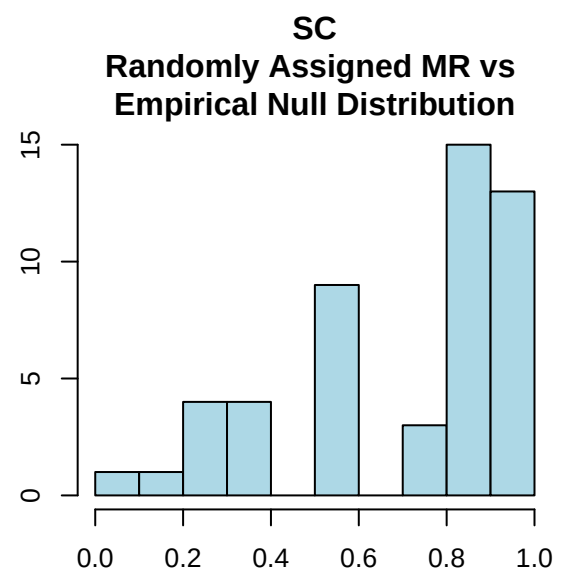

PC
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

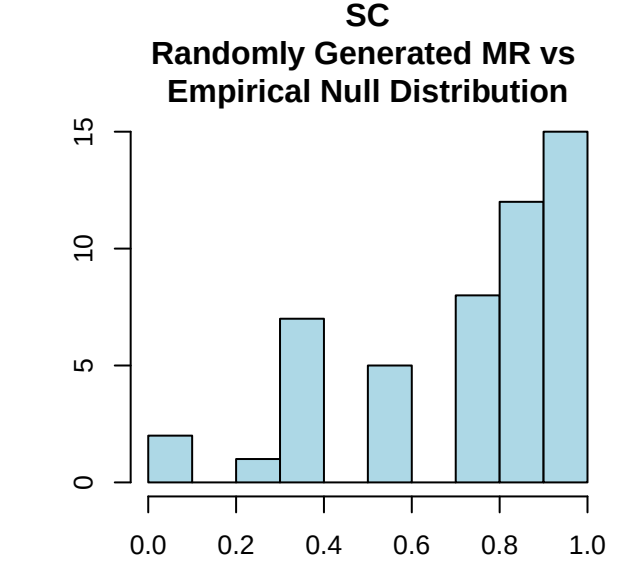

PC
Randomly Assigned MR vs
Empirical Null Distribution
0
2
4
6
8
10
12
0.2
0.4
0.6
0.8
1.0

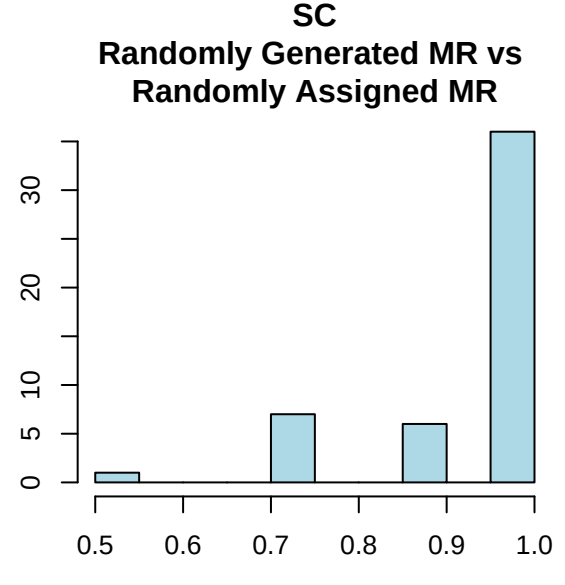

PC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
0.2
0.4
0.6
0.8
1.0

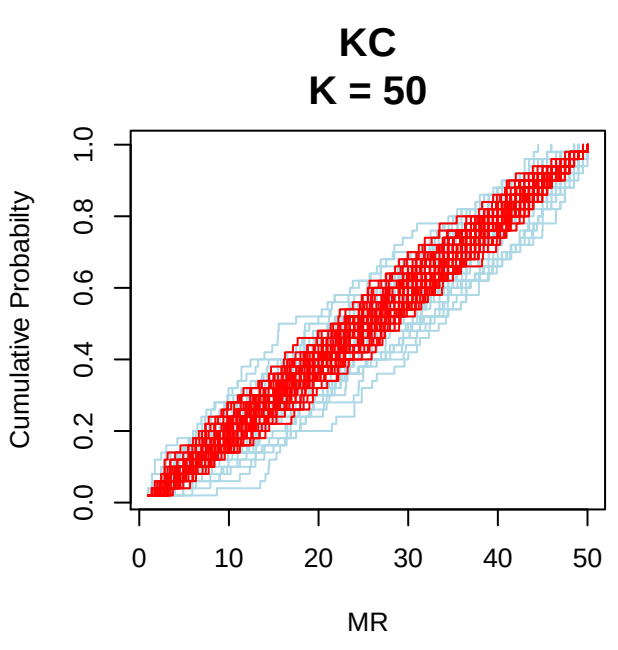

PC
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
25
30
0.5
0.6
0.7
0.8
0.9
1.0

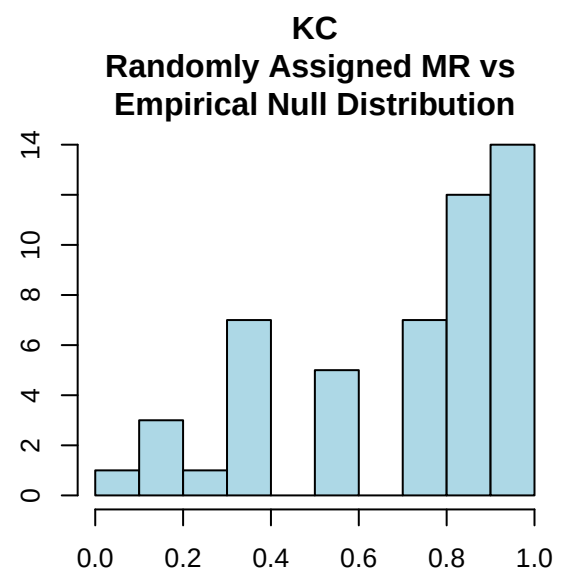

SC
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

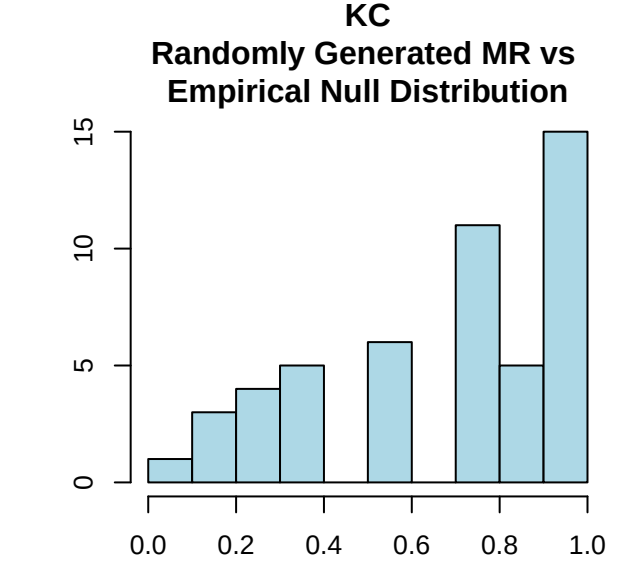

SC
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

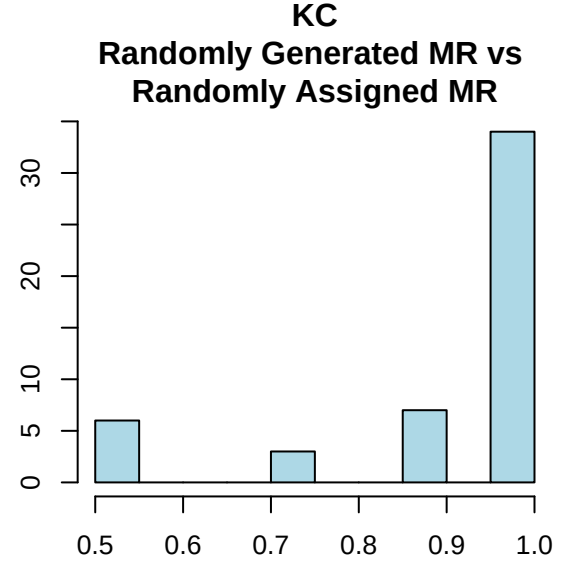

SC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

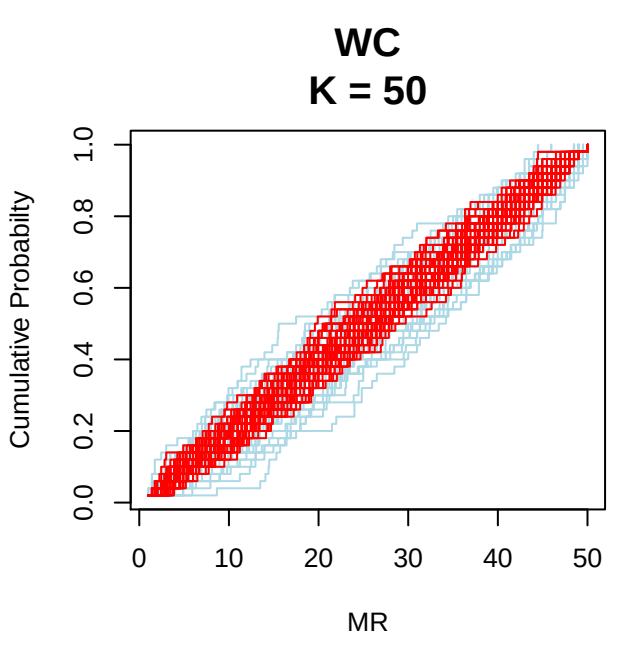

SC
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
20
30
0.5
0.6
0.7
0.8
0.9
1.0

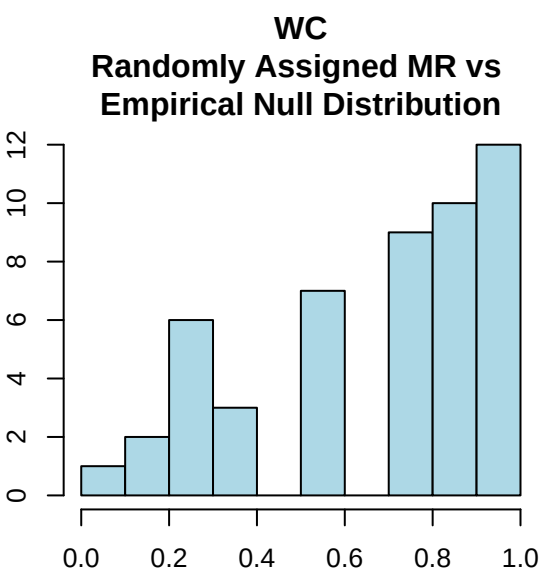

KC
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

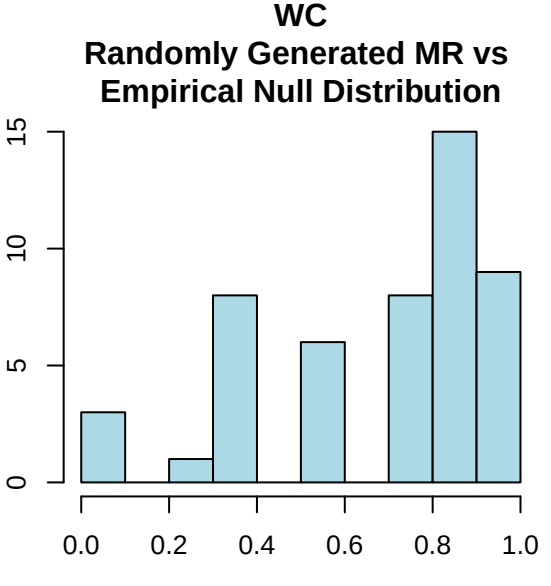

KC
Randomly Assigned MR vs
Empirical Null Distribution
0
2
4
6
8
10
14
0.0
0.2
0.4
0.6
0.8
1.0

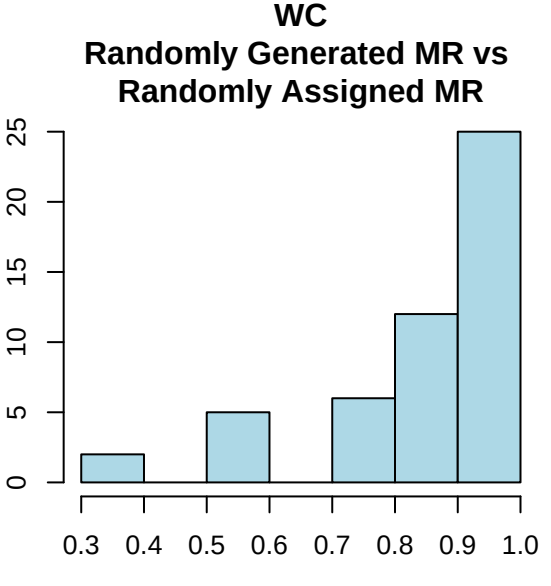

KC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

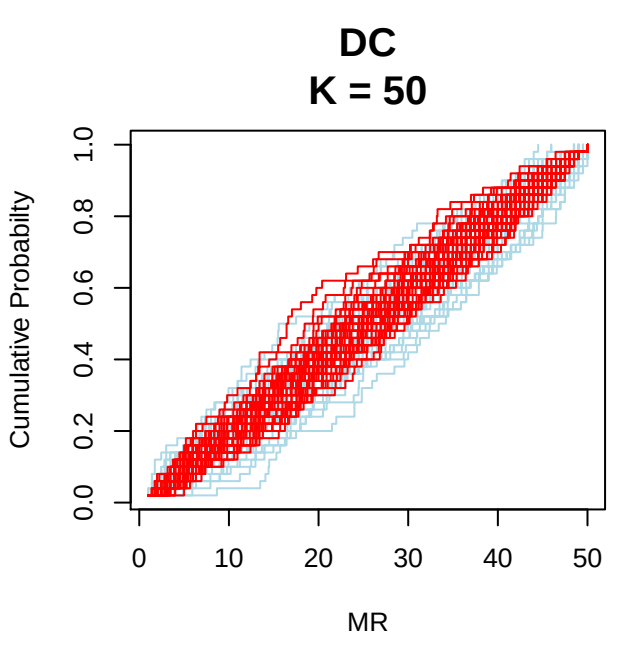

KC
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
20
30
0.5
0.6
0.7
0.8
0.9
1.0

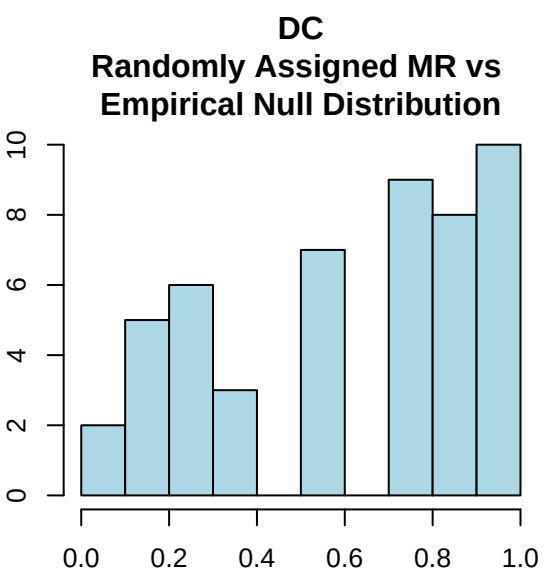

WC
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

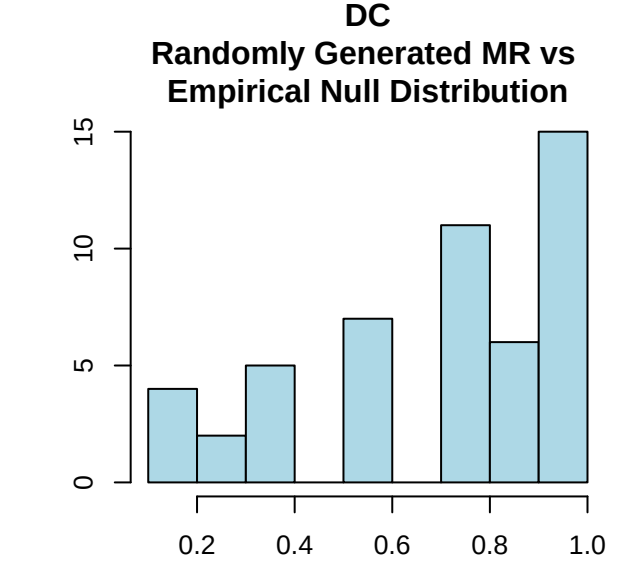

WC
Randomly Assigned MR vs
Empirical Null Distribution
0
2
4
6
8
10
12
0.0
0.2
0.4
0.6
0.8
1.0

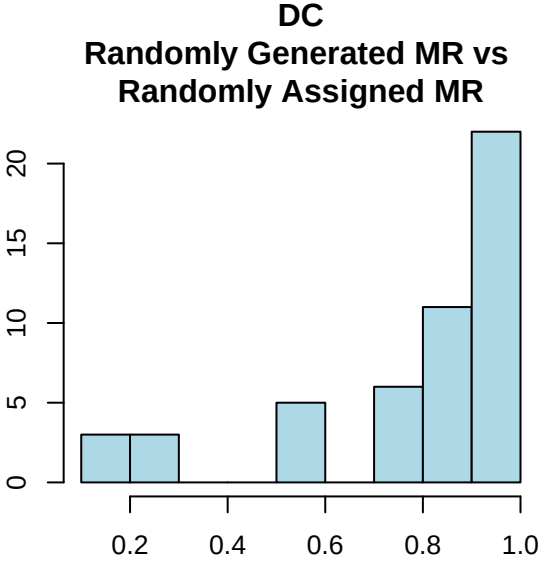

WC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

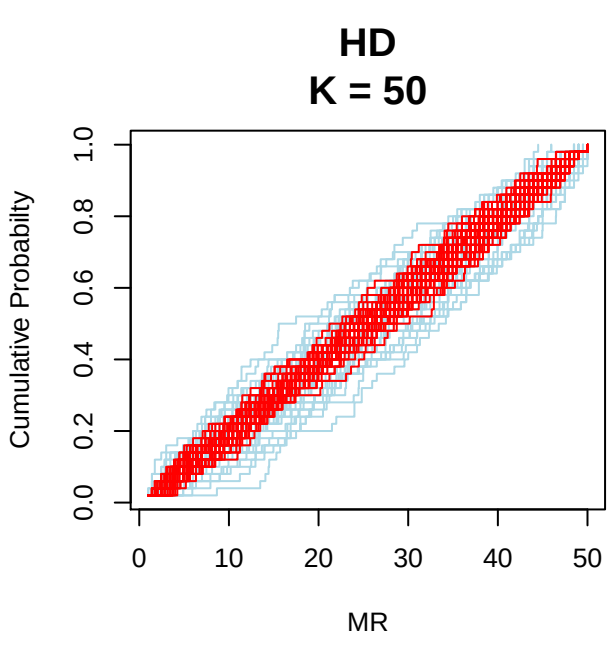

WC
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
25
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

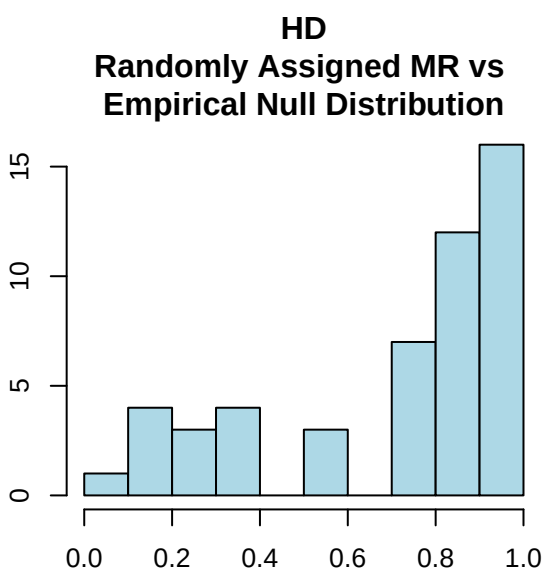

DC
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

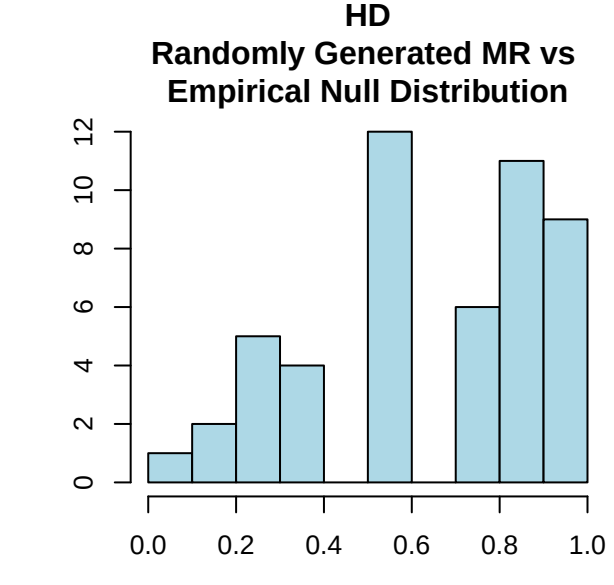

DC
Randomly Assigned MR vs
Empirical Null Distribution
0
2
4
6
8
10
0.0
0.2
0.4
0.6
0.8
1.0

