

Applications PSC-SNE

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Cases

Case 1

Sample on the $(\mathbb{S}^1)^2$ where $p = 1$ and $r = 2$.

Data:

```
# Sample on the (S^1)^2
n <- 200
vmf11 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_cir(th = 0)), kappa = 10)
vmf12 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_cir(th = pi)), kappa = 10)
x1 <- sdetorus::toPiInt(cbind(DirStats::to_rad(vmf11),
                                DirStats::to_rad(vmf12)))

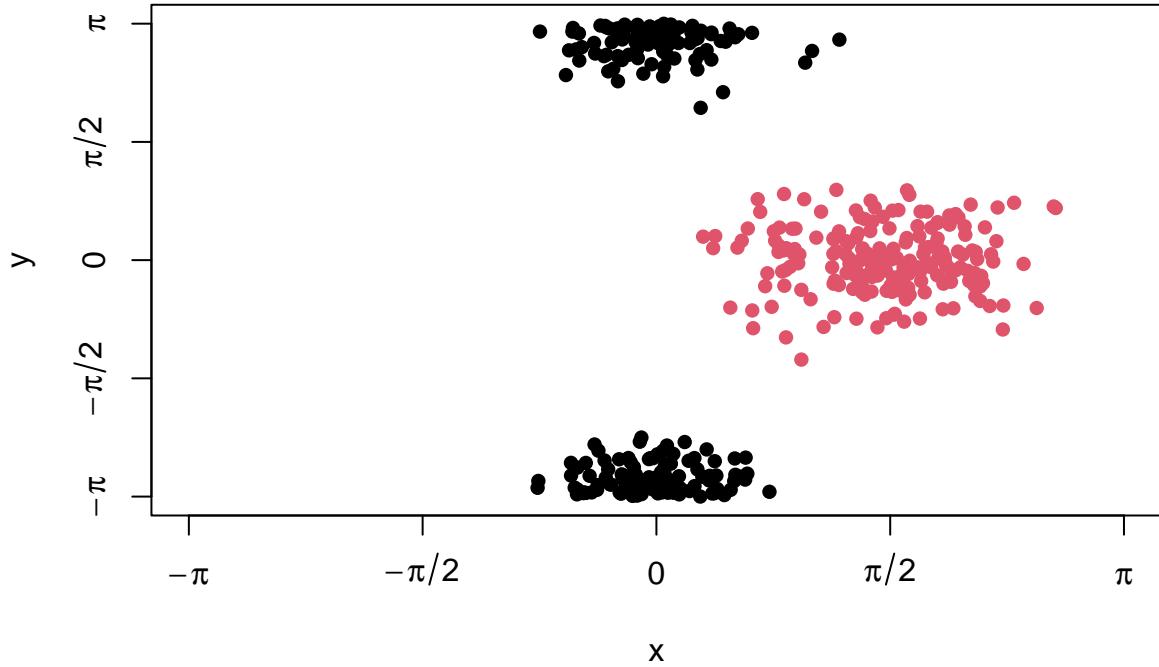
vmf21 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_cir(th = pi / 2)), kappa = 5)
vmf22 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_cir(th = 0)), kappa = 5)
x2 <- sdetorus::toPiInt(cbind(DirStats::to_rad(vmf21),DirStats::to_rad(vmf22)))

x <- rbind(x1, x2)

# Cartesian coordinates
n <- 400
x_array <- array(dim = c(n, 2, 2))
x_array[, , 1] <- DirStats::to_cir(x[, 1])
x_array[, , 2] <- DirStats::to_cir(x[, 2])

indexes <- sample(1:n)
x_array <- x_array[indexes,,]
colors <- rep(c(1, 2), each = n/2)[indexes]

plot(x, xlim = c(-pi, pi), ylim = c(-pi, pi), axes = FALSE,
      col = rep(c(1, 2), each = n/2), pch = 16,
      xlab = "x", ylab = "y")
sdetorus::torusAxis()
```



Let's calculate the rho parameters based on a perplexity of 20:

```
# Time difference of 27.58008 secs
rho_first_20 <- rho_optim_bst(x_array, 20)

## Time difference of 23.47741 secs

First, let's reduce to dimension  $\mathbb{S}^1$  then  $d = 1$  (circumference):
Y <- psc_sne(X=x_array, d=1, rho_psc_list = rho_first_20, num_iteration=500,
               colors=colors, visualize_prog = TRUE)

## It: 1; obj: 1.678e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.671e-01
## It: 2; obj: 1.607e+01; abs: 7.066e-01; rel: 4.212e-02; norm: 3.839e-01
## It: 3; obj: 1.568e+01; abs: 3.845e-01; rel: 2.393e-02; norm: 5.110e-01
## It: 4; obj: 1.549e+01; abs: 1.949e-01; rel: 1.242e-02; norm: 5.757e-01
## It: 5; obj: 1.534e+01; abs: 1.476e-01; rel: 9.530e-03; norm: 6.140e-01
## It: 6; obj: 1.520e+01; abs: 1.413e-01; rel: 9.207e-03; norm: 6.409e-01
## It: 7; obj: 1.508e+01; abs: 1.234e-01; rel: 8.118e-03; norm: 6.677e-01
## It: 8; obj: 1.498e+01; abs: 9.605e-02; rel: 6.371e-03; norm: 6.958e-01
## It: 9; obj: 1.488e+01; abs: 9.685e-02; rel: 6.465e-03; norm: 7.185e-01
## It: 10; obj: 1.481e+01; abs: 7.639e-02; rel: 5.132e-03; norm: 7.381e-01
## It: 11; obj: 1.474e+01; abs: 6.655e-02; rel: 4.494e-03; norm: 7.530e-01
## It: 12; obj: 1.468e+01; abs: 6.089e-02; rel: 4.131e-03; norm: 7.648e-01
## It: 13; obj: 1.462e+01; abs: 6.034e-02; rel: 4.110e-03; norm: 7.758e-01
## It: 14; obj: 1.456e+01; abs: 6.049e-02; rel: 4.137e-03; norm: 7.864e-01
## It: 15; obj: 1.451e+01; abs: 5.416e-02; rel: 3.720e-03; norm: 7.985e-01
## It: 16; obj: 1.446e+01; abs: 4.589e-02; rel: 3.164e-03; norm: 8.119e-01
## It: 17; obj: 1.442e+01; abs: 4.150e-02; rel: 2.870e-03; norm: 8.254e-01
## It: 18; obj: 1.438e+01; abs: 3.563e-02; rel: 2.472e-03; norm: 8.385e-01
## It: 19; obj: 1.436e+01; abs: 2.554e-02; rel: 1.776e-03; norm: 8.506e-01
## It: 20; obj: 1.434e+01; abs: 1.763e-02; rel: 1.228e-03; norm: 8.602e-01
## It: 21; obj: 1.432e+01; abs: 1.562e-02; rel: 1.089e-03; norm: 8.669e-01
## It: 22; obj: 1.431e+01; abs: 1.648e-02; rel: 1.150e-03; norm: 8.721e-01
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## It: 23; obj: 1.429e+01; abs: 1.550e-02; rel: 1.084e-03; norm: 8.768e-01
## It: 24; obj: 1.428e+01; abs: 9.864e-03; rel: 6.902e-04; norm: 8.815e-01
## It: 25; obj: 1.427e+01; abs: 8.467e-03; rel: 5.929e-04; norm: 8.859e-01
## It: 26; obj: 1.426e+01; abs: 1.300e-02; rel: 9.105e-04; norm: 8.901e-01
## It: 27; obj: 1.424e+01; abs: 2.251e-02; rel: 1.578e-03; norm: 8.946e-01
## It: 28; obj: 1.421e+01; abs: 2.666e-02; rel: 1.872e-03; norm: 8.998e-01
## It: 29; obj: 1.419e+01; abs: 1.918e-02; rel: 1.349e-03; norm: 9.062e-01
## It: 30; obj: 1.418e+01; abs: 1.369e-02; rel: 9.644e-04; norm: 9.133e-01
## It: 31; obj: 1.417e+01; abs: 1.069e-02; rel: 7.537e-04; norm: 9.210e-01
## It: 32; obj: 1.416e+01; abs: 5.229e-03; rel: 3.691e-04; norm: 9.299e-01
## It: 33; obj: 1.416e+01; abs: 4.817e-03; rel: 3.401e-04; norm: 9.389e-01
## It: 34; obj: 1.415e+01; abs: 4.129e-03; rel: 2.916e-04; norm: 9.482e-01
## It: 35; obj: 1.415e+01; abs: 4.330e-03; rel: 3.059e-04; norm: 9.582e-01
## It: 36; obj: 1.414e+01; abs: 7.200e-03; rel: 5.089e-04; norm: 9.682e-01
## It: 37; obj: 1.413e+01; abs: 1.010e-02; rel: 7.142e-04; norm: 9.789e-01
## It: 38; obj: 1.412e+01; abs: 9.697e-03; rel: 6.862e-04; norm: 9.900e-01
## It: 39; obj: 1.411e+01; abs: 9.434e-03; rel: 6.681e-04; norm: 1.000e+00
## It: 40; obj: 1.410e+01; abs: 1.070e-02; rel: 7.579e-04; norm: 1.010e+00
## It: 41; obj: 1.409e+01; abs: 1.205e-02; rel: 8.544e-04; norm: 1.020e+00
## It: 42; obj: 1.408e+01; abs: 1.209e-02; rel: 8.577e-04; norm: 1.029e+00
## It: 43; obj: 1.407e+01; abs: 9.967e-03; rel: 7.080e-04; norm: 1.038e+00
## It: 44; obj: 1.406e+01; abs: 6.820e-03; rel: 4.848e-04; norm: 1.047e+00
## It: 45; obj: 1.406e+01; abs: 3.923e-03; rel: 2.790e-04; norm: 1.055e+00
## It: 46; obj: 1.405e+01; abs: 1.908e-03; rel: 1.357e-04; norm: 1.062e+00
## It: 47; obj: 1.405e+01; abs: 8.852e-04; rel: 6.298e-05; norm: 1.069e+00
## It: 48; obj: 1.405e+01; abs: 5.139e-04; rel: 3.657e-05; norm: 1.075e+00
## It: 49; obj: 1.405e+01; abs: 4.021e-04; rel: 2.861e-05; norm: 1.080e+00
## It: 50; obj: 1.405e+01; abs: 3.103e-04; rel: 2.208e-05; norm: 1.085e+00
## It: 51; obj: 1.405e+01; abs: 1.554e-04; rel: 1.106e-05; norm: 1.089e+00
## It: 52; obj: 1.405e+01; abs: 3.865e-05; rel: 2.750e-06; norm: 1.093e+00
## It: 53; obj: 1.405e+01; abs: 2.114e-04; rel: 1.504e-05; norm: 1.096e+00
## It: 54; obj: 1.405e+01; abs: 3.169e-04; rel: 2.255e-05; norm: 1.099e+00
## It: 55; obj: 1.405e+01; abs: 3.377e-04; rel: 2.403e-05; norm: 1.101e+00
## It: 56; obj: 1.405e+01; abs: 2.766e-04; rel: 1.968e-05; norm: 1.103e+00
## It: 57; obj: 1.405e+01; abs: 1.451e-04; rel: 1.033e-05; norm: 1.104e+00
## It: 58; obj: 1.405e+01; abs: 4.715e-05; rel: 3.355e-06; norm: 1.105e+00
## It: 59; obj: 1.405e+01; abs: 2.997e-04; rel: 2.132e-05; norm: 1.106e+00
## It: 60; obj: 1.405e+01; abs: 6.254e-04; rel: 4.450e-05; norm: 1.107e+00
## It: 61; obj: 1.405e+01; abs: 1.055e-03; rel: 7.506e-05; norm: 1.108e+00
## It: 62; obj: 1.405e+01; abs: 1.640e-03; rel: 1.167e-04; norm: 1.109e+00
## It: 63; obj: 1.405e+01; abs: 2.459e-03; rel: 1.750e-04; norm: 1.109e+00
## It: 64; obj: 1.404e+01; abs: 3.614e-03; rel: 2.573e-04; norm: 1.110e+00
## It: 65; obj: 1.404e+01; abs: 5.198e-03; rel: 3.701e-04; norm: 1.110e+00
## It: 66; obj: 1.403e+01; abs: 7.210e-03; rel: 5.136e-04; norm: 1.111e+00
## It: 67; obj: 1.402e+01; abs: 9.420e-03; rel: 6.713e-04; norm: 1.111e+00
## It: 68; obj: 1.401e+01; abs: 1.137e-02; rel: 8.107e-04; norm: 1.112e+00
## It: 69; obj: 1.400e+01; abs: 1.268e-02; rel: 9.053e-04; norm: 1.112e+00
## It: 70; obj: 1.398e+01; abs: 1.344e-02; rel: 9.604e-04; norm: 1.113e+00
## It: 71; obj: 1.397e+01; abs: 1.401e-02; rel: 1.002e-03; norm: 1.113e+00
## It: 72; obj: 1.396e+01; abs: 1.442e-02; rel: 1.032e-03; norm: 1.113e+00
## It: 73; obj: 1.394e+01; abs: 1.424e-02; rel: 1.020e-03; norm: 1.114e+00
## It: 74; obj: 1.393e+01; abs: 1.360e-02; rel: 9.752e-04; norm: 1.114e+00
## It: 75; obj: 1.392e+01; abs: 1.312e-02; rel: 9.416e-04; norm: 1.114e+00

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## It: 76; obj: 1.390e+01; abs: 1.320e-02; rel: 9.486e-04; norm: 1.115e+00
## It: 77; obj: 1.389e+01; abs: 1.388e-02; rel: 9.981e-04; norm: 1.116e+00
## It: 78; obj: 1.387e+01; abs: 1.473e-02; rel: 1.061e-03; norm: 1.117e+00
## It: 79; obj: 1.386e+01; abs: 1.507e-02; rel: 1.086e-03; norm: 1.119e+00
## It: 80; obj: 1.384e+01; abs: 1.415e-02; rel: 1.021e-03; norm: 1.121e+00
## It: 81; obj: 1.383e+01; abs: 1.172e-02; rel: 8.469e-04; norm: 1.122e+00
## It: 82; obj: 1.382e+01; abs: 8.497e-03; rel: 6.143e-04; norm: 1.124e+00
## It: 83; obj: 1.382e+01; abs: 5.390e-03; rel: 3.899e-04; norm: 1.126e+00
## It: 84; obj: 1.382e+01; abs: 2.782e-03; rel: 2.013e-04; norm: 1.128e+00
## It: 85; obj: 1.382e+01; abs: 6.664e-04; rel: 4.824e-05; norm: 1.131e+00
## It: 86; obj: 1.382e+01; abs: 1.059e-03; rel: 7.665e-05; norm: 1.133e+00
## It: 87; obj: 1.382e+01; abs: 2.491e-03; rel: 1.803e-04; norm: 1.135e+00
## It: 88; obj: 1.382e+01; abs: 3.697e-03; rel: 2.676e-04; norm: 1.138e+00
## It: 89; obj: 1.383e+01; abs: 4.721e-03; rel: 3.415e-04; norm: 1.141e+00
## It: 90; obj: 1.383e+01; abs: 5.586e-03; rel: 4.040e-04; norm: 1.143e+00
## It: 91; obj: 1.384e+01; abs: 6.306e-03; rel: 4.559e-04; norm: 1.146e+00
## It: 92; obj: 1.385e+01; abs: 6.891e-03; rel: 4.979e-04; norm: 1.149e+00
## It: 93; obj: 1.385e+01; abs: 7.346e-03; rel: 5.305e-04; norm: 1.151e+00
## It: 94; obj: 1.386e+01; abs: 7.679e-03; rel: 5.543e-04; norm: 1.154e+00
## It: 95; obj: 1.387e+01; abs: 7.901e-03; rel: 5.700e-04; norm: 1.156e+00
## It: 96; obj: 1.388e+01; abs: 8.023e-03; rel: 5.785e-04; norm: 1.159e+00
## It: 97; obj: 1.389e+01; abs: 8.058e-03; rel: 5.806e-04; norm: 1.161e+00
## It: 98; obj: 1.389e+01; abs: 8.019e-03; rel: 5.775e-04; norm: 1.163e+00
## It: 99; obj: 1.390e+01; abs: 7.918e-03; rel: 5.699e-04; norm: 1.165e+00
## It: 100; obj: 1.391e+01; abs: 7.768e-03; rel: 5.588e-04; norm: 1.167e+00

## It: 101; obj: 2.038e+00; abs: 1.187e+01; rel: 8.535e-01; norm: 1.219e-01
## It: 102; obj: 2.005e+00; abs: 3.235e-02; rel: 1.587e-02; norm: 1.253e-01
## It: 103; obj: 1.991e+00; abs: 1.481e-02; rel: 7.385e-03; norm: 1.285e-01
## It: 104; obj: 1.985e+00; abs: 5.521e-03; rel: 2.773e-03; norm: 1.302e-01
## It: 105; obj: 1.983e+00; abs: 1.726e-03; rel: 8.695e-04; norm: 1.309e-01
## It: 106; obj: 1.982e+00; abs: 8.205e-04; rel: 4.137e-04; norm: 1.312e-01
## It: 107; obj: 1.982e+00; abs: 4.642e-04; rel: 2.342e-04; norm: 1.313e-01
## It: 108; obj: 1.982e+00; abs: 1.790e-04; rel: 9.031e-05; norm: 1.314e-01
## It: 109; obj: 1.982e+00; abs: 2.957e-04; rel: 1.492e-04; norm: 1.314e-01
## It: 110; obj: 1.982e+00; abs: 2.557e-04; rel: 1.290e-04; norm: 1.314e-01
## It: 111; obj: 1.982e+00; abs: 3.398e-04; rel: 1.715e-04; norm: 1.314e-01
## It: 112; obj: 1.982e+00; abs: 1.881e-04; rel: 9.493e-05; norm: 1.314e-01
## It: 113; obj: 1.982e+00; abs: 1.655e-04; rel: 8.353e-05; norm: 1.314e-01
## It: 114; obj: 1.982e+00; abs: 4.488e-04; rel: 2.265e-04; norm: 1.315e-01
## It: 115; obj: 1.982e+00; abs: 3.357e-04; rel: 1.694e-04; norm: 1.315e-01
## It: 116; obj: 1.982e+00; abs: 2.416e-04; rel: 1.219e-04; norm: 1.315e-01
## It: 117; obj: 1.982e+00; abs: 5.370e-04; rel: 2.710e-04; norm: 1.315e-01
## It: 118; obj: 1.982e+00; abs: 3.901e-04; rel: 1.968e-04; norm: 1.314e-01
## It: 119; obj: 1.982e+00; abs: 6.448e-05; rel: 3.254e-05; norm: 1.315e-01
## It: 120; obj: 1.982e+00; abs: 5.095e-04; rel: 2.571e-04; norm: 1.315e-01
## It: 121; obj: 1.982e+00; abs: 4.018e-04; rel: 2.027e-04; norm: 1.315e-01
## It: 122; obj: 1.981e+00; abs: 2.735e-04; rel: 1.380e-04; norm: 1.315e-01
## It: 123; obj: 1.982e+00; abs: 6.319e-04; rel: 3.189e-04; norm: 1.315e-01
## It: 124; obj: 1.981e+00; abs: 5.947e-04; rel: 3.001e-04; norm: 1.314e-01
## It: 125; obj: 1.982e+00; abs: 7.322e-05; rel: 3.695e-05; norm: 1.315e-01

## It: 126; obj: 1.982e+00; abs: 5.195e-04; rel: 2.622e-04; norm: 1.316e-01
## It: 127; obj: 1.982e+00; abs: 3.629e-04; rel: 1.831e-04; norm: 1.315e-01
## It: 128; obj: 1.981e+00; abs: 3.497e-04; rel: 1.765e-04; norm: 1.315e-01

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## It: 129; obj: 1.982e+00; abs: 6.732e-04; rel: 3.398e-04; norm: 1.315e-01
## It: 130; obj: 1.981e+00; abs: 6.310e-04; rel: 3.184e-04; norm: 1.315e-01
## It: 131; obj: 1.981e+00; abs: 1.099e-04; rel: 5.546e-05; norm: 1.315e-01
## It: 132; obj: 1.982e+00; abs: 5.784e-04; rel: 2.919e-04; norm: 1.316e-01
## It: 133; obj: 1.982e+00; abs: 3.318e-04; rel: 1.674e-04; norm: 1.316e-01
## It: 134; obj: 1.981e+00; abs: 4.357e-04; rel: 2.199e-04; norm: 1.316e-01
## It: 135; obj: 1.982e+00; abs: 7.171e-04; rel: 3.619e-04; norm: 1.315e-01
## It: 136; obj: 1.981e+00; abs: 5.691e-04; rel: 2.872e-04; norm: 1.315e-01
## It: 137; obj: 1.982e+00; abs: 4.845e-05; rel: 2.445e-05; norm: 1.315e-01
## It: 138; obj: 1.982e+00; abs: 6.861e-04; rel: 3.463e-04; norm: 1.316e-01
## It: 139; obj: 1.982e+00; abs: 4.061e-04; rel: 2.049e-04; norm: 1.316e-01
## It: 140; obj: 1.981e+00; abs: 4.870e-04; rel: 2.457e-04; norm: 1.316e-01
## It: 141; obj: 1.982e+00; abs: 7.479e-04; rel: 3.775e-04; norm: 1.315e-01
## It: 142; obj: 1.981e+00; abs: 5.760e-04; rel: 2.906e-04; norm: 1.315e-01
## It: 143; obj: 1.982e+00; abs: 4.361e-05; rel: 2.201e-05; norm: 1.315e-01
## It: 144; obj: 1.982e+00; abs: 7.255e-04; rel: 3.661e-04; norm: 1.316e-01
## It: 145; obj: 1.982e+00; abs: 4.386e-04; rel: 2.213e-04; norm: 1.315e-01
## It: 146; obj: 1.981e+00; abs: 5.054e-04; rel: 2.550e-04; norm: 1.315e-01
## It: 147; obj: 1.982e+00; abs: 7.629e-04; rel: 3.850e-04; norm: 1.315e-01
## It: 148; obj: 1.981e+00; abs: 5.889e-04; rel: 2.971e-04; norm: 1.315e-01
## It: 149; obj: 1.982e+00; abs: 4.836e-05; rel: 2.440e-05; norm: 1.315e-01
## It: 150; obj: 1.982e+00; abs: 7.438e-04; rel: 3.754e-04; norm: 1.315e-01

## It: 151; obj: 1.982e+00; abs: 4.490e-04; rel: 2.265e-04; norm: 1.315e-01
## It: 152; obj: 1.981e+00; abs: 5.159e-04; rel: 2.603e-04; norm: 1.315e-01
## It: 153; obj: 1.982e+00; abs: 7.711e-04; rel: 3.892e-04; norm: 1.315e-01
## It: 154; obj: 1.981e+00; abs: 5.870e-04; rel: 2.962e-04; norm: 1.314e-01
## It: 155; obj: 1.982e+00; abs: 4.252e-05; rel: 2.146e-05; norm: 1.315e-01
## It: 156; obj: 1.982e+00; abs: 7.557e-04; rel: 3.814e-04; norm: 1.315e-01
## It: 157; obj: 1.982e+00; abs: 4.631e-04; rel: 2.336e-04; norm: 1.315e-01
## It: 158; obj: 1.981e+00; abs: 5.199e-04; rel: 2.624e-04; norm: 1.315e-01
## It: 159; obj: 1.982e+00; abs: 7.751e-04; rel: 3.912e-04; norm: 1.315e-01
## It: 160; obj: 1.981e+00; abs: 5.972e-04; rel: 3.013e-04; norm: 1.314e-01
## It: 161; obj: 1.982e+00; abs: 4.924e-05; rel: 2.485e-05; norm: 1.315e-01
## It: 162; obj: 1.982e+00; abs: 7.598e-04; rel: 3.834e-04; norm: 1.315e-01
## It: 163; obj: 1.982e+00; abs: 4.608e-04; rel: 2.325e-04; norm: 1.315e-01
## It: 164; obj: 1.981e+00; abs: 5.240e-04; rel: 2.644e-04; norm: 1.315e-01
## It: 165; obj: 1.982e+00; abs: 7.778e-04; rel: 3.926e-04; norm: 1.315e-01
## It: 166; obj: 1.981e+00; abs: 5.896e-04; rel: 2.974e-04; norm: 1.314e-01
## It: 167; obj: 1.982e+00; abs: 4.088e-05; rel: 2.063e-05; norm: 1.315e-01
## It: 168; obj: 1.982e+00; abs: 7.647e-04; rel: 3.859e-04; norm: 1.315e-01
## It: 169; obj: 1.982e+00; abs: 4.717e-04; rel: 2.379e-04; norm: 1.315e-01
## It: 170; obj: 1.981e+00; abs: 5.239e-04; rel: 2.644e-04; norm: 1.315e-01
## It: 171; obj: 1.982e+00; abs: 7.786e-04; rel: 3.930e-04; norm: 1.315e-01
## It: 172; obj: 1.981e+00; abs: 6.018e-04; rel: 3.036e-04; norm: 1.314e-01
## It: 173; obj: 1.982e+00; abs: 5.119e-05; rel: 2.583e-05; norm: 1.315e-01
## It: 174; obj: 1.982e+00; abs: 7.642e-04; rel: 3.856e-04; norm: 1.315e-01
## It: 175; obj: 1.982e+00; abs: 4.626e-04; rel: 2.334e-04; norm: 1.315e-01

## It: 176; obj: 1.981e+00; abs: 5.268e-04; rel: 2.658e-04; norm: 1.315e-01
## It: 177; obj: 1.982e+00; abs: 7.799e-04; rel: 3.936e-04; norm: 1.315e-01
## It: 178; obj: 1.981e+00; abs: 5.882e-04; rel: 2.967e-04; norm: 1.314e-01
## It: 179; obj: 1.982e+00; abs: 3.838e-05; rel: 1.937e-05; norm: 1.315e-01
## It: 180; obj: 1.982e+00; abs: 7.677e-04; rel: 3.875e-04; norm: 1.315e-01
## It: 181; obj: 1.982e+00; abs: 4.762e-04; rel: 2.403e-04; norm: 1.315e-01

```

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## It: 182; obj: 1.981e+00; abs: 5.247e-04; rel: 2.648e-04; norm: 1.315e-01
## It: 183; obj: 1.982e+00; abs: 7.795e-04; rel: 3.934e-04; norm: 1.315e-01
## It: 184; obj: 1.981e+00; abs: 6.061e-04; rel: 3.058e-04; norm: 1.314e-01
## It: 185; obj: 1.982e+00; abs: 5.442e-05; rel: 2.747e-05; norm: 1.314e-01
## It: 186; obj: 1.982e+00; abs: 7.648e-04; rel: 3.860e-04; norm: 1.315e-01
## It: 187; obj: 1.982e+00; abs: 4.605e-04; rel: 2.323e-04; norm: 1.315e-01
## It: 188; obj: 1.981e+00; abs: 5.282e-04; rel: 2.665e-04; norm: 1.315e-01
## It: 189; obj: 1.982e+00; abs: 7.807e-04; rel: 3.940e-04; norm: 1.315e-01
## It: 190; obj: 1.981e+00; abs: 5.842e-04; rel: 2.947e-04; norm: 1.314e-01
## It: 191; obj: 1.982e+00; abs: 3.444e-05; rel: 1.738e-05; norm: 1.314e-01
## It: 192; obj: 1.982e+00; abs: 7.692e-04; rel: 3.882e-04; norm: 1.315e-01
## It: 193; obj: 1.982e+00; abs: 4.808e-04; rel: 2.425e-04; norm: 1.315e-01
## It: 194; obj: 1.981e+00; abs: 5.242e-04; rel: 2.645e-04; norm: 1.315e-01
## It: 195; obj: 1.982e+00; abs: 7.795e-04; rel: 3.934e-04; norm: 1.315e-01
## It: 196; obj: 1.981e+00; abs: 6.119e-04; rel: 3.087e-04; norm: 1.314e-01
## It: 197; obj: 1.982e+00; abs: 5.954e-05; rel: 3.005e-05; norm: 1.314e-01
## It: 198; obj: 1.982e+00; abs: 7.639e-04; rel: 3.855e-04; norm: 1.315e-01
## It: 199; obj: 1.982e+00; abs: 4.556e-04; rel: 2.298e-04; norm: 1.315e-01
## It: 200; obj: 1.981e+00; abs: 5.293e-04; rel: 2.671e-04; norm: 1.315e-01

## It: 201; obj: 1.982e+00; abs: 7.811e-04; rel: 3.942e-04; norm: 1.315e-01
## It: 202; obj: 1.982e+00; abs: 5.773e-04; rel: 2.913e-04; norm: 1.314e-01
## It: 203; obj: 1.982e+00; abs: 2.825e-05; rel: 1.425e-05; norm: 1.314e-01
## It: 204; obj: 1.982e+00; abs: 7.702e-04; rel: 3.887e-04; norm: 1.315e-01
## It: 205; obj: 1.982e+00; abs: 4.870e-04; rel: 2.457e-04; norm: 1.315e-01
## It: 206; obj: 1.981e+00; abs: 5.229e-04; rel: 2.639e-04; norm: 1.315e-01
## It: 207; obj: 1.982e+00; abs: 7.790e-04; rel: 3.932e-04; norm: 1.315e-01
## It: 208; obj: 1.981e+00; abs: 6.205e-04; rel: 3.130e-04; norm: 1.314e-01
## It: 209; obj: 1.982e+00; abs: 6.754e-05; rel: 3.409e-05; norm: 1.314e-01
## It: 210; obj: 1.982e+00; abs: 7.616e-04; rel: 3.843e-04; norm: 1.315e-01
## It: 211; obj: 1.982e+00; abs: 4.473e-04; rel: 2.257e-04; norm: 1.315e-01
## It: 212; obj: 1.981e+00; abs: 5.307e-04; rel: 2.678e-04; norm: 1.315e-01
## It: 213; obj: 1.982e+00; abs: 7.814e-04; rel: 3.944e-04; norm: 1.315e-01
## It: 214; obj: 1.982e+00; abs: 5.663e-04; rel: 2.857e-04; norm: 1.314e-01
## It: 215; obj: 1.982e+00; abs: 1.867e-05; rel: 9.420e-06; norm: 1.314e-01
## It: 216; obj: 1.982e+00; abs: 7.711e-04; rel: 3.892e-04; norm: 1.315e-01
## It: 217; obj: 1.982e+00; abs: 4.962e-04; rel: 2.503e-04; norm: 1.315e-01
## It: 218; obj: 1.981e+00; abs: 5.206e-04; rel: 2.627e-04; norm: 1.315e-01
## It: 219; obj: 1.982e+00; abs: 7.779e-04; rel: 3.926e-04; norm: 1.314e-01
## It: 220; obj: 1.981e+00; abs: 6.334e-04; rel: 3.196e-04; norm: 1.314e-01
## It: 221; obj: 1.982e+00; abs: 7.994e-05; rel: 4.035e-05; norm: 1.314e-01
## It: 222; obj: 1.982e+00; abs: 7.570e-04; rel: 3.820e-04; norm: 1.315e-01
## It: 223; obj: 1.982e+00; abs: 4.341e-04; rel: 2.190e-04; norm: 1.315e-01
## It: 224; obj: 1.981e+00; abs: 5.325e-04; rel: 2.687e-04; norm: 1.315e-01
## It: 225; obj: 1.982e+00; abs: 7.814e-04; rel: 3.944e-04; norm: 1.315e-01

## It: 226; obj: 1.982e+00; abs: 5.494e-04; rel: 2.772e-04; norm: 1.314e-01
## It: 227; obj: 1.982e+00; abs: 4.206e-06; rel: 2.123e-06; norm: 1.314e-01
## It: 228; obj: 1.982e+00; abs: 7.715e-04; rel: 3.894e-04; norm: 1.315e-01
## It: 229; obj: 1.982e+00; abs: 5.095e-04; rel: 2.570e-04; norm: 1.315e-01
## It: 230; obj: 1.981e+00; abs: 5.168e-04; rel: 2.608e-04; norm: 1.315e-01
## It: 231; obj: 1.982e+00; abs: 7.757e-04; rel: 3.915e-04; norm: 1.314e-01
## It: 232; obj: 1.981e+00; abs: 6.522e-04; rel: 3.291e-04; norm: 1.314e-01
## It: 233; obj: 1.982e+00; abs: 9.872e-05; rel: 4.982e-05; norm: 1.314e-01
## It: 234; obj: 1.982e+00; abs: 7.481e-04; rel: 3.775e-04; norm: 1.315e-01

```

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## It: 235; obj: 1.982e+00; abs: 4.132e-04; rel: 2.085e-04; norm: 1.315e-01
## It: 236; obj: 1.981e+00; abs: 5.344e-04; rel: 2.697e-04; norm: 1.315e-01
## It: 237; obj: 1.982e+00; abs: 7.810e-04; rel: 3.942e-04; norm: 1.315e-01
## It: 238; obj: 1.982e+00; abs: 5.244e-04; rel: 2.645e-04; norm: 1.314e-01
## It: 239; obj: 1.982e+00; abs: 1.649e-05; rel: 8.322e-06; norm: 1.314e-01
## It: 240; obj: 1.982e+00; abs: 7.703e-04; rel: 3.887e-04; norm: 1.315e-01
## It: 241; obj: 1.982e+00; abs: 5.277e-04; rel: 2.662e-04; norm: 1.315e-01
## It: 242; obj: 1.981e+00; abs: 5.107e-04; rel: 2.577e-04; norm: 1.315e-01
## It: 243; obj: 1.982e+00; abs: 7.716e-04; rel: 3.894e-04; norm: 1.314e-01
## It: 244; obj: 1.981e+00; abs: 6.773e-04; rel: 3.417e-04; norm: 1.314e-01
## It: 245; obj: 1.982e+00; abs: 1.255e-04; rel: 6.332e-05; norm: 1.314e-01
## It: 246; obj: 1.982e+00; abs: 7.310e-04; rel: 3.689e-04; norm: 1.315e-01
## It: 247; obj: 1.982e+00; abs: 3.824e-04; rel: 1.929e-04; norm: 1.315e-01
## It: 248; obj: 1.981e+00; abs: 5.606e-04; rel: 2.828e-04; norm: 1.315e-01
## It: 249; obj: 1.982e+00; abs: 9.958e-04; rel: 5.026e-04; norm: 1.314e-01
## It: 250; obj: 1.984e+00; abs: 1.264e-03; rel: 6.379e-04; norm: 1.314e-01
## It: 251; obj: 1.985e+00; abs: 1.931e-03; rel: 9.736e-04; norm: 1.315e-01
## It: 252; obj: 1.982e+00; abs: 3.438e-03; rel: 1.732e-03; norm: 1.314e-01
## It: 253; obj: 1.981e+00; abs: 6.664e-04; rel: 3.362e-04; norm: 1.315e-01
## It: 254; obj: 1.982e+00; abs: 8.577e-04; rel: 4.329e-04; norm: 1.315e-01
## It: 255; obj: 1.983e+00; abs: 1.213e-03; rel: 6.120e-04; norm: 1.314e-01
## It: 256; obj: 1.985e+00; abs: 1.771e-03; rel: 8.930e-04; norm: 1.315e-01
## It: 257; obj: 1.982e+00; abs: 2.945e-03; rel: 1.483e-03; norm: 1.314e-01
## It: 258; obj: 1.981e+00; abs: 9.001e-04; rel: 4.541e-04; norm: 1.315e-01
## It: 259; obj: 1.982e+00; abs: 8.012e-04; rel: 4.044e-04; norm: 1.315e-01
## It: 260; obj: 1.983e+00; abs: 1.195e-03; rel: 6.026e-04; norm: 1.314e-01
## It: 261; obj: 1.985e+00; abs: 1.671e-03; rel: 8.423e-04; norm: 1.315e-01
## It: 262; obj: 1.982e+00; abs: 2.559e-03; rel: 1.289e-03; norm: 1.314e-01
## It: 263; obj: 1.981e+00; abs: 1.123e-03; rel: 5.663e-04; norm: 1.315e-01
## It: 264; obj: 1.982e+00; abs: 7.629e-04; rel: 3.851e-04; norm: 1.314e-01
## It: 265; obj: 1.983e+00; abs: 1.162e-03; rel: 5.864e-04; norm: 1.314e-01
## It: 266; obj: 1.985e+00; abs: 1.561e-03; rel: 7.872e-04; norm: 1.315e-01
## It: 267; obj: 1.983e+00; abs: 2.146e-03; rel: 1.081e-03; norm: 1.314e-01
## It: 268; obj: 1.981e+00; abs: 1.370e-03; rel: 6.912e-04; norm: 1.315e-01
## It: 269; obj: 1.982e+00; abs: 7.344e-04; rel: 3.707e-04; norm: 1.314e-01
## It: 270; obj: 1.983e+00; abs: 1.074e-03; rel: 5.421e-04; norm: 1.314e-01
## It: 271; obj: 1.984e+00; abs: 1.351e-03; rel: 6.812e-04; norm: 1.315e-01
## It: 272; obj: 1.983e+00; abs: 1.520e-03; rel: 7.659e-04; norm: 1.314e-01
## It: 273; obj: 1.981e+00; abs: 1.675e-03; rel: 8.446e-04; norm: 1.315e-01
## It: 274; obj: 1.982e+00; abs: 7.011e-04; rel: 3.539e-04; norm: 1.314e-01
## It: 275; obj: 1.983e+00; abs: 6.362e-04; rel: 3.210e-04; norm: 1.314e-01
## It: 276; obj: 1.983e+00; abs: 2.374e-04; rel: 1.198e-04; norm: 1.314e-01
## It: 277; obj: 1.983e+00; abs: 6.784e-05; rel: 3.421e-05; norm: 1.315e-01
## It: 278; obj: 1.981e+00; abs: 1.502e-03; rel: 7.573e-04; norm: 1.315e-01
## It: 279; obj: 1.982e+00; abs: 7.347e-04; rel: 3.708e-04; norm: 1.314e-01
## It: 280; obj: 1.983e+00; abs: 7.816e-04; rel: 3.944e-04; norm: 1.314e-01
## It: 281; obj: 1.983e+00; abs: 6.577e-04; rel: 3.317e-04; norm: 1.314e-01
## It: 282; obj: 1.983e+00; abs: 5.550e-04; rel: 2.798e-04; norm: 1.315e-01
## It: 283; obj: 1.981e+00; abs: 1.618e-03; rel: 8.161e-04; norm: 1.315e-01
## It: 284; obj: 1.982e+00; abs: 7.163e-04; rel: 3.615e-04; norm: 1.314e-01
## It: 285; obj: 1.982e+00; abs: 3.142e-04; rel: 1.585e-04; norm: 1.314e-01
## It: 286; obj: 1.982e+00; abs: 2.955e-04; rel: 1.491e-04; norm: 1.314e-01
## It: 287; obj: 1.983e+00; abs: 6.347e-04; rel: 3.202e-04; norm: 1.315e-01

```

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## It: 288; obj: 1.982e+00; abs: 1.158e-03; rel: 5.839e-04; norm: 1.315e-01
## It: 289; obj: 1.982e+00; abs: 3.480e-04; rel: 1.756e-04; norm: 1.314e-01
## It: 290; obj: 1.983e+00; abs: 1.097e-03; rel: 5.533e-04; norm: 1.314e-01
## It: 291; obj: 1.984e+00; abs: 1.498e-03; rel: 7.555e-04; norm: 1.314e-01
## It: 292; obj: 1.983e+00; abs: 1.286e-03; rel: 6.481e-04; norm: 1.314e-01
## It: 293; obj: 1.981e+00; abs: 1.863e-03; rel: 9.396e-04; norm: 1.315e-01
## It: 294; obj: 1.982e+00; abs: 6.579e-04; rel: 3.321e-04; norm: 1.314e-01
## It: 295; obj: 1.982e+00; abs: 1.097e-06; rel: 5.536e-07; norm: 1.314e-01
## It: 296; obj: 1.982e+00; abs: 2.621e-04; rel: 1.322e-04; norm: 1.314e-01
## It: 297; obj: 1.983e+00; abs: 9.832e-04; rel: 4.961e-04; norm: 1.315e-01
## It: 298; obj: 1.982e+00; abs: 4.176e-04; rel: 2.106e-04; norm: 1.315e-01
## It: 299; obj: 1.981e+00; abs: 9.025e-04; rel: 4.553e-04; norm: 1.315e-01
## It: 300; obj: 1.982e+00; abs: 8.360e-04; rel: 4.219e-04; norm: 1.314e-01
## It: 301; obj: 1.983e+00; abs: 1.194e-03; rel: 6.024e-04; norm: 1.314e-01
## It: 302; obj: 1.985e+00; abs: 1.688e-03; rel: 8.510e-04; norm: 1.315e-01
## It: 303; obj: 1.982e+00; abs: 2.671e-03; rel: 1.345e-03; norm: 1.314e-01
## It: 304; obj: 1.981e+00; abs: 1.047e-03; rel: 5.280e-04; norm: 1.315e-01
## It: 305; obj: 1.982e+00; abs: 7.800e-04; rel: 3.937e-04; norm: 1.315e-01
## It: 306; obj: 1.983e+00; abs: 1.176e-03; rel: 5.934e-04; norm: 1.314e-01
## It: 307; obj: 1.985e+00; abs: 1.610e-03; rel: 8.116e-04; norm: 1.315e-01
## It: 308; obj: 1.983e+00; abs: 2.329e-03; rel: 1.173e-03; norm: 1.314e-01
## It: 309; obj: 1.981e+00; abs: 1.258e-03; rel: 6.347e-04; norm: 1.315e-01
## It: 310; obj: 1.982e+00; abs: 7.466e-04; rel: 3.768e-04; norm: 1.314e-01
## It: 311; obj: 1.983e+00; abs: 1.125e-03; rel: 5.677e-04; norm: 1.314e-01
## It: 312; obj: 1.985e+00; abs: 1.466e-03; rel: 7.394e-04; norm: 1.315e-01
## It: 313; obj: 1.983e+00; abs: 1.838e-03; rel: 9.261e-04; norm: 1.314e-01
## It: 314; obj: 1.981e+00; abs: 1.538e-03; rel: 7.757e-04; norm: 1.315e-01
## It: 315; obj: 1.982e+00; abs: 7.169e-04; rel: 3.619e-04; norm: 1.314e-01
## It: 316; obj: 1.983e+00; abs: 9.242e-04; rel: 4.663e-04; norm: 1.314e-01
## It: 317; obj: 1.984e+00; abs: 1.022e-03; rel: 5.156e-04; norm: 1.315e-01
## It: 318; obj: 1.983e+00; abs: 9.315e-04; rel: 4.695e-04; norm: 1.315e-01
## It: 319; obj: 1.981e+00; abs: 1.733e-03; rel: 8.738e-04; norm: 1.315e-01
## It: 320; obj: 1.982e+00; abs: 6.892e-04; rel: 3.479e-04; norm: 1.314e-01
## It: 321; obj: 1.982e+00; abs: 2.675e-05; rel: 1.350e-05; norm: 1.314e-01
## It: 322; obj: 1.982e+00; abs: 2.864e-04; rel: 1.445e-04; norm: 1.314e-01
## It: 323; obj: 1.983e+00; abs: 9.417e-04; rel: 4.752e-04; norm: 1.315e-01
## It: 324; obj: 1.982e+00; abs: 5.872e-04; rel: 2.961e-04; norm: 1.315e-01
## It: 325; obj: 1.981e+00; abs: 7.426e-04; rel: 3.746e-04; norm: 1.315e-01
## It: 326; obj: 1.982e+00; abs: 9.112e-04; rel: 4.599e-04; norm: 1.314e-01
## It: 327; obj: 1.983e+00; abs: 1.228e-03; rel: 6.195e-04; norm: 1.314e-01
## It: 328; obj: 1.985e+00; abs: 1.837e-03; rel: 9.260e-04; norm: 1.315e-01
## It: 329; obj: 1.982e+00; abs: 3.163e-03; rel: 1.593e-03; norm: 1.314e-01
## It: 330; obj: 1.981e+00; abs: 7.788e-04; rel: 3.929e-04; norm: 1.315e-01
## It: 331; obj: 1.982e+00; abs: 8.369e-04; rel: 4.224e-04; norm: 1.315e-01
## It: 332; obj: 1.983e+00; abs: 1.206e-03; rel: 6.086e-04; norm: 1.314e-01
## It: 333; obj: 1.985e+00; abs: 1.744e-03; rel: 8.795e-04; norm: 1.315e-01
## It: 334; obj: 1.982e+00; abs: 2.843e-03; rel: 1.432e-03; norm: 1.314e-01
## It: 335; obj: 1.981e+00; abs: 9.503e-04; rel: 4.794e-04; norm: 1.315e-01
## It: 336; obj: 1.982e+00; abs: 7.917e-04; rel: 3.996e-04; norm: 1.315e-01
## It: 337; obj: 1.983e+00; abs: 1.189e-03; rel: 5.996e-04; norm: 1.314e-01
## It: 338; obj: 1.985e+00; abs: 1.652e-03; rel: 8.330e-04; norm: 1.315e-01
## It: 339; obj: 1.983e+00; abs: 2.492e-03; rel: 1.255e-03; norm: 1.314e-01
## It: 340; obj: 1.981e+00; abs: 1.159e-03; rel: 5.846e-04; norm: 1.315e-01

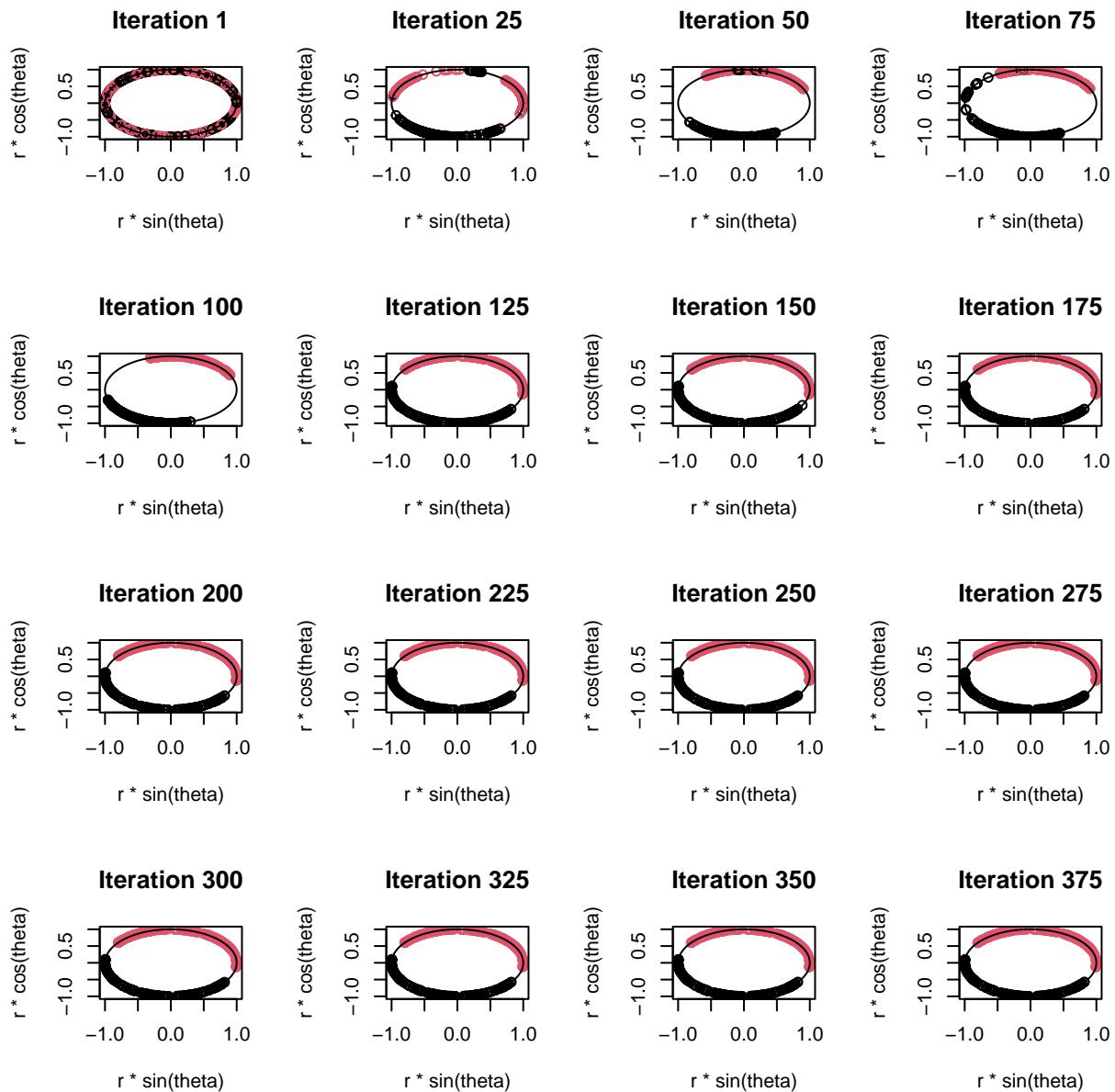
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## It: 341; obj: 1.982e+00; abs: 7.580e-04; rel: 3.826e-04; norm: 1.314e-01
## It: 342; obj: 1.983e+00; abs: 1.154e-03; rel: 5.822e-04; norm: 1.314e-01
## It: 343; obj: 1.985e+00; abs: 1.539e-03; rel: 7.760e-04; norm: 1.315e-01
## It: 344; obj: 1.983e+00; abs: 2.074e-03; rel: 1.045e-03; norm: 1.314e-01
## It: 345; obj: 1.981e+00; abs: 1.410e-03; rel: 7.110e-04; norm: 1.315e-01
## It: 346; obj: 1.982e+00; abs: 7.301e-04; rel: 3.685e-04; norm: 1.314e-01
## It: 347; obj: 1.983e+00; abs: 1.049e-03; rel: 5.293e-04; norm: 1.314e-01
## It: 348; obj: 1.984e+00; abs: 1.295e-03; rel: 6.532e-04; norm: 1.315e-01
## It: 349; obj: 1.983e+00; abs: 1.395e-03; rel: 7.028e-04; norm: 1.314e-01
## It: 350; obj: 1.981e+00; abs: 1.710e-03; rel: 8.625e-04; norm: 1.315e-01

## It: 351; obj: 1.982e+00; abs: 6.956e-04; rel: 3.511e-04; norm: 1.314e-01
## It: 352; obj: 1.982e+00; abs: 4.900e-04; rel: 2.472e-04; norm: 1.314e-01
## It: 353; obj: 1.982e+00; abs: 1.055e-04; rel: 5.322e-05; norm: 1.314e-01
## It: 354; obj: 1.983e+00; abs: 3.433e-04; rel: 1.732e-04; norm: 1.315e-01
## It: 355; obj: 1.981e+00; abs: 1.364e-03; rel: 6.879e-04; norm: 1.315e-01
## It: 356; obj: 1.982e+00; abs: 7.056e-04; rel: 3.561e-04; norm: 1.314e-01
## It: 357; obj: 1.983e+00; abs: 1.098e-03; rel: 5.542e-04; norm: 1.314e-01
## It: 358; obj: 1.985e+00; abs: 1.398e-03; rel: 7.048e-04; norm: 1.315e-01
## It: 359; obj: 1.983e+00; abs: 1.612e-03; rel: 8.124e-04; norm: 1.314e-01
## It: 360; obj: 1.981e+00; abs: 1.646e-03; rel: 8.301e-04; norm: 1.315e-01
## It: 361; obj: 1.982e+00; abs: 7.038e-04; rel: 3.552e-04; norm: 1.314e-01
## It: 362; obj: 1.983e+00; abs: 7.324e-04; rel: 3.695e-04; norm: 1.314e-01
## It: 363; obj: 1.983e+00; abs: 5.106e-04; rel: 2.575e-04; norm: 1.314e-01
## It: 364; obj: 1.983e+00; abs: 3.666e-04; rel: 1.849e-04; norm: 1.315e-01
## It: 365; obj: 1.981e+00; abs: 1.579e-03; rel: 7.963e-04; norm: 1.315e-01
## It: 366; obj: 1.982e+00; abs: 7.244e-04; rel: 3.656e-04; norm: 1.314e-01
## It: 367; obj: 1.982e+00; abs: 4.599e-04; rel: 2.320e-04; norm: 1.314e-01
## It: 368; obj: 1.982e+00; abs: 1.339e-04; rel: 6.755e-05; norm: 1.314e-01
## It: 369; obj: 1.983e+00; abs: 3.617e-04; rel: 1.825e-04; norm: 1.315e-01
## It: 370; obj: 1.981e+00; abs: 1.347e-03; rel: 6.791e-04; norm: 1.315e-01
## It: 371; obj: 1.982e+00; abs: 6.981e-04; rel: 3.523e-04; norm: 1.314e-01
## It: 372; obj: 1.983e+00; abs: 1.110e-03; rel: 5.601e-04; norm: 1.314e-01
## It: 373; obj: 1.985e+00; abs: 1.425e-03; rel: 7.183e-04; norm: 1.315e-01
## It: 374; obj: 1.983e+00; abs: 1.677e-03; rel: 8.449e-04; norm: 1.314e-01
## It: 375; obj: 1.981e+00; abs: 1.620e-03; rel: 8.171e-04; norm: 1.315e-01

```



```

## It: 376; obj: 1.982e+00; abs: 7.065e-04; rel: 3.566e-04; norm: 1.314e-01
## It: 377; obj: 1.983e+00; abs: 7.938e-04; rel: 4.005e-04; norm: 1.314e-01
## It: 378; obj: 1.983e+00; abs: 6.857e-04; rel: 3.458e-04; norm: 1.314e-01
## It: 379; obj: 1.983e+00; abs: 5.516e-04; rel: 2.781e-04; norm: 1.315e-01
## It: 380; obj: 1.981e+00; abs: 1.632e-03; rel: 8.230e-04; norm: 1.315e-01
## It: 381; obj: 1.982e+00; abs: 7.128e-04; rel: 3.598e-04; norm: 1.314e-01
## It: 382; obj: 1.982e+00; abs: 2.446e-04; rel: 1.234e-04; norm: 1.314e-01
## It: 383; obj: 1.982e+00; abs: 3.238e-04; rel: 1.634e-04; norm: 1.314e-01
## It: 384; obj: 1.983e+00; abs: 7.269e-04; rel: 3.668e-04; norm: 1.315e-01
## It: 385; obj: 1.982e+00; abs: 1.064e-03; rel: 5.367e-04; norm: 1.315e-01
## It: 386; obj: 1.982e+00; abs: 4.455e-05; rel: 2.248e-05; norm: 1.315e-01
## It: 387; obj: 1.983e+00; abs: 1.071e-03; rel: 5.407e-04; norm: 1.314e-01
## It: 388; obj: 1.984e+00; abs: 1.642e-03; rel: 8.282e-04; norm: 1.314e-01
## It: 389; obj: 1.983e+00; abs: 8.137e-04; rel: 4.101e-04; norm: 1.314e-01
## It: 390; obj: 1.981e+00; abs: 2.037e-03; rel: 1.027e-03; norm: 1.315e-01
## It: 391; obj: 1.982e+00; abs: 5.493e-04; rel: 2.772e-04; norm: 1.314e-01

```

```

## It: 392; obj: 1.981e+00; abs: 6.501e-04; rel: 3.280e-04; norm: 1.314e-01
## It: 393; obj: 1.982e+00; abs: 4.483e-04; rel: 2.263e-04; norm: 1.315e-01
## It: 394; obj: 1.983e+00; abs: 1.156e-03; rel: 5.834e-04; norm: 1.315e-01
## It: 395; obj: 1.982e+00; abs: 1.221e-03; rel: 6.158e-04; norm: 1.315e-01
## It: 396; obj: 1.981e+00; abs: 3.905e-04; rel: 1.971e-04; norm: 1.315e-01
## It: 397; obj: 1.982e+00; abs: 1.049e-03; rel: 5.293e-04; norm: 1.314e-01
## It: 398; obj: 1.984e+00; abs: 1.252e-03; rel: 6.314e-04; norm: 1.314e-01
## It: 399; obj: 1.986e+00; abs: 1.968e-03; rel: 9.921e-04; norm: 1.315e-01
## It: 400; obj: 1.982e+00; abs: 3.604e-03; rel: 1.815e-03; norm: 1.314e-01
## It: 401; obj: 1.981e+00; abs: 5.843e-04; rel: 2.948e-04; norm: 1.315e-01
## It: 402; obj: 1.982e+00; abs: 8.858e-04; rel: 4.471e-04; norm: 1.315e-01
## It: 403; obj: 1.983e+00; abs: 1.216e-03; rel: 6.134e-04; norm: 1.314e-01
## It: 404; obj: 1.985e+00; abs: 1.834e-03; rel: 9.246e-04; norm: 1.315e-01
## It: 405; obj: 1.982e+00; abs: 3.161e-03; rel: 1.592e-03; norm: 1.314e-01
## It: 406; obj: 1.981e+00; abs: 7.812e-04; rel: 3.941e-04; norm: 1.315e-01
## It: 407; obj: 1.982e+00; abs: 8.327e-04; rel: 4.203e-04; norm: 1.315e-01
## It: 408; obj: 1.983e+00; abs: 1.207e-03; rel: 6.087e-04; norm: 1.314e-01
## It: 409; obj: 1.985e+00; abs: 1.739e-03; rel: 8.766e-04; norm: 1.315e-01
## It: 410; obj: 1.982e+00; abs: 2.819e-03; rel: 1.420e-03; norm: 1.314e-01
## It: 411; obj: 1.981e+00; abs: 9.653e-04; rel: 4.870e-04; norm: 1.315e-01
## It: 412; obj: 1.982e+00; abs: 7.883e-04; rel: 3.978e-04; norm: 1.315e-01
## It: 413; obj: 1.983e+00; abs: 1.187e-03; rel: 5.988e-04; norm: 1.314e-01
## It: 414; obj: 1.985e+00; abs: 1.644e-03; rel: 8.288e-04; norm: 1.315e-01
## It: 415; obj: 1.983e+00; abs: 2.460e-03; rel: 1.239e-03; norm: 1.314e-01
## It: 416; obj: 1.981e+00; abs: 1.179e-03; rel: 5.945e-04; norm: 1.315e-01
## It: 417; obj: 1.982e+00; abs: 7.556e-04; rel: 3.813e-04; norm: 1.314e-01
## It: 418; obj: 1.983e+00; abs: 1.149e-03; rel: 5.798e-04; norm: 1.314e-01
## It: 419; obj: 1.985e+00; abs: 1.526e-03; rel: 7.695e-04; norm: 1.315e-01
## It: 420; obj: 1.983e+00; abs: 2.030e-03; rel: 1.023e-03; norm: 1.314e-01
## It: 421; obj: 1.981e+00; abs: 1.435e-03; rel: 7.237e-04; norm: 1.315e-01
## It: 422; obj: 1.982e+00; abs: 7.276e-04; rel: 3.672e-04; norm: 1.314e-01
## It: 423; obj: 1.983e+00; abs: 1.030e-03; rel: 5.199e-04; norm: 1.314e-01
## It: 424; obj: 1.984e+00; abs: 1.256e-03; rel: 6.332e-04; norm: 1.315e-01
## It: 425; obj: 1.983e+00; abs: 1.311e-03; rel: 6.606e-04; norm: 1.314e-01
## It: 426; obj: 1.981e+00; abs: 1.728e-03; rel: 8.716e-04; norm: 1.315e-01
## It: 427; obj: 1.982e+00; abs: 6.924e-04; rel: 3.495e-04; norm: 1.314e-01
## It: 428; obj: 1.982e+00; abs: 3.842e-04; rel: 1.938e-04; norm: 1.314e-01
## It: 429; obj: 1.982e+00; abs: 2.511e-04; rel: 1.266e-04; norm: 1.314e-01
## It: 430; obj: 1.983e+00; abs: 5.603e-04; rel: 2.827e-04; norm: 1.315e-01
## It: 431; obj: 1.981e+00; abs: 1.227e-03; rel: 6.189e-04; norm: 1.315e-01
## It: 432; obj: 1.982e+00; abs: 5.396e-04; rel: 2.723e-04; norm: 1.314e-01
## It: 433; obj: 1.983e+00; abs: 1.121e-03; rel: 5.658e-04; norm: 1.314e-01
## It: 434; obj: 1.985e+00; abs: 1.485e-03; rel: 7.490e-04; norm: 1.314e-01
## It: 435; obj: 1.983e+00; abs: 1.613e-03; rel: 8.128e-04; norm: 1.314e-01
## It: 436; obj: 1.981e+00; abs: 1.692e-03; rel: 8.532e-04; norm: 1.315e-01
## It: 437; obj: 1.982e+00; abs: 6.942e-04; rel: 3.504e-04; norm: 1.314e-01
## It: 438; obj: 1.983e+00; abs: 6.641e-04; rel: 3.351e-04; norm: 1.314e-01
## It: 439; obj: 1.983e+00; abs: 3.070e-04; rel: 1.549e-04; norm: 1.314e-01
## It: 440; obj: 1.983e+00; abs: 1.410e-04; rel: 7.112e-05; norm: 1.315e-01
## It: 441; obj: 1.981e+00; abs: 1.522e-03; rel: 7.676e-04; norm: 1.315e-01
## It: 442; obj: 1.982e+00; abs: 7.328e-04; rel: 3.699e-04; norm: 1.314e-01
## It: 443; obj: 1.983e+00; abs: 7.017e-04; rel: 3.541e-04; norm: 1.314e-01
## It: 444; obj: 1.983e+00; abs: 4.382e-04; rel: 2.210e-04; norm: 1.314e-01

```

```

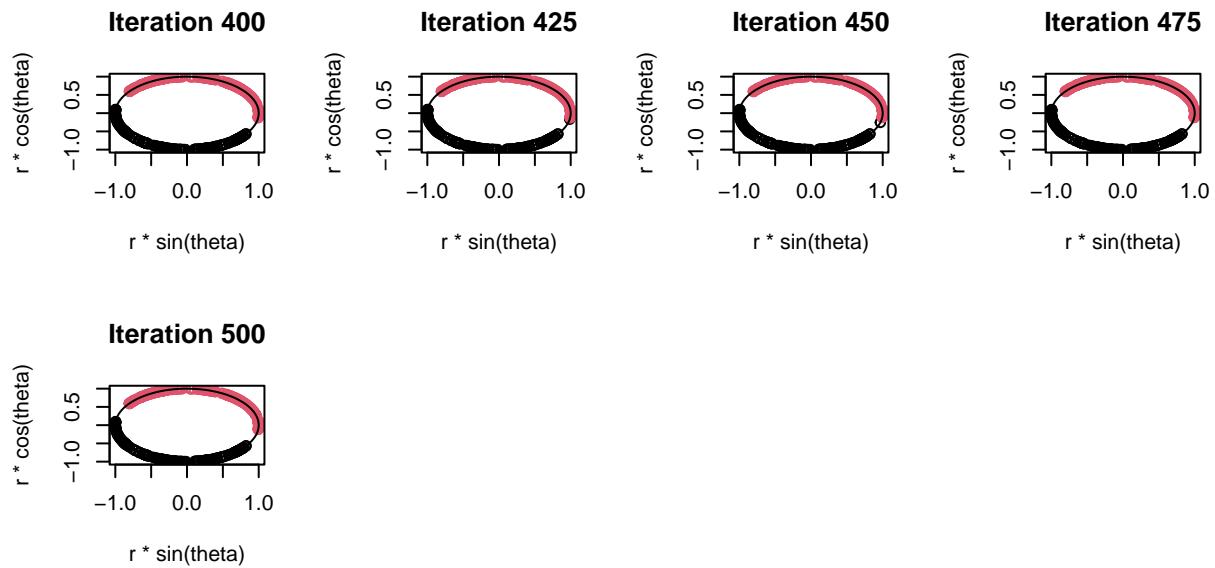
## It: 445; obj: 1.983e+00; abs: 3.196e-04; rel: 1.611e-04; norm: 1.315e-01
## It: 446; obj: 1.981e+00; abs: 1.554e-03; rel: 7.835e-04; norm: 1.315e-01
## It: 447; obj: 1.982e+00; abs: 7.291e-04; rel: 3.680e-04; norm: 1.314e-01
## It: 448; obj: 1.983e+00; abs: 5.680e-04; rel: 2.866e-04; norm: 1.314e-01
## It: 449; obj: 1.983e+00; abs: 8.489e-05; rel: 4.282e-05; norm: 1.314e-01
## It: 450; obj: 1.983e+00; abs: 8.185e-05; rel: 4.128e-05; norm: 1.315e-01
## It: 451; obj: 1.981e+00; abs: 1.450e-03; rel: 7.313e-04; norm: 1.315e-01
## It: 452; obj: 1.982e+00; abs: 7.338e-04; rel: 3.704e-04; norm: 1.314e-01
## It: 453; obj: 1.983e+00; abs: 9.427e-04; rel: 4.756e-04; norm: 1.314e-01
## It: 454; obj: 1.984e+00; abs: 1.050e-03; rel: 5.297e-04; norm: 1.315e-01
## It: 455; obj: 1.983e+00; abs: 1.007e-03; rel: 5.078e-04; norm: 1.315e-01
## It: 456; obj: 1.981e+00; abs: 1.728e-03; rel: 8.715e-04; norm: 1.315e-01
## It: 457; obj: 1.982e+00; abs: 6.917e-04; rel: 3.491e-04; norm: 1.314e-01
## It: 458; obj: 1.982e+00; abs: 1.337e-04; rel: 6.747e-05; norm: 1.314e-01
## It: 459; obj: 1.982e+00; abs: 3.213e-04; rel: 1.621e-04; norm: 1.314e-01
## It: 460; obj: 1.983e+00; abs: 8.578e-04; rel: 4.328e-04; norm: 1.315e-01
## It: 461; obj: 1.982e+00; abs: 8.383e-04; rel: 4.228e-04; norm: 1.315e-01
## It: 462; obj: 1.981e+00; abs: 5.516e-04; rel: 2.783e-04; norm: 1.315e-01
## It: 463; obj: 1.982e+00; abs: 1.023e-03; rel: 5.162e-04; norm: 1.314e-01
## It: 464; obj: 1.984e+00; abs: 1.266e-03; rel: 6.388e-04; norm: 1.314e-01
## It: 465; obj: 1.986e+00; abs: 1.956e-03; rel: 9.863e-04; norm: 1.315e-01
## It: 466; obj: 1.982e+00; abs: 3.502e-03; rel: 1.764e-03; norm: 1.314e-01
## It: 467; obj: 1.981e+00; abs: 6.280e-04; rel: 3.169e-04; norm: 1.315e-01
## It: 468; obj: 1.982e+00; abs: 8.760e-04; rel: 4.421e-04; norm: 1.315e-01
## It: 469; obj: 1.983e+00; abs: 1.215e-03; rel: 6.131e-04; norm: 1.314e-01
## It: 470; obj: 1.985e+00; abs: 1.822e-03; rel: 9.185e-04; norm: 1.315e-01
## It: 471; obj: 1.982e+00; abs: 3.118e-03; rel: 1.571e-03; norm: 1.314e-01
## It: 472; obj: 1.981e+00; abs: 8.010e-04; rel: 4.041e-04; norm: 1.315e-01
## It: 473; obj: 1.982e+00; abs: 8.274e-04; rel: 4.176e-04; norm: 1.315e-01
## It: 474; obj: 1.983e+00; abs: 1.205e-03; rel: 6.077e-04; norm: 1.314e-01
## It: 475; obj: 1.985e+00; abs: 1.730e-03; rel: 8.722e-04; norm: 1.315e-01
## It: 476; obj: 1.982e+00; abs: 2.788e-03; rel: 1.404e-03; norm: 1.314e-01
## It: 477; obj: 1.981e+00; abs: 9.824e-04; rel: 4.956e-04; norm: 1.315e-01
## It: 478; obj: 1.982e+00; abs: 7.852e-04; rel: 3.963e-04; norm: 1.315e-01
## It: 479; obj: 1.983e+00; abs: 1.185e-03; rel: 5.976e-04; norm: 1.314e-01
## It: 480; obj: 1.985e+00; abs: 1.636e-03; rel: 8.249e-04; norm: 1.315e-01
## It: 481; obj: 1.983e+00; abs: 2.431e-03; rel: 1.225e-03; norm: 1.314e-01
## It: 482; obj: 1.981e+00; abs: 1.196e-03; rel: 6.031e-04; norm: 1.315e-01
## It: 483; obj: 1.982e+00; abs: 7.534e-04; rel: 3.803e-04; norm: 1.314e-01
## It: 484; obj: 1.983e+00; abs: 1.145e-03; rel: 5.776e-04; norm: 1.314e-01
## It: 485; obj: 1.985e+00; abs: 1.514e-03; rel: 7.635e-04; norm: 1.315e-01
## It: 486; obj: 1.983e+00; abs: 1.992e-03; rel: 1.003e-03; norm: 1.314e-01
## It: 487; obj: 1.981e+00; abs: 1.456e-03; rel: 7.344e-04; norm: 1.315e-01
## It: 488; obj: 1.982e+00; abs: 7.254e-04; rel: 3.661e-04; norm: 1.314e-01
## It: 489; obj: 1.983e+00; abs: 1.013e-03; rel: 5.110e-04; norm: 1.314e-01
## It: 490; obj: 1.984e+00; abs: 1.218e-03; rel: 6.141e-04; norm: 1.315e-01
## It: 491; obj: 1.983e+00; abs: 1.238e-03; rel: 6.238e-04; norm: 1.314e-01
## It: 492; obj: 1.981e+00; abs: 1.739e-03; rel: 8.771e-04; norm: 1.315e-01
## It: 493; obj: 1.982e+00; abs: 6.901e-04; rel: 3.483e-04; norm: 1.314e-01
## It: 494; obj: 1.982e+00; abs: 2.933e-04; rel: 1.480e-04; norm: 1.314e-01
## It: 495; obj: 1.982e+00; abs: 3.116e-04; rel: 1.572e-04; norm: 1.314e-01
## It: 496; obj: 1.983e+00; abs: 6.959e-04; rel: 3.511e-04; norm: 1.315e-01
## It: 497; obj: 1.982e+00; abs: 1.103e-03; rel: 5.561e-04; norm: 1.315e-01

```

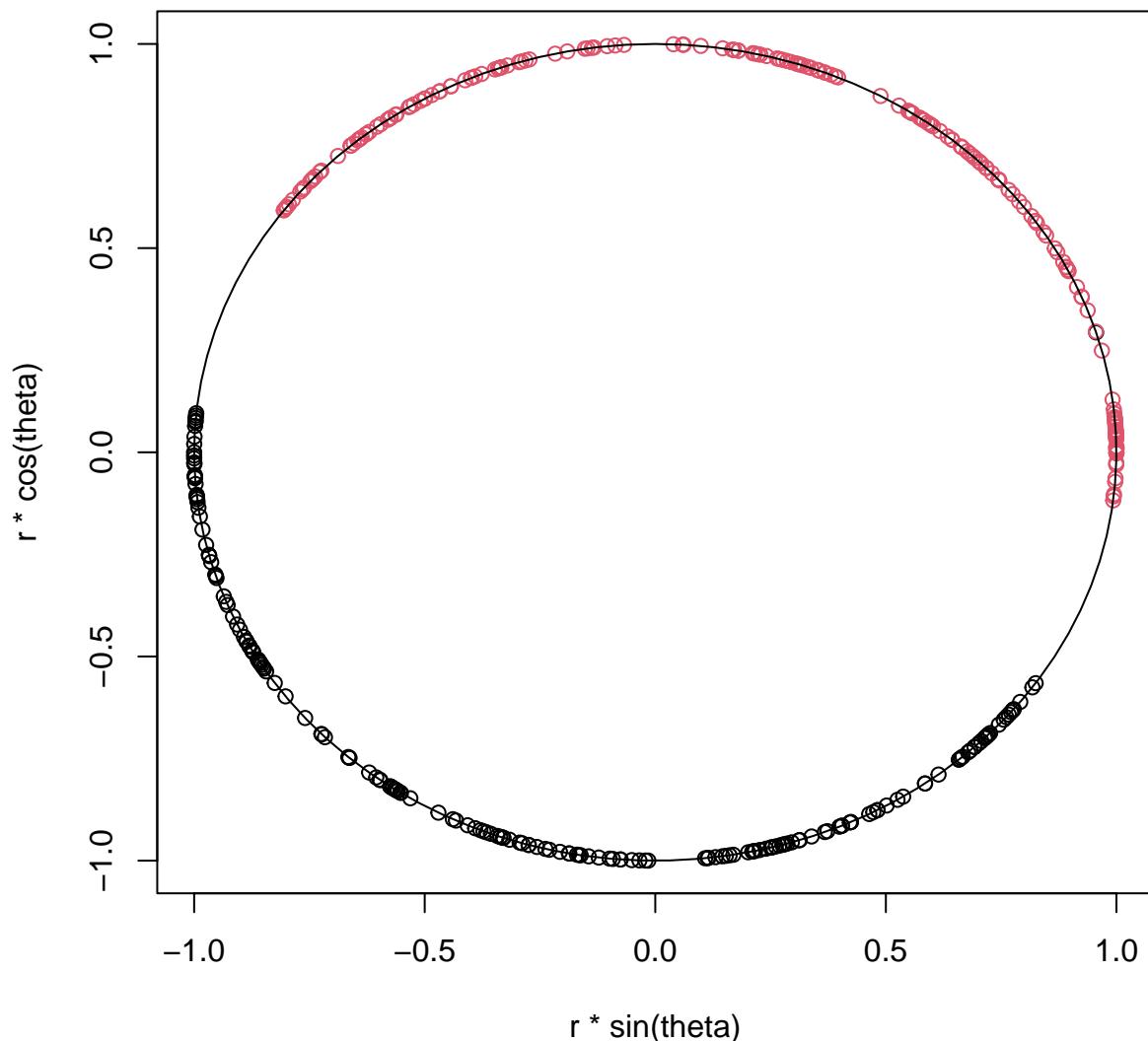
```