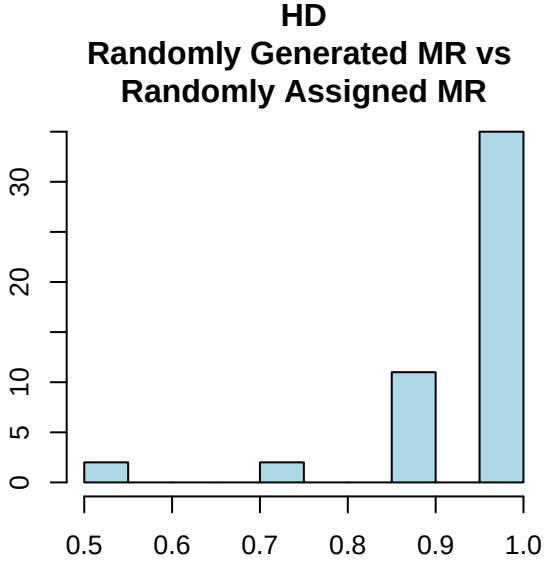

DC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
0.2
0.4
0.6
0.8
1.0

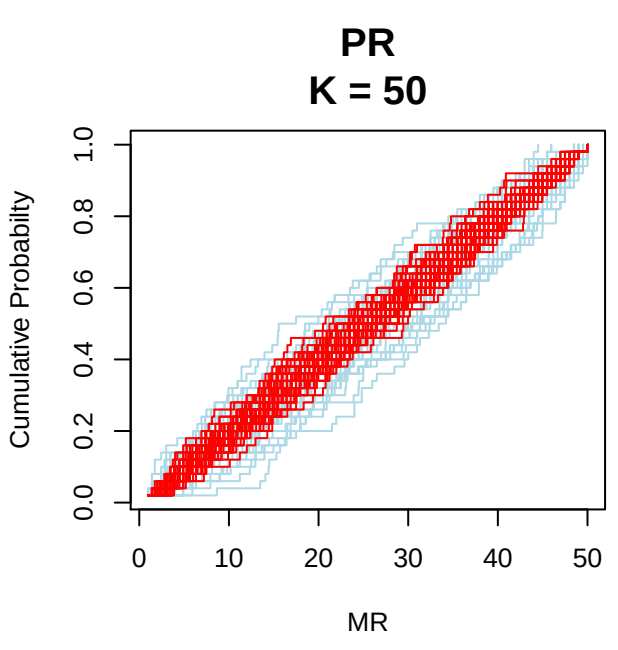

DC
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
0.2
0.4
0.6
0.8
1.0

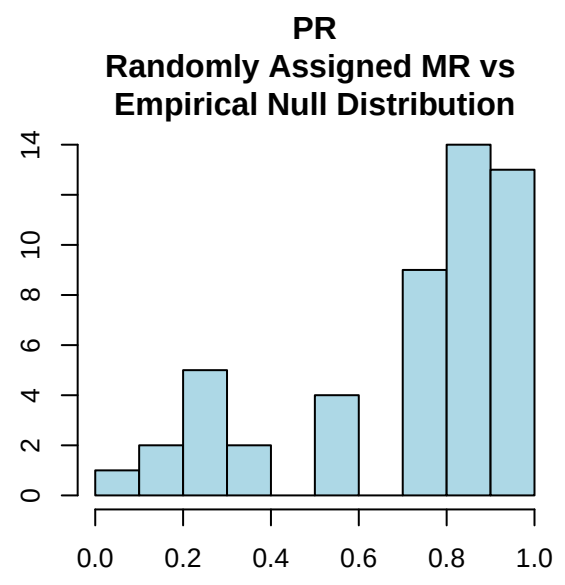

HD
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

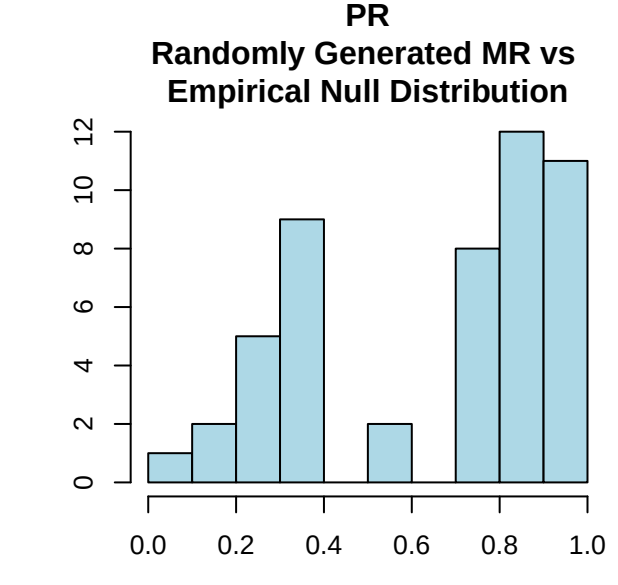

HD
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

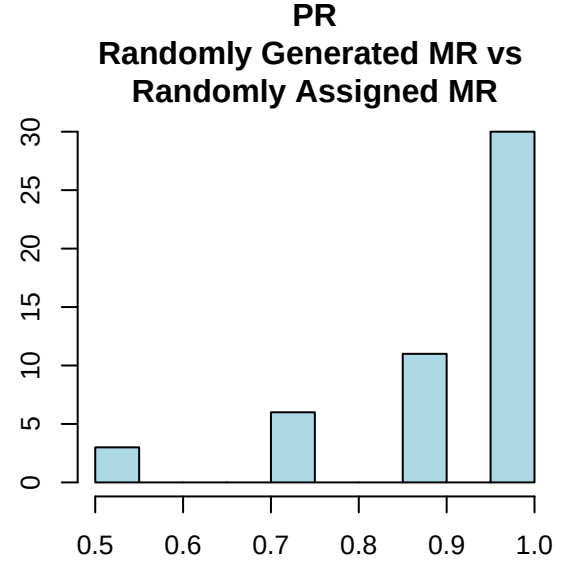

HD
Randomly Generated MR vs
Empirical Null Distribution
0
2
4
6
8
10
12
0.0
0.2
0.4
0.6
0.8
1.0

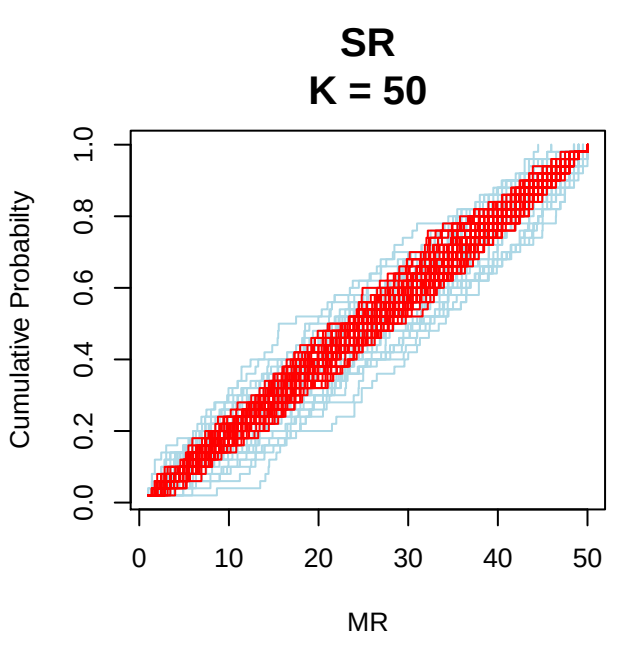

HD
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
20
30
0.5
0.6
0.7
0.8
0.9
1.0

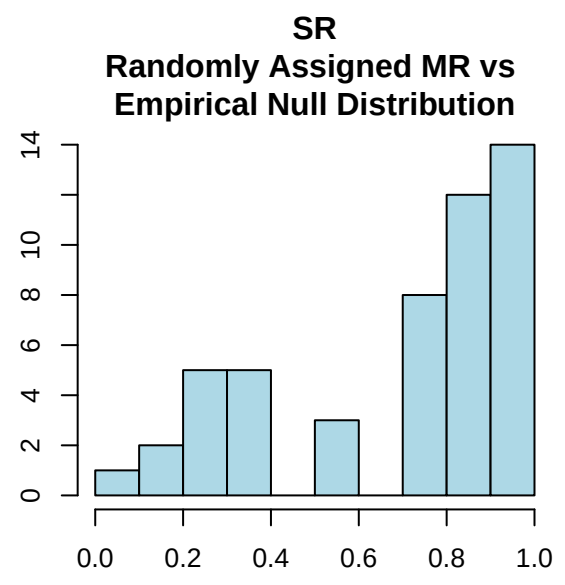

PR
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

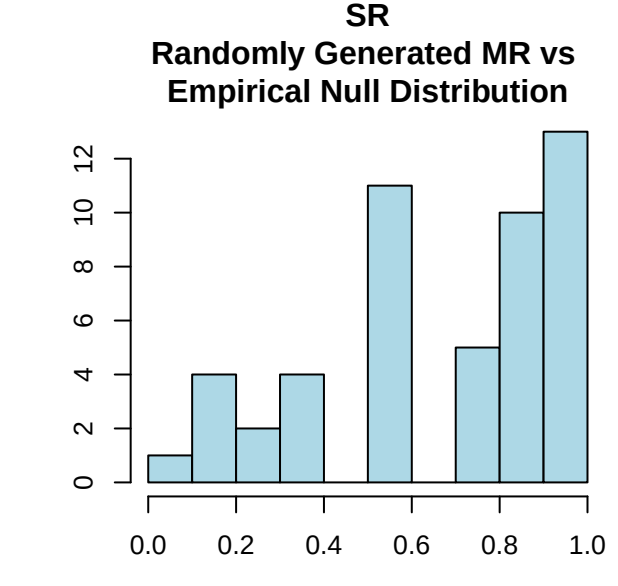

PR
Randomly Assigned MR vs
Empirical Null Distribution
0
2
4
6
8
10
14
0.0
0.2
0.4
0.6
0.8
1.0

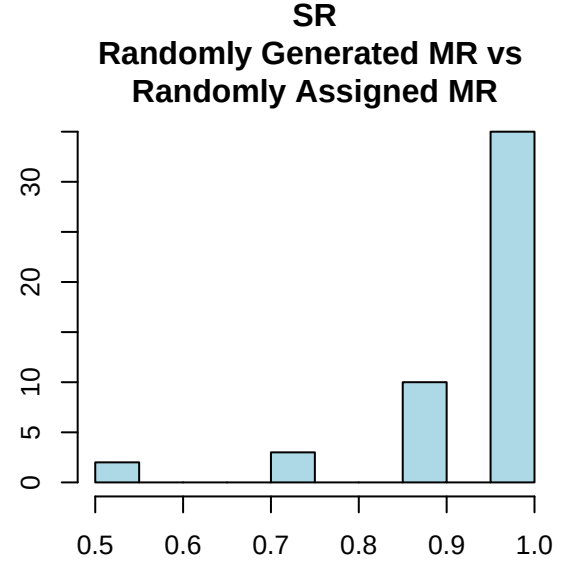

PR
Randomly Generated MR vs
Empirical Null Distribution
0
2
4
6
8
10
12
0.0
0.2
0.4
0.6
0.8
1.0

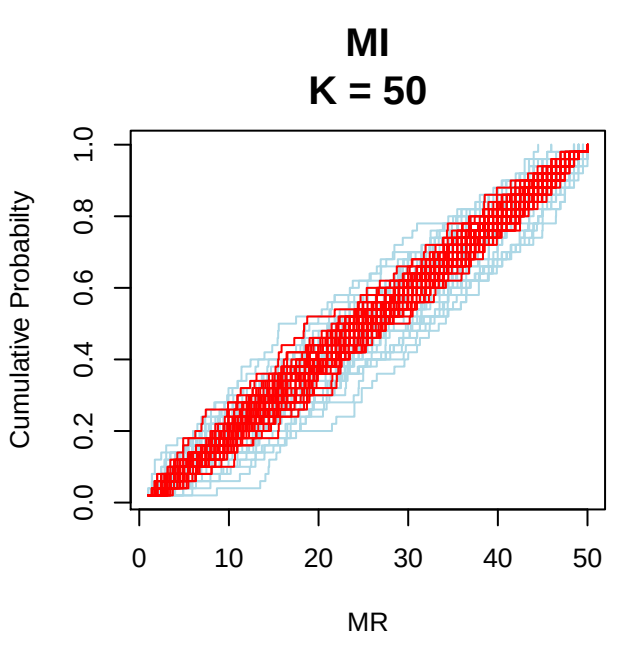

PR
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
25
30
0.5
0.6
0.7
0.8
0.9
1.0

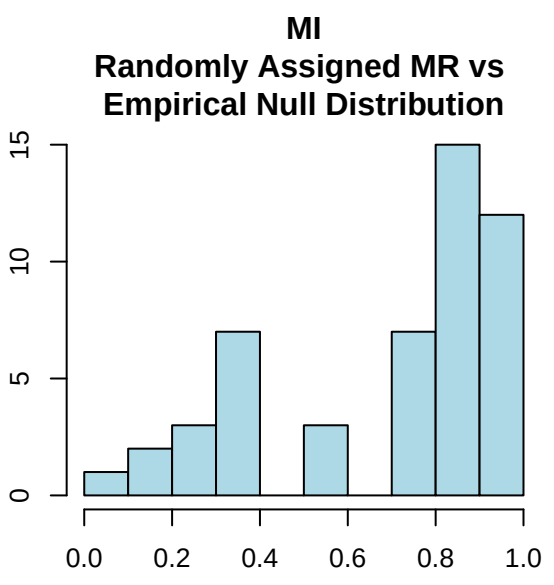

SR
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

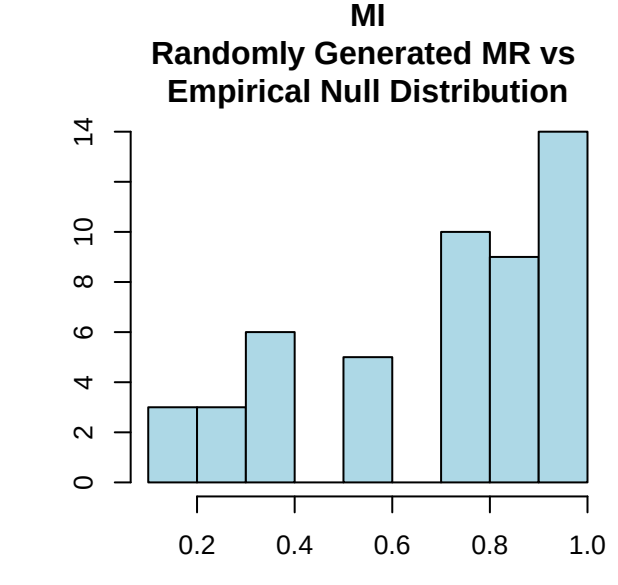

SR
Randomly Assigned MR vs
Empirical Null Distribution
0
2
4
6
8
10
14
0.0
0.2
0.4
0.6
0.8
1.0

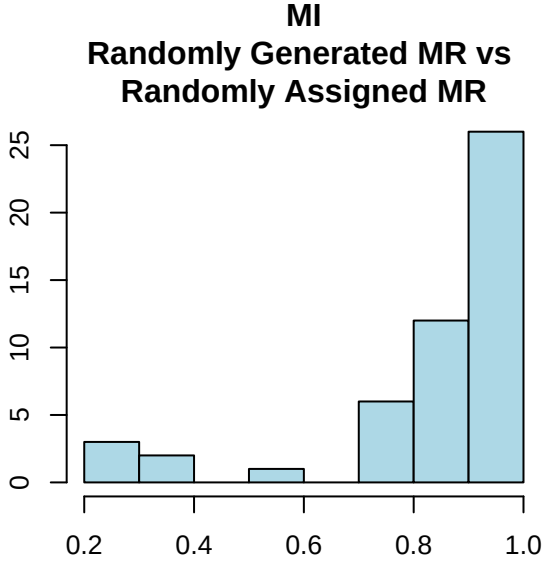

SR
Randomly Generated MR vs
Empirical Null Distribution
0
2
4
6
8
10
12
0.0
0.2
0.4
0.6
0.8
1.0

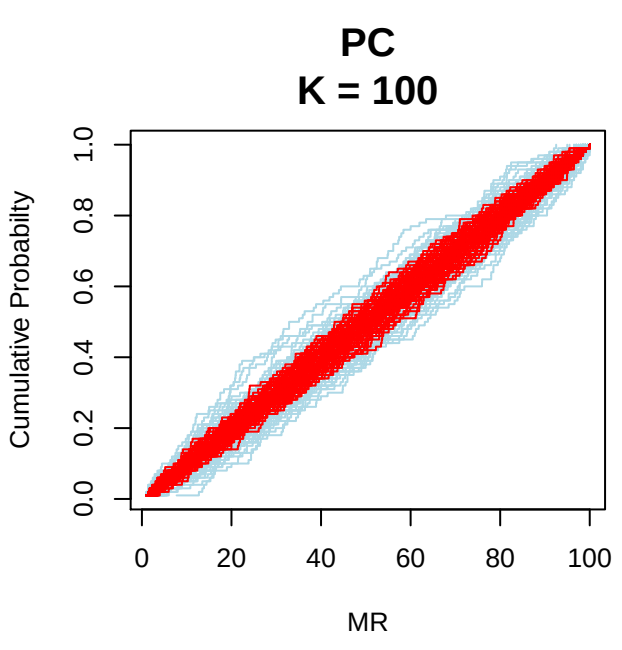

SR
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
20
30
0.5
0.6
0.7
0.8
0.9
1.0

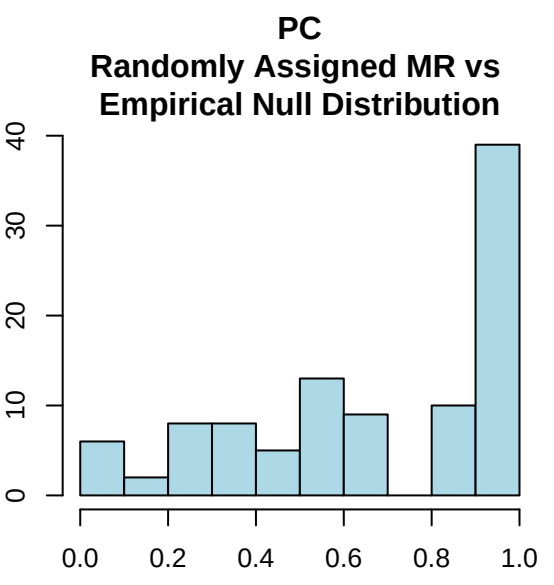

MI
K = 50
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
10
20
30
40
50
MR

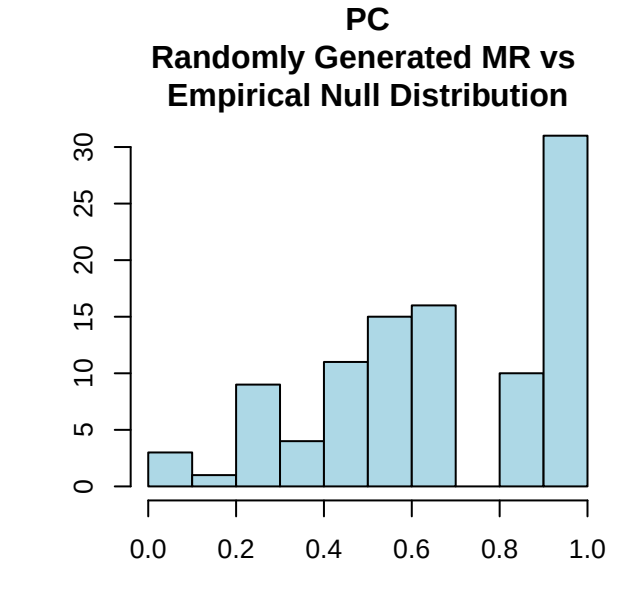

MI
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
0.0
0.2
0.4
0.6
0.8
1.0

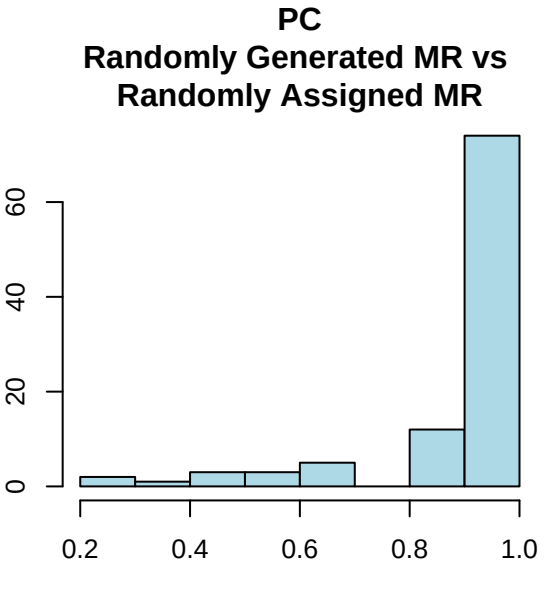

MI
Randomly Generated MR vs
Empirical Null Distribution
0
2
4
6
8
10
14
0.2
0.4
0.6
0.8
1.0

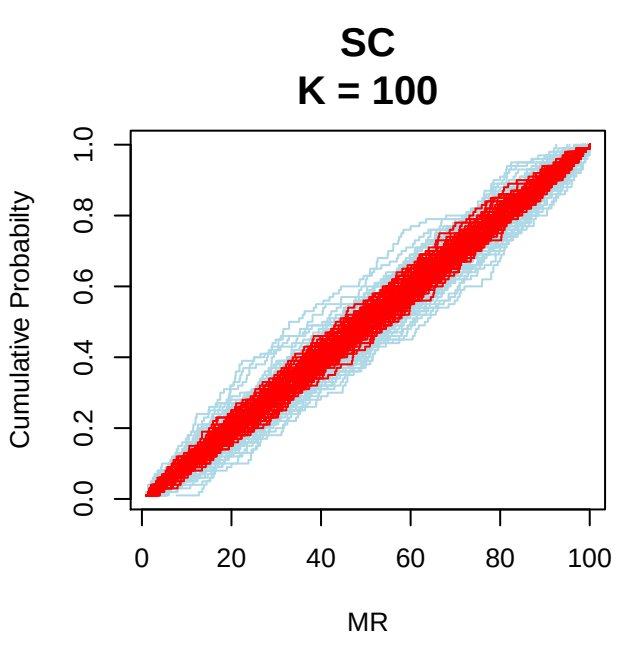

MI
Randomly Generated MR vs
Randomly Assigned MR
0
5
10
15
20
25
0.2
0.4
0.6
0.8
1.0