## It: 498; obj: 1.982e+00; abs: 1.139e-04; rel: 5.749e-05; norm: 1.315e-01
## It: 499; obj: 1.983e+00; abs: 1.079e-03; rel: 5.445e-04; norm: 1.314e-01
## It: 500; obj: 1.984e+00; abs: 1.574e-03; rel: 7.941e-04; norm: 1.314e-01

```



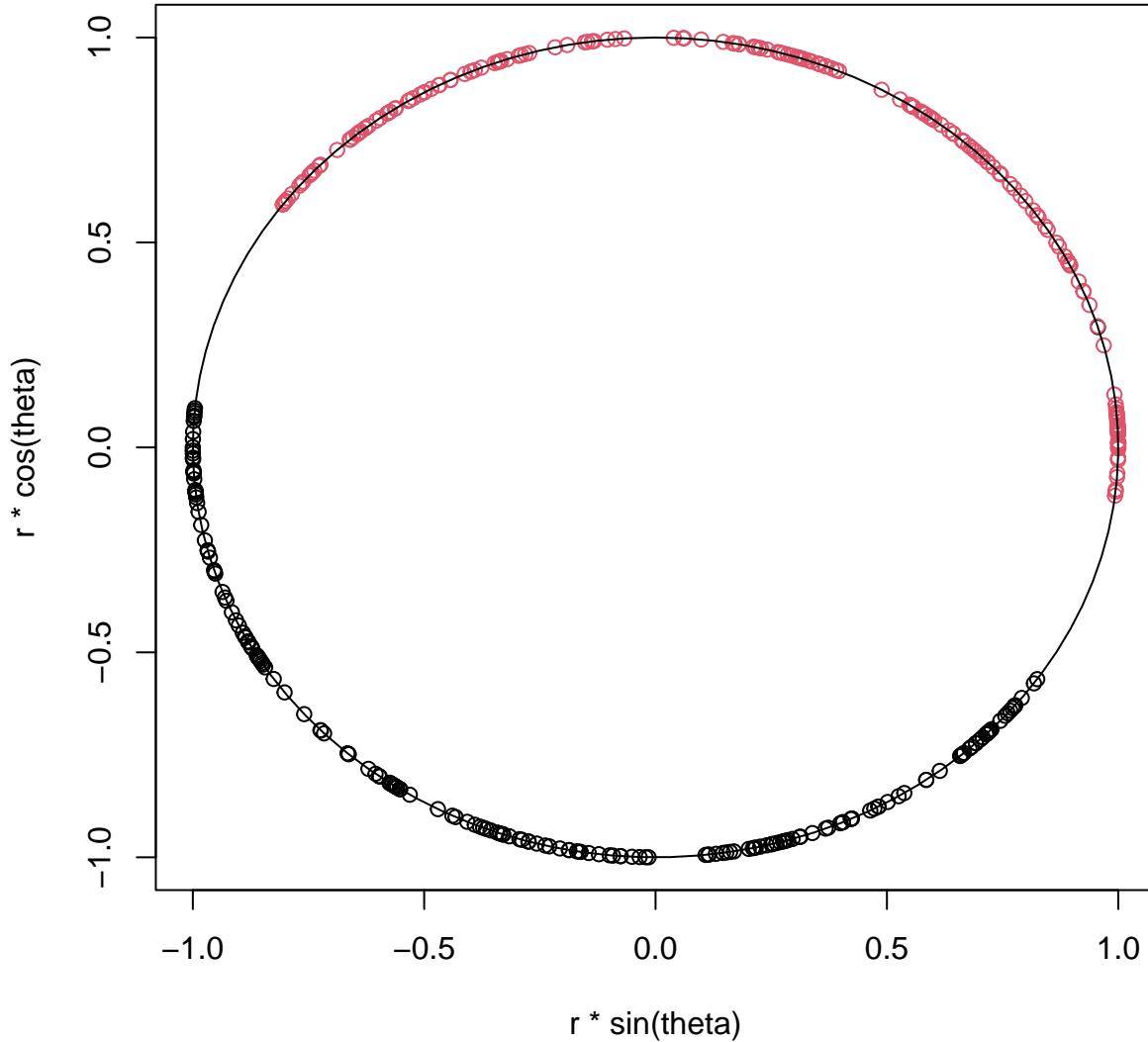
Iteration 500



```
Y_rad <- DirStats::to_rad(Y)
r <- 1
theta <- Y_rad

plot(r*sin(theta),
      r*cos(theta),
      col=colors,
      xlim=c(-max(r),max(r)),
      ylim=c(-max(r),max(r)))

polygon(max(r)*sin(seq(0,2*pi,length.out=100)),max(r)*cos(seq(0,2*pi,length.out=100)))
```



Now we are going to reduce to dimension \mathbb{S}^2 then $d = 2$ (sphere):

```
Y <- psc_sne(X=x_array, d=2, rho_psc_list = rho_first_20, num_iteration=500,
               colors=colors, visualize_prog = TRUE, eta=100, check=F)
```

```
## It: 1; obj: 1.735e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 2.017e-01
## It: 2; obj: 1.466e+01; abs: 2.689e+00; rel: 1.550e-01; norm: 5.123e-01
## It: 3; obj: 1.382e+01; abs: 8.462e-01; rel: 5.771e-02; norm: 8.884e-01
## It: 4; obj: 1.340e+01; abs: 4.207e-01; rel: 3.044e-02; norm: 1.021e+00
## It: 5; obj: 1.307e+01; abs: 3.244e-01; rel: 2.422e-02; norm: 1.093e+00
## It: 6; obj: 1.282e+01; abs: 2.492e-01; rel: 1.907e-02; norm: 1.143e+00
## It: 7; obj: 1.263e+01; abs: 1.939e-01; rel: 1.512e-02; norm: 1.177e+00
## It: 8; obj: 1.249e+01; abs: 1.410e-01; rel: 1.116e-02; norm: 1.201e+00
## It: 9; obj: 1.237e+01; abs: 1.152e-01; rel: 9.227e-03; norm: 1.219e+00
## It: 10; obj: 1.226e+01; abs: 1.134e-01; rel: 9.161e-03; norm: 1.235e+00
## It: 11; obj: 1.215e+01; abs: 1.082e-01; rel: 8.822e-03; norm: 1.252e+00
## It: 12; obj: 1.206e+01; abs: 9.609e-02; rel: 7.908e-03; norm: 1.269e+00
## It: 13; obj: 1.197e+01; abs: 8.586e-02; rel: 7.122e-03; norm: 1.284e+00
## It: 14; obj: 1.190e+01; abs: 7.355e-02; rel: 6.144e-03; norm: 1.298e+00
## It: 15; obj: 1.184e+01; abs: 5.383e-02; rel: 4.525e-03; norm: 1.310e+00
```

```

## It: 16; obj: 1.181e+01; abs: 3.573e-02; rel: 3.017e-03; norm: 1.320e+00
## It: 17; obj: 1.178e+01; abs: 2.320e-02; rel: 1.965e-03; norm: 1.329e+00
## It: 18; obj: 1.177e+01; abs: 1.496e-02; rel: 1.270e-03; norm: 1.336e+00
## It: 19; obj: 1.176e+01; abs: 1.082e-02; rel: 9.193e-04; norm: 1.343e+00
## It: 20; obj: 1.175e+01; abs: 1.036e-02; rel: 8.811e-04; norm: 1.350e+00
## It: 21; obj: 1.173e+01; abs: 1.355e-02; rel: 1.153e-03; norm: 1.356e+00
## It: 22; obj: 1.172e+01; abs: 1.881e-02; rel: 1.603e-03; norm: 1.362e+00
## It: 23; obj: 1.169e+01; abs: 2.347e-02; rel: 2.003e-03; norm: 1.367e+00
## It: 24; obj: 1.166e+01; abs: 2.730e-02; rel: 2.335e-03; norm: 1.371e+00
## It: 25; obj: 1.164e+01; abs: 2.936e-02; rel: 2.517e-03; norm: 1.376e+00
## It: 26; obj: 1.161e+01; abs: 2.904e-02; rel: 2.496e-03; norm: 1.380e+00
## It: 27; obj: 1.158e+01; abs: 2.689e-02; rel: 2.317e-03; norm: 1.384e+00
## It: 28; obj: 1.155e+01; abs: 2.444e-02; rel: 2.110e-03; norm: 1.390e+00
## It: 29; obj: 1.153e+01; abs: 2.193e-02; rel: 1.898e-03; norm: 1.397e+00
## It: 30; obj: 1.151e+01; abs: 1.946e-02; rel: 1.687e-03; norm: 1.407e+00
## It: 31; obj: 1.150e+01; abs: 1.728e-02; rel: 1.501e-03; norm: 1.418e+00
## It: 32; obj: 1.148e+01; abs: 1.554e-02; rel: 1.352e-03; norm: 1.432e+00
## It: 33; obj: 1.147e+01; abs: 1.413e-02; rel: 1.231e-03; norm: 1.447e+00
## It: 34; obj: 1.145e+01; abs: 1.281e-02; rel: 1.117e-03; norm: 1.463e+00
## It: 35; obj: 1.144e+01; abs: 1.126e-02; rel: 9.833e-04; norm: 1.481e+00
## It: 36; obj: 1.143e+01; abs: 9.234e-03; rel: 8.070e-04; norm: 1.501e+00
## It: 37; obj: 1.143e+01; abs: 6.628e-03; rel: 5.798e-04; norm: 1.522e+00
## It: 38; obj: 1.142e+01; abs: 3.542e-03; rel: 3.100e-04; norm: 1.545e+00
## It: 39; obj: 1.142e+01; abs: 1.460e-04; rel: 1.278e-05; norm: 1.569e+00
## It: 40; obj: 1.143e+01; abs: 3.433e-03; rel: 3.005e-04; norm: 1.594e+00
## It: 41; obj: 1.143e+01; abs: 7.133e-03; rel: 6.243e-04; norm: 1.620e+00
## It: 42; obj: 1.144e+01; abs: 1.087e-02; rel: 9.505e-04; norm: 1.647e+00
## It: 43; obj: 1.146e+01; abs: 1.442e-02; rel: 1.260e-03; norm: 1.674e+00
## It: 44; obj: 1.148e+01; abs: 1.750e-02; rel: 1.527e-03; norm: 1.701e+00
## It: 45; obj: 1.150e+01; abs: 1.993e-02; rel: 1.737e-03; norm: 1.728e+00
## It: 46; obj: 1.152e+01; abs: 2.181e-02; rel: 1.897e-03; norm: 1.755e+00
## It: 47; obj: 1.154e+01; abs: 2.335e-02; rel: 2.028e-03; norm: 1.782e+00
## It: 48; obj: 1.157e+01; abs: 2.477e-02; rel: 2.146e-03; norm: 1.809e+00
## It: 49; obj: 1.159e+01; abs: 2.617e-02; rel: 2.263e-03; norm: 1.835e+00
## It: 50; obj: 1.162e+01; abs: 2.764e-02; rel: 2.384e-03; norm: 1.860e+00
## It: 51; obj: 1.165e+01; abs: 2.916e-02; rel: 2.509e-03; norm: 1.885e+00
## It: 52; obj: 1.168e+01; abs: 3.063e-02; rel: 2.630e-03; norm: 1.909e+00
## It: 53; obj: 1.171e+01; abs: 3.184e-02; rel: 2.726e-03; norm: 1.933e+00
## It: 54; obj: 1.174e+01; abs: 3.248e-02; rel: 2.774e-03; norm: 1.955e+00
## It: 55; obj: 1.178e+01; abs: 3.224e-02; rel: 2.746e-03; norm: 1.977e+00
## It: 56; obj: 1.181e+01; abs: 3.093e-02; rel: 2.626e-03; norm: 1.999e+00
## It: 57; obj: 1.184e+01; abs: 2.865e-02; rel: 2.427e-03; norm: 2.019e+00
## It: 58; obj: 1.186e+01; abs: 2.597e-02; rel: 2.194e-03; norm: 2.039e+00
## It: 59; obj: 1.189e+01; abs: 2.370e-02; rel: 1.998e-03; norm: 2.057e+00
## It: 60; obj: 1.191e+01; abs: 2.245e-02; rel: 1.889e-03; norm: 2.074e+00
## It: 61; obj: 1.193e+01; abs: 2.229e-02; rel: 1.872e-03; norm: 2.090e+00
## It: 62; obj: 1.195e+01; abs: 2.285e-02; rel: 1.915e-03; norm: 2.105e+00
## It: 63; obj: 1.198e+01; abs: 2.370e-02; rel: 1.983e-03; norm: 2.118e+00
## It: 64; obj: 1.200e+01; abs: 2.452e-02; rel: 2.048e-03; norm: 2.130e+00
## It: 65; obj: 1.203e+01; abs: 2.513e-02; rel: 2.094e-03; norm: 2.141e+00
## It: 66; obj: 1.205e+01; abs: 2.545e-02; rel: 2.117e-03; norm: 2.151e+00
## It: 67; obj: 1.208e+01; abs: 2.546e-02; rel: 2.113e-03; norm: 2.161e+00
## It: 68; obj: 1.210e+01; abs: 2.516e-02; rel: 2.083e-03; norm: 2.170e+00

```

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## It: 69; obj: 1.213e+01; abs: 2.457e-02; rel: 2.030e-03; norm: 2.178e+00
## It: 70; obj: 1.215e+01; abs: 2.370e-02; rel: 1.955e-03; norm: 2.186e+00
## It: 71; obj: 1.217e+01; abs: 2.261e-02; rel: 1.861e-03; norm: 2.194e+00
## It: 72; obj: 1.219e+01; abs: 2.133e-02; rel: 1.752e-03; norm: 2.201e+00
## It: 73; obj: 1.221e+01; abs: 1.994e-02; rel: 1.635e-03; norm: 2.207e+00
## It: 74; obj: 1.223e+01; abs: 1.850e-02; rel: 1.514e-03; norm: 2.213e+00
## It: 75; obj: 1.225e+01; abs: 1.707e-02; rel: 1.396e-03; norm: 2.219e+00
## It: 76; obj: 1.227e+01; abs: 1.571e-02; rel: 1.283e-03; norm: 2.224e+00
## It: 77; obj: 1.228e+01; abs: 1.444e-02; rel: 1.177e-03; norm: 2.229e+00
## It: 78; obj: 1.229e+01; abs: 1.325e-02; rel: 1.079e-03; norm: 2.233e+00
## It: 79; obj: 1.231e+01; abs: 1.216e-02; rel: 9.890e-04; norm: 2.237e+00
## It: 80; obj: 1.232e+01; abs: 1.115e-02; rel: 9.063e-04; norm: 2.240e+00
## It: 81; obj: 1.233e+01; abs: 1.023e-02; rel: 8.306e-04; norm: 2.243e+00
## It: 82; obj: 1.234e+01; abs: 9.386e-03; rel: 7.614e-04; norm: 2.246e+00
## It: 83; obj: 1.235e+01; abs: 8.616e-03; rel: 6.984e-04; norm: 2.249e+00
## It: 84; obj: 1.235e+01; abs: 7.914e-03; rel: 6.411e-04; norm: 2.251e+00
## It: 85; obj: 1.236e+01; abs: 7.274e-03; rel: 5.889e-04; norm: 2.253e+00
## It: 86; obj: 1.237e+01; abs: 6.691e-03; rel: 5.413e-04; norm: 2.255e+00
## It: 87; obj: 1.237e+01; abs: 6.158e-03; rel: 4.979e-04; norm: 2.256e+00
## It: 88; obj: 1.238e+01; abs: 5.671e-03; rel: 4.583e-04; norm: 2.258e+00
## It: 89; obj: 1.238e+01; abs: 5.225e-03; rel: 4.221e-04; norm: 2.259e+00
## It: 90; obj: 1.239e+01; abs: 4.815e-03; rel: 3.888e-04; norm: 2.260e+00
## It: 91; obj: 1.239e+01; abs: 4.437e-03; rel: 3.581e-04; norm: 2.261e+00
## It: 92; obj: 1.240e+01; abs: 4.088e-03; rel: 3.298e-04; norm: 2.262e+00
## It: 93; obj: 1.240e+01; abs: 3.764e-03; rel: 3.036e-04; norm: 2.263e+00
## It: 94; obj: 1.240e+01; abs: 3.462e-03; rel: 2.792e-04; norm: 2.264e+00
## It: 95; obj: 1.241e+01; abs: 3.180e-03; rel: 2.564e-04; norm: 2.265e+00
## It: 96; obj: 1.241e+01; abs: 2.915e-03; rel: 2.349e-04; norm: 2.265e+00
## It: 97; obj: 1.241e+01; abs: 2.665e-03; rel: 2.147e-04; norm: 2.266e+00
## It: 98; obj: 1.242e+01; abs: 2.427e-03; rel: 1.955e-04; norm: 2.266e+00
## It: 99; obj: 1.242e+01; abs: 2.199e-03; rel: 1.771e-04; norm: 2.267e+00
## It: 100; obj: 1.242e+01; abs: 1.979e-03; rel: 1.594e-04; norm: 2.267e+00
## It: 101; obj: 1.540e+00; abs: 1.088e+01; rel: 8.760e-01; norm: 1.742e-01
## It: 102; obj: 1.328e+00; abs: 2.114e-01; rel: 1.373e-01; norm: 1.624e-01
## It: 103; obj: 1.253e+00; abs: 7.501e-02; rel: 5.648e-02; norm: 1.715e-01
## It: 104; obj: 1.235e+00; abs: 1.770e-02; rel: 1.412e-02; norm: 1.814e-01
## It: 105; obj: 1.229e+00; abs: 6.434e-03; rel: 5.208e-03; norm: 1.841e-01
## It: 106; obj: 1.220e+00; abs: 8.829e-03; rel: 7.184e-03; norm: 1.855e-01
## It: 107; obj: 1.218e+00; abs: 2.433e-03; rel: 1.994e-03; norm: 1.863e-01
## It: 108; obj: 1.215e+00; abs: 2.953e-03; rel: 2.425e-03; norm: 1.865e-01
## It: 109; obj: 1.213e+00; abs: 1.350e-03; rel: 1.111e-03; norm: 1.864e-01
## It: 110; obj: 1.204e+00; abs: 9.071e-03; rel: 7.475e-03; norm: 1.870e-01
## It: 111; obj: 1.202e+00; abs: 2.716e-03; rel: 2.256e-03; norm: 1.872e-01
## It: 112; obj: 1.203e+00; abs: 1.745e-03; rel: 1.452e-03; norm: 1.875e-01
## It: 113; obj: 1.211e+00; abs: 7.687e-03; rel: 6.387e-03; norm: 1.879e-01
## It: 114; obj: 1.206e+00; abs: 5.459e-03; rel: 4.508e-03; norm: 1.880e-01
## It: 115; obj: 1.202e+00; abs: 3.887e-03; rel: 3.224e-03; norm: 1.879e-01
## It: 116; obj: 1.204e+00; abs: 2.152e-03; rel: 1.790e-03; norm: 1.880e-01
## It: 117; obj: 1.199e+00; abs: 4.775e-03; rel: 3.966e-03; norm: 1.884e-01
## It: 118; obj: 1.199e+00; abs: 6.009e-04; rel: 5.011e-04; norm: 1.885e-01
## It: 119; obj: 1.202e+00; abs: 3.503e-03; rel: 2.923e-03; norm: 1.883e-01
## It: 120; obj: 1.205e+00; abs: 2.741e-03; rel: 2.280e-03; norm: 1.883e-01
## It: 121; obj: 1.198e+00; abs: 6.369e-03; rel: 5.287e-03; norm: 1.884e-01

```

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## It: 122; obj: 1.202e+00; abs: 3.419e-03; rel: 2.853e-03; norm: 1.887e-01
## It: 123; obj: 1.205e+00; abs: 2.804e-03; rel: 2.333e-03; norm: 1.888e-01
## It: 124; obj: 1.205e+00; abs: 8.638e-05; rel: 7.170e-05; norm: 1.890e-01
## It: 125; obj: 1.197e+00; abs: 7.315e-03; rel: 6.073e-03; norm: 1.888e-01
## It: 126; obj: 1.196e+00; abs: 1.072e-03; rel: 8.954e-04; norm: 1.887e-01
## It: 127; obj: 1.198e+00; abs: 2.161e-03; rel: 1.807e-03; norm: 1.890e-01
## It: 128; obj: 1.196e+00; abs: 2.052e-03; rel: 1.712e-03; norm: 1.890e-01
## It: 129; obj: 1.195e+00; abs: 1.180e-03; rel: 9.862e-04; norm: 1.890e-01
## It: 130; obj: 1.198e+00; abs: 2.484e-03; rel: 2.079e-03; norm: 1.888e-01
## It: 131; obj: 1.202e+00; abs: 4.352e-03; rel: 3.634e-03; norm: 1.889e-01
## It: 132; obj: 1.195e+00; abs: 7.023e-03; rel: 5.843e-03; norm: 1.891e-01
## It: 133; obj: 1.195e+00; abs: 1.155e-04; rel: 9.670e-05; norm: 1.891e-01
## It: 134; obj: 1.198e+00; abs: 3.309e-03; rel: 2.770e-03; norm: 1.892e-01
## It: 135; obj: 1.196e+00; abs: 2.009e-03; rel: 1.677e-03; norm: 1.893e-01
## It: 136; obj: 1.198e+00; abs: 1.518e-03; rel: 1.269e-03; norm: 1.890e-01
## It: 137; obj: 1.200e+00; abs: 2.456e-03; rel: 2.051e-03; norm: 1.893e-01
## It: 138; obj: 1.195e+00; abs: 4.999e-03; rel: 4.166e-03; norm: 1.893e-01
## It: 139; obj: 1.195e+00; abs: 5.502e-05; rel: 4.604e-05; norm: 1.893e-01
## It: 140; obj: 1.198e+00; abs: 3.334e-03; rel: 2.790e-03; norm: 1.892e-01
## It: 141; obj: 1.196e+00; abs: 2.332e-03; rel: 1.946e-03; norm: 1.894e-01
## It: 142; obj: 1.195e+00; abs: 1.318e-03; rel: 1.102e-03; norm: 1.895e-01
## It: 143; obj: 1.197e+00; abs: 2.118e-03; rel: 1.773e-03; norm: 1.893e-01
## It: 144; obj: 1.197e+00; abs: 2.445e-04; rel: 2.043e-04; norm: 1.895e-01
## It: 145; obj: 1.194e+00; abs: 2.701e-03; rel: 2.257e-03; norm: 1.895e-01
## It: 146; obj: 1.194e+00; abs: 2.496e-04; rel: 2.091e-04; norm: 1.895e-01
## It: 147; obj: 1.197e+00; abs: 3.449e-03; rel: 2.890e-03; norm: 1.895e-01
## It: 148; obj: 1.195e+00; abs: 2.534e-03; rel: 2.117e-03; norm: 1.897e-01
## It: 149; obj: 1.195e+00; abs: 3.773e-04; rel: 3.158e-04; norm: 1.897e-01
## It: 150; obj: 1.194e+00; abs: 7.939e-04; rel: 6.644e-04; norm: 1.897e-01
## It: 151; obj: 1.192e+00; abs: 2.207e-03; rel: 1.849e-03; norm: 1.897e-01
## It: 152; obj: 1.193e+00; abs: 9.398e-04; rel: 7.885e-04; norm: 1.898e-01
## It: 153; obj: 1.196e+00; abs: 3.350e-03; rel: 2.808e-03; norm: 1.897e-01
## It: 154; obj: 1.195e+00; abs: 1.446e-03; rel: 1.209e-03; norm: 1.901e-01
## It: 155; obj: 1.192e+00; abs: 2.505e-03; rel: 2.097e-03; norm: 1.898e-01
## It: 156; obj: 1.193e+00; abs: 1.255e-03; rel: 1.053e-03; norm: 1.900e-01
## It: 157; obj: 1.194e+00; abs: 5.363e-04; rel: 4.493e-04; norm: 1.900e-01
## It: 158; obj: 1.193e+00; abs: 1.346e-03; rel: 1.127e-03; norm: 1.900e-01
## It: 159; obj: 1.192e+00; abs: 2.751e-04; rel: 2.306e-04; norm: 1.899e-01
## It: 160; obj: 1.192e+00; abs: 2.388e-04; rel: 2.003e-04; norm: 1.900e-01
## It: 161; obj: 1.192e+00; abs: 6.420e-04; rel: 5.385e-04; norm: 1.901e-01
## It: 162; obj: 1.192e+00; abs: 3.344e-04; rel: 2.807e-04; norm: 1.901e-01
## It: 163; obj: 1.194e+00; abs: 2.436e-03; rel: 2.044e-03; norm: 1.902e-01
## It: 164; obj: 1.192e+00; abs: 2.296e-03; rel: 1.923e-03; norm: 1.902e-01
## It: 165; obj: 1.191e+00; abs: 1.192e-03; rel: 9.998e-04; norm: 1.902e-01
## It: 166; obj: 1.193e+00; abs: 1.803e-03; rel: 1.514e-03; norm: 1.902e-01
## It: 167; obj: 1.191e+00; abs: 1.739e-03; rel: 1.458e-03; norm: 1.903e-01
## It: 168; obj: 1.190e+00; abs: 8.824e-04; rel: 7.410e-04; norm: 1.904e-01
## It: 169; obj: 1.193e+00; abs: 2.861e-03; rel: 2.404e-03; norm: 1.903e-01
## It: 170; obj: 1.191e+00; abs: 1.876e-03; rel: 1.573e-03; norm: 1.907e-01
## It: 171; obj: 1.190e+00; abs: 9.361e-04; rel: 7.860e-04; norm: 1.903e-01
## It: 172; obj: 1.190e+00; abs: 9.308e-05; rel: 7.822e-05; norm: 1.904e-01
## It: 173; obj: 1.187e+00; abs: 3.506e-03; rel: 2.946e-03; norm: 1.906e-01
## It: 174; obj: 1.188e+00; abs: 1.081e-03; rel: 9.111e-04; norm: 1.903e-01

```

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## It: 175; obj: 1.192e+00; abs: 4.584e-03; rel: 3.860e-03; norm: 1.904e-01
## It: 176; obj: 1.186e+00; abs: 5.984e-03; rel: 5.019e-03; norm: 1.903e-01
## It: 177; obj: 1.183e+00; abs: 2.877e-03; rel: 2.425e-03; norm: 1.904e-01
## It: 178; obj: 1.184e+00; abs: 5.330e-04; rel: 4.504e-04; norm: 1.905e-01
## It: 179; obj: 1.186e+00; abs: 2.383e-03; rel: 2.013e-03; norm: 1.905e-01
## It: 180; obj: 1.185e+00; abs: 1.295e-03; rel: 1.091e-03; norm: 1.905e-01
## It: 181; obj: 1.183e+00; abs: 1.880e-03; rel: 1.586e-03; norm: 1.903e-01
## It: 182; obj: 1.180e+00; abs: 2.991e-03; rel: 2.528e-03; norm: 1.904e-01
## It: 183; obj: 1.177e+00; abs: 3.221e-03; rel: 2.730e-03; norm: 1.903e-01
## It: 184; obj: 1.175e+00; abs: 1.900e-03; rel: 1.614e-03; norm: 1.904e-01
## It: 185; obj: 1.177e+00; abs: 2.116e-03; rel: 1.801e-03; norm: 1.904e-01
## It: 186; obj: 1.179e+00; abs: 1.897e-03; rel: 1.612e-03; norm: 1.905e-01
## It: 187; obj: 1.174e+00; abs: 4.598e-03; rel: 3.899e-03; norm: 1.907e-01
## It: 188; obj: 1.172e+00; abs: 2.305e-03; rel: 1.963e-03; norm: 1.906e-01
## It: 189; obj: 1.174e+00; abs: 2.300e-03; rel: 1.962e-03; norm: 1.907e-01
## It: 190; obj: 1.176e+00; abs: 1.117e-03; rel: 9.509e-04; norm: 1.908e-01
## It: 191; obj: 1.173e+00; abs: 2.252e-03; rel: 1.916e-03; norm: 1.908e-01
## It: 192; obj: 1.173e+00; abs: 7.258e-04; rel: 6.186e-04; norm: 1.907e-01
## It: 193; obj: 1.175e+00; abs: 2.176e-03; rel: 1.855e-03; norm: 1.908e-01
## It: 194; obj: 1.173e+00; abs: 2.067e-03; rel: 1.759e-03; norm: 1.909e-01
## It: 195; obj: 1.173e+00; abs: 4.635e-04; rel: 3.952e-04; norm: 1.909e-01
## It: 196; obj: 1.174e+00; abs: 7.777e-04; rel: 6.629e-04; norm: 1.908e-01
## It: 197; obj: 1.171e+00; abs: 2.952e-03; rel: 2.514e-03; norm: 1.908e-01
## It: 198; obj: 1.170e+00; abs: 9.170e-04; rel: 7.831e-04; norm: 1.908e-01
## It: 199; obj: 1.173e+00; abs: 2.672e-03; rel: 2.283e-03; norm: 1.909e-01
## It: 200; obj: 1.173e+00; abs: 5.755e-04; rel: 4.907e-04; norm: 1.909e-01
## It: 201; obj: 1.171e+00; abs: 2.296e-03; rel: 1.957e-03; norm: 1.909e-01
## It: 202; obj: 1.170e+00; abs: 7.231e-04; rel: 6.175e-04; norm: 1.908e-01
## It: 203; obj: 1.173e+00; abs: 2.756e-03; rel: 2.355e-03; norm: 1.910e-01
## It: 204; obj: 1.173e+00; abs: 4.157e-04; rel: 3.544e-04; norm: 1.910e-01
## It: 205; obj: 1.173e+00; abs: 1.179e-04; rel: 1.005e-04; norm: 1.909e-01
## It: 206; obj: 1.172e+00; abs: 3.095e-04; rel: 2.639e-04; norm: 1.910e-01
## It: 207; obj: 1.170e+00; abs: 2.498e-03; rel: 2.130e-03; norm: 1.909e-01
## It: 208; obj: 1.170e+00; abs: 7.388e-05; rel: 6.315e-05; norm: 1.910e-01
## It: 209; obj: 1.173e+00; abs: 3.331e-03; rel: 2.848e-03; norm: 1.908e-01
## It: 210; obj: 1.175e+00; abs: 1.623e-03; rel: 1.383e-03; norm: 1.910e-01
## It: 211; obj: 1.171e+00; abs: 3.530e-03; rel: 3.005e-03; norm: 1.911e-01
## It: 212; obj: 1.169e+00; abs: 2.109e-03; rel: 1.801e-03; norm: 1.909e-01
## It: 213; obj: 1.172e+00; abs: 2.488e-03; rel: 2.128e-03; norm: 1.909e-01
## It: 214; obj: 1.175e+00; abs: 2.978e-03; rel: 2.541e-03; norm: 1.910e-01
## It: 215; obj: 1.172e+00; abs: 2.637e-03; rel: 2.245e-03; norm: 1.910e-01
## It: 216; obj: 1.171e+00; abs: 1.215e-03; rel: 1.037e-03; norm: 1.909e-01
## It: 217; obj: 1.173e+00; abs: 1.981e-03; rel: 1.692e-03; norm: 1.909e-01
## It: 218; obj: 1.172e+00; abs: 7.182e-04; rel: 6.124e-04; norm: 1.910e-01
## It: 219; obj: 1.170e+00; abs: 2.160e-03; rel: 1.843e-03; norm: 1.909e-01
## It: 220; obj: 1.171e+00; abs: 1.238e-03; rel: 1.058e-03; norm: 1.908e-01
## It: 221; obj: 1.174e+00; abs: 3.129e-03; rel: 2.671e-03; norm: 1.909e-01
## It: 222; obj: 1.171e+00; abs: 3.389e-03; rel: 2.886e-03; norm: 1.911e-01
## It: 223; obj: 1.171e+00; abs: 4.002e-04; rel: 3.418e-04; norm: 1.908e-01
## It: 224; obj: 1.174e+00; abs: 3.040e-03; rel: 2.595e-03; norm: 1.910e-01
## It: 225; obj: 1.172e+00; abs: 2.059e-03; rel: 1.753e-03; norm: 1.910e-01
## It: 226; obj: 1.171e+00; abs: 8.243e-04; rel: 7.031e-04; norm: 1.910e-01

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## It: 227; obj: 1.173e+00; abs: 1.871e-03; rel: 1.597e-03; norm: 1.909e-01
## It: 228; obj: 1.172e+00; abs: 1.483e-03; rel: 1.264e-03; norm: 1.911e-01
## It: 229; obj: 1.172e+00; abs: 1.830e-04; rel: 1.562e-04; norm: 1.910e-01
## It: 230; obj: 1.173e+00; abs: 1.603e-03; rel: 1.368e-03; norm: 1.908e-01
## It: 231; obj: 1.170e+00; abs: 2.766e-03; rel: 2.357e-03; norm: 1.910e-01
## It: 232; obj: 1.170e+00; abs: 5.523e-04; rel: 4.718e-04; norm: 1.911e-01
## It: 233; obj: 1.171e+00; abs: 1.123e-03; rel: 9.596e-04; norm: 1.910e-01
## It: 234; obj: 1.175e+00; abs: 3.916e-03; rel: 3.344e-03; norm: 1.907e-01
## It: 235; obj: 1.172e+00; abs: 3.460e-03; rel: 2.945e-03; norm: 1.910e-01
## It: 236; obj: 1.169e+00; abs: 2.015e-03; rel: 1.720e-03; norm: 1.911e-01
## It: 237; obj: 1.172e+00; abs: 2.409e-03; rel: 2.059e-03; norm: 1.910e-01
## It: 238; obj: 1.177e+00; abs: 4.827e-03; rel: 4.119e-03; norm: 1.908e-01
## It: 239; obj: 1.170e+00; abs: 6.744e-03; rel: 5.731e-03; norm: 1.909e-01
## It: 240; obj: 1.170e+00; abs: 1.819e-04; rel: 1.555e-04; norm: 1.913e-01
## It: 241; obj: 1.174e+00; abs: 3.951e-03; rel: 3.377e-03; norm: 1.909e-01
## It: 242; obj: 1.174e+00; abs: 1.303e-06; rel: 1.110e-06; norm: 1.912e-01
## It: 243; obj: 1.172e+00; abs: 1.683e-03; rel: 1.434e-03; norm: 1.910e-01
## It: 244; obj: 1.174e+00; abs: 1.579e-03; rel: 1.347e-03; norm: 1.910e-01
## It: 245; obj: 1.176e+00; abs: 2.276e-03; rel: 1.940e-03; norm: 1.909e-01
## It: 246; obj: 1.176e+00; abs: 1.997e-04; rel: 1.698e-04; norm: 1.910e-01
## It: 247; obj: 1.172e+00; abs: 3.787e-03; rel: 3.221e-03; norm: 1.908e-01
## It: 248; obj: 1.175e+00; abs: 3.292e-03; rel: 2.809e-03; norm: 1.908e-01
## It: 249; obj: 1.175e+00; abs: 2.001e-04; rel: 1.703e-04; norm: 1.909e-01
## It: 250; obj: 1.173e+00; abs: 2.256e-03; rel: 1.920e-03; norm: 1.910e-01

## It: 251; obj: 1.176e+00; abs: 3.345e-03; rel: 2.853e-03; norm: 1.910e-01
## It: 252; obj: 1.179e+00; abs: 3.299e-03; rel: 2.805e-03; norm: 1.908e-01
## It: 253; obj: 1.178e+00; abs: 1.311e-03; rel: 1.112e-03; norm: 1.907e-01
## It: 254; obj: 1.173e+00; abs: 4.738e-03; rel: 4.021e-03; norm: 1.910e-01
## It: 255; obj: 1.175e+00; abs: 1.456e-03; rel: 1.241e-03; norm: 1.908e-01
## It: 256; obj: 1.180e+00; abs: 5.344e-03; rel: 4.549e-03; norm: 1.908e-01
## It: 257; obj: 1.179e+00; abs: 1.070e-03; rel: 9.065e-04; norm: 1.909e-01
## It: 258; obj: 1.175e+00; abs: 4.087e-03; rel: 3.467e-03; norm: 1.910e-01
## It: 259; obj: 1.175e+00; abs: 4.502e-05; rel: 3.831e-05; norm: 1.907e-01
## It: 260; obj: 1.181e+00; abs: 5.532e-03; rel: 4.708e-03; norm: 1.909e-01
## It: 261; obj: 1.181e+00; abs: 6.620e-04; rel: 5.607e-04; norm: 1.909e-01
## It: 262; obj: 1.181e+00; abs: 8.313e-05; rel: 7.037e-05; norm: 1.907e-01
## It: 263; obj: 1.179e+00; abs: 2.441e-03; rel: 2.067e-03; norm: 1.906e-01
## It: 264; obj: 1.179e+00; abs: 2.926e-04; rel: 2.482e-04; norm: 1.907e-01
## It: 265; obj: 1.180e+00; abs: 1.185e-03; rel: 1.005e-03; norm: 1.910e-01
## It: 266; obj: 1.183e+00; abs: 3.124e-03; rel: 2.647e-03; norm: 1.906e-01
## It: 267; obj: 1.181e+00; abs: 2.420e-03; rel: 2.045e-03; norm: 1.908e-01
## It: 268; obj: 1.181e+00; abs: 4.639e-04; rel: 3.928e-04; norm: 1.907e-01
## It: 269; obj: 1.176e+00; abs: 5.185e-03; rel: 4.389e-03; norm: 1.907e-01
## It: 270; obj: 1.179e+00; abs: 2.907e-03; rel: 2.472e-03; norm: 1.909e-01
## It: 271; obj: 1.181e+00; abs: 1.507e-03; rel: 1.278e-03; norm: 1.909e-01
## It: 272; obj: 1.183e+00; abs: 1.895e-03; rel: 1.605e-03; norm: 1.906e-01
## It: 273; obj: 1.182e+00; abs: 6.114e-04; rel: 5.170e-04; norm: 1.906e-01
## It: 274; obj: 1.180e+00; abs: 1.683e-03; rel: 1.424e-03; norm: 1.910e-01
## It: 275; obj: 1.178e+00; abs: 1.887e-03; rel: 1.599e-03; norm: 1.910e-01

## It: 276; obj: 1.182e+00; abs: 3.464e-03; rel: 2.940e-03; norm: 1.905e-01
## It: 277; obj: 1.181e+00; abs: 1.245e-03; rel: 1.054e-03; norm: 1.906e-01
## It: 278; obj: 1.180e+00; abs: 4.195e-04; rel: 3.554e-04; norm: 1.908e-01
## It: 279; obj: 1.180e+00; abs: 5.844e-04; rel: 4.952e-04; norm: 1.909e-01

```

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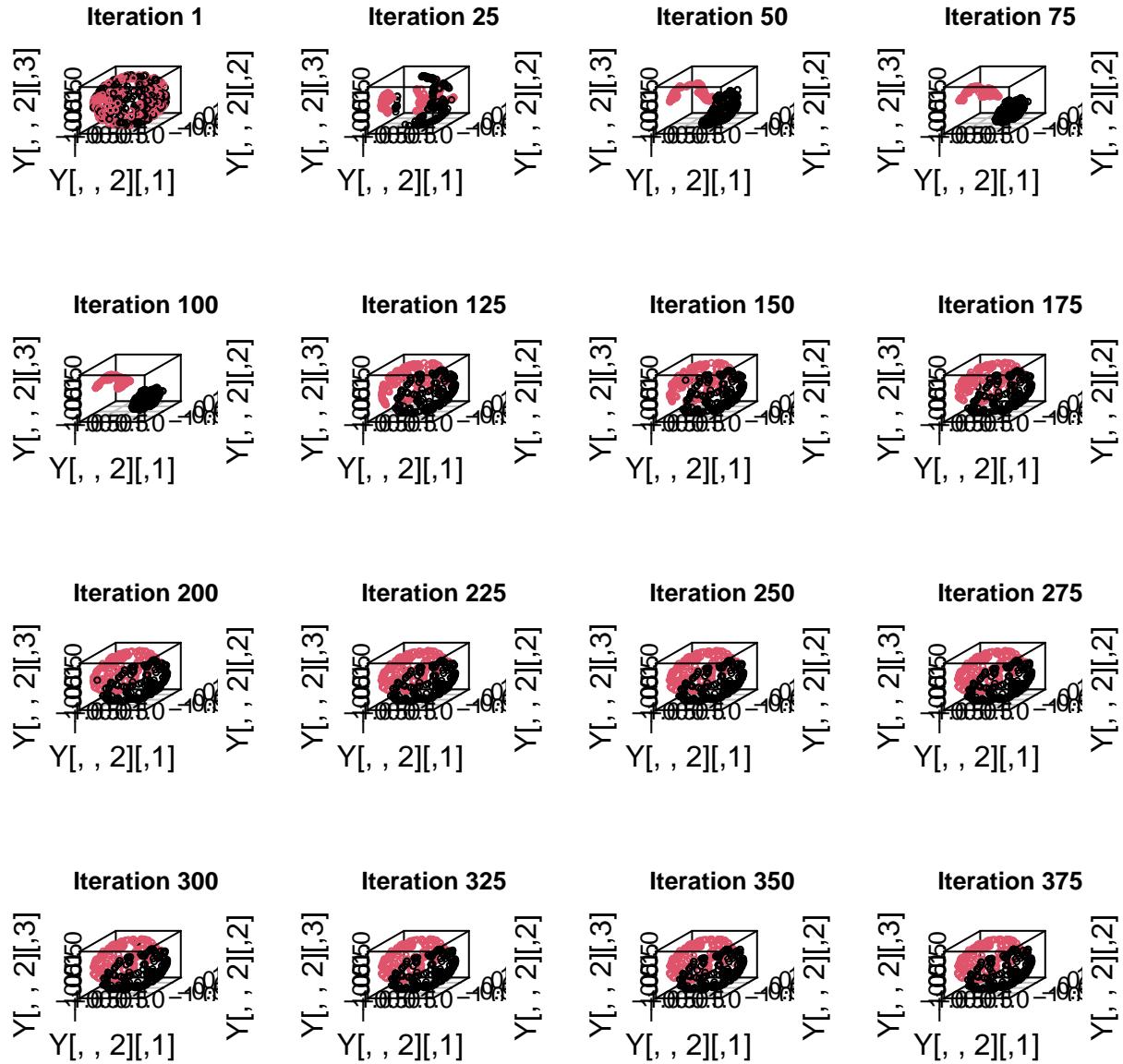
## It: 280; obj: 1.179e+00; abs: 1.560e-04; rel: 1.323e-04; norm: 1.907e-01
## It: 281; obj: 1.181e+00; abs: 1.817e-03; rel: 1.541e-03; norm: 1.907e-01
## It: 282; obj: 1.181e+00; abs: 2.035e-04; rel: 1.723e-04; norm: 1.908e-01
## It: 283; obj: 1.179e+00; abs: 2.011e-03; rel: 1.703e-03; norm: 1.909e-01
## It: 284; obj: 1.179e+00; abs: 6.466e-04; rel: 5.482e-04; norm: 1.904e-01
## It: 285; obj: 1.182e+00; abs: 3.150e-03; rel: 2.673e-03; norm: 1.907e-01
## It: 286; obj: 1.182e+00; abs: 8.755e-05; rel: 7.408e-05; norm: 1.910e-01
## It: 287; obj: 1.179e+00; abs: 2.564e-03; rel: 2.169e-03; norm: 1.908e-01
## It: 288; obj: 1.178e+00; abs: 1.308e-03; rel: 1.109e-03; norm: 1.904e-01
## It: 289; obj: 1.181e+00; abs: 2.653e-03; rel: 2.252e-03; norm: 1.907e-01
## It: 290; obj: 1.184e+00; abs: 3.284e-03; rel: 2.782e-03; norm: 1.911e-01
## It: 291; obj: 1.183e+00; abs: 1.401e-03; rel: 1.183e-03; norm: 1.908e-01
## It: 292; obj: 1.180e+00; abs: 2.555e-03; rel: 2.161e-03; norm: 1.905e-01
## It: 293; obj: 1.179e+00; abs: 1.157e-03; rel: 9.802e-04; norm: 1.906e-01
## It: 294; obj: 1.180e+00; abs: 1.038e-03; rel: 8.804e-04; norm: 1.911e-01
## It: 295; obj: 1.181e+00; abs: 1.423e-03; rel: 1.206e-03; norm: 1.907e-01
## It: 296; obj: 1.183e+00; abs: 1.632e-03; rel: 1.381e-03; norm: 1.908e-01
## It: 297; obj: 1.183e+00; abs: 4.318e-04; rel: 3.650e-04; norm: 1.904e-01
## It: 298; obj: 1.180e+00; abs: 3.061e-03; rel: 2.587e-03; norm: 1.911e-01
## It: 299; obj: 1.179e+00; abs: 1.598e-03; rel: 1.354e-03; norm: 1.908e-01
## It: 300; obj: 1.181e+00; abs: 2.007e-03; rel: 1.703e-03; norm: 1.909e-01
## It: 301; obj: 1.185e+00; abs: 3.741e-03; rel: 3.168e-03; norm: 1.905e-01
## It: 302; obj: 1.182e+00; abs: 2.356e-03; rel: 1.989e-03; norm: 1.909e-01
## It: 303; obj: 1.177e+00; abs: 5.141e-03; rel: 4.349e-03; norm: 1.908e-01
## It: 304; obj: 1.179e+00; abs: 2.398e-03; rel: 2.038e-03; norm: 1.909e-01
## It: 305; obj: 1.186e+00; abs: 6.140e-03; rel: 5.206e-03; norm: 1.906e-01
## It: 306; obj: 1.187e+00; abs: 1.470e-03; rel: 1.240e-03; norm: 1.910e-01
## It: 307; obj: 1.178e+00; abs: 8.931e-03; rel: 7.524e-03; norm: 1.909e-01
## It: 308; obj: 1.178e+00; abs: 4.459e-04; rel: 3.785e-04; norm: 1.909e-01
## It: 309; obj: 1.182e+00; abs: 4.056e-03; rel: 3.444e-03; norm: 1.906e-01
## It: 310; obj: 1.184e+00; abs: 2.525e-03; rel: 2.137e-03; norm: 1.909e-01
## It: 311; obj: 1.181e+00; abs: 3.707e-03; rel: 3.130e-03; norm: 1.907e-01
## It: 312; obj: 1.180e+00; abs: 9.632e-04; rel: 8.159e-04; norm: 1.908e-01
## It: 313; obj: 1.180e+00; abs: 1.881e-05; rel: 1.595e-05; norm: 1.906e-01
## It: 314; obj: 1.181e+00; abs: 1.412e-03; rel: 1.197e-03; norm: 1.907e-01
## It: 315; obj: 1.182e+00; abs: 1.375e-03; rel: 1.164e-03; norm: 1.906e-01
## It: 316; obj: 1.179e+00; abs: 2.927e-03; rel: 2.476e-03; norm: 1.907e-01
## It: 317; obj: 1.178e+00; abs: 1.130e-03; rel: 9.581e-04; norm: 1.909e-01
## It: 318; obj: 1.179e+00; abs: 8.923e-04; rel: 7.573e-04; norm: 1.909e-01
## It: 319; obj: 1.181e+00; abs: 2.031e-03; rel: 1.722e-03; norm: 1.910e-01
## It: 320; obj: 1.181e+00; abs: 1.932e-04; rel: 1.636e-04; norm: 1.905e-01
## It: 321; obj: 1.182e+00; abs: 7.286e-04; rel: 6.167e-04; norm: 1.909e-01
## It: 322; obj: 1.180e+00; abs: 2.223e-03; rel: 1.881e-03; norm: 1.909e-01
## It: 323; obj: 1.181e+00; abs: 9.235e-04; rel: 7.826e-04; norm: 1.908e-01
## It: 324; obj: 1.181e+00; abs: 1.006e-04; rel: 8.520e-05; norm: 1.906e-01
## It: 325; obj: 1.182e+00; abs: 1.447e-03; rel: 1.225e-03; norm: 1.909e-01
## It: 326; obj: 1.180e+00; abs: 2.317e-03; rel: 1.959e-03; norm: 1.910e-01
## It: 327; obj: 1.181e+00; abs: 9.652e-04; rel: 8.179e-04; norm: 1.908e-01
## It: 328; obj: 1.180e+00; abs: 9.413e-04; rel: 7.970e-04; norm: 1.907e-01
## It: 329; obj: 1.182e+00; abs: 1.930e-03; rel: 1.635e-03; norm: 1.908e-01
## It: 330; obj: 1.181e+00; abs: 1.114e-03; rel: 9.424e-04; norm: 1.909e-01
## It: 331; obj: 1.181e+00; abs: 7.777e-05; rel: 6.585e-05; norm: 1.907e-01
## It: 332; obj: 1.181e+00; abs: 3.737e-04; rel: 3.165e-04; norm: 1.908e-01

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## It: 333; obj: 1.179e+00; abs: 1.030e-03; rel: 8.724e-04; norm: 1.907e-01
## It: 334; obj: 1.183e+00; abs: 3.106e-03; rel: 2.634e-03; norm: 1.909e-01
## It: 335; obj: 1.184e+00; abs: 1.047e-03; rel: 8.851e-04; norm: 1.908e-01
## It: 336; obj: 1.183e+00; abs: 2.249e-04; rel: 1.900e-04; norm: 1.910e-01
## It: 337; obj: 1.180e+00; abs: 3.491e-03; rel: 2.950e-03; norm: 1.907e-01
## It: 338; obj: 1.179e+00; abs: 1.149e-03; rel: 9.739e-04; norm: 1.910e-01
## It: 339; obj: 1.178e+00; abs: 1.091e-03; rel: 9.255e-04; norm: 1.908e-01
## It: 340; obj: 1.182e+00; abs: 3.981e-03; rel: 3.381e-03; norm: 1.910e-01
## It: 341; obj: 1.182e+00; abs: 3.856e-04; rel: 3.263e-04; norm: 1.907e-01
## It: 342; obj: 1.181e+00; abs: 1.392e-03; rel: 1.178e-03; norm: 1.909e-01
## It: 343; obj: 1.178e+00; abs: 2.553e-03; rel: 2.163e-03; norm: 1.907e-01
## It: 344; obj: 1.179e+00; abs: 1.069e-03; rel: 9.070e-04; norm: 1.908e-01
## It: 345; obj: 1.178e+00; abs: 1.221e-03; rel: 1.036e-03; norm: 1.907e-01
## It: 346; obj: 1.179e+00; abs: 1.319e-03; rel: 1.120e-03; norm: 1.908e-01
## It: 347; obj: 1.178e+00; abs: 1.369e-03; rel: 1.161e-03; norm: 1.906e-01
## It: 348; obj: 1.180e+00; abs: 2.116e-03; rel: 1.796e-03; norm: 1.908e-01
## It: 349; obj: 1.176e+00; abs: 4.038e-03; rel: 3.422e-03; norm: 1.908e-01
## It: 350; obj: 1.176e+00; abs: 9.692e-05; rel: 8.242e-05; norm: 1.909e-01
## It: 351; obj: 1.177e+00; abs: 1.148e-03; rel: 9.763e-04; norm: 1.908e-01
## It: 352; obj: 1.180e+00; abs: 2.507e-03; rel: 2.130e-03; norm: 1.908e-01
## It: 353; obj: 1.179e+00; abs: 6.877e-05; rel: 5.830e-05; norm: 1.907e-01
## It: 354; obj: 1.182e+00; abs: 2.500e-03; rel: 2.120e-03; norm: 1.908e-01
## It: 355; obj: 1.183e+00; abs: 1.263e-03; rel: 1.069e-03; norm: 1.909e-01
## It: 356; obj: 1.182e+00; abs: 1.449e-03; rel: 1.224e-03; norm: 1.910e-01
## It: 357; obj: 1.178e+00; abs: 3.293e-03; rel: 2.786e-03; norm: 1.908e-01
## It: 358; obj: 1.179e+00; abs: 7.971e-04; rel: 6.764e-04; norm: 1.906e-01
## It: 359; obj: 1.180e+00; abs: 6.030e-04; rel: 5.114e-04; norm: 1.907e-01
## It: 360; obj: 1.180e+00; abs: 3.234e-04; rel: 2.741e-04; norm: 1.909e-01
## It: 361; obj: 1.180e+00; abs: 7.474e-04; rel: 6.336e-04; norm: 1.908e-01
## It: 362; obj: 1.181e+00; abs: 6.631e-04; rel: 5.618e-04; norm: 1.907e-01
## It: 363; obj: 1.179e+00; abs: 2.005e-03; rel: 1.698e-03; norm: 1.907e-01
## It: 364; obj: 1.179e+00; abs: 2.892e-04; rel: 2.453e-04; norm: 1.909e-01
## It: 365; obj: 1.182e+00; abs: 2.835e-03; rel: 2.405e-03; norm: 1.908e-01
## It: 366; obj: 1.181e+00; abs: 2.856e-05; rel: 2.417e-05; norm: 1.907e-01
## It: 367; obj: 1.176e+00; abs: 5.100e-03; rel: 4.317e-03; norm: 1.905e-01
## It: 368; obj: 1.176e+00; abs: 7.760e-04; rel: 6.597e-04; norm: 1.908e-01
## It: 369; obj: 1.179e+00; abs: 2.900e-03; rel: 2.467e-03; norm: 1.908e-01
## It: 370; obj: 1.183e+00; abs: 4.165e-03; rel: 3.534e-03; norm: 1.908e-01
## It: 371; obj: 1.182e+00; abs: 1.125e-03; rel: 9.510e-04; norm: 1.906e-01
## It: 372; obj: 1.177e+00; abs: 4.347e-03; rel: 3.679e-03; norm: 1.907e-01
## It: 373; obj: 1.179e+00; abs: 1.761e-03; rel: 1.496e-03; norm: 1.908e-01
## It: 374; obj: 1.180e+00; abs: 7.535e-04; rel: 6.391e-04; norm: 1.910e-01
## It: 375; obj: 1.180e+00; abs: 7.855e-04; rel: 6.659e-04; norm: 1.908e-01

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## It: 376; obj: 1.178e+00; abs: 2.601e-03; rel: 2.203e-03; norm: 1.908e-01
## It: 377; obj: 1.178e+00; abs: 4.583e-04; rel: 3.891e-04; norm: 1.906e-01
## It: 378; obj: 1.182e+00; abs: 4.127e-03; rel: 3.502e-03; norm: 1.909e-01
## It: 379; obj: 1.182e+00; abs: 8.290e-04; rel: 7.011e-04; norm: 1.910e-01
## It: 380; obj: 1.180e+00; abs: 1.176e-03; rel: 9.952e-04; norm: 1.908e-01
## It: 381; obj: 1.181e+00; abs: 5.906e-04; rel: 5.003e-04; norm: 1.906e-01
## It: 382; obj: 1.181e+00; abs: 3.411e-04; rel: 2.888e-04; norm: 1.910e-01
## It: 383; obj: 1.176e+00; abs: 4.864e-03; rel: 4.120e-03; norm: 1.909e-01
## It: 384; obj: 1.178e+00; abs: 1.671e-03; rel: 1.421e-03; norm: 1.909e-01
## It: 385; obj: 1.183e+00; abs: 5.183e-03; rel: 4.401e-03; norm: 1.906e-01
## It: 386; obj: 1.185e+00; abs: 2.060e-03; rel: 1.742e-03; norm: 1.909e-01
## It: 387; obj: 1.177e+00; abs: 7.639e-03; rel: 6.448e-03; norm: 1.907e-01
## It: 388; obj: 1.177e+00; abs: 4.503e-04; rel: 3.826e-04; norm: 1.907e-01
## It: 389; obj: 1.180e+00; abs: 3.383e-03; rel: 2.875e-03; norm: 1.908e-01
## It: 390; obj: 1.183e+00; abs: 3.277e-03; rel: 2.777e-03; norm: 1.909e-01
## It: 391; obj: 1.177e+00; abs: 6.497e-03; rel: 5.491e-03; norm: 1.907e-01
## It: 392; obj: 1.177e+00; abs: 1.551e-04; rel: 1.318e-04; norm: 1.908e-01

```

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## It: 393; obj: 1.178e+00; abs: 7.983e-04; rel: 6.783e-04; norm: 1.907e-01
## It: 394; obj: 1.179e+00; abs: 1.490e-03; rel: 1.265e-03; norm: 1.910e-01
## It: 395; obj: 1.179e+00; abs: 6.664e-04; rel: 5.650e-04; norm: 1.907e-01
## It: 396; obj: 1.179e+00; abs: 3.159e-04; rel: 2.680e-04; norm: 1.909e-01
## It: 397; obj: 1.182e+00; abs: 3.232e-03; rel: 2.742e-03; norm: 1.905e-01
## It: 398; obj: 1.183e+00; abs: 7.180e-04; rel: 6.074e-04; norm: 1.910e-01
## It: 399; obj: 1.182e+00; abs: 1.117e-03; rel: 9.445e-04; norm: 1.910e-01
## It: 400; obj: 1.179e+00; abs: 3.022e-03; rel: 2.557e-03; norm: 1.909e-01

## It: 401; obj: 1.180e+00; abs: 1.484e-03; rel: 1.259e-03; norm: 1.906e-01
## It: 402; obj: 1.180e+00; abs: 1.122e-04; rel: 9.508e-05; norm: 1.910e-01
## It: 403; obj: 1.180e+00; abs: 2.731e-04; rel: 2.314e-04; norm: 1.911e-01
## It: 404; obj: 1.178e+00; abs: 1.652e-03; rel: 1.400e-03; norm: 1.907e-01
## It: 405; obj: 1.183e+00; abs: 4.147e-03; rel: 3.519e-03; norm: 1.907e-01
## It: 406; obj: 1.184e+00; abs: 1.012e-03; rel: 8.555e-04; norm: 1.910e-01
## It: 407; obj: 1.182e+00; abs: 1.803e-03; rel: 1.523e-03; norm: 1.910e-01
## It: 408; obj: 1.178e+00; abs: 3.669e-03; rel: 3.104e-03; norm: 1.908e-01
## It: 409; obj: 1.181e+00; abs: 2.962e-03; rel: 2.514e-03; norm: 1.906e-01
## It: 410; obj: 1.183e+00; abs: 1.536e-03; rel: 1.301e-03; norm: 1.912e-01
## It: 411; obj: 1.182e+00; abs: 9.363e-04; rel: 7.917e-04; norm: 1.909e-01
## It: 412; obj: 1.179e+00; abs: 2.530e-03; rel: 2.141e-03; norm: 1.907e-01
## It: 413; obj: 1.181e+00; abs: 2.183e-03; rel: 1.851e-03; norm: 1.906e-01
## It: 414; obj: 1.182e+00; abs: 1.163e-03; rel: 9.847e-04; norm: 1.912e-01
## It: 415; obj: 1.180e+00; abs: 2.245e-03; rel: 1.898e-03; norm: 1.910e-01
## It: 416; obj: 1.178e+00; abs: 2.328e-03; rel: 1.973e-03; norm: 1.907e-01
## It: 417; obj: 1.182e+00; abs: 3.754e-03; rel: 3.187e-03; norm: 1.904e-01
## It: 418; obj: 1.184e+00; abs: 2.169e-03; rel: 1.836e-03; norm: 1.912e-01
## It: 419; obj: 1.181e+00; abs: 2.880e-03; rel: 2.433e-03; norm: 1.910e-01
## It: 420; obj: 1.178e+00; abs: 2.847e-03; rel: 2.410e-03; norm: 1.909e-01
## It: 421; obj: 1.181e+00; abs: 3.358e-03; rel: 2.850e-03; norm: 1.904e-01
## It: 422; obj: 1.183e+00; abs: 1.612e-03; rel: 1.365e-03; norm: 1.912e-01
## It: 423; obj: 1.181e+00; abs: 2.207e-03; rel: 1.865e-03; norm: 1.910e-01
## It: 424; obj: 1.180e+00; abs: 1.376e-03; rel: 1.165e-03; norm: 1.908e-01
## It: 425; obj: 1.182e+00; abs: 2.743e-03; rel: 2.326e-03; norm: 1.906e-01

## It: 426; obj: 1.182e+00; abs: 1.821e-04; rel: 1.540e-04; norm: 1.911e-01
## It: 427; obj: 1.180e+00; abs: 2.001e-03; rel: 1.692e-03; norm: 1.908e-01
## It: 428; obj: 1.180e+00; abs: 5.696e-05; rel: 4.826e-05; norm: 1.908e-01
## It: 429; obj: 1.182e+00; abs: 1.492e-03; rel: 1.264e-03; norm: 1.907e-01
## It: 430; obj: 1.180e+00; abs: 1.676e-03; rel: 1.418e-03; norm: 1.909e-01
## It: 431; obj: 1.178e+00; abs: 2.784e-03; rel: 2.358e-03; norm: 1.907e-01
## It: 432; obj: 1.180e+00; abs: 2.938e-03; rel: 2.495e-03; norm: 1.909e-01
## It: 433; obj: 1.185e+00; abs: 4.107e-03; rel: 3.479e-03; norm: 1.906e-01
## It: 434; obj: 1.181e+00; abs: 3.184e-03; rel: 2.688e-03; norm: 1.909e-01
## It: 435; obj: 1.175e+00; abs: 6.500e-03; rel: 5.502e-03; norm: 1.908e-01
## It: 436; obj: 1.178e+00; abs: 2.994e-03; rel: 2.548e-03; norm: 1.909e-01
## It: 437; obj: 1.185e+00; abs: 6.656e-03; rel: 5.651e-03; norm: 1.906e-01
## It: 438; obj: 1.183e+00; abs: 1.800e-03; rel: 1.520e-03; norm: 1.909e-01
## It: 439; obj: 1.177e+00; abs: 5.259e-03; rel: 4.446e-03; norm: 1.909e-01
## It: 440; obj: 1.178e+00; abs: 1.278e-04; rel: 1.085e-04; norm: 1.908e-01
## It: 441; obj: 1.183e+00; abs: 5.647e-03; rel: 4.795e-03; norm: 1.906e-01
## It: 442; obj: 1.182e+00; abs: 1.080e-03; rel: 9.126e-04; norm: 1.910e-01
## It: 443; obj: 1.179e+00; abs: 3.409e-03; rel: 2.884e-03; norm: 1.909e-01
## It: 444; obj: 1.179e+00; abs: 5.073e-04; rel: 4.304e-04; norm: 1.906e-01
## It: 445; obj: 1.184e+00; abs: 4.355e-03; rel: 3.693e-03; norm: 1.906e-01

```

```

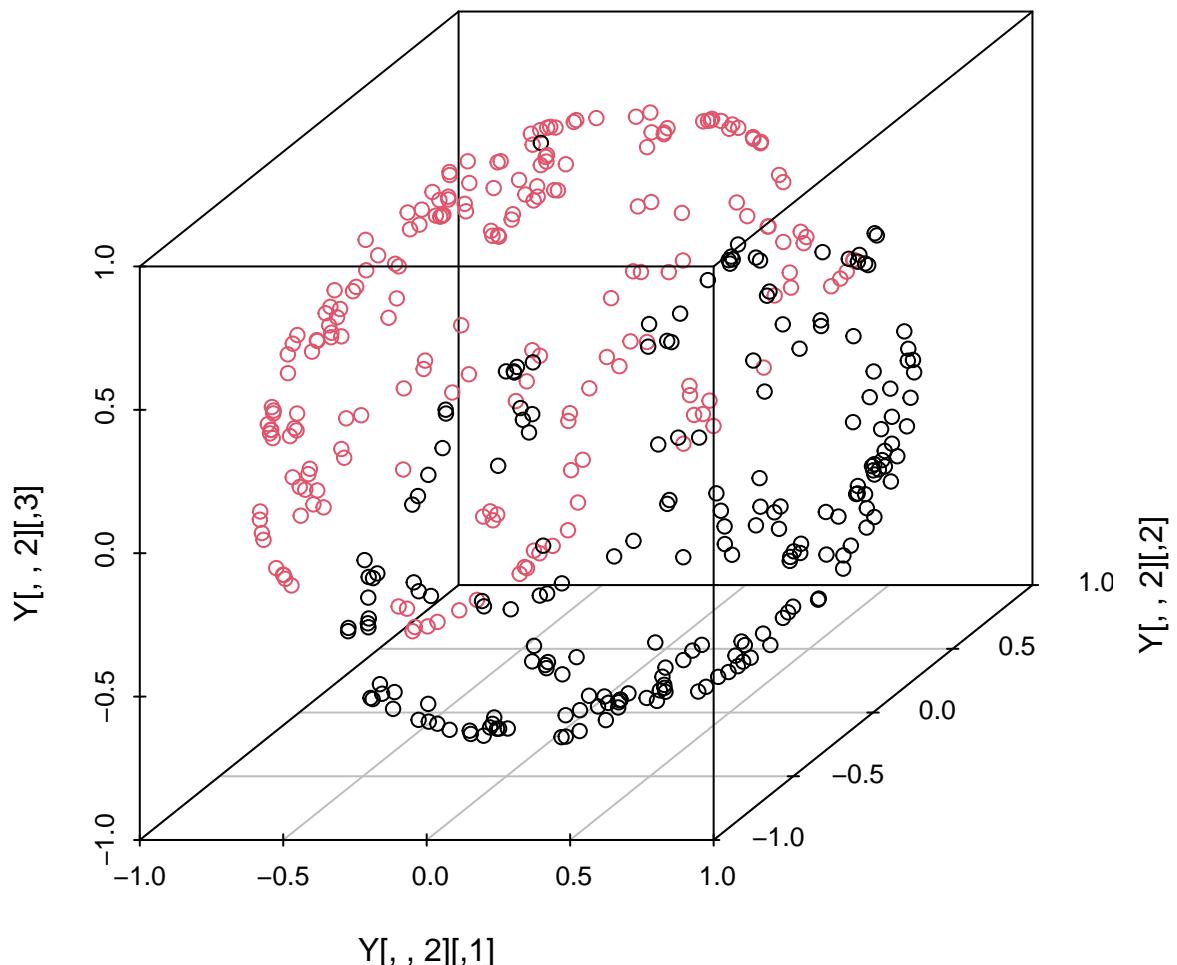
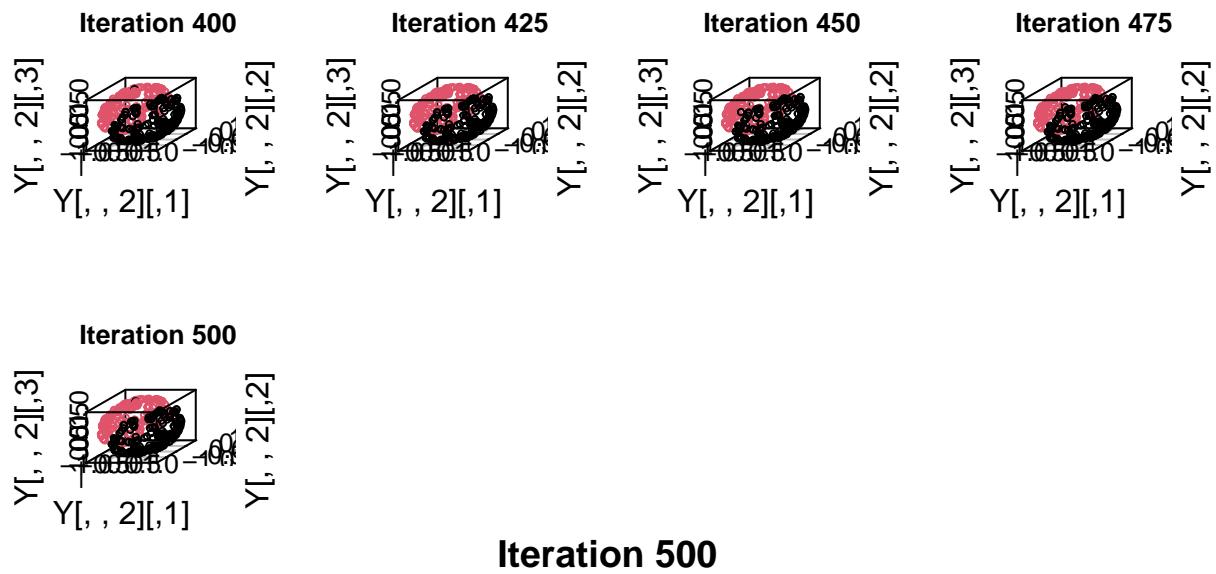
## It: 446; obj: 1.182e+00; abs: 2.035e-03; rel: 1.719e-03; norm: 1.912e-01
## It: 447; obj: 1.179e+00; abs: 2.456e-03; rel: 2.079e-03; norm: 1.910e-01
## It: 448; obj: 1.181e+00; abs: 1.384e-03; rel: 1.174e-03; norm: 1.908e-01
## It: 449; obj: 1.184e+00; abs: 3.894e-03; rel: 3.299e-03; norm: 1.906e-01
## It: 450; obj: 1.181e+00; abs: 3.611e-03; rel: 3.048e-03; norm: 1.912e-01
## It: 451; obj: 1.179e+00; abs: 1.836e-03; rel: 1.555e-03; norm: 1.910e-01
## It: 452; obj: 1.181e+00; abs: 1.974e-03; rel: 1.675e-03; norm: 1.909e-01
## It: 453; obj: 1.184e+00; abs: 3.151e-03; rel: 2.669e-03; norm: 1.906e-01
## It: 454; obj: 1.180e+00; abs: 4.033e-03; rel: 3.406e-03; norm: 1.912e-01
## It: 455; obj: 1.178e+00; abs: 1.743e-03; rel: 1.477e-03; norm: 1.910e-01
## It: 456; obj: 1.180e+00; abs: 1.572e-03; rel: 1.334e-03; norm: 1.907e-01
## It: 457; obj: 1.184e+00; abs: 4.467e-03; rel: 3.786e-03; norm: 1.906e-01
## It: 458; obj: 1.183e+00; abs: 1.379e-03; rel: 1.164e-03; norm: 1.911e-01
## It: 459; obj: 1.179e+00; abs: 4.378e-03; rel: 3.701e-03; norm: 1.910e-01
## It: 460; obj: 1.177e+00; abs: 1.158e-03; rel: 9.822e-04; norm: 1.906e-01
## It: 461; obj: 1.182e+00; abs: 4.960e-03; rel: 4.212e-03; norm: 1.907e-01
## It: 462; obj: 1.185e+00; abs: 2.939e-03; rel: 2.485e-03; norm: 1.911e-01
## It: 463; obj: 1.180e+00; abs: 5.703e-03; rel: 4.812e-03; norm: 1.911e-01
## It: 464; obj: 1.177e+00; abs: 3.036e-03; rel: 2.574e-03; norm: 1.907e-01
## It: 465; obj: 1.181e+00; abs: 4.701e-03; rel: 3.996e-03; norm: 1.907e-01
## It: 466; obj: 1.184e+00; abs: 3.103e-03; rel: 2.626e-03; norm: 1.912e-01
## It: 467; obj: 1.181e+00; abs: 3.494e-03; rel: 2.950e-03; norm: 1.910e-01
## It: 468; obj: 1.179e+00; abs: 1.805e-03; rel: 1.529e-03; norm: 1.907e-01
## It: 469; obj: 1.182e+00; abs: 2.858e-03; rel: 2.424e-03; norm: 1.906e-01
## It: 470; obj: 1.182e+00; abs: 1.535e-04; rel: 1.298e-04; norm: 1.912e-01
## It: 471; obj: 1.179e+00; abs: 2.687e-03; rel: 2.273e-03; norm: 1.910e-01
## It: 472; obj: 1.180e+00; abs: 1.930e-04; rel: 1.637e-04; norm: 1.907e-01
## It: 473; obj: 1.183e+00; abs: 3.822e-03; rel: 3.240e-03; norm: 1.907e-01
## It: 474; obj: 1.183e+00; abs: 6.572e-04; rel: 5.554e-04; norm: 1.912e-01
## It: 475; obj: 1.178e+00; abs: 4.857e-03; rel: 4.106e-03; norm: 1.909e-01
## It: 476; obj: 1.179e+00; abs: 6.892e-04; rel: 5.851e-04; norm: 1.908e-01
## It: 477; obj: 1.182e+00; abs: 3.883e-03; rel: 3.295e-03; norm: 1.907e-01
## It: 478; obj: 1.183e+00; abs: 1.670e-04; rel: 1.412e-04; norm: 1.911e-01
## It: 479; obj: 1.182e+00; abs: 2.204e-04; rel: 1.864e-04; norm: 1.909e-01
## It: 480; obj: 1.178e+00; abs: 4.312e-03; rel: 3.647e-03; norm: 1.907e-01
## It: 481; obj: 1.181e+00; abs: 2.466e-03; rel: 2.093e-03; norm: 1.908e-01
## It: 482; obj: 1.181e+00; abs: 5.648e-04; rel: 4.784e-04; norm: 1.910e-01
## It: 483; obj: 1.183e+00; abs: 1.850e-03; rel: 1.566e-03; norm: 1.912e-01
## It: 484; obj: 1.180e+00; abs: 3.384e-03; rel: 2.861e-03; norm: 1.908e-01
## It: 485; obj: 1.181e+00; abs: 1.528e-03; rel: 1.296e-03; norm: 1.909e-01
## It: 486; obj: 1.181e+00; abs: 4.962e-05; rel: 4.201e-05; norm: 1.911e-01
## It: 487; obj: 1.181e+00; abs: 1.623e-04; rel: 1.374e-04; norm: 1.911e-01
## It: 488; obj: 1.179e+00; abs: 1.789e-03; rel: 1.514e-03; norm: 1.907e-01
## It: 489; obj: 1.182e+00; abs: 2.946e-03; rel: 2.497e-03; norm: 1.907e-01
## It: 490; obj: 1.182e+00; abs: 2.510e-04; rel: 2.122e-04; norm: 1.911e-01
## It: 491; obj: 1.181e+00; abs: 1.394e-03; rel: 1.179e-03; norm: 1.909e-01
## It: 492; obj: 1.177e+00; abs: 3.931e-03; rel: 3.329e-03; norm: 1.906e-01
## It: 493; obj: 1.180e+00; abs: 3.369e-03; rel: 2.863e-03; norm: 1.907e-01
## It: 494; obj: 1.182e+00; abs: 1.861e-03; rel: 1.576e-03; norm: 1.911e-01
## It: 495; obj: 1.182e+00; abs: 3.677e-04; rel: 3.111e-04; norm: 1.909e-01
## It: 496; obj: 1.179e+00; abs: 2.428e-03; rel: 2.054e-03; norm: 1.907e-01
## It: 497; obj: 1.181e+00; abs: 1.359e-03; rel: 1.153e-03; norm: 1.907e-01
## It: 498; obj: 1.180e+00; abs: 3.250e-04; rel: 2.753e-04; norm: 1.911e-01

```

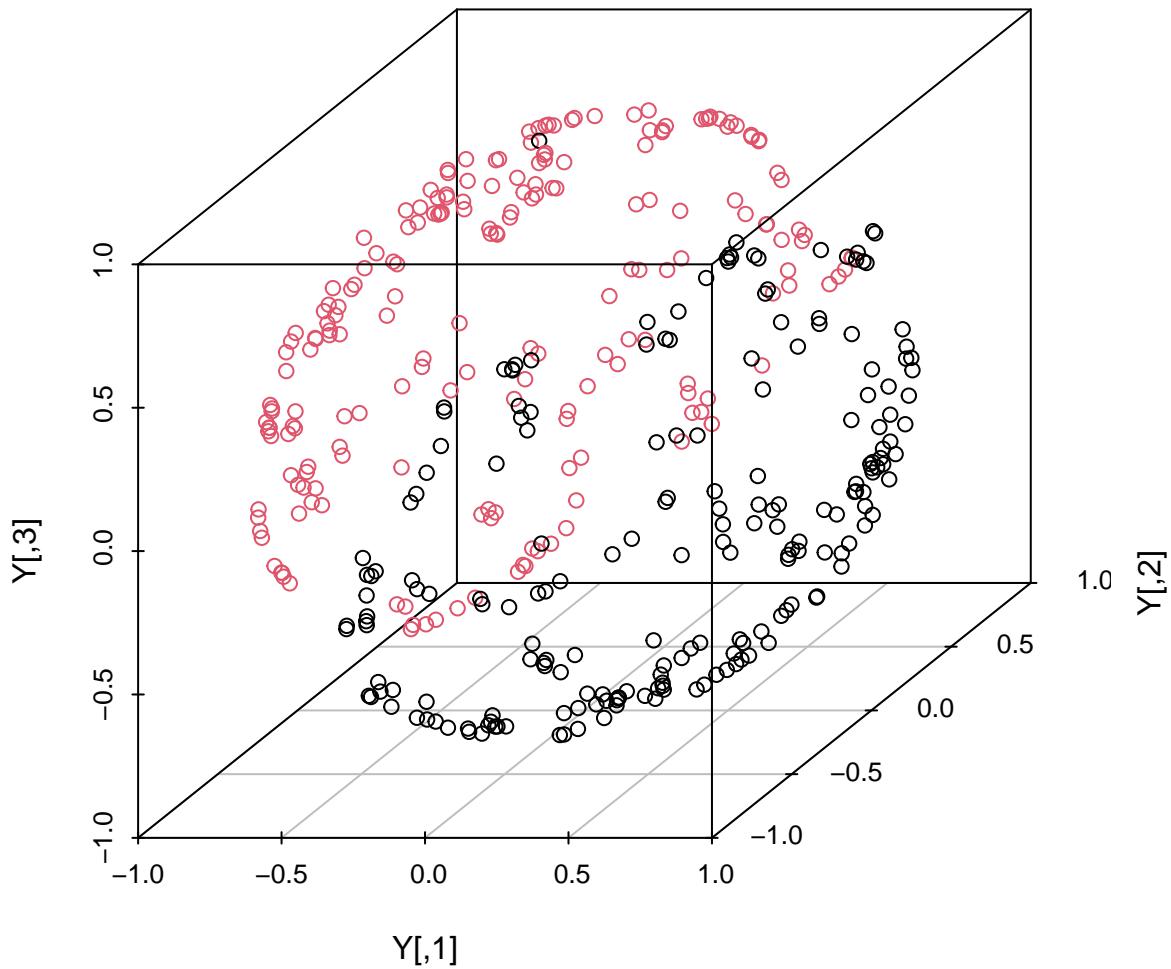
```

## It: 499; obj: 1.180e+00; abs: 3.216e-04; rel: 2.725e-04; norm: 1.909e-01
## It: 500; obj: 1.179e+00; abs: 1.260e-03; rel: 1.067e-03; norm: 1.906e-01

```



```
scatterplot3d::scatterplot3d(Y, xlim = c(-1, 1), ylim = c(-1, 1),
                             zlim = c(-1, 1), color = colors)
```



It's clearly clustered the two groups we had in the original generated data.

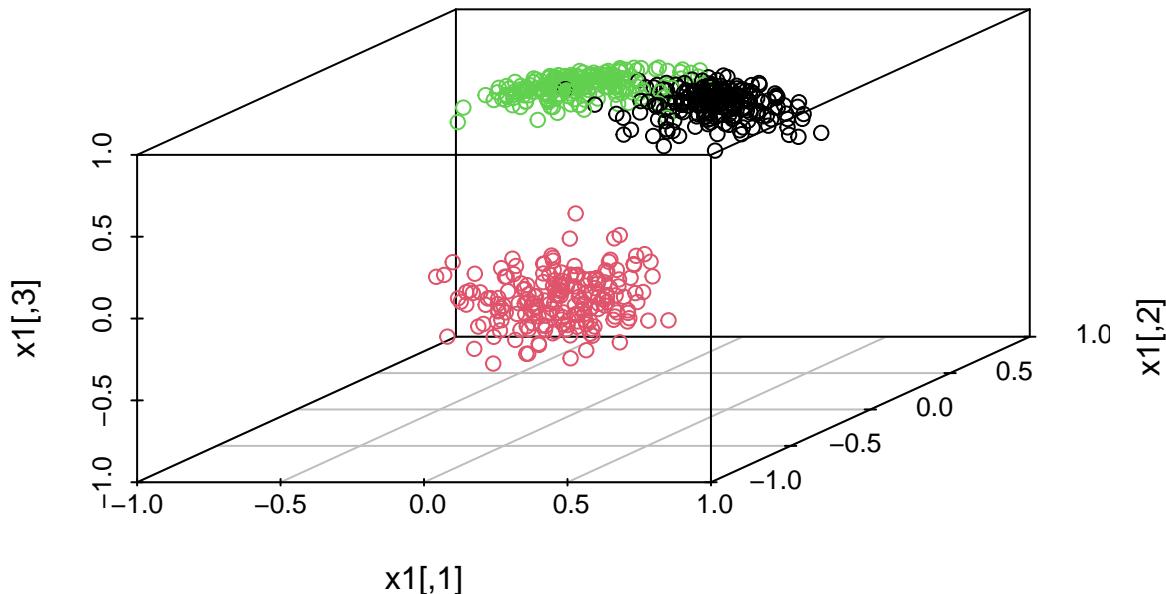
Case 2

Sample on the $(\mathbb{S}^2)^2$ where $p = 2$ and $r = 2$.

```
n=200
d=2
r=2
samp1 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_sph(th = 0, ph = 0.5)),
                           kappa = 50)
samp2 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_sph(th = 2, ph = -1.5)),
                           kappa = 50)
samp3 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_sph(th = -1, ph = 0)),
                           kappa = 50)
x1 <- rbind(samp1, samp2, samp3)

scatterplot3d::scatterplot3d(x1,
                             xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
                             color = rep(1:3, each = n), main="Sphere 1")
```

Sphere 1



```

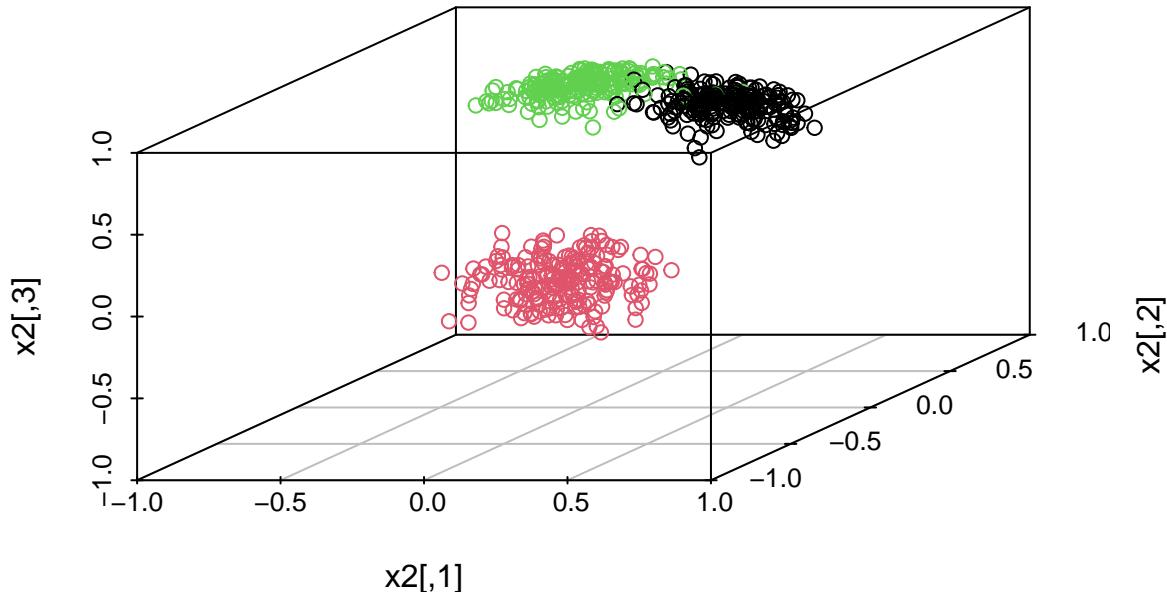
rgl::plot3d(0, 0, 0, xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
            radius = 1, type = "s", col = "lightblue", alpha = 0.25,
            lit = FALSE)
rgl::points3d(x1, col = rep(c(1,2,3), each=n))

samp4 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_sph(th = 0, ph = 0.55)),
                           kappa = 60)
samp5 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_sph(th = 2, ph = -1.41)),
                           kappa = 60)
samp6 <- rotasym::r_vMF(n = n, mu = drop(DirStats::to_sph(th = -1.1, ph = 0.05)),
                           kappa = 60)
x2 <- rbind(samp4, samp5, samp6)

scatterplot3d::scatterplot3d(x2,
                             xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
                             color = rep(1:3, each = n), main="Sphere 2")

```

Sphere 2



```

rgl::plot3d(0, 0, 0, xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
            radius = 1, type = "s", col = "lightblue", alpha = 0.25,
            lit = FALSE)
rgl::points3d(x2, col = rep(c(1,2,3), each=n))

x_2 <- array(dim = c(n*3, 3, 2))
x_2[, , 1] <- x1
x_2[, , 2] <- x2

n <- nrow(x_2)
indexes <- sample(1:n)
x_2 <- x_2[indexes,,]
colors <- rep(c(1, 2, 3), each = n / 3)[indexes]

```

Let's calculate the rho parameters based on a perplexity of 20:

```
rho_second_perp20 <- rho_optim_bst(x_2, 20)
```

```
## Time difference of 55.43019 secs
```

First, let's reduce to dimension \mathbb{S}^1 then $d = 1$ (circumference):

```
Y <- psc_sne(X=x_2, d=1, rho_psc_list = rho_second_perp20, num_iteration=500,
               colors=colors, visualize_prog = TRUE)
```

```

## It: 1; obj: 1.844e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.308e-01
## It: 2; obj: 1.767e+01; abs: 7.733e-01; rel: 4.193e-02; norm: 2.948e-01
## It: 3; obj: 1.719e+01; abs: 4.818e-01; rel: 2.727e-02; norm: 3.923e-01
## It: 4; obj: 1.687e+01; abs: 3.196e-01; rel: 1.860e-02; norm: 4.553e-01
## It: 5; obj: 1.665e+01; abs: 2.148e-01; rel: 1.273e-02; norm: 4.972e-01
## It: 6; obj: 1.649e+01; abs: 1.642e-01; rel: 9.861e-03; norm: 5.234e-01
## It: 7; obj: 1.636e+01; abs: 1.311e-01; rel: 7.951e-03; norm: 5.471e-01

```

```

## It: 8; obj: 1.625e+01; abs: 1.048e-01; rel: 6.408e-03; norm: 5.780e-01
## It: 9; obj: 1.616e+01; abs: 8.815e-02; rel: 5.424e-03; norm: 6.058e-01
## It: 10; obj: 1.609e+01; abs: 7.555e-02; rel: 4.674e-03; norm: 6.325e-01
## It: 11; obj: 1.602e+01; abs: 6.688e-02; rel: 4.157e-03; norm: 6.588e-01
## It: 12; obj: 1.597e+01; abs: 5.252e-02; rel: 3.278e-03; norm: 6.832e-01
## It: 13; obj: 1.592e+01; abs: 4.631e-02; rel: 2.900e-03; norm: 7.049e-01
## It: 14; obj: 1.587e+01; abs: 4.802e-02; rel: 3.016e-03; norm: 7.233e-01
## It: 15; obj: 1.583e+01; abs: 4.689e-02; rel: 2.954e-03; norm: 7.403e-01
## It: 16; obj: 1.579e+01; abs: 4.299e-02; rel: 2.716e-03; norm: 7.566e-01
## It: 17; obj: 1.575e+01; abs: 3.596e-02; rel: 2.278e-03; norm: 7.729e-01
## It: 18; obj: 1.572e+01; abs: 3.025e-02; rel: 1.921e-03; norm: 7.885e-01
## It: 19; obj: 1.569e+01; abs: 2.628e-02; rel: 1.672e-03; norm: 8.033e-01
## It: 20; obj: 1.567e+01; abs: 2.327e-02; rel: 1.483e-03; norm: 8.174e-01
## It: 21; obj: 1.565e+01; abs: 2.018e-02; rel: 1.288e-03; norm: 8.309e-01
## It: 22; obj: 1.563e+01; abs: 1.665e-02; rel: 1.064e-03; norm: 8.440e-01
## It: 23; obj: 1.562e+01; abs: 1.332e-02; rel: 8.518e-04; norm: 8.560e-01
## It: 24; obj: 1.561e+01; abs: 1.013e-02; rel: 6.487e-04; norm: 8.667e-01
## It: 25; obj: 1.560e+01; abs: 8.347e-03; rel: 5.347e-04; norm: 8.761e-01
## It: 26; obj: 1.560e+01; abs: 5.454e-03; rel: 3.496e-04; norm: 8.843e-01
## It: 27; obj: 1.559e+01; abs: 3.519e-03; rel: 2.257e-04; norm: 8.912e-01
## It: 28; obj: 1.559e+01; abs: 3.151e-03; rel: 2.021e-04; norm: 8.968e-01
## It: 29; obj: 1.559e+01; abs: 3.480e-03; rel: 2.232e-04; norm: 9.014e-01
## It: 30; obj: 1.558e+01; abs: 3.946e-03; rel: 2.532e-04; norm: 9.052e-01
## It: 31; obj: 1.558e+01; abs: 4.503e-03; rel: 2.890e-04; norm: 9.082e-01
## It: 32; obj: 1.557e+01; abs: 5.277e-03; rel: 3.388e-04; norm: 9.107e-01
## It: 33; obj: 1.557e+01; abs: 6.164e-03; rel: 3.959e-04; norm: 9.128e-01
## It: 34; obj: 1.556e+01; abs: 6.855e-03; rel: 4.404e-04; norm: 9.145e-01
## It: 35; obj: 1.555e+01; abs: 7.055e-03; rel: 4.535e-04; norm: 9.160e-01
## It: 36; obj: 1.554e+01; abs: 6.784e-03; rel: 4.362e-04; norm: 9.173e-01
## It: 37; obj: 1.554e+01; abs: 6.133e-03; rel: 3.946e-04; norm: 9.185e-01
## It: 38; obj: 1.553e+01; abs: 5.116e-03; rel: 3.292e-04; norm: 9.194e-01
## It: 39; obj: 1.553e+01; abs: 3.864e-03; rel: 2.487e-04; norm: 9.201e-01
## It: 40; obj: 1.553e+01; abs: 2.616e-03; rel: 1.684e-04; norm: 9.206e-01
## It: 41; obj: 1.553e+01; abs: 1.594e-03; rel: 1.026e-04; norm: 9.210e-01
## It: 42; obj: 1.552e+01; abs: 9.383e-04; rel: 6.044e-05; norm: 9.214e-01
## It: 43; obj: 1.552e+01; abs: 5.655e-04; rel: 3.643e-05; norm: 9.219e-01
## It: 44; obj: 1.552e+01; abs: 9.183e-05; rel: 5.916e-06; norm: 9.226e-01
## It: 45; obj: 1.552e+01; abs: 8.881e-04; rel: 5.721e-05; norm: 9.235e-01
## It: 46; obj: 1.553e+01; abs: 1.826e-03; rel: 1.176e-04; norm: 9.246e-01
## It: 47; obj: 1.553e+01; abs: 1.835e-03; rel: 1.182e-04; norm: 9.255e-01
## It: 48; obj: 1.553e+01; abs: 1.572e-03; rel: 1.012e-04; norm: 9.263e-01
## It: 49; obj: 1.553e+01; abs: 1.296e-03; rel: 8.343e-05; norm: 9.271e-01
## It: 50; obj: 1.553e+01; abs: 8.223e-04; rel: 5.295e-05; norm: 9.278e-01
## It: 51; obj: 1.553e+01; abs: 1.025e-03; rel: 6.597e-05; norm: 9.285e-01
## It: 52; obj: 1.553e+01; abs: 1.455e-03; rel: 9.369e-05; norm: 9.291e-01
## It: 53; obj: 1.554e+01; abs: 1.421e-03; rel: 9.150e-05; norm: 9.294e-01
## It: 54; obj: 1.554e+01; abs: 1.189e-03; rel: 7.656e-05; norm: 9.295e-01
## It: 55; obj: 1.554e+01; abs: 9.585e-04; rel: 6.169e-05; norm: 9.295e-01
## It: 56; obj: 1.554e+01; abs: 7.713e-04; rel: 4.964e-05; norm: 9.294e-01
## It: 57; obj: 1.554e+01; abs: 6.250e-04; rel: 4.022e-05; norm: 9.294e-01
## It: 58; obj: 1.554e+01; abs: 5.108e-04; rel: 3.287e-05; norm: 9.293e-01
## It: 59; obj: 1.554e+01; abs: 4.210e-04; rel: 2.709e-05; norm: 9.292e-01
## It: 60; obj: 1.554e+01; abs: 3.496e-04; rel: 2.250e-05; norm: 9.291e-01

```

```

## It: 61; obj: 1.554e+01; abs: 2.920e-04; rel: 1.879e-05; norm: 9.290e-01
## It: 62; obj: 1.554e+01; abs: 2.448e-04; rel: 1.575e-05; norm: 9.289e-01
## It: 63; obj: 1.554e+01; abs: 2.054e-04; rel: 1.322e-05; norm: 9.288e-01
## It: 64; obj: 1.554e+01; abs: 1.720e-04; rel: 1.107e-05; norm: 9.287e-01
## It: 65; obj: 1.554e+01; abs: 1.431e-04; rel: 9.206e-06; norm: 9.286e-01
## It: 66; obj: 1.554e+01; abs: 1.177e-04; rel: 7.571e-06; norm: 9.285e-01
## It: 67; obj: 1.554e+01; abs: 9.498e-05; rel: 6.112e-06; norm: 9.284e-01
## It: 68; obj: 1.554e+01; abs: 7.448e-05; rel: 4.792e-06; norm: 9.283e-01
## It: 69; obj: 1.554e+01; abs: 5.574e-05; rel: 3.587e-06; norm: 9.282e-01
## It: 70; obj: 1.554e+01; abs: 3.846e-05; rel: 2.475e-06; norm: 9.281e-01
## It: 71; obj: 1.554e+01; abs: 2.241e-05; rel: 1.442e-06; norm: 9.280e-01
## It: 72; obj: 1.554e+01; abs: 7.399e-06; rel: 4.761e-07; norm: 9.279e-01
## It: 73; obj: 1.554e+01; abs: 6.687e-06; rel: 4.303e-07; norm: 9.278e-01
## It: 74; obj: 1.554e+01; abs: 1.995e-05; rel: 1.284e-06; norm: 9.277e-01
## It: 75; obj: 1.554e+01; abs: 3.248e-05; rel: 2.090e-06; norm: 9.277e-01

## It: 76; obj: 1.554e+01; abs: 4.432e-05; rel: 2.852e-06; norm: 9.276e-01
## It: 77; obj: 1.554e+01; abs: 5.553e-05; rel: 3.573e-06; norm: 9.275e-01
## It: 78; obj: 1.554e+01; abs: 6.614e-05; rel: 4.255e-06; norm: 9.274e-01
## It: 79; obj: 1.554e+01; abs: 7.617e-05; rel: 4.901e-06; norm: 9.274e-01
## It: 80; obj: 1.554e+01; abs: 8.566e-05; rel: 5.511e-06; norm: 9.273e-01
## It: 81; obj: 1.554e+01; abs: 9.461e-05; rel: 6.088e-06; norm: 9.272e-01
## It: 82; obj: 1.554e+01; abs: 1.031e-04; rel: 6.631e-06; norm: 9.272e-01
## It: 83; obj: 1.554e+01; abs: 1.110e-04; rel: 7.142e-06; norm: 9.271e-01
## It: 84; obj: 1.554e+01; abs: 1.185e-04; rel: 7.622e-06; norm: 9.271e-01
## It: 85; obj: 1.554e+01; abs: 1.254e-04; rel: 8.071e-06; norm: 9.270e-01
## It: 86; obj: 1.554e+01; abs: 1.320e-04; rel: 8.491e-06; norm: 9.269e-01
## It: 87; obj: 1.554e+01; abs: 1.380e-04; rel: 8.882e-06; norm: 9.269e-01
## It: 88; obj: 1.554e+01; abs: 1.437e-04; rel: 9.245e-06; norm: 9.268e-01
## It: 89; obj: 1.554e+01; abs: 1.489e-04; rel: 9.580e-06; norm: 9.268e-01
## It: 90; obj: 1.554e+01; abs: 1.537e-04; rel: 9.890e-06; norm: 9.267e-01
## It: 91; obj: 1.554e+01; abs: 1.581e-04; rel: 1.017e-05; norm: 9.267e-01
## It: 92; obj: 1.554e+01; abs: 1.622e-04; rel: 1.043e-05; norm: 9.267e-01
## It: 93; obj: 1.554e+01; abs: 1.658e-04; rel: 1.067e-05; norm: 9.266e-01
## It: 94; obj: 1.554e+01; abs: 1.692e-04; rel: 1.089e-05; norm: 9.266e-01
## It: 95; obj: 1.554e+01; abs: 1.722e-04; rel: 1.108e-05; norm: 9.265e-01
## It: 96; obj: 1.554e+01; abs: 1.749e-04; rel: 1.125e-05; norm: 9.265e-01
## It: 97; obj: 1.554e+01; abs: 1.773e-04; rel: 1.141e-05; norm: 9.264e-01
## It: 98; obj: 1.554e+01; abs: 1.794e-04; rel: 1.154e-05; norm: 9.264e-01
## It: 99; obj: 1.554e+01; abs: 1.812e-04; rel: 1.166e-05; norm: 9.264e-01
## It: 100; obj: 1.554e+01; abs: 1.828e-04; rel: 1.176e-05; norm: 9.263e-01

## It: 101; obj: 2.472e+00; abs: 1.307e+01; rel: 8.409e-01; norm: 9.054e-02
## It: 102; obj: 2.441e+00; abs: 3.038e-02; rel: 1.229e-02; norm: 9.229e-02
## It: 103; obj: 2.417e+00; abs: 2.449e-02; rel: 1.003e-02; norm: 9.697e-02
## It: 104; obj: 2.402e+00; abs: 1.459e-02; rel: 6.036e-03; norm: 1.027e-01
## It: 105; obj: 2.395e+00; abs: 7.721e-03; rel: 3.214e-03; norm: 1.067e-01
## It: 106; obj: 2.391e+00; abs: 3.695e-03; rel: 1.543e-03; norm: 1.085e-01
## It: 107; obj: 2.388e+00; abs: 2.617e-03; rel: 1.095e-03; norm: 1.091e-01
## It: 108; obj: 2.387e+00; abs: 1.610e-03; rel: 6.743e-04; norm: 1.092e-01
## It: 109; obj: 2.385e+00; abs: 1.192e-03; rel: 4.996e-04; norm: 1.092e-01
## It: 110; obj: 2.385e+00; abs: 8.870e-04; rel: 3.718e-04; norm: 1.092e-01
## It: 111; obj: 2.384e+00; abs: 6.440e-04; rel: 2.701e-04; norm: 1.092e-01
## It: 112; obj: 2.383e+00; abs: 5.061e-04; rel: 2.123e-04; norm: 1.091e-01
## It: 113; obj: 2.383e+00; abs: 3.759e-04; rel: 1.577e-04; norm: 1.091e-01

```

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## It: 114; obj: 2.383e+00; abs: 2.866e-04; rel: 1.203e-04; norm: 1.090e-01
## It: 115; obj: 2.383e+00; abs: 2.170e-04; rel: 9.109e-05; norm: 1.090e-01
## It: 116; obj: 2.382e+00; abs: 1.642e-04; rel: 6.892e-05; norm: 1.090e-01
## It: 117; obj: 2.382e+00; abs: 1.259e-04; rel: 5.286e-05; norm: 1.090e-01
## It: 118; obj: 2.382e+00; abs: 9.637e-05; rel: 4.045e-05; norm: 1.089e-01
## It: 119; obj: 2.382e+00; abs: 7.369e-05; rel: 3.093e-05; norm: 1.089e-01
## It: 120; obj: 2.382e+00; abs: 5.676e-05; rel: 2.383e-05; norm: 1.089e-01
## It: 121; obj: 2.382e+00; abs: 4.429e-05; rel: 1.859e-05; norm: 1.089e-01
## It: 122; obj: 2.382e+00; abs: 3.539e-05; rel: 1.486e-05; norm: 1.089e-01
## It: 123; obj: 2.382e+00; abs: 2.900e-05; rel: 1.217e-05; norm: 1.089e-01
## It: 124; obj: 2.382e+00; abs: 2.432e-05; rel: 1.021e-05; norm: 1.089e-01
## It: 125; obj: 2.382e+00; abs: 2.089e-05; rel: 8.771e-06; norm: 1.089e-01

## It: 126; obj: 2.382e+00; abs: 1.833e-05; rel: 7.694e-06; norm: 1.089e-01
## It: 127; obj: 2.382e+00; abs: 1.634e-05; rel: 6.858e-06; norm: 1.089e-01
## It: 128; obj: 2.382e+00; abs: 1.471e-05; rel: 6.177e-06; norm: 1.089e-01
## It: 129; obj: 2.382e+00; abs: 1.334e-05; rel: 5.599e-06; norm: 1.089e-01
## It: 130; obj: 2.382e+00; abs: 1.215e-05; rel: 5.103e-06; norm: 1.089e-01
## It: 131; obj: 2.382e+00; abs: 1.112e-05; rel: 4.669e-06; norm: 1.089e-01
## It: 132; obj: 2.382e+00; abs: 1.020e-05; rel: 4.280e-06; norm: 1.089e-01
## It: 133; obj: 2.382e+00; abs: 9.349e-06; rel: 3.925e-06; norm: 1.089e-01
## It: 134; obj: 2.382e+00; abs: 8.573e-06; rel: 3.600e-06; norm: 1.089e-01
## It: 135; obj: 2.382e+00; abs: 7.862e-06; rel: 3.301e-06; norm: 1.089e-01
## It: 136; obj: 2.382e+00; abs: 7.207e-06; rel: 3.026e-06; norm: 1.090e-01
## It: 137; obj: 2.382e+00; abs: 6.601e-06; rel: 2.772e-06; norm: 1.090e-01
## It: 138; obj: 2.382e+00; abs: 6.042e-06; rel: 2.537e-06; norm: 1.090e-01
## It: 139; obj: 2.382e+00; abs: 5.528e-06; rel: 2.321e-06; norm: 1.090e-01
## It: 140; obj: 2.382e+00; abs: 5.057e-06; rel: 2.123e-06; norm: 1.090e-01
## It: 141; obj: 2.382e+00; abs: 4.625e-06; rel: 1.942e-06; norm: 1.090e-01
## It: 142; obj: 2.382e+00; abs: 4.228e-06; rel: 1.775e-06; norm: 1.090e-01
## It: 143; obj: 2.382e+00; abs: 3.866e-06; rel: 1.623e-06; norm: 1.090e-01
## It: 144; obj: 2.382e+00; abs: 3.535e-06; rel: 1.484e-06; norm: 1.090e-01
## It: 145; obj: 2.382e+00; abs: 3.232e-06; rel: 1.357e-06; norm: 1.090e-01
## It: 146; obj: 2.382e+00; abs: 2.956e-06; rel: 1.241e-06; norm: 1.090e-01
## It: 147; obj: 2.382e+00; abs: 2.704e-06; rel: 1.135e-06; norm: 1.090e-01
## It: 148; obj: 2.382e+00; abs: 2.474e-06; rel: 1.039e-06; norm: 1.090e-01
## It: 149; obj: 2.382e+00; abs: 2.265e-06; rel: 9.511e-07; norm: 1.090e-01
## It: 150; obj: 2.382e+00; abs: 2.075e-06; rel: 8.711e-07; norm: 1.090e-01

## It: 151; obj: 2.382e+00; abs: 1.901e-06; rel: 7.982e-07; norm: 1.090e-01
## It: 152; obj: 2.382e+00; abs: 1.743e-06; rel: 7.317e-07; norm: 1.090e-01
## It: 153; obj: 2.382e+00; abs: 1.598e-06; rel: 6.711e-07; norm: 1.090e-01
## It: 154; obj: 2.382e+00; abs: 1.467e-06; rel: 6.158e-07; norm: 1.090e-01
## It: 155; obj: 2.382e+00; abs: 1.347e-06; rel: 5.654e-07; norm: 1.090e-01
## It: 156; obj: 2.382e+00; abs: 1.237e-06; rel: 5.194e-07; norm: 1.090e-01
## It: 157; obj: 2.382e+00; abs: 1.137e-06; rel: 4.773e-07; norm: 1.090e-01
## It: 158; obj: 2.382e+00; abs: 1.045e-06; rel: 4.390e-07; norm: 1.090e-01
## It: 159; obj: 2.382e+00; abs: 9.619e-07; rel: 4.039e-07; norm: 1.090e-01
## It: 160; obj: 2.382e+00; abs: 8.855e-07; rel: 3.718e-07; norm: 1.090e-01
## It: 161; obj: 2.382e+00; abs: 8.156e-07; rel: 3.424e-07; norm: 1.090e-01
## It: 162; obj: 2.382e+00; abs: 7.515e-07; rel: 3.155e-07; norm: 1.090e-01
## It: 163; obj: 2.382e+00; abs: 6.929e-07; rel: 2.909e-07; norm: 1.090e-01
## It: 164; obj: 2.382e+00; abs: 6.391e-07; rel: 2.683e-07; norm: 1.090e-01
## It: 165; obj: 2.382e+00; abs: 5.898e-07; rel: 2.476e-07; norm: 1.090e-01
## It: 166; obj: 2.382e+00; abs: 5.445e-07; rel: 2.286e-07; norm: 1.090e-01

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## It: 167; obj: 2.382e+00; abs: 5.030e-07; rel: 2.112e-07; norm: 1.090e-01
## It: 168; obj: 2.382e+00; abs: 4.648e-07; rel: 1.951e-07; norm: 1.090e-01
## It: 169; obj: 2.382e+00; abs: 4.297e-07; rel: 1.804e-07; norm: 1.090e-01
## It: 170; obj: 2.382e+00; abs: 3.974e-07; rel: 1.668e-07; norm: 1.090e-01
## It: 171; obj: 2.382e+00; abs: 3.676e-07; rel: 1.544e-07; norm: 1.090e-01
## It: 172; obj: 2.382e+00; abs: 3.403e-07; rel: 1.429e-07; norm: 1.090e-01
## It: 173; obj: 2.382e+00; abs: 3.150e-07; rel: 1.323e-07; norm: 1.090e-01
## It: 174; obj: 2.382e+00; abs: 2.918e-07; rel: 1.225e-07; norm: 1.090e-01
## It: 175; obj: 2.382e+00; abs: 2.704e-07; rel: 1.135e-07; norm: 1.090e-01
## It: 176; obj: 2.382e+00; abs: 2.506e-07; rel: 1.052e-07; norm: 1.090e-01
## It: 177; obj: 2.382e+00; abs: 2.323e-07; rel: 9.754e-08; norm: 1.090e-01
## It: 178; obj: 2.382e+00; abs: 2.154e-07; rel: 9.046e-08; norm: 1.090e-01
## It: 179; obj: 2.382e+00; abs: 1.999e-07; rel: 8.392e-08; norm: 1.090e-01
## It: 180; obj: 2.382e+00; abs: 1.855e-07; rel: 7.787e-08; norm: 1.090e-01
## It: 181; obj: 2.382e+00; abs: 1.721e-07; rel: 7.228e-08; norm: 1.090e-01
## It: 182; obj: 2.382e+00; abs: 1.598e-07; rel: 6.711e-08; norm: 1.090e-01
## It: 183; obj: 2.382e+00; abs: 1.484e-07; rel: 6.232e-08; norm: 1.090e-01
## It: 184; obj: 2.382e+00; abs: 1.379e-07; rel: 5.789e-08; norm: 1.090e-01
## It: 185; obj: 2.382e+00; abs: 1.281e-07; rel: 5.378e-08; norm: 1.090e-01
## It: 186; obj: 2.382e+00; abs: 1.190e-07; rel: 4.998e-08; norm: 1.090e-01
## It: 187; obj: 2.382e+00; abs: 1.107e-07; rel: 4.646e-08; norm: 1.090e-01
## It: 188; obj: 2.382e+00; abs: 1.029e-07; rel: 4.319e-08; norm: 1.090e-01
## It: 189; obj: 2.382e+00; abs: 9.566e-08; rel: 4.017e-08; norm: 1.090e-01
## It: 190; obj: 2.382e+00; abs: 8.898e-08; rel: 3.736e-08; norm: 1.090e-01
## It: 191; obj: 2.382e+00; abs: 8.277e-08; rel: 3.475e-08; norm: 1.090e-01
## It: 192; obj: 2.382e+00; abs: 7.701e-08; rel: 3.234e-08; norm: 1.090e-01
## It: 193; obj: 2.382e+00; abs: 7.167e-08; rel: 3.009e-08; norm: 1.090e-01
## It: 194; obj: 2.382e+00; abs: 6.670e-08; rel: 2.801e-08; norm: 1.090e-01
## It: 195; obj: 2.382e+00; abs: 6.209e-08; rel: 2.607e-08; norm: 1.090e-01
## It: 196; obj: 2.382e+00; abs: 5.781e-08; rel: 2.427e-08; norm: 1.090e-01
## It: 197; obj: 2.382e+00; abs: 5.383e-08; rel: 2.260e-08; norm: 1.090e-01
## It: 198; obj: 2.382e+00; abs: 5.013e-08; rel: 2.105e-08; norm: 1.090e-01
## It: 199; obj: 2.382e+00; abs: 4.670e-08; rel: 1.961e-08; norm: 1.090e-01
## It: 200; obj: 2.382e+00; abs: 4.350e-08; rel: 1.827e-08; norm: 1.090e-01
## It: 201; obj: 2.382e+00; abs: 4.053e-08; rel: 1.702e-08; norm: 1.090e-01
## It: 202; obj: 2.382e+00; abs: 3.777e-08; rel: 1.586e-08; norm: 1.090e-01
## It: 203; obj: 2.382e+00; abs: 3.520e-08; rel: 1.478e-08; norm: 1.090e-01
## It: 204; obj: 2.382e+00; abs: 3.280e-08; rel: 1.377e-08; norm: 1.090e-01
## It: 205; obj: 2.382e+00; abs: 3.058e-08; rel: 1.284e-08; norm: 1.090e-01
## It: 206; obj: 2.382e+00; abs: 2.851e-08; rel: 1.197e-08; norm: 1.090e-01
## It: 207; obj: 2.382e+00; abs: 2.658e-08; rel: 1.116e-08; norm: 1.090e-01
## It: 208; obj: 2.382e+00; abs: 2.478e-08; rel: 1.041e-08; norm: 1.090e-01
## It: 209; obj: 2.382e+00; abs: 2.311e-08; rel: 9.703e-09; norm: 1.090e-01
## It: 210; obj: 2.382e+00; abs: 2.155e-08; rel: 9.049e-09; norm: 1.090e-01
## It: 211; obj: 2.382e+00; abs: 2.010e-08; rel: 8.440e-09; norm: 1.090e-01
## It: 212; obj: 2.382e+00; abs: 1.875e-08; rel: 7.873e-09; norm: 1.090e-01
## It: 213; obj: 2.382e+00; abs: 1.749e-08; rel: 7.345e-09; norm: 1.090e-01
## It: 214; obj: 2.382e+00; abs: 1.632e-08; rel: 6.852e-09; norm: 1.090e-01
## It: 215; obj: 2.382e+00; abs: 1.523e-08; rel: 6.393e-09; norm: 1.090e-01
## It: 216; obj: 2.382e+00; abs: 1.421e-08; rel: 5.966e-09; norm: 1.090e-01
## It: 217; obj: 2.382e+00; abs: 1.326e-08; rel: 5.567e-09; norm: 1.090e-01
## It: 218; obj: 2.382e+00; abs: 1.237e-08; rel: 5.195e-09; norm: 1.090e-01
## It: 219; obj: 2.382e+00; abs: 1.155e-08; rel: 4.849e-09; norm: 1.090e-01

```

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## It: 220; obj: 2.382e+00; abs: 1.078e-08; rel: 4.526e-09; norm: 1.090e-01
## It: 221; obj: 2.382e+00; abs: 1.006e-08; rel: 4.224e-09; norm: 1.090e-01
## It: 222; obj: 2.382e+00; abs: 9.392e-09; rel: 3.944e-09; norm: 1.090e-01
## It: 223; obj: 2.382e+00; abs: 8.768e-09; rel: 3.681e-09; norm: 1.090e-01
## It: 224; obj: 2.382e+00; abs: 8.186e-09; rel: 3.437e-09; norm: 1.090e-01
## It: 225; obj: 2.382e+00; abs: 7.643e-09; rel: 3.209e-09; norm: 1.090e-01
## It: 226; obj: 2.382e+00; abs: 7.136e-09; rel: 2.996e-09; norm: 1.090e-01
## It: 227; obj: 2.382e+00; abs: 6.664e-09; rel: 2.798e-09; norm: 1.090e-01
## It: 228; obj: 2.382e+00; abs: 6.223e-09; rel: 2.613e-09; norm: 1.090e-01
## It: 229; obj: 2.382e+00; abs: 5.811e-09; rel: 2.440e-09; norm: 1.090e-01
## It: 230; obj: 2.382e+00; abs: 5.427e-09; rel: 2.279e-09; norm: 1.090e-01
## It: 231; obj: 2.382e+00; abs: 5.069e-09; rel: 2.128e-09; norm: 1.090e-01
## It: 232; obj: 2.382e+00; abs: 4.734e-09; rel: 1.988e-09; norm: 1.090e-01
## It: 233; obj: 2.382e+00; abs: 4.422e-09; rel: 1.857e-09; norm: 1.090e-01
## It: 234; obj: 2.382e+00; abs: 4.131e-09; rel: 1.734e-09; norm: 1.090e-01
## It: 235; obj: 2.382e+00; abs: 3.858e-09; rel: 1.620e-09; norm: 1.090e-01
## It: 236; obj: 2.382e+00; abs: 3.604e-09; rel: 1.513e-09; norm: 1.090e-01
## It: 237; obj: 2.382e+00; abs: 3.367e-09; rel: 1.414e-09; norm: 1.090e-01
## It: 238; obj: 2.382e+00; abs: 3.146e-09; rel: 1.321e-09; norm: 1.090e-01
## It: 239; obj: 2.382e+00; abs: 2.939e-09; rel: 1.234e-09; norm: 1.090e-01
## It: 240; obj: 2.382e+00; abs: 2.746e-09; rel: 1.153e-09; norm: 1.090e-01
## It: 241; obj: 2.382e+00; abs: 2.566e-09; rel: 1.077e-09; norm: 1.090e-01
## It: 242; obj: 2.382e+00; abs: 2.397e-09; rel: 1.007e-09; norm: 1.090e-01
## It: 243; obj: 2.382e+00; abs: 2.240e-09; rel: 9.406e-10; norm: 1.090e-01
## It: 244; obj: 2.382e+00; abs: 2.093e-09; rel: 8.790e-10; norm: 1.090e-01
## It: 245; obj: 2.382e+00; abs: 1.956e-09; rel: 8.213e-10; norm: 1.090e-01
## It: 246; obj: 2.382e+00; abs: 1.828e-09; rel: 7.675e-10; norm: 1.090e-01
## It: 247; obj: 2.382e+00; abs: 1.708e-09; rel: 7.173e-10; norm: 1.090e-01
## It: 248; obj: 2.382e+00; abs: 1.839e-09; rel: 7.722e-10; norm: 1.090e-01
## It: 249; obj: 2.382e+00; abs: 1.805e-09; rel: 7.578e-10; norm: 1.090e-01
## It: 250; obj: 2.382e+00; abs: 1.712e-09; rel: 7.187e-10; norm: 1.090e-01
## It: 251; obj: 2.382e+00; abs: 1.593e-09; rel: 6.690e-10; norm: 1.090e-01
## It: 252; obj: 2.382e+00; abs: 1.465e-09; rel: 6.150e-10; norm: 1.090e-01
## It: 253; obj: 2.382e+00; abs: 1.341e-09; rel: 5.631e-10; norm: 1.090e-01
## It: 254; obj: 2.382e+00; abs: 1.228e-09; rel: 5.158e-10; norm: 1.090e-01
## It: 255; obj: 2.382e+00; abs: 1.126e-09; rel: 4.728e-10; norm: 1.090e-01
## It: 256; obj: 2.382e+00; abs: 1.033e-09; rel: 4.337e-10; norm: 1.090e-01
## It: 257; obj: 2.382e+00; abs: 9.472e-10; rel: 3.977e-10; norm: 1.090e-01
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## It: 259; obj: 2.382e+00; abs: 7.950e-10; rel: 3.338e-10; norm: 1.090e-01
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## It: 261; obj: 2.382e+00; abs: 6.672e-10; rel: 2.801e-10; norm: 1.090e-01
## It: 262; obj: 2.382e+00; abs: 6.113e-10; rel: 2.567e-10; norm: 1.090e-01
## It: 263; obj: 2.382e+00; abs: 5.605e-10; rel: 2.353e-10; norm: 1.090e-01
## It: 264; obj: 2.382e+00; abs: 5.142e-10; rel: 2.159e-10; norm: 1.090e-01
## It: 265; obj: 2.382e+00; abs: 4.718e-10; rel: 1.981e-10; norm: 1.090e-01
## It: 266; obj: 2.382e+00; abs: 4.321e-10; rel: 1.814e-10; norm: 1.090e-01
## It: 267; obj: 2.382e+00; abs: 3.945e-10; rel: 1.656e-10; norm: 1.090e-01
## It: 268; obj: 2.382e+00; abs: 3.605e-10; rel: 1.514e-10; norm: 1.090e-01
## It: 269; obj: 2.382e+00; abs: 3.315e-10; rel: 1.392e-10; norm: 1.090e-01
## It: 270; obj: 2.382e+00; abs: 3.065e-10; rel: 1.287e-10; norm: 1.090e-01
## It: 271; obj: 2.382e+00; abs: 2.817e-10; rel: 1.183e-10; norm: 1.090e-01
## It: 272; obj: 2.382e+00; abs: 2.535e-10; rel: 1.065e-10; norm: 1.090e-01

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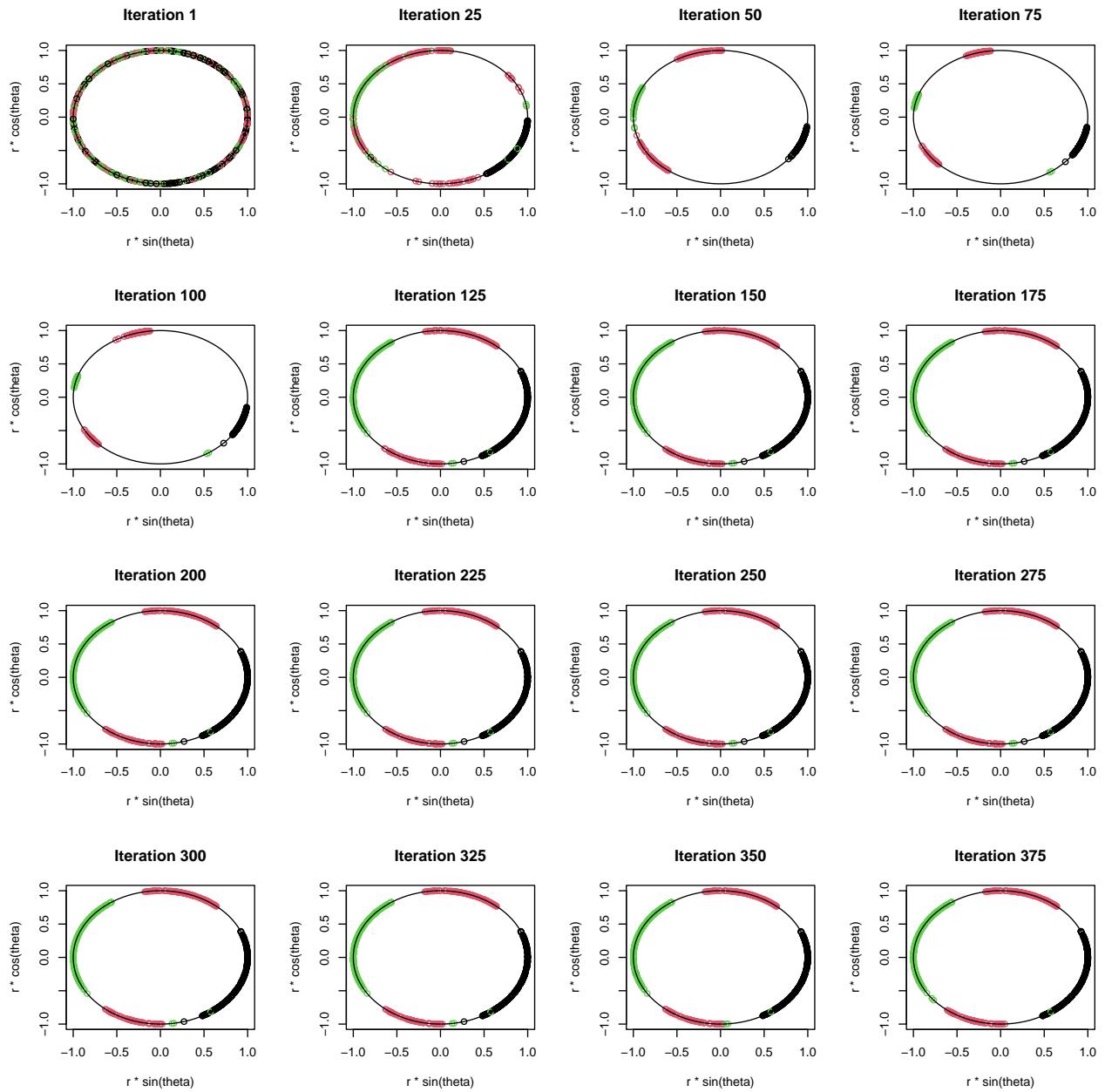
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## It: 275; obj: 2.382e+00; abs: 1.989e-10; rel: 8.350e-11; norm: 1.090e-01
## It: 276; obj: 2.382e+00; abs: 1.936e-10; rel: 8.128e-11; norm: 1.090e-01
## It: 277; obj: 2.382e+00; abs: 1.689e-10; rel: 7.092e-11; norm: 1.090e-01
## It: 278; obj: 2.382e+00; abs: 1.217e-10; rel: 5.109e-11; norm: 1.090e-01
## It: 279; obj: 2.382e+00; abs: 8.524e-11; rel: 3.579e-11; norm: 1.090e-01
## It: 280; obj: 2.382e+00; abs: 1.008e-10; rel: 4.232e-11; norm: 1.090e-01
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## It: 286; obj: 2.382e+00; abs: 9.622e-11; rel: 4.040e-11; norm: 1.090e-01
## It: 287; obj: 2.382e+00; abs: 3.579e-10; rel: 1.503e-10; norm: 1.090e-01
## It: 288; obj: 2.382e+00; abs: 1.487e-10; rel: 6.244e-11; norm: 1.090e-01
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## It: 290; obj: 2.382e+00; abs: 1.216e-09; rel: 5.104e-10; norm: 1.090e-01
## It: 291; obj: 2.382e+00; abs: 6.234e-10; rel: 2.617e-10; norm: 1.090e-01
## It: 292; obj: 2.382e+00; abs: 9.136e-10; rel: 3.836e-10; norm: 1.090e-01
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## It: 313; obj: 2.382e+00; abs: 4.060e-07; rel: 1.705e-07; norm: 1.090e-01
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## It: 316; obj: 2.382e+00; abs: 7.015e-07; rel: 2.945e-07; norm: 1.090e-01
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## It: 329; obj: 2.382e+00; abs: 7.545e-05; rel: 3.168e-05; norm: 1.091e-01
## It: 330; obj: 2.382e+00; abs: 3.404e-05; rel: 1.429e-05; norm: 1.091e-01
## It: 331; obj: 2.382e+00; abs: 8.969e-05; rel: 3.766e-05; norm: 1.090e-01
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## It: 334; obj: 2.382e+00; abs: 2.284e-04; rel: 9.588e-05; norm: 1.090e-01
## It: 335; obj: 2.382e+00; abs: 1.767e-04; rel: 7.417e-05; norm: 1.090e-01
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## It: 347; obj: 2.382e+00; abs: 2.643e-04; rel: 1.110e-04; norm: 1.091e-01
## It: 348; obj: 2.383e+00; abs: 6.396e-04; rel: 2.685e-04; norm: 1.091e-01
## It: 349; obj: 2.383e+00; abs: 1.144e-04; rel: 4.800e-05; norm: 1.091e-01
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## It: 352; obj: 2.383e+00; abs: 1.243e-03; rel: 5.214e-04; norm: 1.091e-01
## It: 353; obj: 2.382e+00; abs: 5.088e-04; rel: 2.135e-04; norm: 1.091e-01
## It: 354; obj: 2.382e+00; abs: 1.854e-04; rel: 7.780e-05; norm: 1.090e-01
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## It: 365; obj: 2.384e+00; abs: 5.035e-04; rel: 2.112e-04; norm: 1.090e-01
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## It: 378; obj: 2.383e+00; abs: 3.192e-04; rel: 1.340e-04; norm: 1.090e-01
## It: 379; obj: 2.383e+00; abs: 4.731e-04; rel: 1.985e-04; norm: 1.090e-01
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## It: 388; obj: 2.381e+00; abs: 1.064e-03; rel: 4.467e-04; norm: 1.091e-01
## It: 389; obj: 2.381e+00; abs: 7.494e-05; rel: 3.147e-05; norm: 1.090e-01

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## It: 399; obj: 2.382e+00; abs: 6.448e-04; rel: 2.707e-04; norm: 1.090e-01
## It: 400; obj: 2.383e+00; abs: 6.741e-04; rel: 2.829e-04; norm: 1.090e-01

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## It: 403; obj: 2.381e+00; abs: 4.674e-05; rel: 1.963e-05; norm: 1.090e-01
## It: 404; obj: 2.382e+00; abs: 3.721e-04; rel: 1.563e-04; norm: 1.090e-01
## It: 405; obj: 2.382e+00; abs: 2.258e-04; rel: 9.482e-05; norm: 1.091e-01
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## It: 408; obj: 2.382e+00; abs: 1.218e-03; rel: 5.109e-04; norm: 1.090e-01
## It: 409; obj: 2.381e+00; abs: 7.438e-04; rel: 3.122e-04; norm: 1.090e-01
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## It: 421; obj: 2.383e+00; abs: 6.754e-04; rel: 2.835e-04; norm: 1.090e-01
## It: 422; obj: 2.382e+00; abs: 1.226e-03; rel: 5.144e-04; norm: 1.090e-01
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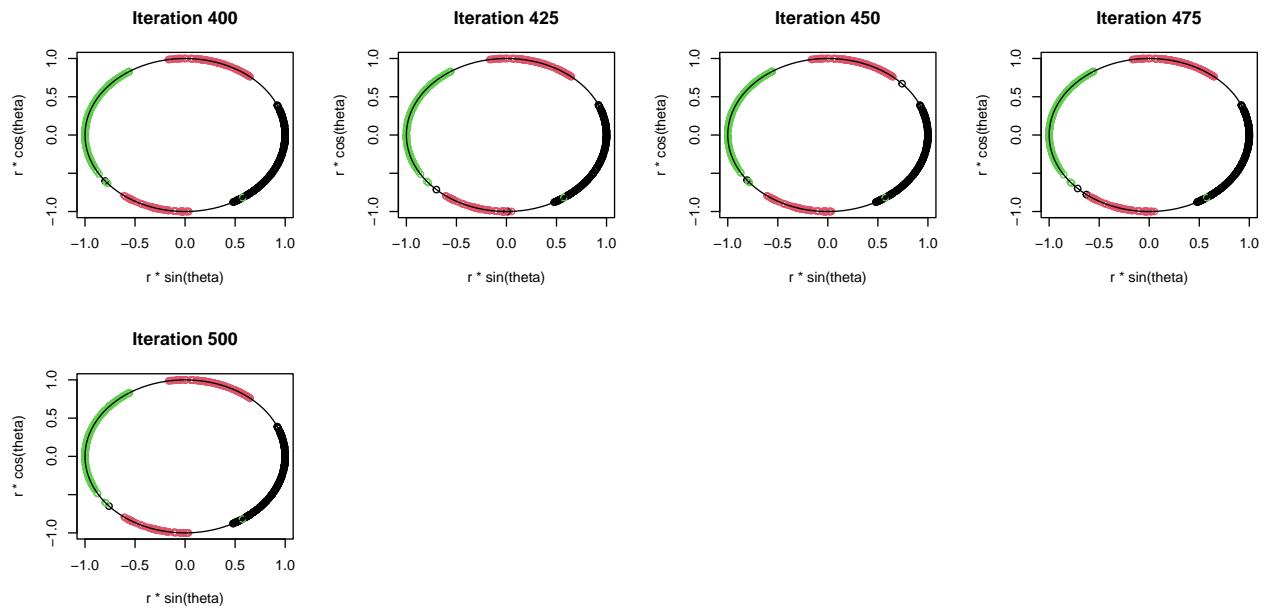
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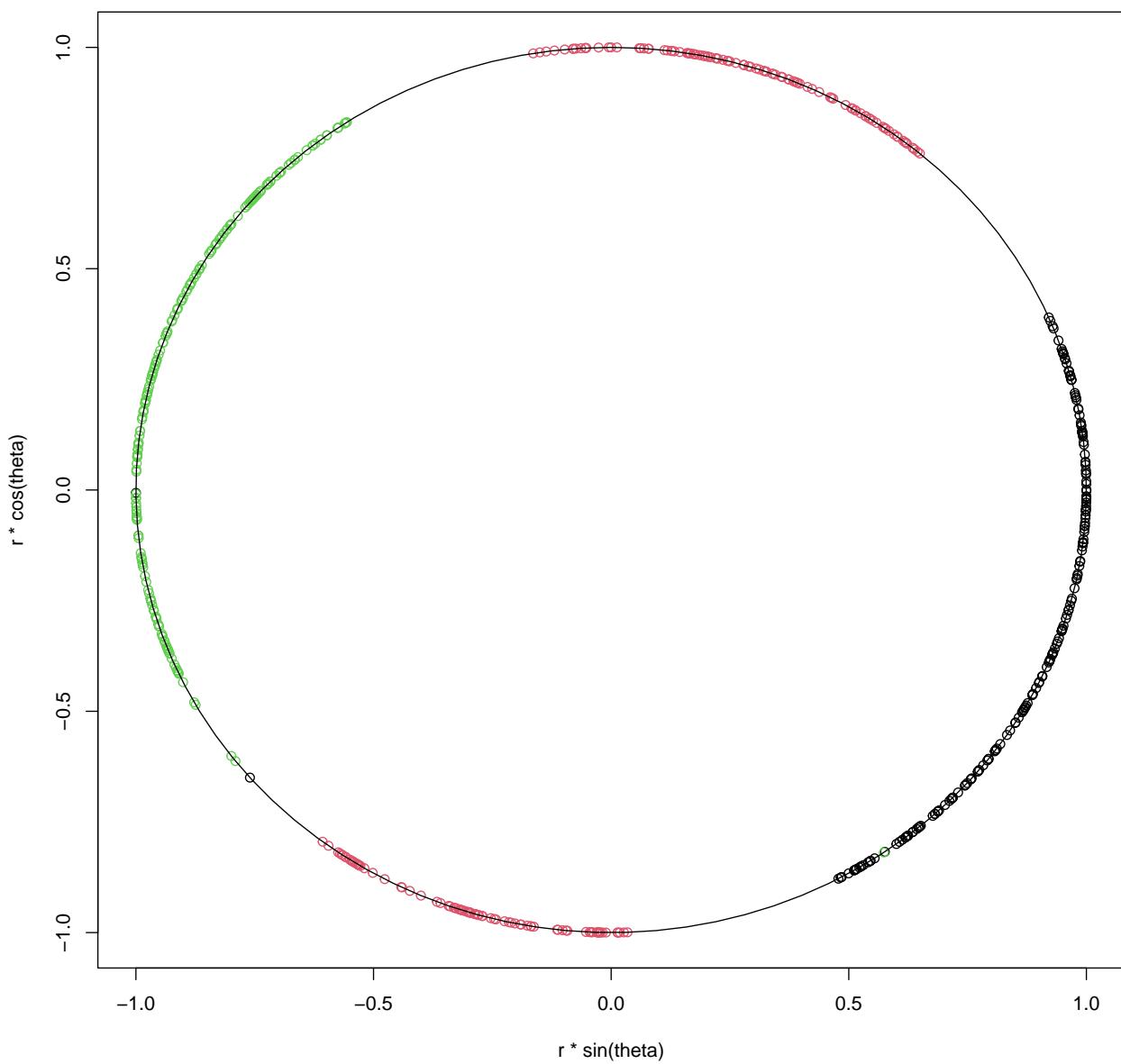
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## It: 496; obj: 2.382e+00; abs: 2.255e-04; rel: 9.468e-05; norm: 1.091e-01
## It: 497; obj: 2.382e+00; abs: 6.424e-04; rel: 2.697e-04; norm: 1.090e-01
## It: 498; obj: 2.383e+00; abs: 6.742e-04; rel: 2.830e-04; norm: 1.090e-01
## It: 499; obj: 2.382e+00; abs: 1.224e-03; rel: 5.134e-04; norm: 1.090e-01
## It: 500; obj: 2.381e+00; abs: 7.394e-04; rel: 3.104e-04; norm: 1.090e-01

```



Iteration 500

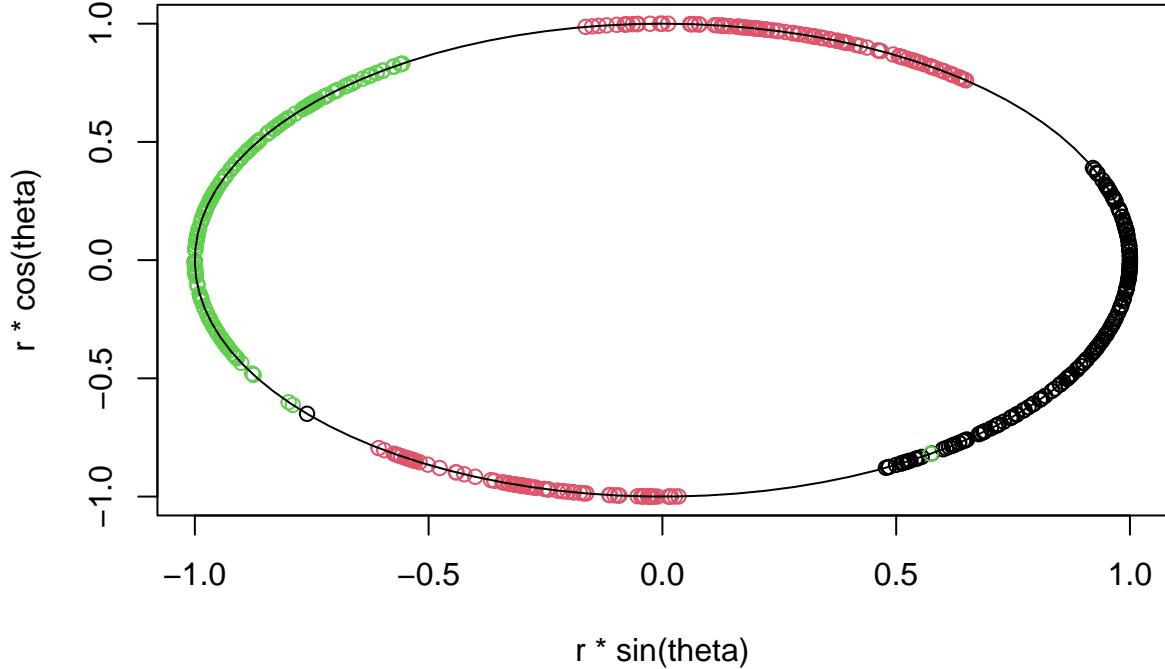


```

Y_rad <- DirStats:::to_rad(Y)
r <- 1
theta <- Y_rad
plot(r*sin(theta),
     r*cos(theta),
     col=colors,
     xlim=c(-max(r),max(r)),
     ylim=c(-max(r),max(r)))

polygon(max(r)*sin(seq(0,2*pi,length.out=100)),max(r)*cos(seq(0,2*pi,length.out=100)))

```



Now we are going to reduce to dimension \mathbb{S}^2 then $d = 2$ (sphere):

```
Y <- psc_sne(X=x_2, d=2, rho_psc_list = rho_second_perp20, num_iteration=500,
               colors=colors, visualize_prog = TRUE)
```

```
## It: 1; obj: 1.992e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.613e-01
## It: 2; obj: 1.635e+01; abs: 3.568e+00; rel: 1.791e-01; norm: 3.233e-01
## It: 3; obj: 1.489e+01; abs: 1.461e+00; rel: 8.933e-02; norm: 6.768e-01
## It: 4; obj: 1.431e+01; abs: 5.763e-01; rel: 3.870e-02; norm: 8.474e-01
## It: 5; obj: 1.398e+01; abs: 3.315e-01; rel: 2.316e-02; norm: 9.290e-01
## It: 6; obj: 1.375e+01; abs: 2.309e-01; rel: 1.651e-02; norm: 9.810e-01
## It: 7; obj: 1.360e+01; abs: 1.545e-01; rel: 1.124e-02; norm: 1.026e+00
## It: 8; obj: 1.349e+01; abs: 1.052e-01; rel: 7.734e-03; norm: 1.077e+00
## It: 9; obj: 1.341e+01; abs: 7.889e-02; rel: 5.847e-03; norm: 1.132e+00
## It: 10; obj: 1.335e+01; abs: 6.666e-02; rel: 4.970e-03; norm: 1.188e+00
## It: 11; obj: 1.331e+01; abs: 3.450e-02; rel: 2.585e-03; norm: 1.245e+00
## It: 12; obj: 1.330e+01; abs: 1.575e-02; rel: 1.183e-03; norm: 1.299e+00
## It: 13; obj: 1.329e+01; abs: 1.039e-02; rel: 7.812e-04; norm: 1.347e+00
## It: 14; obj: 1.329e+01; abs: 5.081e-04; rel: 3.824e-05; norm: 1.390e+00
## It: 15; obj: 1.328e+01; abs: 3.144e-03; rel: 2.366e-04; norm: 1.426e+00
## It: 16; obj: 1.327e+01; abs: 9.490e-03; rel: 7.144e-04; norm: 1.459e+00
## It: 17; obj: 1.327e+01; abs: 7.740e-03; rel: 5.831e-04; norm: 1.489e+00
## It: 18; obj: 1.327e+01; abs: 7.240e-03; rel: 5.457e-04; norm: 1.515e+00
## It: 19; obj: 1.329e+01; abs: 2.096e-02; rel: 1.579e-03; norm: 1.536e+00
## It: 20; obj: 1.332e+01; abs: 2.768e-02; rel: 2.082e-03; norm: 1.552e+00
## It: 21; obj: 1.335e+01; abs: 3.015e-02; rel: 2.263e-03; norm: 1.565e+00
## It: 22; obj: 1.338e+01; abs: 3.099e-02; rel: 2.321e-03; norm: 1.576e+00
## It: 23; obj: 1.341e+01; abs: 3.121e-02; rel: 2.332e-03; norm: 1.586e+00
## It: 24; obj: 1.345e+01; abs: 3.131e-02; rel: 2.334e-03; norm: 1.595e+00
## It: 25; obj: 1.348e+01; abs: 3.162e-02; rel: 2.352e-03; norm: 1.603e+00
## It: 26; obj: 1.351e+01; abs: 3.236e-02; rel: 2.401e-03; norm: 1.610e+00
## It: 27; obj: 1.354e+01; abs: 3.343e-02; rel: 2.474e-03; norm: 1.617e+00
```

```

## It: 28; obj: 1.358e+01; abs: 3.439e-02; rel: 2.539e-03; norm: 1.622e+00
## It: 29; obj: 1.361e+01; abs: 3.460e-02; rel: 2.549e-03; norm: 1.627e+00
## It: 30; obj: 1.365e+01; abs: 3.362e-02; rel: 2.470e-03; norm: 1.631e+00
## It: 31; obj: 1.368e+01; abs: 3.138e-02; rel: 2.299e-03; norm: 1.633e+00
## It: 32; obj: 1.371e+01; abs: 2.815e-02; rel: 2.058e-03; norm: 1.635e+00
## It: 33; obj: 1.373e+01; abs: 2.436e-02; rel: 1.777e-03; norm: 1.636e+00
## It: 34; obj: 1.375e+01; abs: 2.045e-02; rel: 1.490e-03; norm: 1.636e+00
## It: 35; obj: 1.377e+01; abs: 1.675e-02; rel: 1.218e-03; norm: 1.636e+00
## It: 36; obj: 1.378e+01; abs: 1.342e-02; rel: 9.746e-04; norm: 1.635e+00
## It: 37; obj: 1.379e+01; abs: 1.052e-02; rel: 7.634e-04; norm: 1.634e+00
## It: 38; obj: 1.380e+01; abs: 8.043e-03; rel: 5.832e-04; norm: 1.633e+00
## It: 39; obj: 1.381e+01; abs: 5.945e-03; rel: 4.309e-04; norm: 1.631e+00
## It: 40; obj: 1.381e+01; abs: 4.176e-03; rel: 3.025e-04; norm: 1.629e+00
## It: 41; obj: 1.381e+01; abs: 2.687e-03; rel: 1.945e-04; norm: 1.627e+00
## It: 42; obj: 1.381e+01; abs: 1.436e-03; rel: 1.040e-04; norm: 1.625e+00
## It: 43; obj: 1.381e+01; abs: 3.880e-04; rel: 2.809e-05; norm: 1.623e+00
## It: 44; obj: 1.381e+01; abs: 4.864e-04; rel: 3.521e-05; norm: 1.621e+00
## It: 45; obj: 1.381e+01; abs: 1.211e-03; rel: 8.769e-05; norm: 1.619e+00
## It: 46; obj: 1.381e+01; abs: 1.806e-03; rel: 1.308e-04; norm: 1.616e+00
## It: 47; obj: 1.381e+01; abs: 2.286e-03; rel: 1.656e-04; norm: 1.614e+00
## It: 48; obj: 1.381e+01; abs: 2.665e-03; rel: 1.930e-04; norm: 1.612e+00
## It: 49; obj: 1.380e+01; abs: 2.951e-03; rel: 2.138e-04; norm: 1.609e+00
## It: 50; obj: 1.380e+01; abs: 3.157e-03; rel: 2.287e-04; norm: 1.607e+00

## It: 51; obj: 1.380e+01; abs: 3.293e-03; rel: 2.387e-04; norm: 1.605e+00
## It: 52; obj: 1.379e+01; abs: 3.374e-03; rel: 2.446e-04; norm: 1.602e+00
## It: 53; obj: 1.379e+01; abs: 3.414e-03; rel: 2.476e-04; norm: 1.600e+00
## It: 54; obj: 1.379e+01; abs: 3.430e-03; rel: 2.487e-04; norm: 1.598e+00
## It: 55; obj: 1.378e+01; abs: 3.433e-03; rel: 2.490e-04; norm: 1.596e+00
## It: 56; obj: 1.378e+01; abs: 3.431e-03; rel: 2.490e-04; norm: 1.593e+00
## It: 57; obj: 1.378e+01; abs: 3.432e-03; rel: 2.491e-04; norm: 1.591e+00
## It: 58; obj: 1.377e+01; abs: 3.437e-03; rel: 2.495e-04; norm: 1.589e+00
## It: 59; obj: 1.377e+01; abs: 3.448e-03; rel: 2.503e-04; norm: 1.587e+00
## It: 60; obj: 1.376e+01; abs: 3.463e-03; rel: 2.515e-04; norm: 1.585e+00
## It: 61; obj: 1.376e+01; abs: 3.483e-03; rel: 2.530e-04; norm: 1.583e+00
## It: 62; obj: 1.376e+01; abs: 3.504e-03; rel: 2.546e-04; norm: 1.581e+00
## It: 63; obj: 1.375e+01; abs: 3.526e-03; rel: 2.563e-04; norm: 1.579e+00
## It: 64; obj: 1.375e+01; abs: 3.545e-03; rel: 2.577e-04; norm: 1.577e+00
## It: 65; obj: 1.375e+01; abs: 3.560e-03; rel: 2.589e-04; norm: 1.575e+00
## It: 66; obj: 1.374e+01; abs: 3.570e-03; rel: 2.597e-04; norm: 1.573e+00
## It: 67; obj: 1.374e+01; abs: 3.573e-03; rel: 2.600e-04; norm: 1.571e+00
## It: 68; obj: 1.374e+01; abs: 3.569e-03; rel: 2.598e-04; norm: 1.569e+00
## It: 69; obj: 1.373e+01; abs: 3.556e-03; rel: 2.589e-04; norm: 1.568e+00
## It: 70; obj: 1.373e+01; abs: 3.535e-03; rel: 2.574e-04; norm: 1.566e+00
## It: 71; obj: 1.373e+01; abs: 3.504e-03; rel: 2.552e-04; norm: 1.564e+00
## It: 72; obj: 1.372e+01; abs: 3.465e-03; rel: 2.524e-04; norm: 1.562e+00
## It: 73; obj: 1.372e+01; abs: 3.417e-03; rel: 2.490e-04; norm: 1.561e+00
## It: 74; obj: 1.372e+01; abs: 3.361e-03; rel: 2.450e-04; norm: 1.559e+00
## It: 75; obj: 1.371e+01; abs: 3.297e-03; rel: 2.404e-04; norm: 1.557e+00

## It: 76; obj: 1.371e+01; abs: 3.226e-03; rel: 2.353e-04; norm: 1.556e+00
## It: 77; obj: 1.371e+01; abs: 3.149e-03; rel: 2.297e-04; norm: 1.554e+00
## It: 78; obj: 1.370e+01; abs: 3.066e-03; rel: 2.237e-04; norm: 1.553e+00
## It: 79; obj: 1.370e+01; abs: 2.979e-03; rel: 2.174e-04; norm: 1.551e+00
## It: 80; obj: 1.370e+01; abs: 2.889e-03; rel: 2.109e-04; norm: 1.550e+00