PC
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR


PC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0


PC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0


PC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
0.2
0.4
0.6
0.8
1.0


SC
K = 100
Cumulative Probability
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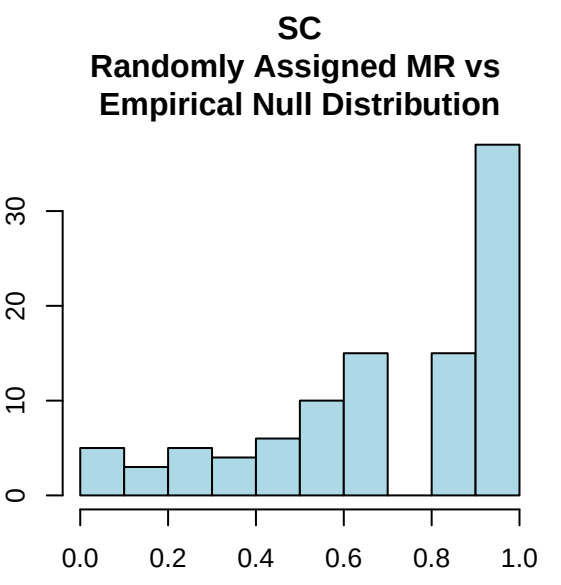
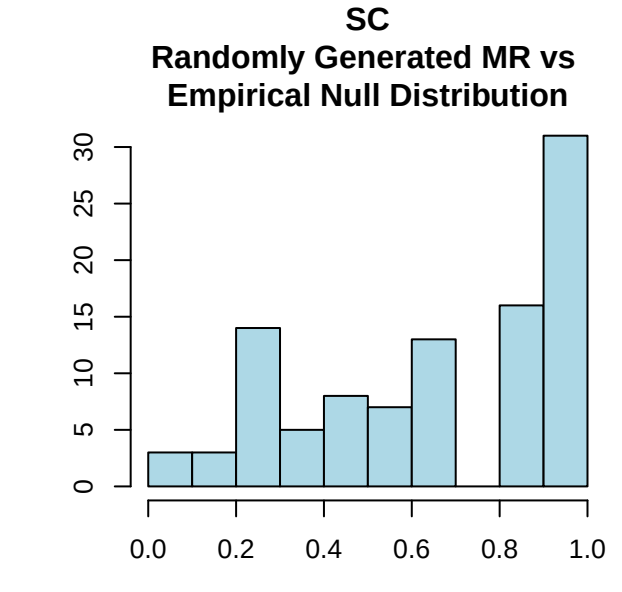
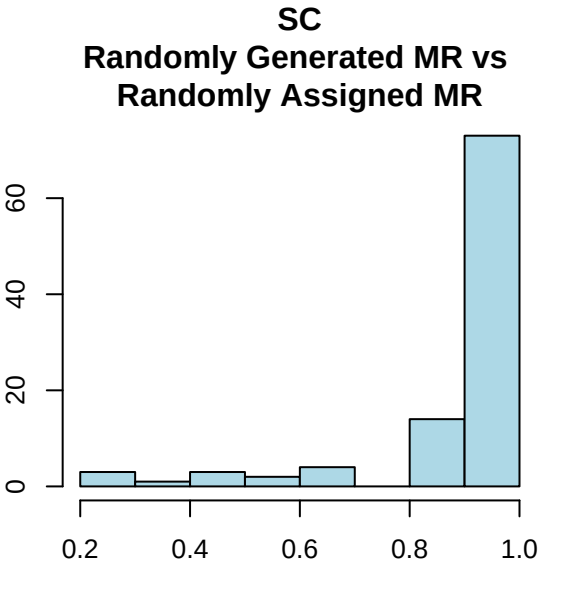
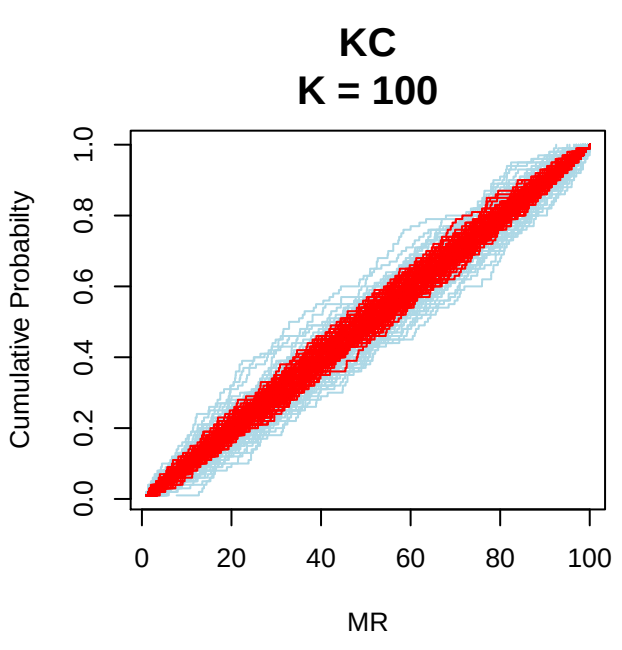
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR


SC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0


SC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0


SC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
0.2
0.4
0.6
0.8
1.0


KC
K = 100
Cumulative Probability
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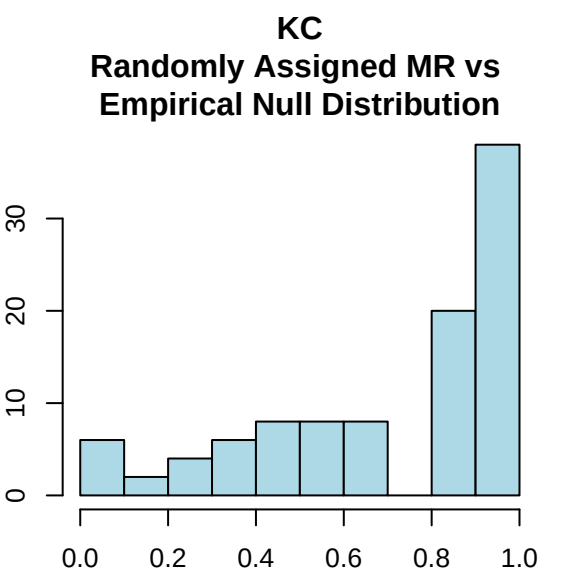
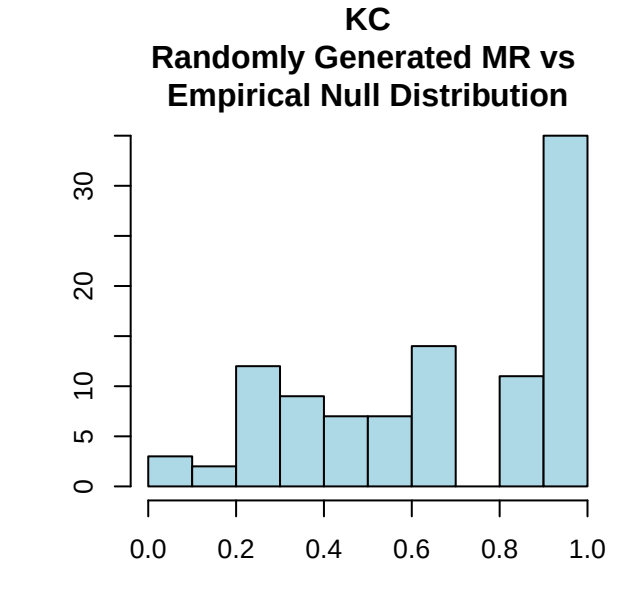
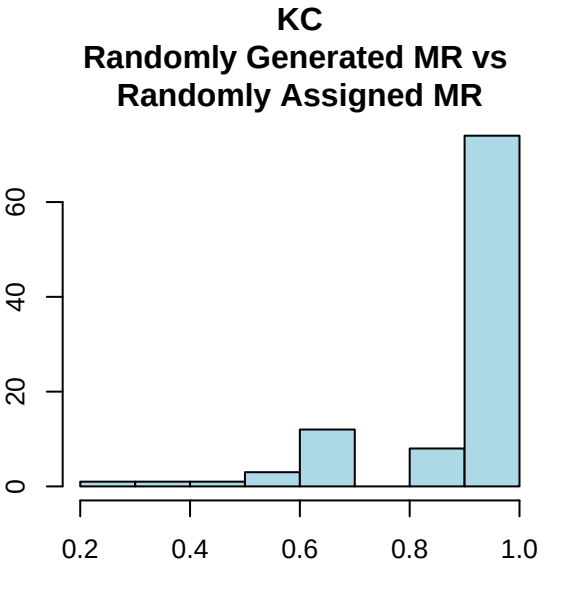
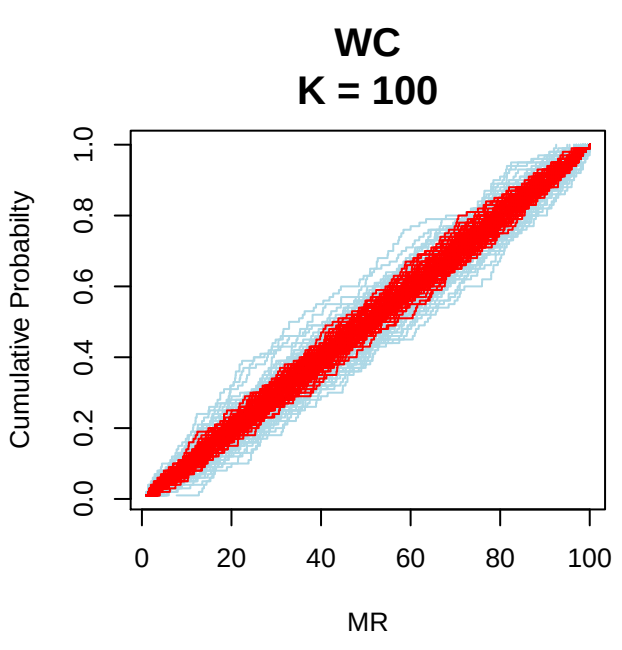
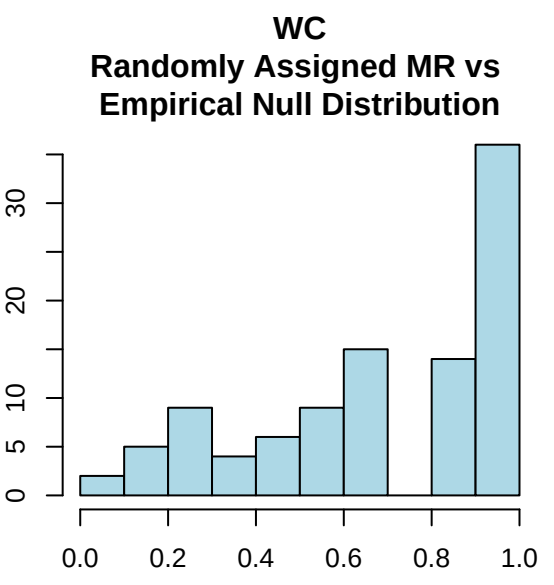
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

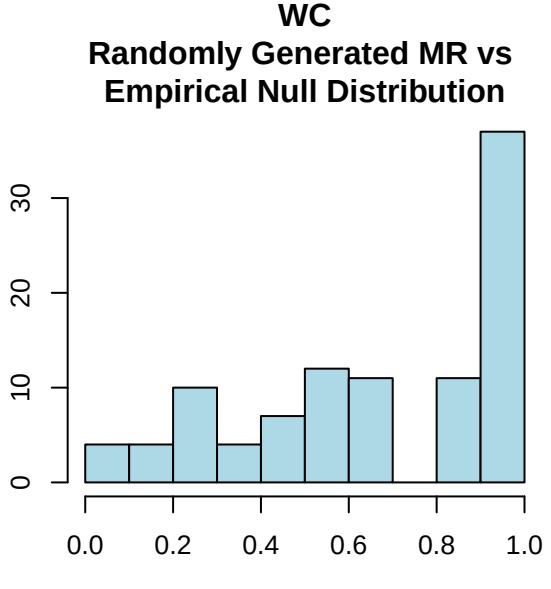

KC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

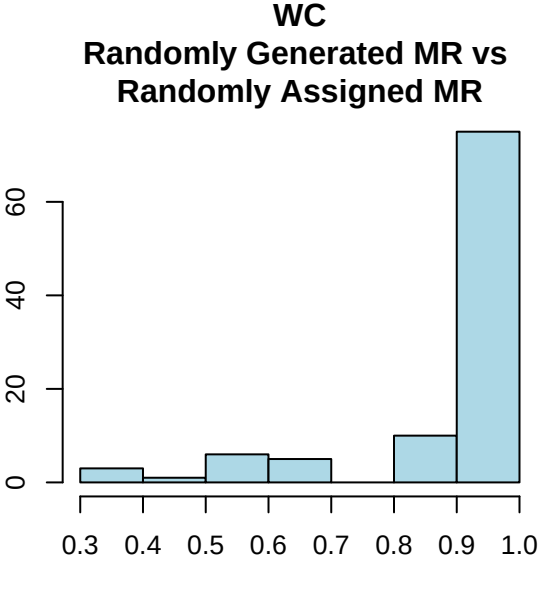

KC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

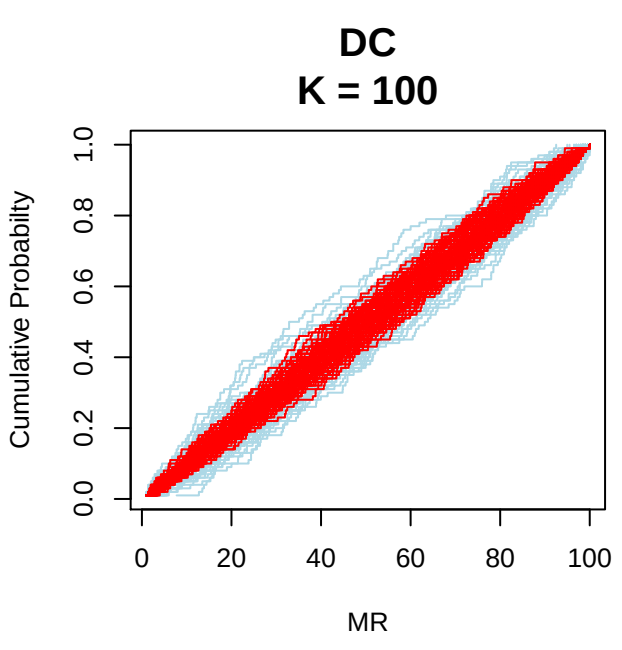

KC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
0.2
0.4
0.6
0.8
1.0

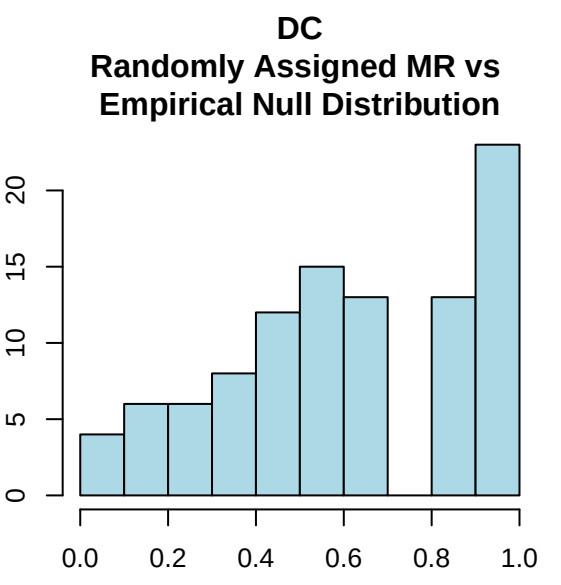

WC
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

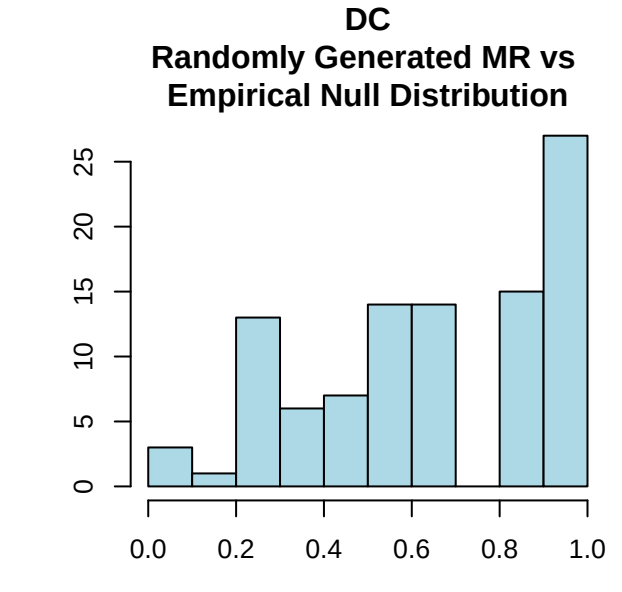

WC
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

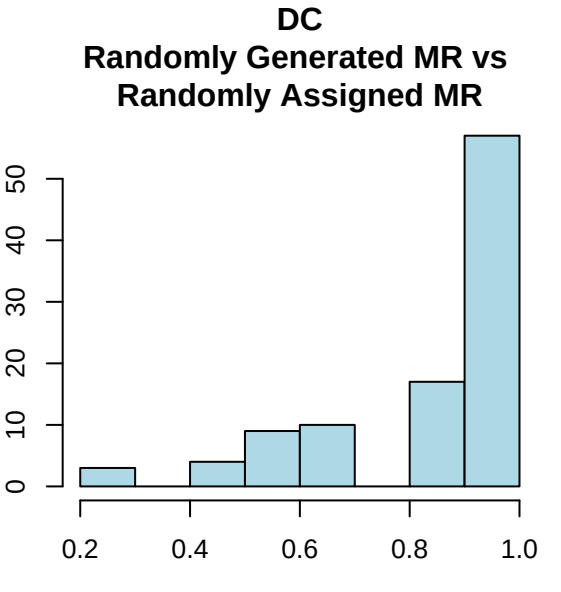

WC
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

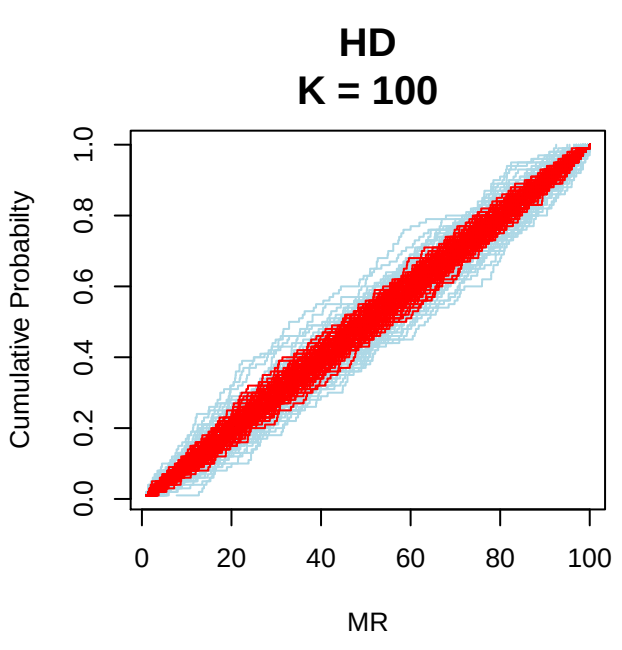

WC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

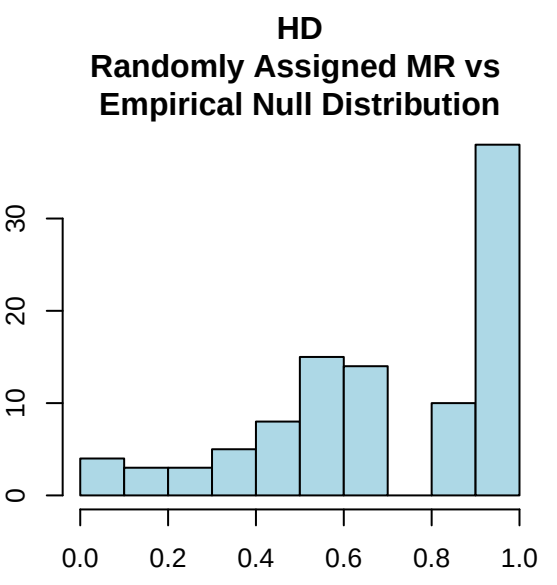

DC
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

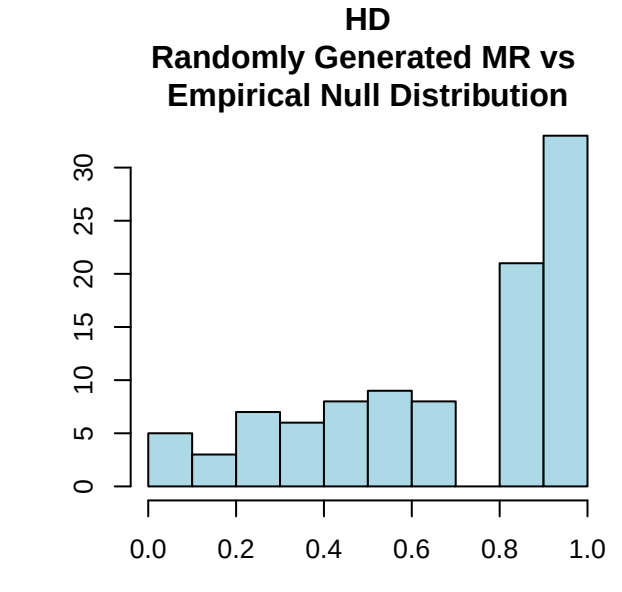

DC
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
20
0.0
0.2
0.4
0.6
0.8
1.0

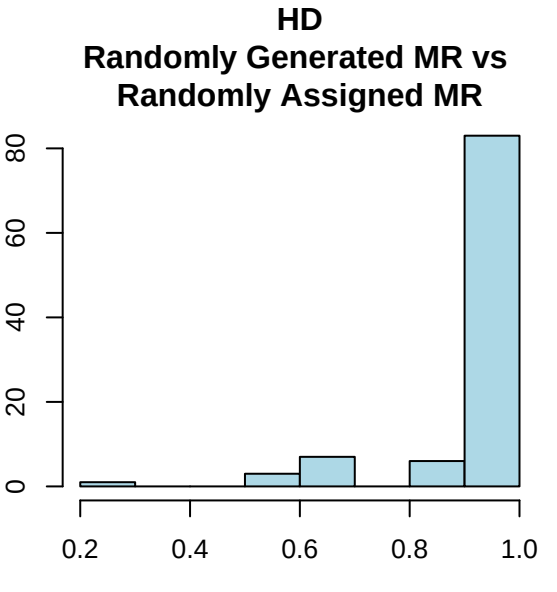

DC
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
20
25
0.0
0.2
0.4
0.6
0.8
1.0