```

```

## It: 81; obj: 1.369e+01; abs: 2.796e-03; rel: 2.041e-04; norm: 1.548e+00
## It: 82; obj: 1.369e+01; abs: 2.701e-03; rel: 1.972e-04; norm: 1.547e+00
## It: 83; obj: 1.369e+01; abs: 2.605e-03; rel: 1.902e-04; norm: 1.546e+00
## It: 84; obj: 1.369e+01; abs: 2.508e-03; rel: 1.832e-04; norm: 1.544e+00
## It: 85; obj: 1.368e+01; abs: 2.413e-03; rel: 1.763e-04; norm: 1.543e+00
## It: 86; obj: 1.368e+01; abs: 2.318e-03; rel: 1.694e-04; norm: 1.542e+00
## It: 87; obj: 1.368e+01; abs: 2.225e-03; rel: 1.626e-04; norm: 1.541e+00
## It: 88; obj: 1.368e+01; abs: 2.134e-03; rel: 1.560e-04; norm: 1.539e+00
## It: 89; obj: 1.368e+01; abs: 2.045e-03; rel: 1.495e-04; norm: 1.538e+00
## It: 90; obj: 1.367e+01; abs: 1.959e-03; rel: 1.432e-04; norm: 1.537e+00
## It: 91; obj: 1.367e+01; abs: 1.876e-03; rel: 1.372e-04; norm: 1.536e+00
## It: 92; obj: 1.367e+01; abs: 1.795e-03; rel: 1.313e-04; norm: 1.535e+00
## It: 93; obj: 1.367e+01; abs: 1.718e-03; rel: 1.257e-04; norm: 1.534e+00
## It: 94; obj: 1.367e+01; abs: 1.644e-03; rel: 1.203e-04; norm: 1.534e+00
## It: 95; obj: 1.366e+01; abs: 1.573e-03; rel: 1.151e-04; norm: 1.533e+00
## It: 96; obj: 1.366e+01; abs: 1.505e-03; rel: 1.102e-04; norm: 1.532e+00
## It: 97; obj: 1.366e+01; abs: 1.441e-03; rel: 1.054e-04; norm: 1.531e+00
## It: 98; obj: 1.366e+01; abs: 1.379e-03; rel: 1.009e-04; norm: 1.530e+00
## It: 99; obj: 1.366e+01; abs: 1.320e-03; rel: 9.660e-05; norm: 1.530e+00
## It: 100; obj: 1.366e+01; abs: 1.263e-03; rel: 9.249e-05; norm: 1.529e+00

## It: 101; obj: 1.972e+00; abs: 1.169e+01; rel: 8.556e-01; norm: 1.268e-01
## It: 102; obj: 1.829e+00; abs: 1.425e-01; rel: 7.228e-02; norm: 1.283e-01
## It: 103; obj: 1.791e+00; abs: 3.864e-02; rel: 2.113e-02; norm: 1.461e-01
## It: 104; obj: 1.784e+00; abs: 6.470e-03; rel: 3.613e-03; norm: 1.482e-01
## It: 105; obj: 1.765e+00; abs: 1.962e-02; rel: 1.100e-02; norm: 1.493e-01
## It: 106; obj: 1.754e+00; abs: 1.081e-02; rel: 6.126e-03; norm: 1.492e-01
## It: 107; obj: 1.732e+00; abs: 2.214e-02; rel: 1.263e-02; norm: 1.489e-01
## It: 108; obj: 1.732e+00; abs: 6.069e-04; rel: 3.505e-04; norm: 1.485e-01
## It: 109; obj: 1.747e+00; abs: 1.469e-02; rel: 8.481e-03; norm: 1.487e-01
## It: 110; obj: 1.753e+00; abs: 5.627e-03; rel: 3.221e-03; norm: 1.501e-01
## It: 111; obj: 1.757e+00; abs: 4.512e-03; rel: 2.575e-03; norm: 1.489e-01
## It: 112; obj: 1.733e+00; abs: 2.454e-02; rel: 1.396e-02; norm: 1.473e-01
## It: 113; obj: 1.750e+00; abs: 1.708e-02; rel: 9.856e-03; norm: 1.482e-01
## It: 114; obj: 1.764e+00; abs: 1.482e-02; rel: 8.472e-03; norm: 1.482e-01
## It: 115; obj: 1.749e+00; abs: 1.567e-02; rel: 8.879e-03; norm: 1.478e-01
## It: 116; obj: 1.746e+00; abs: 2.389e-03; rel: 1.366e-03; norm: 1.487e-01
## It: 117; obj: 1.742e+00; abs: 4.448e-03; rel: 2.547e-03; norm: 1.485e-01
## It: 118; obj: 1.743e+00; abs: 1.159e-03; rel: 6.656e-04; norm: 1.479e-01
## It: 119; obj: 1.757e+00; abs: 1.405e-02; rel: 8.063e-03; norm: 1.490e-01
## It: 120; obj: 1.745e+00; abs: 1.253e-02; rel: 7.129e-03; norm: 1.505e-01
## It: 121; obj: 1.718e+00; abs: 2.662e-02; rel: 1.526e-02; norm: 1.494e-01
## It: 122; obj: 1.728e+00; abs: 9.889e-03; rel: 5.756e-03; norm: 1.483e-01
## It: 123; obj: 1.749e+00; abs: 2.071e-02; rel: 1.198e-02; norm: 1.499e-01
## It: 124; obj: 1.736e+00; abs: 1.218e-02; rel: 6.964e-03; norm: 1.501e-01
## It: 125; obj: 1.732e+00; abs: 4.011e-03; rel: 2.310e-03; norm: 1.499e-01

## It: 126; obj: 1.752e+00; abs: 1.979e-02; rel: 1.142e-02; norm: 1.503e-01
## It: 127; obj: 1.765e+00; abs: 1.266e-02; rel: 7.227e-03; norm: 1.503e-01
## It: 128; obj: 1.736e+00; abs: 2.925e-02; rel: 1.657e-02; norm: 1.502e-01
## It: 129; obj: 1.722e+00; abs: 1.396e-02; rel: 8.041e-03; norm: 1.500e-01
## It: 130; obj: 1.725e+00; abs: 3.707e-03; rel: 2.153e-03; norm: 1.492e-01
## It: 131; obj: 1.749e+00; abs: 2.394e-02; rel: 1.388e-02; norm: 1.500e-01
## It: 132; obj: 1.748e+00; abs: 9.363e-04; rel: 5.352e-04; norm: 1.506e-01
## It: 133; obj: 1.722e+00; abs: 2.611e-02; rel: 1.494e-02; norm: 1.484e-01

```

```

## It: 134; obj: 1.731e+00; abs: 8.602e-03; rel: 4.995e-03; norm: 1.489e-01
## It: 135; obj: 1.748e+00; abs: 1.726e-02; rel: 9.971e-03; norm: 1.513e-01
## It: 136; obj: 1.728e+00; abs: 2.035e-02; rel: 1.164e-02; norm: 1.497e-01
## It: 137; obj: 1.711e+00; abs: 1.667e-02; rel: 9.647e-03; norm: 1.495e-01
## It: 138; obj: 1.737e+00; abs: 2.576e-02; rel: 1.506e-02; norm: 1.502e-01
## It: 139; obj: 1.730e+00; abs: 7.116e-03; rel: 4.097e-03; norm: 1.495e-01
## It: 140; obj: 1.726e+00; abs: 3.275e-03; rel: 1.893e-03; norm: 1.497e-01
## It: 141; obj: 1.733e+00; abs: 6.579e-03; rel: 3.811e-03; norm: 1.513e-01
## It: 142; obj: 1.715e+00; abs: 1.853e-02; rel: 1.069e-02; norm: 1.495e-01
## It: 143; obj: 1.740e+00; abs: 2.596e-02; rel: 1.514e-02; norm: 1.507e-01
## It: 144; obj: 1.742e+00; abs: 1.869e-03; rel: 1.074e-03; norm: 1.512e-01
## It: 145; obj: 1.702e+00; abs: 4.039e-02; rel: 2.318e-02; norm: 1.496e-01
## It: 146; obj: 1.733e+00; abs: 3.094e-02; rel: 1.818e-02; norm: 1.496e-01
## It: 147; obj: 1.762e+00; abs: 2.944e-02; rel: 1.699e-02; norm: 1.503e-01
## It: 148; obj: 1.739e+00; abs: 2.368e-02; rel: 1.344e-02; norm: 1.501e-01
## It: 149; obj: 1.754e+00; abs: 1.541e-02; rel: 8.865e-03; norm: 1.492e-01
## It: 150; obj: 1.748e+00; abs: 6.288e-03; rel: 3.585e-03; norm: 1.506e-01
## It: 151; obj: 1.733e+00; abs: 1.437e-02; rel: 8.223e-03; norm: 1.507e-01
## It: 152; obj: 1.744e+00; abs: 1.088e-02; rel: 6.278e-03; norm: 1.500e-01
## It: 153; obj: 1.752e+00; abs: 7.399e-03; rel: 4.242e-03; norm: 1.516e-01
## It: 154; obj: 1.717e+00; abs: 3.474e-02; rel: 1.983e-02; norm: 1.495e-01
## It: 155; obj: 1.713e+00; abs: 4.358e-03; rel: 2.538e-03; norm: 1.495e-01
## It: 156; obj: 1.723e+00; abs: 1.011e-02; rel: 5.904e-03; norm: 1.503e-01
## It: 157; obj: 1.729e+00; abs: 6.298e-03; rel: 3.656e-03; norm: 1.503e-01
## It: 158; obj: 1.724e+00; abs: 5.378e-03; rel: 3.110e-03; norm: 1.509e-01
## It: 159; obj: 1.715e+00; abs: 8.771e-03; rel: 5.089e-03; norm: 1.499e-01
## It: 160; obj: 1.710e+00; abs: 4.615e-03; rel: 2.691e-03; norm: 1.515e-01
## It: 161; obj: 1.713e+00; abs: 2.614e-03; rel: 1.529e-03; norm: 1.497e-01
## It: 162; obj: 1.705e+00; abs: 8.331e-03; rel: 4.864e-03; norm: 1.501e-01
## It: 163; obj: 1.726e+00; abs: 2.126e-02; rel: 1.247e-02; norm: 1.510e-01
## It: 164; obj: 1.728e+00; abs: 2.349e-03; rel: 1.361e-03; norm: 1.521e-01
## It: 165; obj: 1.719e+00; abs: 9.200e-03; rel: 5.324e-03; norm: 1.515e-01
## It: 166; obj: 1.717e+00; abs: 1.895e-03; rel: 1.102e-03; norm: 1.505e-01
## It: 167; obj: 1.739e+00; abs: 2.212e-02; rel: 1.288e-02; norm: 1.513e-01
## It: 168; obj: 1.721e+00; abs: 1.775e-02; rel: 1.021e-02; norm: 1.509e-01
## It: 169; obj: 1.725e+00; abs: 3.980e-03; rel: 2.312e-03; norm: 1.511e-01
## It: 170; obj: 1.731e+00; abs: 5.750e-03; rel: 3.333e-03; norm: 1.505e-01
## It: 171; obj: 1.749e+00; abs: 1.748e-02; rel: 1.010e-02; norm: 1.522e-01
## It: 172; obj: 1.723e+00; abs: 2.540e-02; rel: 1.453e-02; norm: 1.519e-01
## It: 173; obj: 1.703e+00; abs: 2.068e-02; rel: 1.200e-02; norm: 1.507e-01
## It: 174; obj: 1.724e+00; abs: 2.123e-02; rel: 1.247e-02; norm: 1.507e-01
## It: 175; obj: 1.729e+00; abs: 5.526e-03; rel: 3.206e-03; norm: 1.512e-01
## It: 176; obj: 1.732e+00; abs: 2.768e-03; rel: 1.601e-03; norm: 1.504e-01
## It: 177; obj: 1.751e+00; abs: 1.913e-02; rel: 1.104e-02; norm: 1.520e-01
## It: 178; obj: 1.729e+00; abs: 2.224e-02; rel: 1.270e-02; norm: 1.515e-01
## It: 179; obj: 1.730e+00; abs: 9.039e-04; rel: 5.228e-04; norm: 1.505e-01
## It: 180; obj: 1.734e+00; abs: 3.901e-03; rel: 2.255e-03; norm: 1.515e-01
## It: 181; obj: 1.713e+00; abs: 2.101e-02; rel: 1.212e-02; norm: 1.508e-01
## It: 182; obj: 1.719e+00; abs: 5.789e-03; rel: 3.380e-03; norm: 1.514e-01
## It: 183; obj: 1.719e+00; abs: 1.288e-04; rel: 7.494e-05; norm: 1.522e-01
## It: 184; obj: 1.729e+00; abs: 1.071e-02; rel: 6.229e-03; norm: 1.518e-01
## It: 185; obj: 1.735e+00; abs: 5.484e-03; rel: 3.171e-03; norm: 1.517e-01
## It: 186; obj: 1.726e+00; abs: 8.589e-03; rel: 4.951e-03; norm: 1.509e-01

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## It: 187; obj: 1.724e+00; abs: 2.236e-03; rel: 1.295e-03; norm: 1.512e-01
## It: 188; obj: 1.736e+00; abs: 1.173e-02; rel: 6.805e-03; norm: 1.504e-01
## It: 189; obj: 1.748e+00; abs: 1.178e-02; rel: 6.789e-03; norm: 1.530e-01
## It: 190; obj: 1.748e+00; abs: 2.106e-04; rel: 1.205e-04; norm: 1.514e-01
## It: 191; obj: 1.744e+00; abs: 3.822e-03; rel: 2.187e-03; norm: 1.503e-01
## It: 192; obj: 1.743e+00; abs: 6.600e-04; rel: 3.784e-04; norm: 1.506e-01
## It: 193; obj: 1.757e+00; abs: 1.351e-02; rel: 7.748e-03; norm: 1.513e-01
## It: 194; obj: 1.738e+00; abs: 1.905e-02; rel: 1.084e-02; norm: 1.511e-01
## It: 195; obj: 1.750e+00; abs: 1.213e-02; rel: 6.978e-03; norm: 1.504e-01
## It: 196; obj: 1.747e+00; abs: 3.146e-03; rel: 1.798e-03; norm: 1.505e-01
## It: 197; obj: 1.735e+00; abs: 1.200e-02; rel: 6.871e-03; norm: 1.502e-01
## It: 198; obj: 1.730e+00; abs: 4.620e-03; rel: 2.663e-03; norm: 1.513e-01
## It: 199; obj: 1.756e+00; abs: 2.565e-02; rel: 1.482e-02; norm: 1.510e-01
## It: 200; obj: 1.754e+00; abs: 1.794e-03; rel: 1.022e-03; norm: 1.517e-01
## It: 201; obj: 1.723e+00; abs: 3.122e-02; rel: 1.780e-02; norm: 1.518e-01
## It: 202; obj: 1.718e+00; abs: 5.205e-03; rel: 3.021e-03; norm: 1.511e-01
## It: 203; obj: 1.747e+00; abs: 2.972e-02; rel: 1.730e-02; norm: 1.502e-01
## It: 204; obj: 1.765e+00; abs: 1.805e-02; rel: 1.033e-02; norm: 1.522e-01
## It: 205; obj: 1.755e+00; abs: 1.031e-02; rel: 5.839e-03; norm: 1.515e-01
## It: 206; obj: 1.731e+00; abs: 2.407e-02; rel: 1.371e-02; norm: 1.506e-01
## It: 207; obj: 1.724e+00; abs: 7.063e-03; rel: 4.081e-03; norm: 1.519e-01
## It: 208; obj: 1.713e+00; abs: 1.102e-02; rel: 6.392e-03; norm: 1.512e-01
## It: 209; obj: 1.722e+00; abs: 9.049e-03; rel: 5.283e-03; norm: 1.495e-01
## It: 210; obj: 1.735e+00; abs: 1.271e-02; rel: 7.384e-03; norm: 1.510e-01
## It: 211; obj: 1.735e+00; abs: 8.020e-04; rel: 4.624e-04; norm: 1.517e-01
## It: 212; obj: 1.707e+00; abs: 2.798e-02; rel: 1.612e-02; norm: 1.492e-01
## It: 213; obj: 1.730e+00; abs: 2.231e-02; rel: 1.307e-02; norm: 1.506e-01
## It: 214; obj: 1.740e+00; abs: 1.023e-02; rel: 5.913e-03; norm: 1.514e-01
## It: 215; obj: 1.718e+00; abs: 2.170e-02; rel: 1.247e-02; norm: 1.497e-01
## It: 216; obj: 1.718e+00; abs: 6.695e-04; rel: 3.896e-04; norm: 1.505e-01
## It: 217; obj: 1.714e+00; abs: 3.167e-03; rel: 1.844e-03; norm: 1.506e-01
## It: 218; obj: 1.707e+00; abs: 6.915e-03; rel: 4.034e-03; norm: 1.494e-01
## It: 219; obj: 1.709e+00; abs: 1.636e-03; rel: 9.579e-04; norm: 1.506e-01
## It: 220; obj: 1.704e+00; abs: 4.902e-03; rel: 2.868e-03; norm: 1.497e-01
## It: 221; obj: 1.719e+00; abs: 1.469e-02; rel: 8.617e-03; norm: 1.500e-01
## It: 222; obj: 1.717e+00; abs: 2.219e-03; rel: 1.291e-03; norm: 1.516e-01
## It: 223; obj: 1.698e+00; abs: 1.867e-02; rel: 1.088e-02; norm: 1.512e-01
## It: 224; obj: 1.712e+00; abs: 1.383e-02; rel: 8.147e-03; norm: 1.503e-01
## It: 225; obj: 1.698e+00; abs: 1.345e-02; rel: 7.857e-03; norm: 1.507e-01
## It: 226; obj: 1.703e+00; abs: 4.382e-03; rel: 2.580e-03; norm: 1.511e-01
## It: 227; obj: 1.714e+00; abs: 1.161e-02; rel: 6.818e-03; norm: 1.504e-01
## It: 228; obj: 1.711e+00; abs: 3.411e-03; rel: 1.990e-03; norm: 1.520e-01
## It: 229; obj: 1.694e+00; abs: 1.692e-02; rel: 9.886e-03; norm: 1.501e-01
## It: 230; obj: 1.697e+00; abs: 2.495e-03; rel: 1.473e-03; norm: 1.489e-01
## It: 231; obj: 1.705e+00; abs: 8.900e-03; rel: 5.246e-03; norm: 1.515e-01
## It: 232; obj: 1.717e+00; abs: 1.137e-02; rel: 6.665e-03; norm: 1.513e-01
## It: 233; obj: 1.725e+00; abs: 8.644e-03; rel: 5.035e-03; norm: 1.514e-01
## It: 234; obj: 1.708e+00; abs: 1.787e-02; rel: 1.035e-02; norm: 1.515e-01
## It: 235; obj: 1.703e+00; abs: 4.616e-03; rel: 2.703e-03; norm: 1.499e-01
## It: 236; obj: 1.714e+00; abs: 1.073e-02; rel: 6.298e-03; norm: 1.501e-01
## It: 237; obj: 1.714e+00; abs: 1.116e-04; rel: 6.513e-05; norm: 1.518e-01
## It: 238; obj: 1.712e+00; abs: 1.706e-03; rel: 9.957e-04; norm: 1.513e-01
## It: 239; obj: 1.701e+00; abs: 1.062e-02; rel: 6.201e-03; norm: 1.498e-01

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## It: 240; obj: 1.706e+00; abs: 4.243e-03; rel: 2.494e-03; norm: 1.518e-01
## It: 241; obj: 1.688e+00; abs: 1.771e-02; rel: 1.039e-02; norm: 1.507e-01
## It: 242; obj: 1.711e+00; abs: 2.331e-02; rel: 1.381e-02; norm: 1.502e-01
## It: 243; obj: 1.706e+00; abs: 5.284e-03; rel: 3.088e-03; norm: 1.520e-01
## It: 244; obj: 1.701e+00; abs: 4.746e-03; rel: 2.782e-03; norm: 1.505e-01
## It: 245; obj: 1.714e+00; abs: 1.336e-02; rel: 7.856e-03; norm: 1.504e-01
## It: 246; obj: 1.720e+00; abs: 5.831e-03; rel: 3.401e-03; norm: 1.522e-01
## It: 247; obj: 1.713e+00; abs: 7.108e-03; rel: 4.132e-03; norm: 1.508e-01
## It: 248; obj: 1.725e+00; abs: 1.148e-02; rel: 6.702e-03; norm: 1.494e-01
## It: 249; obj: 1.714e+00; abs: 1.074e-02; rel: 6.227e-03; norm: 1.510e-01
## It: 250; obj: 1.716e+00; abs: 1.820e-03; rel: 1.062e-03; norm: 1.516e-01

## It: 251; obj: 1.732e+00; abs: 1.624e-02; rel: 9.463e-03; norm: 1.502e-01
## It: 252; obj: 1.724e+00; abs: 7.507e-03; rel: 4.334e-03; norm: 1.513e-01
## It: 253; obj: 1.714e+00; abs: 1.010e-02; rel: 5.854e-03; norm: 1.508e-01
## It: 254; obj: 1.705e+00; abs: 9.341e-03; rel: 5.448e-03; norm: 1.493e-01
## It: 255; obj: 1.695e+00; abs: 1.047e-02; rel: 6.142e-03; norm: 1.498e-01
## It: 256; obj: 1.702e+00; abs: 7.237e-03; rel: 4.271e-03; norm: 1.498e-01
## It: 257; obj: 1.713e+00; abs: 1.123e-02; rel: 6.601e-03; norm: 1.506e-01
## It: 258; obj: 1.707e+00; abs: 5.684e-03; rel: 3.318e-03; norm: 1.507e-01
## It: 259; obj: 1.707e+00; abs: 1.840e-04; rel: 1.078e-04; norm: 1.502e-01
## It: 260; obj: 1.689e+00; abs: 1.844e-02; rel: 1.080e-02; norm: 1.507e-01
## It: 261; obj: 1.705e+00; abs: 1.581e-02; rel: 9.364e-03; norm: 1.505e-01
## It: 262; obj: 1.689e+00; abs: 1.551e-02; rel: 9.099e-03; norm: 1.503e-01
## It: 263; obj: 1.687e+00; abs: 2.306e-03; rel: 1.365e-03; norm: 1.499e-01
## It: 264; obj: 1.687e+00; abs: 4.335e-04; rel: 2.570e-04; norm: 1.505e-01
## It: 265; obj: 1.685e+00; abs: 2.054e-03; rel: 1.218e-03; norm: 1.506e-01
## It: 266; obj: 1.676e+00; abs: 8.672e-03; rel: 5.146e-03; norm: 1.505e-01
## It: 267; obj: 1.676e+00; abs: 5.771e-05; rel: 3.442e-05; norm: 1.511e-01
## It: 268; obj: 1.681e+00; abs: 4.871e-03; rel: 2.906e-03; norm: 1.499e-01
## It: 269; obj: 1.681e+00; abs: 6.235e-04; rel: 3.708e-04; norm: 1.502e-01
## It: 270; obj: 1.680e+00; abs: 9.141e-04; rel: 5.439e-04; norm: 1.502e-01
## It: 271; obj: 1.678e+00; abs: 1.307e-03; rel: 7.782e-04; norm: 1.503e-01
## It: 272; obj: 1.677e+00; abs: 1.783e-03; rel: 1.062e-03; norm: 1.509e-01
## It: 273; obj: 1.695e+00; abs: 1.833e-02; rel: 1.093e-02; norm: 1.512e-01
## It: 274; obj: 1.688e+00; abs: 6.942e-03; rel: 4.096e-03; norm: 1.507e-01
## It: 275; obj: 1.672e+00; abs: 1.630e-02; rel: 9.656e-03; norm: 1.510e-01

## It: 276; obj: 1.675e+00; abs: 3.534e-03; rel: 2.114e-03; norm: 1.509e-01
## It: 277; obj: 1.699e+00; abs: 2.395e-02; rel: 1.430e-02; norm: 1.512e-01
## It: 278; obj: 1.700e+00; abs: 6.422e-04; rel: 3.779e-04; norm: 1.512e-01
## It: 279; obj: 1.681e+00; abs: 1.859e-02; rel: 1.094e-02; norm: 1.511e-01
## It: 280; obj: 1.683e+00; abs: 1.880e-03; rel: 1.118e-03; norm: 1.500e-01
## It: 281; obj: 1.677e+00; abs: 6.373e-03; rel: 3.786e-03; norm: 1.510e-01
## It: 282; obj: 1.679e+00; abs: 2.720e-03; rel: 1.622e-03; norm: 1.502e-01
## It: 283; obj: 1.682e+00; abs: 2.237e-03; rel: 1.332e-03; norm: 1.503e-01
## It: 284; obj: 1.680e+00; abs: 1.704e-03; rel: 1.013e-03; norm: 1.506e-01
## It: 285; obj: 1.682e+00; abs: 2.131e-03; rel: 1.268e-03; norm: 1.508e-01
## It: 286; obj: 1.677e+00; abs: 5.053e-03; rel: 3.004e-03; norm: 1.508e-01
## It: 287; obj: 1.680e+00; abs: 3.196e-03; rel: 1.905e-03; norm: 1.518e-01
## It: 288; obj: 1.680e+00; abs: 7.369e-04; rel: 4.385e-04; norm: 1.515e-01
## It: 289; obj: 1.679e+00; abs: 3.191e-04; rel: 1.900e-04; norm: 1.509e-01
## It: 290; obj: 1.685e+00; abs: 5.391e-03; rel: 3.210e-03; norm: 1.507e-01
## It: 291; obj: 1.677e+00; abs: 7.586e-03; rel: 4.503e-03; norm: 1.510e-01
## It: 292; obj: 1.678e+00; abs: 8.085e-04; rel: 4.821e-04; norm: 1.522e-01

```

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## It: 293; obj: 1.687e+00; abs: 9.544e-03; rel: 5.688e-03; norm: 1.504e-01
## It: 294; obj: 1.656e+00; abs: 3.148e-02; rel: 1.866e-02; norm: 1.515e-01
## It: 295; obj: 1.662e+00; abs: 5.912e-03; rel: 3.570e-03; norm: 1.501e-01
## It: 296; obj: 1.679e+00; abs: 1.722e-02; rel: 1.036e-02; norm: 1.507e-01
## It: 297; obj: 1.670e+00; abs: 9.039e-03; rel: 5.384e-03; norm: 1.501e-01
## It: 298; obj: 1.677e+00; abs: 6.568e-03; rel: 3.933e-03; norm: 1.507e-01
## It: 299; obj: 1.693e+00; abs: 1.637e-02; rel: 9.767e-03; norm: 1.509e-01
## It: 300; obj: 1.680e+00; abs: 1.306e-02; rel: 7.716e-03; norm: 1.510e-01

## It: 301; obj: 1.682e+00; abs: 2.150e-03; rel: 1.280e-03; norm: 1.508e-01
## It: 302; obj: 1.680e+00; abs: 2.357e-03; rel: 1.401e-03; norm: 1.512e-01
## It: 303; obj: 1.671e+00; abs: 8.839e-03; rel: 5.262e-03; norm: 1.514e-01
## It: 304; obj: 1.670e+00; abs: 8.815e-04; rel: 5.276e-04; norm: 1.494e-01
## It: 305; obj: 1.684e+00; abs: 1.397e-02; rel: 8.363e-03; norm: 1.504e-01
## It: 306; obj: 1.690e+00; abs: 5.899e-03; rel: 3.503e-03; norm: 1.515e-01
## It: 307; obj: 1.678e+00; abs: 1.230e-02; rel: 7.279e-03; norm: 1.525e-01
## It: 308; obj: 1.664e+00; abs: 1.316e-02; rel: 7.847e-03; norm: 1.503e-01
## It: 309; obj: 1.666e+00; abs: 1.274e-03; rel: 7.655e-04; norm: 1.505e-01
## It: 310; obj: 1.691e+00; abs: 2.509e-02; rel: 1.506e-02; norm: 1.515e-01
## It: 311; obj: 1.702e+00; abs: 1.079e-02; rel: 6.384e-03; norm: 1.509e-01
## It: 312; obj: 1.689e+00; abs: 1.271e-02; rel: 7.471e-03; norm: 1.511e-01
## It: 313; obj: 1.676e+00; abs: 1.285e-02; rel: 7.607e-03; norm: 1.505e-01
## It: 314; obj: 1.689e+00; abs: 1.272e-02; rel: 7.587e-03; norm: 1.518e-01
## It: 315; obj: 1.691e+00; abs: 2.394e-03; rel: 1.417e-03; norm: 1.517e-01
## It: 316; obj: 1.692e+00; abs: 7.110e-04; rel: 4.204e-04; norm: 1.510e-01
## It: 317; obj: 1.676e+00; abs: 1.547e-02; rel: 9.146e-03; norm: 1.502e-01
## It: 318; obj: 1.664e+00; abs: 1.187e-02; rel: 7.080e-03; norm: 1.516e-01
## It: 319; obj: 1.668e+00; abs: 4.035e-03; rel: 2.424e-03; norm: 1.510e-01
## It: 320; obj: 1.689e+00; abs: 2.057e-02; rel: 1.233e-02; norm: 1.498e-01
## It: 321; obj: 1.691e+00; abs: 2.184e-03; rel: 1.293e-03; norm: 1.525e-01
## It: 322; obj: 1.688e+00; abs: 3.243e-03; rel: 1.917e-03; norm: 1.522e-01
## It: 323; obj: 1.688e+00; abs: 6.904e-05; rel: 4.090e-05; norm: 1.511e-01
## It: 324; obj: 1.682e+00; abs: 5.564e-03; rel: 3.296e-03; norm: 1.514e-01
## It: 325; obj: 1.679e+00; abs: 3.753e-03; rel: 2.231e-03; norm: 1.505e-01

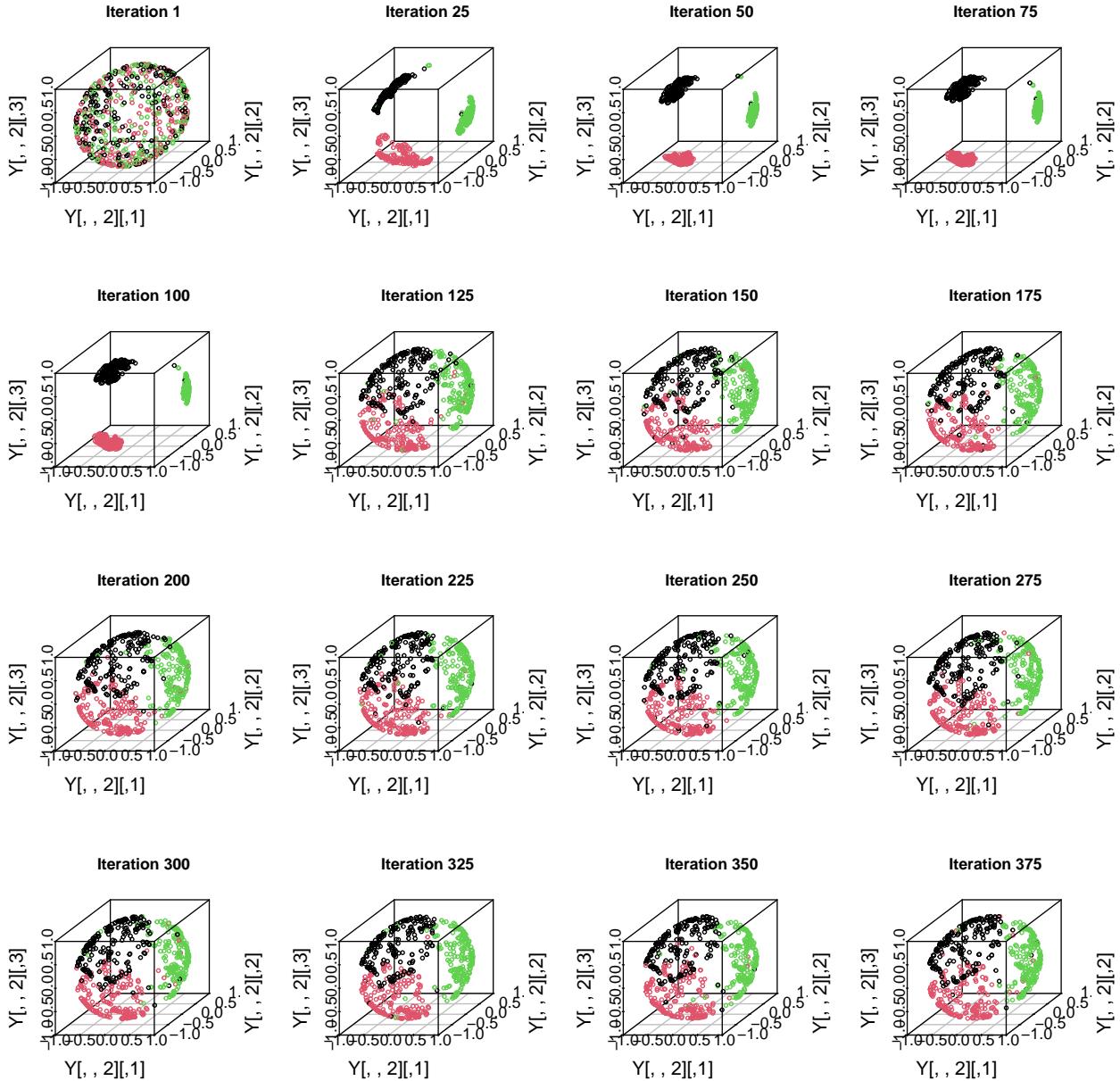
## It: 326; obj: 1.681e+00; abs: 2.501e-03; rel: 1.490e-03; norm: 1.507e-01
## It: 327; obj: 1.685e+00; abs: 4.179e-03; rel: 2.486e-03; norm: 1.506e-01
## It: 328; obj: 1.696e+00; abs: 1.043e-02; rel: 6.187e-03; norm: 1.524e-01
## It: 329; obj: 1.681e+00; abs: 1.475e-02; rel: 8.698e-03; norm: 1.504e-01
## It: 330; obj: 1.667e+00; abs: 1.427e-02; rel: 8.488e-03; norm: 1.507e-01
## It: 331; obj: 1.686e+00; abs: 1.904e-02; rel: 1.142e-02; norm: 1.514e-01
## It: 332; obj: 1.690e+00; abs: 3.754e-03; rel: 2.227e-03; norm: 1.515e-01
## It: 333; obj: 1.669e+00; abs: 2.037e-02; rel: 1.206e-02; norm: 1.512e-01
## It: 334; obj: 1.673e+00; abs: 3.817e-03; rel: 2.287e-03; norm: 1.503e-01
## It: 335; obj: 1.682e+00; abs: 9.221e-03; rel: 5.511e-03; norm: 1.511e-01
## It: 336; obj: 1.678e+00; abs: 4.444e-03; rel: 2.642e-03; norm: 1.520e-01
## It: 337; obj: 1.689e+00; abs: 1.102e-02; rel: 6.571e-03; norm: 1.510e-01
## It: 338; obj: 1.682e+00; abs: 6.964e-03; rel: 4.123e-03; norm: 1.516e-01
## It: 339; obj: 1.670e+00; abs: 1.229e-02; rel: 7.304e-03; norm: 1.512e-01
## It: 340; obj: 1.661e+00; abs: 8.309e-03; rel: 4.977e-03; norm: 1.511e-01
## It: 341; obj: 1.664e+00; abs: 2.966e-03; rel: 1.785e-03; norm: 1.515e-01
## It: 342; obj: 1.676e+00; abs: 1.184e-02; rel: 7.115e-03; norm: 1.518e-01
## It: 343; obj: 1.688e+00; abs: 1.184e-02; rel: 7.061e-03; norm: 1.514e-01
## It: 344; obj: 1.683e+00; abs: 5.094e-03; rel: 3.018e-03; norm: 1.511e-01
## It: 345; obj: 1.665e+00; abs: 1.804e-02; rel: 1.072e-02; norm: 1.524e-01

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## It: 346; obj: 1.674e+00; abs: 9.674e-03; rel: 5.811e-03; norm: 1.509e-01
## It: 347; obj: 1.670e+00; abs: 4.023e-03; rel: 2.402e-03; norm: 1.501e-01
## It: 348; obj: 1.667e+00; abs: 3.498e-03; rel: 2.094e-03; norm: 1.515e-01
## It: 349; obj: 1.671e+00; abs: 3.566e-03; rel: 2.139e-03; norm: 1.515e-01
## It: 350; obj: 1.692e+00; abs: 2.162e-02; rel: 1.294e-02; norm: 1.498e-01
## It: 351; obj: 1.693e+00; abs: 1.235e-03; rel: 7.297e-04; norm: 1.514e-01
## It: 352; obj: 1.678e+00; abs: 1.566e-02; rel: 9.246e-03; norm: 1.519e-01
## It: 353; obj: 1.670e+00; abs: 8.024e-03; rel: 4.783e-03; norm: 1.499e-01
## It: 354; obj: 1.672e+00; abs: 2.319e-03; rel: 1.389e-03; norm: 1.509e-01
## It: 355; obj: 1.677e+00; abs: 4.633e-03; rel: 2.771e-03; norm: 1.513e-01
## It: 356; obj: 1.689e+00; abs: 1.236e-02; rel: 7.370e-03; norm: 1.502e-01
## It: 357; obj: 1.681e+00; abs: 8.093e-03; rel: 4.791e-03; norm: 1.517e-01
## It: 358; obj: 1.674e+00; abs: 6.695e-03; rel: 3.983e-03; norm: 1.514e-01
## It: 359; obj: 1.686e+00; abs: 1.139e-02; rel: 6.804e-03; norm: 1.516e-01
## It: 360; obj: 1.697e+00; abs: 1.188e-02; rel: 7.050e-03; norm: 1.510e-01
## It: 361; obj: 1.687e+00; abs: 1.034e-02; rel: 6.094e-03; norm: 1.516e-01
## It: 362; obj: 1.675e+00; abs: 1.242e-02; rel: 7.364e-03; norm: 1.507e-01
## It: 363; obj: 1.669e+00; abs: 5.857e-03; rel: 3.497e-03; norm: 1.513e-01
## It: 364; obj: 1.680e+00; abs: 1.118e-02; rel: 6.699e-03; norm: 1.504e-01
## It: 365; obj: 1.694e+00; abs: 1.364e-02; rel: 8.119e-03; norm: 1.510e-01
## It: 366; obj: 1.685e+00; abs: 8.206e-03; rel: 4.845e-03; norm: 1.529e-01
## It: 367; obj: 1.679e+00; abs: 6.593e-03; rel: 3.912e-03; norm: 1.519e-01
## It: 368; obj: 1.669e+00; abs: 9.798e-03; rel: 5.836e-03; norm: 1.507e-01
## It: 369; obj: 1.656e+00; abs: 1.338e-02; rel: 8.019e-03; norm: 1.496e-01
## It: 370; obj: 1.674e+00; abs: 1.799e-02; rel: 1.086e-02; norm: 1.511e-01
## It: 371; obj: 1.691e+00; abs: 1.741e-02; rel: 1.040e-02; norm: 1.503e-01
## It: 372; obj: 1.690e+00; abs: 1.177e-03; rel: 6.959e-04; norm: 1.507e-01
## It: 373; obj: 1.677e+00; abs: 1.319e-02; rel: 7.803e-03; norm: 1.518e-01
## It: 374; obj: 1.686e+00; abs: 8.798e-03; rel: 5.247e-03; norm: 1.511e-01
## It: 375; obj: 1.690e+00; abs: 4.916e-03; rel: 2.917e-03; norm: 1.525e-01

```



```

## It: 376; obj: 1.687e+00; abs: 3.243e-03; rel: 1.919e-03; norm: 1.520e-01
## It: 377; obj: 1.673e+00; abs: 1.414e-02; rel: 8.382e-03; norm: 1.501e-01
## It: 378; obj: 1.682e+00; abs: 8.787e-03; rel: 5.252e-03; norm: 1.498e-01
## It: 379; obj: 1.689e+00; abs: 7.159e-03; rel: 4.256e-03; norm: 1.503e-01
## It: 380; obj: 1.687e+00; abs: 2.448e-03; rel: 1.449e-03; norm: 1.503e-01
## It: 381; obj: 1.692e+00; abs: 5.551e-03; rel: 3.291e-03; norm: 1.497e-01
## It: 382; obj: 1.692e+00; abs: 2.528e-04; rel: 1.494e-04; norm: 1.507e-01
## It: 383; obj: 1.690e+00; abs: 1.916e-03; rel: 1.132e-03; norm: 1.508e-01
## It: 384; obj: 1.691e+00; abs: 5.188e-04; rel: 3.069e-04; norm: 1.500e-01
## It: 385; obj: 1.676e+00; abs: 1.544e-02; rel: 9.133e-03; norm: 1.508e-01
## It: 386; obj: 1.686e+00; abs: 1.045e-02; rel: 6.237e-03; norm: 1.505e-01
## It: 387; obj: 1.675e+00; abs: 1.139e-02; rel: 6.756e-03; norm: 1.509e-01
## It: 388; obj: 1.680e+00; abs: 4.998e-03; rel: 2.985e-03; norm: 1.504e-01
## It: 389; obj: 1.669e+00; abs: 1.040e-02; rel: 6.193e-03; norm: 1.515e-01
## It: 390; obj: 1.681e+00; abs: 1.161e-02; rel: 6.954e-03; norm: 1.501e-01

```

```

## It: 391; obj: 1.695e+00; abs: 1.409e-02; rel: 8.385e-03; norm: 1.496e-01
## It: 392; obj: 1.677e+00; abs: 1.759e-02; rel: 1.038e-02; norm: 1.495e-01
## It: 393; obj: 1.670e+00; abs: 7.280e-03; rel: 4.341e-03; norm: 1.515e-01
## It: 394; obj: 1.673e+00; abs: 2.868e-03; rel: 1.718e-03; norm: 1.508e-01
## It: 395; obj: 1.676e+00; abs: 2.640e-03; rel: 1.578e-03; norm: 1.500e-01
## It: 396; obj: 1.681e+00; abs: 5.366e-03; rel: 3.202e-03; norm: 1.504e-01
## It: 397; obj: 1.686e+00; abs: 4.741e-03; rel: 2.821e-03; norm: 1.503e-01
## It: 398; obj: 1.675e+00; abs: 1.027e-02; rel: 6.095e-03; norm: 1.506e-01
## It: 399; obj: 1.665e+00; abs: 1.011e-02; rel: 6.036e-03; norm: 1.502e-01
## It: 400; obj: 1.666e+00; abs: 3.809e-04; rel: 2.287e-04; norm: 1.495e-01

## It: 401; obj: 1.672e+00; abs: 6.552e-03; rel: 3.934e-03; norm: 1.507e-01
## It: 402; obj: 1.672e+00; abs: 5.225e-04; rel: 3.125e-04; norm: 1.497e-01
## It: 403; obj: 1.670e+00; abs: 1.950e-03; rel: 1.167e-03; norm: 1.496e-01
## It: 404; obj: 1.674e+00; abs: 4.413e-03; rel: 2.643e-03; norm: 1.503e-01
## It: 405; obj: 1.658e+00; abs: 1.587e-02; rel: 9.479e-03; norm: 1.496e-01
## It: 406; obj: 1.658e+00; abs: 5.531e-04; rel: 3.335e-04; norm: 1.499e-01
## It: 407; obj: 1.672e+00; abs: 1.427e-02; rel: 8.606e-03; norm: 1.492e-01
## It: 408; obj: 1.682e+00; abs: 9.745e-03; rel: 5.829e-03; norm: 1.498e-01
## It: 409; obj: 1.668e+00; abs: 1.337e-02; rel: 7.949e-03; norm: 1.501e-01
## It: 410; obj: 1.661e+00; abs: 7.668e-03; rel: 4.596e-03; norm: 1.507e-01
## It: 411; obj: 1.665e+00; abs: 4.698e-03; rel: 2.829e-03; norm: 1.493e-01
## It: 412; obj: 1.664e+00; abs: 1.152e-03; rel: 6.917e-04; norm: 1.492e-01
## It: 413; obj: 1.659e+00; abs: 5.000e-03; rel: 3.004e-03; norm: 1.498e-01
## It: 414; obj: 1.675e+00; abs: 1.614e-02; rel: 9.725e-03; norm: 1.494e-01
## It: 415; obj: 1.677e+00; abs: 2.068e-03; rel: 1.234e-03; norm: 1.500e-01
## It: 416; obj: 1.676e+00; abs: 1.494e-03; rel: 8.909e-04; norm: 1.502e-01
## It: 417; obj: 1.666e+00; abs: 9.771e-03; rel: 5.830e-03; norm: 1.505e-01
## It: 418; obj: 1.663e+00; abs: 3.486e-03; rel: 2.092e-03; norm: 1.505e-01
## It: 419; obj: 1.677e+00; abs: 1.395e-02; rel: 8.392e-03; norm: 1.504e-01
## It: 420; obj: 1.675e+00; abs: 1.672e-03; rel: 9.972e-04; norm: 1.499e-01
## It: 421; obj: 1.652e+00; abs: 2.341e-02; rel: 1.397e-02; norm: 1.506e-01
## It: 422; obj: 1.664e+00; abs: 1.283e-02; rel: 7.767e-03; norm: 1.496e-01
## It: 423; obj: 1.670e+00; abs: 5.737e-03; rel: 3.447e-03; norm: 1.501e-01
## It: 424; obj: 1.670e+00; abs: 3.468e-04; rel: 2.077e-04; norm: 1.509e-01
## It: 425; obj: 1.676e+00; abs: 6.029e-03; rel: 3.611e-03; norm: 1.495e-01

## It: 426; obj: 1.666e+00; abs: 1.002e-02; rel: 5.982e-03; norm: 1.499e-01
## It: 427; obj: 1.663e+00; abs: 2.776e-03; rel: 1.667e-03; norm: 1.497e-01
## It: 428; obj: 1.658e+00; abs: 4.944e-03; rel: 2.973e-03; norm: 1.488e-01
## It: 429; obj: 1.659e+00; abs: 1.238e-03; rel: 7.468e-04; norm: 1.502e-01
## It: 430; obj: 1.648e+00; abs: 1.080e-02; rel: 6.509e-03; norm: 1.496e-01
## It: 431; obj: 1.657e+00; abs: 8.400e-03; rel: 5.096e-03; norm: 1.486e-01
## It: 432; obj: 1.656e+00; abs: 9.154e-04; rel: 5.525e-04; norm: 1.494e-01
## It: 433; obj: 1.652e+00; abs: 3.493e-03; rel: 2.109e-03; norm: 1.495e-01
## It: 434; obj: 1.653e+00; abs: 5.024e-04; rel: 3.040e-04; norm: 1.494e-01
## It: 435; obj: 1.658e+00; abs: 5.194e-03; rel: 3.142e-03; norm: 1.494e-01
## It: 436; obj: 1.664e+00; abs: 6.017e-03; rel: 3.629e-03; norm: 1.499e-01
## It: 437; obj: 1.668e+00; abs: 3.961e-03; rel: 2.380e-03; norm: 1.497e-01
## It: 438; obj: 1.666e+00; abs: 2.326e-03; rel: 1.394e-03; norm: 1.497e-01
## It: 439; obj: 1.667e+00; abs: 1.666e-03; rel: 1.000e-03; norm: 1.498e-01
## It: 440; obj: 1.670e+00; abs: 2.927e-03; rel: 1.755e-03; norm: 1.500e-01
## It: 441; obj: 1.665e+00; abs: 5.729e-03; rel: 3.430e-03; norm: 1.495e-01
## It: 442; obj: 1.654e+00; abs: 1.067e-02; rel: 6.410e-03; norm: 1.499e-01
## It: 443; obj: 1.658e+00; abs: 3.864e-03; rel: 2.336e-03; norm: 1.500e-01

```

```

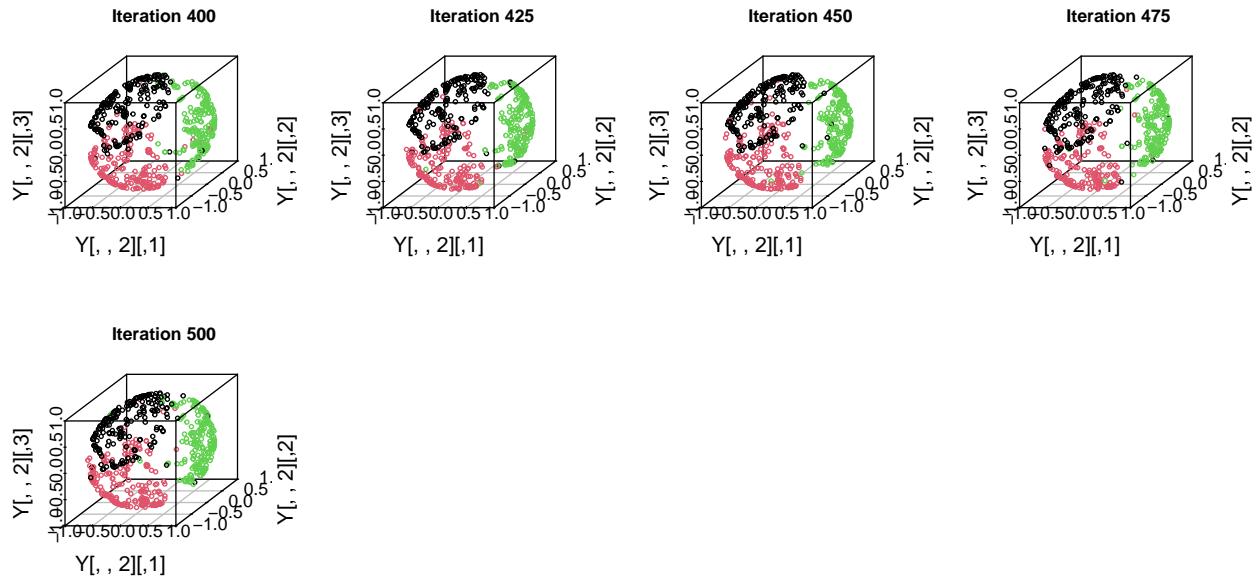
## It: 444; obj: 1.664e+00; abs: 6.476e-03; rel: 3.906e-03; norm: 1.490e-01
## It: 445; obj: 1.664e+00; abs: 8.454e-04; rel: 5.079e-04; norm: 1.494e-01
## It: 446; obj: 1.674e+00; abs: 1.027e-02; rel: 6.173e-03; norm: 1.503e-01
## It: 447; obj: 1.665e+00; abs: 8.459e-03; rel: 5.054e-03; norm: 1.496e-01
## It: 448; obj: 1.665e+00; abs: 7.365e-04; rel: 4.423e-04; norm: 1.491e-01
## It: 449; obj: 1.660e+00; abs: 4.784e-03; rel: 2.874e-03; norm: 1.502e-01
## It: 450; obj: 1.661e+00; abs: 9.351e-04; rel: 5.634e-04; norm: 1.497e-01
## It: 451; obj: 1.665e+00; abs: 3.935e-03; rel: 2.369e-03; norm: 1.497e-01
## It: 452; obj: 1.689e+00; abs: 2.422e-02; rel: 1.455e-02; norm: 1.490e-01
## It: 453; obj: 1.669e+00; abs: 2.009e-02; rel: 1.189e-02; norm: 1.504e-01
## It: 454; obj: 1.656e+00; abs: 1.311e-02; rel: 7.855e-03; norm: 1.500e-01
## It: 455; obj: 1.669e+00; abs: 1.309e-02; rel: 7.908e-03; norm: 1.495e-01
## It: 456; obj: 1.671e+00; abs: 2.075e-03; rel: 1.243e-03; norm: 1.500e-01
## It: 457; obj: 1.676e+00; abs: 4.766e-03; rel: 2.853e-03; norm: 1.509e-01
## It: 458; obj: 1.679e+00; abs: 3.033e-03; rel: 1.810e-03; norm: 1.493e-01
## It: 459; obj: 1.668e+00; abs: 1.092e-02; rel: 6.505e-03; norm: 1.495e-01
## It: 460; obj: 1.669e+00; abs: 1.723e-03; rel: 1.033e-03; norm: 1.506e-01
## It: 461; obj: 1.667e+00; abs: 2.443e-03; rel: 1.464e-03; norm: 1.500e-01
## It: 462; obj: 1.679e+00; abs: 1.204e-02; rel: 7.222e-03; norm: 1.492e-01
## It: 463; obj: 1.661e+00; abs: 1.784e-02; rel: 1.062e-02; norm: 1.496e-01
## It: 464; obj: 1.686e+00; abs: 2.449e-02; rel: 1.474e-02; norm: 1.488e-01
## It: 465; obj: 1.676e+00; abs: 1.011e-02; rel: 5.998e-03; norm: 1.503e-01
## It: 466; obj: 1.657e+00; abs: 1.909e-02; rel: 1.140e-02; norm: 1.492e-01
## It: 467; obj: 1.678e+00; abs: 2.163e-02; rel: 1.306e-02; norm: 1.494e-01
## It: 468; obj: 1.688e+00; abs: 1.021e-02; rel: 6.082e-03; norm: 1.509e-01
## It: 469; obj: 1.653e+00; abs: 3.539e-02; rel: 2.096e-02; norm: 1.504e-01
## It: 470; obj: 1.656e+00; abs: 2.930e-03; rel: 1.773e-03; norm: 1.493e-01
## It: 471; obj: 1.667e+00; abs: 1.107e-02; rel: 6.687e-03; norm: 1.507e-01
## It: 472; obj: 1.666e+00; abs: 1.005e-03; rel: 6.026e-04; norm: 1.501e-01
## It: 473; obj: 1.665e+00; abs: 1.242e-03; rel: 7.457e-04; norm: 1.496e-01
## It: 474; obj: 1.674e+00; abs: 9.271e-03; rel: 5.569e-03; norm: 1.500e-01
## It: 475; obj: 1.669e+00; abs: 4.496e-03; rel: 2.686e-03; norm: 1.505e-01
## It: 476; obj: 1.679e+00; abs: 9.234e-03; rel: 5.531e-03; norm: 1.492e-01
## It: 477; obj: 1.677e+00; abs: 2.188e-03; rel: 1.303e-03; norm: 1.503e-01
## It: 478; obj: 1.663e+00; abs: 1.378e-02; rel: 8.221e-03; norm: 1.496e-01
## It: 479; obj: 1.674e+00; abs: 1.163e-02; rel: 6.995e-03; norm: 1.498e-01
## It: 480; obj: 1.673e+00; abs: 1.121e-03; rel: 6.695e-04; norm: 1.500e-01
## It: 481; obj: 1.667e+00; abs: 6.353e-03; rel: 3.797e-03; norm: 1.499e-01
## It: 482; obj: 1.676e+00; abs: 9.467e-03; rel: 5.679e-03; norm: 1.496e-01
## It: 483; obj: 1.672e+00; abs: 4.266e-03; rel: 2.545e-03; norm: 1.503e-01
## It: 484; obj: 1.665e+00; abs: 7.270e-03; rel: 4.348e-03; norm: 1.487e-01
## It: 485; obj: 1.676e+00; abs: 1.112e-02; rel: 6.677e-03; norm: 1.500e-01
## It: 486; obj: 1.676e+00; abs: 3.281e-04; rel: 1.958e-04; norm: 1.502e-01
## It: 487; obj: 1.656e+00; abs: 1.988e-02; rel: 1.186e-02; norm: 1.493e-01
## It: 488; obj: 1.657e+00; abs: 2.256e-04; rel: 1.362e-04; norm: 1.505e-01
## It: 489; obj: 1.654e+00; abs: 2.220e-03; rel: 1.340e-03; norm: 1.506e-01
## It: 490; obj: 1.659e+00; abs: 4.533e-03; rel: 2.740e-03; norm: 1.506e-01
## It: 491; obj: 1.676e+00; abs: 1.685e-02; rel: 1.016e-02; norm: 1.501e-01
## It: 492; obj: 1.662e+00; abs: 1.338e-02; rel: 7.987e-03; norm: 1.493e-01
## It: 493; obj: 1.652e+00; abs: 1.036e-02; rel: 6.234e-03; norm: 1.505e-01
## It: 494; obj: 1.658e+00; abs: 6.403e-03; rel: 3.876e-03; norm: 1.498e-01
## It: 495; obj: 1.688e+00; abs: 2.968e-02; rel: 1.790e-02; norm: 1.491e-01
## It: 496; obj: 1.674e+00; abs: 1.376e-02; rel: 8.153e-03; norm: 1.505e-01

```

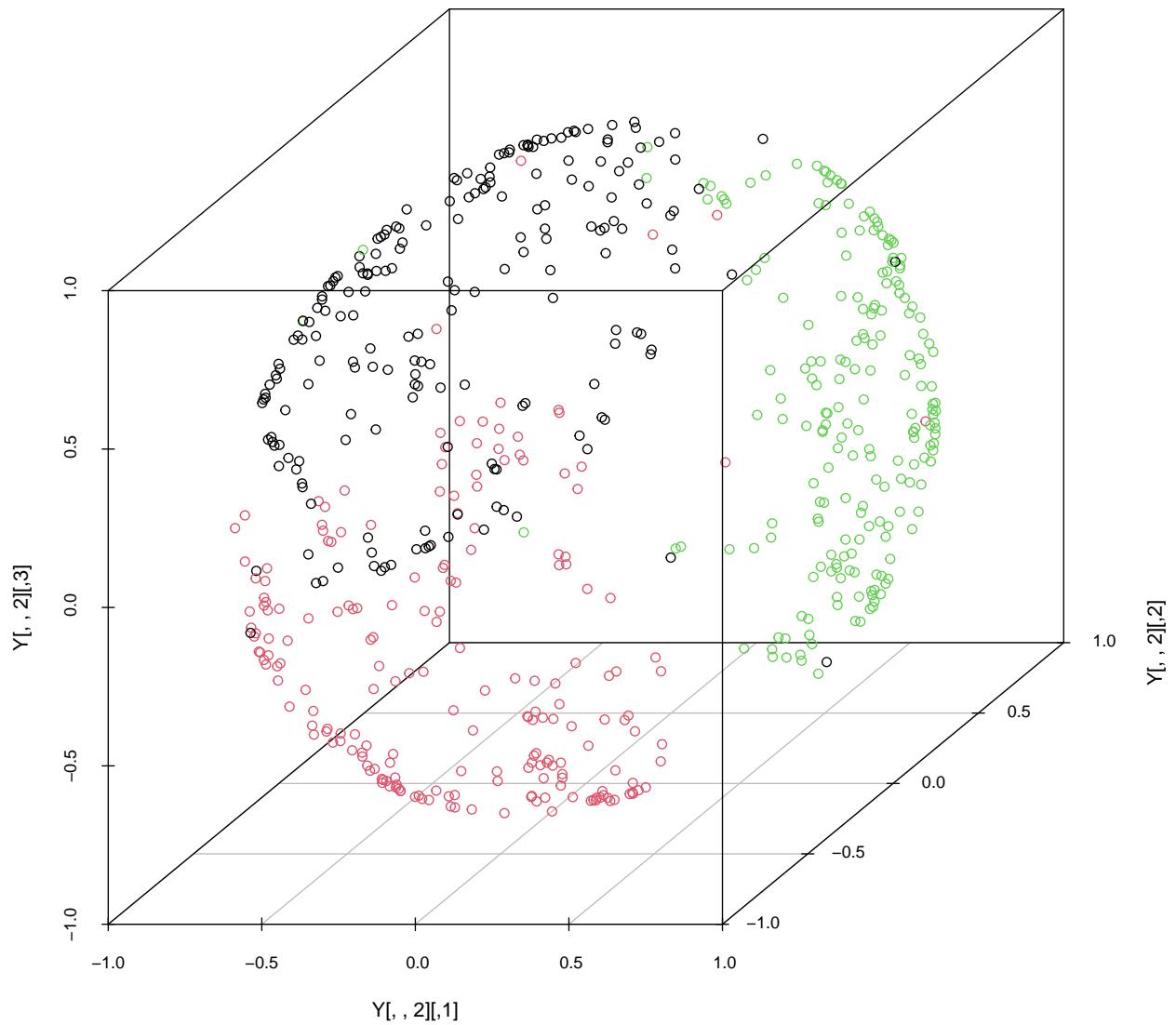
```

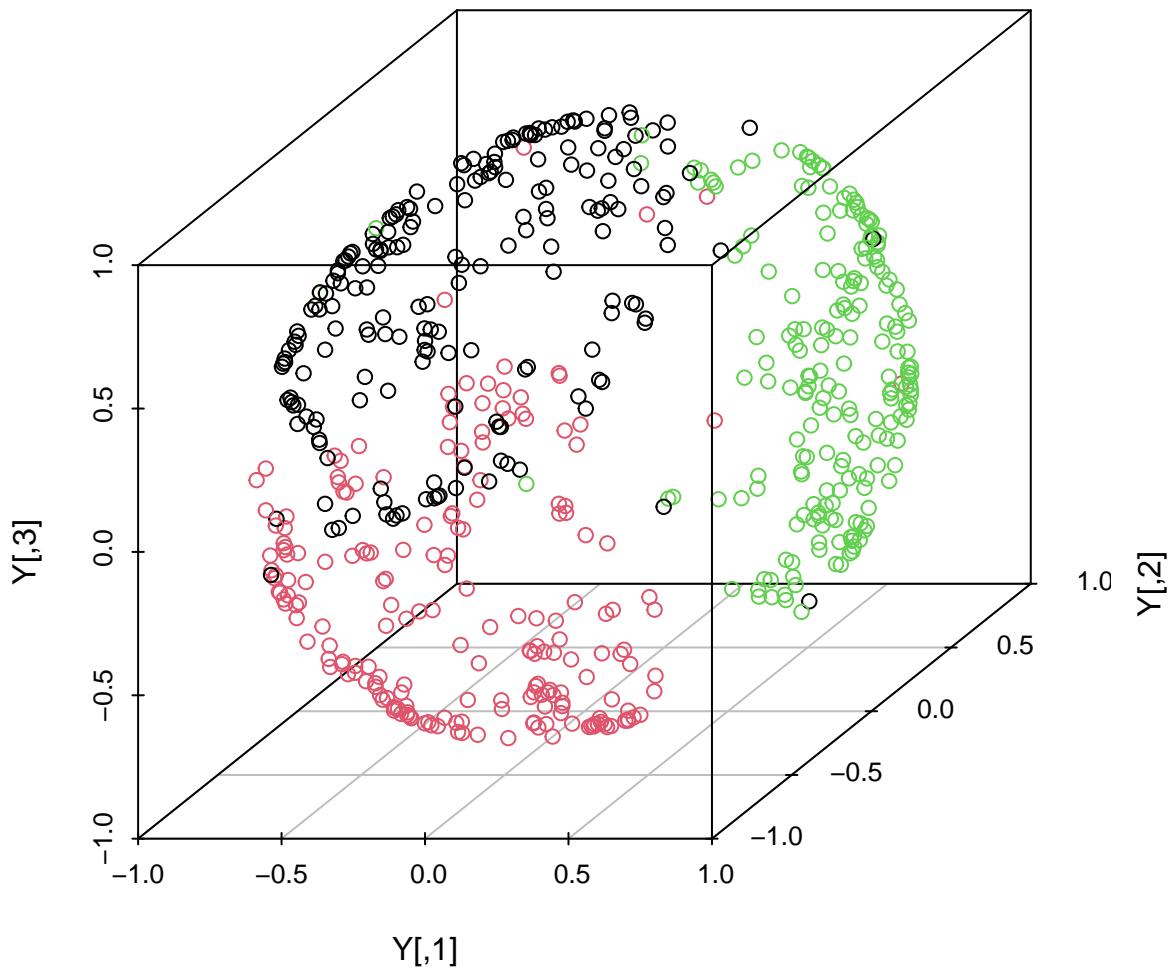
## It: 497; obj: 1.655e+00; abs: 1.909e-02; rel: 1.140e-02; norm: 1.494e-01
## It: 498; obj: 1.662e+00; abs: 6.437e-03; rel: 3.889e-03; norm: 1.490e-01
## It: 499; obj: 1.661e+00; abs: 4.739e-04; rel: 2.852e-04; norm: 1.497e-01
## It: 500; obj: 1.666e+00; abs: 5.208e-03; rel: 3.135e-03; norm: 1.489e-01

```



Iteration 500





It's clearly clustered the three groups we had in the original generated data.

Case 3

Sample on the $(\mathbb{S}^1)^3$ where $p = 1$ and $r = 3$.

```
# Sample on the (S^1)^2
n_ori <- 200
vmf11 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = 0)), kappa = 10)
vmf12 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = pi)), kappa = 10)
vmf13 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = pi/2)), kappa = 10)
x1 <- sdetorus::toPiInt(cbind(DirStats::to_rad(vmf11),
                                DirStats::to_rad(vmf12),
                                DirStats::to_rad(vmf13)))

vmf21 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = pi / 2)), kappa = 5)
vmf22 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = 0)), kappa = 5)
vmf23 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = pi)), kappa = 5)
x2 <- sdetorus::toPiInt(cbind(DirStats::to_rad(vmf21), DirStats::to_rad(vmf22),
                                DirStats::to_rad(vmf23)))

vmf31 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = pi)), kappa = 30)
vmf32 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = 0)), kappa = 30)
```

```

vmf33 <- rotasym::r_vMF(n = n_ori, mu = drop(DirStats::to_cir(th = pi/2)), kappa = 30)
x3 <- sdetorus::toPiInt(cbind(DirStats::to_rad(vmf31), DirStats::to_rad(vmf32),
                                DirStats::to_rad(vmf33)))

```

Now, let's do the same visualization with the data on the torus:

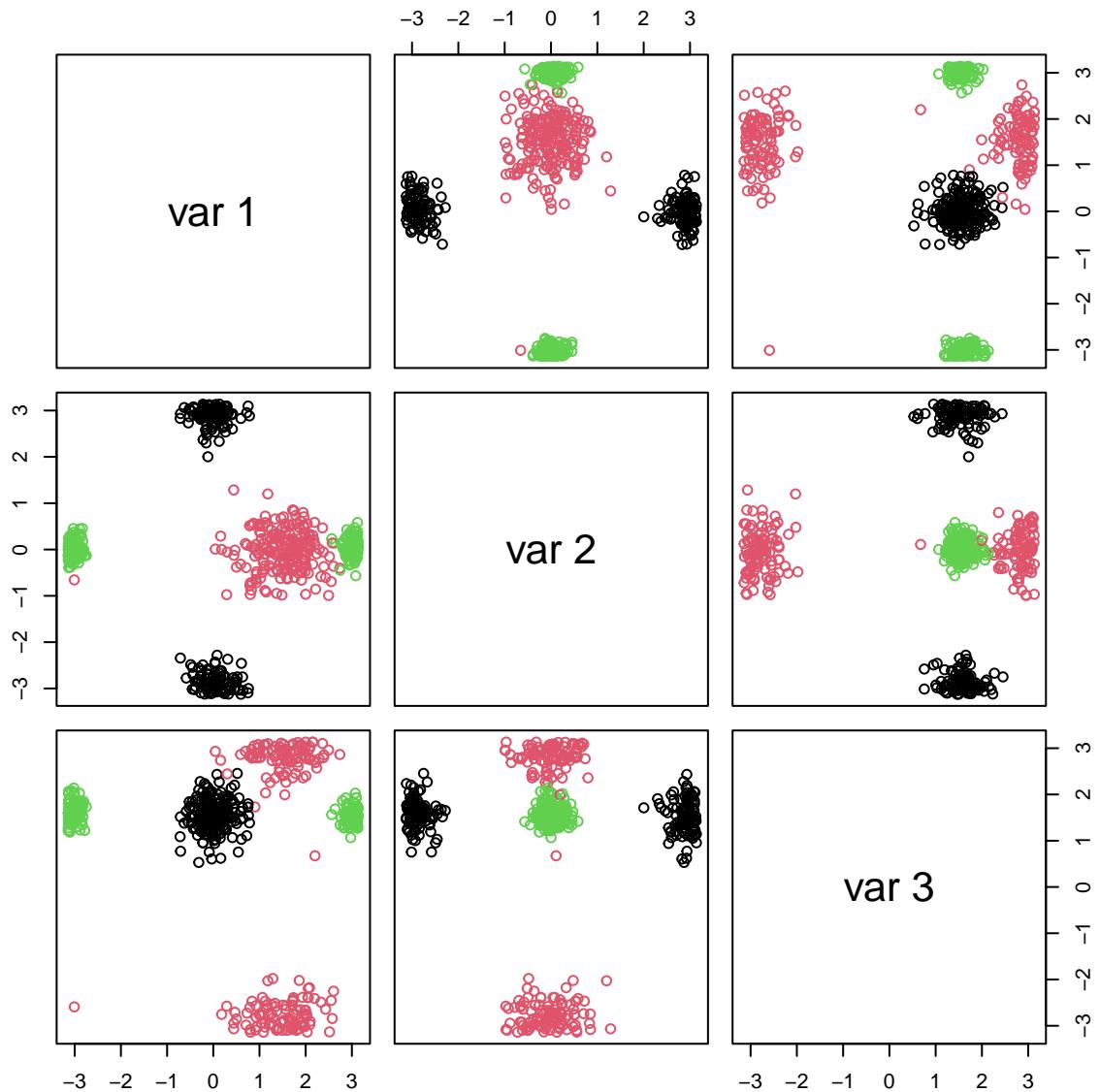
```

x <- rbind(x1, x2, x3)
n <- n_ori * 3
x_3 <- array(dim = c(n, 2, 3))
x_3[, , 1] <- DirStats::to_cir(x[, 1])
x_3[, , 2] <- DirStats::to_cir(x[, 2])
x_3[, , 3] <- DirStats::to_cir(x[, 3])

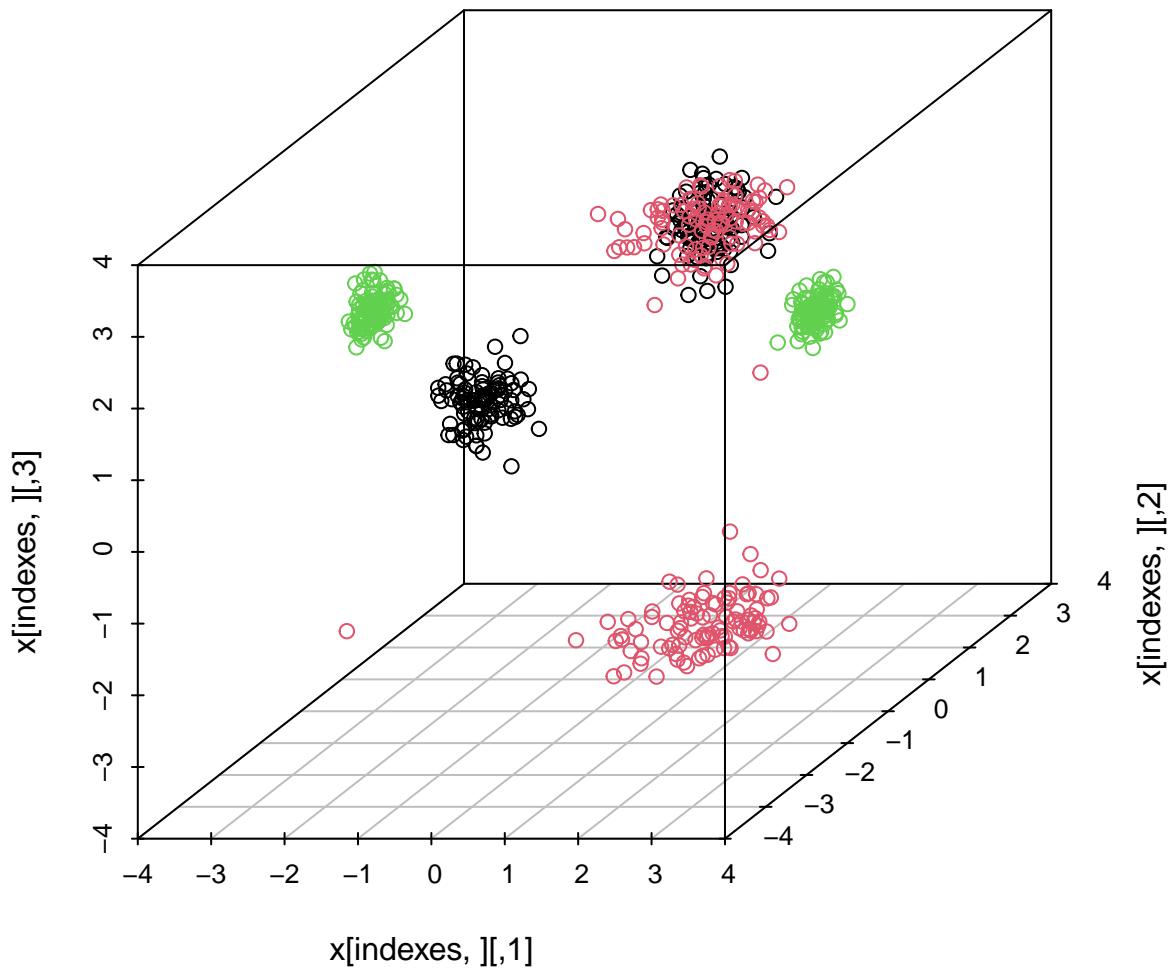
n <- nrow(x_3)
indexes <- sample(1:n)
x_3 <- x_3[indexes,,]
colors <- rep(c(1, 2, 3), each = n / 3)[indexes]

pairs(x[indexes,], col = colors)

```



```
scatterplot3d::scatterplot3d(x[indexes,], xlim = c(-pi, pi), ylim = c(-pi, pi),  
                             zlim = c(-pi, pi),  
                             color = colors)
```



Let's calculate the rho parameters based on a perplexity of 25:

```
rho_third_perp25 <- rho_optim_bst(x_3, 25)
```

Time difference of 1.146174 mins

First, let's reduce to dimension \mathbb{S}^1 then $d = 1$ (circumference):

```
Y <- psc_sne(X=x_3, d=1, rho_psc_list = rho_third_perp25, num_iteration=500,
               colors=colors, visualize_prog = TRUE)
```

```
## It: 1; obj: 1.783e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.414e-01
## It: 2; obj: 1.712e+01; abs: 7.090e-01; rel: 3.977e-02; norm: 2.723e-01
## It: 3; obj: 1.660e+01; abs: 5.148e-01; rel: 3.007e-02; norm: 3.684e-01
## It: 4; obj: 1.629e+01; abs: 3.159e-01; rel: 1.903e-02; norm: 4.527e-01
## It: 5; obj: 1.605e+01; abs: 2.439e-01; rel: 1.497e-02; norm: 5.096e-01
## It: 6; obj: 1.583e+01; abs: 2.117e-01; rel: 1.319e-02; norm: 5.505e-01
## It: 7; obj: 1.564e+01; abs: 1.891e-01; rel: 1.195e-02; norm: 5.841e-01
## It: 8; obj: 1.547e+01; abs: 1.751e-01; rel: 1.119e-02; norm: 6.133e-01
## It: 9; obj: 1.532e+01; abs: 1.497e-01; rel: 9.678e-03; norm: 6.433e-01
## It: 10; obj: 1.520e+01; abs: 1.174e-01; rel: 7.663e-03; norm: 6.760e-01
## It: 11; obj: 1.512e+01; abs: 8.415e-02; rel: 5.535e-03; norm: 7.101e-01
## It: 12; obj: 1.507e+01; abs: 5.283e-02; rel: 3.495e-03; norm: 7.418e-01
## It: 13; obj: 1.504e+01; abs: 2.730e-02; rel: 1.812e-03; norm: 7.695e-01
```

```

## It: 14; obj: 1.503e+01; abs: 1.003e-02; rel: 6.667e-04; norm: 7.947e-01
## It: 15; obj: 1.503e+01; abs: 3.558e-04; rel: 2.368e-05; norm: 8.183e-01
## It: 16; obj: 1.504e+01; abs: 8.527e-03; rel: 5.674e-04; norm: 8.414e-01
## It: 17; obj: 1.505e+01; abs: 1.552e-02; rel: 1.032e-03; norm: 8.642e-01
## It: 18; obj: 1.507e+01; abs: 1.943e-02; rel: 1.291e-03; norm: 8.861e-01
## It: 19; obj: 1.509e+01; abs: 1.963e-02; rel: 1.303e-03; norm: 9.065e-01
## It: 20; obj: 1.511e+01; abs: 2.320e-02; rel: 1.538e-03; norm: 9.257e-01
## It: 21; obj: 1.514e+01; abs: 2.661e-02; rel: 1.761e-03; norm: 9.424e-01
## It: 22; obj: 1.517e+01; abs: 2.660e-02; rel: 1.757e-03; norm: 9.554e-01
## It: 23; obj: 1.519e+01; abs: 2.504e-02; rel: 1.651e-03; norm: 9.661e-01
## It: 24; obj: 1.521e+01; abs: 2.222e-02; rel: 1.463e-03; norm: 9.751e-01
## It: 25; obj: 1.523e+01; abs: 1.827e-02; rel: 1.201e-03; norm: 9.827e-01
## It: 26; obj: 1.525e+01; abs: 1.308e-02; rel: 8.588e-04; norm: 9.892e-01
## It: 27; obj: 1.525e+01; abs: 6.363e-03; rel: 4.174e-04; norm: 9.947e-01
## It: 28; obj: 1.525e+01; abs: 2.235e-03; rel: 1.465e-04; norm: 9.995e-01
## It: 29; obj: 1.524e+01; abs: 1.305e-02; rel: 8.558e-04; norm: 1.004e+00
## It: 30; obj: 1.521e+01; abs: 2.617e-02; rel: 1.718e-03; norm: 1.008e+00
## It: 31; obj: 1.517e+01; abs: 4.079e-02; rel: 2.682e-03; norm: 1.012e+00
## It: 32; obj: 1.512e+01; abs: 5.425e-02; rel: 3.576e-03; norm: 1.015e+00
## It: 33; obj: 1.505e+01; abs: 6.220e-02; rel: 4.115e-03; norm: 1.018e+00
## It: 34; obj: 1.499e+01; abs: 6.193e-02; rel: 4.114e-03; norm: 1.019e+00
## It: 35; obj: 1.494e+01; abs: 5.546e-02; rel: 3.700e-03; norm: 1.019e+00
## It: 36; obj: 1.489e+01; abs: 4.703e-02; rel: 3.149e-03; norm: 1.016e+00
## It: 37; obj: 1.485e+01; abs: 3.928e-02; rel: 2.638e-03; norm: 1.011e+00
## It: 38; obj: 1.482e+01; abs: 3.293e-02; rel: 2.217e-03; norm: 1.006e+00
## It: 39; obj: 1.479e+01; abs: 2.789e-02; rel: 1.882e-03; norm: 1.000e+00
## It: 40; obj: 1.476e+01; abs: 2.390e-02; rel: 1.616e-03; norm: 9.940e-01
## It: 41; obj: 1.474e+01; abs: 2.070e-02; rel: 1.402e-03; norm: 9.880e-01
## It: 42; obj: 1.473e+01; abs: 1.810e-02; rel: 1.228e-03; norm: 9.822e-01
## It: 43; obj: 1.471e+01; abs: 1.596e-02; rel: 1.084e-03; norm: 9.765e-01
## It: 44; obj: 1.470e+01; abs: 1.418e-02; rel: 9.638e-04; norm: 9.710e-01
## It: 45; obj: 1.468e+01; abs: 1.267e-02; rel: 8.624e-04; norm: 9.657e-01
## It: 46; obj: 1.467e+01; abs: 1.139e-02; rel: 7.760e-04; norm: 9.606e-01
## It: 47; obj: 1.466e+01; abs: 1.030e-02; rel: 7.017e-04; norm: 9.557e-01
## It: 48; obj: 1.465e+01; abs: 9.345e-03; rel: 6.374e-04; norm: 9.509e-01
## It: 49; obj: 1.464e+01; abs: 8.517e-03; rel: 5.813e-04; norm: 9.464e-01
## It: 50; obj: 1.464e+01; abs: 7.792e-03; rel: 5.321e-04; norm: 9.420e-01
## It: 51; obj: 1.463e+01; abs: 7.152e-03; rel: 4.887e-04; norm: 9.378e-01
## It: 52; obj: 1.462e+01; abs: 6.585e-03; rel: 4.502e-04; norm: 9.338e-01
## It: 53; obj: 1.462e+01; abs: 6.081e-03; rel: 4.159e-04; norm: 9.299e-01
## It: 54; obj: 1.461e+01; abs: 5.630e-03; rel: 3.852e-04; norm: 9.261e-01
## It: 55; obj: 1.461e+01; abs: 5.225e-03; rel: 3.576e-04; norm: 9.225e-01
## It: 56; obj: 1.460e+01; abs: 4.861e-03; rel: 3.328e-04; norm: 9.189e-01
## It: 57; obj: 1.460e+01; abs: 4.531e-03; rel: 3.103e-04; norm: 9.156e-01
## It: 58; obj: 1.459e+01; abs: 4.232e-03; rel: 2.900e-04; norm: 9.123e-01
## It: 59; obj: 1.459e+01; abs: 3.961e-03; rel: 2.714e-04; norm: 9.091e-01
## It: 60; obj: 1.458e+01; abs: 3.713e-03; rel: 2.545e-04; norm: 9.061e-01
## It: 61; obj: 1.458e+01; abs: 3.487e-03; rel: 2.391e-04; norm: 9.031e-01
## It: 62; obj: 1.458e+01; abs: 3.279e-03; rel: 2.249e-04; norm: 9.002e-01
## It: 63; obj: 1.457e+01; abs: 3.089e-03; rel: 2.119e-04; norm: 8.975e-01
## It: 64; obj: 1.457e+01; abs: 2.913e-03; rel: 1.999e-04; norm: 8.948e-01
## It: 65; obj: 1.457e+01; abs: 2.751e-03; rel: 1.888e-04; norm: 8.922e-01
## It: 66; obj: 1.457e+01; abs: 2.602e-03; rel: 1.786e-04; norm: 8.896e-01

```

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## It: 67; obj: 1.456e+01; abs: 2.463e-03; rel: 1.691e-04; norm: 8.872e-01
## It: 68; obj: 1.456e+01; abs: 2.335e-03; rel: 1.603e-04; norm: 8.848e-01
## It: 69; obj: 1.456e+01; abs: 2.215e-03; rel: 1.521e-04; norm: 8.825e-01
## It: 70; obj: 1.456e+01; abs: 2.104e-03; rel: 1.445e-04; norm: 8.802e-01
## It: 71; obj: 1.455e+01; abs: 2.001e-03; rel: 1.374e-04; norm: 8.781e-01
## It: 72; obj: 1.455e+01; abs: 1.904e-03; rel: 1.308e-04; norm: 8.759e-01
## It: 73; obj: 1.455e+01; abs: 1.813e-03; rel: 1.246e-04; norm: 8.739e-01
## It: 74; obj: 1.455e+01; abs: 1.729e-03; rel: 1.188e-04; norm: 8.719e-01
## It: 75; obj: 1.455e+01; abs: 1.649e-03; rel: 1.134e-04; norm: 8.699e-01
## It: 76; obj: 1.455e+01; abs: 1.575e-03; rel: 1.082e-04; norm: 8.680e-01
## It: 77; obj: 1.454e+01; abs: 1.505e-03; rel: 1.034e-04; norm: 8.662e-01
## It: 78; obj: 1.454e+01; abs: 1.439e-03; rel: 9.891e-05; norm: 8.644e-01
## It: 79; obj: 1.454e+01; abs: 1.376e-03; rel: 9.464e-05; norm: 8.627e-01
## It: 80; obj: 1.454e+01; abs: 1.318e-03; rel: 9.062e-05; norm: 8.610e-01
## It: 81; obj: 1.454e+01; abs: 1.262e-03; rel: 8.682e-05; norm: 8.593e-01
## It: 82; obj: 1.454e+01; abs: 1.210e-03; rel: 8.322e-05; norm: 8.577e-01
## It: 83; obj: 1.454e+01; abs: 1.160e-03; rel: 7.982e-05; norm: 8.561e-01
## It: 84; obj: 1.454e+01; abs: 1.113e-03; rel: 7.660e-05; norm: 8.546e-01
## It: 85; obj: 1.453e+01; abs: 1.069e-03; rel: 7.354e-05; norm: 8.531e-01
## It: 86; obj: 1.453e+01; abs: 1.027e-03; rel: 7.064e-05; norm: 8.517e-01
## It: 87; obj: 1.453e+01; abs: 9.867e-04; rel: 6.789e-05; norm: 8.502e-01
## It: 88; obj: 1.453e+01; abs: 9.485e-04; rel: 6.527e-05; norm: 8.489e-01
## It: 89; obj: 1.453e+01; abs: 9.123e-04; rel: 6.278e-05; norm: 8.475e-01
## It: 90; obj: 1.453e+01; abs: 8.777e-04; rel: 6.041e-05; norm: 8.462e-01
## It: 91; obj: 1.453e+01; abs: 8.448e-04; rel: 5.814e-05; norm: 8.449e-01
## It: 92; obj: 1.453e+01; abs: 8.134e-04; rel: 5.599e-05; norm: 8.437e-01
## It: 93; obj: 1.453e+01; abs: 7.835e-04; rel: 5.393e-05; norm: 8.425e-01
## It: 94; obj: 1.453e+01; abs: 7.549e-04; rel: 5.196e-05; norm: 8.413e-01
## It: 95; obj: 1.453e+01; abs: 7.276e-04; rel: 5.009e-05; norm: 8.401e-01
## It: 96; obj: 1.453e+01; abs: 7.015e-04; rel: 4.829e-05; norm: 8.390e-01
## It: 97; obj: 1.452e+01; abs: 6.765e-04; rel: 4.657e-05; norm: 8.379e-01
## It: 98; obj: 1.452e+01; abs: 6.526e-04; rel: 4.493e-05; norm: 8.368e-01
## It: 99; obj: 1.452e+01; abs: 6.297e-04; rel: 4.335e-05; norm: 8.357e-01
## It: 100; obj: 1.452e+01; abs: 6.077e-04; rel: 4.184e-05; norm: 8.347e-01
## It: 101; obj: 2.227e+00; abs: 1.230e+01; rel: 8.467e-01; norm: 7.855e-02
## It: 102; obj: 2.191e+00; abs: 3.597e-02; rel: 1.615e-02; norm: 8.250e-02
## It: 103; obj: 2.156e+00; abs: 3.441e-02; rel: 1.571e-02; norm: 9.123e-02
## It: 104; obj: 2.137e+00; abs: 1.949e-02; rel: 9.041e-03; norm: 9.955e-02
## It: 105; obj: 2.129e+00; abs: 7.402e-03; rel: 3.464e-03; norm: 1.037e-01
## It: 106; obj: 2.127e+00; abs: 2.452e-03; rel: 1.151e-03; norm: 1.051e-01
## It: 107; obj: 2.126e+00; abs: 9.508e-04; rel: 4.470e-04; norm: 1.056e-01
## It: 108; obj: 2.126e+00; abs: 1.944e-04; rel: 9.146e-05; norm: 1.056e-01
## It: 109; obj: 2.125e+00; abs: 8.078e-04; rel: 3.800e-04; norm: 1.056e-01
## It: 110; obj: 2.125e+00; abs: 2.244e-04; rel: 1.056e-04; norm: 1.056e-01
## It: 111; obj: 2.125e+00; abs: 4.983e-06; rel: 2.345e-06; norm: 1.056e-01
## It: 112; obj: 2.125e+00; abs: 1.169e-04; rel: 5.501e-05; norm: 1.055e-01
## It: 113; obj: 2.124e+00; abs: 3.177e-04; rel: 1.495e-04; norm: 1.055e-01
## It: 114; obj: 2.124e+00; abs: 8.101e-05; rel: 3.813e-05; norm: 1.056e-01
## It: 115; obj: 2.124e+00; abs: 1.074e-04; rel: 5.054e-05; norm: 1.055e-01
## It: 116; obj: 2.124e+00; abs: 2.460e-04; rel: 1.158e-04; norm: 1.055e-01
## It: 117; obj: 2.124e+00; abs: 5.147e-05; rel: 2.423e-05; norm: 1.055e-01
## It: 118; obj: 2.124e+00; abs: 2.887e-05; rel: 1.359e-05; norm: 1.055e-01
## It: 119; obj: 2.124e+00; abs: 1.360e-04; rel: 6.402e-05; norm: 1.055e-01

```

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## It: 120; obj: 2.124e+00; abs: 6.670e-05; rel: 3.141e-05; norm: 1.055e-01
## It: 121; obj: 2.124e+00; abs: 2.871e-05; rel: 1.352e-05; norm: 1.055e-01
## It: 122; obj: 2.124e+00; abs: 7.200e-05; rel: 3.390e-05; norm: 1.055e-01
## It: 123; obj: 2.124e+00; abs: 1.061e-04; rel: 4.995e-05; norm: 1.055e-01
## It: 124; obj: 2.124e+00; abs: 2.540e-05; rel: 1.196e-05; norm: 1.055e-01
## It: 125; obj: 2.124e+00; abs: 7.373e-06; rel: 3.472e-06; norm: 1.054e-01
## It: 126; obj: 2.124e+00; abs: 9.360e-05; rel: 4.407e-05; norm: 1.054e-01
## It: 127; obj: 2.124e+00; abs: 3.194e-05; rel: 1.504e-05; norm: 1.054e-01
## It: 128; obj: 2.124e+00; abs: 1.278e-05; rel: 6.017e-06; norm: 1.054e-01
## It: 129; obj: 2.123e+00; abs: 5.895e-05; rel: 2.776e-05; norm: 1.054e-01
## It: 130; obj: 2.123e+00; abs: 5.848e-05; rel: 2.754e-05; norm: 1.054e-01
## It: 131; obj: 2.123e+00; abs: 1.468e-05; rel: 6.913e-06; norm: 1.054e-01
## It: 132; obj: 2.123e+00; abs: 3.680e-05; rel: 1.733e-05; norm: 1.054e-01
## It: 133; obj: 2.123e+00; abs: 4.849e-05; rel: 2.283e-05; norm: 1.054e-01
## It: 134; obj: 2.123e+00; abs: 1.337e-05; rel: 6.299e-06; norm: 1.054e-01
## It: 135; obj: 2.123e+00; abs: 2.392e-05; rel: 1.127e-05; norm: 1.054e-01
## It: 136; obj: 2.123e+00; abs: 3.413e-05; rel: 1.608e-05; norm: 1.054e-01
## It: 137; obj: 2.123e+00; abs: 1.287e-05; rel: 6.060e-06; norm: 1.053e-01
## It: 138; obj: 2.123e+00; abs: 1.296e-05; rel: 6.102e-06; norm: 1.053e-01
## It: 139; obj: 2.123e+00; abs: 2.201e-05; rel: 1.037e-05; norm: 1.053e-01
## It: 140; obj: 2.123e+00; abs: 7.532e-06; rel: 3.547e-06; norm: 1.053e-01
## It: 141; obj: 2.123e+00; abs: 8.925e-06; rel: 4.204e-06; norm: 1.053e-01
## It: 142; obj: 2.123e+00; abs: 1.363e-05; rel: 6.421e-06; norm: 1.053e-01
## It: 143; obj: 2.123e+00; abs: 6.048e-06; rel: 2.849e-06; norm: 1.053e-01
## It: 144; obj: 2.123e+00; abs: 6.252e-06; rel: 2.945e-06; norm: 1.053e-01
## It: 145; obj: 2.123e+00; abs: 9.161e-06; rel: 4.315e-06; norm: 1.053e-01
## It: 146; obj: 2.123e+00; abs: 4.761e-06; rel: 2.242e-06; norm: 1.053e-01
## It: 147; obj: 2.123e+00; abs: 5.515e-06; rel: 2.597e-06; norm: 1.053e-01
## It: 148; obj: 2.123e+00; abs: 6.872e-06; rel: 3.237e-06; norm: 1.053e-01
## It: 149; obj: 2.123e+00; abs: 4.569e-06; rel: 2.152e-06; norm: 1.053e-01
## It: 150; obj: 2.123e+00; abs: 5.009e-06; rel: 2.359e-06; norm: 1.053e-01
## It: 151; obj: 2.123e+00; abs: 5.676e-06; rel: 2.673e-06; norm: 1.053e-01
## It: 152; obj: 2.123e+00; abs: 4.486e-06; rel: 2.113e-06; norm: 1.053e-01
## It: 153; obj: 2.123e+00; abs: 4.893e-06; rel: 2.305e-06; norm: 1.053e-01
## It: 154; obj: 2.123e+00; abs: 5.186e-06; rel: 2.443e-06; norm: 1.053e-01
## It: 155; obj: 2.123e+00; abs: 4.583e-06; rel: 2.159e-06; norm: 1.053e-01
## It: 156; obj: 2.123e+00; abs: 4.835e-06; rel: 2.277e-06; norm: 1.053e-01
## It: 157; obj: 2.123e+00; abs: 4.978e-06; rel: 2.345e-06; norm: 1.053e-01
## It: 158; obj: 2.123e+00; abs: 4.724e-06; rel: 2.225e-06; norm: 1.053e-01
## It: 159; obj: 2.123e+00; abs: 4.925e-06; rel: 2.320e-06; norm: 1.053e-01
## It: 160; obj: 2.123e+00; abs: 5.015e-06; rel: 2.362e-06; norm: 1.053e-01
## It: 161; obj: 2.123e+00; abs: 4.922e-06; rel: 2.318e-06; norm: 1.053e-01
## It: 162; obj: 2.123e+00; abs: 5.070e-06; rel: 2.388e-06; norm: 1.053e-01
## It: 163; obj: 2.123e+00; abs: 5.154e-06; rel: 2.428e-06; norm: 1.053e-01
## It: 164; obj: 2.123e+00; abs: 5.171e-06; rel: 2.436e-06; norm: 1.053e-01
## It: 165; obj: 2.123e+00; abs: 5.311e-06; rel: 2.502e-06; norm: 1.053e-01
## It: 166; obj: 2.123e+00; abs: 5.406e-06; rel: 2.546e-06; norm: 1.053e-01
## It: 167; obj: 2.123e+00; abs: 5.475e-06; rel: 2.579e-06; norm: 1.053e-01
## It: 168; obj: 2.123e+00; abs: 5.611e-06; rel: 2.643e-06; norm: 1.053e-01
## It: 169; obj: 2.123e+00; abs: 5.728e-06; rel: 2.698e-06; norm: 1.053e-01
## It: 170; obj: 2.123e+00; abs: 5.845e-06; rel: 2.753e-06; norm: 1.053e-01
## It: 171; obj: 2.123e+00; abs: 5.998e-06; rel: 2.825e-06; norm: 1.053e-01
## It: 172; obj: 2.123e+00; abs: 6.144e-06; rel: 2.894e-06; norm: 1.053e-01

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## It: 173; obj: 2.123e+00; abs: 6.298e-06; rel: 2.966e-06; norm: 1.053e-01
## It: 174; obj: 2.123e+00; abs: 6.478e-06; rel: 3.051e-06; norm: 1.053e-01
## It: 175; obj: 2.123e+00; abs: 6.668e-06; rel: 3.141e-06; norm: 1.053e-01
## It: 176; obj: 2.123e+00; abs: 6.875e-06; rel: 3.238e-06; norm: 1.053e-01
## It: 177; obj: 2.123e+00; abs: 7.109e-06; rel: 3.349e-06; norm: 1.053e-01
## It: 178; obj: 2.123e+00; abs: 7.364e-06; rel: 3.469e-06; norm: 1.053e-01
## It: 179; obj: 2.123e+00; abs: 7.648e-06; rel: 3.602e-06; norm: 1.053e-01
## It: 180; obj: 2.123e+00; abs: 7.970e-06; rel: 3.754e-06; norm: 1.053e-01
## It: 181; obj: 2.123e+00; abs: 8.331e-06; rel: 3.924e-06; norm: 1.053e-01
## It: 182; obj: 2.123e+00; abs: 8.739e-06; rel: 4.117e-06; norm: 1.053e-01
## It: 183; obj: 2.123e+00; abs: 9.202e-06; rel: 4.335e-06; norm: 1.053e-01
## It: 184; obj: 2.123e+00; abs: 9.724e-06; rel: 4.580e-06; norm: 1.053e-01
## It: 185; obj: 2.123e+00; abs: 1.031e-05; rel: 4.857e-06; norm: 1.053e-01
## It: 186; obj: 2.123e+00; abs: 1.097e-05; rel: 5.166e-06; norm: 1.053e-01
## It: 187; obj: 2.123e+00; abs: 1.169e-05; rel: 5.508e-06; norm: 1.054e-01
## It: 188; obj: 2.123e+00; abs: 1.249e-05; rel: 5.881e-06; norm: 1.054e-01
## It: 189; obj: 2.123e+00; abs: 1.333e-05; rel: 6.281e-06; norm: 1.054e-01
## It: 190; obj: 2.123e+00; abs: 1.422e-05; rel: 6.699e-06; norm: 1.054e-01
## It: 191; obj: 2.123e+00; abs: 1.513e-05; rel: 7.125e-06; norm: 1.054e-01
## It: 192; obj: 2.123e+00; abs: 1.602e-05; rel: 7.546e-06; norm: 1.054e-01
## It: 193; obj: 2.123e+00; abs: 1.687e-05; rel: 7.948e-06; norm: 1.054e-01
## It: 194; obj: 2.123e+00; abs: 1.765e-05; rel: 8.313e-06; norm: 1.054e-01
## It: 195; obj: 2.123e+00; abs: 1.832e-05; rel: 8.628e-06; norm: 1.054e-01
## It: 196; obj: 2.123e+00; abs: 1.885e-05; rel: 8.878e-06; norm: 1.054e-01
## It: 197; obj: 2.123e+00; abs: 1.921e-05; rel: 9.051e-06; norm: 1.054e-01
## It: 198; obj: 2.123e+00; abs: 1.940e-05; rel: 9.139e-06; norm: 1.054e-01
## It: 199; obj: 2.123e+00; abs: 1.939e-05; rel: 9.137e-06; norm: 1.054e-01
## It: 200; obj: 2.123e+00; abs: 1.920e-05; rel: 9.045e-06; norm: 1.054e-01
## It: 201; obj: 2.123e+00; abs: 1.883e-05; rel: 8.869e-06; norm: 1.054e-01
## It: 202; obj: 2.123e+00; abs: 1.829e-05; rel: 8.617e-06; norm: 1.055e-01
## It: 203; obj: 2.123e+00; abs: 1.762e-05; rel: 8.303e-06; norm: 1.055e-01
## It: 204; obj: 2.123e+00; abs: 1.686e-05; rel: 7.941e-06; norm: 1.055e-01
## It: 205; obj: 2.123e+00; abs: 1.602e-05; rel: 7.547e-06; norm: 1.055e-01
## It: 206; obj: 2.123e+00; abs: 1.514e-05; rel: 7.133e-06; norm: 1.055e-01
## It: 207; obj: 2.123e+00; abs: 1.425e-05; rel: 6.713e-06; norm: 1.055e-01
## It: 208; obj: 2.123e+00; abs: 1.336e-05; rel: 6.294e-06; norm: 1.055e-01
## It: 209; obj: 2.123e+00; abs: 1.249e-05; rel: 5.886e-06; norm: 1.055e-01
## It: 210; obj: 2.123e+00; abs: 1.166e-05; rel: 5.492e-06; norm: 1.056e-01
## It: 211; obj: 2.122e+00; abs: 1.086e-05; rel: 5.115e-06; norm: 1.056e-01
## It: 212; obj: 2.122e+00; abs: 1.010e-05; rel: 4.758e-06; norm: 1.056e-01
## It: 213; obj: 2.122e+00; abs: 9.384e-06; rel: 4.421e-06; norm: 1.056e-01
## It: 214; obj: 2.122e+00; abs: 8.712e-06; rel: 4.104e-06; norm: 1.056e-01
## It: 215; obj: 2.122e+00; abs: 8.080e-06; rel: 3.807e-06; norm: 1.056e-01
## It: 216; obj: 2.122e+00; abs: 7.488e-06; rel: 3.528e-06; norm: 1.056e-01
## It: 217; obj: 2.122e+00; abs: 6.933e-06; rel: 3.267e-06; norm: 1.056e-01
## It: 218; obj: 2.122e+00; abs: 6.414e-06; rel: 3.022e-06; norm: 1.056e-01
## It: 219; obj: 2.122e+00; abs: 5.927e-06; rel: 2.793e-06; norm: 1.056e-01
## It: 220; obj: 2.122e+00; abs: 5.472e-06; rel: 2.578e-06; norm: 1.056e-01
## It: 221; obj: 2.122e+00; abs: 5.045e-06; rel: 2.377e-06; norm: 1.056e-01
## It: 222; obj: 2.122e+00; abs: 4.646e-06; rel: 2.189e-06; norm: 1.056e-01
## It: 223; obj: 2.122e+00; abs: 4.273e-06; rel: 2.013e-06; norm: 1.057e-01
## It: 224; obj: 2.122e+00; abs: 3.924e-06; rel: 1.849e-06; norm: 1.057e-01
## It: 225; obj: 2.122e+00; abs: 3.599e-06; rel: 1.696e-06; norm: 1.057e-01

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## It: 226; obj: 2.122e+00; abs: 3.296e-06; rel: 1.553e-06; norm: 1.057e-01
## It: 227; obj: 2.122e+00; abs: 3.014e-06; rel: 1.420e-06; norm: 1.057e-01
## It: 228; obj: 2.122e+00; abs: 2.752e-06; rel: 1.297e-06; norm: 1.057e-01
## It: 229; obj: 2.122e+00; abs: 2.510e-06; rel: 1.182e-06; norm: 1.057e-01
## It: 230; obj: 2.122e+00; abs: 2.285e-06; rel: 1.077e-06; norm: 1.057e-01
## It: 231; obj: 2.122e+00; abs: 2.079e-06; rel: 9.794e-07; norm: 1.057e-01
## It: 232; obj: 2.122e+00; abs: 1.888e-06; rel: 8.896e-07; norm: 1.057e-01
## It: 233; obj: 2.122e+00; abs: 1.713e-06; rel: 8.072e-07; norm: 1.057e-01
## It: 234; obj: 2.122e+00; abs: 1.553e-06; rel: 7.316e-07; norm: 1.057e-01
## It: 235; obj: 2.122e+00; abs: 1.406e-06; rel: 6.624e-07; norm: 1.057e-01
## It: 236; obj: 2.122e+00; abs: 1.272e-06; rel: 5.993e-07; norm: 1.057e-01
## It: 237; obj: 2.122e+00; abs: 1.150e-06; rel: 5.417e-07; norm: 1.057e-01
## It: 238; obj: 2.122e+00; abs: 1.039e-06; rel: 4.893e-07; norm: 1.057e-01
## It: 239; obj: 2.122e+00; abs: 9.375e-07; rel: 4.417e-07; norm: 1.057e-01
## It: 240; obj: 2.122e+00; abs: 8.458e-07; rel: 3.985e-07; norm: 1.057e-01
## It: 241; obj: 2.122e+00; abs: 7.628e-07; rel: 3.594e-07; norm: 1.057e-01
## It: 242; obj: 2.122e+00; abs: 6.876e-07; rel: 3.240e-07; norm: 1.057e-01
## It: 243; obj: 2.122e+00; abs: 6.197e-07; rel: 2.920e-07; norm: 1.057e-01
## It: 244; obj: 2.122e+00; abs: 5.583e-07; rel: 2.631e-07; norm: 1.057e-01
## It: 245; obj: 2.122e+00; abs: 5.030e-07; rel: 2.370e-07; norm: 1.057e-01
## It: 246; obj: 2.122e+00; abs: 4.531e-07; rel: 2.135e-07; norm: 1.057e-01
## It: 247; obj: 2.122e+00; abs: 4.082e-07; rel: 1.923e-07; norm: 1.057e-01
## It: 248; obj: 2.122e+00; abs: 4.229e-07; rel: 1.993e-07; norm: 1.057e-01
## It: 249; obj: 2.122e+00; abs: 3.973e-07; rel: 1.872e-07; norm: 1.057e-01
## It: 250; obj: 2.122e+00; abs: 3.597e-07; rel: 1.695e-07; norm: 1.058e-01

## It: 251; obj: 2.122e+00; abs: 3.221e-07; rel: 1.518e-07; norm: 1.058e-01
## It: 252; obj: 2.122e+00; abs: 2.886e-07; rel: 1.360e-07; norm: 1.058e-01
## It: 253; obj: 2.122e+00; abs: 2.555e-07; rel: 1.204e-07; norm: 1.058e-01
## It: 254; obj: 2.122e+00; abs: 2.193e-07; rel: 1.033e-07; norm: 1.058e-01
## It: 255; obj: 2.122e+00; abs: 1.855e-07; rel: 8.741e-08; norm: 1.058e-01
## It: 256; obj: 2.122e+00; abs: 1.636e-07; rel: 7.709e-08; norm: 1.058e-01
## It: 257; obj: 2.122e+00; abs: 1.485e-07; rel: 6.999e-08; norm: 1.058e-01
## It: 258; obj: 2.122e+00; abs: 1.253e-07; rel: 5.906e-08; norm: 1.058e-01
## It: 259; obj: 2.122e+00; abs: 9.831e-08; rel: 4.632e-08; norm: 1.058e-01
## It: 260; obj: 2.122e+00; abs: 9.241e-08; rel: 4.354e-08; norm: 1.058e-01
## It: 261; obj: 2.122e+00; abs: 1.081e-07; rel: 5.092e-08; norm: 1.058e-01
## It: 262; obj: 2.122e+00; abs: 1.017e-07; rel: 4.793e-08; norm: 1.058e-01
## It: 263; obj: 2.122e+00; abs: 5.131e-08; rel: 2.417e-08; norm: 1.058e-01
## It: 264; obj: 2.122e+00; abs: 1.841e-08; rel: 8.676e-09; norm: 1.058e-01
## It: 265; obj: 2.122e+00; abs: 6.096e-08; rel: 2.872e-08; norm: 1.058e-01
## It: 266; obj: 2.122e+00; abs: 9.752e-08; rel: 4.595e-08; norm: 1.058e-01
## It: 267; obj: 2.122e+00; abs: 1.551e-08; rel: 7.306e-09; norm: 1.058e-01
## It: 268; obj: 2.122e+00; abs: 9.232e-08; rel: 4.350e-08; norm: 1.058e-01
## It: 269; obj: 2.122e+00; abs: 2.264e-08; rel: 1.067e-08; norm: 1.058e-01
## It: 270; obj: 2.122e+00; abs: 1.698e-07; rel: 8.002e-08; norm: 1.058e-01
## It: 271; obj: 2.122e+00; abs: 1.261e-07; rel: 5.941e-08; norm: 1.058e-01
## It: 272; obj: 2.122e+00; abs: 2.480e-07; rel: 1.168e-07; norm: 1.058e-01
## It: 273; obj: 2.122e+00; abs: 3.406e-07; rel: 1.605e-07; norm: 1.058e-01
## It: 274; obj: 2.122e+00; abs: 2.067e-07; rel: 9.739e-08; norm: 1.058e-01
## It: 275; obj: 2.122e+00; abs: 4.270e-07; rel: 2.012e-07; norm: 1.058e-01

## It: 276; obj: 2.122e+00; abs: 4.104e-07; rel: 1.934e-07; norm: 1.058e-01
## It: 277; obj: 2.122e+00; abs: 1.138e-06; rel: 5.364e-07; norm: 1.058e-01
## It: 278; obj: 2.122e+00; abs: 3.748e-07; rel: 1.766e-07; norm: 1.058e-01

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## It: 279; obj: 2.122e+00; abs: 1.150e-06; rel: 5.417e-07; norm: 1.058e-01
## It: 280; obj: 2.122e+00; abs: 6.328e-07; rel: 2.982e-07; norm: 1.058e-01
## It: 281; obj: 2.122e+00; abs: 2.781e-06; rel: 1.310e-06; norm: 1.058e-01
## It: 282; obj: 2.122e+00; abs: 2.972e-06; rel: 1.401e-06; norm: 1.058e-01
## It: 283; obj: 2.122e+00; abs: 2.586e-06; rel: 1.219e-06; norm: 1.058e-01
## It: 284; obj: 2.122e+00; abs: 2.871e-06; rel: 1.353e-06; norm: 1.058e-01
## It: 285; obj: 2.122e+00; abs: 4.886e-06; rel: 2.302e-06; norm: 1.058e-01
## It: 286; obj: 2.122e+00; abs: 9.317e-06; rel: 4.390e-06; norm: 1.058e-01
## It: 287; obj: 2.122e+00; abs: 5.182e-06; rel: 2.442e-06; norm: 1.058e-01
## It: 288; obj: 2.122e+00; abs: 4.632e-06; rel: 2.182e-06; norm: 1.058e-01
## It: 289; obj: 2.122e+00; abs: 1.146e-05; rel: 5.400e-06; norm: 1.058e-01
## It: 290; obj: 2.122e+00; abs: 9.950e-06; rel: 4.688e-06; norm: 1.058e-01
## It: 291; obj: 2.122e+00; abs: 3.921e-05; rel: 1.847e-05; norm: 1.058e-01
## It: 292; obj: 2.122e+00; abs: 7.136e-06; rel: 3.362e-06; norm: 1.058e-01
## It: 293; obj: 2.122e+00; abs: 3.814e-05; rel: 1.797e-05; norm: 1.058e-01
## It: 294; obj: 2.122e+00; abs: 1.890e-05; rel: 8.903e-06; norm: 1.058e-01
## It: 295; obj: 2.122e+00; abs: 5.237e-05; rel: 2.468e-05; norm: 1.058e-01
## It: 296; obj: 2.123e+00; abs: 7.234e-05; rel: 3.408e-05; norm: 1.058e-01
## It: 297; obj: 2.123e+00; abs: 1.107e-04; rel: 5.214e-05; norm: 1.058e-01
## It: 298; obj: 2.123e+00; abs: 6.090e-05; rel: 2.869e-05; norm: 1.058e-01
## It: 299; obj: 2.122e+00; abs: 1.123e-04; rel: 5.289e-05; norm: 1.058e-01
## It: 300; obj: 2.122e+00; abs: 7.041e-05; rel: 3.317e-05; norm: 1.058e-01

## It: 301; obj: 2.123e+00; abs: 1.982e-04; rel: 9.337e-05; norm: 1.058e-01
## It: 302; obj: 2.123e+00; abs: 2.369e-04; rel: 1.116e-04; norm: 1.058e-01
## It: 303; obj: 2.123e+00; abs: 4.274e-05; rel: 2.013e-05; norm: 1.058e-01
## It: 304; obj: 2.122e+00; abs: 3.081e-04; rel: 1.451e-04; norm: 1.059e-01
## It: 305; obj: 2.122e+00; abs: 1.420e-05; rel: 6.689e-06; norm: 1.059e-01
## It: 306; obj: 2.123e+00; abs: 1.574e-04; rel: 7.416e-05; norm: 1.058e-01
## It: 307; obj: 2.123e+00; abs: 4.123e-04; rel: 1.943e-04; norm: 1.059e-01
## It: 308; obj: 2.123e+00; abs: 3.253e-04; rel: 1.532e-04; norm: 1.059e-01
## It: 309; obj: 2.122e+00; abs: 2.684e-04; rel: 1.264e-04; norm: 1.059e-01
## It: 310; obj: 2.122e+00; abs: 3.649e-05; rel: 1.719e-05; norm: 1.058e-01
## It: 311; obj: 2.123e+00; abs: 3.668e-04; rel: 1.728e-04; norm: 1.058e-01
## It: 312; obj: 2.123e+00; abs: 2.195e-04; rel: 1.034e-04; norm: 1.059e-01
## It: 313; obj: 2.123e+00; abs: 1.663e-04; rel: 7.835e-05; norm: 1.059e-01
## It: 314; obj: 2.122e+00; abs: 3.734e-04; rel: 1.759e-04; norm: 1.059e-01
## It: 315; obj: 2.123e+00; abs: 5.917e-05; rel: 2.788e-05; norm: 1.059e-01
## It: 316; obj: 2.123e+00; abs: 2.352e-04; rel: 1.108e-04; norm: 1.058e-01
## It: 317; obj: 2.123e+00; abs: 3.959e-04; rel: 1.865e-04; norm: 1.059e-01
## It: 318; obj: 2.123e+00; abs: 5.338e-04; rel: 2.514e-04; norm: 1.059e-01
## It: 319; obj: 2.122e+00; abs: 1.904e-04; rel: 8.972e-05; norm: 1.059e-01
## It: 320; obj: 2.123e+00; abs: 1.056e-04; rel: 4.974e-05; norm: 1.058e-01
## It: 321; obj: 2.123e+00; abs: 3.733e-04; rel: 1.759e-04; norm: 1.058e-01
## It: 322; obj: 2.123e+00; abs: 1.380e-04; rel: 6.501e-05; norm: 1.059e-01
## It: 323; obj: 2.123e+00; abs: 3.101e-04; rel: 1.460e-04; norm: 1.059e-01
## It: 324; obj: 2.122e+00; abs: 2.663e-04; rel: 1.255e-04; norm: 1.059e-01
## It: 325; obj: 2.123e+00; abs: 9.951e-05; rel: 4.688e-05; norm: 1.059e-01

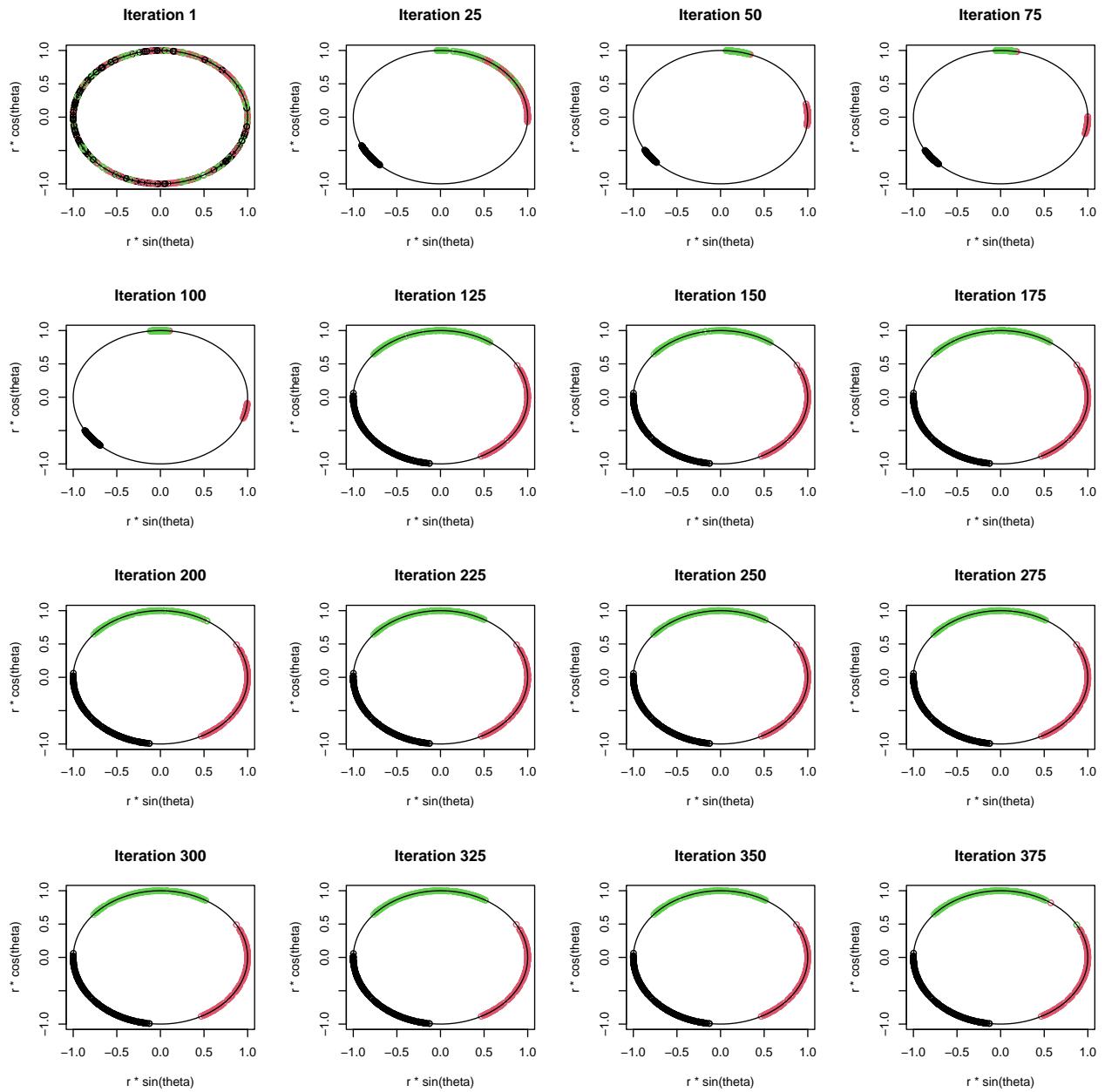
## It: 326; obj: 2.123e+00; abs: 3.859e-04; rel: 1.818e-04; norm: 1.058e-01
## It: 327; obj: 2.123e+00; abs: 2.258e-04; rel: 1.063e-04; norm: 1.059e-01
## It: 328; obj: 2.123e+00; abs: 6.241e-04; rel: 2.939e-04; norm: 1.059e-01
## It: 329; obj: 2.122e+00; abs: 1.675e-04; rel: 7.890e-05; norm: 1.058e-01
## It: 330; obj: 2.123e+00; abs: 3.574e-04; rel: 1.684e-04; norm: 1.058e-01
## It: 331; obj: 2.123e+00; abs: 4.032e-04; rel: 1.899e-04; norm: 1.059e-01

```

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## It: 332; obj: 2.123e+00; abs: 5.423e-05; rel: 2.554e-05; norm: 1.059e-01
## It: 333; obj: 2.123e+00; abs: 5.047e-04; rel: 2.377e-04; norm: 1.059e-01
## It: 334; obj: 2.123e+00; abs: 4.073e-05; rel: 1.919e-05; norm: 1.059e-01
## It: 335; obj: 2.123e+00; abs: 2.229e-04; rel: 1.050e-04; norm: 1.058e-01
## It: 336; obj: 2.123e+00; abs: 2.928e-04; rel: 1.379e-04; norm: 1.058e-01
## It: 337; obj: 2.123e+00; abs: 1.376e-04; rel: 6.482e-05; norm: 1.059e-01
## It: 338; obj: 2.123e+00; abs: 1.246e-04; rel: 5.870e-05; norm: 1.059e-01
## It: 339; obj: 2.123e+00; abs: 2.670e-04; rel: 1.258e-04; norm: 1.058e-01
## It: 340; obj: 2.123e+00; abs: 1.810e-04; rel: 8.527e-05; norm: 1.058e-01
## It: 341; obj: 2.123e+00; abs: 5.521e-04; rel: 2.601e-04; norm: 1.059e-01
## It: 342; obj: 2.124e+00; abs: 1.712e-04; rel: 8.063e-05; norm: 1.058e-01
## It: 343; obj: 2.124e+00; abs: 3.477e-04; rel: 1.637e-04; norm: 1.058e-01
## It: 344; obj: 2.124e+00; abs: 4.503e-04; rel: 2.120e-04; norm: 1.059e-01
## It: 345; obj: 2.125e+00; abs: 6.557e-04; rel: 3.087e-04; norm: 1.058e-01
## It: 346; obj: 2.123e+00; abs: 1.596e-03; rel: 7.508e-04; norm: 1.058e-01
## It: 347; obj: 2.123e+00; abs: 6.175e-04; rel: 2.908e-04; norm: 1.059e-01
## It: 348; obj: 2.123e+00; abs: 1.887e-04; rel: 8.887e-05; norm: 1.058e-01
## It: 349; obj: 2.123e+00; abs: 2.619e-04; rel: 1.234e-04; norm: 1.057e-01
## It: 350; obj: 2.124e+00; abs: 1.029e-03; rel: 4.848e-04; norm: 1.058e-01
## It: 351; obj: 2.125e+00; abs: 8.460e-04; rel: 3.982e-04; norm: 1.059e-01
## It: 352; obj: 2.125e+00; abs: 1.155e-04; rel: 5.437e-05; norm: 1.057e-01
## It: 353; obj: 2.123e+00; abs: 2.364e-03; rel: 1.113e-03; norm: 1.058e-01
## It: 354; obj: 2.123e+00; abs: 4.017e-04; rel: 1.892e-04; norm: 1.058e-01
## It: 355; obj: 2.124e+00; abs: 5.080e-04; rel: 2.393e-04; norm: 1.057e-01
## It: 356; obj: 2.125e+00; abs: 9.766e-04; rel: 4.599e-04; norm: 1.058e-01
## It: 357; obj: 2.124e+00; abs: 1.323e-04; rel: 6.227e-05; norm: 1.059e-01
## It: 358; obj: 2.125e+00; abs: 3.128e-04; rel: 1.473e-04; norm: 1.057e-01
## It: 359; obj: 2.123e+00; abs: 1.777e-03; rel: 8.362e-04; norm: 1.057e-01
## It: 360; obj: 2.123e+00; abs: 1.658e-04; rel: 7.809e-05; norm: 1.058e-01
## It: 361; obj: 2.124e+00; abs: 4.819e-04; rel: 2.270e-04; norm: 1.059e-01
## It: 362; obj: 2.123e+00; abs: 2.156e-04; rel: 1.015e-04; norm: 1.058e-01
## It: 363; obj: 2.124e+00; abs: 4.862e-04; rel: 2.290e-04; norm: 1.059e-01
## It: 364; obj: 2.124e+00; abs: 5.825e-04; rel: 2.743e-04; norm: 1.059e-01
## It: 365; obj: 2.125e+00; abs: 9.265e-04; rel: 4.361e-04; norm: 1.057e-01
## It: 366; obj: 2.123e+00; abs: 2.284e-03; rel: 1.075e-03; norm: 1.058e-01
## It: 367; obj: 2.123e+00; abs: 3.042e-04; rel: 1.433e-04; norm: 1.059e-01
## It: 368; obj: 2.123e+00; abs: 6.339e-05; rel: 2.986e-05; norm: 1.057e-01
## It: 369; obj: 2.123e+00; abs: 9.673e-05; rel: 4.556e-05; norm: 1.057e-01
## It: 370; obj: 2.123e+00; abs: 4.173e-04; rel: 1.965e-04; norm: 1.058e-01
## It: 371; obj: 2.124e+00; abs: 4.251e-04; rel: 2.002e-04; norm: 1.059e-01
## It: 372; obj: 2.123e+00; abs: 7.755e-04; rel: 3.652e-04; norm: 1.059e-01
## It: 373; obj: 2.123e+00; abs: 4.262e-04; rel: 2.008e-04; norm: 1.059e-01
## It: 374; obj: 2.123e+00; abs: 5.423e-04; rel: 2.555e-04; norm: 1.058e-01
## It: 375; obj: 2.124e+00; abs: 7.364e-04; rel: 3.468e-04; norm: 1.058e-01

```



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## It: 376; obj: 2.124e+00; abs: 2.324e-04; rel: 1.094e-04; norm: 1.058e-01
## It: 377; obj: 2.124e+00; abs: 2.170e-04; rel: 1.021e-04; norm: 1.059e-01
## It: 378; obj: 2.125e+00; abs: 4.429e-04; rel: 2.085e-04; norm: 1.057e-01
## It: 379; obj: 2.123e+00; abs: 1.667e-03; rel: 7.845e-04; norm: 1.057e-01
## It: 380; obj: 2.123e+00; abs: 5.995e-05; rel: 2.824e-05; norm: 1.059e-01
## It: 381; obj: 2.123e+00; abs: 1.903e-04; rel: 8.962e-05; norm: 1.059e-01
## It: 382; obj: 2.123e+00; abs: 1.315e-04; rel: 6.194e-05; norm: 1.058e-01
## It: 383; obj: 2.124e+00; abs: 7.193e-04; rel: 3.388e-04; norm: 1.058e-01
## It: 384; obj: 2.125e+00; abs: 7.235e-04; rel: 3.407e-04; norm: 1.059e-01
## It: 385; obj: 2.125e+00; abs: 8.208e-04; rel: 3.863e-04; norm: 1.057e-01
## It: 386; obj: 2.123e+00; abs: 2.770e-03; rel: 1.303e-03; norm: 1.058e-01
## It: 387; obj: 2.123e+00; abs: 5.318e-05; rel: 2.505e-05; norm: 1.058e-01
## It: 388; obj: 2.123e+00; abs: 2.228e-04; rel: 1.049e-04; norm: 1.057e-01
## It: 389; obj: 2.123e+00; abs: 1.650e-05; rel: 7.773e-06; norm: 1.058e-01

```

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## It: 390; obj: 2.123e+00; abs: 4.213e-04; rel: 1.984e-04; norm: 1.059e-01
## It: 391; obj: 2.123e+00; abs: 1.314e-05; rel: 6.188e-06; norm: 1.059e-01
## It: 392; obj: 2.123e+00; abs: 6.987e-04; rel: 3.291e-04; norm: 1.059e-01
## It: 393; obj: 2.123e+00; abs: 3.180e-05; rel: 1.498e-05; norm: 1.058e-01
## It: 394; obj: 2.123e+00; abs: 8.003e-04; rel: 3.770e-04; norm: 1.058e-01
## It: 395; obj: 2.124e+00; abs: 3.844e-04; rel: 1.810e-04; norm: 1.058e-01
## It: 396; obj: 2.124e+00; abs: 2.067e-05; rel: 9.734e-06; norm: 1.059e-01
## It: 397; obj: 2.124e+00; abs: 4.052e-04; rel: 1.908e-04; norm: 1.059e-01
## It: 398; obj: 2.125e+00; abs: 7.986e-04; rel: 3.760e-04; norm: 1.057e-01
## It: 399; obj: 2.123e+00; abs: 1.675e-03; rel: 7.883e-04; norm: 1.057e-01
## It: 400; obj: 2.123e+00; abs: 2.414e-04; rel: 1.137e-04; norm: 1.059e-01

## It: 401; obj: 2.123e+00; abs: 4.677e-05; rel: 2.203e-05; norm: 1.059e-01
## It: 402; obj: 2.123e+00; abs: 1.917e-04; rel: 9.030e-05; norm: 1.058e-01
## It: 403; obj: 2.124e+00; abs: 7.833e-04; rel: 3.689e-04; norm: 1.058e-01
## It: 404; obj: 2.125e+00; abs: 9.642e-04; rel: 4.540e-04; norm: 1.059e-01
## It: 405; obj: 2.125e+00; abs: 1.380e-04; rel: 6.493e-05; norm: 1.057e-01
## It: 406; obj: 2.123e+00; abs: 2.553e-03; rel: 1.201e-03; norm: 1.058e-01
## It: 407; obj: 2.123e+00; abs: 1.592e-04; rel: 7.501e-05; norm: 1.058e-01
## It: 408; obj: 2.123e+00; abs: 4.737e-04; rel: 2.232e-04; norm: 1.058e-01
## It: 409; obj: 2.123e+00; abs: 9.383e-05; rel: 4.419e-05; norm: 1.058e-01
## It: 410; obj: 2.123e+00; abs: 1.995e-04; rel: 9.395e-05; norm: 1.059e-01
## It: 411; obj: 2.123e+00; abs: 1.468e-04; rel: 6.915e-05; norm: 1.059e-01
## It: 412; obj: 2.123e+00; abs: 5.024e-04; rel: 2.366e-04; norm: 1.059e-01
## It: 413; obj: 2.123e+00; abs: 2.087e-04; rel: 9.830e-05; norm: 1.058e-01
## It: 414; obj: 2.124e+00; abs: 8.245e-04; rel: 3.884e-04; norm: 1.058e-01
## It: 415; obj: 2.124e+00; abs: 1.605e-04; rel: 7.558e-05; norm: 1.058e-01
## It: 416; obj: 2.124e+00; abs: 4.276e-04; rel: 2.014e-04; norm: 1.059e-01
## It: 417; obj: 2.125e+00; abs: 7.755e-04; rel: 3.651e-04; norm: 1.058e-01
## It: 418; obj: 2.125e+00; abs: 3.411e-05; rel: 1.605e-05; norm: 1.057e-01
## It: 419; obj: 2.123e+00; abs: 1.489e-03; rel: 7.009e-04; norm: 1.059e-01
## It: 420; obj: 2.123e+00; abs: 1.111e-04; rel: 5.232e-05; norm: 1.058e-01
## It: 421; obj: 2.124e+00; abs: 2.631e-04; rel: 1.239e-04; norm: 1.058e-01
## It: 422; obj: 2.124e+00; abs: 6.989e-04; rel: 3.291e-04; norm: 1.059e-01
## It: 423; obj: 2.125e+00; abs: 8.848e-04; rel: 4.165e-04; norm: 1.058e-01
## It: 424; obj: 2.124e+00; abs: 1.005e-03; rel: 4.731e-04; norm: 1.058e-01
## It: 425; obj: 2.123e+00; abs: 1.557e-03; rel: 7.330e-04; norm: 1.059e-01

## It: 426; obj: 2.123e+00; abs: 3.371e-04; rel: 1.588e-04; norm: 1.058e-01
## It: 427; obj: 2.124e+00; abs: 6.270e-04; rel: 2.954e-04; norm: 1.057e-01
## It: 428; obj: 2.125e+00; abs: 1.025e-03; rel: 4.827e-04; norm: 1.058e-01
## It: 429; obj: 2.125e+00; abs: 7.646e-04; rel: 3.599e-04; norm: 1.059e-01
## It: 430; obj: 2.124e+00; abs: 1.191e-03; rel: 5.602e-04; norm: 1.058e-01
## It: 431; obj: 2.123e+00; abs: 1.533e-03; rel: 7.216e-04; norm: 1.059e-01
## It: 432; obj: 2.123e+00; abs: 5.705e-04; rel: 2.688e-04; norm: 1.058e-01
## It: 433; obj: 2.124e+00; abs: 1.115e-03; rel: 5.252e-04; norm: 1.058e-01
## It: 434; obj: 2.125e+00; abs: 4.255e-04; rel: 2.003e-04; norm: 1.060e-01
## It: 435; obj: 2.125e+00; abs: 3.538e-05; rel: 1.665e-05; norm: 1.059e-01
## It: 436; obj: 2.123e+00; abs: 1.603e-03; rel: 7.542e-04; norm: 1.057e-01
## It: 437; obj: 2.123e+00; abs: 3.653e-04; rel: 1.721e-04; norm: 1.058e-01
## It: 438; obj: 2.124e+00; abs: 7.759e-04; rel: 3.655e-04; norm: 1.059e-01
## It: 439; obj: 2.124e+00; abs: 1.854e-04; rel: 8.730e-05; norm: 1.058e-01
## It: 440; obj: 2.124e+00; abs: 2.061e-04; rel: 9.704e-05; norm: 1.059e-01
## It: 441; obj: 2.125e+00; abs: 7.475e-04; rel: 3.520e-04; norm: 1.059e-01
## It: 442; obj: 2.125e+00; abs: 8.546e-05; rel: 4.022e-05; norm: 1.057e-01

```

```

## It: 443; obj: 2.123e+00; abs: 1.335e-03; rel: 6.285e-04; norm: 1.059e-01
## It: 444; obj: 2.123e+00; abs: 1.630e-05; rel: 7.675e-06; norm: 1.059e-01
## It: 445; obj: 2.123e+00; abs: 1.783e-04; rel: 8.395e-05; norm: 1.058e-01
## It: 446; obj: 2.124e+00; abs: 6.023e-04; rel: 2.836e-04; norm: 1.058e-01
## It: 447; obj: 2.125e+00; abs: 1.027e-03; rel: 4.837e-04; norm: 1.059e-01
## It: 448; obj: 2.124e+00; abs: 7.674e-04; rel: 3.611e-04; norm: 1.058e-01
## It: 449; obj: 2.123e+00; abs: 1.426e-03; rel: 6.713e-04; norm: 1.059e-01
## It: 450; obj: 2.123e+00; abs: 1.122e-04; rel: 5.285e-05; norm: 1.059e-01

## It: 451; obj: 2.124e+00; abs: 6.157e-04; rel: 2.900e-04; norm: 1.058e-01
## It: 452; obj: 2.124e+00; abs: 8.577e-04; rel: 4.039e-04; norm: 1.059e-01
## It: 453; obj: 2.125e+00; abs: 9.456e-04; rel: 4.451e-04; norm: 1.059e-01
## It: 454; obj: 2.124e+00; abs: 1.782e-03; rel: 8.385e-04; norm: 1.059e-01
## It: 455; obj: 2.122e+00; abs: 1.176e-03; rel: 5.538e-04; norm: 1.059e-01
## It: 456; obj: 2.123e+00; abs: 5.762e-04; rel: 2.715e-04; norm: 1.058e-01
## It: 457; obj: 2.124e+00; abs: 7.607e-04; rel: 3.583e-04; norm: 1.058e-01
## It: 458; obj: 2.125e+00; abs: 7.855e-04; rel: 3.699e-04; norm: 1.059e-01
## It: 459; obj: 2.125e+00; abs: 3.560e-04; rel: 1.676e-04; norm: 1.060e-01
## It: 460; obj: 2.124e+00; abs: 1.103e-03; rel: 5.192e-04; norm: 1.059e-01
## It: 461; obj: 2.123e+00; abs: 1.234e-03; rel: 5.810e-04; norm: 1.059e-01
## It: 462; obj: 2.123e+00; abs: 8.342e-04; rel: 3.930e-04; norm: 1.059e-01
## It: 463; obj: 2.124e+00; abs: 7.206e-04; rel: 3.394e-04; norm: 1.059e-01
## It: 464; obj: 2.124e+00; abs: 9.981e-05; rel: 4.699e-05; norm: 1.060e-01
## It: 465; obj: 2.124e+00; abs: 3.066e-04; rel: 1.443e-04; norm: 1.060e-01
## It: 466; obj: 2.123e+00; abs: 1.231e-03; rel: 5.797e-04; norm: 1.059e-01
## It: 467; obj: 2.122e+00; abs: 6.843e-04; rel: 3.223e-04; norm: 1.061e-01
## It: 468; obj: 2.123e+00; abs: 2.441e-04; rel: 1.150e-04; norm: 1.061e-01
## It: 469; obj: 2.122e+00; abs: 2.968e-04; rel: 1.398e-04; norm: 1.061e-01
## It: 470; obj: 2.123e+00; abs: 4.869e-04; rel: 2.294e-04; norm: 1.062e-01
## It: 471; obj: 2.124e+00; abs: 8.006e-04; rel: 3.771e-04; norm: 1.063e-01
## It: 472; obj: 2.124e+00; abs: 9.417e-05; rel: 4.434e-05; norm: 1.062e-01
## It: 473; obj: 2.122e+00; abs: 1.922e-03; rel: 9.051e-04; norm: 1.062e-01
## It: 474; obj: 2.122e+00; abs: 4.947e-06; rel: 2.332e-06; norm: 1.063e-01
## It: 475; obj: 2.122e+00; abs: 4.986e-04; rel: 2.350e-04; norm: 1.063e-01

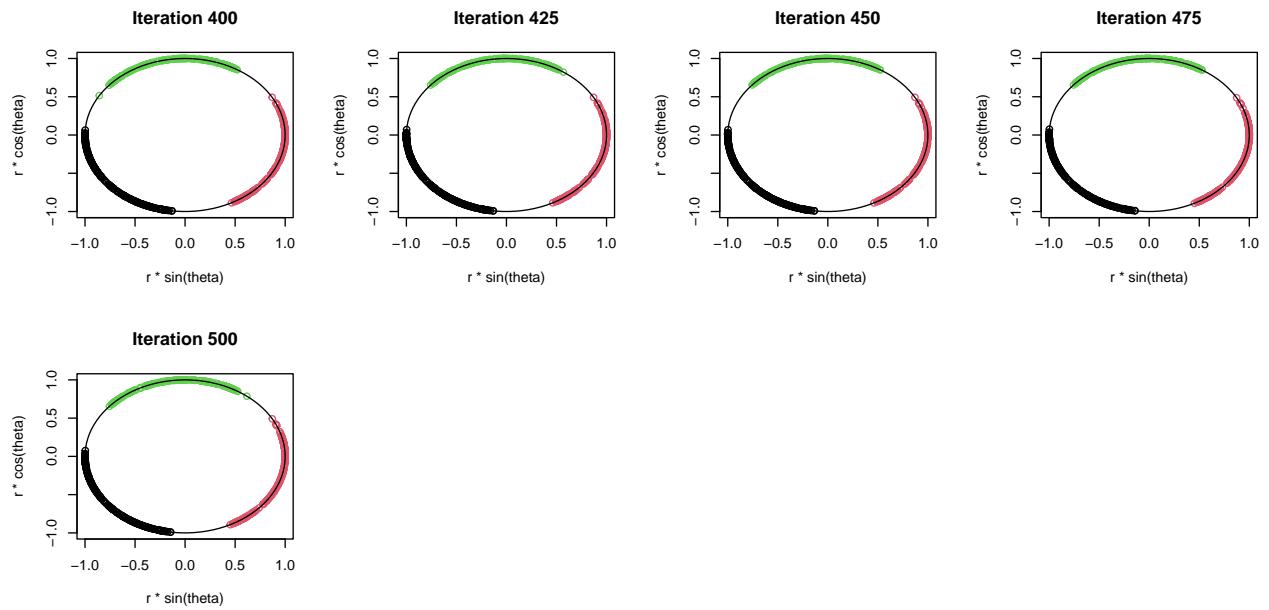
## It: 476; obj: 2.123e+00; abs: 1.010e-03; rel: 4.759e-04; norm: 1.064e-01
## It: 477; obj: 2.124e+00; abs: 7.838e-04; rel: 3.692e-04; norm: 1.065e-01
## It: 478; obj: 2.122e+00; abs: 1.703e-03; rel: 8.017e-04; norm: 1.064e-01
## It: 479; obj: 2.121e+00; abs: 1.144e-03; rel: 5.389e-04; norm: 1.064e-01
## It: 480; obj: 2.122e+00; abs: 5.255e-04; rel: 2.477e-04; norm: 1.066e-01
## It: 481; obj: 2.122e+00; abs: 6.539e-04; rel: 3.082e-04; norm: 1.064e-01
## It: 482; obj: 2.123e+00; abs: 1.099e-03; rel: 5.176e-04; norm: 1.063e-01
## It: 483; obj: 2.124e+00; abs: 1.347e-04; rel: 6.343e-05; norm: 1.064e-01
## It: 484; obj: 2.122e+00; abs: 1.093e-03; rel: 5.146e-04; norm: 1.063e-01
## It: 485; obj: 2.121e+00; abs: 1.212e-03; rel: 5.710e-04; norm: 1.064e-01
## It: 486; obj: 2.122e+00; abs: 8.295e-04; rel: 3.910e-04; norm: 1.066e-01
## It: 487; obj: 2.123e+00; abs: 7.308e-04; rel: 3.444e-04; norm: 1.065e-01
## It: 488; obj: 2.123e+00; abs: 2.959e-04; rel: 1.394e-04; norm: 1.064e-01
## It: 489; obj: 2.123e+00; abs: 2.671e-04; rel: 1.258e-04; norm: 1.066e-01
## It: 490; obj: 2.122e+00; abs: 1.360e-03; rel: 6.407e-04; norm: 1.065e-01
## It: 491; obj: 2.122e+00; abs: 3.929e-04; rel: 1.851e-04; norm: 1.064e-01
## It: 492; obj: 2.122e+00; abs: 6.906e-04; rel: 3.255e-04; norm: 1.064e-01
## It: 493; obj: 2.122e+00; abs: 2.983e-04; rel: 1.405e-04; norm: 1.064e-01
## It: 494; obj: 2.123e+00; abs: 5.385e-04; rel: 2.538e-04; norm: 1.063e-01
## It: 495; obj: 2.124e+00; abs: 1.075e-03; rel: 5.063e-04; norm: 1.065e-01

```

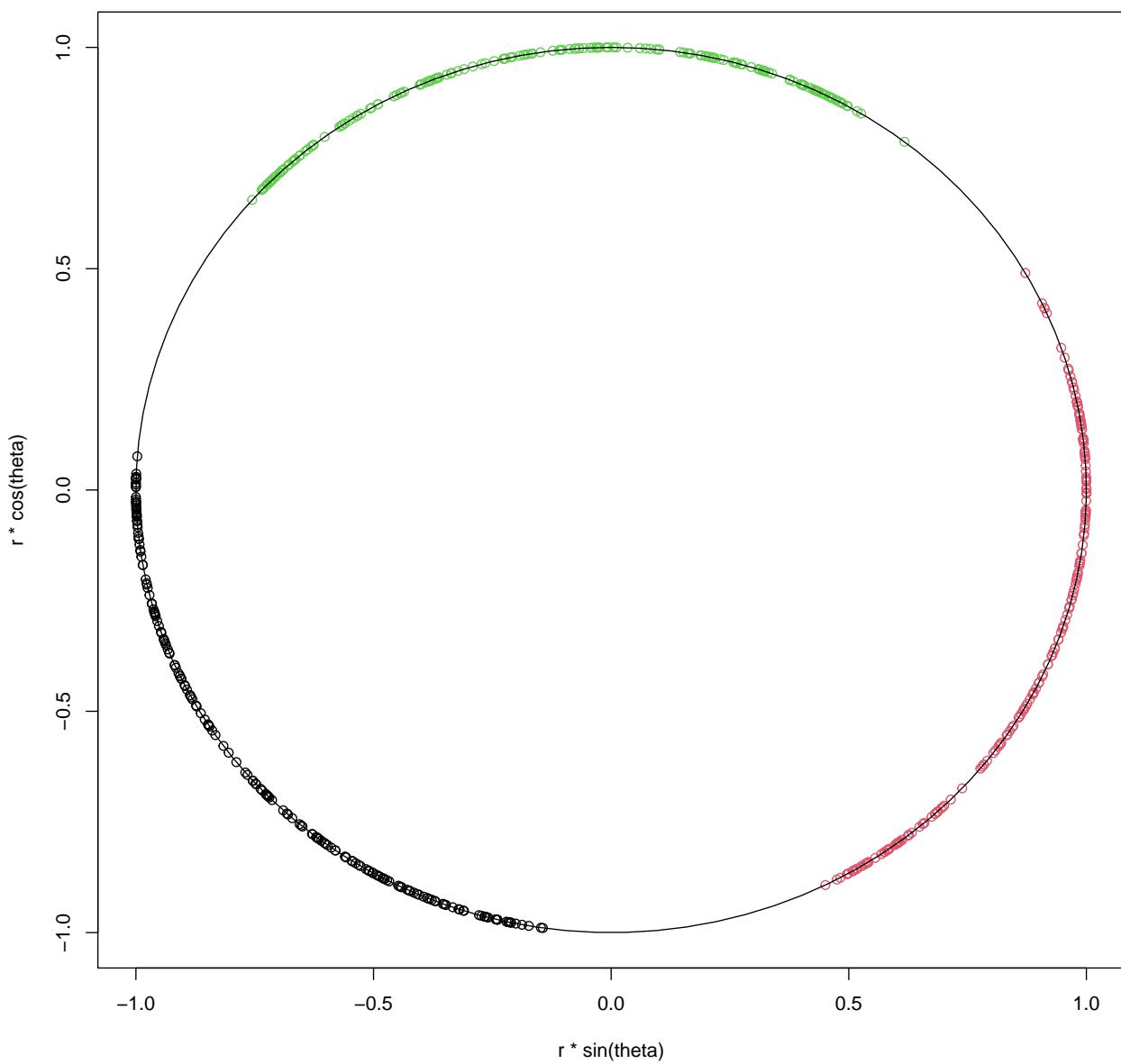
```

## It: 496; obj: 2.123e+00; abs: 2.928e-04; rel: 1.379e-04; norm: 1.065e-01
## It: 497; obj: 2.122e+00; abs: 1.550e-03; rel: 7.299e-04; norm: 1.064e-01
## It: 498; obj: 2.122e+00; abs: 6.798e-05; rel: 3.204e-05; norm: 1.065e-01
## It: 499; obj: 2.122e+00; abs: 5.486e-04; rel: 2.586e-04; norm: 1.065e-01
## It: 500; obj: 2.123e+00; abs: 7.914e-04; rel: 3.729e-04; norm: 1.064e-01

```



Iteration 500

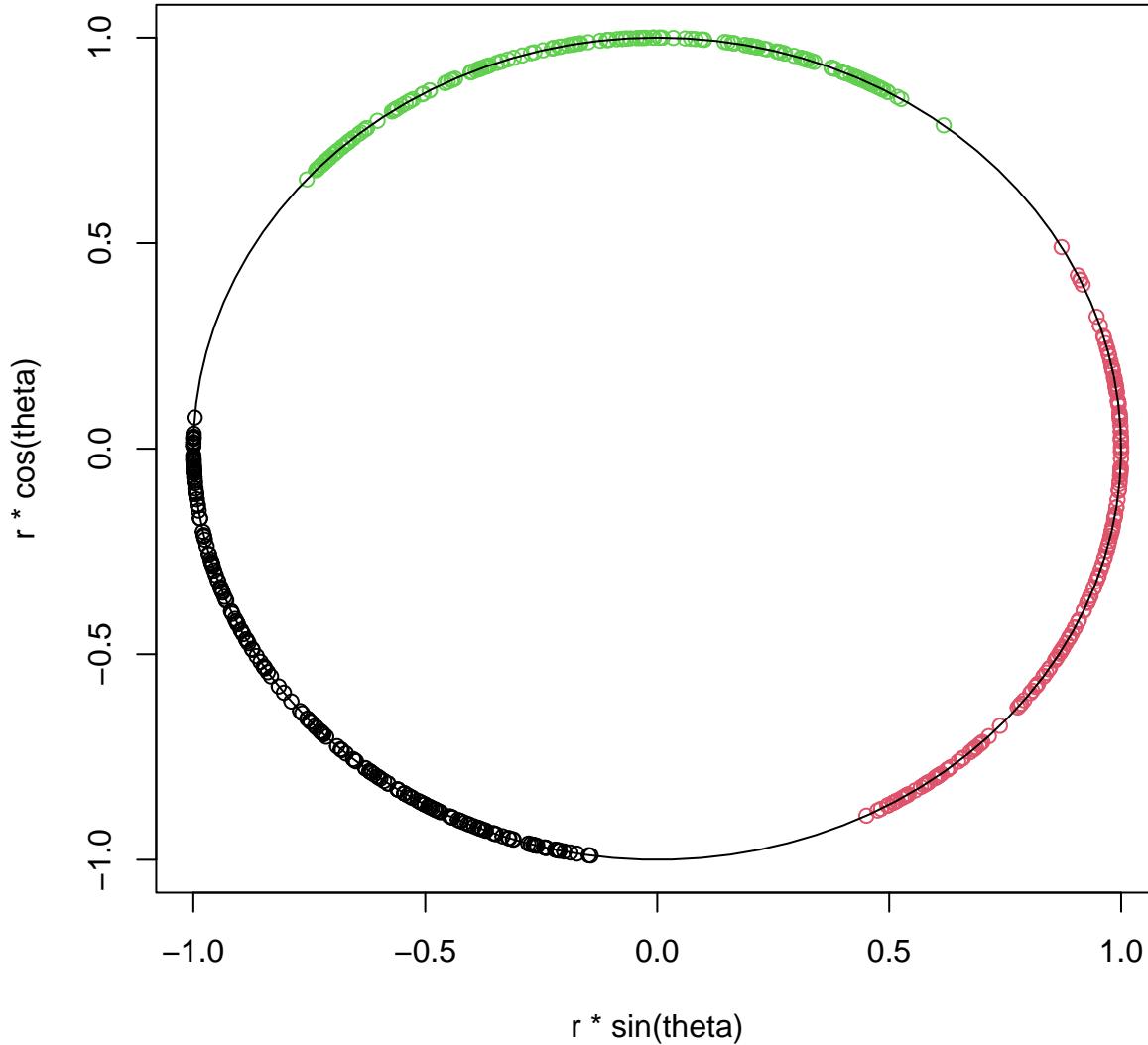


```

Y_rad <- DirStats:::to_rad(Y)
r <- 1
theta <- Y_rad
plot(r*sin(theta),
     r*cos(theta),
     col=colors,
     xlim=c(-max(r),max(r)),
     ylim=c(-max(r),max(r)))

polygon(max(r)*sin(seq(0,2*pi,length.out=100)),max(r)*cos(seq(0,2*pi,length.out=100)))