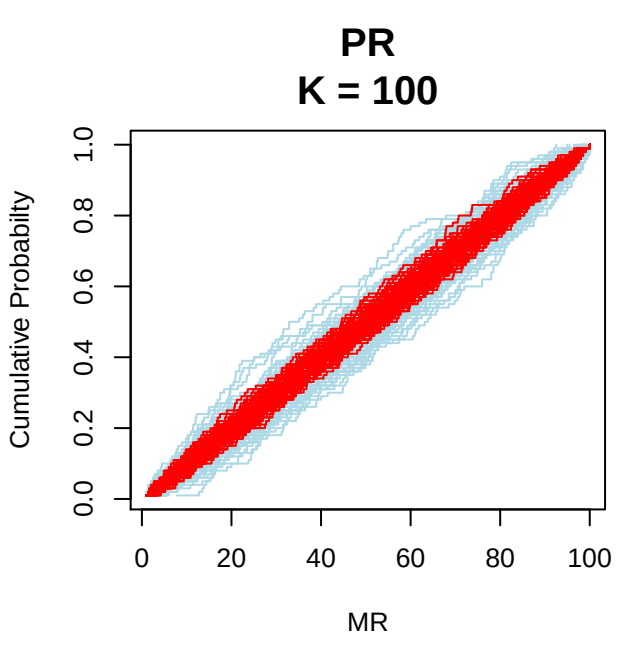

DC
Randomly Generated MR vs
Randomly Assigned MR
0
10
20
30
40
50
0.2
0.4
0.6
0.8
1.0

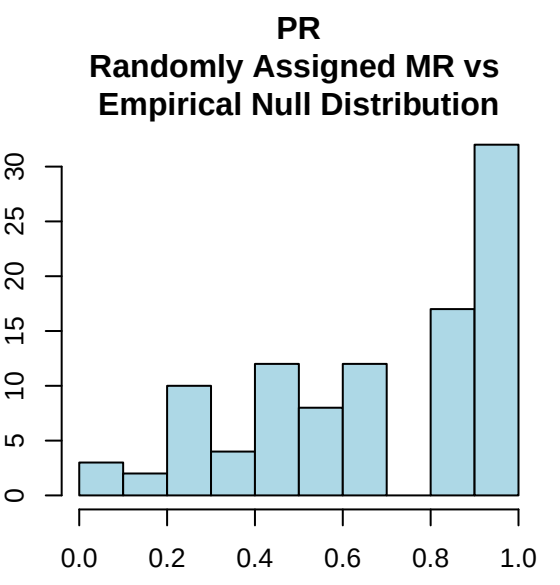

HD
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

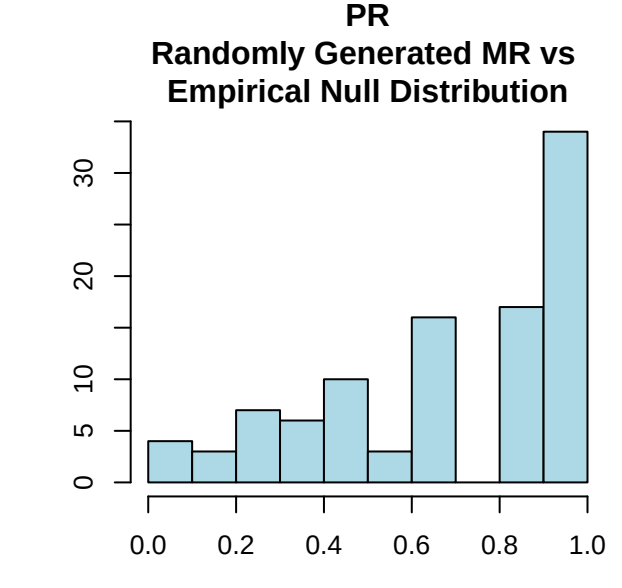

HD
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

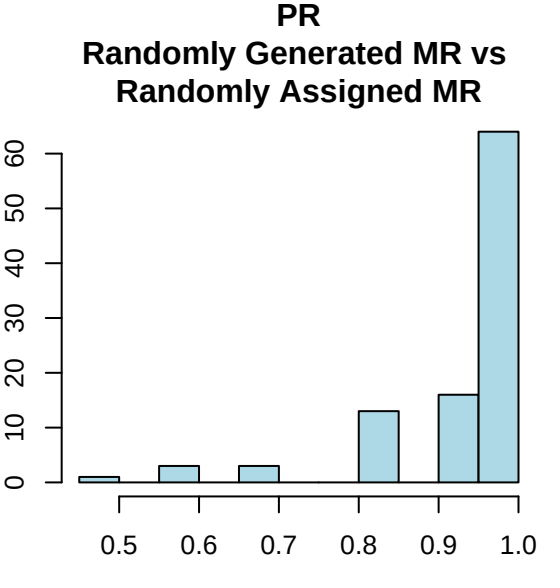

HD
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

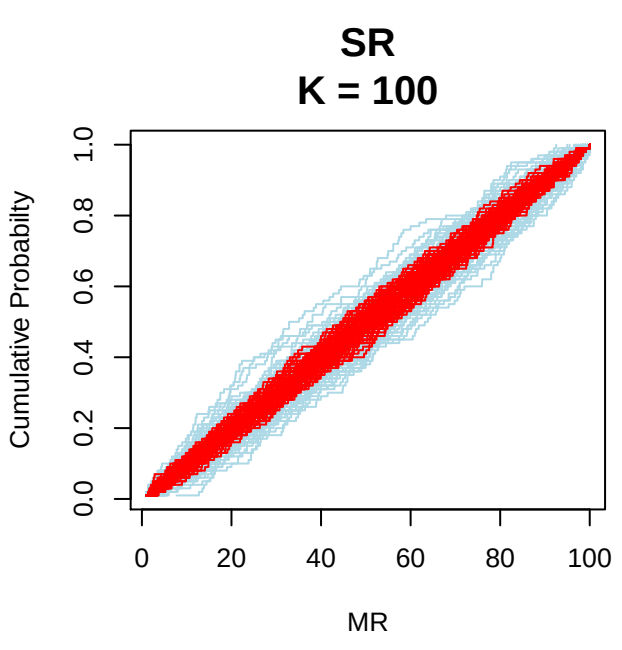

HD
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
0.2
0.4
0.6
0.8
1.0

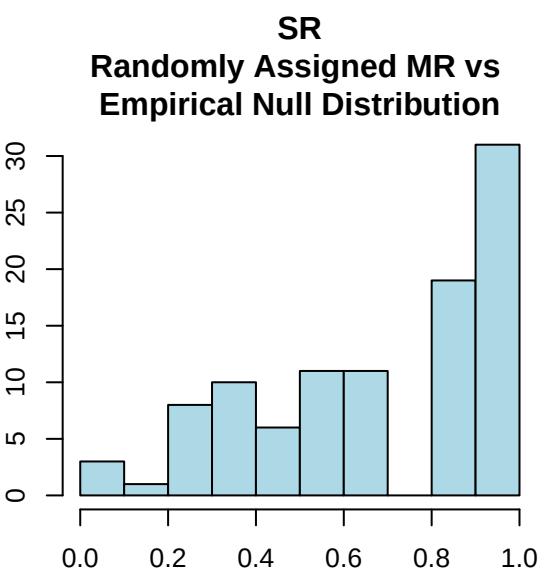

PR
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

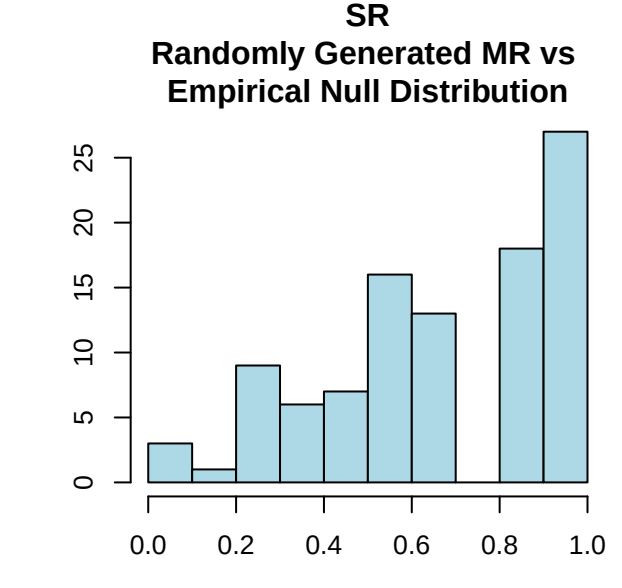

PR
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

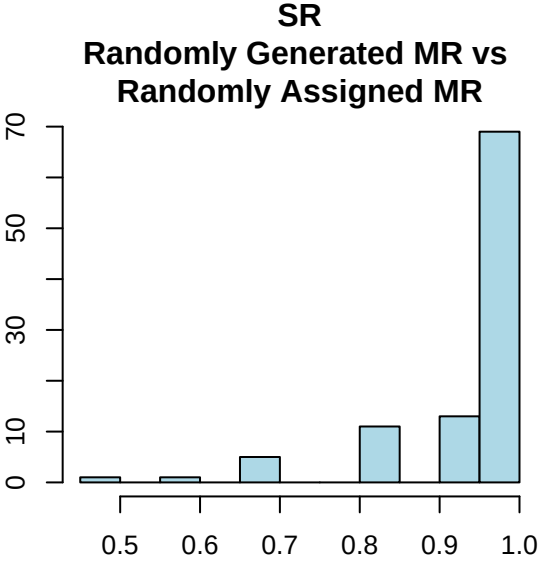

PR
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

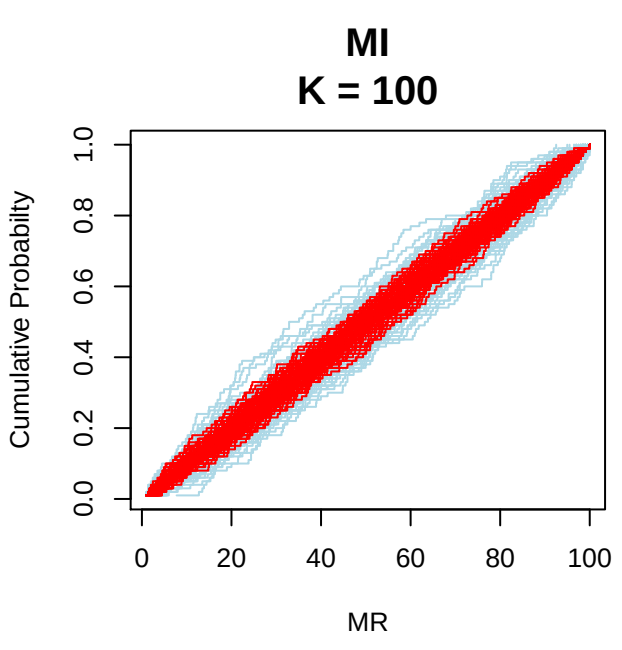

PR
Randomly Generated MR vs
Randomly Assigned MR
0
10
20
30
40
50
60
0.5
0.6
0.7
0.8
0.9
1.0

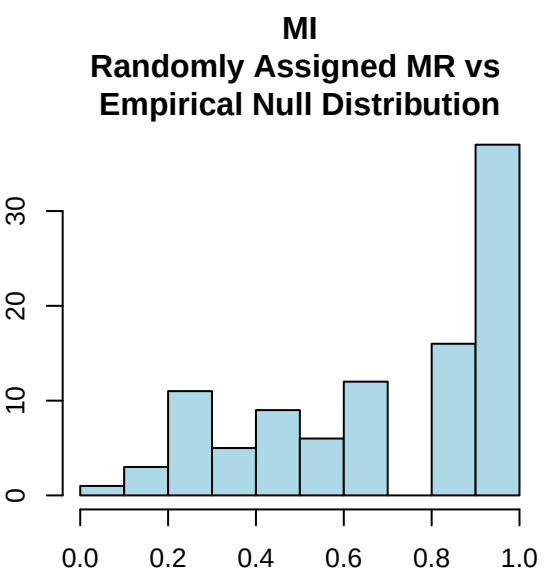

SR
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

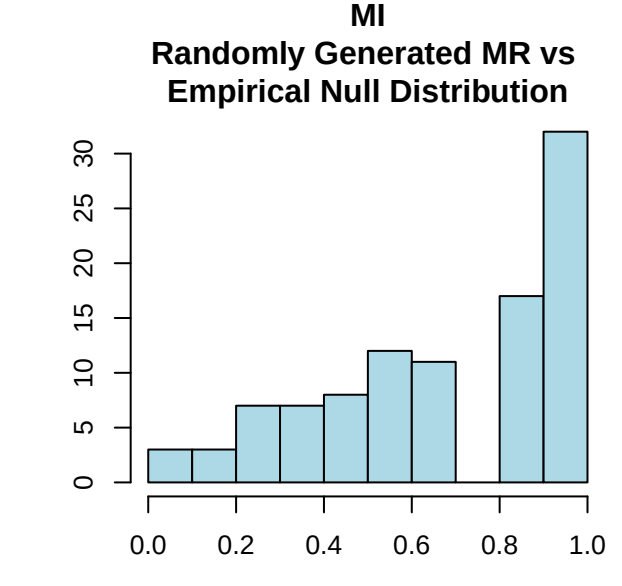

SR
Randomly Assigned MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

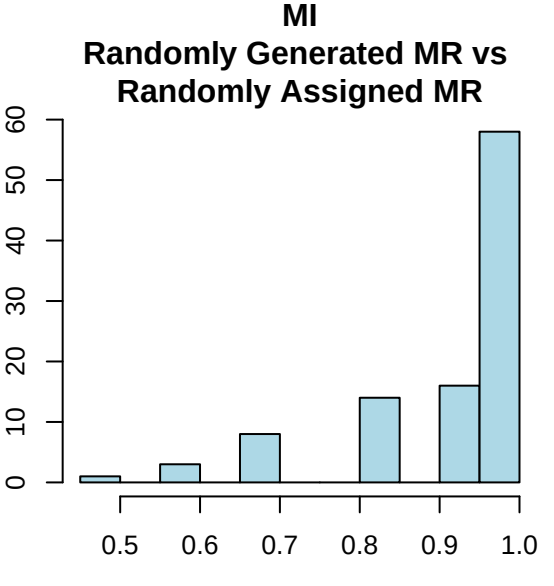

SR
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
20
25
0.0
0.2
0.4
0.6
0.8
1.0

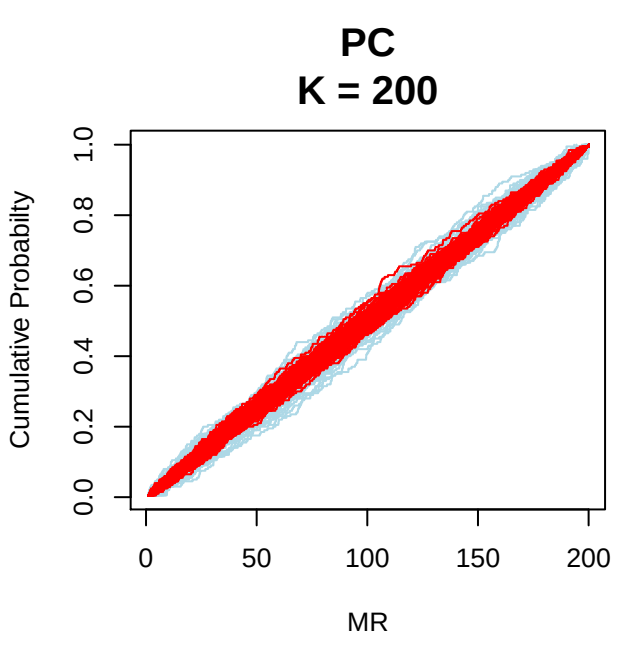

SR
Randomly Generated MR vs
Randomly Assigned MR
0
10
30
50
70
0.5
0.6
0.7
0.8
0.9
1.0

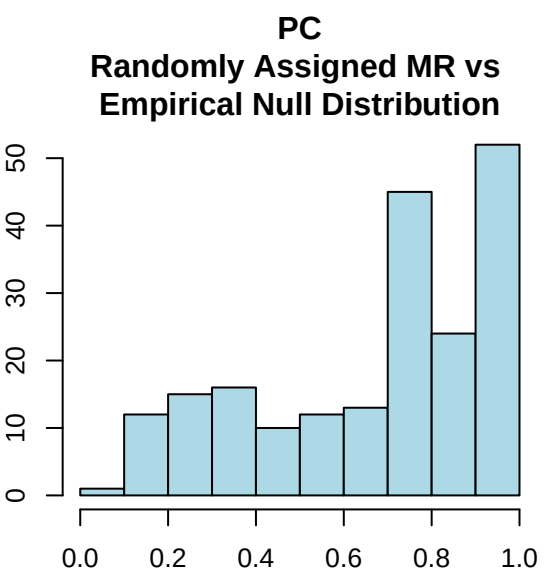

MI
K = 100
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
20
40
60
80
100
MR

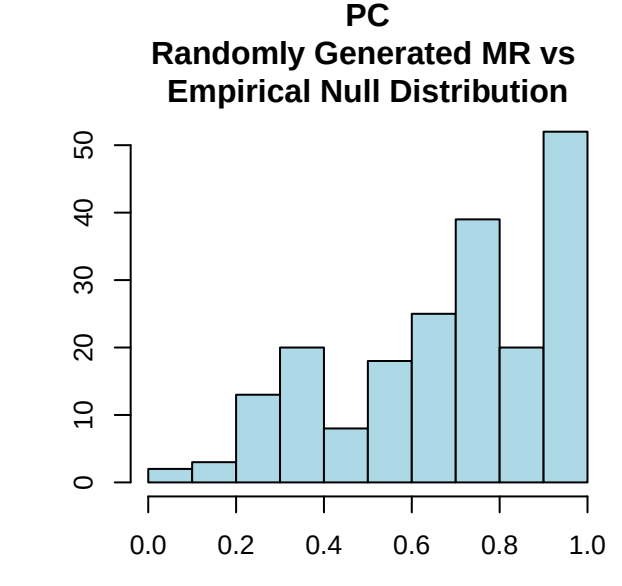

MI
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
0.0
0.2
0.4
0.6
0.8
1.0

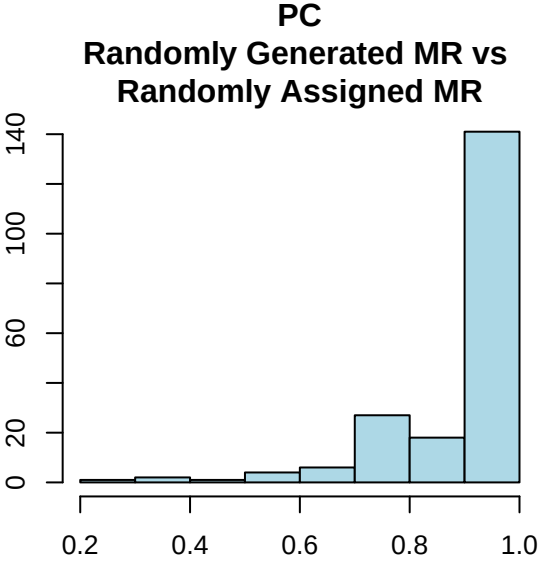

MI
Randomly Generated MR vs
Empirical Null Distribution
0
5
10
15
20
25
30
0.0
0.2
0.4
0.6
0.8
1.0

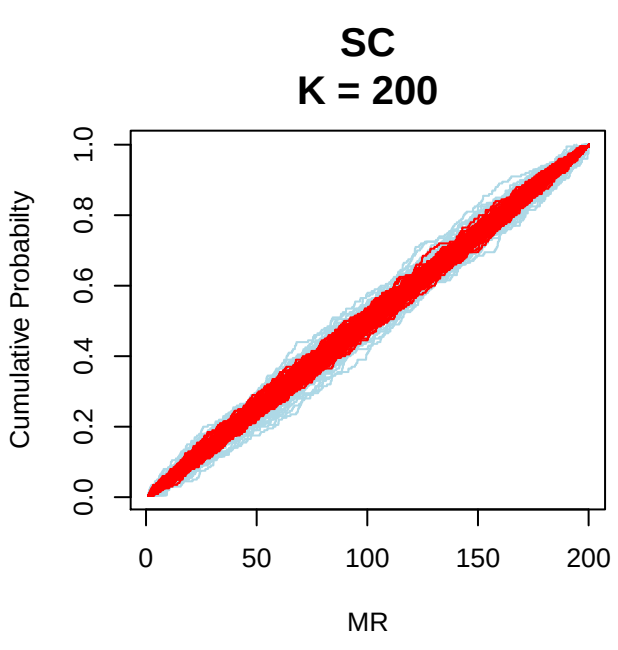

MI
Randomly Generated MR vs
Randomly Assigned MR
0
10
20
30
40
50
60
0.5
0.6
0.7
0.8
0.9
1.0