```



Now we are going to reduce to dimension \mathbb{S}^2 then $d = 2$ (sphere):

```
Y <- psc_sne(X=x_3, d=2, rho_psc_list = rho_third_perp25, num_iteration=500,
               colors=colors, visualize_prog = TRUE)
```

```
## It: 1; obj: 1.797e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.590e-01
## It: 2; obj: 1.453e+01; abs: 3.443e+00; rel: 1.916e-01; norm: 4.474e-01
## It: 3; obj: 1.352e+01; abs: 1.010e+00; rel: 6.949e-02; norm: 8.799e-01
## It: 4; obj: 1.304e+01; abs: 4.751e-01; rel: 3.514e-02; norm: 1.051e+00
## It: 5; obj: 1.278e+01; abs: 2.591e-01; rel: 1.986e-02; norm: 1.146e+00
## It: 6; obj: 1.264e+01; abs: 1.427e-01; rel: 1.117e-02; norm: 1.216e+00
## It: 7; obj: 1.256e+01; abs: 8.298e-02; rel: 6.564e-03; norm: 1.276e+00
## It: 8; obj: 1.253e+01; abs: 2.820e-02; rel: 2.245e-03; norm: 1.329e+00
## It: 9; obj: 1.255e+01; abs: 1.700e-02; rel: 1.357e-03; norm: 1.374e+00
## It: 10; obj: 1.258e+01; abs: 3.538e-02; rel: 2.820e-03; norm: 1.411e+00
## It: 11; obj: 1.262e+01; abs: 3.291e-02; rel: 2.616e-03; norm: 1.443e+00
## It: 12; obj: 1.264e+01; abs: 2.737e-02; rel: 2.169e-03; norm: 1.472e+00
## It: 13; obj: 1.267e+01; abs: 2.285e-02; rel: 1.807e-03; norm: 1.498e+00
## It: 14; obj: 1.269e+01; abs: 2.062e-02; rel: 1.628e-03; norm: 1.522e+00
## It: 15; obj: 1.272e+01; abs: 2.919e-02; rel: 2.301e-03; norm: 1.544e+00
```

```

## It: 16; obj: 1.276e+01; abs: 4.269e-02; rel: 3.357e-03; norm: 1.566e+00
## It: 17; obj: 1.281e+01; abs: 4.947e-02; rel: 3.878e-03; norm: 1.586e+00
## It: 18; obj: 1.285e+01; abs: 4.601e-02; rel: 3.592e-03; norm: 1.604e+00
## It: 19; obj: 1.290e+01; abs: 4.871e-02; rel: 3.790e-03; norm: 1.621e+00
## It: 20; obj: 1.295e+01; abs: 4.449e-02; rel: 3.448e-03; norm: 1.636e+00
## It: 21; obj: 1.296e+01; abs: 1.363e-02; rel: 1.053e-03; norm: 1.649e+00
## It: 22; obj: 1.295e+01; abs: 9.754e-03; rel: 7.526e-04; norm: 1.662e+00
## It: 23; obj: 1.295e+01; abs: 3.577e-03; rel: 2.762e-04; norm: 1.676e+00
## It: 24; obj: 1.297e+01; abs: 2.697e-02; rel: 2.083e-03; norm: 1.688e+00
## It: 25; obj: 1.301e+01; abs: 3.923e-02; rel: 3.023e-03; norm: 1.697e+00
## It: 26; obj: 1.305e+01; abs: 3.853e-02; rel: 2.960e-03; norm: 1.702e+00
## It: 27; obj: 1.309e+01; abs: 3.377e-02; rel: 2.587e-03; norm: 1.705e+00
## It: 28; obj: 1.311e+01; abs: 2.848e-02; rel: 2.176e-03; norm: 1.707e+00
## It: 29; obj: 1.314e+01; abs: 2.366e-02; rel: 1.804e-03; norm: 1.709e+00
## It: 30; obj: 1.316e+01; abs: 1.949e-02; rel: 1.483e-03; norm: 1.709e+00
## It: 31; obj: 1.317e+01; abs: 1.595e-02; rel: 1.212e-03; norm: 1.709e+00
## It: 32; obj: 1.319e+01; abs: 1.298e-02; rel: 9.851e-04; norm: 1.709e+00
## It: 33; obj: 1.320e+01; abs: 1.049e-02; rel: 7.956e-04; norm: 1.708e+00
## It: 34; obj: 1.321e+01; abs: 8.416e-03; rel: 6.377e-04; norm: 1.708e+00
## It: 35; obj: 1.321e+01; abs: 6.685e-03; rel: 5.062e-04; norm: 1.707e+00
## It: 36; obj: 1.322e+01; abs: 5.241e-03; rel: 3.967e-04; norm: 1.706e+00
## It: 37; obj: 1.322e+01; abs: 4.036e-03; rel: 3.053e-04; norm: 1.705e+00
## It: 38; obj: 1.322e+01; abs: 3.028e-03; rel: 2.290e-04; norm: 1.703e+00
## It: 39; obj: 1.323e+01; abs: 2.186e-03; rel: 1.653e-04; norm: 1.702e+00
## It: 40; obj: 1.323e+01; abs: 1.480e-03; rel: 1.119e-04; norm: 1.701e+00
## It: 41; obj: 1.323e+01; abs: 8.876e-04; rel: 6.710e-05; norm: 1.700e+00
## It: 42; obj: 1.323e+01; abs: 3.906e-04; rel: 2.952e-05; norm: 1.698e+00
## It: 43; obj: 1.323e+01; abs: 2.694e-05; rel: 2.037e-06; norm: 1.697e+00
## It: 44; obj: 1.323e+01; abs: 3.777e-04; rel: 2.855e-05; norm: 1.696e+00
## It: 45; obj: 1.323e+01; abs: 6.722e-04; rel: 5.081e-05; norm: 1.694e+00
## It: 46; obj: 1.323e+01; abs: 9.192e-04; rel: 6.949e-05; norm: 1.693e+00
## It: 47; obj: 1.323e+01; abs: 1.126e-03; rel: 8.511e-05; norm: 1.692e+00
## It: 48; obj: 1.323e+01; abs: 1.298e-03; rel: 9.815e-05; norm: 1.690e+00
## It: 49; obj: 1.322e+01; abs: 1.441e-03; rel: 1.090e-04; norm: 1.689e+00
## It: 50; obj: 1.322e+01; abs: 1.559e-03; rel: 1.179e-04; norm: 1.688e+00
## It: 51; obj: 1.322e+01; abs: 1.655e-03; rel: 1.252e-04; norm: 1.687e+00
## It: 52; obj: 1.322e+01; abs: 1.732e-03; rel: 1.310e-04; norm: 1.685e+00
## It: 53; obj: 1.322e+01; abs: 1.793e-03; rel: 1.356e-04; norm: 1.684e+00
## It: 54; obj: 1.322e+01; abs: 1.840e-03; rel: 1.392e-04; norm: 1.683e+00
## It: 55; obj: 1.321e+01; abs: 1.874e-03; rel: 1.418e-04; norm: 1.682e+00
## It: 56; obj: 1.321e+01; abs: 1.898e-03; rel: 1.437e-04; norm: 1.680e+00
## It: 57; obj: 1.321e+01; abs: 1.913e-03; rel: 1.448e-04; norm: 1.679e+00
## It: 58; obj: 1.321e+01; abs: 1.919e-03; rel: 1.453e-04; norm: 1.678e+00
## It: 59; obj: 1.321e+01; abs: 1.918e-03; rel: 1.452e-04; norm: 1.677e+00
## It: 60; obj: 1.320e+01; abs: 1.911e-03; rel: 1.447e-04; norm: 1.676e+00
## It: 61; obj: 1.320e+01; abs: 1.899e-03; rel: 1.438e-04; norm: 1.674e+00
## It: 62; obj: 1.320e+01; abs: 1.882e-03; rel: 1.426e-04; norm: 1.673e+00
## It: 63; obj: 1.320e+01; abs: 1.862e-03; rel: 1.410e-04; norm: 1.672e+00
## It: 64; obj: 1.320e+01; abs: 1.837e-03; rel: 1.392e-04; norm: 1.671e+00
## It: 65; obj: 1.319e+01; abs: 1.811e-03; rel: 1.372e-04; norm: 1.670e+00
## It: 66; obj: 1.319e+01; abs: 1.781e-03; rel: 1.350e-04; norm: 1.669e+00
## It: 67; obj: 1.319e+01; abs: 1.750e-03; rel: 1.327e-04; norm: 1.668e+00
## It: 68; obj: 1.319e+01; abs: 1.717e-03; rel: 1.302e-04; norm: 1.667e+00

```

```

## It: 69; obj: 1.319e+01; abs: 1.683e-03; rel: 1.276e-04; norm: 1.666e+00
## It: 70; obj: 1.319e+01; abs: 1.648e-03; rel: 1.250e-04; norm: 1.665e+00
## It: 71; obj: 1.318e+01; abs: 1.613e-03; rel: 1.223e-04; norm: 1.664e+00
## It: 72; obj: 1.318e+01; abs: 1.577e-03; rel: 1.196e-04; norm: 1.663e+00
## It: 73; obj: 1.318e+01; abs: 1.541e-03; rel: 1.169e-04; norm: 1.662e+00
## It: 74; obj: 1.318e+01; abs: 1.504e-03; rel: 1.141e-04; norm: 1.661e+00
## It: 75; obj: 1.318e+01; abs: 1.468e-03; rel: 1.114e-04; norm: 1.660e+00
## It: 76; obj: 1.318e+01; abs: 1.433e-03; rel: 1.087e-04; norm: 1.659e+00
## It: 77; obj: 1.318e+01; abs: 1.397e-03; rel: 1.060e-04; norm: 1.658e+00
## It: 78; obj: 1.317e+01; abs: 1.362e-03; rel: 1.034e-04; norm: 1.657e+00
## It: 79; obj: 1.317e+01; abs: 1.328e-03; rel: 1.008e-04; norm: 1.656e+00
## It: 80; obj: 1.317e+01; abs: 1.295e-03; rel: 9.829e-05; norm: 1.655e+00
## It: 81; obj: 1.317e+01; abs: 1.262e-03; rel: 9.581e-05; norm: 1.654e+00
## It: 82; obj: 1.317e+01; abs: 1.230e-03; rel: 9.339e-05; norm: 1.653e+00
## It: 83; obj: 1.317e+01; abs: 1.199e-03; rel: 9.104e-05; norm: 1.653e+00
## It: 84; obj: 1.317e+01; abs: 1.169e-03; rel: 8.876e-05; norm: 1.652e+00
## It: 85; obj: 1.317e+01; abs: 1.140e-03; rel: 8.655e-05; norm: 1.651e+00
## It: 86; obj: 1.316e+01; abs: 1.111e-03; rel: 8.441e-05; norm: 1.650e+00
## It: 87; obj: 1.316e+01; abs: 1.084e-03; rel: 8.234e-05; norm: 1.649e+00
## It: 88; obj: 1.316e+01; abs: 1.058e-03; rel: 8.035e-05; norm: 1.648e+00
## It: 89; obj: 1.316e+01; abs: 1.032e-03; rel: 7.844e-05; norm: 1.648e+00
## It: 90; obj: 1.316e+01; abs: 1.008e-03; rel: 7.660e-05; norm: 1.647e+00
## It: 91; obj: 1.316e+01; abs: 9.849e-04; rel: 7.484e-05; norm: 1.646e+00
## It: 92; obj: 1.316e+01; abs: 9.626e-04; rel: 7.315e-05; norm: 1.645e+00
## It: 93; obj: 1.316e+01; abs: 9.414e-04; rel: 7.154e-05; norm: 1.644e+00
## It: 94; obj: 1.316e+01; abs: 9.212e-04; rel: 7.001e-05; norm: 1.644e+00
## It: 95; obj: 1.316e+01; abs: 9.019e-04; rel: 6.855e-05; norm: 1.643e+00
## It: 96; obj: 1.315e+01; abs: 8.837e-04; rel: 6.717e-05; norm: 1.642e+00
## It: 97; obj: 1.315e+01; abs: 8.664e-04; rel: 6.586e-05; norm: 1.641e+00
## It: 98; obj: 1.315e+01; abs: 8.501e-04; rel: 6.463e-05; norm: 1.641e+00
## It: 99; obj: 1.315e+01; abs: 8.348e-04; rel: 6.347e-05; norm: 1.640e+00
## It: 100; obj: 1.315e+01; abs: 8.205e-04; rel: 6.239e-05; norm: 1.639e+00
## It: 101; obj: 1.849e+00; abs: 1.130e+01; rel: 8.594e-01; norm: 1.154e-01
## It: 102; obj: 1.639e+00; abs: 2.093e-01; rel: 1.132e-01; norm: 1.179e-01
## It: 103; obj: 1.523e+00; abs: 1.161e-01; rel: 7.084e-02; norm: 1.390e-01
## It: 104; obj: 1.526e+00; abs: 2.244e-03; rel: 1.473e-03; norm: 1.437e-01
## It: 105; obj: 1.550e+00; abs: 2.485e-02; rel: 1.629e-02; norm: 1.448e-01
## It: 106; obj: 1.534e+00; abs: 1.685e-02; rel: 1.087e-02; norm: 1.423e-01
## It: 107; obj: 1.525e+00; abs: 8.197e-03; rel: 5.345e-03; norm: 1.415e-01
## It: 108; obj: 1.548e+00; abs: 2.226e-02; rel: 1.459e-02; norm: 1.431e-01
## It: 109; obj: 1.540e+00; abs: 7.179e-03; rel: 4.639e-03; norm: 1.418e-01
## It: 110; obj: 1.523e+00; abs: 1.722e-02; rel: 1.118e-02; norm: 1.422e-01
## It: 111; obj: 1.541e+00; abs: 1.811e-02; rel: 1.189e-02; norm: 1.434e-01
## It: 112; obj: 1.534e+00; abs: 7.166e-03; rel: 4.650e-03; norm: 1.423e-01
## It: 113; obj: 1.529e+00; abs: 5.298e-03; rel: 3.453e-03; norm: 1.420e-01
## It: 114; obj: 1.521e+00; abs: 8.082e-03; rel: 5.286e-03; norm: 1.416e-01
## It: 115; obj: 1.523e+00; abs: 2.524e-03; rel: 1.660e-03; norm: 1.423e-01
## It: 116; obj: 1.531e+00; abs: 8.041e-03; rel: 5.279e-03; norm: 1.423e-01
## It: 117; obj: 1.540e+00; abs: 8.973e-03; rel: 5.860e-03; norm: 1.423e-01
## It: 118; obj: 1.525e+00; abs: 1.496e-02; rel: 9.712e-03; norm: 1.427e-01
## It: 119; obj: 1.530e+00; abs: 4.869e-03; rel: 3.192e-03; norm: 1.420e-01
## It: 120; obj: 1.550e+00; abs: 1.994e-02; rel: 1.303e-02; norm: 1.433e-01
## It: 121; obj: 1.539e+00; abs: 1.104e-02; rel: 7.119e-03; norm: 1.428e-01

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## It: 122; obj: 1.546e+00; abs: 7.146e-03; rel: 4.643e-03; norm: 1.440e-01
## It: 123; obj: 1.549e+00; abs: 3.061e-03; rel: 1.979e-03; norm: 1.433e-01
## It: 124; obj: 1.540e+00; abs: 9.505e-03; rel: 6.135e-03; norm: 1.422e-01
## It: 125; obj: 1.536e+00; abs: 3.870e-03; rel: 2.513e-03; norm: 1.425e-01
## It: 126; obj: 1.527e+00; abs: 9.091e-03; rel: 5.919e-03; norm: 1.419e-01
## It: 127; obj: 1.540e+00; abs: 1.263e-02; rel: 8.274e-03; norm: 1.418e-01
## It: 128; obj: 1.550e+00; abs: 1.097e-02; rel: 7.126e-03; norm: 1.424e-01
## It: 129; obj: 1.551e+00; abs: 3.276e-04; rel: 2.113e-04; norm: 1.426e-01
## It: 130; obj: 1.541e+00; abs: 1.004e-02; rel: 6.474e-03; norm: 1.424e-01
## It: 131; obj: 1.543e+00; abs: 1.887e-03; rel: 1.225e-03; norm: 1.427e-01
## It: 132; obj: 1.538e+00; abs: 5.001e-03; rel: 3.242e-03; norm: 1.427e-01
## It: 133; obj: 1.537e+00; abs: 1.792e-04; rel: 1.166e-04; norm: 1.423e-01
## It: 134; obj: 1.560e+00; abs: 2.235e-02; rel: 1.454e-02; norm: 1.437e-01
## It: 135; obj: 1.541e+00; abs: 1.850e-02; rel: 1.186e-02; norm: 1.429e-01
## It: 136; obj: 1.538e+00; abs: 2.876e-03; rel: 1.866e-03; norm: 1.419e-01
## It: 137; obj: 1.540e+00; abs: 1.663e-03; rel: 1.081e-03; norm: 1.427e-01
## It: 138; obj: 1.556e+00; abs: 1.595e-02; rel: 1.036e-02; norm: 1.439e-01
## It: 139; obj: 1.547e+00; abs: 9.375e-03; rel: 6.025e-03; norm: 1.426e-01
## It: 140; obj: 1.516e+00; abs: 3.025e-02; rel: 1.956e-02; norm: 1.429e-01
## It: 141; obj: 1.543e+00; abs: 2.639e-02; rel: 1.740e-02; norm: 1.426e-01
## It: 142; obj: 1.547e+00; abs: 4.270e-03; rel: 2.768e-03; norm: 1.436e-01
## It: 143; obj: 1.533e+00; abs: 1.423e-02; rel: 9.200e-03; norm: 1.427e-01
## It: 144; obj: 1.528e+00; abs: 4.976e-03; rel: 3.246e-03; norm: 1.425e-01
## It: 145; obj: 1.535e+00; abs: 7.314e-03; rel: 4.787e-03; norm: 1.429e-01
## It: 146; obj: 1.539e+00; abs: 3.783e-03; rel: 2.464e-03; norm: 1.428e-01
## It: 147; obj: 1.545e+00; abs: 5.795e-03; rel: 3.765e-03; norm: 1.436e-01
## It: 148; obj: 1.527e+00; abs: 1.751e-02; rel: 1.133e-02; norm: 1.435e-01
## It: 149; obj: 1.521e+00; abs: 6.327e-03; rel: 4.142e-03; norm: 1.426e-01
## It: 150; obj: 1.528e+00; abs: 6.910e-03; rel: 4.543e-03; norm: 1.431e-01
## It: 151; obj: 1.545e+00; abs: 1.687e-02; rel: 1.104e-02; norm: 1.429e-01
## It: 152; obj: 1.536e+00; abs: 9.127e-03; rel: 5.909e-03; norm: 1.429e-01
## It: 153; obj: 1.539e+00; abs: 3.721e-03; rel: 2.423e-03; norm: 1.438e-01
## It: 154; obj: 1.545e+00; abs: 5.531e-03; rel: 3.593e-03; norm: 1.431e-01
## It: 155; obj: 1.540e+00; abs: 4.607e-03; rel: 2.982e-03; norm: 1.426e-01
## It: 156; obj: 1.537e+00; abs: 3.616e-03; rel: 2.348e-03; norm: 1.430e-01
## It: 157; obj: 1.517e+00; abs: 1.959e-02; rel: 1.275e-02; norm: 1.422e-01
## It: 158; obj: 1.526e+00; abs: 9.281e-03; rel: 6.118e-03; norm: 1.428e-01
## It: 159; obj: 1.527e+00; abs: 9.996e-04; rel: 6.549e-04; norm: 1.424e-01
## It: 160; obj: 1.529e+00; abs: 1.377e-03; rel: 9.016e-04; norm: 1.424e-01
## It: 161; obj: 1.530e+00; abs: 9.080e-04; rel: 5.940e-04; norm: 1.425e-01
## It: 162; obj: 1.528e+00; abs: 1.587e-03; rel: 1.038e-03; norm: 1.431e-01
## It: 163; obj: 1.532e+00; abs: 3.749e-03; rel: 2.453e-03; norm: 1.427e-01
## It: 164; obj: 1.533e+00; abs: 1.653e-03; rel: 1.079e-03; norm: 1.428e-01
## It: 165; obj: 1.522e+00; abs: 1.095e-02; rel: 7.139e-03; norm: 1.426e-01
## It: 166; obj: 1.515e+00; abs: 7.817e-03; rel: 5.134e-03; norm: 1.422e-01
## It: 167; obj: 1.519e+00; abs: 4.335e-03; rel: 2.862e-03; norm: 1.414e-01
## It: 168; obj: 1.525e+00; abs: 6.274e-03; rel: 4.130e-03; norm: 1.428e-01
## It: 169; obj: 1.522e+00; abs: 2.779e-03; rel: 1.822e-03; norm: 1.427e-01
## It: 170; obj: 1.526e+00; abs: 3.584e-03; rel: 2.354e-03; norm: 1.421e-01
## It: 171; obj: 1.538e+00; abs: 1.228e-02; rel: 8.045e-03; norm: 1.426e-01
## It: 172; obj: 1.542e+00; abs: 4.012e-03; rel: 2.608e-03; norm: 1.428e-01
## It: 173; obj: 1.541e+00; abs: 1.503e-03; rel: 9.745e-04; norm: 1.424e-01
## It: 174; obj: 1.556e+00; abs: 1.537e-02; rel: 9.975e-03; norm: 1.437e-01

```

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## It: 175; obj: 1.540e+00; abs: 1.593e-02; rel: 1.024e-02; norm: 1.436e-01
## It: 176; obj: 1.535e+00; abs: 5.577e-03; rel: 3.621e-03; norm: 1.425e-01
## It: 177; obj: 1.531e+00; abs: 3.531e-03; rel: 2.301e-03; norm: 1.429e-01
## It: 178; obj: 1.520e+00; abs: 1.136e-02; rel: 7.417e-03; norm: 1.420e-01
## It: 179; obj: 1.540e+00; abs: 2.066e-02; rel: 1.359e-02; norm: 1.424e-01
## It: 180; obj: 1.538e+00; abs: 2.563e-03; rel: 1.664e-03; norm: 1.441e-01
## It: 181; obj: 1.519e+00; abs: 1.906e-02; rel: 1.240e-02; norm: 1.428e-01
## It: 182; obj: 1.534e+00; abs: 1.528e-02; rel: 1.006e-02; norm: 1.425e-01
## It: 183; obj: 1.541e+00; abs: 6.359e-03; rel: 4.145e-03; norm: 1.434e-01
## It: 184; obj: 1.525e+00; abs: 1.567e-02; rel: 1.017e-02; norm: 1.431e-01
## It: 185; obj: 1.540e+00; abs: 1.533e-02; rel: 1.005e-02; norm: 1.430e-01
## It: 186; obj: 1.538e+00; abs: 2.055e-03; rel: 1.334e-03; norm: 1.444e-01
## It: 187; obj: 1.533e+00; abs: 5.076e-03; rel: 3.300e-03; norm: 1.424e-01
## It: 188; obj: 1.556e+00; abs: 2.247e-02; rel: 1.466e-02; norm: 1.426e-01
## It: 189; obj: 1.538e+00; abs: 1.728e-02; rel: 1.111e-02; norm: 1.439e-01
## It: 190; obj: 1.518e+00; abs: 2.032e-02; rel: 1.321e-02; norm: 1.425e-01
## It: 191; obj: 1.543e+00; abs: 2.494e-02; rel: 1.643e-02; norm: 1.427e-01
## It: 192; obj: 1.538e+00; abs: 4.395e-03; rel: 2.848e-03; norm: 1.443e-01
## It: 193; obj: 1.519e+00; abs: 1.961e-02; rel: 1.275e-02; norm: 1.433e-01
## It: 194; obj: 1.526e+00; abs: 7.627e-03; rel: 5.022e-03; norm: 1.428e-01
## It: 195; obj: 1.529e+00; abs: 2.408e-03; rel: 1.578e-03; norm: 1.430e-01
## It: 196; obj: 1.531e+00; abs: 1.930e-03; rel: 1.263e-03; norm: 1.430e-01
## It: 197; obj: 1.536e+00; abs: 5.319e-03; rel: 3.475e-03; norm: 1.426e-01
## It: 198; obj: 1.538e+00; abs: 1.560e-03; rel: 1.016e-03; norm: 1.426e-01
## It: 199; obj: 1.525e+00; abs: 1.230e-02; rel: 7.999e-03; norm: 1.422e-01
## It: 200; obj: 1.526e+00; abs: 6.114e-04; rel: 4.008e-04; norm: 1.425e-01
## It: 201; obj: 1.524e+00; abs: 2.054e-03; rel: 1.346e-03; norm: 1.427e-01
## It: 202; obj: 1.518e+00; abs: 5.646e-03; rel: 3.705e-03; norm: 1.423e-01
## It: 203; obj: 1.514e+00; abs: 3.917e-03; rel: 2.580e-03; norm: 1.412e-01
## It: 204; obj: 1.501e+00; abs: 1.386e-02; rel: 9.153e-03; norm: 1.415e-01
## It: 205; obj: 1.503e+00; abs: 2.612e-03; rel: 1.741e-03; norm: 1.420e-01
## It: 206; obj: 1.511e+00; abs: 7.445e-03; rel: 4.953e-03; norm: 1.420e-01
## It: 207; obj: 1.517e+00; abs: 6.621e-03; rel: 4.383e-03; norm: 1.425e-01
## It: 208; obj: 1.523e+00; abs: 5.696e-03; rel: 3.754e-03; norm: 1.428e-01
## It: 209; obj: 1.514e+00; abs: 8.820e-03; rel: 5.792e-03; norm: 1.423e-01
## It: 210; obj: 1.512e+00; abs: 1.706e-03; rel: 1.127e-03; norm: 1.426e-01
## It: 211; obj: 1.503e+00; abs: 9.708e-03; rel: 6.419e-03; norm: 1.421e-01
## It: 212; obj: 1.504e+00; abs: 1.634e-03; rel: 1.087e-03; norm: 1.417e-01
## It: 213; obj: 1.517e+00; abs: 1.317e-02; rel: 8.753e-03; norm: 1.423e-01
## It: 214; obj: 1.507e+00; abs: 1.018e-02; rel: 6.711e-03; norm: 1.425e-01
## It: 215; obj: 1.493e+00; abs: 1.420e-02; rel: 9.418e-03; norm: 1.422e-01
## It: 216; obj: 1.490e+00; abs: 3.467e-03; rel: 2.322e-03; norm: 1.418e-01
## It: 217; obj: 1.501e+00; abs: 1.150e-02; rel: 7.722e-03; norm: 1.424e-01
## It: 218; obj: 1.492e+00; abs: 8.824e-03; rel: 5.878e-03; norm: 1.420e-01
## It: 219; obj: 1.497e+00; abs: 5.019e-03; rel: 3.363e-03; norm: 1.417e-01
## It: 220; obj: 1.508e+00; abs: 1.020e-02; rel: 6.813e-03; norm: 1.424e-01
## It: 221; obj: 1.489e+00; abs: 1.878e-02; rel: 1.246e-02; norm: 1.418e-01
## It: 222; obj: 1.483e+00; abs: 5.465e-03; rel: 3.671e-03; norm: 1.420e-01
## It: 223; obj: 1.496e+00; abs: 1.262e-02; rel: 8.510e-03; norm: 1.410e-01
## It: 224; obj: 1.502e+00; abs: 5.734e-03; rel: 3.833e-03; norm: 1.421e-01
## It: 225; obj: 1.507e+00; abs: 5.515e-03; rel: 3.673e-03; norm: 1.422e-01
## It: 226; obj: 1.504e+00; abs: 3.249e-03; rel: 2.156e-03; norm: 1.425e-01

```

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## It: 227; obj: 1.502e+00; abs: 2.182e-03; rel: 1.451e-03; norm: 1.420e-01
## It: 228; obj: 1.495e+00; abs: 7.193e-03; rel: 4.790e-03; norm: 1.426e-01
## It: 229; obj: 1.489e+00; abs: 5.719e-03; rel: 3.827e-03; norm: 1.417e-01
## It: 230; obj: 1.497e+00; abs: 7.948e-03; rel: 5.339e-03; norm: 1.419e-01
## It: 231; obj: 1.508e+00; abs: 1.112e-02; rel: 7.428e-03; norm: 1.423e-01
## It: 232; obj: 1.511e+00; abs: 3.145e-03; rel: 2.086e-03; norm: 1.423e-01
## It: 233; obj: 1.509e+00; abs: 2.068e-03; rel: 1.369e-03; norm: 1.423e-01
## It: 234; obj: 1.481e+00; abs: 2.748e-02; rel: 1.821e-02; norm: 1.420e-01
## It: 235; obj: 1.490e+00; abs: 8.440e-03; rel: 5.697e-03; norm: 1.413e-01
## It: 236; obj: 1.515e+00; abs: 2.489e-02; rel: 1.670e-02; norm: 1.420e-01
## It: 237; obj: 1.506e+00; abs: 8.706e-03; rel: 5.747e-03; norm: 1.425e-01
## It: 238; obj: 1.498e+00; abs: 8.194e-03; rel: 5.441e-03; norm: 1.420e-01
## It: 239; obj: 1.517e+00; abs: 1.881e-02; rel: 1.256e-02; norm: 1.425e-01
## It: 240; obj: 1.500e+00; abs: 1.658e-02; rel: 1.093e-02; norm: 1.425e-01
## It: 241; obj: 1.491e+00; abs: 9.350e-03; rel: 6.233e-03; norm: 1.419e-01
## It: 242; obj: 1.506e+00; abs: 1.561e-02; rel: 1.047e-02; norm: 1.416e-01
## It: 243; obj: 1.494e+00; abs: 1.227e-02; rel: 8.147e-03; norm: 1.420e-01
## It: 244; obj: 1.502e+00; abs: 7.398e-03; rel: 4.951e-03; norm: 1.420e-01
## It: 245; obj: 1.516e+00; abs: 1.454e-02; rel: 9.683e-03; norm: 1.422e-01
## It: 246; obj: 1.497e+00; abs: 1.875e-02; rel: 1.237e-02; norm: 1.418e-01
## It: 247; obj: 1.497e+00; abs: 6.434e-04; rel: 4.297e-04; norm: 1.416e-01
## It: 248; obj: 1.518e+00; abs: 2.141e-02; rel: 1.431e-02; norm: 1.422e-01
## It: 249; obj: 1.502e+00; abs: 1.602e-02; rel: 1.055e-02; norm: 1.423e-01
## It: 250; obj: 1.493e+00; abs: 8.595e-03; rel: 5.722e-03; norm: 1.418e-01

## It: 251; obj: 1.521e+00; abs: 2.739e-02; rel: 1.834e-02; norm: 1.417e-01
## It: 252; obj: 1.515e+00; abs: 5.891e-03; rel: 3.873e-03; norm: 1.427e-01
## It: 253; obj: 1.503e+00; abs: 1.216e-02; rel: 8.029e-03; norm: 1.413e-01
## It: 254; obj: 1.511e+00; abs: 8.448e-03; rel: 5.622e-03; norm: 1.408e-01
## It: 255; obj: 1.506e+00; abs: 5.646e-03; rel: 3.736e-03; norm: 1.419e-01
## It: 256; obj: 1.497e+00; abs: 8.499e-03; rel: 5.645e-03; norm: 1.410e-01
## It: 257; obj: 1.510e+00; abs: 1.271e-02; rel: 8.492e-03; norm: 1.415e-01
## It: 258; obj: 1.495e+00; abs: 1.436e-02; rel: 9.510e-03; norm: 1.411e-01
## It: 259; obj: 1.503e+00; abs: 7.997e-03; rel: 5.347e-03; norm: 1.404e-01
## It: 260; obj: 1.509e+00; abs: 5.435e-03; rel: 3.615e-03; norm: 1.412e-01
## It: 261; obj: 1.495e+00; abs: 1.412e-02; rel: 9.357e-03; norm: 1.412e-01
## It: 262; obj: 1.500e+00; abs: 5.532e-03; rel: 3.701e-03; norm: 1.417e-01
## It: 263; obj: 1.508e+00; abs: 7.205e-03; rel: 4.803e-03; norm: 1.413e-01
## It: 264; obj: 1.489e+00; abs: 1.801e-02; rel: 1.195e-02; norm: 1.405e-01
## It: 265; obj: 1.483e+00; abs: 6.049e-03; rel: 4.061e-03; norm: 1.399e-01
## It: 266; obj: 1.504e+00; abs: 2.054e-02; rel: 1.384e-02; norm: 1.410e-01
## It: 267; obj: 1.506e+00; abs: 2.221e-03; rel: 1.477e-03; norm: 1.414e-01
## It: 268; obj: 1.496e+00; abs: 1.056e-02; rel: 7.009e-03; norm: 1.414e-01
## It: 269; obj: 1.488e+00; abs: 7.620e-03; rel: 5.095e-03; norm: 1.416e-01
## It: 270; obj: 1.497e+00; abs: 8.782e-03; rel: 5.902e-03; norm: 1.415e-01
## It: 271; obj: 1.492e+00; abs: 4.515e-03; rel: 3.017e-03; norm: 1.401e-01
## It: 272; obj: 1.485e+00; abs: 7.142e-03; rel: 4.786e-03; norm: 1.410e-01
## It: 273; obj: 1.489e+00; abs: 4.013e-03; rel: 2.702e-03; norm: 1.415e-01
## It: 274; obj: 1.486e+00; abs: 2.710e-03; rel: 1.820e-03; norm: 1.413e-01
## It: 275; obj: 1.484e+00; abs: 2.699e-03; rel: 1.815e-03; norm: 1.409e-01

## It: 276; obj: 1.488e+00; abs: 4.023e-03; rel: 2.712e-03; norm: 1.403e-01
## It: 277; obj: 1.490e+00; abs: 2.569e-03; rel: 1.727e-03; norm: 1.419e-01
## It: 278; obj: 1.488e+00; abs: 2.047e-03; rel: 1.374e-03; norm: 1.421e-01
## It: 279; obj: 1.497e+00; abs: 9.137e-03; rel: 6.139e-03; norm: 1.409e-01

```

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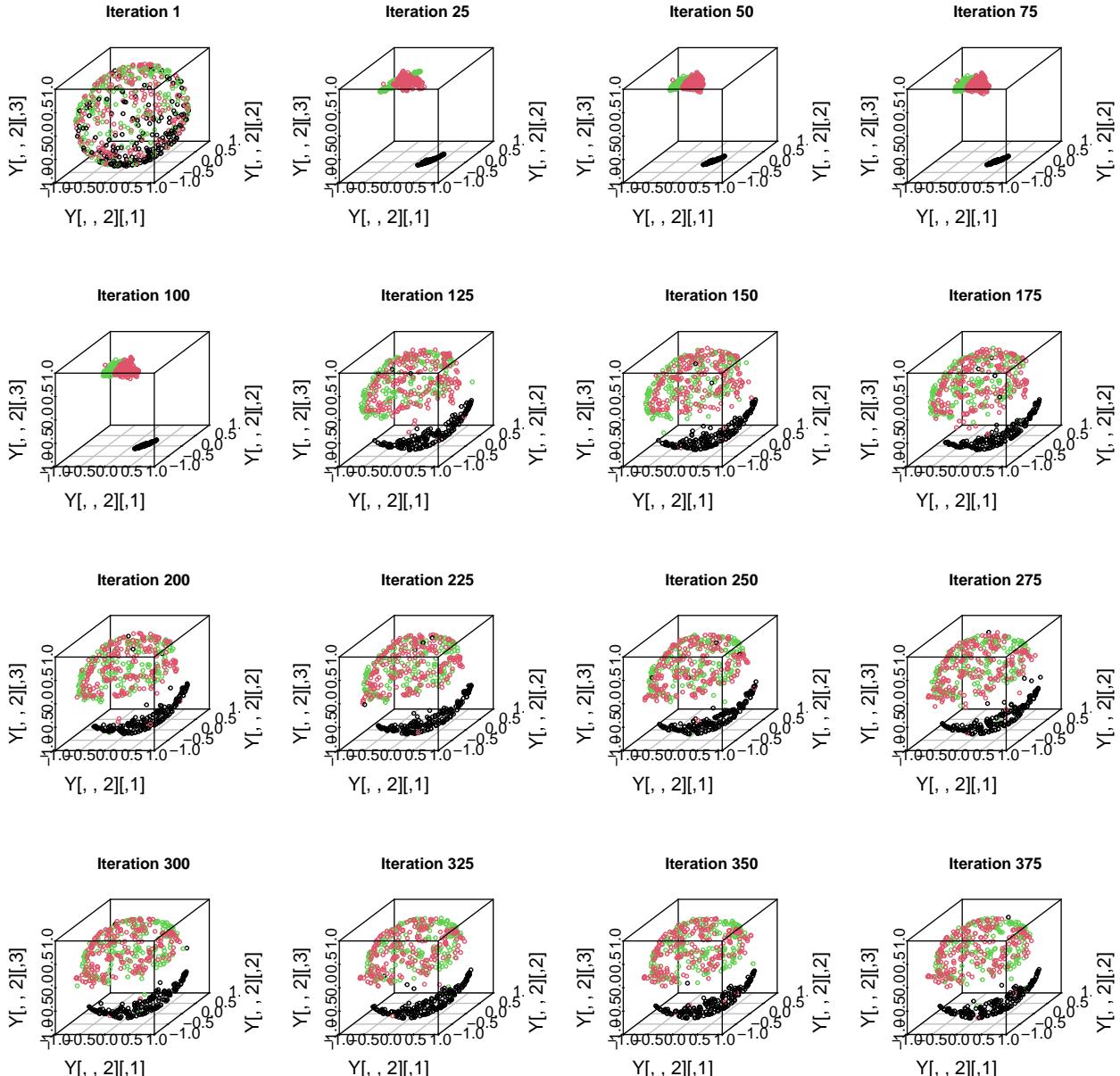
## It: 280; obj: 1.481e+00; abs: 1.684e-02; rel: 1.125e-02; norm: 1.413e-01
## It: 281; obj: 1.472e+00; abs: 8.472e-03; rel: 5.722e-03; norm: 1.401e-01
## It: 282; obj: 1.485e+00; abs: 1.299e-02; rel: 8.827e-03; norm: 1.403e-01
## It: 283; obj: 1.486e+00; abs: 1.022e-03; rel: 6.879e-04; norm: 1.413e-01
## It: 284; obj: 1.482e+00; abs: 4.045e-03; rel: 2.722e-03; norm: 1.408e-01
## It: 285; obj: 1.488e+00; abs: 6.095e-03; rel: 4.113e-03; norm: 1.410e-01
## It: 286; obj: 1.478e+00; abs: 1.048e-02; rel: 7.041e-03; norm: 1.417e-01
## It: 287; obj: 1.478e+00; abs: 1.858e-04; rel: 1.258e-04; norm: 1.422e-01
## It: 288; obj: 1.483e+00; abs: 4.640e-03; rel: 3.139e-03; norm: 1.412e-01
## It: 289; obj: 1.479e+00; abs: 3.455e-03; rel: 2.330e-03; norm: 1.406e-01
## It: 290; obj: 1.476e+00; abs: 3.418e-03; rel: 2.311e-03; norm: 1.408e-01
## It: 291; obj: 1.480e+00; abs: 4.172e-03; rel: 2.827e-03; norm: 1.409e-01
## It: 292; obj: 1.473e+00; abs: 7.161e-03; rel: 4.839e-03; norm: 1.415e-01
## It: 293; obj: 1.476e+00; abs: 3.018e-03; rel: 2.049e-03; norm: 1.417e-01
## It: 294; obj: 1.469e+00; abs: 6.593e-03; rel: 4.468e-03; norm: 1.411e-01
## It: 295; obj: 1.478e+00; abs: 9.252e-03; rel: 6.298e-03; norm: 1.408e-01
## It: 296; obj: 1.475e+00; abs: 3.727e-03; rel: 2.521e-03; norm: 1.404e-01
## It: 297; obj: 1.456e+00; abs: 1.831e-02; rel: 1.242e-02; norm: 1.405e-01
## It: 298; obj: 1.458e+00; abs: 1.200e-03; rel: 8.238e-04; norm: 1.403e-01
## It: 299; obj: 1.471e+00; abs: 1.381e-02; rel: 9.478e-03; norm: 1.408e-01
## It: 300; obj: 1.480e+00; abs: 8.914e-03; rel: 6.058e-03; norm: 1.402e-01
## It: 301; obj: 1.483e+00; abs: 3.122e-03; rel: 2.109e-03; norm: 1.411e-01
## It: 302; obj: 1.482e+00; abs: 1.542e-03; rel: 1.039e-03; norm: 1.408e-01
## It: 303; obj: 1.465e+00; abs: 1.694e-02; rel: 1.143e-02; norm: 1.405e-01
## It: 304; obj: 1.462e+00; abs: 3.295e-03; rel: 2.249e-03; norm: 1.408e-01
## It: 305; obj: 1.478e+00; abs: 1.607e-02; rel: 1.099e-02; norm: 1.408e-01
## It: 306; obj: 1.475e+00; abs: 3.051e-03; rel: 2.065e-03; norm: 1.403e-01
## It: 307; obj: 1.467e+00; abs: 8.098e-03; rel: 5.492e-03; norm: 1.415e-01
## It: 308; obj: 1.462e+00; abs: 4.142e-03; rel: 2.825e-03; norm: 1.409e-01
## It: 309; obj: 1.460e+00; abs: 2.029e-03; rel: 1.388e-03; norm: 1.398e-01
## It: 310; obj: 1.477e+00; abs: 1.645e-02; rel: 1.126e-02; norm: 1.403e-01
## It: 311; obj: 1.475e+00; abs: 2.259e-03; rel: 1.530e-03; norm: 1.406e-01
## It: 312; obj: 1.476e+00; abs: 1.359e-03; rel: 9.218e-04; norm: 1.405e-01
## It: 313; obj: 1.485e+00; abs: 8.678e-03; rel: 5.880e-03; norm: 1.409e-01
## It: 314; obj: 1.471e+00; abs: 1.320e-02; rel: 8.893e-03; norm: 1.403e-01
## It: 315; obj: 1.472e+00; abs: 1.700e-04; rel: 1.156e-04; norm: 1.403e-01
## It: 316; obj: 1.476e+00; abs: 4.224e-03; rel: 2.871e-03; norm: 1.406e-01
## It: 317; obj: 1.464e+00; abs: 1.167e-02; rel: 7.904e-03; norm: 1.408e-01
## It: 318; obj: 1.465e+00; abs: 7.586e-04; rel: 5.181e-04; norm: 1.400e-01
## It: 319; obj: 1.471e+00; abs: 6.311e-03; rel: 4.308e-03; norm: 1.404e-01
## It: 320; obj: 1.476e+00; abs: 5.123e-03; rel: 3.483e-03; norm: 1.403e-01
## It: 321; obj: 1.468e+00; abs: 8.599e-03; rel: 5.825e-03; norm: 1.399e-01
## It: 322; obj: 1.472e+00; abs: 4.376e-03; rel: 2.981e-03; norm: 1.403e-01
## It: 323; obj: 1.477e+00; abs: 5.038e-03; rel: 3.422e-03; norm: 1.408e-01
## It: 324; obj: 1.477e+00; abs: 3.091e-04; rel: 2.092e-04; norm: 1.399e-01
## It: 325; obj: 1.479e+00; abs: 1.363e-03; rel: 9.226e-04; norm: 1.406e-01
## It: 326; obj: 1.471e+00; abs: 8.194e-03; rel: 5.541e-03; norm: 1.416e-01
## It: 327; obj: 1.475e+00; abs: 4.638e-03; rel: 3.154e-03; norm: 1.396e-01
## It: 328; obj: 1.480e+00; abs: 4.851e-03; rel: 3.289e-03; norm: 1.406e-01
## It: 329; obj: 1.470e+00; abs: 1.002e-02; rel: 6.770e-03; norm: 1.406e-01
## It: 330; obj: 1.472e+00; abs: 1.915e-03; rel: 1.303e-03; norm: 1.398e-01
## It: 331; obj: 1.471e+00; abs: 6.057e-04; rel: 4.115e-04; norm: 1.401e-01
## It: 332; obj: 1.472e+00; abs: 4.423e-04; rel: 3.006e-04; norm: 1.407e-01

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## It: 333; obj: 1.480e+00; abs: 7.871e-03; rel: 5.348e-03; norm: 1.402e-01
## It: 334; obj: 1.477e+00; abs: 2.977e-03; rel: 2.012e-03; norm: 1.408e-01
## It: 335; obj: 1.471e+00; abs: 5.857e-03; rel: 3.966e-03; norm: 1.408e-01
## It: 336; obj: 1.466e+00; abs: 4.926e-03; rel: 3.349e-03; norm: 1.401e-01
## It: 337; obj: 1.470e+00; abs: 4.490e-03; rel: 3.063e-03; norm: 1.403e-01
## It: 338; obj: 1.458e+00; abs: 1.189e-02; rel: 8.089e-03; norm: 1.405e-01
## It: 339; obj: 1.464e+00; abs: 5.655e-03; rel: 3.877e-03; norm: 1.403e-01
## It: 340; obj: 1.478e+00; abs: 1.360e-02; rel: 9.285e-03; norm: 1.415e-01
## It: 341; obj: 1.473e+00; abs: 4.805e-03; rel: 3.251e-03; norm: 1.403e-01
## It: 342; obj: 1.466e+00; abs: 6.627e-03; rel: 4.499e-03; norm: 1.393e-01
## It: 343; obj: 1.454e+00; abs: 1.203e-02; rel: 8.201e-03; norm: 1.409e-01
## It: 344; obj: 1.467e+00; abs: 1.257e-02; rel: 8.640e-03; norm: 1.408e-01
## It: 345; obj: 1.485e+00; abs: 1.847e-02; rel: 1.259e-02; norm: 1.403e-01
## It: 346; obj: 1.485e+00; abs: 6.772e-04; rel: 4.559e-04; norm: 1.409e-01
## It: 347; obj: 1.471e+00; abs: 1.404e-02; rel: 9.456e-03; norm: 1.418e-01
## It: 348; obj: 1.472e+00; abs: 1.532e-03; rel: 1.042e-03; norm: 1.403e-01
## It: 349; obj: 1.476e+00; abs: 3.420e-03; rel: 2.323e-03; norm: 1.417e-01
## It: 350; obj: 1.474e+00; abs: 1.250e-03; rel: 8.474e-04; norm: 1.413e-01
## It: 351; obj: 1.479e+00; abs: 4.396e-03; rel: 2.982e-03; norm: 1.398e-01
## It: 352; obj: 1.482e+00; abs: 3.706e-03; rel: 2.506e-03; norm: 1.415e-01
## It: 353; obj: 1.480e+00; abs: 2.617e-03; rel: 1.765e-03; norm: 1.420e-01
## It: 354; obj: 1.462e+00; abs: 1.730e-02; rel: 1.169e-02; norm: 1.401e-01
## It: 355; obj: 1.473e+00; abs: 1.021e-02; rel: 6.984e-03; norm: 1.408e-01
## It: 356; obj: 1.485e+00; abs: 1.193e-02; rel: 8.100e-03; norm: 1.412e-01
## It: 357; obj: 1.474e+00; abs: 1.038e-02; rel: 6.989e-03; norm: 1.404e-01
## It: 358; obj: 1.472e+00; abs: 2.562e-03; rel: 1.738e-03; norm: 1.417e-01
## It: 359; obj: 1.484e+00; abs: 1.180e-02; rel: 8.021e-03; norm: 1.411e-01
## It: 360; obj: 1.473e+00; abs: 1.042e-02; rel: 7.024e-03; norm: 1.407e-01
## It: 361; obj: 1.469e+00; abs: 3.856e-03; rel: 2.617e-03; norm: 1.411e-01
## It: 362; obj: 1.481e+00; abs: 1.187e-02; rel: 8.082e-03; norm: 1.409e-01
## It: 363; obj: 1.486e+00; abs: 5.043e-03; rel: 3.405e-03; norm: 1.411e-01
## It: 364; obj: 1.481e+00; abs: 4.826e-03; rel: 3.247e-03; norm: 1.405e-01
## It: 365; obj: 1.471e+00; abs: 1.064e-02; rel: 7.184e-03; norm: 1.412e-01
## It: 366; obj: 1.479e+00; abs: 8.289e-03; rel: 5.636e-03; norm: 1.409e-01
## It: 367; obj: 1.497e+00; abs: 1.767e-02; rel: 1.195e-02; norm: 1.416e-01
## It: 368; obj: 1.485e+00; abs: 1.207e-02; rel: 8.066e-03; norm: 1.405e-01
## It: 369; obj: 1.462e+00; abs: 2.256e-02; rel: 1.520e-02; norm: 1.403e-01
## It: 370; obj: 1.477e+00; abs: 1.495e-02; rel: 1.022e-02; norm: 1.416e-01
## It: 371; obj: 1.482e+00; abs: 4.920e-03; rel: 3.331e-03; norm: 1.416e-01
## It: 372; obj: 1.476e+00; abs: 5.878e-03; rel: 3.967e-03; norm: 1.396e-01
## It: 373; obj: 1.481e+00; abs: 5.203e-03; rel: 3.525e-03; norm: 1.393e-01
## It: 374; obj: 1.474e+00; abs: 6.698e-03; rel: 4.522e-03; norm: 1.419e-01
## It: 375; obj: 1.476e+00; abs: 1.620e-03; rel: 1.099e-03; norm: 1.406e-01

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## It: 376; obj: 1.489e+00; abs: 1.307e-02; rel: 8.855e-03; norm: 1.401e-01
## It: 377; obj: 1.468e+00; abs: 2.084e-02; rel: 1.400e-02; norm: 1.404e-01
## It: 378; obj: 1.461e+00; abs: 7.072e-03; rel: 4.817e-03; norm: 1.407e-01
## It: 379; obj: 1.472e+00; abs: 1.110e-02; rel: 7.593e-03; norm: 1.401e-01
## It: 380; obj: 1.470e+00; abs: 2.477e-03; rel: 1.682e-03; norm: 1.411e-01
## It: 381; obj: 1.470e+00; abs: 6.391e-06; rel: 4.348e-06; norm: 1.403e-01
## It: 382; obj: 1.475e+00; abs: 4.886e-03; rel: 3.324e-03; norm: 1.406e-01
## It: 383; obj: 1.487e+00; abs: 1.198e-02; rel: 8.121e-03; norm: 1.415e-01
## It: 384; obj: 1.477e+00; abs: 9.925e-03; rel: 6.676e-03; norm: 1.408e-01
## It: 385; obj: 1.473e+00; abs: 4.183e-03; rel: 2.833e-03; norm: 1.407e-01
## It: 386; obj: 1.475e+00; abs: 2.689e-03; rel: 1.826e-03; norm: 1.417e-01
## It: 387; obj: 1.469e+00; abs: 6.132e-03; rel: 4.156e-03; norm: 1.414e-01
## It: 388; obj: 1.477e+00; abs: 7.632e-03; rel: 5.195e-03; norm: 1.396e-01
## It: 389; obj: 1.481e+00; abs: 4.331e-03; rel: 2.933e-03; norm: 1.410e-01
## It: 390; obj: 1.483e+00; abs: 1.422e-03; rel: 9.600e-04; norm: 1.408e-01

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## It: 391; obj: 1.470e+00; abs: 1.295e-02; rel: 8.732e-03; norm: 1.401e-01
## It: 392; obj: 1.469e+00; abs: 9.723e-04; rel: 6.616e-04; norm: 1.403e-01
## It: 393; obj: 1.488e+00; abs: 1.914e-02; rel: 1.303e-02; norm: 1.405e-01
## It: 394; obj: 1.484e+00; abs: 4.254e-03; rel: 2.859e-03; norm: 1.409e-01
## It: 395; obj: 1.476e+00; abs: 7.225e-03; rel: 4.870e-03; norm: 1.416e-01
## It: 396; obj: 1.475e+00; abs: 1.682e-03; rel: 1.140e-03; norm: 1.405e-01
## It: 397; obj: 1.476e+00; abs: 1.107e-03; rel: 7.505e-04; norm: 1.399e-01
## It: 398; obj: 1.480e+00; abs: 4.373e-03; rel: 2.963e-03; norm: 1.407e-01
## It: 399; obj: 1.478e+00; abs: 2.478e-03; rel: 1.674e-03; norm: 1.410e-01
## It: 400; obj: 1.468e+00; abs: 9.506e-03; rel: 6.433e-03; norm: 1.396e-01
## It: 401; obj: 1.477e+00; abs: 8.780e-03; rel: 5.980e-03; norm: 1.403e-01
## It: 402; obj: 1.475e+00; abs: 1.760e-03; rel: 1.191e-03; norm: 1.406e-01
## It: 403; obj: 1.461e+00; abs: 1.425e-02; rel: 9.657e-03; norm: 1.405e-01
## It: 404; obj: 1.469e+00; abs: 8.474e-03; rel: 5.800e-03; norm: 1.405e-01
## It: 405; obj: 1.487e+00; abs: 1.789e-02; rel: 1.218e-02; norm: 1.405e-01
## It: 406; obj: 1.477e+00; abs: 1.069e-02; rel: 7.188e-03; norm: 1.396e-01
## It: 407; obj: 1.485e+00; abs: 8.837e-03; rel: 5.985e-03; norm: 1.414e-01
## It: 408; obj: 1.498e+00; abs: 1.214e-02; rel: 8.176e-03; norm: 1.412e-01
## It: 409; obj: 1.486e+00; abs: 1.112e-02; rel: 7.424e-03; norm: 1.404e-01
## It: 410; obj: 1.473e+00; abs: 1.321e-02; rel: 8.885e-03; norm: 1.406e-01
## It: 411; obj: 1.488e+00; abs: 1.476e-02; rel: 1.002e-02; norm: 1.420e-01
## It: 412; obj: 1.479e+00; abs: 8.619e-03; rel: 5.792e-03; norm: 1.408e-01
## It: 413; obj: 1.473e+00; abs: 6.349e-03; rel: 4.292e-03; norm: 1.408e-01
## It: 414; obj: 1.483e+00; abs: 9.565e-03; rel: 6.493e-03; norm: 1.418e-01
## It: 415; obj: 1.467e+00; abs: 1.533e-02; rel: 1.034e-02; norm: 1.401e-01
## It: 416; obj: 1.475e+00; abs: 7.345e-03; rel: 5.006e-03; norm: 1.401e-01
## It: 417; obj: 1.488e+00; abs: 1.329e-02; rel: 9.013e-03; norm: 1.430e-01
## It: 418; obj: 1.466e+00; abs: 2.208e-02; rel: 1.484e-02; norm: 1.405e-01
## It: 419; obj: 1.474e+00; abs: 7.771e-03; rel: 5.302e-03; norm: 1.398e-01
## It: 420; obj: 1.488e+00; abs: 1.398e-02; rel: 9.489e-03; norm: 1.419e-01
## It: 421; obj: 1.486e+00; abs: 1.752e-03; rel: 1.178e-03; norm: 1.401e-01
## It: 422; obj: 1.476e+00; abs: 1.023e-02; rel: 6.884e-03; norm: 1.403e-01
## It: 423; obj: 1.474e+00; abs: 1.428e-03; rel: 9.675e-04; norm: 1.403e-01
## It: 424; obj: 1.470e+00; abs: 4.515e-03; rel: 3.063e-03; norm: 1.406e-01
## It: 425; obj: 1.482e+00; abs: 1.274e-02; rel: 8.672e-03; norm: 1.404e-01
## It: 426; obj: 1.478e+00; abs: 4.505e-03; rel: 3.039e-03; norm: 1.413e-01
## It: 427; obj: 1.465e+00; abs: 1.282e-02; rel: 8.677e-03; norm: 1.409e-01
## It: 428; obj: 1.470e+00; abs: 5.198e-03; rel: 3.548e-03; norm: 1.407e-01
## It: 429; obj: 1.474e+00; abs: 3.927e-03; rel: 2.671e-03; norm: 1.416e-01
## It: 430; obj: 1.471e+00; abs: 2.902e-03; rel: 1.968e-03; norm: 1.405e-01
## It: 431; obj: 1.469e+00; abs: 2.408e-03; rel: 1.637e-03; norm: 1.413e-01
## It: 432; obj: 1.468e+00; abs: 1.248e-03; rel: 8.498e-04; norm: 1.415e-01
## It: 433; obj: 1.486e+00; abs: 1.802e-02; rel: 1.228e-02; norm: 1.410e-01
## It: 434; obj: 1.479e+00; abs: 6.535e-03; rel: 4.399e-03; norm: 1.407e-01
## It: 435; obj: 1.473e+00; abs: 6.589e-03; rel: 4.454e-03; norm: 1.419e-01
## It: 436; obj: 1.481e+00; abs: 8.609e-03; rel: 5.847e-03; norm: 1.407e-01
## It: 437; obj: 1.497e+00; abs: 1.570e-02; rel: 1.060e-02; norm: 1.408e-01
## It: 438; obj: 1.485e+00; abs: 1.179e-02; rel: 7.876e-03; norm: 1.417e-01
## It: 439; obj: 1.470e+00; abs: 1.525e-02; rel: 1.027e-02; norm: 1.411e-01
## It: 440; obj: 1.470e+00; abs: 3.326e-04; rel: 2.263e-04; norm: 1.406e-01
## It: 441; obj: 1.483e+00; abs: 1.305e-02; rel: 8.879e-03; norm: 1.400e-01
## It: 442; obj: 1.480e+00; abs: 2.818e-03; rel: 1.900e-03; norm: 1.402e-01
## It: 443; obj: 1.472e+00; abs: 8.842e-03; rel: 5.973e-03; norm: 1.403e-01

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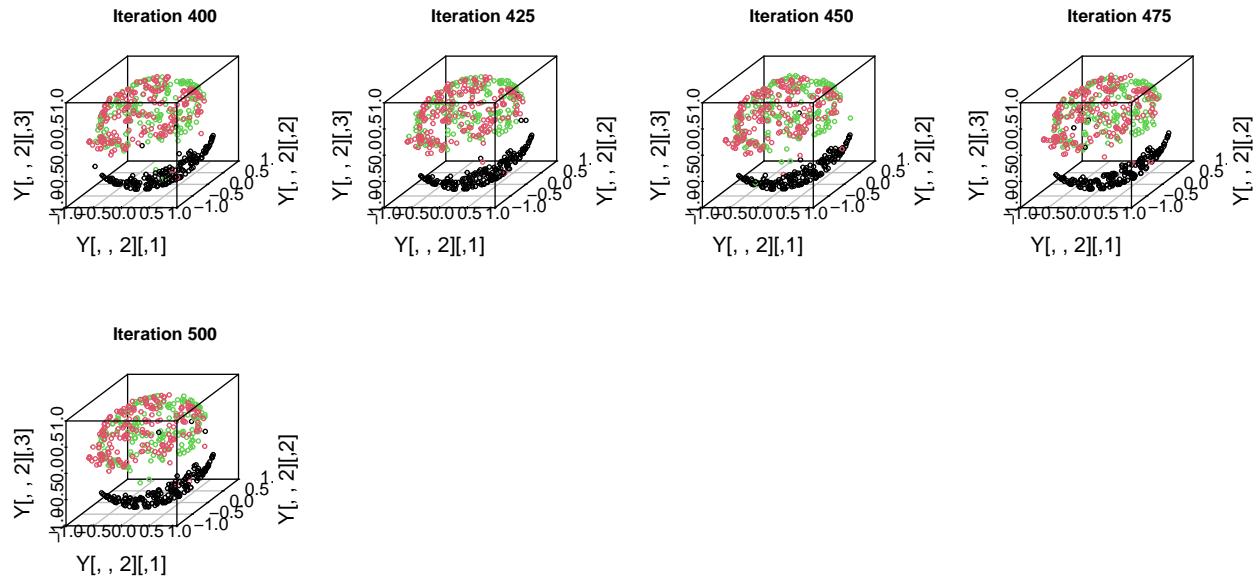
## It: 444; obj: 1.467e+00; abs: 4.522e-03; rel: 3.073e-03; norm: 1.402e-01
## It: 445; obj: 1.469e+00; abs: 1.627e-03; rel: 1.109e-03; norm: 1.399e-01
## It: 446; obj: 1.457e+00; abs: 1.117e-02; rel: 7.608e-03; norm: 1.405e-01
## It: 447; obj: 1.467e+00; abs: 9.953e-03; rel: 6.829e-03; norm: 1.413e-01
## It: 448; obj: 1.474e+00; abs: 6.667e-03; rel: 4.543e-03; norm: 1.407e-01
## It: 449; obj: 1.479e+00; abs: 5.023e-03; rel: 3.407e-03; norm: 1.413e-01
## It: 450; obj: 1.479e+00; abs: 3.292e-04; rel: 2.225e-04; norm: 1.414e-01
## It: 451; obj: 1.472e+00; abs: 6.322e-03; rel: 4.275e-03; norm: 1.394e-01
## It: 452; obj: 1.472e+00; abs: 6.616e-04; rel: 4.493e-04; norm: 1.397e-01
## It: 453; obj: 1.482e+00; abs: 1.014e-02; rel: 6.888e-03; norm: 1.417e-01
## It: 454; obj: 1.479e+00; abs: 3.353e-03; rel: 2.262e-03; norm: 1.404e-01
## It: 455; obj: 1.476e+00; abs: 2.786e-03; rel: 1.884e-03; norm: 1.398e-01
## It: 456; obj: 1.472e+00; abs: 3.592e-03; rel: 2.434e-03; norm: 1.417e-01
## It: 457; obj: 1.464e+00; abs: 8.362e-03; rel: 5.680e-03; norm: 1.408e-01
## It: 458; obj: 1.461e+00; abs: 2.438e-03; rel: 1.666e-03; norm: 1.396e-01
## It: 459; obj: 1.468e+00; abs: 6.723e-03; rel: 4.600e-03; norm: 1.403e-01
## It: 460; obj: 1.460e+00; abs: 8.299e-03; rel: 5.653e-03; norm: 1.401e-01
## It: 461; obj: 1.461e+00; abs: 7.202e-04; rel: 4.933e-04; norm: 1.391e-01
## It: 462; obj: 1.464e+00; abs: 3.263e-03; rel: 2.234e-03; norm: 1.410e-01
## It: 463; obj: 1.462e+00; abs: 1.620e-03; rel: 1.106e-03; norm: 1.404e-01
## It: 464; obj: 1.463e+00; abs: 1.043e-03; rel: 7.134e-04; norm: 1.410e-01
## It: 465; obj: 1.479e+00; abs: 1.584e-02; rel: 1.083e-02; norm: 1.408e-01
## It: 466; obj: 1.475e+00; abs: 4.115e-03; rel: 2.782e-03; norm: 1.404e-01
## It: 467; obj: 1.463e+00; abs: 1.190e-02; rel: 8.069e-03; norm: 1.409e-01
## It: 468; obj: 1.465e+00; abs: 2.034e-03; rel: 1.390e-03; norm: 1.410e-01
## It: 469; obj: 1.479e+00; abs: 1.390e-02; rel: 9.489e-03; norm: 1.400e-01
## It: 470; obj: 1.481e+00; abs: 2.134e-03; rel: 1.443e-03; norm: 1.407e-01
## It: 471; obj: 1.478e+00; abs: 3.142e-03; rel: 2.121e-03; norm: 1.418e-01
## It: 472; obj: 1.481e+00; abs: 3.497e-03; rel: 2.366e-03; norm: 1.406e-01
## It: 473; obj: 1.481e+00; abs: 7.692e-04; rel: 5.192e-04; norm: 1.403e-01
## It: 474; obj: 1.480e+00; abs: 6.308e-04; rel: 4.260e-04; norm: 1.412e-01
## It: 475; obj: 1.477e+00; abs: 2.991e-03; rel: 2.021e-03; norm: 1.410e-01
## It: 476; obj: 1.471e+00; abs: 5.959e-03; rel: 4.034e-03; norm: 1.411e-01
## It: 477; obj: 1.476e+00; abs: 5.182e-03; rel: 3.523e-03; norm: 1.412e-01
## It: 478; obj: 1.482e+00; abs: 6.171e-03; rel: 4.180e-03; norm: 1.406e-01
## It: 479; obj: 1.481e+00; abs: 1.766e-03; rel: 1.191e-03; norm: 1.410e-01
## It: 480; obj: 1.480e+00; abs: 9.919e-04; rel: 6.699e-04; norm: 1.414e-01
## It: 481; obj: 1.477e+00; abs: 2.976e-03; rel: 2.011e-03; norm: 1.408e-01
## It: 482; obj: 1.471e+00; abs: 6.173e-03; rel: 4.180e-03; norm: 1.402e-01
## It: 483; obj: 1.473e+00; abs: 2.571e-03; rel: 1.748e-03; norm: 1.409e-01
## It: 484; obj: 1.482e+00; abs: 9.278e-03; rel: 6.298e-03; norm: 1.414e-01
## It: 485; obj: 1.488e+00; abs: 5.787e-03; rel: 3.903e-03; norm: 1.413e-01
## It: 486; obj: 1.483e+00; abs: 5.592e-03; rel: 3.757e-03; norm: 1.421e-01
## It: 487; obj: 1.465e+00; abs: 1.770e-02; rel: 1.194e-02; norm: 1.415e-01
## It: 488; obj: 1.474e+00; abs: 8.653e-03; rel: 5.907e-03; norm: 1.405e-01
## It: 489; obj: 1.480e+00; abs: 6.666e-03; rel: 4.524e-03; norm: 1.406e-01
## It: 490; obj: 1.474e+00; abs: 6.060e-03; rel: 4.094e-03; norm: 1.403e-01
## It: 491; obj: 1.474e+00; abs: 4.427e-04; rel: 3.003e-04; norm: 1.402e-01
## It: 492; obj: 1.482e+00; abs: 8.542e-03; rel: 5.796e-03; norm: 1.407e-01
## It: 493; obj: 1.488e+00; abs: 5.434e-03; rel: 3.666e-03; norm: 1.410e-01
## It: 494; obj: 1.466e+00; abs: 2.205e-02; rel: 1.482e-02; norm: 1.398e-01
## It: 495; obj: 1.468e+00; abs: 1.909e-03; rel: 1.302e-03; norm: 1.409e-01
## It: 496; obj: 1.473e+00; abs: 5.270e-03; rel: 3.591e-03; norm: 1.409e-01

```

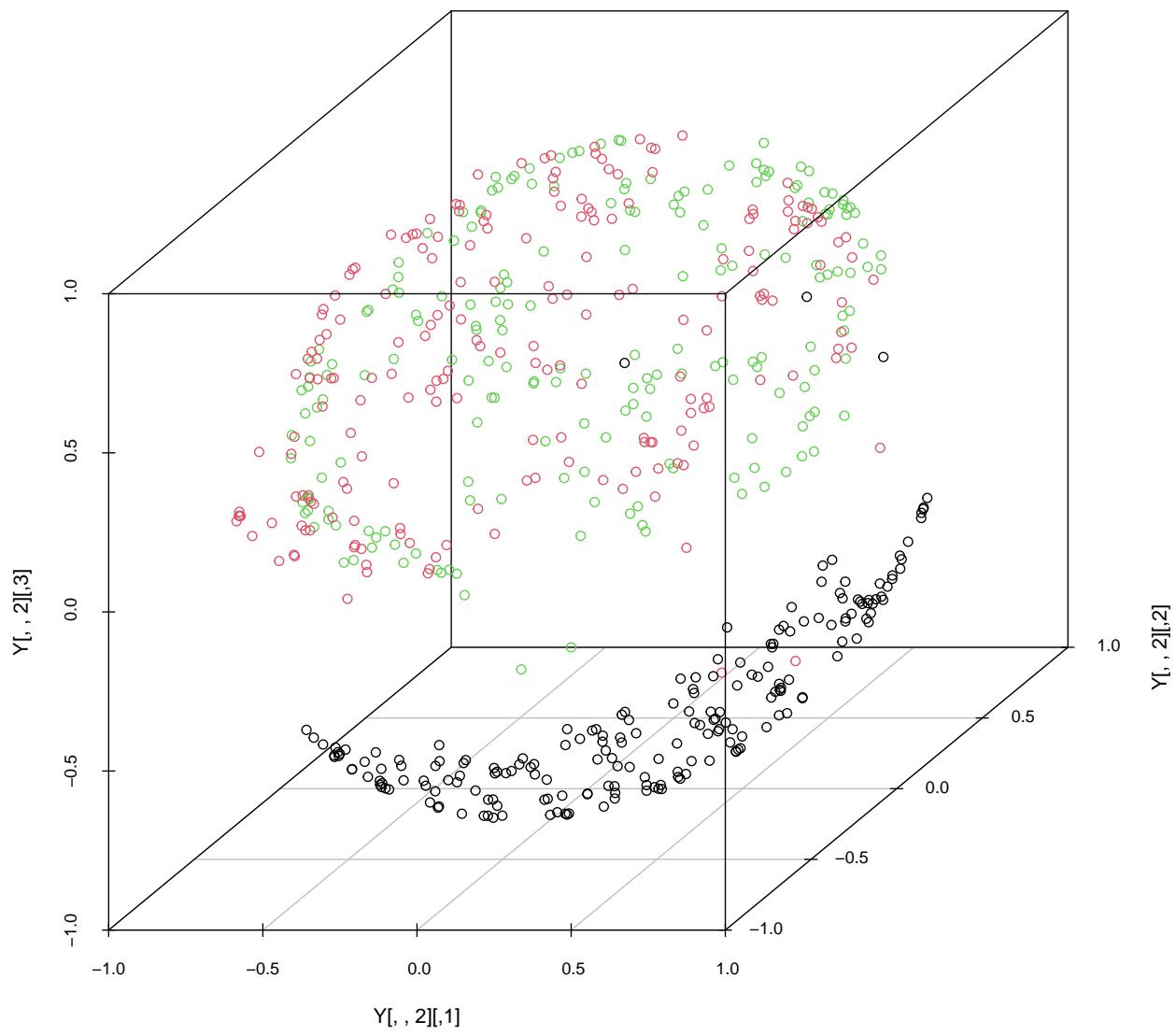
```