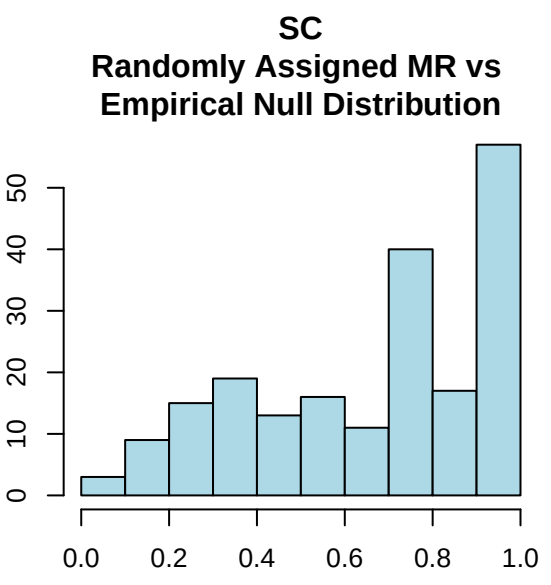

PC
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

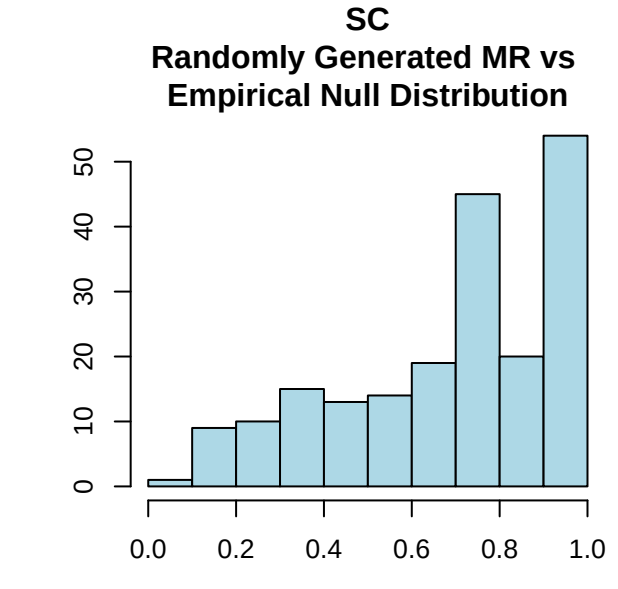

PC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

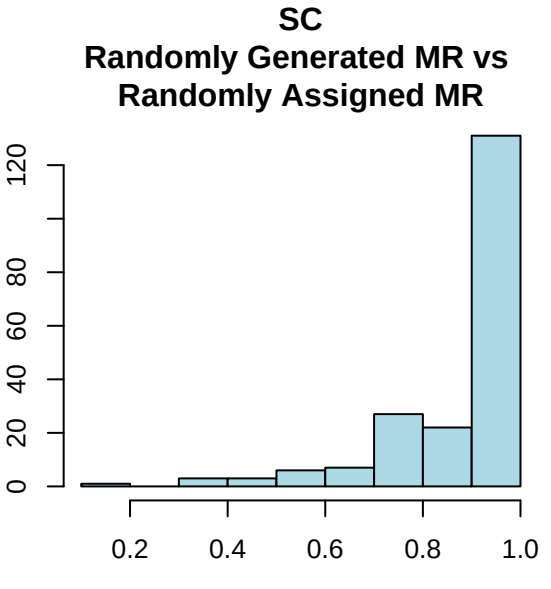

PC
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

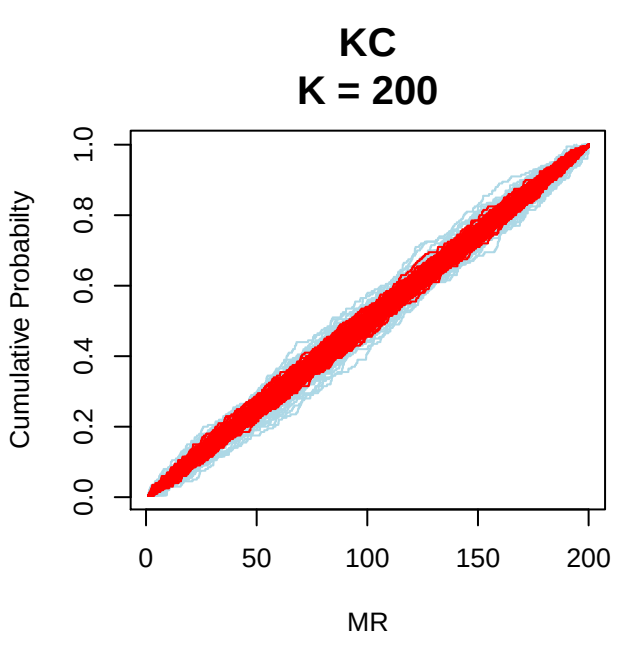

PC
Randomly Generated MR vs
Randomly Assigned MR
0
20
60
100
140
0.2
0.4
0.6
0.8
1.0

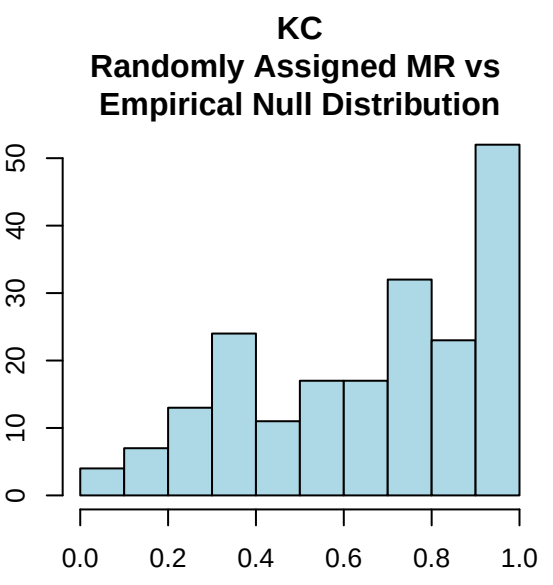

SC
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

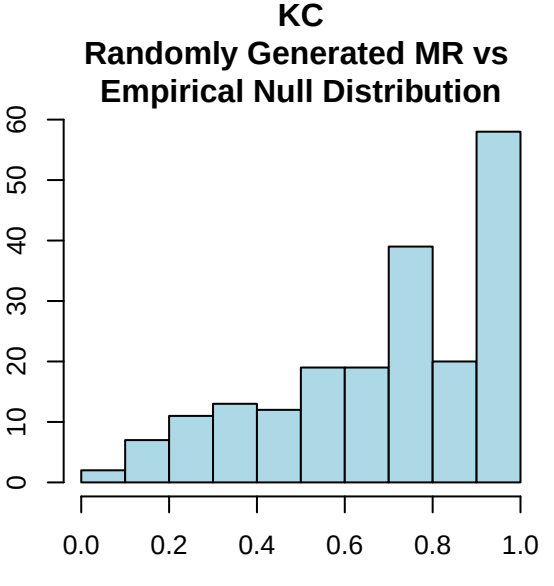

SC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

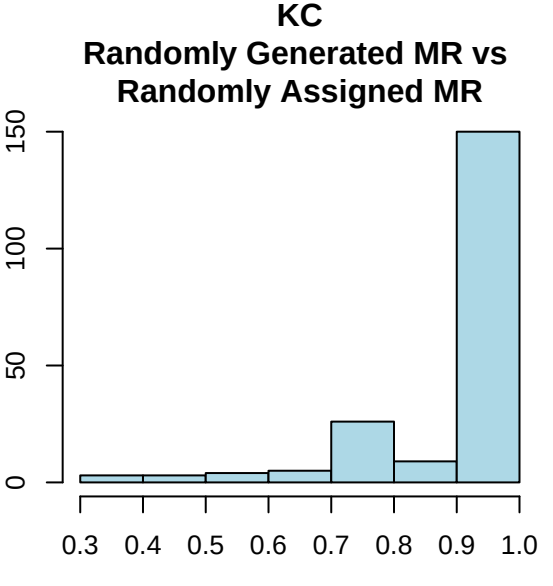

SC
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

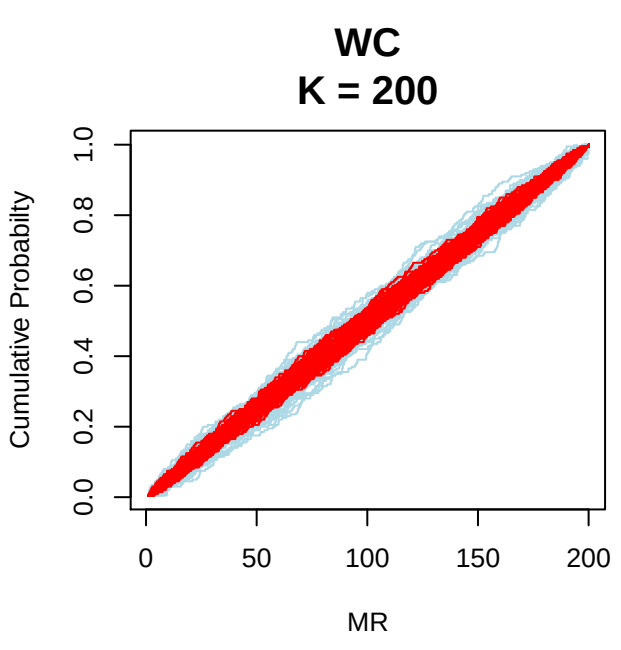

SC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
120
0.2
0.4
0.6
0.8
1.0

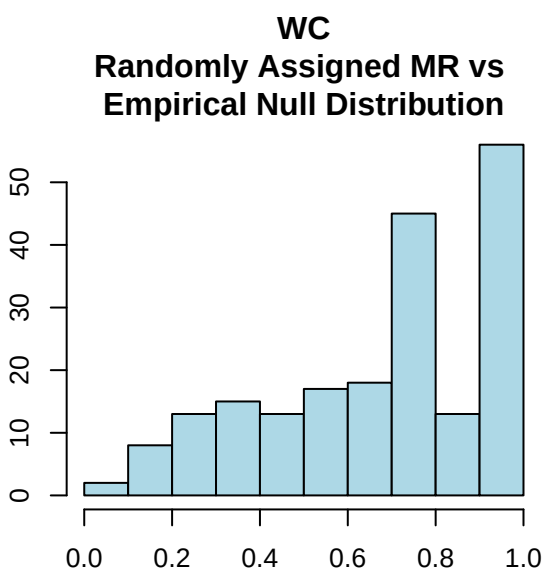

KC
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

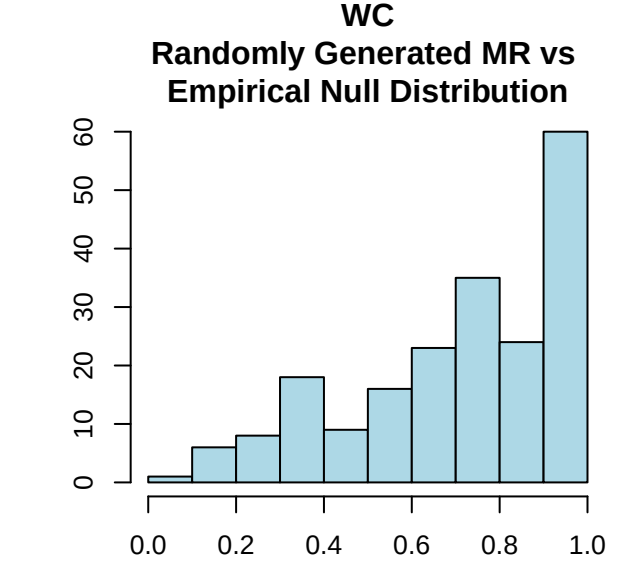

KC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

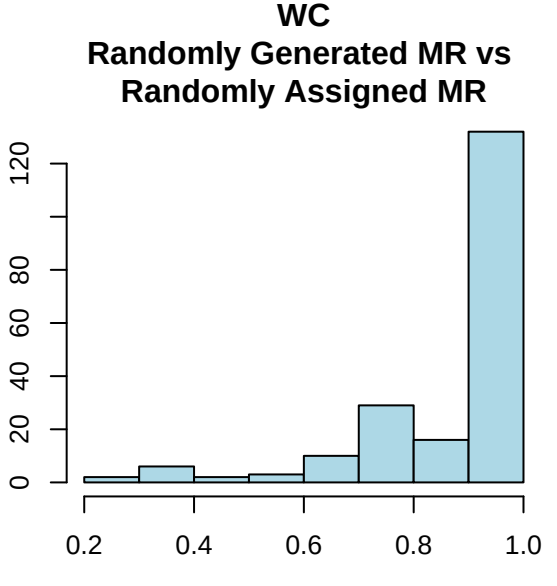

KC
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

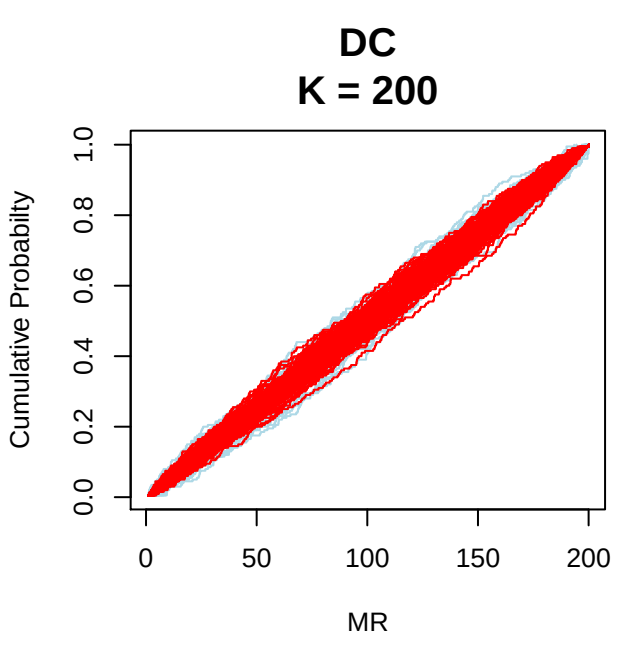

KC
Randomly Generated MR vs
Randomly Assigned MR
0
50
100
150
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0

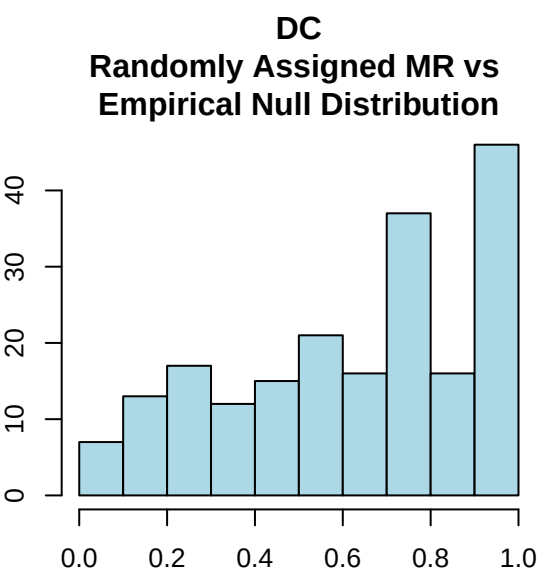

WC
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

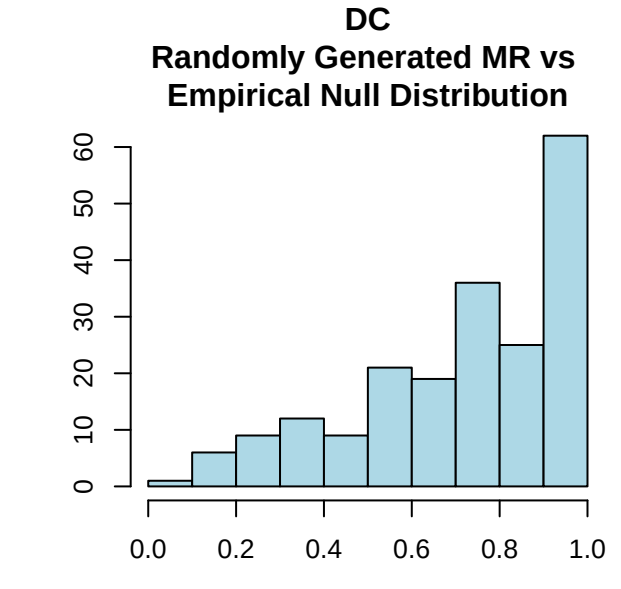

WC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

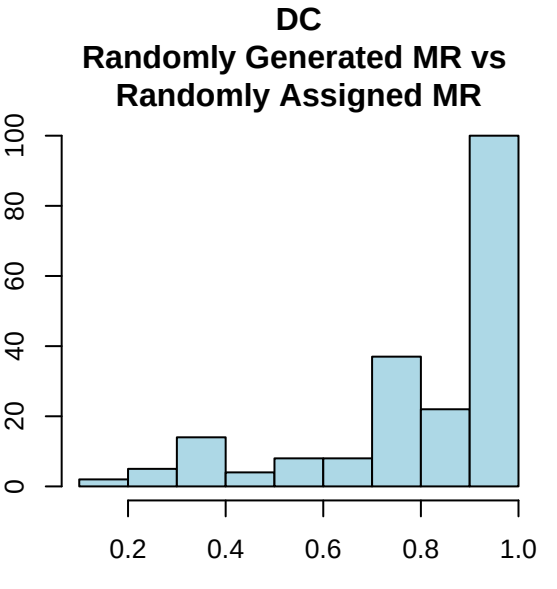

WC
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

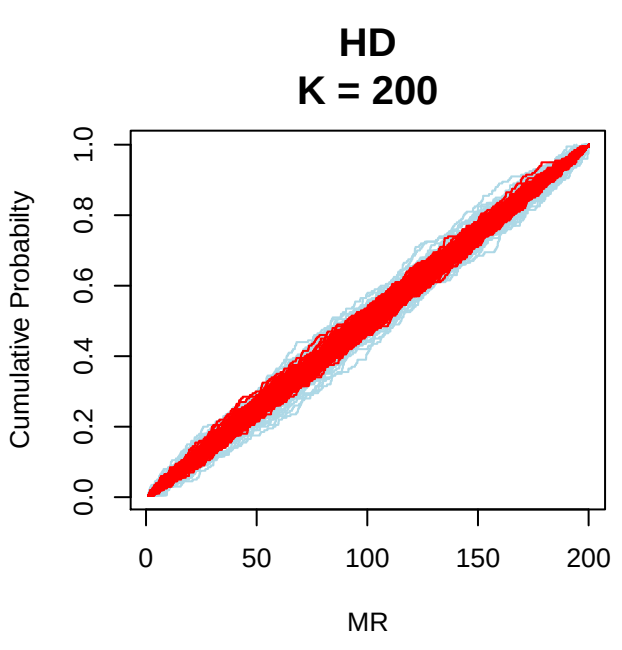

WC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
120
0.2
0.4
0.6
0.8
1.0

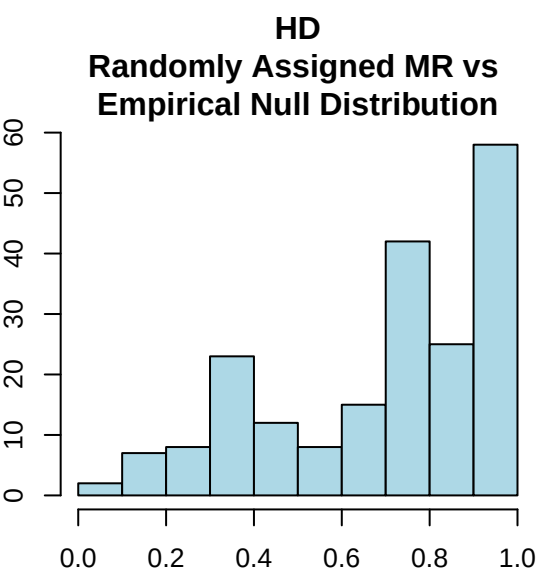

DC
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

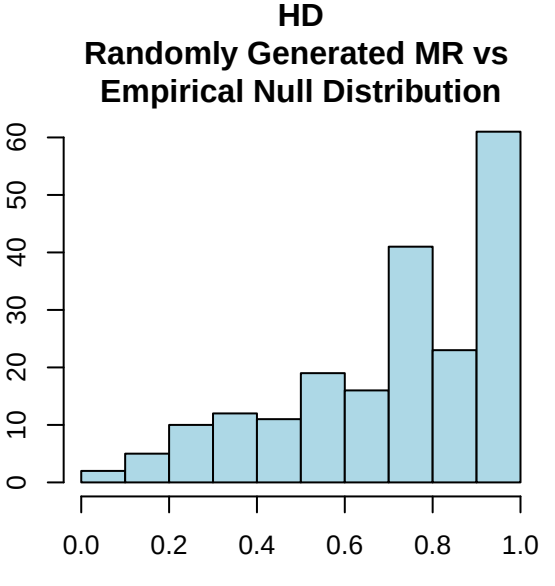

DC
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
0.0
0.2
0.4
0.6
0.8
1.0

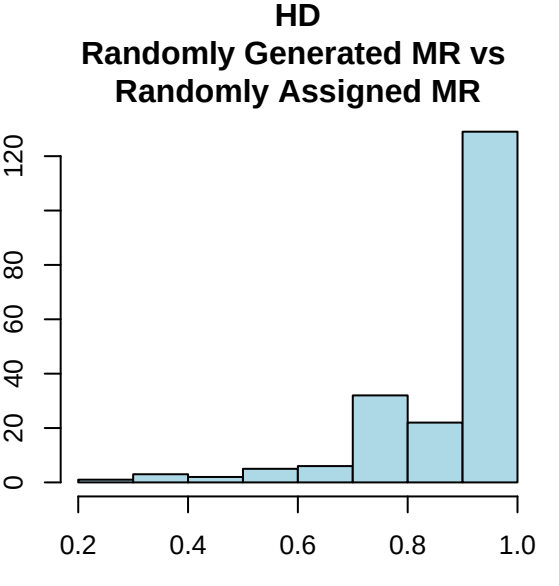

DC
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

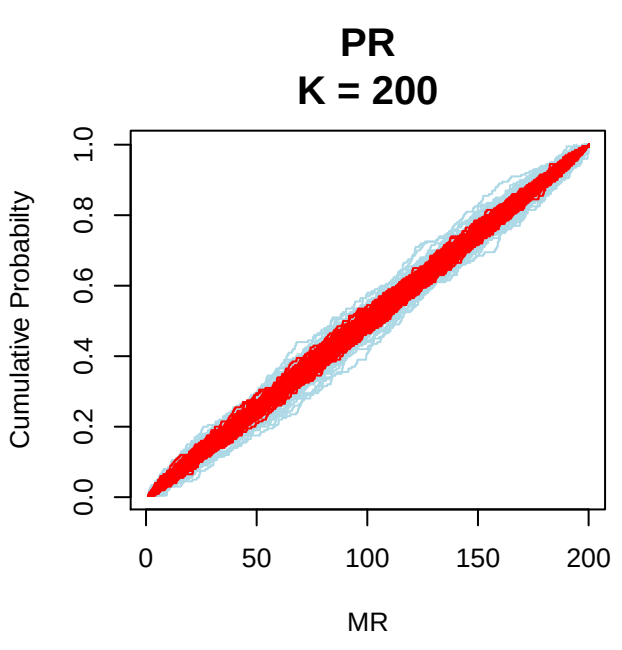

DC
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
100
0.2
0.4
0.6
0.8
1.0

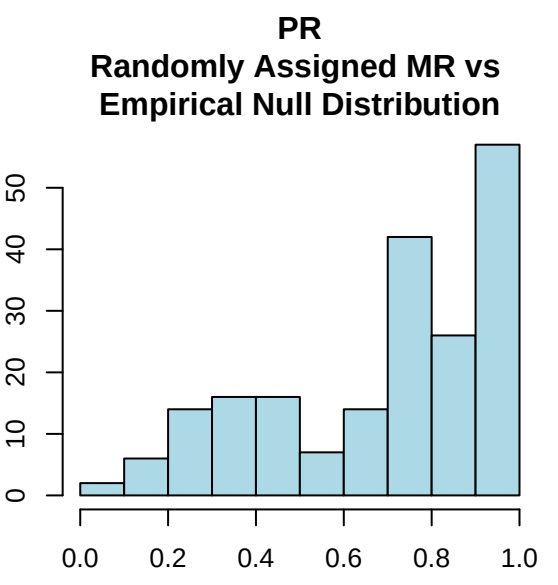

HD
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

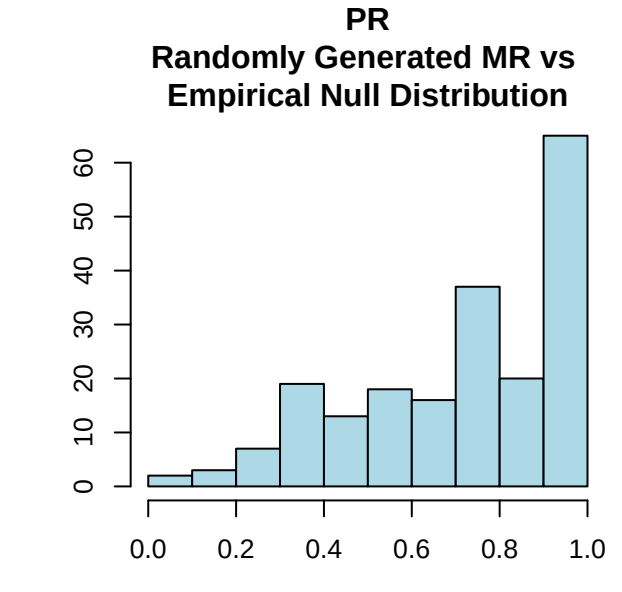

HD
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

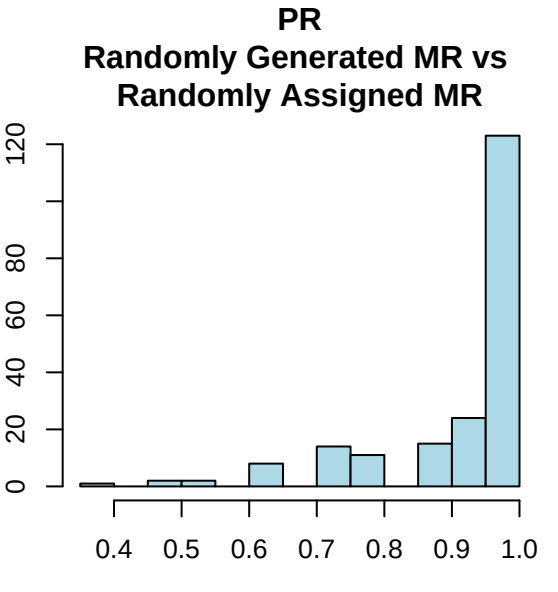

HD
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

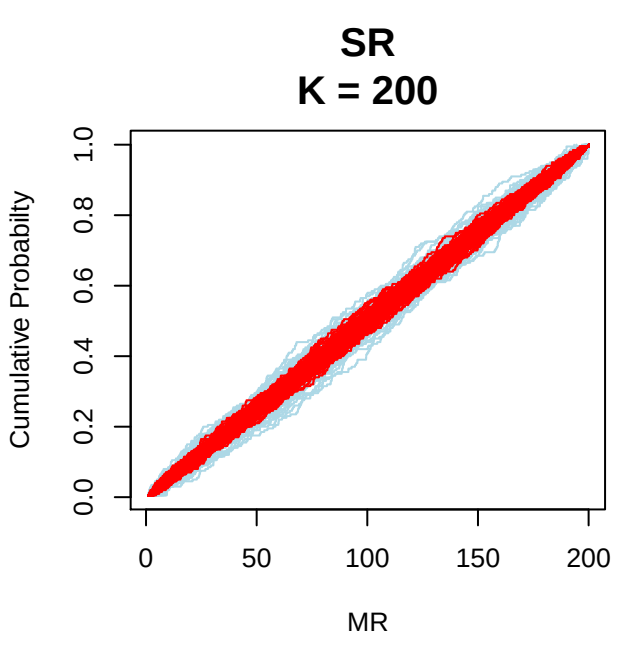

HD
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
120
0.2
0.4
0.6
0.8
1.0

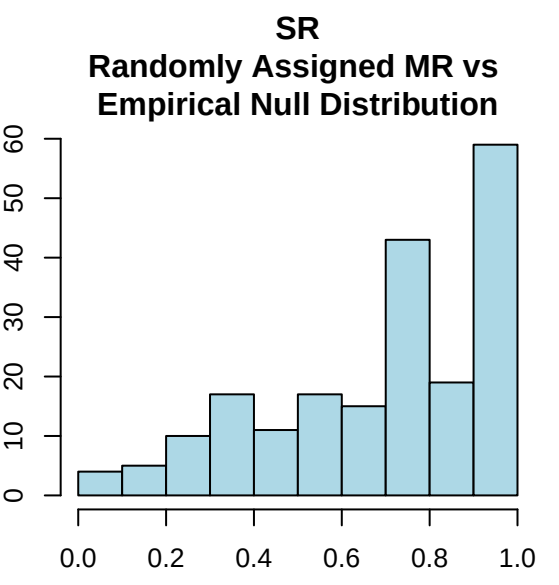

PR
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

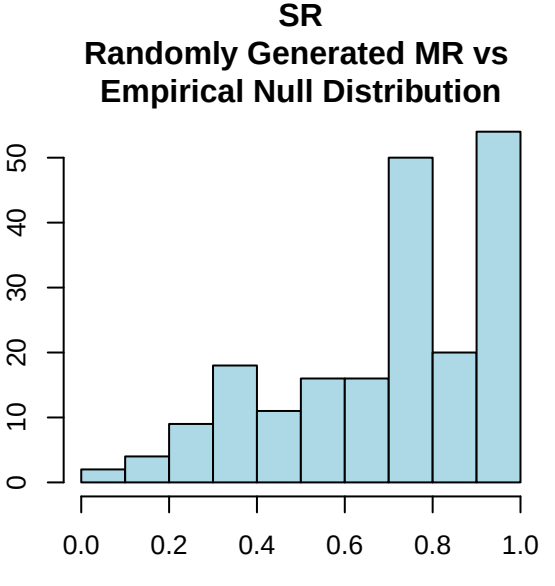

PR
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

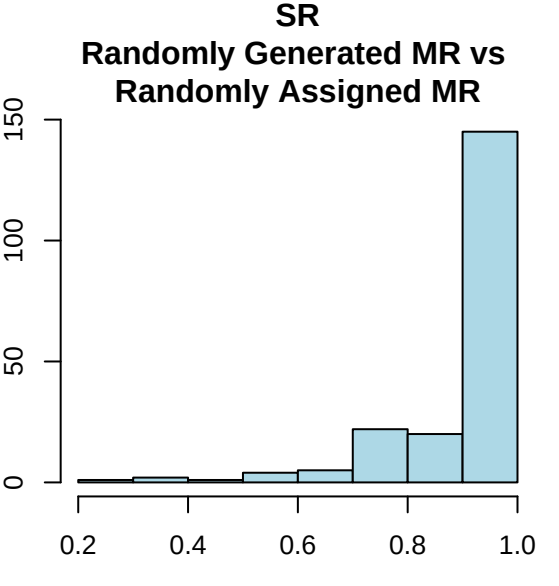

PR
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

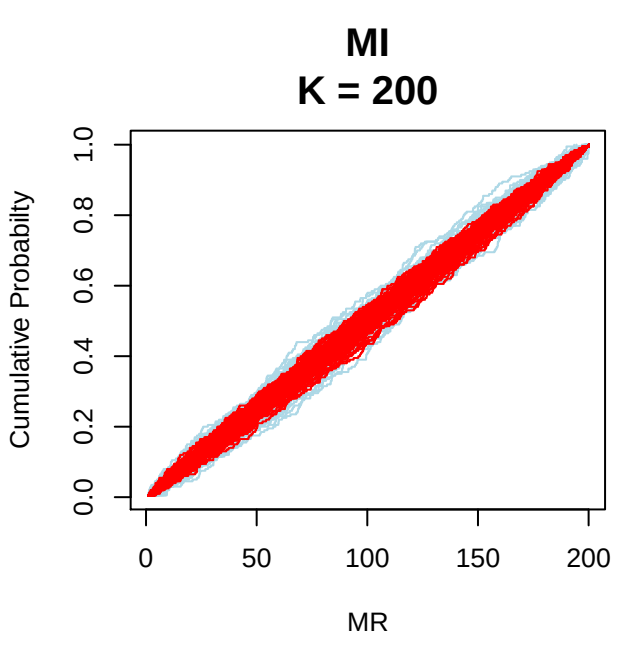

PR
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
120
0.4
0.5
0.6
0.7
0.8
0.9
1.0

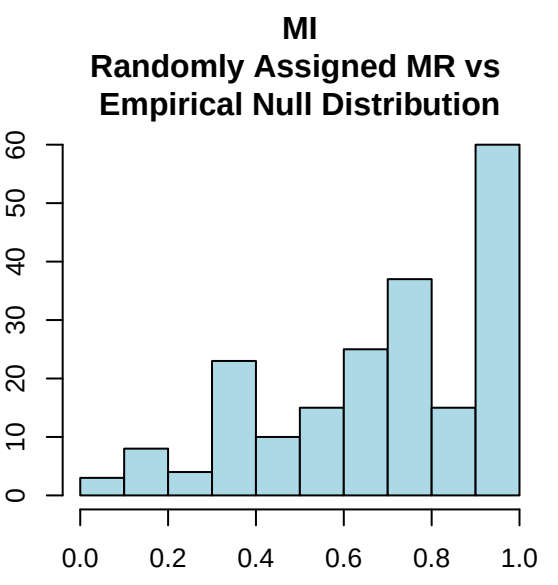

SR
K = 200
Cumulative Probabilty
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

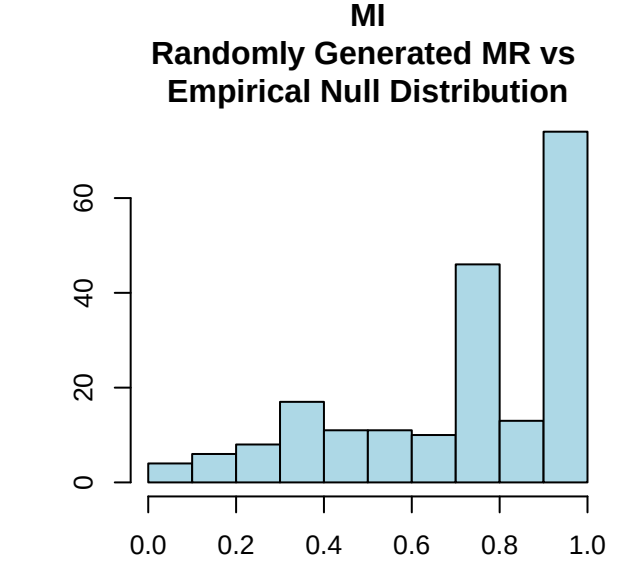

SR
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

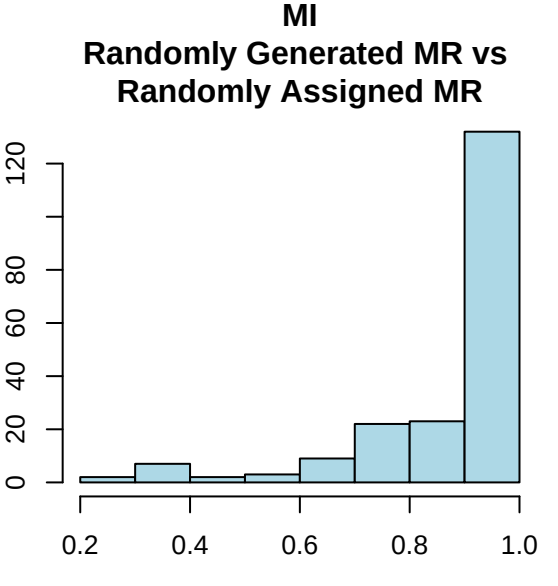

SR
Randomly Generated MR vs
Empirical Null Distribution
0
10
20
30
40
50
0.0
0.2
0.4
0.6
0.8
1.0

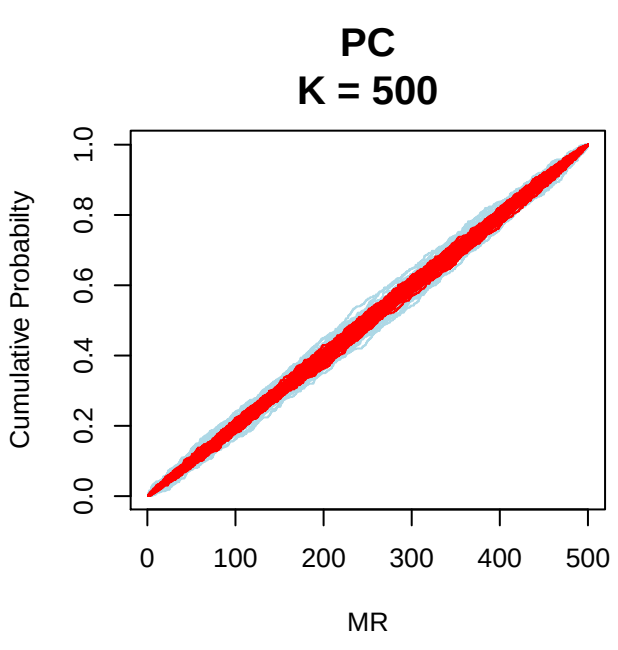

SR
Randomly Generated MR vs
Randomly Assigned MR
0
50
100
150
0.2
0.4
0.6
0.8
1.0

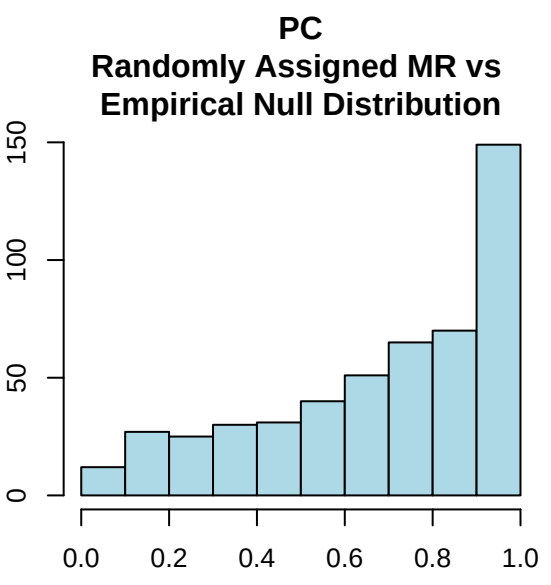

MI
K = 200
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
50
100
150
200
MR

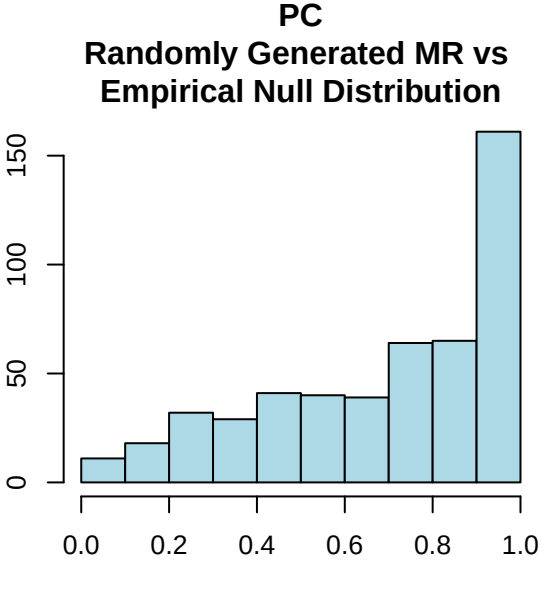

MI
Randomly Assigned MR vs
Empirical Null Distribution
0
10
20
30
40
50
60
0.0
0.2
0.4
0.6
0.8
1.0

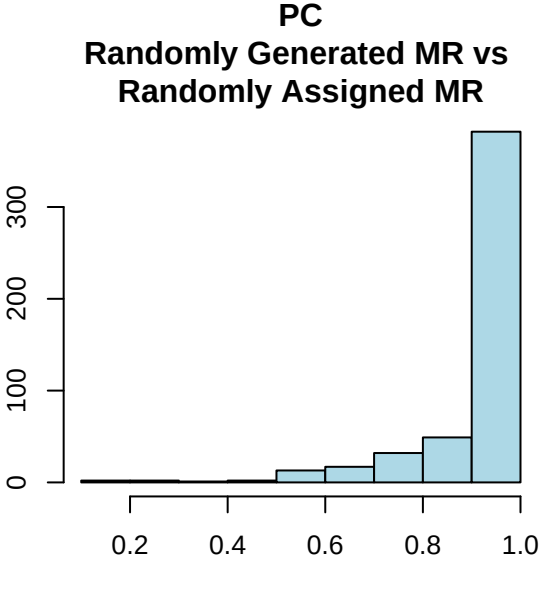

MI
Randomly Generated MR vs
Empirical Null Distribution
0
20
40
60
0.0
0.2
0.4
0.6
0.8
1.0

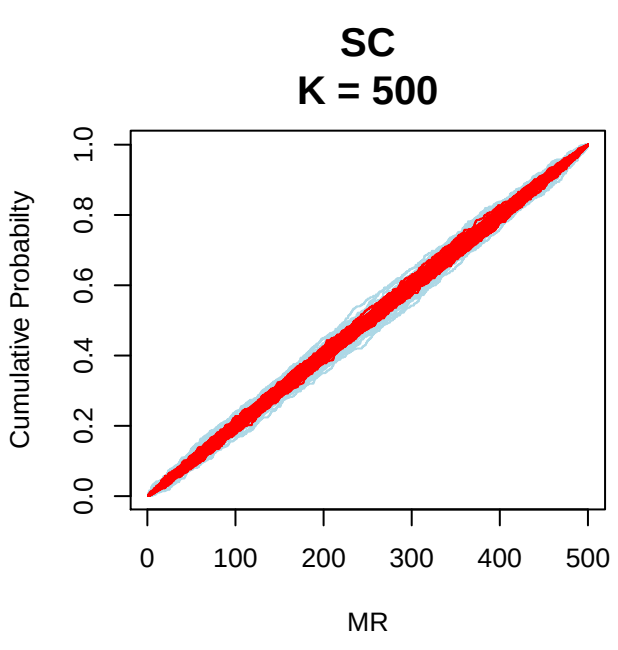

MI
Randomly Generated MR vs
Randomly Assigned MR
0
20
40
60
80
120
0.2
0.4
0.6
0.8
1.0