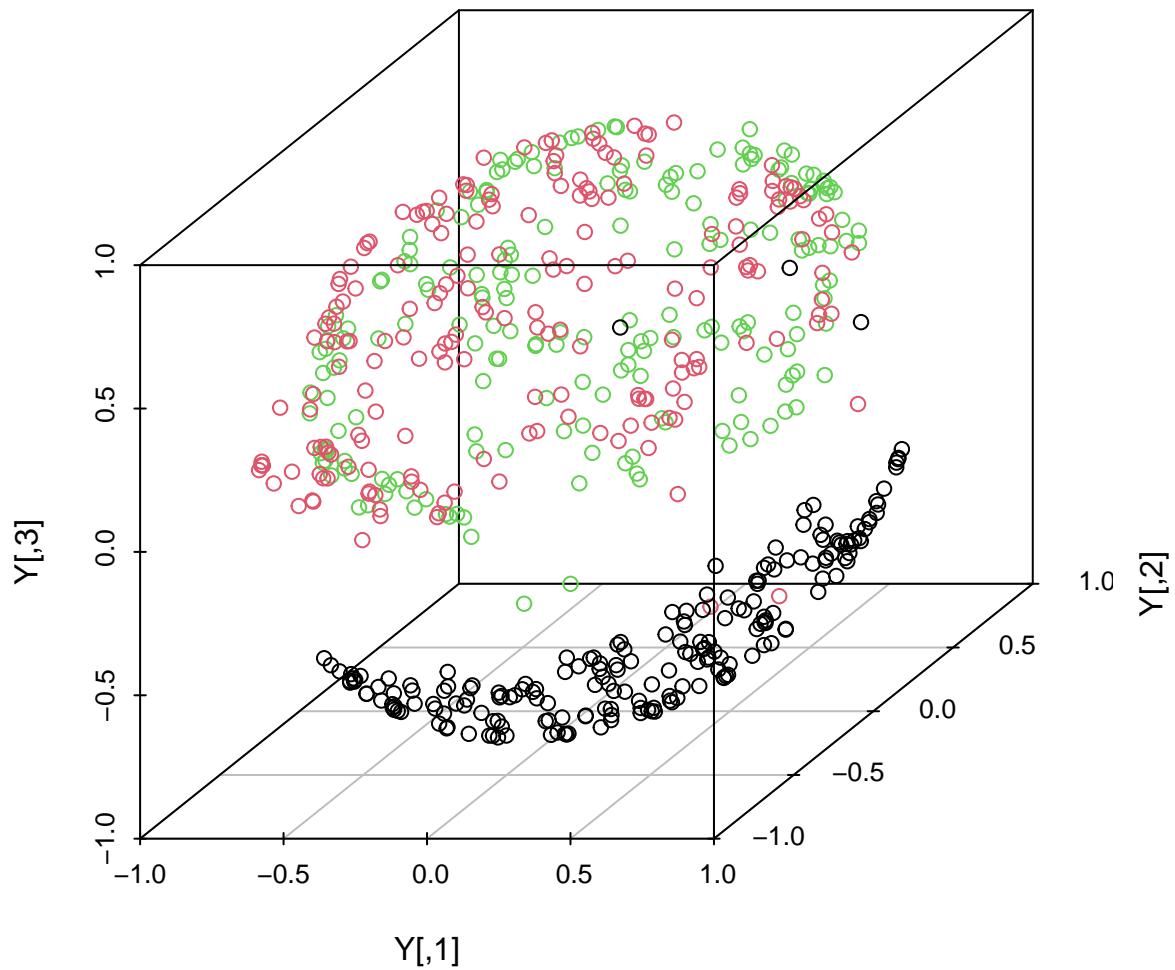
## It: 497; obj: 1.481e+00; abs: 8.377e-03; rel: 5.688e-03; norm: 1.397e-01
## It: 498; obj: 1.492e+00; abs: 1.043e-02; rel: 7.041e-03; norm: 1.410e-01
## It: 499; obj: 1.475e+00; abs: 1.653e-02; rel: 1.108e-02; norm: 1.420e-01
## It: 500; obj: 1.473e+00; abs: 1.639e-03; rel: 1.111e-03; norm: 1.398e-01

```



Iteration 500



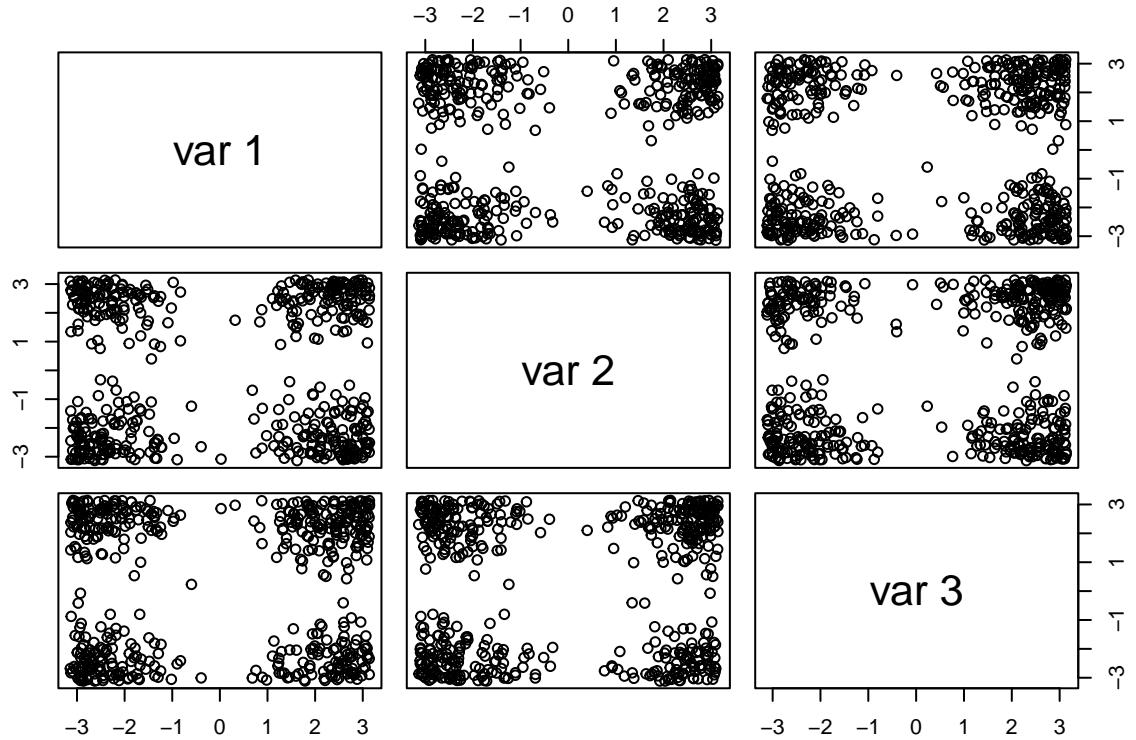


Case 4

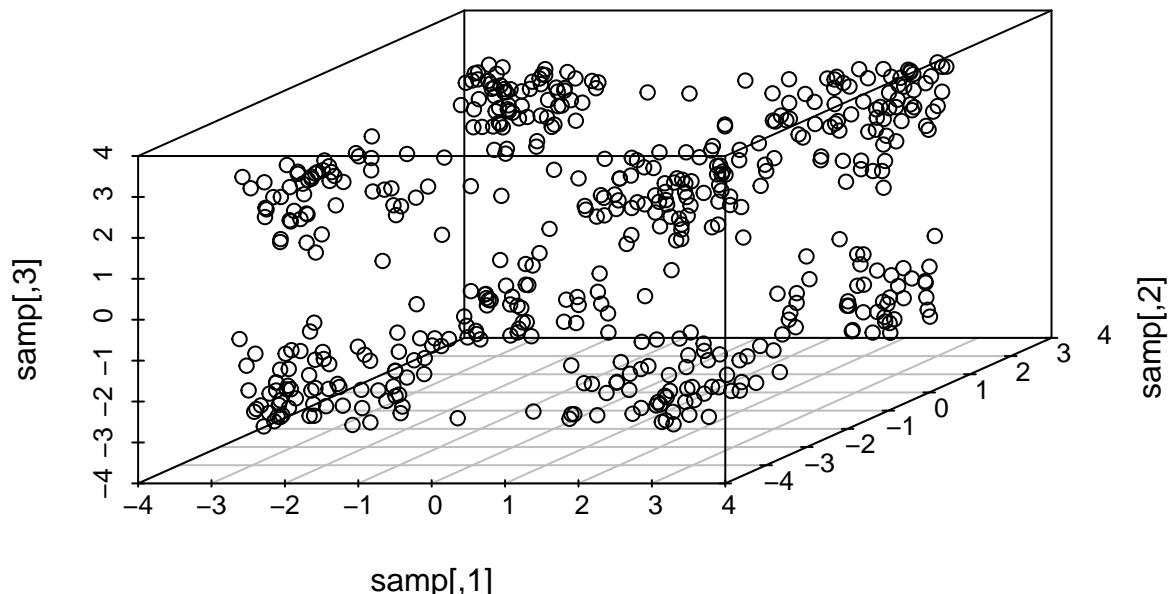
```

d <- 3
n <- 5e2
samp <- sdetorus::toPiInt(mvtnorm::rmvnorm(n = n, mean = rep(pi, d)))
pairs(samp)

```



```
scatterplot3d::scatterplot3d(samp, xlim = c(-pi, pi), ylim = c(-pi, pi), zlim = c(-pi, pi))
```



```
x_4 <- array(dim = c(n, 2, 3))
x_4[, , 1] <- DirStats::to_cir(samp[, 1])
x_4[, , 2] <- DirStats::to_cir(samp[, 2])
x_4[, , 3] <- DirStats::to_cir(samp[, 3])
```

Let's calculate the rho parameters based on a perplexity of 25:

```
rho_four_perp20 <- rho_optim_bst(x_4, 20)
```

```
## Time difference of 44.00805 secs
```

First, let's reduce to dimension \mathbb{S}^1 then $d = 1$ (circumference):

```
Y <- psc_sne(X=x_4, d=1, rho_psc_list = rho_four_perp20, num_iteration=500,
               visualize_prog = TRUE)
```

```
## It: 1; obj: 1.763e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.469e-01
## It: 2; obj: 1.695e+01; abs: 6.797e-01; rel: 3.855e-02; norm: 3.184e-01
## It: 3; obj: 1.663e+01; abs: 3.180e-01; rel: 1.876e-02; norm: 4.264e-01
## It: 4; obj: 1.642e+01; abs: 2.165e-01; rel: 1.302e-02; norm: 4.809e-01
## It: 5; obj: 1.623e+01; abs: 1.891e-01; rel: 1.152e-02; norm: 5.134e-01
## It: 6; obj: 1.609e+01; abs: 1.376e-01; rel: 8.482e-03; norm: 5.412e-01
## It: 7; obj: 1.598e+01; abs: 1.084e-01; rel: 6.738e-03; norm: 5.650e-01
## It: 8; obj: 1.589e+01; abs: 8.752e-02; rel: 5.477e-03; norm: 5.854e-01
## It: 9; obj: 1.581e+01; abs: 7.862e-02; rel: 4.947e-03; norm: 6.029e-01
## It: 10; obj: 1.574e+01; abs: 7.315e-02; rel: 4.626e-03; norm: 6.200e-01
## It: 11; obj: 1.568e+01; abs: 6.468e-02; rel: 4.109e-03; norm: 6.375e-01
## It: 12; obj: 1.562e+01; abs: 5.752e-02; rel: 3.669e-03; norm: 6.542e-01
## It: 13; obj: 1.556e+01; abs: 5.400e-02; rel: 3.458e-03; norm: 6.694e-01
## It: 14; obj: 1.552e+01; abs: 4.806e-02; rel: 3.088e-03; norm: 6.841e-01
## It: 15; obj: 1.548e+01; abs: 3.744e-02; rel: 2.413e-03; norm: 6.983e-01
## It: 16; obj: 1.545e+01; abs: 2.706e-02; rel: 1.748e-03; norm: 7.099e-01
## It: 17; obj: 1.543e+01; abs: 2.178e-02; rel: 1.410e-03; norm: 7.190e-01
## It: 18; obj: 1.541e+01; abs: 2.015e-02; rel: 1.306e-03; norm: 7.263e-01
## It: 19; obj: 1.539e+01; abs: 2.355e-02; rel: 1.528e-03; norm: 7.323e-01
## It: 20; obj: 1.536e+01; abs: 2.472e-02; rel: 1.607e-03; norm: 7.372e-01
## It: 21; obj: 1.534e+01; abs: 2.566e-02; rel: 1.670e-03; norm: 7.411e-01
## It: 22; obj: 1.531e+01; abs: 2.297e-02; rel: 1.498e-03; norm: 7.446e-01
## It: 23; obj: 1.529e+01; abs: 1.859e-02; rel: 1.214e-03; norm: 7.473e-01
## It: 24; obj: 1.528e+01; abs: 1.411e-02; rel: 9.228e-04; norm: 7.491e-01
## It: 25; obj: 1.527e+01; abs: 1.056e-02; rel: 6.913e-04; norm: 7.504e-01
## It: 26; obj: 1.526e+01; abs: 8.019e-03; rel: 5.252e-04; norm: 7.511e-01
## It: 27; obj: 1.526e+01; abs: 6.509e-03; rel: 4.265e-04; norm: 7.513e-01
## It: 28; obj: 1.525e+01; abs: 5.692e-03; rel: 3.731e-04; norm: 7.511e-01
## It: 29; obj: 1.524e+01; abs: 5.165e-03; rel: 3.387e-04; norm: 7.506e-01
## It: 30; obj: 1.524e+01; abs: 4.698e-03; rel: 3.082e-04; norm: 7.498e-01
## It: 31; obj: 1.524e+01; abs: 4.212e-03; rel: 2.764e-04; norm: 7.489e-01
## It: 32; obj: 1.523e+01; abs: 3.696e-03; rel: 2.426e-04; norm: 7.478e-01
## It: 33; obj: 1.523e+01; abs: 3.159e-03; rel: 2.074e-04; norm: 7.466e-01
## It: 34; obj: 1.523e+01; abs: 2.619e-03; rel: 1.720e-04; norm: 7.452e-01
## It: 35; obj: 1.522e+01; abs: 2.092e-03; rel: 1.374e-04; norm: 7.438e-01
## It: 36; obj: 1.522e+01; abs: 1.592e-03; rel: 1.046e-04; norm: 7.424e-01
## It: 37; obj: 1.522e+01; abs: 1.125e-03; rel: 7.391e-05; norm: 7.410e-01
## It: 38; obj: 1.522e+01; abs: 6.999e-04; rel: 4.598e-05; norm: 7.396e-01
## It: 39; obj: 1.522e+01; abs: 2.797e-04; rel: 1.838e-05; norm: 7.383e-01
## It: 40; obj: 1.522e+01; abs: 2.210e-04; rel: 1.452e-05; norm: 7.371e-01
## It: 41; obj: 1.522e+01; abs: 8.218e-04; rel: 5.399e-05; norm: 7.361e-01
## It: 42; obj: 1.522e+01; abs: 1.423e-03; rel: 9.351e-05; norm: 7.351e-01
## It: 43; obj: 1.522e+01; abs: 1.919e-03; rel: 1.261e-04; norm: 7.341e-01
## It: 44; obj: 1.523e+01; abs: 2.290e-03; rel: 1.504e-04; norm: 7.330e-01
## It: 45; obj: 1.523e+01; abs: 2.574e-03; rel: 1.690e-04; norm: 7.320e-01
## It: 46; obj: 1.523e+01; abs: 2.810e-03; rel: 1.845e-04; norm: 7.308e-01
## It: 47; obj: 1.524e+01; abs: 3.019e-03; rel: 1.982e-04; norm: 7.297e-01
## It: 48; obj: 1.524e+01; abs: 3.209e-03; rel: 2.106e-04; norm: 7.286e-01
## It: 49; obj: 1.524e+01; abs: 3.378e-03; rel: 2.217e-04; norm: 7.275e-01
```

```

## It: 50; obj: 1.525e+01; abs: 3.517e-03; rel: 2.308e-04; norm: 7.264e-01
## It: 51; obj: 1.525e+01; abs: 3.611e-03; rel: 2.369e-04; norm: 7.254e-01
## It: 52; obj: 1.525e+01; abs: 3.643e-03; rel: 2.389e-04; norm: 7.244e-01
## It: 53; obj: 1.526e+01; abs: 3.598e-03; rel: 2.359e-04; norm: 7.235e-01
## It: 54; obj: 1.526e+01; abs: 3.459e-03; rel: 2.267e-04; norm: 7.227e-01
## It: 55; obj: 1.526e+01; abs: 3.211e-03; rel: 2.104e-04; norm: 7.220e-01
## It: 56; obj: 1.527e+01; abs: 2.856e-03; rel: 1.871e-04; norm: 7.213e-01
## It: 57; obj: 1.527e+01; abs: 2.450e-03; rel: 1.605e-04; norm: 7.208e-01
## It: 58; obj: 1.527e+01; abs: 2.131e-03; rel: 1.395e-04; norm: 7.204e-01
## It: 59; obj: 1.527e+01; abs: 2.033e-03; rel: 1.332e-04; norm: 7.201e-01
## It: 60; obj: 1.527e+01; abs: 2.157e-03; rel: 1.412e-04; norm: 7.200e-01
## It: 61; obj: 1.528e+01; abs: 2.383e-03; rel: 1.560e-04; norm: 7.198e-01
## It: 62; obj: 1.528e+01; abs: 2.620e-03; rel: 1.715e-04; norm: 7.198e-01
## It: 63; obj: 1.528e+01; abs: 2.840e-03; rel: 1.859e-04; norm: 7.199e-01
## It: 64; obj: 1.529e+01; abs: 3.033e-03; rel: 1.984e-04; norm: 7.201e-01
## It: 65; obj: 1.529e+01; abs: 3.163e-03; rel: 2.069e-04; norm: 7.203e-01
## It: 66; obj: 1.529e+01; abs: 3.227e-03; rel: 2.111e-04; norm: 7.207e-01
## It: 67; obj: 1.530e+01; abs: 3.285e-03; rel: 2.148e-04; norm: 7.210e-01
## It: 68; obj: 1.530e+01; abs: 3.377e-03; rel: 2.208e-04; norm: 7.214e-01
## It: 69; obj: 1.530e+01; abs: 3.491e-03; rel: 2.282e-04; norm: 7.218e-01
## It: 70; obj: 1.531e+01; abs: 3.603e-03; rel: 2.355e-04; norm: 7.223e-01
## It: 71; obj: 1.531e+01; abs: 3.703e-03; rel: 2.419e-04; norm: 7.227e-01
## It: 72; obj: 1.531e+01; abs: 3.787e-03; rel: 2.473e-04; norm: 7.233e-01
## It: 73; obj: 1.532e+01; abs: 3.858e-03; rel: 2.520e-04; norm: 7.238e-01
## It: 74; obj: 1.532e+01; abs: 3.921e-03; rel: 2.560e-04; norm: 7.244e-01
## It: 75; obj: 1.533e+01; abs: 3.978e-03; rel: 2.597e-04; norm: 7.250e-01
## It: 76; obj: 1.533e+01; abs: 4.029e-03; rel: 2.629e-04; norm: 7.256e-01
## It: 77; obj: 1.533e+01; abs: 4.074e-03; rel: 2.658e-04; norm: 7.263e-01
## It: 78; obj: 1.534e+01; abs: 4.112e-03; rel: 2.682e-04; norm: 7.270e-01
## It: 79; obj: 1.534e+01; abs: 4.143e-03; rel: 2.701e-04; norm: 7.277e-01
## It: 80; obj: 1.535e+01; abs: 4.167e-03; rel: 2.716e-04; norm: 7.284e-01
## It: 81; obj: 1.535e+01; abs: 4.185e-03; rel: 2.727e-04; norm: 7.291e-01
## It: 82; obj: 1.535e+01; abs: 4.197e-03; rel: 2.734e-04; norm: 7.299e-01
## It: 83; obj: 1.536e+01; abs: 4.206e-03; rel: 2.739e-04; norm: 7.307e-01
## It: 84; obj: 1.536e+01; abs: 4.213e-03; rel: 2.743e-04; norm: 7.314e-01
## It: 85; obj: 1.537e+01; abs: 4.221e-03; rel: 2.748e-04; norm: 7.322e-01
## It: 86; obj: 1.537e+01; abs: 4.231e-03; rel: 2.754e-04; norm: 7.331e-01
## It: 87; obj: 1.538e+01; abs: 4.245e-03; rel: 2.762e-04; norm: 7.339e-01
## It: 88; obj: 1.538e+01; abs: 4.264e-03; rel: 2.773e-04; norm: 7.347e-01
## It: 89; obj: 1.538e+01; abs: 4.289e-03; rel: 2.789e-04; norm: 7.356e-01
## It: 90; obj: 1.539e+01; abs: 4.320e-03; rel: 2.808e-04; norm: 7.364e-01
## It: 91; obj: 1.539e+01; abs: 4.357e-03; rel: 2.832e-04; norm: 7.373e-01
## It: 92; obj: 1.540e+01; abs: 4.402e-03; rel: 2.860e-04; norm: 7.382e-01
## It: 93; obj: 1.540e+01; abs: 4.453e-03; rel: 2.892e-04; norm: 7.391e-01
## It: 94; obj: 1.541e+01; abs: 4.512e-03; rel: 2.929e-04; norm: 7.400e-01
## It: 95; obj: 1.541e+01; abs: 4.577e-03; rel: 2.971e-04; norm: 7.409e-01
## It: 96; obj: 1.541e+01; abs: 4.651e-03; rel: 3.018e-04; norm: 7.418e-01
## It: 97; obj: 1.542e+01; abs: 4.732e-03; rel: 3.070e-04; norm: 7.427e-01
## It: 98; obj: 1.542e+01; abs: 4.823e-03; rel: 3.128e-04; norm: 7.436e-01
## It: 99; obj: 1.543e+01; abs: 4.923e-03; rel: 3.191e-04; norm: 7.445e-01
## It: 100; obj: 1.543e+01; abs: 5.033e-03; rel: 3.262e-04; norm: 7.453e-01
## It: 101; obj: 2.444e+00; abs: 1.299e+01; rel: 8.417e-01; norm: 1.022e-01

```

```

## It: 102; obj: 2.419e+00; abs: 2.430e-02; rel: 9.943e-03; norm: 9.972e-02
## It: 103; obj: 2.397e+00; abs: 2.184e-02; rel: 9.028e-03; norm: 9.808e-02
## It: 104; obj: 2.383e+00; abs: 1.490e-02; rel: 6.214e-03; norm: 9.758e-02
## It: 105; obj: 2.373e+00; abs: 9.369e-03; rel: 3.932e-03; norm: 9.745e-02
## It: 106; obj: 2.367e+00; abs: 6.506e-03; rel: 2.741e-03; norm: 9.699e-02
## It: 107; obj: 2.362e+00; abs: 5.030e-03; rel: 2.125e-03; norm: 9.678e-02
## It: 108; obj: 2.360e+00; abs: 1.345e-03; rel: 5.697e-04; norm: 9.710e-02
## It: 109; obj: 2.359e+00; abs: 1.015e-03; rel: 4.301e-04; norm: 9.715e-02
## It: 110; obj: 2.355e+00; abs: 4.580e-03; rel: 1.941e-03; norm: 9.729e-02
## It: 111; obj: 2.354e+00; abs: 1.105e-03; rel: 4.694e-04; norm: 9.722e-02
## It: 112; obj: 2.353e+00; abs: 9.395e-04; rel: 3.992e-04; norm: 9.770e-02
## It: 113; obj: 2.352e+00; abs: 5.009e-04; rel: 2.129e-04; norm: 9.744e-02
## It: 114; obj: 2.353e+00; abs: 9.251e-04; rel: 3.933e-04; norm: 9.751e-02
## It: 115; obj: 2.351e+00; abs: 2.366e-03; rel: 1.005e-03; norm: 9.748e-02
## It: 116; obj: 2.350e+00; abs: 7.715e-04; rel: 3.282e-04; norm: 9.710e-02
## It: 117; obj: 2.349e+00; abs: 1.209e-03; rel: 5.146e-04; norm: 9.743e-02
## It: 118; obj: 2.349e+00; abs: 1.993e-04; rel: 8.483e-05; norm: 9.739e-02
## It: 119; obj: 2.349e+00; abs: 1.046e-04; rel: 4.455e-05; norm: 9.728e-02
## It: 120; obj: 2.349e+00; abs: 2.917e-04; rel: 1.242e-04; norm: 9.749e-02
## It: 121; obj: 2.348e+00; abs: 9.290e-04; rel: 3.955e-04; norm: 9.718e-02
## It: 122; obj: 2.348e+00; abs: 2.080e-04; rel: 8.856e-05; norm: 9.709e-02
## It: 123; obj: 2.349e+00; abs: 1.500e-03; rel: 6.387e-04; norm: 9.732e-02
## It: 124; obj: 2.349e+00; abs: 2.714e-04; rel: 1.155e-04; norm: 9.713e-02
## It: 125; obj: 2.351e+00; abs: 1.572e-03; rel: 6.690e-04; norm: 9.717e-02

## It: 126; obj: 2.348e+00; abs: 3.085e-03; rel: 1.312e-03; norm: 9.706e-02
## It: 127; obj: 2.348e+00; abs: 1.006e-06; rel: 4.286e-07; norm: 9.724e-02
## It: 128; obj: 2.348e+00; abs: 7.790e-05; rel: 3.318e-05; norm: 9.719e-02
## It: 129; obj: 2.348e+00; abs: 1.307e-04; rel: 5.567e-05; norm: 9.685e-02
## It: 130; obj: 2.349e+00; abs: 1.426e-03; rel: 6.074e-04; norm: 9.702e-02
## It: 131; obj: 2.350e+00; abs: 1.161e-03; rel: 4.943e-04; norm: 9.700e-02
## It: 132; obj: 2.349e+00; abs: 8.640e-04; rel: 3.676e-04; norm: 9.716e-02
## It: 133; obj: 2.347e+00; abs: 1.889e-03; rel: 8.041e-04; norm: 9.691e-02
## It: 134; obj: 2.347e+00; abs: 9.111e-05; rel: 3.881e-05; norm: 9.685e-02
## It: 135; obj: 2.348e+00; abs: 5.689e-04; rel: 2.424e-04; norm: 9.705e-02
## It: 136; obj: 2.348e+00; abs: 3.041e-04; rel: 1.295e-04; norm: 9.690e-02
## It: 137; obj: 2.350e+00; abs: 1.338e-03; rel: 5.696e-04; norm: 9.695e-02
## It: 138; obj: 2.348e+00; abs: 1.748e-03; rel: 7.438e-04; norm: 9.707e-02
## It: 139; obj: 2.348e+00; abs: 1.531e-04; rel: 6.519e-05; norm: 9.680e-02
## It: 140; obj: 2.349e+00; abs: 8.202e-04; rel: 3.494e-04; norm: 9.684e-02
## It: 141; obj: 2.348e+00; abs: 1.237e-04; rel: 5.268e-05; norm: 9.704e-02
## It: 142; obj: 2.348e+00; abs: 7.236e-04; rel: 3.081e-04; norm: 9.707e-02
## It: 143; obj: 2.350e+00; abs: 1.932e-03; rel: 8.228e-04; norm: 9.686e-02
## It: 144; obj: 2.348e+00; abs: 1.523e-03; rel: 6.483e-04; norm: 9.690e-02
## It: 145; obj: 2.347e+00; abs: 8.836e-04; rel: 3.763e-04; norm: 9.715e-02
## It: 146; obj: 2.347e+00; abs: 4.294e-04; rel: 1.829e-04; norm: 9.710e-02
## It: 147; obj: 2.348e+00; abs: 1.065e-03; rel: 4.540e-04; norm: 9.691e-02
## It: 148; obj: 2.348e+00; abs: 6.123e-04; rel: 2.608e-04; norm: 9.696e-02
## It: 149; obj: 2.349e+00; abs: 6.656e-04; rel: 2.834e-04; norm: 9.695e-02
## It: 150; obj: 2.349e+00; abs: 2.954e-04; rel: 1.257e-04; norm: 9.724e-02

## It: 151; obj: 2.348e+00; abs: 9.453e-04; rel: 4.023e-04; norm: 9.722e-02
## It: 152; obj: 2.347e+00; abs: 1.514e-03; rel: 6.447e-04; norm: 9.708e-02
## It: 153; obj: 2.348e+00; abs: 1.421e-03; rel: 6.055e-04; norm: 9.704e-02
## It: 154; obj: 2.349e+00; abs: 8.494e-04; rel: 3.617e-04; norm: 9.711e-02

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## It: 155; obj: 2.350e+00; abs: 1.050e-03; rel: 4.468e-04; norm: 9.731e-02
## It: 156; obj: 2.349e+00; abs: 1.263e-03; rel: 5.376e-04; norm: 9.723e-02
## It: 157; obj: 2.348e+00; abs: 1.146e-03; rel: 4.877e-04; norm: 9.716e-02
## It: 158; obj: 2.348e+00; abs: 8.729e-05; rel: 3.718e-05; norm: 9.735e-02
## It: 159; obj: 2.349e+00; abs: 1.254e-03; rel: 5.343e-04; norm: 9.725e-02
## It: 160; obj: 2.349e+00; abs: 3.502e-04; rel: 1.491e-04; norm: 9.727e-02
## It: 161; obj: 2.351e+00; abs: 1.399e-03; rel: 5.956e-04; norm: 9.742e-02
## It: 162; obj: 2.347e+00; abs: 3.755e-03; rel: 1.598e-03; norm: 9.736e-02
## It: 163; obj: 2.347e+00; abs: 1.024e-04; rel: 4.364e-05; norm: 9.727e-02
## It: 164; obj: 2.347e+00; abs: 3.149e-04; rel: 1.342e-04; norm: 9.743e-02
## It: 165; obj: 2.346e+00; abs: 3.551e-04; rel: 1.513e-04; norm: 9.740e-02
## It: 166; obj: 2.348e+00; abs: 1.807e-03; rel: 7.700e-04; norm: 9.744e-02
## It: 167; obj: 2.350e+00; abs: 1.311e-03; rel: 5.583e-04; norm: 9.743e-02
## It: 168; obj: 2.347e+00; abs: 2.479e-03; rel: 1.055e-03; norm: 9.750e-02
## It: 169; obj: 2.347e+00; abs: 5.479e-04; rel: 2.334e-04; norm: 9.759e-02
## It: 170; obj: 2.348e+00; abs: 1.924e-03; rel: 8.199e-04; norm: 9.747e-02
## It: 171; obj: 2.350e+00; abs: 1.743e-03; rel: 7.420e-04; norm: 9.743e-02
## It: 172; obj: 2.347e+00; abs: 2.733e-03; rel: 1.163e-03; norm: 9.744e-02
## It: 173; obj: 2.348e+00; abs: 8.920e-04; rel: 3.800e-04; norm: 9.741e-02
## It: 174; obj: 2.348e+00; abs: 2.458e-04; rel: 1.047e-04; norm: 9.775e-02
## It: 175; obj: 2.348e+00; abs: 1.666e-04; rel: 7.094e-05; norm: 9.756e-02

## It: 176; obj: 2.347e+00; abs: 1.765e-03; rel: 7.515e-04; norm: 9.745e-02
## It: 177; obj: 2.346e+00; abs: 3.472e-04; rel: 1.480e-04; norm: 9.749e-02
## It: 178; obj: 2.347e+00; abs: 1.039e-03; rel: 4.429e-04; norm: 9.757e-02
## It: 179; obj: 2.351e+00; abs: 3.295e-03; rel: 1.404e-03; norm: 9.756e-02
## It: 180; obj: 2.349e+00; abs: 1.680e-03; rel: 7.147e-04; norm: 9.735e-02
## It: 181; obj: 2.347e+00; abs: 1.637e-03; rel: 6.970e-04; norm: 9.761e-02
## It: 182; obj: 2.346e+00; abs: 9.333e-04; rel: 3.976e-04; norm: 9.780e-02
## It: 183; obj: 2.348e+00; abs: 1.255e-03; rel: 5.349e-04; norm: 9.761e-02
## It: 184; obj: 2.348e+00; abs: 8.790e-04; rel: 3.744e-04; norm: 9.763e-02
## It: 185; obj: 2.349e+00; abs: 2.651e-04; rel: 1.129e-04; norm: 9.763e-02
## It: 186; obj: 2.348e+00; abs: 7.210e-04; rel: 3.070e-04; norm: 9.764e-02
## It: 187; obj: 2.349e+00; abs: 1.126e-03; rel: 4.798e-04; norm: 9.747e-02
## It: 188; obj: 2.349e+00; abs: 3.130e-04; rel: 1.332e-04; norm: 9.766e-02
## It: 189; obj: 2.348e+00; abs: 1.157e-03; rel: 4.925e-04; norm: 9.780e-02
## It: 190; obj: 2.347e+00; abs: 5.070e-04; rel: 2.160e-04; norm: 9.783e-02
## It: 191; obj: 2.350e+00; abs: 2.732e-03; rel: 1.164e-03; norm: 9.783e-02
## It: 192; obj: 2.349e+00; abs: 1.064e-03; rel: 4.527e-04; norm: 9.777e-02
## It: 193; obj: 2.346e+00; abs: 2.550e-03; rel: 1.086e-03; norm: 9.767e-02
## It: 194; obj: 2.347e+00; abs: 7.362e-04; rel: 3.138e-04; norm: 9.770e-02
## It: 195; obj: 2.348e+00; abs: 9.729e-04; rel: 4.145e-04; norm: 9.757e-02
## It: 196; obj: 2.348e+00; abs: 5.470e-04; rel: 2.330e-04; norm: 9.772e-02
## It: 197; obj: 2.349e+00; abs: 2.961e-04; rel: 1.261e-04; norm: 9.776e-02
## It: 198; obj: 2.347e+00; abs: 1.297e-03; rel: 5.524e-04; norm: 9.780e-02
## It: 199; obj: 2.348e+00; abs: 6.442e-04; rel: 2.744e-04; norm: 9.776e-02
## It: 200; obj: 2.348e+00; abs: 1.062e-04; rel: 4.524e-05; norm: 9.780e-02

## It: 201; obj: 2.349e+00; abs: 5.486e-04; rel: 2.336e-04; norm: 9.776e-02
## It: 202; obj: 2.347e+00; abs: 1.968e-03; rel: 8.378e-04; norm: 9.771e-02
## It: 203; obj: 2.348e+00; abs: 1.652e-03; rel: 7.038e-04; norm: 9.761e-02
## It: 204; obj: 2.348e+00; abs: 1.093e-04; rel: 4.653e-05; norm: 9.780e-02
## It: 205; obj: 2.347e+00; abs: 1.594e-03; rel: 6.790e-04; norm: 9.765e-02
## It: 206; obj: 2.346e+00; abs: 2.582e-04; rel: 1.100e-04; norm: 9.789e-02
## It: 207; obj: 2.348e+00; abs: 1.049e-03; rel: 4.469e-04; norm: 9.794e-02

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## It: 208; obj: 2.347e+00; abs: 4.388e-04; rel: 1.869e-04; norm: 9.761e-02
## It: 209; obj: 2.349e+00; abs: 1.545e-03; rel: 6.581e-04; norm: 9.779e-02
## It: 210; obj: 2.347e+00; abs: 1.529e-03; rel: 6.509e-04; norm: 9.766e-02
## It: 211; obj: 2.347e+00; abs: 6.719e-05; rel: 2.863e-05; norm: 9.760e-02
## It: 212; obj: 2.348e+00; abs: 1.301e-03; rel: 5.544e-04; norm: 9.776e-02
## It: 213; obj: 2.347e+00; abs: 1.090e-03; rel: 4.639e-04; norm: 9.781e-02
## It: 214; obj: 2.347e+00; abs: 6.188e-04; rel: 2.636e-04; norm: 9.799e-02
## It: 215; obj: 2.348e+00; abs: 1.589e-03; rel: 6.771e-04; norm: 9.768e-02
## It: 216; obj: 2.348e+00; abs: 1.238e-04; rel: 5.274e-05; norm: 9.781e-02
## It: 217; obj: 2.349e+00; abs: 6.400e-04; rel: 2.726e-04; norm: 9.795e-02
## It: 218; obj: 2.347e+00; abs: 1.955e-03; rel: 8.322e-04; norm: 9.769e-02
## It: 219; obj: 2.346e+00; abs: 4.730e-04; rel: 2.015e-04; norm: 9.783e-02
## It: 220; obj: 2.347e+00; abs: 8.768e-04; rel: 3.737e-04; norm: 9.755e-02
## It: 221; obj: 2.350e+00; abs: 3.134e-03; rel: 1.335e-03; norm: 9.759e-02
## It: 222; obj: 2.350e+00; abs: 3.699e-04; rel: 1.574e-04; norm: 9.820e-02
## It: 223; obj: 2.347e+00; abs: 3.397e-03; rel: 1.446e-03; norm: 9.786e-02
## It: 224; obj: 2.345e+00; abs: 1.455e-03; rel: 6.201e-04; norm: 9.786e-02
## It: 225; obj: 2.347e+00; abs: 1.353e-03; rel: 5.769e-04; norm: 9.771e-02
## It: 226; obj: 2.348e+00; abs: 1.474e-03; rel: 6.281e-04; norm: 9.752e-02
## It: 227; obj: 2.351e+00; abs: 3.065e-03; rel: 1.305e-03; norm: 9.775e-02
## It: 228; obj: 2.349e+00; abs: 2.201e-03; rel: 9.362e-04; norm: 9.777e-02
## It: 229; obj: 2.347e+00; abs: 2.112e-03; rel: 8.993e-04; norm: 9.775e-02
## It: 230; obj: 2.346e+00; abs: 4.459e-04; rel: 1.900e-04; norm: 9.791e-02
## It: 231; obj: 2.347e+00; abs: 6.407e-04; rel: 2.731e-04; norm: 9.761e-02
## It: 232; obj: 2.347e+00; abs: 2.515e-06; rel: 1.071e-06; norm: 9.771e-02
## It: 233; obj: 2.350e+00; abs: 2.689e-03; rel: 1.146e-03; norm: 9.784e-02
## It: 234; obj: 2.350e+00; abs: 4.343e-04; rel: 1.848e-04; norm: 9.777e-02
## It: 235; obj: 2.348e+00; abs: 2.007e-03; rel: 8.540e-04; norm: 9.777e-02
## It: 236; obj: 2.346e+00; abs: 2.580e-03; rel: 1.099e-03; norm: 9.772e-02
## It: 237; obj: 2.347e+00; abs: 1.020e-03; rel: 4.347e-04; norm: 9.766e-02
## It: 238; obj: 2.348e+00; abs: 1.792e-03; rel: 7.637e-04; norm: 9.760e-02
## It: 239; obj: 2.350e+00; abs: 1.263e-03; rel: 5.378e-04; norm: 9.779e-02
## It: 240; obj: 2.348e+00; abs: 1.644e-03; rel: 6.997e-04; norm: 9.778e-02
## It: 241; obj: 2.347e+00; abs: 1.404e-03; rel: 5.980e-04; norm: 9.767e-02
## It: 242; obj: 2.348e+00; abs: 9.941e-04; rel: 4.236e-04; norm: 9.783e-02
## It: 243; obj: 2.348e+00; abs: 6.084e-04; rel: 2.591e-04; norm: 9.767e-02
## It: 244; obj: 2.348e+00; abs: 3.294e-04; rel: 1.403e-04; norm: 9.767e-02
## It: 245; obj: 2.350e+00; abs: 1.686e-03; rel: 7.179e-04; norm: 9.797e-02
## It: 246; obj: 2.348e+00; abs: 1.042e-03; rel: 4.434e-04; norm: 9.761e-02
## It: 247; obj: 2.347e+00; abs: 1.877e-03; rel: 7.993e-04; norm: 9.766e-02
## It: 248; obj: 2.348e+00; abs: 9.657e-04; rel: 4.115e-04; norm: 9.784e-02
## It: 249; obj: 2.349e+00; abs: 1.439e-03; rel: 6.129e-04; norm: 9.750e-02
## It: 250; obj: 2.354e+00; abs: 4.568e-03; rel: 1.945e-03; norm: 9.776e-02
## It: 251; obj: 2.355e+00; abs: 1.275e-03; rel: 5.415e-04; norm: 9.778e-02
## It: 252; obj: 2.352e+00; abs: 3.057e-03; rel: 1.298e-03; norm: 9.776e-02
## It: 253; obj: 2.350e+00; abs: 2.269e-03; rel: 9.648e-04; norm: 9.796e-02
## It: 254; obj: 2.350e+00; abs: 4.746e-04; rel: 2.020e-04; norm: 9.782e-02
## It: 255; obj: 2.351e+00; abs: 1.467e-03; rel: 6.242e-04; norm: 9.788e-02
## It: 256; obj: 2.356e+00; abs: 4.063e-03; rel: 1.728e-03; norm: 9.809e-02
## It: 257; obj: 2.356e+00; abs: 4.940e-04; rel: 2.097e-04; norm: 9.775e-02
## It: 258; obj: 2.355e+00; abs: 1.103e-03; rel: 4.680e-04; norm: 9.777e-02
## It: 259; obj: 2.353e+00; abs: 1.816e-03; rel: 7.711e-04; norm: 9.771e-02
## It: 260; obj: 2.352e+00; abs: 1.583e-03; rel: 6.728e-04; norm: 9.770e-02

```

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## It: 261; obj: 2.354e+00; abs: 2.447e-03; rel: 1.040e-03; norm: 9.813e-02
## It: 262; obj: 2.358e+00; abs: 4.132e-03; rel: 1.755e-03; norm: 9.816e-02
## It: 263; obj: 2.358e+00; abs: 1.286e-04; rel: 5.455e-05; norm: 9.808e-02
## It: 264; obj: 2.355e+00; abs: 3.283e-03; rel: 1.392e-03; norm: 9.809e-02
## It: 265; obj: 2.352e+00; abs: 2.876e-03; rel: 1.221e-03; norm: 9.764e-02
## It: 266; obj: 2.353e+00; abs: 1.057e-03; rel: 4.492e-04; norm: 9.782e-02
## It: 267; obj: 2.355e+00; abs: 2.016e-03; rel: 8.567e-04; norm: 9.792e-02
## It: 268; obj: 2.360e+00; abs: 5.058e-03; rel: 2.148e-03; norm: 9.768e-02
## It: 269; obj: 2.359e+00; abs: 1.047e-03; rel: 4.435e-04; norm: 9.833e-02
## It: 270; obj: 2.356e+00; abs: 2.850e-03; rel: 1.208e-03; norm: 9.805e-02
## It: 271; obj: 2.354e+00; abs: 2.737e-03; rel: 1.161e-03; norm: 9.781e-02
## It: 272; obj: 2.354e+00; abs: 4.286e-04; rel: 1.821e-04; norm: 9.799e-02
## It: 273; obj: 2.355e+00; abs: 1.251e-03; rel: 5.315e-04; norm: 9.793e-02
## It: 274; obj: 2.359e+00; abs: 3.816e-03; rel: 1.620e-03; norm: 9.798e-02
## It: 275; obj: 2.360e+00; abs: 1.267e-03; rel: 5.371e-04; norm: 9.777e-02
## It: 276; obj: 2.355e+00; abs: 5.614e-03; rel: 2.378e-03; norm: 9.724e-02
## It: 277; obj: 2.352e+00; abs: 2.244e-03; rel: 9.530e-04; norm: 9.775e-02
## It: 278; obj: 2.356e+00; abs: 3.962e-03; rel: 1.684e-03; norm: 9.823e-02
## It: 279; obj: 2.360e+00; abs: 3.777e-03; rel: 1.603e-03; norm: 9.805e-02
## It: 280; obj: 2.361e+00; abs: 6.805e-04; rel: 2.883e-04; norm: 9.843e-02
## It: 281; obj: 2.359e+00; abs: 1.950e-03; rel: 8.258e-04; norm: 9.755e-02
## It: 282; obj: 2.354e+00; abs: 4.751e-03; rel: 2.014e-03; norm: 9.756e-02
## It: 283; obj: 2.353e+00; abs: 7.232e-04; rel: 3.072e-04; norm: 9.778e-02
## It: 284; obj: 2.354e+00; abs: 7.926e-04; rel: 3.368e-04; norm: 9.744e-02
## It: 285; obj: 2.359e+00; abs: 4.827e-03; rel: 2.050e-03; norm: 9.793e-02
## It: 286; obj: 2.362e+00; abs: 2.816e-03; rel: 1.194e-03; norm: 9.854e-02
## It: 287; obj: 2.361e+00; abs: 1.065e-03; rel: 4.508e-04; norm: 9.758e-02
## It: 288; obj: 2.357e+00; abs: 3.651e-03; rel: 1.547e-03; norm: 9.774e-02
## It: 289; obj: 2.356e+00; abs: 1.431e-03; rel: 6.069e-04; norm: 9.775e-02
## It: 290; obj: 2.355e+00; abs: 4.967e-04; rel: 2.108e-04; norm: 9.746e-02
## It: 291; obj: 2.357e+00; abs: 2.038e-03; rel: 8.655e-04; norm: 9.840e-02
## It: 292; obj: 2.361e+00; abs: 4.049e-03; rel: 1.718e-03; norm: 9.805e-02
## It: 293; obj: 2.363e+00; abs: 2.048e-03; rel: 8.673e-04; norm: 9.760e-02
## It: 294; obj: 2.358e+00; abs: 5.217e-03; rel: 2.207e-03; norm: 9.811e-02
## It: 295; obj: 2.354e+00; abs: 4.116e-03; rel: 1.746e-03; norm: 9.746e-02
## It: 296; obj: 2.353e+00; abs: 6.605e-04; rel: 2.806e-04; norm: 9.755e-02
## It: 297; obj: 2.356e+00; abs: 3.026e-03; rel: 1.286e-03; norm: 9.852e-02
## It: 298; obj: 2.364e+00; abs: 7.491e-03; rel: 3.179e-03; norm: 9.808e-02
## It: 299; obj: 2.368e+00; abs: 4.094e-03; rel: 1.732e-03; norm: 9.766e-02
## It: 300; obj: 2.362e+00; abs: 5.600e-03; rel: 2.365e-03; norm: 9.801e-02
## It: 301; obj: 2.356e+00; abs: 6.687e-03; rel: 2.831e-03; norm: 9.752e-02
## It: 302; obj: 2.353e+00; abs: 3.153e-03; rel: 1.338e-03; norm: 9.766e-02
## It: 303; obj: 2.355e+00; abs: 2.918e-03; rel: 1.240e-03; norm: 9.787e-02
## It: 304; obj: 2.362e+00; abs: 6.656e-03; rel: 2.826e-03; norm: 9.777e-02
## It: 305; obj: 2.363e+00; abs: 1.016e-03; rel: 4.301e-04; norm: 9.791e-02
## It: 306; obj: 2.362e+00; abs: 9.569e-04; rel: 4.049e-04; norm: 9.793e-02
## It: 307; obj: 2.358e+00; abs: 3.981e-03; rel: 1.685e-03; norm: 9.764e-02
## It: 308; obj: 2.356e+00; abs: 2.341e-03; rel: 9.927e-04; norm: 9.774e-02
## It: 309; obj: 2.359e+00; abs: 3.474e-03; rel: 1.475e-03; norm: 9.792e-02
## It: 310; obj: 2.365e+00; abs: 5.634e-03; rel: 2.388e-03; norm: 9.795e-02
## It: 311; obj: 2.365e+00; abs: 4.672e-04; rel: 1.975e-04; norm: 9.786e-02
## It: 312; obj: 2.363e+00; abs: 2.936e-03; rel: 1.241e-03; norm: 9.805e-02
## It: 313; obj: 2.358e+00; abs: 4.986e-03; rel: 2.110e-03; norm: 9.752e-02

```

```

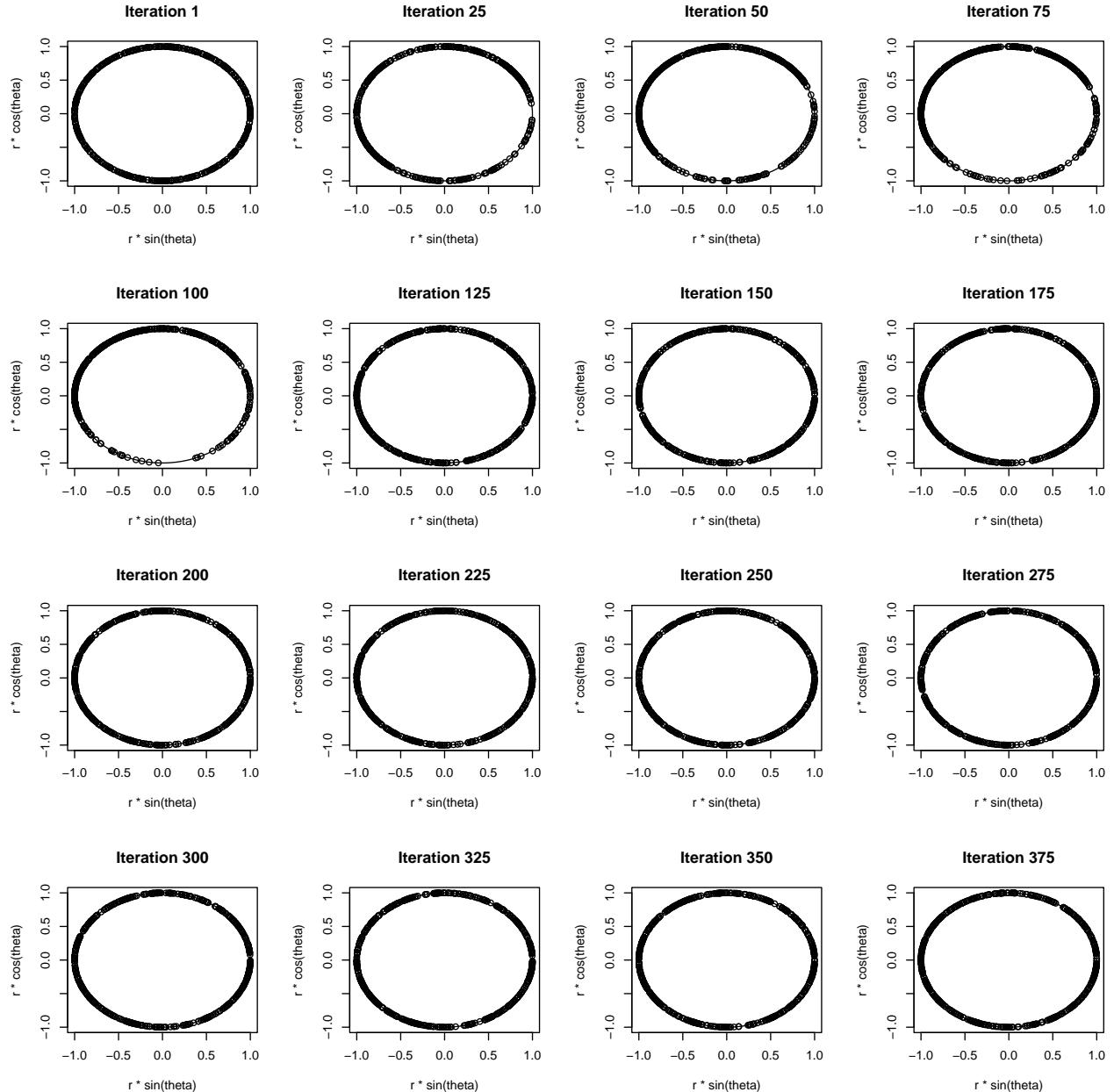
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## It: 315; obj: 2.359e+00; abs: 3.480e-03; rel: 1.478e-03; norm: 9.797e-02
## It: 316; obj: 2.365e+00; abs: 6.830e-03; rel: 2.896e-03; norm: 9.799e-02
## It: 317; obj: 2.365e+00; abs: 8.261e-05; rel: 3.493e-05; norm: 9.763e-02
## It: 318; obj: 2.362e+00; abs: 3.859e-03; rel: 1.631e-03; norm: 9.796e-02
## It: 319; obj: 2.357e+00; abs: 4.182e-03; rel: 1.771e-03; norm: 9.763e-02
## It: 320; obj: 2.357e+00; abs: 1.578e-04; rel: 6.692e-05; norm: 9.766e-02
## It: 321; obj: 2.360e+00; abs: 2.464e-03; rel: 1.045e-03; norm: 9.783e-02
## It: 322; obj: 2.365e+00; abs: 5.340e-03; rel: 2.263e-03; norm: 9.782e-02
## It: 323; obj: 2.367e+00; abs: 2.131e-03; rel: 9.012e-04; norm: 9.781e-02
## It: 324; obj: 2.363e+00; abs: 4.598e-03; rel: 1.942e-03; norm: 9.800e-02
## It: 325; obj: 2.357e+00; abs: 5.347e-03; rel: 2.263e-03; norm: 9.733e-02
## It: 326; obj: 2.359e+00; abs: 1.862e-03; rel: 7.901e-04; norm: 9.777e-02
## It: 327; obj: 2.361e+00; abs: 1.593e-03; rel: 6.752e-04; norm: 9.793e-02
## It: 328; obj: 2.367e+00; abs: 6.252e-03; rel: 2.648e-03; norm: 9.767e-02
## It: 329; obj: 2.364e+00; abs: 2.635e-03; rel: 1.113e-03; norm: 9.776e-02
## It: 330; obj: 2.362e+00; abs: 2.368e-03; rel: 1.001e-03; norm: 9.794e-02
## It: 331; obj: 2.360e+00; abs: 2.179e-03; rel: 9.226e-04; norm: 9.718e-02
## It: 332; obj: 2.360e+00; abs: 2.876e-04; rel: 1.219e-04; norm: 9.785e-02
## It: 333; obj: 2.362e+00; abs: 1.787e-03; rel: 7.570e-04; norm: 9.803e-02
## It: 334; obj: 2.364e+00; abs: 1.987e-03; rel: 8.412e-04; norm: 9.779e-02
## It: 335; obj: 2.360e+00; abs: 3.581e-03; rel: 1.515e-03; norm: 9.791e-02
## It: 336; obj: 2.360e+00; abs: 2.278e-05; rel: 9.654e-06; norm: 9.774e-02
## It: 337; obj: 2.361e+00; abs: 4.719e-04; rel: 1.999e-04; norm: 9.719e-02
## It: 338; obj: 2.363e+00; abs: 2.699e-03; rel: 1.143e-03; norm: 9.760e-02
## It: 339; obj: 2.363e+00; abs: 2.517e-04; rel: 1.065e-04; norm: 9.765e-02
## It: 340; obj: 2.364e+00; abs: 9.005e-04; rel: 3.810e-04; norm: 9.785e-02
## It: 341; obj: 2.361e+00; abs: 3.036e-03; rel: 1.284e-03; norm: 9.787e-02
## It: 342; obj: 2.359e+00; abs: 2.482e-03; rel: 1.051e-03; norm: 9.790e-02
## It: 343; obj: 2.359e+00; abs: 4.328e-04; rel: 1.835e-04; norm: 9.762e-02
## It: 344; obj: 2.361e+00; abs: 2.493e-03; rel: 1.057e-03; norm: 9.769e-02
## It: 345; obj: 2.364e+00; abs: 2.246e-03; rel: 9.513e-04; norm: 9.768e-02
## It: 346; obj: 2.363e+00; abs: 4.293e-04; rel: 1.816e-04; norm: 9.775e-02
## It: 347; obj: 2.360e+00; abs: 3.696e-03; rel: 1.564e-03; norm: 9.766e-02
## It: 348; obj: 2.363e+00; abs: 2.982e-03; rel: 1.264e-03; norm: 9.794e-02
## It: 349; obj: 2.361e+00; abs: 1.265e-03; rel: 5.355e-04; norm: 9.760e-02
## It: 350; obj: 2.362e+00; abs: 5.234e-04; rel: 2.216e-04; norm: 9.819e-02
## It: 351; obj: 2.364e+00; abs: 2.050e-03; rel: 8.679e-04; norm: 9.812e-02
## It: 352; obj: 2.364e+00; abs: 5.768e-04; rel: 2.440e-04; norm: 9.793e-02
## It: 353; obj: 2.360e+00; abs: 4.325e-03; rel: 1.829e-03; norm: 9.811e-02
## It: 354; obj: 2.362e+00; abs: 1.469e-03; rel: 6.225e-04; norm: 9.778e-02
## It: 355; obj: 2.365e+00; abs: 3.773e-03; rel: 1.598e-03; norm: 9.728e-02
## It: 356; obj: 2.366e+00; abs: 5.595e-04; rel: 2.365e-04; norm: 9.789e-02
## It: 357; obj: 2.361e+00; abs: 4.485e-03; rel: 1.896e-03; norm: 9.772e-02
## It: 358; obj: 2.361e+00; abs: 1.474e-04; rel: 6.244e-05; norm: 9.728e-02
## It: 359; obj: 2.362e+00; abs: 5.992e-04; rel: 2.537e-04; norm: 9.740e-02
## It: 360; obj: 2.362e+00; abs: 5.950e-04; rel: 2.519e-04; norm: 9.743e-02
## It: 361; obj: 2.366e+00; abs: 3.923e-03; rel: 1.661e-03; norm: 9.719e-02
## It: 362; obj: 2.365e+00; abs: 1.402e-03; rel: 5.925e-04; norm: 9.788e-02
## It: 363; obj: 2.360e+00; abs: 5.375e-03; rel: 2.273e-03; norm: 9.777e-02
## It: 364; obj: 2.361e+00; abs: 1.203e-03; rel: 5.098e-04; norm: 9.823e-02
## It: 365; obj: 2.361e+00; abs: 4.108e-04; rel: 1.740e-04; norm: 9.779e-02
## It: 366; obj: 2.361e+00; abs: 6.127e-04; rel: 2.595e-04; norm: 9.765e-02

```

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## It: 367; obj: 2.362e+00; abs: 1.594e-03; rel: 6.752e-04; norm: 9.766e-02
## It: 368; obj: 2.361e+00; abs: 1.698e-03; rel: 7.187e-04; norm: 9.805e-02
## It: 369; obj: 2.362e+00; abs: 1.314e-03; rel: 5.567e-04; norm: 9.754e-02
## It: 370; obj: 2.364e+00; abs: 2.294e-03; rel: 9.713e-04; norm: 9.778e-02
## It: 371; obj: 2.366e+00; abs: 1.511e-03; rel: 6.389e-04; norm: 9.745e-02
## It: 372; obj: 2.365e+00; abs: 5.414e-04; rel: 2.289e-04; norm: 9.716e-02
## It: 373; obj: 2.365e+00; abs: 4.152e-04; rel: 1.755e-04; norm: 9.728e-02
## It: 374; obj: 2.361e+00; abs: 4.023e-03; rel: 1.701e-03; norm: 9.780e-02
## It: 375; obj: 2.361e+00; abs: 5.890e-04; rel: 2.495e-04; norm: 9.784e-02

```



```

## It: 376; obj: 2.364e+00; abs: 2.640e-03; rel: 1.118e-03; norm: 9.779e-02
## It: 377; obj: 2.367e+00; abs: 3.161e-03; rel: 1.337e-03; norm: 9.802e-02
## It: 378; obj: 2.365e+00; abs: 2.214e-03; rel: 9.355e-04; norm: 9.742e-02
## It: 379; obj: 2.366e+00; abs: 1.635e-03; rel: 6.915e-04; norm: 9.726e-02
## It: 380; obj: 2.363e+00; abs: 3.824e-03; rel: 1.616e-03; norm: 9.768e-02

```

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## It: 381; obj: 2.359e+00; abs: 3.304e-03; rel: 1.399e-03; norm: 9.797e-02
## It: 382; obj: 2.361e+00; abs: 1.998e-03; rel: 8.469e-04; norm: 9.741e-02
## It: 383; obj: 2.366e+00; abs: 4.788e-03; rel: 2.028e-03; norm: 9.748e-02
## It: 384; obj: 2.367e+00; abs: 1.141e-03; rel: 4.824e-04; norm: 9.734e-02
## It: 385; obj: 2.366e+00; abs: 7.953e-04; rel: 3.360e-04; norm: 9.689e-02
## It: 386; obj: 2.362e+00; abs: 4.632e-03; rel: 1.957e-03; norm: 9.744e-02
## It: 387; obj: 2.359e+00; abs: 2.837e-03; rel: 1.201e-03; norm: 9.780e-02
## It: 388; obj: 2.363e+00; abs: 3.510e-03; rel: 1.488e-03; norm: 9.737e-02
## It: 389; obj: 2.365e+00; abs: 2.702e-03; rel: 1.144e-03; norm: 9.756e-02
## It: 390; obj: 2.369e+00; abs: 3.432e-03; rel: 1.451e-03; norm: 9.725e-02
## It: 391; obj: 2.366e+00; abs: 2.755e-03; rel: 1.163e-03; norm: 9.685e-02
## It: 392; obj: 2.360e+00; abs: 5.577e-03; rel: 2.357e-03; norm: 9.729e-02
## It: 393; obj: 2.359e+00; abs: 8.877e-04; rel: 3.761e-04; norm: 9.735e-02
## It: 394; obj: 2.364e+00; abs: 4.956e-03; rel: 2.101e-03; norm: 9.728e-02
## It: 395; obj: 2.362e+00; abs: 2.087e-03; rel: 8.827e-04; norm: 9.745e-02
## It: 396; obj: 2.364e+00; abs: 1.384e-03; rel: 5.859e-04; norm: 9.700e-02
## It: 397; obj: 2.365e+00; abs: 1.110e-03; rel: 4.697e-04; norm: 9.670e-02
## It: 398; obj: 2.361e+00; abs: 3.976e-03; rel: 1.681e-03; norm: 9.726e-02
## It: 399; obj: 2.361e+00; abs: 2.194e-04; rel: 9.293e-05; norm: 9.726e-02
## It: 400; obj: 2.362e+00; abs: 1.214e-03; rel: 5.142e-04; norm: 9.744e-02

## It: 401; obj: 2.360e+00; abs: 1.585e-03; rel: 6.713e-04; norm: 9.746e-02
## It: 402; obj: 2.364e+00; abs: 3.351e-03; rel: 1.420e-03; norm: 9.695e-02
## It: 403; obj: 2.364e+00; abs: 6.102e-04; rel: 2.582e-04; norm: 9.705e-02
## It: 404; obj: 2.360e+00; abs: 4.103e-03; rel: 1.735e-03; norm: 9.763e-02
## It: 405; obj: 2.360e+00; abs: 2.410e-04; rel: 1.021e-04; norm: 9.745e-02
## It: 406; obj: 2.358e+00; abs: 1.431e-03; rel: 6.065e-04; norm: 9.785e-02
## It: 407; obj: 2.359e+00; abs: 8.729e-04; rel: 3.701e-04; norm: 9.805e-02
## It: 408; obj: 2.363e+00; abs: 4.106e-03; rel: 1.740e-03; norm: 9.791e-02
## It: 409; obj: 2.361e+00; abs: 1.989e-03; rel: 8.418e-04; norm: 9.805e-02
## It: 410; obj: 2.357e+00; abs: 4.902e-03; rel: 2.076e-03; norm: 9.823e-02
## It: 411; obj: 2.359e+00; abs: 2.599e-03; rel: 1.103e-03; norm: 9.829e-02
## It: 412; obj: 2.361e+00; abs: 1.543e-03; rel: 6.540e-04; norm: 9.849e-02
## It: 413; obj: 2.357e+00; abs: 3.804e-03; rel: 1.611e-03; norm: 9.875e-02
## It: 414; obj: 2.359e+00; abs: 2.180e-03; rel: 9.252e-04; norm: 9.858e-02
## It: 415; obj: 2.359e+00; abs: 2.729e-04; rel: 1.157e-04; norm: 9.857e-02
## It: 416; obj: 2.356e+00; abs: 3.121e-03; rel: 1.323e-03; norm: 9.884e-02
## It: 417; obj: 2.355e+00; abs: 9.888e-04; rel: 4.197e-04; norm: 9.883e-02
## It: 418; obj: 2.360e+00; abs: 4.932e-03; rel: 2.094e-03; norm: 9.854e-02
## It: 419; obj: 2.357e+00; abs: 3.018e-03; rel: 1.279e-03; norm: 9.866e-02
## It: 420; obj: 2.357e+00; abs: 5.260e-04; rel: 2.231e-04; norm: 9.879e-02
## It: 421; obj: 2.356e+00; abs: 6.862e-04; rel: 2.912e-04; norm: 9.834e-02
## It: 422; obj: 2.354e+00; abs: 2.386e-03; rel: 1.013e-03; norm: 9.866e-02
## It: 423; obj: 2.356e+00; abs: 2.174e-03; rel: 9.236e-04; norm: 9.936e-02
## It: 424; obj: 2.359e+00; abs: 3.485e-03; rel: 1.479e-03; norm: 9.883e-02
## It: 425; obj: 2.355e+00; abs: 4.598e-03; rel: 1.949e-03; norm: 9.863e-02

## It: 426; obj: 2.358e+00; abs: 3.811e-03; rel: 1.618e-03; norm: 9.875e-02
## It: 427; obj: 2.362e+00; abs: 3.215e-03; rel: 1.363e-03; norm: 9.846e-02
## It: 428; obj: 2.355e+00; abs: 6.881e-03; rel: 2.914e-03; norm: 9.860e-02
## It: 429; obj: 2.353e+00; abs: 1.242e-03; rel: 5.274e-04; norm: 9.861e-02
## It: 430; obj: 2.355e+00; abs: 1.633e-03; rel: 6.939e-04; norm: 9.884e-02
## It: 431; obj: 2.354e+00; abs: 1.258e-03; rel: 5.342e-04; norm: 9.921e-02
## It: 432; obj: 2.360e+00; abs: 5.709e-03; rel: 2.426e-03; norm: 9.885e-02
## It: 433; obj: 2.361e+00; abs: 1.227e-03; rel: 5.201e-04; norm: 9.820e-02

```

```

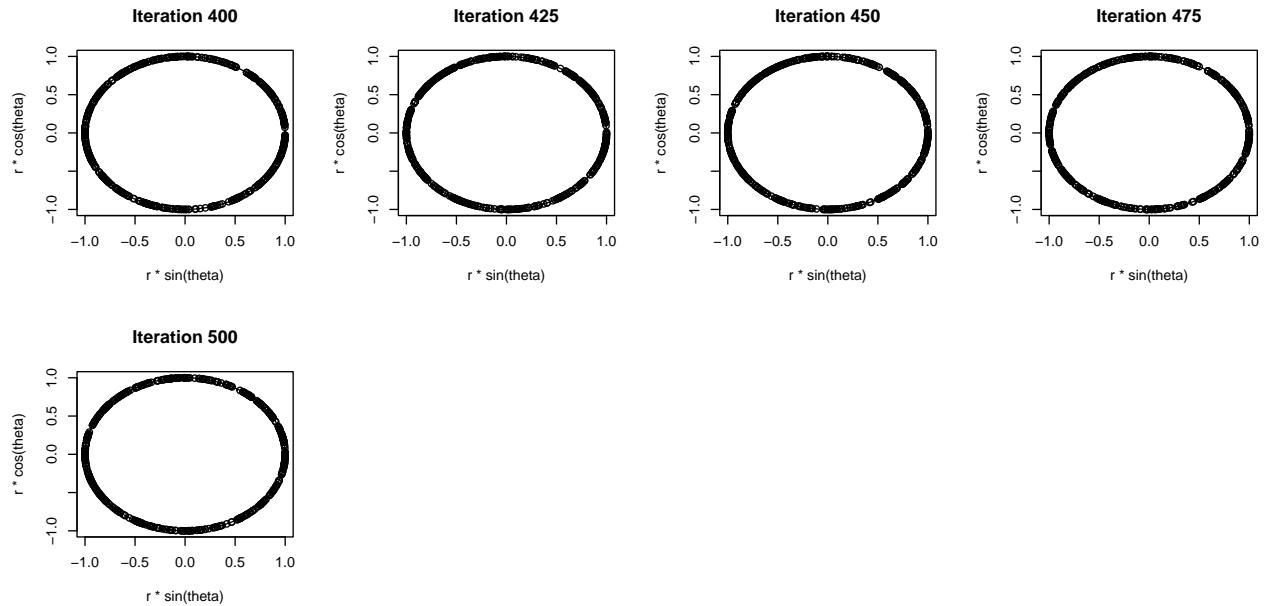
## It: 434; obj: 2.354e+00; abs: 6.662e-03; rel: 2.822e-03; norm: 9.934e-02
## It: 435; obj: 2.355e+00; abs: 1.036e-03; rel: 4.400e-04; norm: 9.869e-02
## It: 436; obj: 2.355e+00; abs: 1.185e-04; rel: 5.032e-05; norm: 9.834e-02
## It: 437; obj: 2.354e+00; abs: 1.103e-03; rel: 4.682e-04; norm: 9.908e-02
## It: 438; obj: 2.359e+00; abs: 4.480e-03; rel: 1.903e-03; norm: 9.886e-02
## It: 439; obj: 2.362e+00; abs: 3.154e-03; rel: 1.337e-03; norm: 9.802e-02
## It: 440; obj: 2.360e+00; abs: 1.728e-03; rel: 7.314e-04; norm: 9.939e-02
## It: 441; obj: 2.354e+00; abs: 5.889e-03; rel: 2.495e-03; norm: 9.877e-02
## It: 442; obj: 2.355e+00; abs: 1.002e-03; rel: 4.255e-04; norm: 9.885e-02
## It: 443; obj: 2.353e+00; abs: 2.503e-03; rel: 1.063e-03; norm: 9.919e-02
## It: 444; obj: 2.357e+00; abs: 4.297e-03; rel: 1.826e-03; norm: 9.859e-02
## It: 445; obj: 2.358e+00; abs: 1.411e-03; rel: 5.988e-04; norm: 9.859e-02
## It: 446; obj: 2.358e+00; abs: 6.813e-04; rel: 2.889e-04; norm: 9.911e-02
## It: 447; obj: 2.355e+00; abs: 3.031e-03; rel: 1.285e-03; norm: 9.841e-02
## It: 448; obj: 2.355e+00; abs: 1.115e-04; rel: 4.735e-05; norm: 9.890e-02
## It: 449; obj: 2.354e+00; abs: 1.765e-04; rel: 7.496e-05; norm: 9.926e-02
## It: 450; obj: 2.356e+00; abs: 1.862e-03; rel: 7.910e-04; norm: 9.869e-02
## It: 451; obj: 2.359e+00; abs: 2.289e-03; rel: 9.713e-04; norm: 9.908e-02
## It: 452; obj: 2.353e+00; abs: 5.322e-03; rel: 2.256e-03; norm: 9.902e-02
## It: 453; obj: 2.355e+00; abs: 2.067e-03; rel: 8.783e-04; norm: 9.877e-02
## It: 454; obj: 2.356e+00; abs: 8.891e-04; rel: 3.775e-04; norm: 9.869e-02
## It: 455; obj: 2.355e+00; abs: 9.126e-04; rel: 3.873e-04; norm: 9.859e-02
## It: 456; obj: 2.355e+00; abs: 7.633e-05; rel: 3.241e-05; norm: 9.871e-02
## It: 457; obj: 2.356e+00; abs: 6.069e-04; rel: 2.577e-04; norm: 9.876e-02
## It: 458; obj: 2.352e+00; abs: 3.511e-03; rel: 1.490e-03; norm: 9.904e-02
## It: 459; obj: 2.355e+00; abs: 2.311e-03; rel: 9.825e-04; norm: 9.886e-02
## It: 460; obj: 2.355e+00; abs: 3.460e-04; rel: 1.469e-04; norm: 9.865e-02
## It: 461; obj: 2.353e+00; abs: 2.441e-03; rel: 1.037e-03; norm: 9.888e-02
## It: 462; obj: 2.358e+00; abs: 5.142e-03; rel: 2.186e-03; norm: 9.857e-02
## It: 463; obj: 2.360e+00; abs: 1.979e-03; rel: 8.394e-04; norm: 9.879e-02
## It: 464; obj: 2.354e+00; abs: 5.861e-03; rel: 2.484e-03; norm: 9.892e-02
## It: 465; obj: 2.356e+00; abs: 1.760e-03; rel: 7.476e-04; norm: 9.879e-02
## It: 466; obj: 2.356e+00; abs: 3.041e-04; rel: 1.291e-04; norm: 9.899e-02
## It: 467; obj: 2.353e+00; abs: 3.122e-03; rel: 1.325e-03; norm: 9.900e-02
## It: 468; obj: 2.356e+00; abs: 2.924e-03; rel: 1.243e-03; norm: 9.863e-02
## It: 469; obj: 2.355e+00; abs: 3.836e-04; rel: 1.628e-04; norm: 9.918e-02
## It: 470; obj: 2.353e+00; abs: 1.904e-03; rel: 8.084e-04; norm: 9.894e-02
## It: 471; obj: 2.357e+00; abs: 3.677e-03; rel: 1.563e-03; norm: 9.848e-02
## It: 472; obj: 2.358e+00; abs: 1.043e-03; rel: 4.427e-04; norm: 9.888e-02
## It: 473; obj: 2.355e+00; abs: 3.105e-03; rel: 1.317e-03; norm: 9.926e-02
## It: 474; obj: 2.356e+00; abs: 1.015e-03; rel: 4.309e-04; norm: 9.856e-02
## It: 475; obj: 2.354e+00; abs: 2.281e-03; rel: 9.680e-04; norm: 9.887e-02
## It: 476; obj: 2.352e+00; abs: 1.486e-03; rel: 6.312e-04; norm: 9.892e-02
## It: 477; obj: 2.356e+00; abs: 3.215e-03; rel: 1.367e-03; norm: 9.870e-02
## It: 478; obj: 2.358e+00; abs: 2.182e-03; rel: 9.261e-04; norm: 9.882e-02
## It: 479; obj: 2.357e+00; abs: 1.231e-03; rel: 5.222e-04; norm: 9.921e-02
## It: 480; obj: 2.356e+00; abs: 3.094e-04; rel: 1.313e-04; norm: 9.895e-02
## It: 481; obj: 2.351e+00; abs: 4.844e-03; rel: 2.056e-03; norm: 9.903e-02
## It: 482; obj: 2.352e+00; abs: 8.825e-04; rel: 3.753e-04; norm: 9.858e-02
## It: 483; obj: 2.355e+00; abs: 2.524e-03; rel: 1.073e-03; norm: 9.852e-02
## It: 484; obj: 2.357e+00; abs: 2.014e-03; rel: 8.552e-04; norm: 9.895e-02
## It: 485; obj: 2.354e+00; abs: 3.020e-03; rel: 1.281e-03; norm: 9.930e-02
## It: 486; obj: 2.355e+00; abs: 1.589e-03; rel: 6.749e-04; norm: 9.898e-02