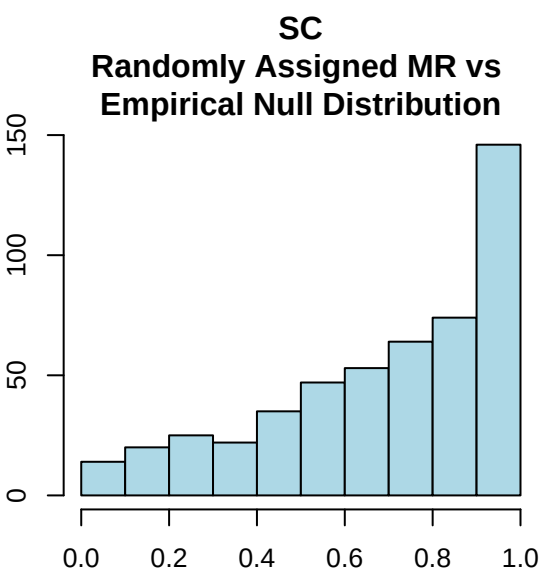

PC
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

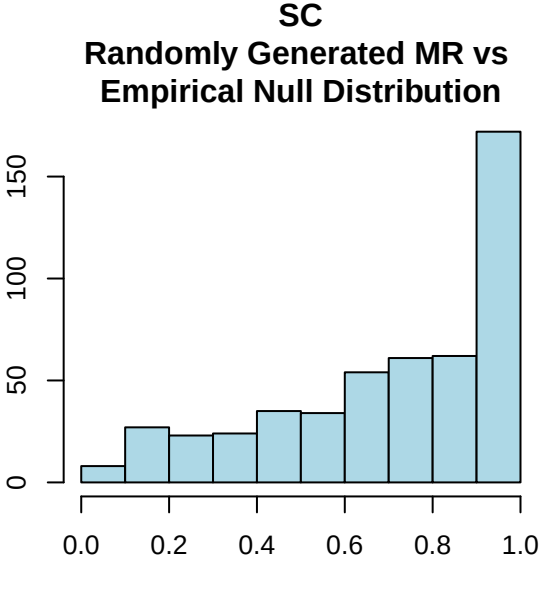

PC
Randomly Assigned MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

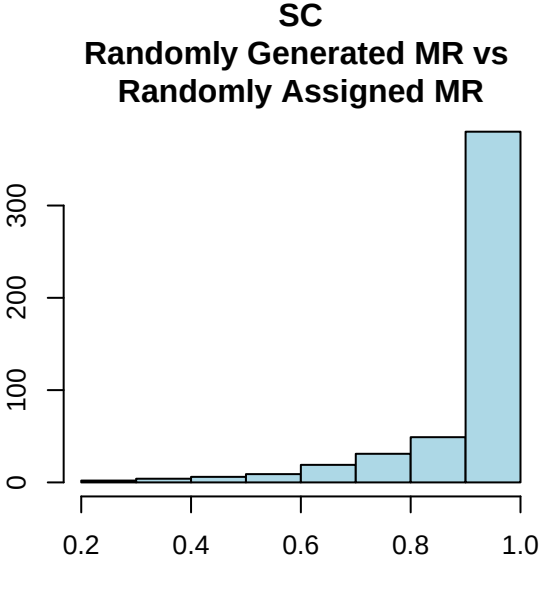

PC
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

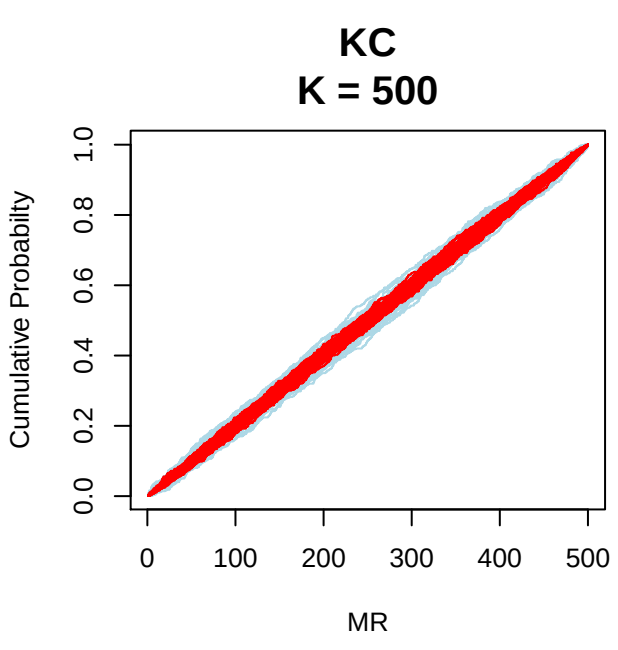

PC
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.2
0.4
0.6
0.8
1.0

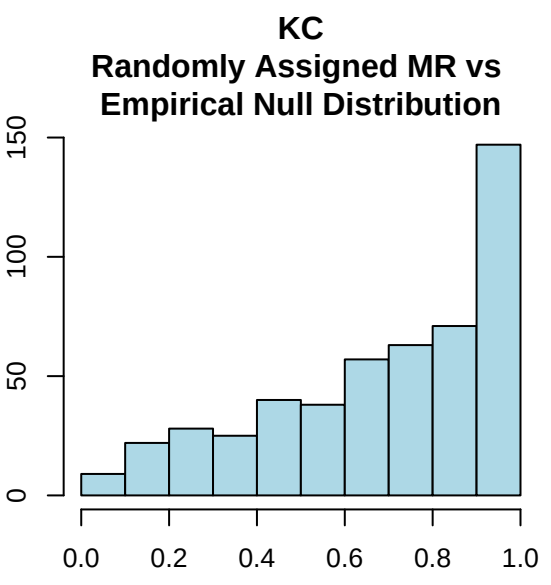

SC
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

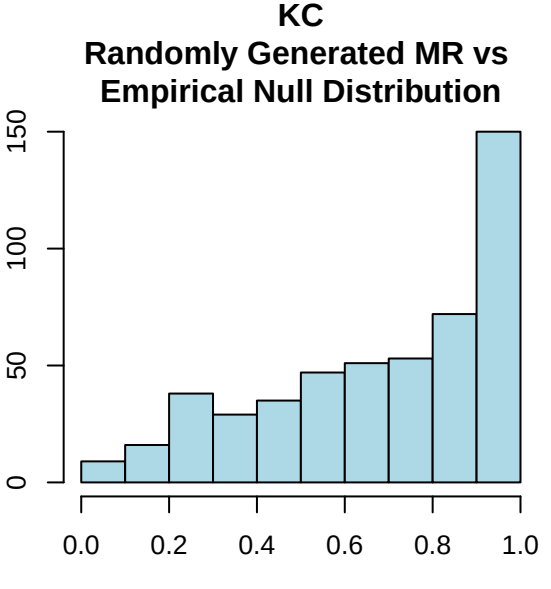

SC
Randomly Assigned MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

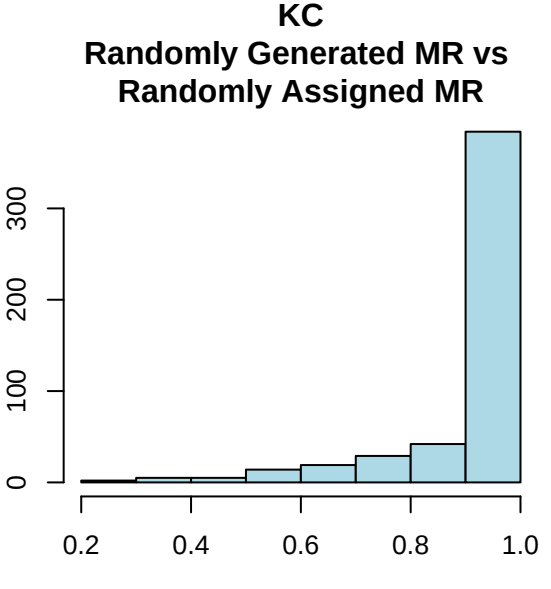

SC
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

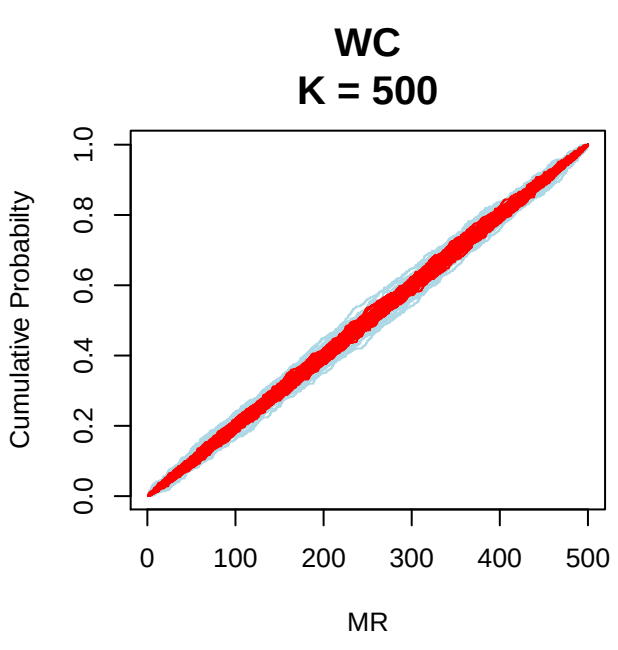

SC
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.2
0.4
0.6
0.8
1.0

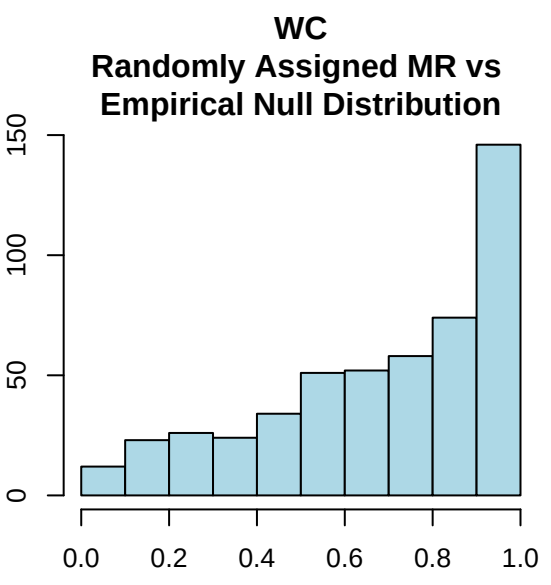

KC
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

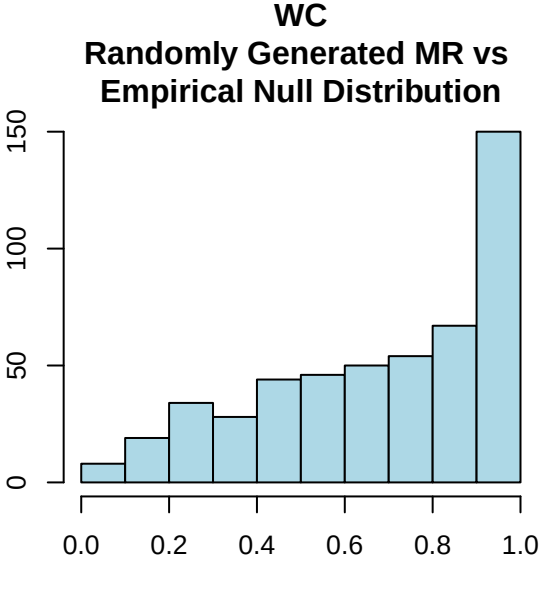

KC
Randomly Assigned MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

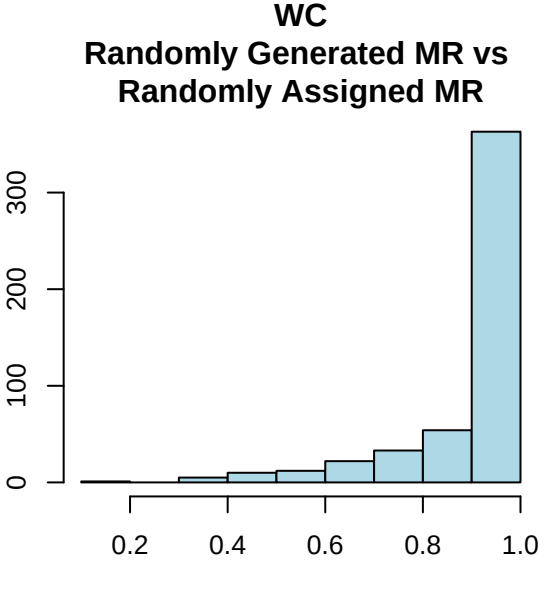

KC
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

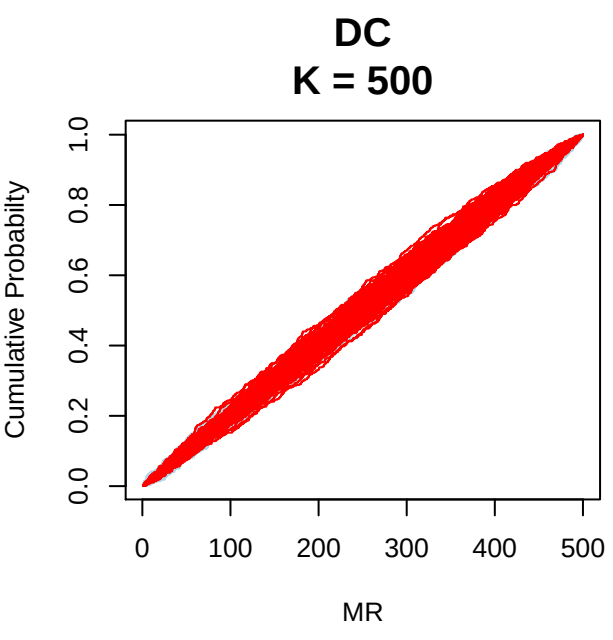

KC
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.2
0.4
0.6
0.8
1.0

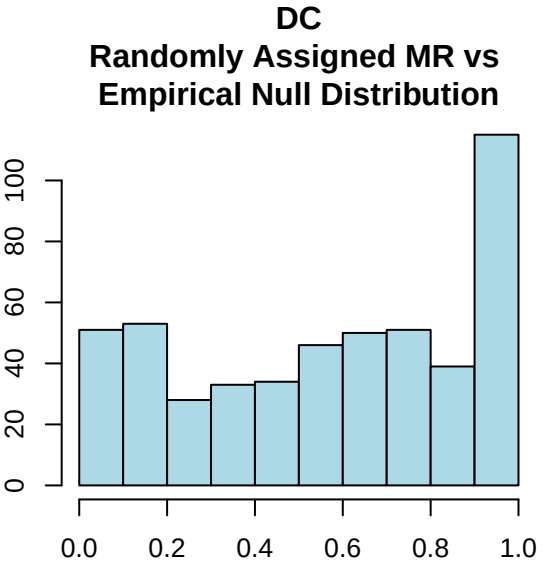

WC
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

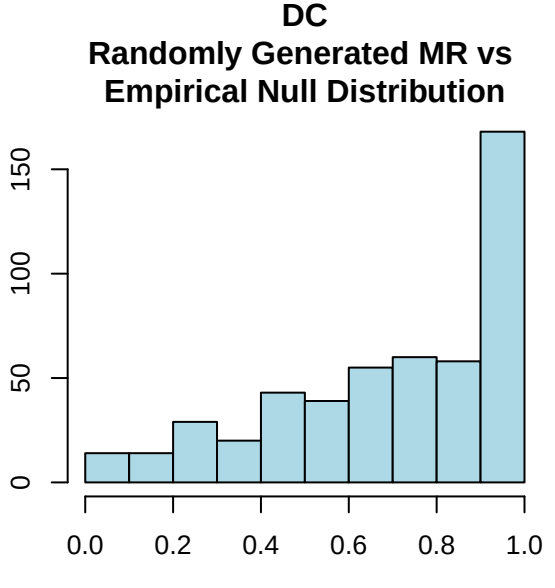

WC
Randomly Assigned MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

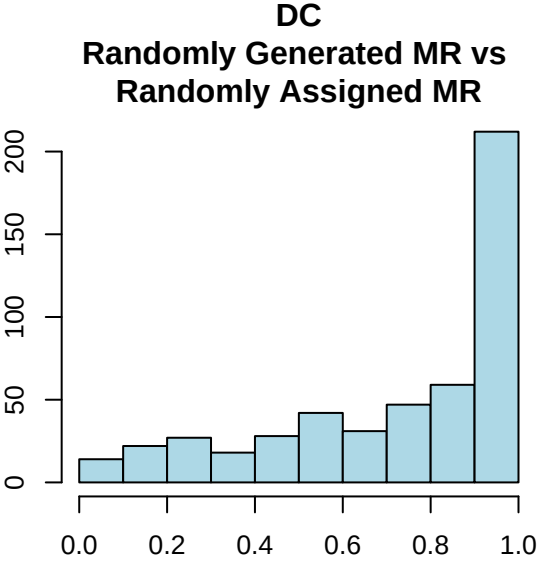

WC
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

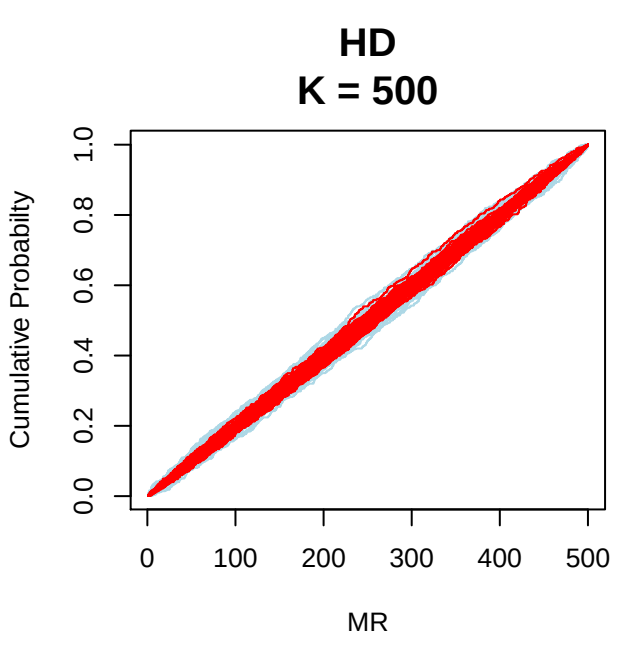

WC
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.2
0.4
0.6
0.8
1.0

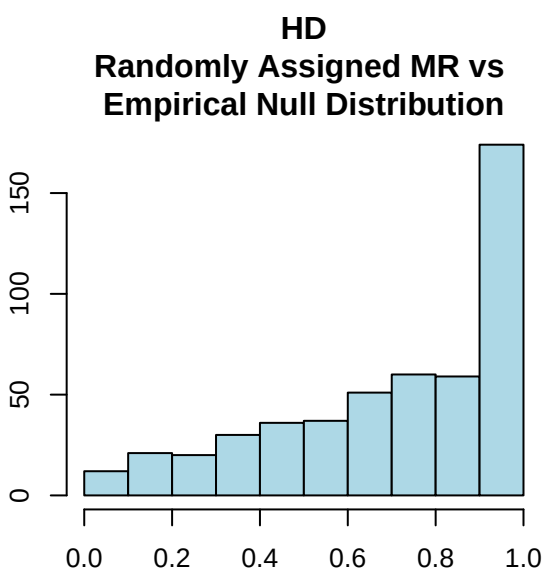

DC
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

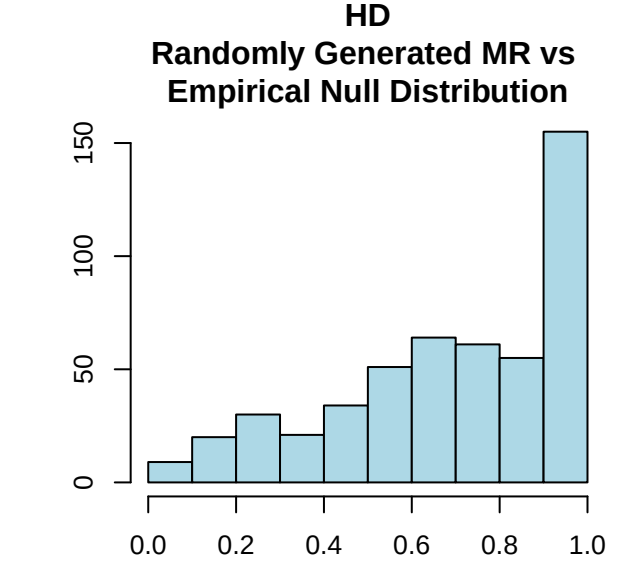

DC
Randomly Assigned MR vs
Empirical Null Distribution
0
20
40
60
80
100
0.0
0.2
0.4
0.6
0.8
1.0

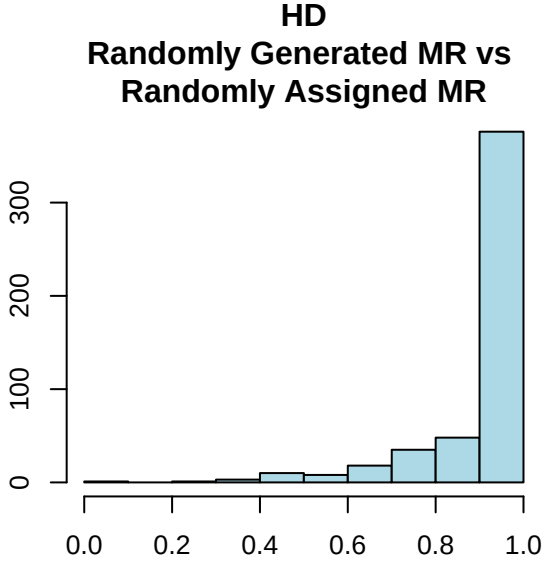

DC
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

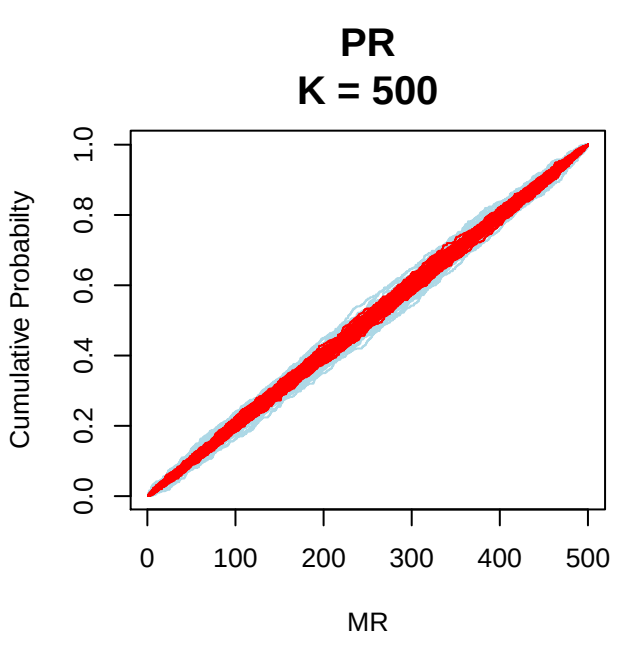

DC
Randomly Generated MR vs
Randomly Assigned MR
0
50
100
150
200
0.0
0.2
0.4
0.6
0.8
1.0

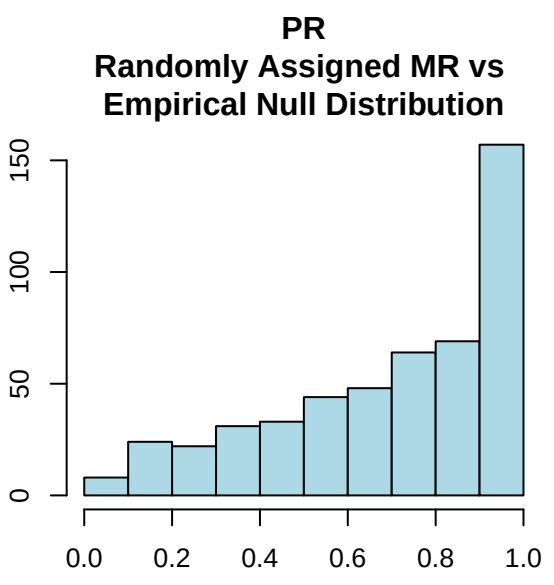

HD
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

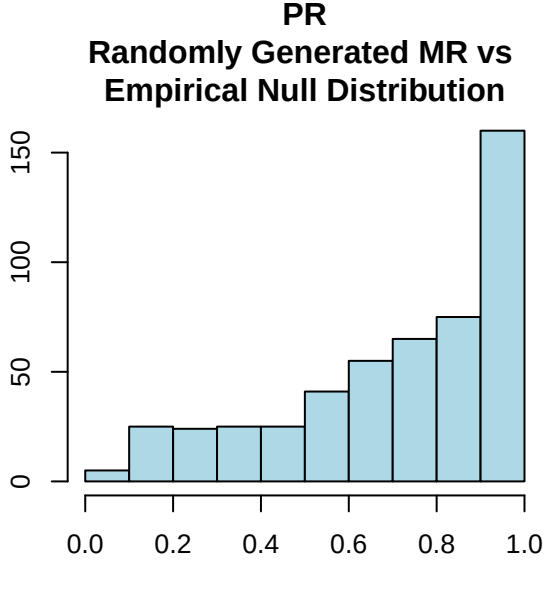

HD
Randomly Assigned MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

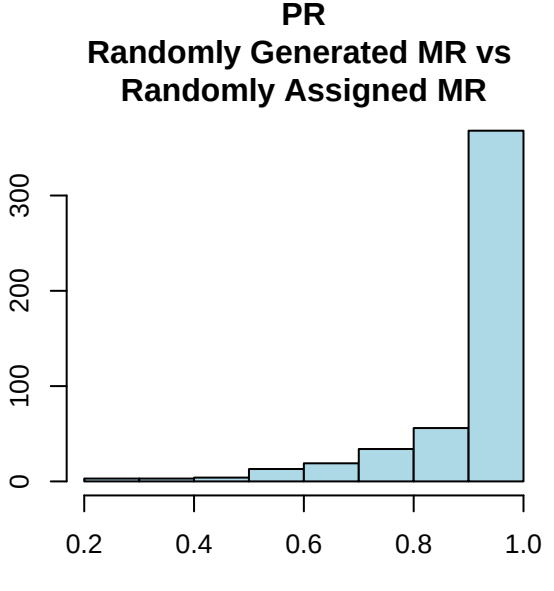

HD
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

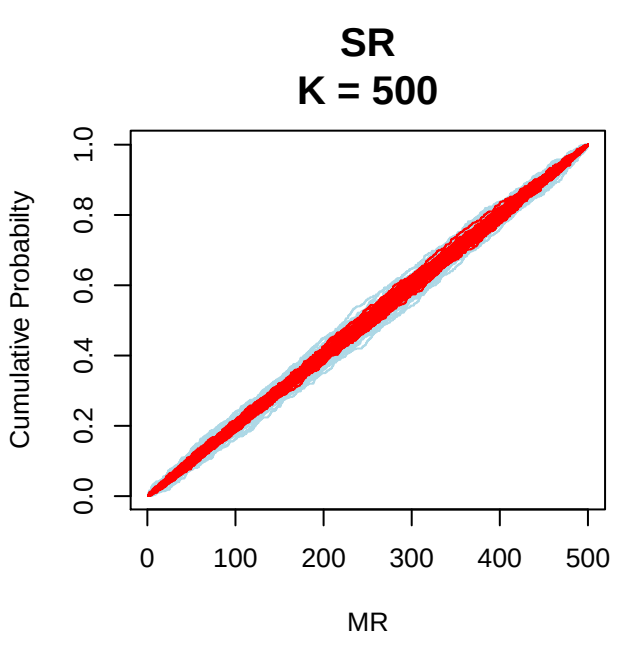

HD
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.0
0.2
0.4
0.6
0.8
1.0

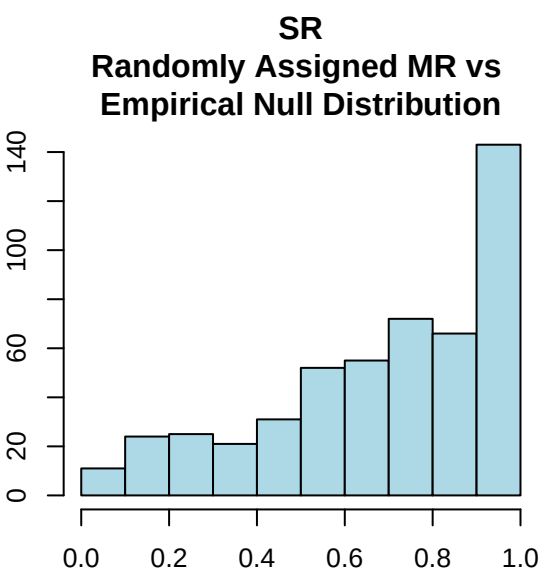

PR
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

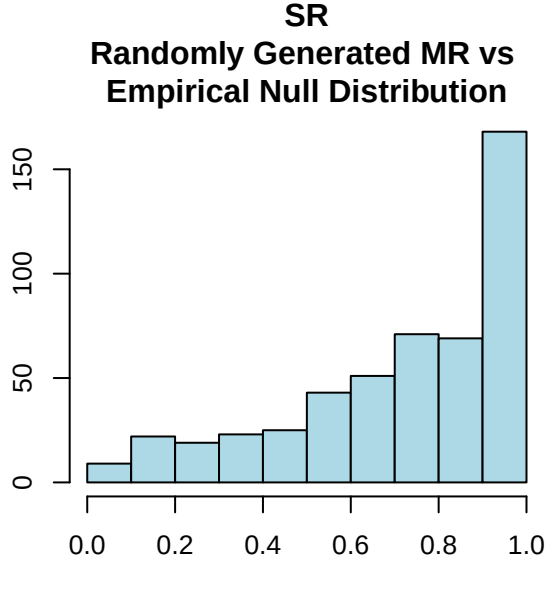

PR
Randomly Assigned MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

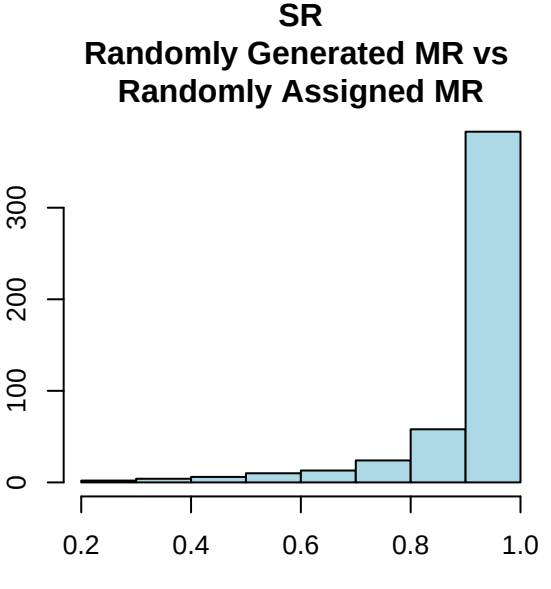

PR
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

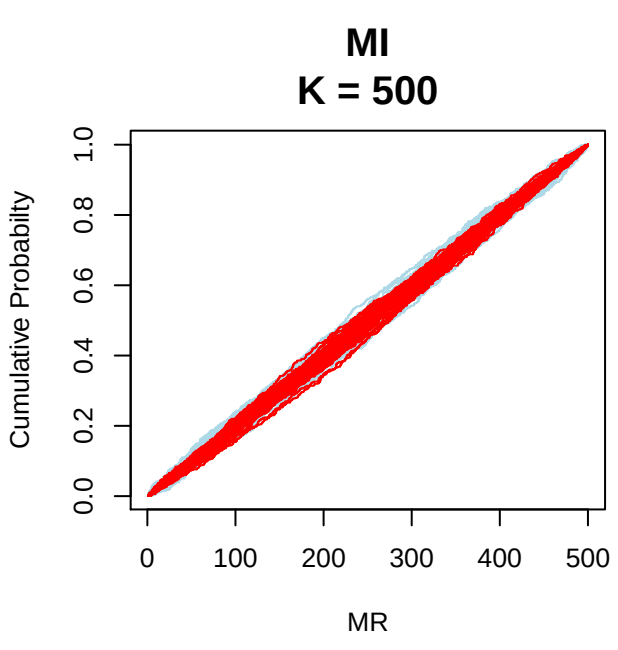

PR
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.2
0.4
0.6
0.8
1.0

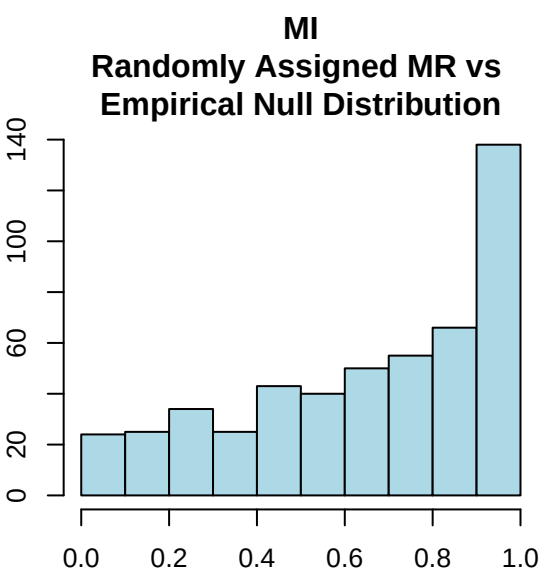

SR
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR

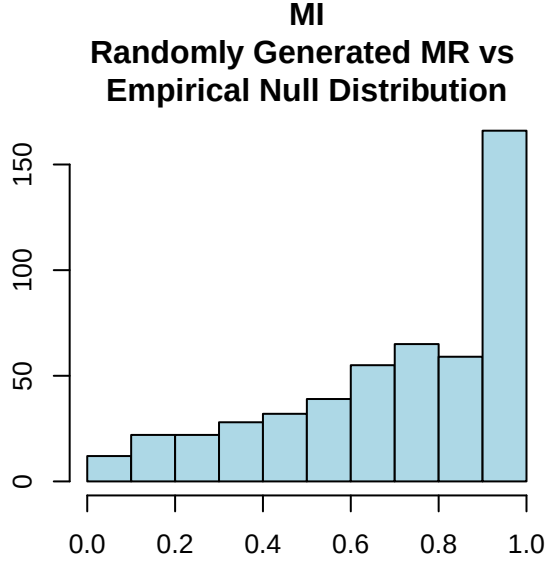

SR
Randomly Assigned MR vs
Empirical Null Distribution
0
20
60
100
140
0.0
0.2
0.4
0.6
0.8
1.0


SR
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0


SR
Randomly Generated MR vs
Randomly Assigned MR
0
100
200
300
0.2
0.4
0.6
0.8
1.0


MI
K = 500
Cumulative Probability
0.0
0.2
0.4
0.6
0.8
1.0
0
100
200
300
400
500
MR


MI
Randomly Assigned MR vs
Empirical Null Distribution
0
20
60
100
140
0.0
0.2
0.4
0.6
0.8
1.0


MI
Randomly Generated MR vs
Empirical Null Distribution
0
50
100
150
0.0
0.2
0.4
0.6
0.8
1.0

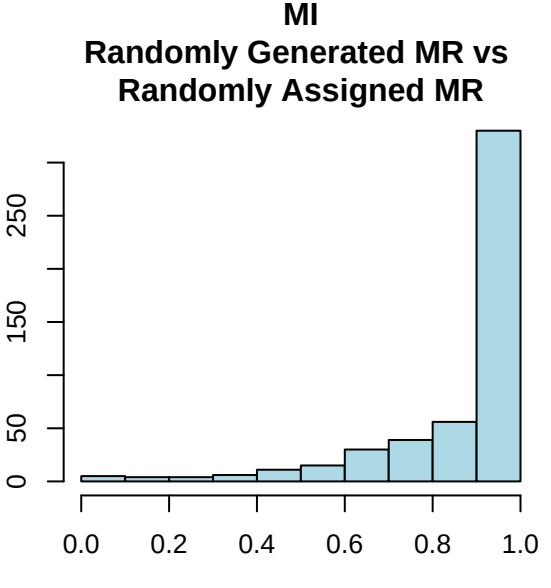

MI
Randomly Generated MR vs
Randomly Assigned MR
0
50
150
250
0.0
0.2
0.4
0.6
0.8
1.0

Figure S2. Empirical cumulative density functions of $\widetilde{\mathbf{MR}}^{\mathcal{M}}_{\mathbf{K}\times\mathbf{K}}(\boldsymbol{i},\cdot)$ versus the empirical null distribution of $\widehat{\mathbf{MR}}_{\mathbf{K}\times\mathbf{K}}$ for the nine co-expression association methods with K=50, 100, 200, 500, and 2000. K randomly generated cumulative density functions of $\widetilde{\mathrm{MR}}^{\mathcal{M}}_{\mathrm{K}\times\mathrm{K}}(i,\cdot)$ and empirical null distributions of $\widehat{\mathrm{MR}}_{\mathrm{K}\times\mathrm{K}}$ are colored by red and light blue in each plot (top-left figure), in which x-axis and y-axis represent the MR values in increasing order and the empirical cumulative probability, respectively. P values of the KS tests among the simulated $\widetilde{\mathrm{MR}}^{\mathcal{M}}_{\mathrm{K}\times\mathrm{K}}(i,\cdot)$ ($\widetilde{\mathrm{MR}}$), $\widehat{\mathrm{MR}}^{\mathcal{M}}_{\mathrm{K}\times\mathrm{K}}(i,\cdot)$ ($\widehat{\mathrm{MR}}$), and the empirical distribution of $\widehat{\mathrm{MR}}_{\mathrm{K}\times\mathrm{K}}$ (N) are shown. The number of bins used for computing the MI is five.

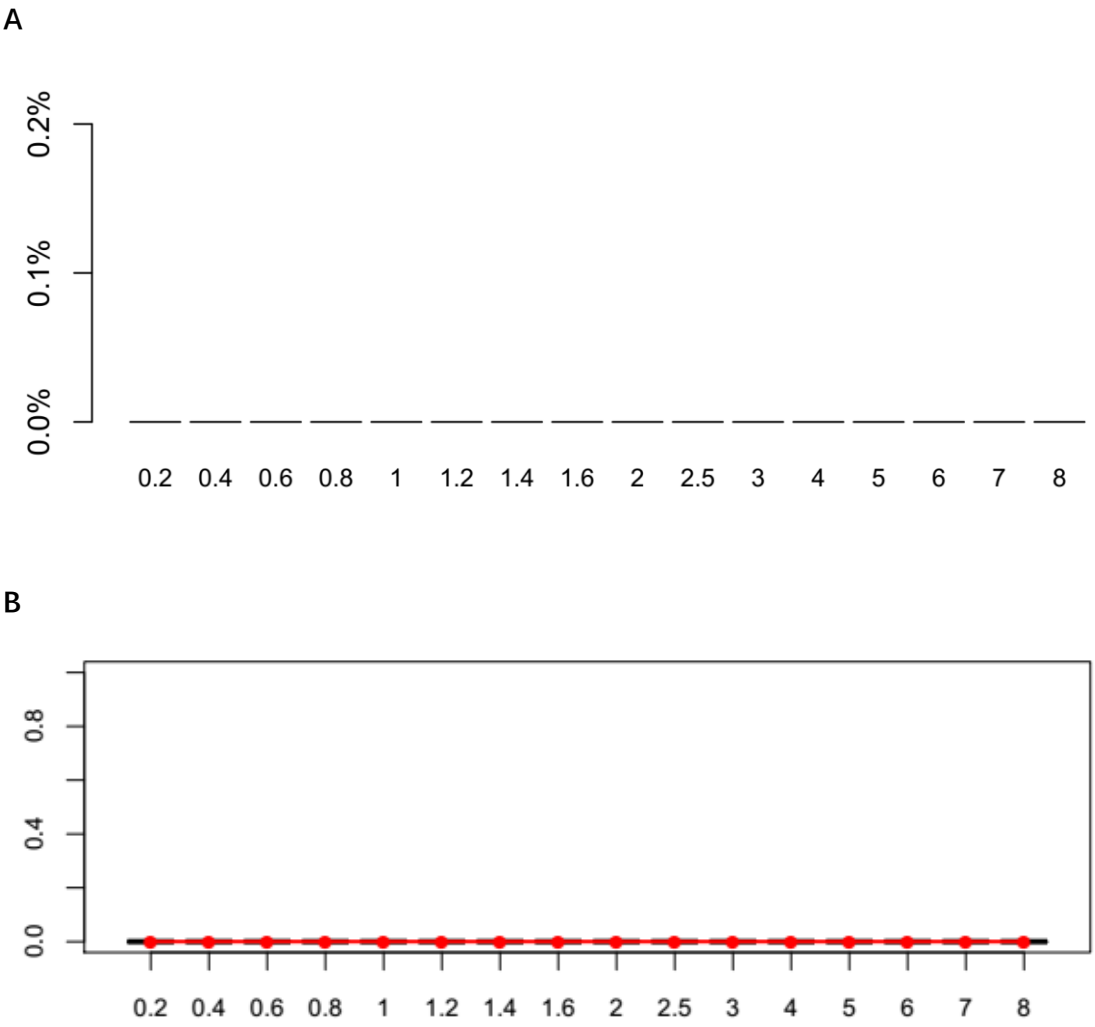


Figure S3. False discover rate of WGCNA and MRHCA on simulated data with different σ^2.

(A) False discover rate of WGCNA. (B) False discover rate of MRHCA.

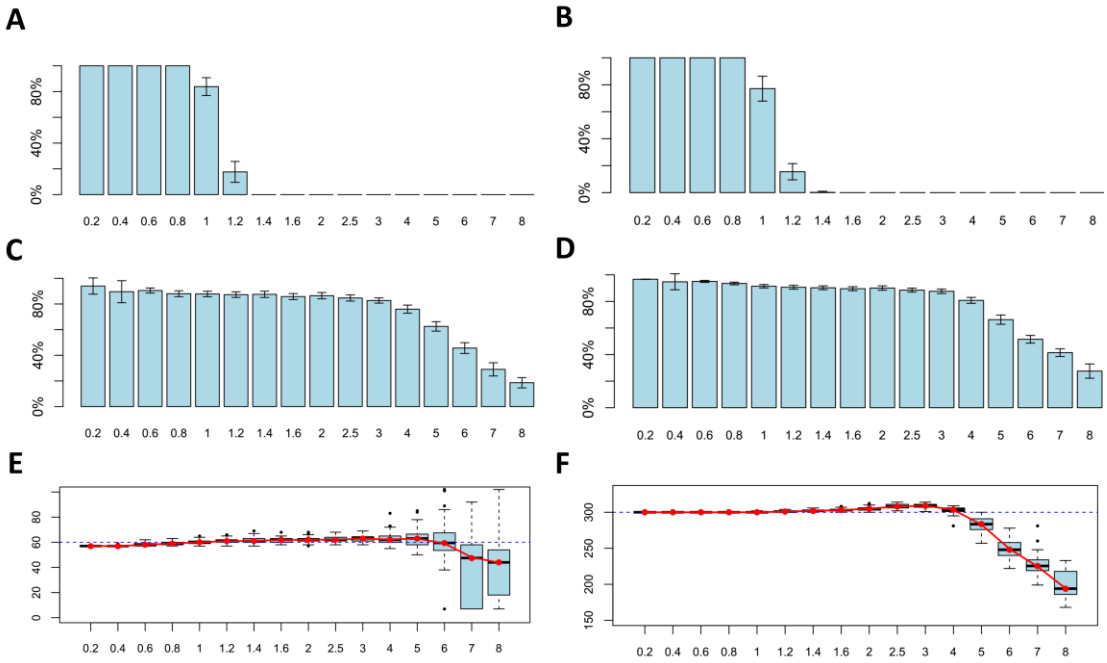
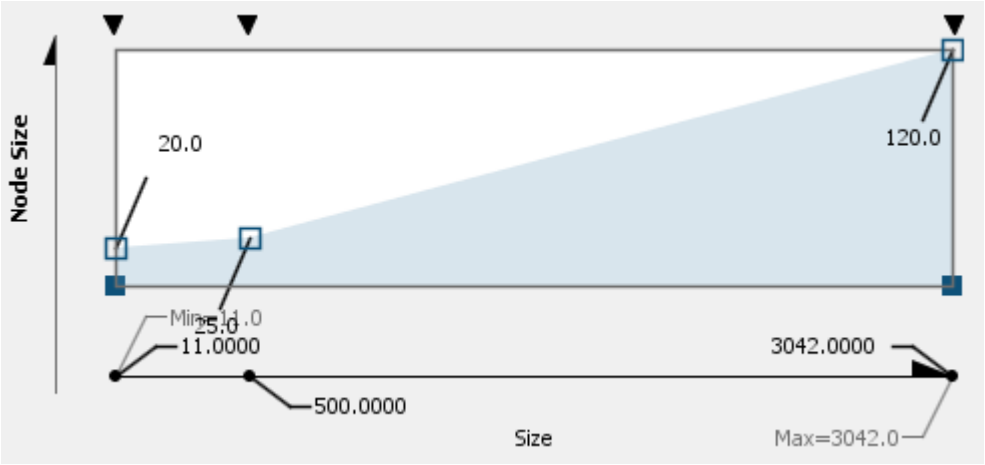


Figure S4. Statistics of the hub genes and co-expression modules identified by MRHCA in simulated data with module size of 40 (A, C, E) and 60 (B, D, F). (A-B) Jaccard Indices between the real module versus WGCNA identified modules with respect to different σ^2 (x-axis). (C-D) Jaccard Indices between the real module versus MRHCA identified modules with respect to different σ^2 (x-axis). (E-F) Average size of the module (y-axis) centered by the top significant hub in 100 rounds of simulation with different σ^2 (x-axis), when the simulated hub and co-expression module with size 40 (E) and 60 (F).

Node size (x-axis is module size):



Edge width (x-axis is MR value):

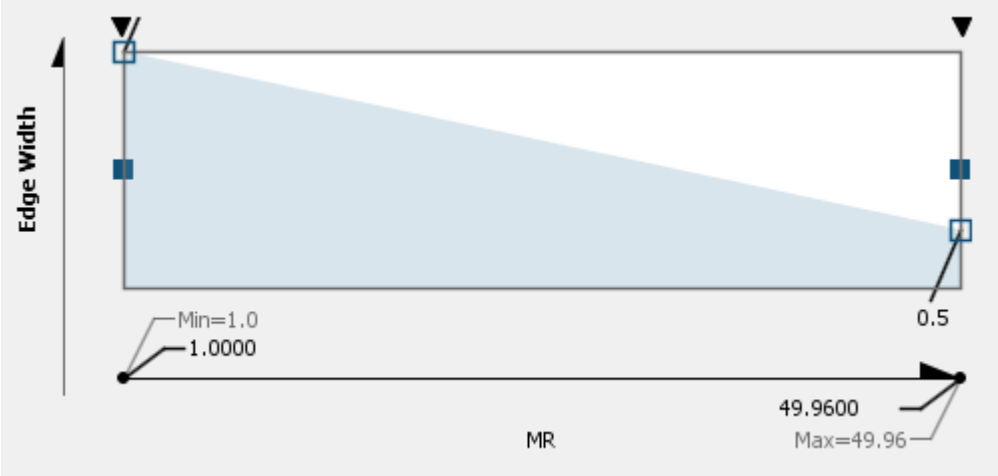


Figure S5. Cytoscape plotting parameters.