```

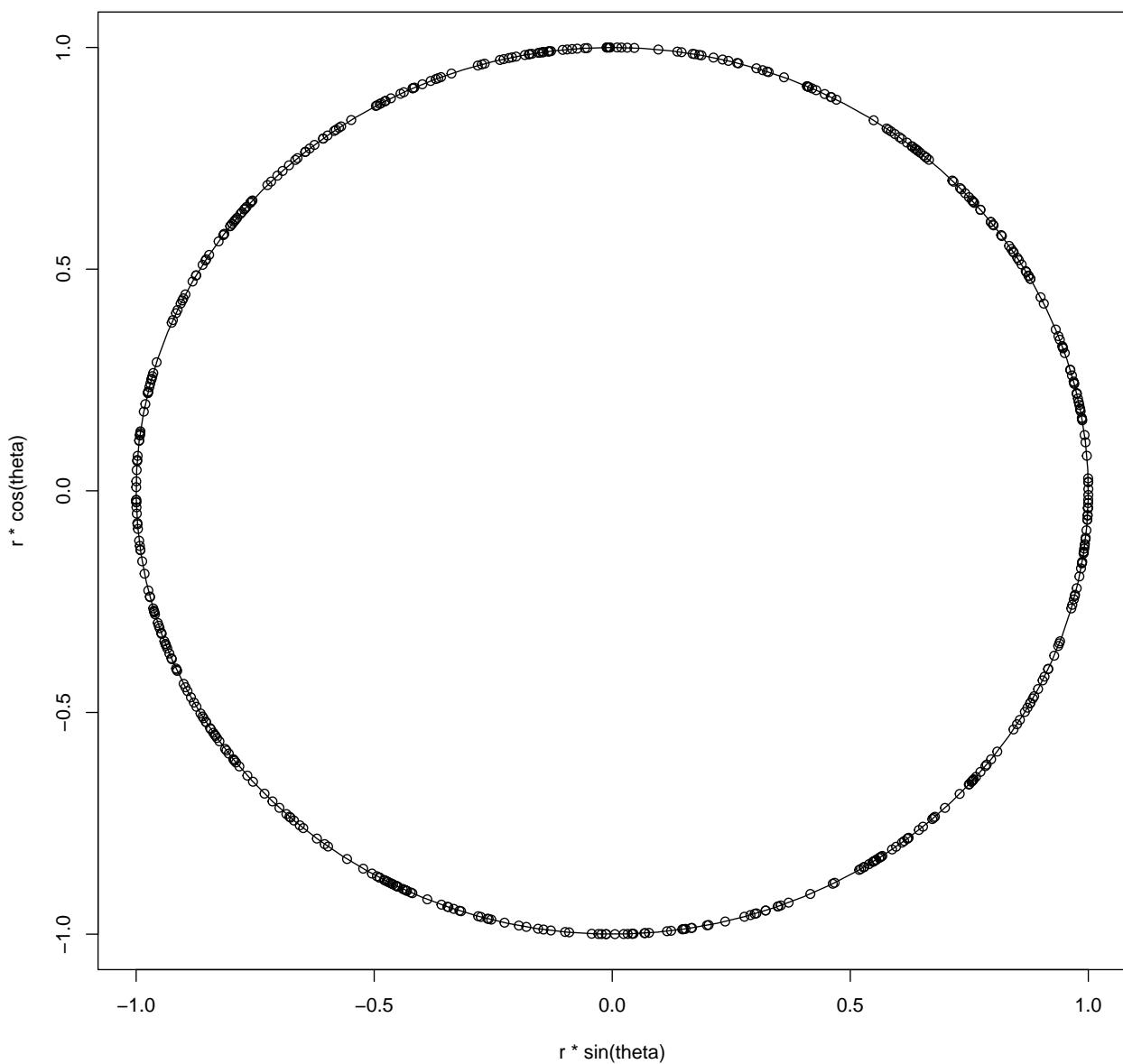
```

## It: 487; obj: 2.353e+00; abs: 2.565e-03; rel: 1.089e-03; norm: 9.892e-02
## It: 488; obj: 2.352e+00; abs: 7.509e-04; rel: 3.191e-04; norm: 9.868e-02
## It: 489; obj: 2.357e+00; abs: 4.766e-03; rel: 2.026e-03; norm: 9.848e-02
## It: 490; obj: 2.360e+00; abs: 3.413e-03; rel: 1.448e-03; norm: 9.867e-02
## It: 491; obj: 2.357e+00; abs: 3.430e-03; rel: 1.453e-03; norm: 9.892e-02
## It: 492; obj: 2.356e+00; abs: 1.105e-03; rel: 4.687e-04; norm: 9.851e-02
## It: 493; obj: 2.353e+00; abs: 2.807e-03; rel: 1.192e-03; norm: 9.893e-02
## It: 494; obj: 2.355e+00; abs: 1.928e-03; rel: 8.194e-04; norm: 9.892e-02
## It: 495; obj: 2.359e+00; abs: 4.409e-03; rel: 1.872e-03; norm: 9.842e-02
## It: 496; obj: 2.360e+00; abs: 7.366e-04; rel: 3.122e-04; norm: 9.891e-02
## It: 497; obj: 2.356e+00; abs: 3.981e-03; rel: 1.687e-03; norm: 9.927e-02
## It: 498; obj: 2.356e+00; abs: 4.986e-04; rel: 2.116e-04; norm: 9.867e-02
## It: 499; obj: 2.353e+00; abs: 3.782e-03; rel: 1.605e-03; norm: 9.875e-02
## It: 500; obj: 2.355e+00; abs: 2.303e-03; rel: 9.787e-04; norm: 9.846e-02

```

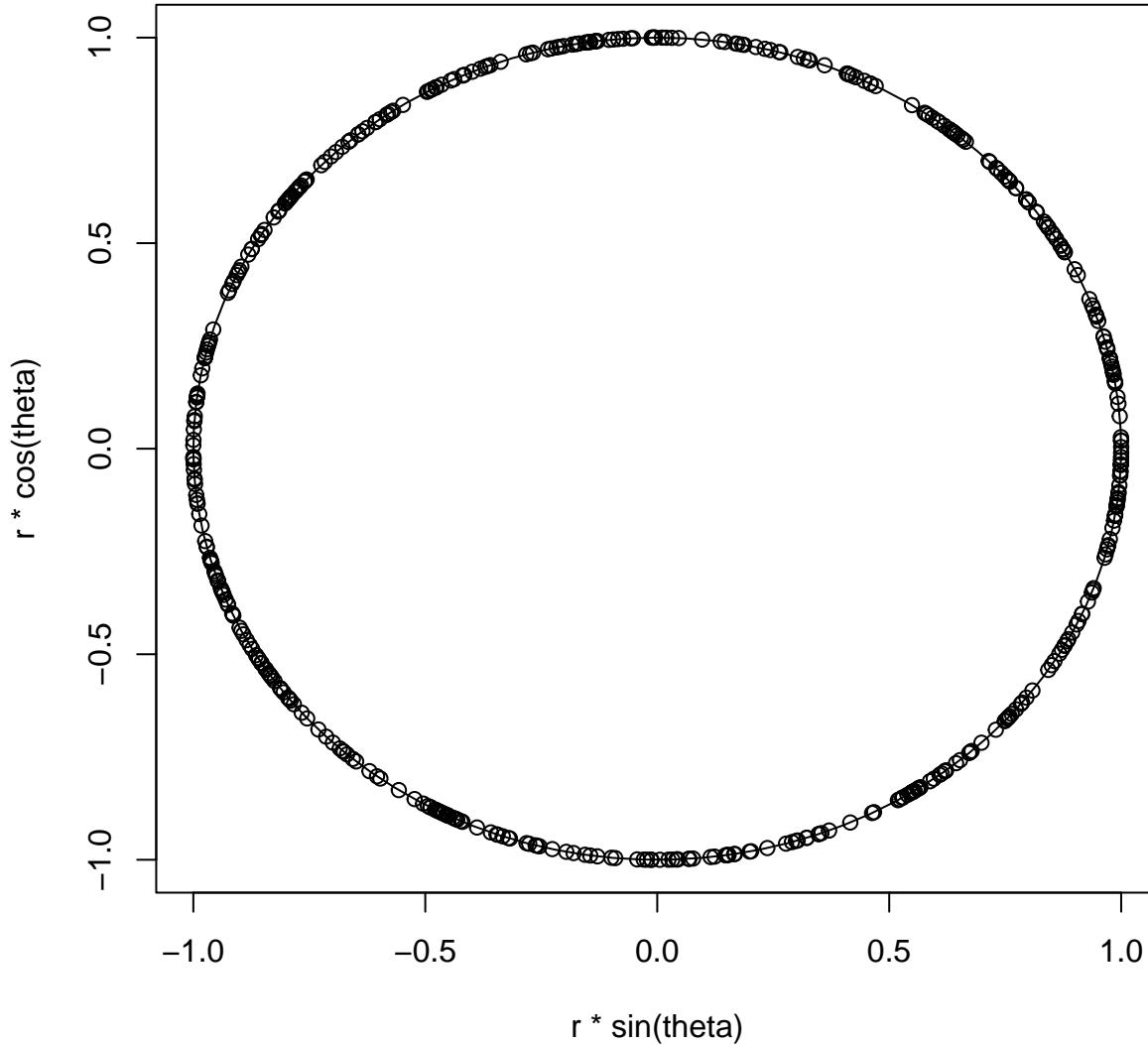


Iteration 500



```
Y_rad <- DirStats:::to_rad(Y)
r <- 1
theta <<- Y_rad
plot(r*sin(theta),
     r*cos(theta),
     xlim=c(-max(r),max(r)),
     ylim=c(-max(r),max(r)))

polygon(max(r)*sin(seq(0,2*pi,length.out=100)),max(r)*cos(seq(0,2*pi,length.out=100)))
```



Now we are going to reduce to dimension \mathbb{S}^2 then $d = 2$ (sphere):

```
Y <- psc_sne(X=x_4, d=2, rho_psc_list = rho_four_perp20, num_iteration=500,
               visualize_prog = TRUE)
```

```
## It: 1; obj: 1.935e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.998e-01
## It: 2; obj: 1.668e+01; abs: 2.667e+00; rel: 1.379e-01; norm: 3.595e-01
## It: 3; obj: 1.529e+01; abs: 1.391e+00; rel: 8.342e-02; norm: 6.218e-01
## It: 4; obj: 1.465e+01; abs: 6.383e-01; rel: 4.175e-02; norm: 7.784e-01
## It: 5; obj: 1.432e+01; abs: 3.282e-01; rel: 2.241e-02; norm: 8.539e-01
## It: 6; obj: 1.412e+01; abs: 2.019e-01; rel: 1.410e-02; norm: 8.963e-01
## It: 7; obj: 1.397e+01; abs: 1.434e-01; rel: 1.016e-02; norm: 9.234e-01
## It: 8; obj: 1.388e+01; abs: 9.801e-02; rel: 7.013e-03; norm: 9.420e-01
## It: 9; obj: 1.380e+01; abs: 7.337e-02; rel: 5.287e-03; norm: 9.650e-01
## It: 10; obj: 1.375e+01; abs: 4.973e-02; rel: 3.603e-03; norm: 9.882e-01
## It: 11; obj: 1.371e+01; abs: 4.064e-02; rel: 2.955e-03; norm: 1.012e+00
## It: 12; obj: 1.368e+01; abs: 3.134e-02; rel: 2.285e-03; norm: 1.033e+00
## It: 13; obj: 1.366e+01; abs: 2.251e-02; rel: 1.645e-03; norm: 1.053e+00
## It: 14; obj: 1.364e+01; abs: 2.301e-02; rel: 1.684e-03; norm: 1.070e+00
## It: 15; obj: 1.361e+01; abs: 2.491e-02; rel: 1.827e-03; norm: 1.086e+00
```

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## It: 16; obj: 1.359e+01; abs: 2.642e-02; rel: 1.941e-03; norm: 1.099e+00
## It: 17; obj: 1.356e+01; abs: 2.237e-02; rel: 1.647e-03; norm: 1.112e+00
## It: 18; obj: 1.354e+01; abs: 2.204e-02; rel: 1.625e-03; norm: 1.122e+00
## It: 19; obj: 1.353e+01; abs: 1.457e-02; rel: 1.076e-03; norm: 1.133e+00
## It: 20; obj: 1.351e+01; abs: 1.407e-02; rel: 1.040e-03; norm: 1.143e+00
## It: 21; obj: 1.350e+01; abs: 7.940e-03; rel: 5.876e-04; norm: 1.153e+00
## It: 22; obj: 1.349e+01; abs: 1.157e-02; rel: 8.569e-04; norm: 1.164e+00
## It: 23; obj: 1.348e+01; abs: 1.245e-02; rel: 9.224e-04; norm: 1.174e+00
## It: 24; obj: 1.347e+01; abs: 1.333e-02; rel: 9.889e-04; norm: 1.184e+00
## It: 25; obj: 1.346e+01; abs: 7.477e-03; rel: 5.552e-04; norm: 1.194e+00

## It: 26; obj: 1.346e+01; abs: 1.791e-03; rel: 1.331e-04; norm: 1.203e+00
## It: 27; obj: 1.346e+01; abs: 4.856e-03; rel: 3.608e-04; norm: 1.212e+00
## It: 28; obj: 1.347e+01; abs: 1.011e-02; rel: 7.507e-04; norm: 1.220e+00
## It: 29; obj: 1.348e+01; abs: 1.194e-02; rel: 8.862e-04; norm: 1.227e+00
## It: 30; obj: 1.350e+01; abs: 1.184e-02; rel: 8.781e-04; norm: 1.234e+00
## It: 31; obj: 1.351e+01; abs: 1.534e-02; rel: 1.136e-03; norm: 1.240e+00
## It: 32; obj: 1.353e+01; abs: 1.862e-02; rel: 1.378e-03; norm: 1.246e+00
## It: 33; obj: 1.356e+01; abs: 2.527e-02; rel: 1.867e-03; norm: 1.251e+00
## It: 34; obj: 1.359e+01; abs: 3.091e-02; rel: 2.280e-03; norm: 1.253e+00
## It: 35; obj: 1.363e+01; abs: 3.938e-02; rel: 2.899e-03; norm: 1.255e+00
## It: 36; obj: 1.367e+01; abs: 4.352e-02; rel: 3.194e-03; norm: 1.255e+00
## It: 37; obj: 1.372e+01; abs: 4.816e-02; rel: 3.523e-03; norm: 1.257e+00
## It: 38; obj: 1.377e+01; abs: 5.049e-02; rel: 3.681e-03; norm: 1.273e+00
## It: 39; obj: 1.382e+01; abs: 5.384e-02; rel: 3.911e-03; norm: 1.297e+00
## It: 40; obj: 1.388e+01; abs: 5.580e-02; rel: 4.037e-03; norm: 1.322e+00
## It: 41; obj: 1.394e+01; abs: 5.855e-02; rel: 4.219e-03; norm: 1.348e+00
## It: 42; obj: 1.400e+01; abs: 6.053e-02; rel: 4.343e-03; norm: 1.375e+00
## It: 43; obj: 1.406e+01; abs: 6.305e-02; rel: 4.505e-03; norm: 1.404e+00
## It: 44; obj: 1.412e+01; abs: 6.512e-02; rel: 4.632e-03; norm: 1.433e+00
## It: 45; obj: 1.419e+01; abs: 6.743e-02; rel: 4.774e-03; norm: 1.462e+00
## It: 46; obj: 1.426e+01; abs: 6.933e-02; rel: 4.885e-03; norm: 1.492e+00
## It: 47; obj: 1.433e+01; abs: 7.118e-02; rel: 4.991e-03; norm: 1.523e+00
## It: 48; obj: 1.441e+01; abs: 7.256e-02; rel: 5.063e-03; norm: 1.553e+00
## It: 49; obj: 1.448e+01; abs: 7.362e-02; rel: 5.111e-03; norm: 1.583e+00
## It: 50; obj: 1.455e+01; abs: 7.408e-02; rel: 5.117e-03; norm: 1.613e+00

## It: 51; obj: 1.463e+01; abs: 7.405e-02; rel: 5.088e-03; norm: 1.642e+00
## It: 52; obj: 1.470e+01; abs: 7.344e-02; rel: 5.021e-03; norm: 1.671e+00
## It: 53; obj: 1.477e+01; abs: 7.234e-02; rel: 4.921e-03; norm: 1.700e+00
## It: 54; obj: 1.484e+01; abs: 7.067e-02; rel: 4.784e-03; norm: 1.727e+00
## It: 55; obj: 1.491e+01; abs: 6.857e-02; rel: 4.619e-03; norm: 1.754e+00
## It: 56; obj: 1.498e+01; abs: 6.618e-02; rel: 4.438e-03; norm: 1.780e+00
## It: 57; obj: 1.504e+01; abs: 6.377e-02; rel: 4.257e-03; norm: 1.804e+00
## It: 58; obj: 1.510e+01; abs: 6.148e-02; rel: 4.087e-03; norm: 1.827e+00
## It: 59; obj: 1.516e+01; abs: 5.943e-02; rel: 3.935e-03; norm: 1.849e+00
## It: 60; obj: 1.522e+01; abs: 5.760e-02; rel: 3.798e-03; norm: 1.869e+00
## It: 61; obj: 1.528e+01; abs: 5.595e-02; rel: 3.676e-03; norm: 1.888e+00
## It: 62; obj: 1.533e+01; abs: 5.440e-02; rel: 3.561e-03; norm: 1.906e+00
## It: 63; obj: 1.538e+01; abs: 5.285e-02; rel: 3.448e-03; norm: 1.922e+00
## It: 64; obj: 1.543e+01; abs: 5.125e-02; rel: 3.331e-03; norm: 1.937e+00
## It: 65; obj: 1.548e+01; abs: 4.955e-02; rel: 3.210e-03; norm: 1.951e+00
## It: 66; obj: 1.553e+01; abs: 4.776e-02; rel: 3.084e-03; norm: 1.964e+00
## It: 67; obj: 1.558e+01; abs: 4.589e-02; rel: 2.954e-03; norm: 1.975e+00
## It: 68; obj: 1.562e+01; abs: 4.394e-02; rel: 2.821e-03; norm: 1.986e+00

```

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## It: 69; obj: 1.566e+01; abs: 4.194e-02; rel: 2.685e-03; norm: 1.996e+00
## It: 70; obj: 1.570e+01; abs: 3.991e-02; rel: 2.548e-03; norm: 2.006e+00
## It: 71; obj: 1.574e+01; abs: 3.787e-02; rel: 2.411e-03; norm: 2.014e+00
## It: 72; obj: 1.578e+01; abs: 3.583e-02; rel: 2.276e-03; norm: 2.022e+00
## It: 73; obj: 1.581e+01; abs: 3.381e-02; rel: 2.143e-03; norm: 2.029e+00
## It: 74; obj: 1.584e+01; abs: 3.183e-02; rel: 2.013e-03; norm: 2.036e+00
## It: 75; obj: 1.587e+01; abs: 2.989e-02; rel: 1.887e-03; norm: 2.042e+00
## It: 76; obj: 1.590e+01; abs: 2.801e-02; rel: 1.765e-03; norm: 2.047e+00
## It: 77; obj: 1.593e+01; abs: 2.620e-02; rel: 1.648e-03; norm: 2.052e+00
## It: 78; obj: 1.595e+01; abs: 2.446e-02; rel: 1.536e-03; norm: 2.057e+00
## It: 79; obj: 1.597e+01; abs: 2.281e-02; rel: 1.430e-03; norm: 2.061e+00
## It: 80; obj: 1.600e+01; abs: 2.123e-02; rel: 1.329e-03; norm: 2.065e+00
## It: 81; obj: 1.602e+01; abs: 1.973e-02; rel: 1.234e-03; norm: 2.069e+00
## It: 82; obj: 1.603e+01; abs: 1.832e-02; rel: 1.144e-03; norm: 2.072e+00
## It: 83; obj: 1.605e+01; abs: 1.700e-02; rel: 1.060e-03; norm: 2.075e+00
## It: 84; obj: 1.607e+01; abs: 1.575e-02; rel: 9.812e-04; norm: 2.078e+00
## It: 85; obj: 1.608e+01; abs: 1.458e-02; rel: 9.076e-04; norm: 2.080e+00
## It: 86; obj: 1.609e+01; abs: 1.349e-02; rel: 8.391e-04; norm: 2.082e+00
## It: 87; obj: 1.611e+01; abs: 1.248e-02; rel: 7.752e-04; norm: 2.085e+00
## It: 88; obj: 1.612e+01; abs: 1.153e-02; rel: 7.159e-04; norm: 2.086e+00
## It: 89; obj: 1.613e+01; abs: 1.065e-02; rel: 6.609e-04; norm: 2.088e+00
## It: 90; obj: 1.614e+01; abs: 9.837e-03; rel: 6.099e-04; norm: 2.090e+00
## It: 91; obj: 1.615e+01; abs: 9.081e-03; rel: 5.627e-04; norm: 2.091e+00
## It: 92; obj: 1.616e+01; abs: 8.381e-03; rel: 5.190e-04; norm: 2.093e+00
## It: 93; obj: 1.616e+01; abs: 7.733e-03; rel: 4.787e-04; norm: 2.094e+00
## It: 94; obj: 1.617e+01; abs: 7.135e-03; rel: 4.414e-04; norm: 2.095e+00
## It: 95; obj: 1.618e+01; abs: 6.582e-03; rel: 4.070e-04; norm: 2.096e+00
## It: 96; obj: 1.618e+01; abs: 6.072e-03; rel: 3.753e-04; norm: 2.097e+00
## It: 97; obj: 1.619e+01; abs: 5.601e-03; rel: 3.461e-04; norm: 2.098e+00
## It: 98; obj: 1.619e+01; abs: 5.167e-03; rel: 3.191e-04; norm: 2.098e+00
## It: 99; obj: 1.620e+01; abs: 4.766e-03; rel: 2.943e-04; norm: 2.099e+00
## It: 100; obj: 1.620e+01; abs: 4.398e-03; rel: 2.715e-04; norm: 2.100e+00
## It: 101; obj: 2.432e+00; abs: 1.377e+01; rel: 8.499e-01; norm: 1.687e-01
## It: 102; obj: 2.116e+00; abs: 3.160e-01; rel: 1.300e-01; norm: 9.335e-02
## It: 103; obj: 2.063e+00; abs: 5.217e-02; rel: 2.466e-02; norm: 1.138e-01
## It: 104; obj: 2.039e+00; abs: 2.491e-02; rel: 1.207e-02; norm: 1.108e-01
## It: 105; obj: 2.095e+00; abs: 5.650e-02; rel: 2.772e-02; norm: 1.221e-01
## It: 106; obj: 2.219e+00; abs: 1.239e-01; rel: 5.912e-02; norm: 1.327e-01
## It: 107; obj: 2.342e+00; abs: 1.232e-01; rel: 5.554e-02; norm: 1.383e-01
## It: 108; obj: 2.516e+00; abs: 1.739e-01; rel: 7.424e-02; norm: 1.540e-01
## It: 109; obj: 2.648e+00; abs: 1.317e-01; rel: 5.236e-02; norm: 1.703e-01
## It: 110; obj: 2.820e+00; abs: 1.721e-01; rel: 6.499e-02; norm: 1.885e-01
## It: 111; obj: 2.883e+00; abs: 6.305e-02; rel: 2.236e-02; norm: 2.097e-01
## It: 112; obj: 2.945e+00; abs: 6.217e-02; rel: 2.157e-02; norm: 2.505e-01
## It: 113; obj: 2.953e+00; abs: 7.880e-03; rel: 2.676e-03; norm: 2.924e-01
## It: 114; obj: 3.005e+00; abs: 5.256e-02; rel: 1.780e-02; norm: 3.387e-01
## It: 115; obj: 2.947e+00; abs: 5.893e-02; rel: 1.961e-02; norm: 3.652e-01
## It: 116; obj: 2.915e+00; abs: 3.194e-02; rel: 1.084e-02; norm: 4.080e-01
## It: 117; obj: 2.891e+00; abs: 2.312e-02; rel: 7.931e-03; norm: 4.117e-01
## It: 118; obj: 2.778e+00; abs: 1.135e-01; rel: 3.924e-02; norm: 4.341e-01
## It: 119; obj: 2.730e+00; abs: 4.839e-02; rel: 1.742e-02; norm: 4.456e-01
## It: 120; obj: 2.711e+00; abs: 1.900e-02; rel: 6.962e-03; norm: 4.621e-01
## It: 121; obj: 2.691e+00; abs: 1.971e-02; rel: 7.272e-03; norm: 4.754e-01

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## It: 122; obj: 2.683e+00; abs: 7.659e-03; rel: 2.846e-03; norm: 4.944e-01
## It: 123; obj: 2.663e+00; abs: 2.012e-02; rel: 7.497e-03; norm: 4.953e-01
## It: 124; obj: 2.670e+00; abs: 6.521e-03; rel: 2.448e-03; norm: 5.053e-01
## It: 125; obj: 2.660e+00; abs: 9.793e-03; rel: 3.668e-03; norm: 5.066e-01
## It: 126; obj: 2.650e+00; abs: 1.004e-02; rel: 3.776e-03; norm: 5.158e-01
## It: 127; obj: 2.643e+00; abs: 6.949e-03; rel: 2.623e-03; norm: 5.068e-01
## It: 128; obj: 2.666e+00; abs: 2.322e-02; rel: 8.787e-03; norm: 5.113e-01
## It: 129; obj: 2.629e+00; abs: 3.717e-02; rel: 1.394e-02; norm: 5.162e-01
## It: 130; obj: 2.652e+00; abs: 2.343e-02; rel: 8.911e-03; norm: 5.127e-01
## It: 131; obj: 2.625e+00; abs: 2.735e-02; rel: 1.031e-02; norm: 5.106e-01
## It: 132; obj: 2.660e+00; abs: 3.492e-02; rel: 1.330e-02; norm: 5.170e-01
## It: 133; obj: 2.621e+00; abs: 3.882e-02; rel: 1.459e-02; norm: 5.167e-01
## It: 134; obj: 2.667e+00; abs: 4.639e-02; rel: 1.770e-02; norm: 5.175e-01
## It: 135; obj: 2.614e+00; abs: 5.317e-02; rel: 1.993e-02; norm: 5.213e-01
## It: 136; obj: 2.659e+00; abs: 4.492e-02; rel: 1.718e-02; norm: 5.196e-01
## It: 137; obj: 2.621e+00; abs: 3.783e-02; rel: 1.423e-02; norm: 5.220e-01
## It: 138; obj: 2.669e+00; abs: 4.719e-02; rel: 1.800e-02; norm: 5.198e-01
## It: 139; obj: 2.630e+00; abs: 3.819e-02; rel: 1.431e-02; norm: 5.229e-01
## It: 140; obj: 2.643e+00; abs: 1.232e-02; rel: 4.683e-03; norm: 5.224e-01
## It: 141; obj: 2.620e+00; abs: 2.239e-02; rel: 8.471e-03; norm: 5.206e-01
## It: 142; obj: 2.635e+00; abs: 1.424e-02; rel: 5.435e-03; norm: 5.217e-01
## It: 143; obj: 2.610e+00; abs: 2.500e-02; rel: 9.489e-03; norm: 5.193e-01
## It: 144; obj: 2.621e+00; abs: 1.127e-02; rel: 4.320e-03; norm: 5.161e-01
## It: 145; obj: 2.596e+00; abs: 2.502e-02; rel: 9.546e-03; norm: 5.162e-01
## It: 146; obj: 2.642e+00; abs: 4.645e-02; rel: 1.789e-02; norm: 5.149e-01
## It: 147; obj: 2.591e+00; abs: 5.178e-02; rel: 1.960e-02; norm: 5.191e-01
## It: 148; obj: 2.649e+00; abs: 5.864e-02; rel: 2.264e-02; norm: 5.151e-01
## It: 149; obj: 2.614e+00; abs: 3.512e-02; rel: 1.326e-02; norm: 5.184e-01
## It: 150; obj: 2.637e+00; abs: 2.276e-02; rel: 8.707e-03; norm: 5.186e-01
## It: 151; obj: 2.592e+00; abs: 4.466e-02; rel: 1.694e-02; norm: 5.174e-01
## It: 152; obj: 2.620e+00; abs: 2.823e-02; rel: 1.089e-02; norm: 5.176e-01
## It: 153; obj: 2.589e+00; abs: 3.165e-02; rel: 1.208e-02; norm: 5.169e-01
## It: 154; obj: 2.627e+00; abs: 3.807e-02; rel: 1.471e-02; norm: 5.178e-01
## It: 155; obj: 2.597e+00; abs: 2.934e-02; rel: 1.117e-02; norm: 5.202e-01
## It: 156; obj: 2.630e+00; abs: 3.244e-02; rel: 1.249e-02; norm: 5.198e-01
## It: 157; obj: 2.606e+00; abs: 2.422e-02; rel: 9.208e-03; norm: 5.199e-01
## It: 158; obj: 2.637e+00; abs: 3.158e-02; rel: 1.212e-02; norm: 5.214e-01
## It: 159; obj: 2.585e+00; abs: 5.228e-02; rel: 1.982e-02; norm: 5.258e-01
## It: 160; obj: 2.627e+00; abs: 4.241e-02; rel: 1.641e-02; norm: 5.204e-01
## It: 161; obj: 2.582e+00; abs: 4.522e-02; rel: 1.721e-02; norm: 5.225e-01
## It: 162; obj: 2.630e+00; abs: 4.762e-02; rel: 1.844e-02; norm: 5.180e-01
## It: 163; obj: 2.592e+00; abs: 3.755e-02; rel: 1.428e-02; norm: 5.214e-01
## It: 164; obj: 2.623e+00; abs: 3.125e-02; rel: 1.205e-02; norm: 5.178e-01
## It: 165; obj: 2.592e+00; abs: 3.101e-02; rel: 1.182e-02; norm: 5.198e-01
## It: 166; obj: 2.624e+00; abs: 3.146e-02; rel: 1.214e-02; norm: 5.181e-01
## It: 167; obj: 2.586e+00; abs: 3.797e-02; rel: 1.447e-02; norm: 5.186e-01
## It: 168; obj: 2.626e+00; abs: 3.983e-02; rel: 1.540e-02; norm: 5.176e-01
## It: 169; obj: 2.591e+00; abs: 3.508e-02; rel: 1.336e-02; norm: 5.204e-01
## It: 170; obj: 2.626e+00; abs: 3.575e-02; rel: 1.380e-02; norm: 5.202e-01
## It: 171; obj: 2.579e+00; abs: 4.792e-02; rel: 1.824e-02; norm: 5.210e-01
## It: 172; obj: 2.627e+00; abs: 4.840e-02; rel: 1.877e-02; norm: 5.160e-01
## It: 173; obj: 2.590e+00; abs: 3.735e-02; rel: 1.422e-02; norm: 5.178e-01
## It: 174; obj: 2.620e+00; abs: 3.060e-02; rel: 1.182e-02; norm: 5.147e-01

```

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## It: 175; obj: 2.581e+00; abs: 3.954e-02; rel: 1.509e-02; norm: 5.174e-01
## It: 176; obj: 2.605e+00; abs: 2.406e-02; rel: 9.321e-03; norm: 5.172e-01
## It: 177; obj: 2.586e+00; abs: 1.894e-02; rel: 7.273e-03; norm: 5.171e-01
## It: 178; obj: 2.599e+00; abs: 1.325e-02; rel: 5.124e-03; norm: 5.172e-01
## It: 179; obj: 2.578e+00; abs: 2.136e-02; rel: 8.220e-03; norm: 5.156e-01
## It: 180; obj: 2.593e+00; abs: 1.578e-02; rel: 6.123e-03; norm: 5.161e-01
## It: 181; obj: 2.577e+00; abs: 1.678e-02; rel: 6.472e-03; norm: 5.139e-01
## It: 182; obj: 2.590e+00; abs: 1.365e-02; rel: 5.298e-03; norm: 5.143e-01
## It: 183; obj: 2.566e+00; abs: 2.475e-02; rel: 9.556e-03; norm: 5.115e-01
## It: 184; obj: 2.603e+00; abs: 3.710e-02; rel: 1.446e-02; norm: 5.094e-01
## It: 185; obj: 2.581e+00; abs: 2.124e-02; rel: 8.162e-03; norm: 5.122e-01
## It: 186; obj: 2.604e+00; abs: 2.258e-02; rel: 8.748e-03; norm: 5.160e-01
## It: 187; obj: 2.561e+00; abs: 4.314e-02; rel: 1.657e-02; norm: 5.181e-01
## It: 188; obj: 2.602e+00; abs: 4.121e-02; rel: 1.609e-02; norm: 5.142e-01
## It: 189; obj: 2.568e+00; abs: 3.413e-02; rel: 1.312e-02; norm: 5.171e-01
## It: 190; obj: 2.595e+00; abs: 2.725e-02; rel: 1.061e-02; norm: 5.169e-01
## It: 191; obj: 2.562e+00; abs: 3.279e-02; rel: 1.263e-02; norm: 5.159e-01
## It: 192; obj: 2.593e+00; abs: 3.013e-02; rel: 1.176e-02; norm: 5.144e-01
## It: 193; obj: 2.559e+00; abs: 3.359e-02; rel: 1.296e-02; norm: 5.167e-01
## It: 194; obj: 2.588e+00; abs: 2.936e-02; rel: 1.147e-02; norm: 5.153e-01
## It: 195; obj: 2.553e+00; abs: 3.550e-02; rel: 1.372e-02; norm: 5.142e-01
## It: 196; obj: 2.588e+00; abs: 3.561e-02; rel: 1.395e-02; norm: 5.133e-01
## It: 197; obj: 2.549e+00; abs: 3.904e-02; rel: 1.508e-02; norm: 5.138e-01
## It: 198; obj: 2.590e+00; abs: 4.078e-02; rel: 1.600e-02; norm: 5.117e-01
## It: 199; obj: 2.556e+00; abs: 3.457e-02; rel: 1.335e-02; norm: 5.103e-01
## It: 200; obj: 2.595e+00; abs: 3.954e-02; rel: 1.547e-02; norm: 5.124e-01
## It: 201; obj: 2.556e+00; abs: 3.915e-02; rel: 1.508e-02; norm: 5.147e-01
## It: 202; obj: 2.595e+00; abs: 3.856e-02; rel: 1.509e-02; norm: 5.144e-01
## It: 203; obj: 2.553e+00; abs: 4.127e-02; rel: 1.591e-02; norm: 5.150e-01
## It: 204; obj: 2.596e+00; abs: 4.320e-02; rel: 1.692e-02; norm: 5.133e-01
## It: 205; obj: 2.557e+00; abs: 3.983e-02; rel: 1.534e-02; norm: 5.152e-01
## It: 206; obj: 2.594e+00; abs: 3.741e-02; rel: 1.463e-02; norm: 5.146e-01
## It: 207; obj: 2.555e+00; abs: 3.889e-02; rel: 1.499e-02; norm: 5.151e-01
## It: 208; obj: 2.589e+00; abs: 3.335e-02; rel: 1.305e-02; norm: 5.134e-01
## It: 209; obj: 2.561e+00; abs: 2.786e-02; rel: 1.076e-02; norm: 5.133e-01
## It: 210; obj: 2.596e+00; abs: 3.499e-02; rel: 1.367e-02; norm: 5.137e-01
## It: 211; obj: 2.554e+00; abs: 4.162e-02; rel: 1.603e-02; norm: 5.164e-01
## It: 212; obj: 2.587e+00; abs: 3.285e-02; rel: 1.286e-02; norm: 5.134e-01
## It: 213; obj: 2.561e+00; abs: 2.627e-02; rel: 1.015e-02; norm: 5.123e-01
## It: 214; obj: 2.596e+00; abs: 3.569e-02; rel: 1.394e-02; norm: 5.122e-01
## It: 215; obj: 2.549e+00; abs: 4.683e-02; rel: 1.804e-02; norm: 5.155e-01
## It: 216; obj: 2.587e+00; abs: 3.790e-02; rel: 1.486e-02; norm: 5.116e-01
## It: 217; obj: 2.553e+00; abs: 3.450e-02; rel: 1.333e-02; norm: 5.118e-01
## It: 218; obj: 2.586e+00; abs: 3.264e-02; rel: 1.279e-02; norm: 5.119e-01
## It: 219; obj: 2.554e+00; abs: 3.184e-02; rel: 1.231e-02; norm: 5.116e-01
## It: 220; obj: 2.588e+00; abs: 3.482e-02; rel: 1.363e-02; norm: 5.094e-01
## It: 221; obj: 2.555e+00; abs: 3.339e-02; rel: 1.290e-02; norm: 5.109e-01
## It: 222; obj: 2.594e+00; abs: 3.878e-02; rel: 1.518e-02; norm: 5.104e-01
## It: 223; obj: 2.559e+00; abs: 3.443e-02; rel: 1.327e-02; norm: 5.130e-01
## It: 224; obj: 2.593e+00; abs: 3.399e-02; rel: 1.328e-02; norm: 5.113e-01
## It: 225; obj: 2.564e+00; abs: 2.936e-02; rel: 1.132e-02; norm: 5.143e-01
## It: 226; obj: 2.594e+00; abs: 2.985e-02; rel: 1.164e-02; norm: 5.142e-01

```

```

## It: 227; obj: 2.555e+00; abs: 3.918e-02; rel: 1.510e-02; norm: 5.152e-01
## It: 228; obj: 2.596e+00; abs: 4.084e-02; rel: 1.599e-02; norm: 5.130e-01
## It: 229; obj: 2.556e+00; abs: 3.920e-02; rel: 1.510e-02; norm: 5.141e-01
## It: 230; obj: 2.593e+00; abs: 3.674e-02; rel: 1.437e-02; norm: 5.136e-01
## It: 231; obj: 2.557e+00; abs: 3.655e-02; rel: 1.410e-02; norm: 5.142e-01
## It: 232; obj: 2.598e+00; abs: 4.132e-02; rel: 1.616e-02; norm: 5.123e-01
## It: 233; obj: 2.553e+00; abs: 4.450e-02; rel: 1.713e-02; norm: 5.143e-01
## It: 234; obj: 2.587e+00; abs: 3.375e-02; rel: 1.322e-02; norm: 5.117e-01
## It: 235; obj: 2.558e+00; abs: 2.909e-02; rel: 1.124e-02; norm: 5.114e-01
## It: 236; obj: 2.592e+00; abs: 3.417e-02; rel: 1.336e-02; norm: 5.107e-01
## It: 237; obj: 2.549e+00; abs: 4.277e-02; rel: 1.650e-02; norm: 5.098e-01
## It: 238; obj: 2.583e+00; abs: 3.341e-02; rel: 1.310e-02; norm: 5.108e-01
## It: 239; obj: 2.550e+00; abs: 3.241e-02; rel: 1.255e-02; norm: 5.102e-01
## It: 240; obj: 2.585e+00; abs: 3.425e-02; rel: 1.343e-02; norm: 5.114e-01
## It: 241; obj: 2.560e+00; abs: 2.451e-02; rel: 9.481e-03; norm: 5.098e-01
## It: 242; obj: 2.592e+00; abs: 3.163e-02; rel: 1.235e-02; norm: 5.109e-01
## It: 243; obj: 2.554e+00; abs: 3.767e-02; rel: 1.453e-02; norm: 5.123e-01
## It: 244; obj: 2.608e+00; abs: 5.422e-02; rel: 2.123e-02; norm: 5.108e-01
## It: 245; obj: 2.567e+00; abs: 4.171e-02; rel: 1.599e-02; norm: 5.132e-01
## It: 246; obj: 2.608e+00; abs: 4.146e-02; rel: 1.615e-02; norm: 5.155e-01
## It: 247; obj: 2.563e+00; abs: 4.491e-02; rel: 1.722e-02; norm: 5.180e-01
## It: 248; obj: 2.574e+00; abs: 1.092e-02; rel: 4.258e-03; norm: 5.175e-01
## It: 249; obj: 2.540e+00; abs: 3.366e-02; rel: 1.308e-02; norm: 5.054e-01
## It: 250; obj: 2.579e+00; abs: 3.884e-02; rel: 1.529e-02; norm: 5.026e-01

## It: 251; obj: 2.541e+00; abs: 3.878e-02; rel: 1.503e-02; norm: 4.967e-01
## It: 252; obj: 2.570e+00; abs: 2.903e-02; rel: 1.143e-02; norm: 4.954e-01
## It: 253; obj: 2.554e+00; abs: 1.597e-02; rel: 6.214e-03; norm: 4.941e-01
## It: 254; obj: 2.558e+00; abs: 4.766e-03; rel: 1.866e-03; norm: 4.962e-01
## It: 255; obj: 2.558e+00; abs: 9.591e-05; rel: 3.749e-05; norm: 4.908e-01
## It: 256; obj: 2.593e+00; abs: 3.409e-02; rel: 1.333e-02; norm: 4.924e-01
## It: 257; obj: 2.538e+00; abs: 5.427e-02; rel: 2.093e-02; norm: 4.923e-01
## It: 258; obj: 2.563e+00; abs: 2.499e-02; rel: 9.845e-03; norm: 4.901e-01
## It: 259; obj: 2.515e+00; abs: 4.812e-02; rel: 1.877e-02; norm: 4.903e-01
## It: 260; obj: 2.559e+00; abs: 4.365e-02; rel: 1.735e-02; norm: 4.870e-01
## It: 261; obj: 2.525e+00; abs: 3.373e-02; rel: 1.318e-02; norm: 4.859e-01
## It: 262; obj: 2.559e+00; abs: 3.403e-02; rel: 1.348e-02; norm: 4.932e-01
## It: 263; obj: 2.528e+00; abs: 3.120e-02; rel: 1.219e-02; norm: 4.928e-01
## It: 264; obj: 2.570e+00; abs: 4.157e-02; rel: 1.644e-02; norm: 4.960e-01
## It: 265; obj: 2.547e+00; abs: 2.267e-02; rel: 8.824e-03; norm: 4.920e-01
## It: 266; obj: 2.580e+00; abs: 3.267e-02; rel: 1.283e-02; norm: 4.974e-01
## It: 267; obj: 2.539e+00; abs: 4.085e-02; rel: 1.584e-02; norm: 4.959e-01
## It: 268; obj: 2.567e+00; abs: 2.823e-02; rel: 1.112e-02; norm: 4.996e-01
## It: 269; obj: 2.546e+00; abs: 2.059e-02; rel: 8.023e-03; norm: 4.954e-01
## It: 270; obj: 2.570e+00; abs: 2.369e-02; rel: 9.305e-03; norm: 5.015e-01
## It: 271; obj: 2.536e+00; abs: 3.384e-02; rel: 1.317e-02; norm: 4.963e-01
## It: 272; obj: 2.571e+00; abs: 3.529e-02; rel: 1.392e-02; norm: 4.967e-01
## It: 273; obj: 2.533e+00; abs: 3.819e-02; rel: 1.485e-02; norm: 4.987e-01
## It: 274; obj: 2.548e+00; abs: 1.495e-02; rel: 5.902e-03; norm: 5.004e-01
## It: 275; obj: 2.525e+00; abs: 2.338e-02; rel: 9.174e-03; norm: 4.970e-01

## It: 276; obj: 2.548e+00; abs: 2.297e-02; rel: 9.096e-03; norm: 4.953e-01
## It: 277; obj: 2.537e+00; abs: 1.066e-02; rel: 4.186e-03; norm: 4.903e-01
## It: 278; obj: 2.560e+00; abs: 2.322e-02; rel: 9.150e-03; norm: 4.951e-01
## It: 279; obj: 2.526e+00; abs: 3.478e-02; rel: 1.359e-02; norm: 4.956e-01

```

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## It: 280; obj: 2.559e+00; abs: 3.326e-02; rel: 1.317e-02; norm: 4.930e-01
## It: 281; obj: 2.547e+00; abs: 1.172e-02; rel: 4.582e-03; norm: 4.901e-01
## It: 282; obj: 2.559e+00; abs: 1.148e-02; rel: 4.509e-03; norm: 4.940e-01
## It: 283; obj: 2.549e+00; abs: 9.201e-03; rel: 3.596e-03; norm: 4.925e-01
## It: 284; obj: 2.552e+00; abs: 2.266e-03; rel: 8.888e-04; norm: 4.994e-01
## It: 285; obj: 2.543e+00; abs: 8.731e-03; rel: 3.422e-03; norm: 4.947e-01
## It: 286; obj: 2.561e+00; abs: 1.843e-02; rel: 7.247e-03; norm: 4.974e-01
## It: 287; obj: 2.556e+00; abs: 5.656e-03; rel: 2.208e-03; norm: 4.962e-01
## It: 288; obj: 2.570e+00; abs: 1.460e-02; rel: 5.714e-03; norm: 5.006e-01
## It: 289; obj: 2.561e+00; abs: 9.443e-03; rel: 3.674e-03; norm: 4.953e-01
## It: 290; obj: 2.558e+00; abs: 2.562e-03; rel: 1.001e-03; norm: 5.007e-01
## It: 291; obj: 2.555e+00; abs: 3.151e-03; rel: 1.232e-03; norm: 5.001e-01
## It: 292; obj: 2.564e+00; abs: 9.341e-03; rel: 3.656e-03; norm: 5.019e-01
## It: 293; obj: 2.539e+00; abs: 2.582e-02; rel: 1.007e-02; norm: 5.010e-01
## It: 294; obj: 2.571e+00; abs: 3.244e-02; rel: 1.278e-02; norm: 5.005e-01
## It: 295; obj: 2.554e+00; abs: 1.668e-02; rel: 6.488e-03; norm: 4.973e-01
## It: 296; obj: 2.585e+00; abs: 3.070e-02; rel: 1.202e-02; norm: 4.950e-01
## It: 297; obj: 2.559e+00; abs: 2.614e-02; rel: 1.011e-02; norm: 4.953e-01
## It: 298; obj: 2.562e+00; abs: 3.351e-03; rel: 1.309e-03; norm: 5.003e-01
## It: 299; obj: 2.542e+00; abs: 1.985e-02; rel: 7.748e-03; norm: 5.016e-01
## It: 300; obj: 2.556e+00; abs: 1.379e-02; rel: 5.423e-03; norm: 4.984e-01

## It: 301; obj: 2.541e+00; abs: 1.549e-02; rel: 6.058e-03; norm: 4.968e-01
## It: 302; obj: 2.555e+00; abs: 1.415e-02; rel: 5.569e-03; norm: 4.965e-01
## It: 303; obj: 2.537e+00; abs: 1.833e-02; rel: 7.175e-03; norm: 4.966e-01
## It: 304; obj: 2.551e+00; abs: 1.467e-02; rel: 5.783e-03; norm: 4.954e-01
## It: 305; obj: 2.534e+00; abs: 1.757e-02; rel: 6.888e-03; norm: 4.961e-01
## It: 306; obj: 2.557e+00; abs: 2.293e-02; rel: 9.051e-03; norm: 4.987e-01
## It: 307; obj: 2.549e+00; abs: 7.764e-03; rel: 3.037e-03; norm: 4.963e-01
## It: 308; obj: 2.548e+00; abs: 5.893e-04; rel: 2.312e-04; norm: 4.974e-01
## It: 309; obj: 2.546e+00; abs: 2.520e-03; rel: 9.889e-04; norm: 4.958e-01
## It: 310; obj: 2.552e+00; abs: 6.073e-03; rel: 2.386e-03; norm: 4.988e-01
## It: 311; obj: 2.536e+00; abs: 1.553e-02; rel: 6.087e-03; norm: 4.941e-01
## It: 312; obj: 2.554e+00; abs: 1.786e-02; rel: 7.040e-03; norm: 4.932e-01
## It: 313; obj: 2.555e+00; abs: 1.240e-03; rel: 4.854e-04; norm: 4.924e-01
## It: 314; obj: 2.573e+00; abs: 1.715e-02; rel: 6.711e-03; norm: 4.965e-01
## It: 315; obj: 2.554e+00; abs: 1.819e-02; rel: 7.070e-03; norm: 4.970e-01
## It: 316; obj: 2.569e+00; abs: 1.472e-02; rel: 5.762e-03; norm: 4.995e-01
## It: 317; obj: 2.546e+00; abs: 2.259e-02; rel: 8.793e-03; norm: 5.021e-01
## It: 318; obj: 2.561e+00; abs: 1.406e-02; rel: 5.521e-03; norm: 5.057e-01
## It: 319; obj: 2.541e+00; abs: 1.913e-02; rel: 7.473e-03; norm: 5.024e-01
## It: 320; obj: 2.544e+00; abs: 2.404e-03; rel: 9.460e-04; norm: 5.006e-01
## It: 321; obj: 2.545e+00; abs: 8.859e-04; rel: 3.483e-04; norm: 4.946e-01
## It: 322; obj: 2.555e+00; abs: 1.026e-02; rel: 4.033e-03; norm: 4.957e-01
## It: 323; obj: 2.538e+00; abs: 1.681e-02; rel: 6.580e-03; norm: 4.920e-01
## It: 324; obj: 2.573e+00; abs: 3.442e-02; rel: 1.356e-02; norm: 4.938e-01
## It: 325; obj: 2.545e+00; abs: 2.790e-02; rel: 1.084e-02; norm: 4.964e-01

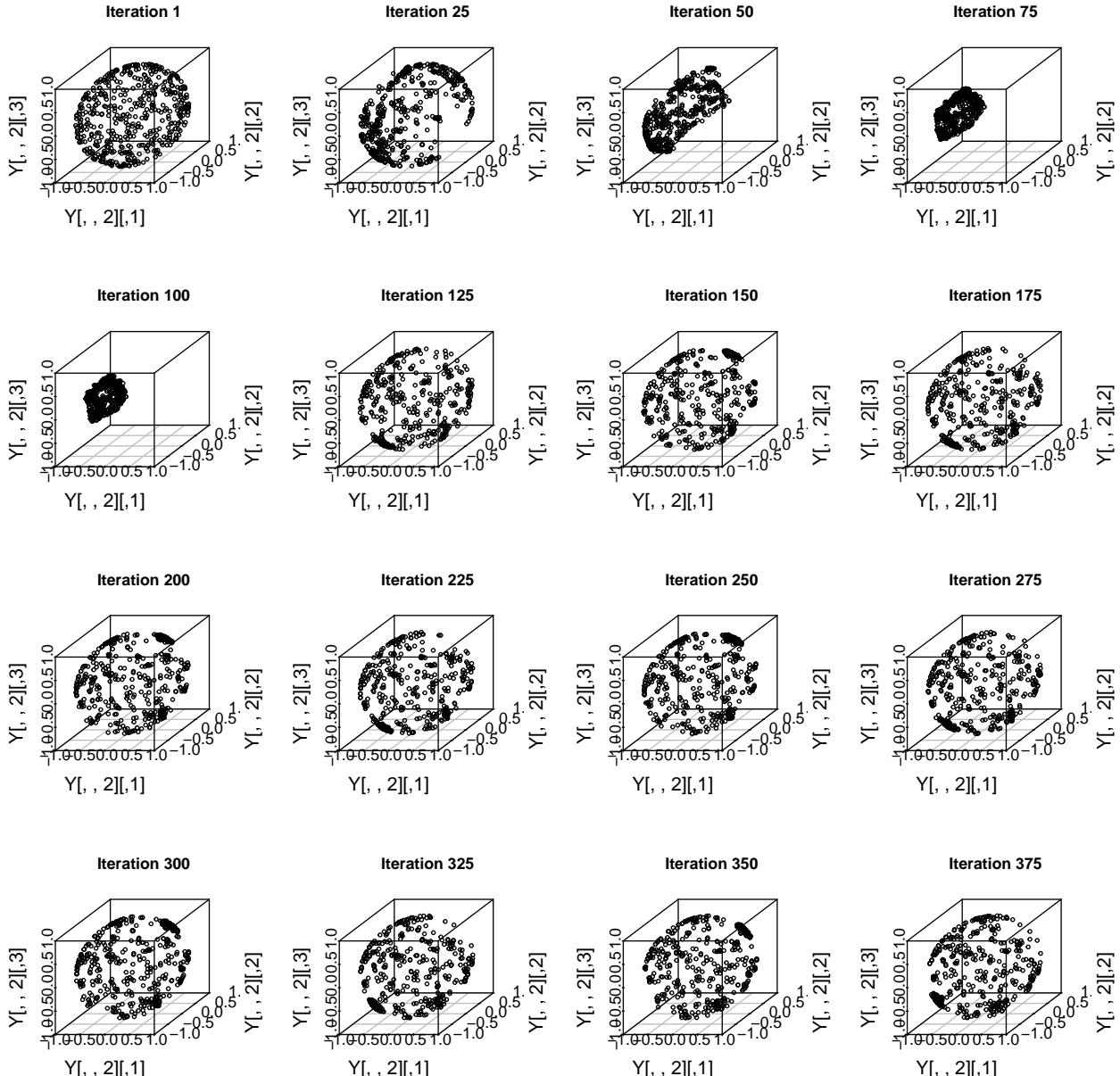
## It: 326; obj: 2.557e+00; abs: 1.240e-02; rel: 4.872e-03; norm: 4.989e-01
## It: 327; obj: 2.547e+00; abs: 9.607e-03; rel: 3.757e-03; norm: 4.964e-01
## It: 328; obj: 2.555e+00; abs: 7.133e-03; rel: 2.800e-03; norm: 5.011e-01
## It: 329; obj: 2.566e+00; abs: 1.178e-02; rel: 4.610e-03; norm: 4.978e-01
## It: 330; obj: 2.553e+00; abs: 1.346e-02; rel: 5.246e-03; norm: 5.023e-01
## It: 331; obj: 2.555e+00; abs: 2.002e-03; rel: 7.841e-04; norm: 4.951e-01
## It: 332; obj: 2.560e+00; abs: 5.137e-03; rel: 2.011e-03; norm: 4.969e-01

```

```

## It: 333; obj: 2.554e+00; abs: 6.056e-03; rel: 2.366e-03; norm: 4.940e-01
## It: 334; obj: 2.561e+00; abs: 7.216e-03; rel: 2.825e-03; norm: 4.996e-01
## It: 335; obj: 2.562e+00; abs: 4.323e-04; rel: 1.688e-04; norm: 4.962e-01
## It: 336; obj: 2.559e+00; abs: 2.889e-03; rel: 1.128e-03; norm: 5.010e-01
## It: 337; obj: 2.540e+00; abs: 1.869e-02; rel: 7.306e-03; norm: 4.969e-01
## It: 338; obj: 2.569e+00; abs: 2.866e-02; rel: 1.128e-02; norm: 5.007e-01
## It: 339; obj: 2.552e+00; abs: 1.638e-02; rel: 6.376e-03; norm: 4.972e-01
## It: 340; obj: 2.567e+00; abs: 1.482e-02; rel: 5.805e-03; norm: 4.996e-01
## It: 341; obj: 2.538e+00; abs: 2.959e-02; rel: 1.153e-02; norm: 4.990e-01
## It: 342; obj: 2.563e+00; abs: 2.546e-02; rel: 1.003e-02; norm: 4.970e-01
## It: 343; obj: 2.548e+00; abs: 1.512e-02; rel: 5.899e-03; norm: 4.928e-01
## It: 344; obj: 2.558e+00; abs: 9.939e-03; rel: 3.901e-03; norm: 4.920e-01
## It: 345; obj: 2.536e+00; abs: 2.185e-02; rel: 8.543e-03; norm: 4.917e-01
## It: 346; obj: 2.569e+00; abs: 3.293e-02; rel: 1.299e-02; norm: 4.902e-01
## It: 347; obj: 2.553e+00; abs: 1.634e-02; rel: 6.361e-03; norm: 4.895e-01
## It: 348; obj: 2.580e+00; abs: 2.786e-02; rel: 1.091e-02; norm: 4.944e-01
## It: 349; obj: 2.568e+00; abs: 1.263e-02; rel: 4.896e-03; norm: 4.954e-01
## It: 350; obj: 2.572e+00; abs: 4.243e-03; rel: 1.652e-03; norm: 4.989e-01
## It: 351; obj: 2.562e+00; abs: 9.540e-03; rel: 3.709e-03; norm: 4.959e-01
## It: 352; obj: 2.573e+00; abs: 1.060e-02; rel: 4.135e-03; norm: 4.992e-01
## It: 353; obj: 2.546e+00; abs: 2.737e-02; rel: 1.064e-02; norm: 4.968e-01
## It: 354; obj: 2.576e+00; abs: 3.017e-02; rel: 1.185e-02; norm: 4.941e-01
## It: 355; obj: 2.563e+00; abs: 1.317e-02; rel: 5.112e-03; norm: 4.927e-01
## It: 356; obj: 2.568e+00; abs: 5.630e-03; rel: 2.197e-03; norm: 4.970e-01
## It: 357; obj: 2.557e+00; abs: 1.166e-02; rel: 4.538e-03; norm: 4.945e-01
## It: 358; obj: 2.551e+00; abs: 5.494e-03; rel: 2.149e-03; norm: 4.999e-01
## It: 359; obj: 2.570e+00; abs: 1.909e-02; rel: 7.481e-03; norm: 4.928e-01
## It: 360; obj: 2.577e+00; abs: 6.294e-03; rel: 2.449e-03; norm: 4.962e-01
## It: 361; obj: 2.547e+00; abs: 2.914e-02; rel: 1.131e-02; norm: 4.964e-01
## It: 362; obj: 2.584e+00; abs: 3.646e-02; rel: 1.431e-02; norm: 4.970e-01
## It: 363; obj: 2.545e+00; abs: 3.853e-02; rel: 1.491e-02; norm: 4.985e-01
## It: 364; obj: 2.584e+00; abs: 3.889e-02; rel: 1.528e-02; norm: 4.959e-01
## It: 365; obj: 2.553e+00; abs: 3.166e-02; rel: 1.225e-02; norm: 4.997e-01
## It: 366; obj: 2.560e+00; abs: 7.480e-03; rel: 2.930e-03; norm: 5.003e-01
## It: 367; obj: 2.566e+00; abs: 5.799e-03; rel: 2.265e-03; norm: 4.943e-01
## It: 368; obj: 2.572e+00; abs: 5.874e-03; rel: 2.289e-03; norm: 5.020e-01
## It: 369; obj: 2.565e+00; abs: 6.777e-03; rel: 2.635e-03; norm: 4.996e-01
## It: 370; obj: 2.571e+00; abs: 6.029e-03; rel: 2.350e-03; norm: 5.030e-01
## It: 371; obj: 2.563e+00; abs: 8.331e-03; rel: 3.240e-03; norm: 5.006e-01
## It: 372; obj: 2.559e+00; abs: 3.961e-03; rel: 1.546e-03; norm: 5.030e-01
## It: 373; obj: 2.554e+00; abs: 4.270e-03; rel: 1.669e-03; norm: 4.963e-01
## It: 374; obj: 2.565e+00; abs: 1.054e-02; rel: 4.128e-03; norm: 4.958e-01
## It: 375; obj: 2.554e+00; abs: 1.087e-02; rel: 4.239e-03; norm: 4.939e-01

```



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## It: 376; obj: 2.565e+00; abs: 1.071e-02; rel: 4.193e-03; norm: 5.005e-01
## It: 377; obj: 2.554e+00; abs: 1.129e-02; rel: 4.404e-03; norm: 4.998e-01
## It: 378; obj: 2.566e+00; abs: 1.287e-02; rel: 5.038e-03; norm: 5.001e-01
## It: 379; obj: 2.557e+00; abs: 9.042e-03; rel: 3.523e-03; norm: 4.960e-01
## It: 380; obj: 2.559e+00; abs: 1.865e-03; rel: 7.294e-04; norm: 5.015e-01
## It: 381; obj: 2.562e+00; abs: 3.060e-03; rel: 1.196e-03; norm: 4.963e-01
## It: 382; obj: 2.563e+00; abs: 6.310e-04; rel: 2.462e-04; norm: 4.974e-01
## It: 383; obj: 2.563e+00; abs: 9.296e-05; rel: 3.627e-05; norm: 4.960e-01
## It: 384; obj: 2.570e+00; abs: 7.475e-03; rel: 2.916e-03; norm: 5.002e-01
## It: 385; obj: 2.569e+00; abs: 1.470e-03; rel: 5.718e-04; norm: 4.926e-01
## It: 386; obj: 2.569e+00; abs: 4.112e-04; rel: 1.601e-04; norm: 4.971e-01
## It: 387; obj: 2.561e+00; abs: 8.754e-03; rel: 3.407e-03; norm: 4.952e-01
## It: 388; obj: 2.570e+00; abs: 9.351e-03; rel: 3.652e-03; norm: 4.993e-01
## It: 389; obj: 2.554e+00; abs: 1.649e-02; rel: 6.416e-03; norm: 4.995e-01
## It: 390; obj: 2.561e+00; abs: 7.608e-03; rel: 2.979e-03; norm: 5.004e-01

```

```

## It: 391; obj: 2.569e+00; abs: 7.413e-03; rel: 2.894e-03; norm: 4.963e-01
## It: 392; obj: 2.559e+00; abs: 9.575e-03; rel: 3.728e-03; norm: 4.973e-01
## It: 393; obj: 2.568e+00; abs: 8.667e-03; rel: 3.387e-03; norm: 4.897e-01
## It: 394; obj: 2.562e+00; abs: 6.094e-03; rel: 2.373e-03; norm: 4.943e-01
## It: 395; obj: 2.563e+00; abs: 1.757e-03; rel: 6.859e-04; norm: 4.935e-01
## It: 396; obj: 2.583e+00; abs: 1.986e-02; rel: 7.749e-03; norm: 4.971e-01
## It: 397; obj: 2.547e+00; abs: 3.598e-02; rel: 1.393e-02; norm: 5.000e-01
## It: 398; obj: 2.560e+00; abs: 1.293e-02; rel: 5.076e-03; norm: 5.028e-01
## It: 399; obj: 2.551e+00; abs: 8.629e-03; rel: 3.371e-03; norm: 4.998e-01
## It: 400; obj: 2.560e+00; abs: 8.702e-03; rel: 3.411e-03; norm: 4.981e-01

## It: 401; obj: 2.546e+00; abs: 1.422e-02; rel: 5.553e-03; norm: 4.967e-01
## It: 402; obj: 2.558e+00; abs: 1.248e-02; rel: 4.903e-03; norm: 4.966e-01
## It: 403; obj: 2.558e+00; abs: 9.182e-04; rel: 3.589e-04; norm: 4.954e-01
## It: 404; obj: 2.562e+00; abs: 4.461e-03; rel: 1.744e-03; norm: 4.941e-01
## It: 405; obj: 2.550e+00; abs: 1.183e-02; rel: 4.618e-03; norm: 4.877e-01
## It: 406; obj: 2.563e+00; abs: 1.273e-02; rel: 4.992e-03; norm: 4.893e-01
## It: 407; obj: 2.552e+00; abs: 1.091e-02; rel: 4.255e-03; norm: 4.916e-01
## It: 408; obj: 2.564e+00; abs: 1.184e-02; rel: 4.638e-03; norm: 4.948e-01
## It: 409; obj: 2.561e+00; abs: 2.564e-03; rel: 1.000e-03; norm: 4.914e-01
## It: 410; obj: 2.585e+00; abs: 2.334e-02; rel: 9.114e-03; norm: 4.935e-01
## It: 411; obj: 2.570e+00; abs: 1.420e-02; rel: 5.494e-03; norm: 4.941e-01
## It: 412; obj: 2.588e+00; abs: 1.730e-02; rel: 6.730e-03; norm: 4.995e-01
## It: 413; obj: 2.561e+00; abs: 2.691e-02; rel: 1.040e-02; norm: 5.017e-01
## It: 414; obj: 2.586e+00; abs: 2.557e-02; rel: 9.985e-03; norm: 5.002e-01
## It: 415; obj: 2.546e+00; abs: 4.050e-02; rel: 1.566e-02; norm: 4.984e-01
## It: 416; obj: 2.578e+00; abs: 3.261e-02; rel: 1.281e-02; norm: 4.975e-01
## It: 417; obj: 2.549e+00; abs: 2.978e-02; rel: 1.155e-02; norm: 4.962e-01
## It: 418; obj: 2.574e+00; abs: 2.526e-02; rel: 9.910e-03; norm: 4.971e-01
## It: 419; obj: 2.554e+00; abs: 2.031e-02; rel: 7.892e-03; norm: 4.943e-01
## It: 420; obj: 2.578e+00; abs: 2.423e-02; rel: 9.490e-03; norm: 4.939e-01
## It: 421; obj: 2.562e+00; abs: 1.555e-02; rel: 6.031e-03; norm: 4.995e-01
## It: 422; obj: 2.579e+00; abs: 1.628e-02; rel: 6.353e-03; norm: 5.014e-01
## It: 423; obj: 2.546e+00; abs: 3.299e-02; rel: 1.279e-02; norm: 4.955e-01
## It: 424; obj: 2.578e+00; abs: 3.191e-02; rel: 1.254e-02; norm: 4.946e-01
## It: 425; obj: 2.567e+00; abs: 1.019e-02; rel: 3.953e-03; norm: 4.955e-01

## It: 426; obj: 2.574e+00; abs: 6.334e-03; rel: 2.467e-03; norm: 5.036e-01
## It: 427; obj: 2.558e+00; abs: 1.542e-02; rel: 5.990e-03; norm: 5.027e-01
## It: 428; obj: 2.576e+00; abs: 1.789e-02; rel: 6.991e-03; norm: 5.016e-01
## It: 429; obj: 2.549e+00; abs: 2.736e-02; rel: 1.062e-02; norm: 5.024e-01
## It: 430; obj: 2.572e+00; abs: 2.301e-02; rel: 9.026e-03; norm: 5.024e-01
## It: 431; obj: 2.549e+00; abs: 2.328e-02; rel: 9.052e-03; norm: 4.998e-01
## It: 432; obj: 2.559e+00; abs: 1.067e-02; rel: 4.188e-03; norm: 4.987e-01
## It: 433; obj: 2.559e+00; abs: 2.870e-05; rel: 1.121e-05; norm: 4.954e-01
## It: 434; obj: 2.557e+00; abs: 2.642e-03; rel: 1.032e-03; norm: 4.985e-01
## It: 435; obj: 2.544e+00; abs: 1.260e-02; rel: 4.928e-03; norm: 4.972e-01
## It: 436; obj: 2.542e+00; abs: 1.568e-03; rel: 6.164e-04; norm: 4.939e-01
## It: 437; obj: 2.516e+00; abs: 2.687e-02; rel: 1.057e-02; norm: 4.886e-01
## It: 438; obj: 2.556e+00; abs: 4.006e-02; rel: 1.592e-02; norm: 4.857e-01
## It: 439; obj: 2.521e+00; abs: 3.499e-02; rel: 1.369e-02; norm: 4.858e-01
## It: 440; obj: 2.548e+00; abs: 2.729e-02; rel: 1.083e-02; norm: 4.833e-01
## It: 441; obj: 2.521e+00; abs: 2.670e-02; rel: 1.048e-02; norm: 4.806e-01
## It: 442; obj: 2.531e+00; abs: 9.298e-03; rel: 3.688e-03; norm: 4.874e-01
## It: 443; obj: 2.524e+00; abs: 6.233e-03; rel: 2.463e-03; norm: 4.912e-01

```

```

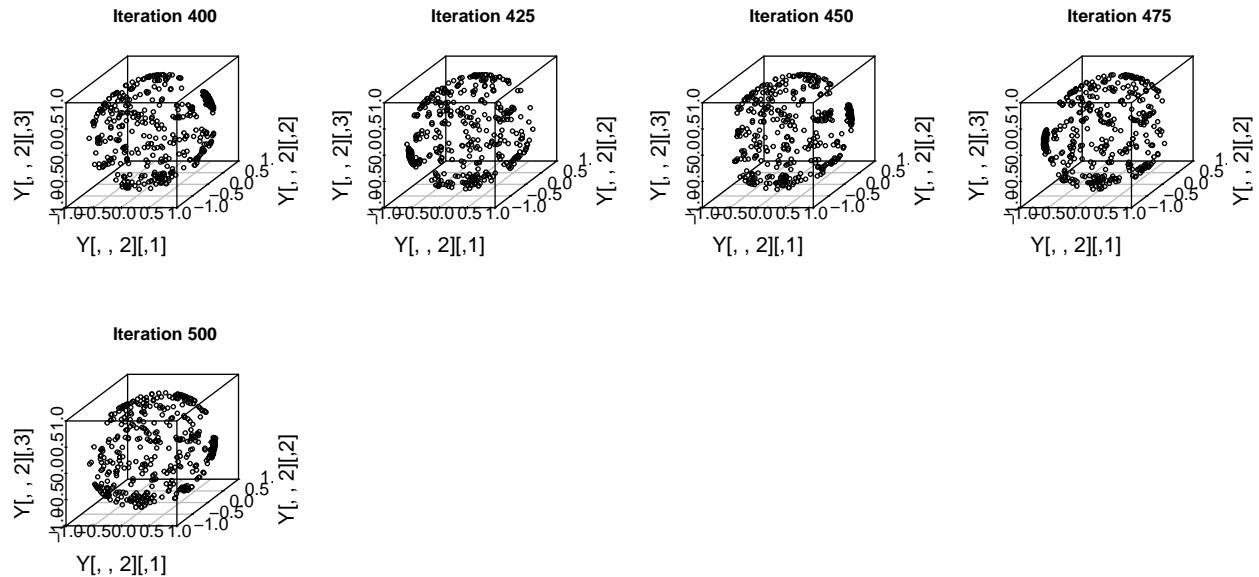
## It: 444; obj: 2.542e+00; abs: 1.769e-02; rel: 7.007e-03; norm: 4.918e-01
## It: 445; obj: 2.523e+00; abs: 1.882e-02; rel: 7.405e-03; norm: 4.855e-01
## It: 446; obj: 2.548e+00; abs: 2.466e-02; rel: 9.774e-03; norm: 4.867e-01
## It: 447; obj: 2.533e+00; abs: 1.459e-02; rel: 5.726e-03; norm: 4.864e-01
## It: 448; obj: 2.553e+00; abs: 1.953e-02; rel: 7.710e-03; norm: 4.881e-01
## It: 449; obj: 2.545e+00; abs: 8.077e-03; rel: 3.164e-03; norm: 4.869e-01
## It: 450; obj: 2.540e+00; abs: 4.285e-03; rel: 1.684e-03; norm: 4.916e-01
## It: 451; obj: 2.529e+00; abs: 1.155e-02; rel: 4.546e-03; norm: 4.881e-01
## It: 452; obj: 2.537e+00; abs: 8.523e-03; rel: 3.370e-03; norm: 4.910e-01
## It: 453; obj: 2.514e+00; abs: 2.306e-02; rel: 9.089e-03; norm: 4.886e-01
## It: 454; obj: 2.524e+00; abs: 9.610e-03; rel: 3.822e-03; norm: 4.881e-01
## It: 455; obj: 2.505e+00; abs: 1.876e-02; rel: 7.434e-03; norm: 4.854e-01
## It: 456; obj: 2.522e+00; abs: 1.638e-02; rel: 6.540e-03; norm: 4.830e-01
## It: 457; obj: 2.491e+00; abs: 3.090e-02; rel: 1.226e-02; norm: 4.784e-01
## It: 458; obj: 2.537e+00; abs: 4.624e-02; rel: 1.857e-02; norm: 4.784e-01
## It: 459; obj: 2.506e+00; abs: 3.095e-02; rel: 1.220e-02; norm: 4.799e-01
## It: 460; obj: 2.509e+00; abs: 3.292e-03; rel: 1.314e-03; norm: 4.859e-01
## It: 461; obj: 2.520e+00; abs: 1.084e-02; rel: 4.322e-03; norm: 4.765e-01
## It: 462; obj: 2.520e+00; abs: 4.259e-04; rel: 1.690e-04; norm: 4.811e-01
## It: 463; obj: 2.495e+00; abs: 2.424e-02; rel: 9.619e-03; norm: 4.798e-01
## It: 464; obj: 2.510e+00; abs: 1.495e-02; rel: 5.993e-03; norm: 4.782e-01
## It: 465; obj: 2.505e+00; abs: 4.839e-03; rel: 1.928e-03; norm: 4.745e-01
## It: 466; obj: 2.536e+00; abs: 3.044e-02; rel: 1.215e-02; norm: 4.809e-01
## It: 467; obj: 2.504e+00; abs: 3.218e-02; rel: 1.269e-02; norm: 4.818e-01
## It: 468; obj: 2.534e+00; abs: 3.065e-02; rel: 1.224e-02; norm: 4.804e-01
## It: 469; obj: 2.495e+00; abs: 3.926e-02; rel: 1.549e-02; norm: 4.771e-01
## It: 470; obj: 2.516e+00; abs: 2.068e-02; rel: 8.290e-03; norm: 4.818e-01
## It: 471; obj: 2.495e+00; abs: 2.034e-02; rel: 8.083e-03; norm: 4.784e-01
## It: 472; obj: 2.520e+00; abs: 2.432e-02; rel: 9.745e-03; norm: 4.771e-01
## It: 473; obj: 2.499e+00; abs: 2.042e-02; rel: 8.102e-03; norm: 4.717e-01
## It: 474; obj: 2.506e+00; abs: 7.076e-03; rel: 2.831e-03; norm: 4.745e-01
## It: 475; obj: 2.521e+00; abs: 1.503e-02; rel: 5.995e-03; norm: 4.738e-01
## It: 476; obj: 2.518e+00; abs: 3.737e-03; rel: 1.482e-03; norm: 4.792e-01
## It: 477; obj: 2.501e+00; abs: 1.700e-02; rel: 6.751e-03; norm: 4.809e-01
## It: 478; obj: 2.508e+00; abs: 7.654e-03; rel: 3.061e-03; norm: 4.802e-01
## It: 479; obj: 2.512e+00; abs: 3.780e-03; rel: 1.507e-03; norm: 4.787e-01
## It: 480; obj: 2.510e+00; abs: 2.518e-03; rel: 1.002e-03; norm: 4.819e-01
## It: 481; obj: 2.499e+00; abs: 1.038e-02; rel: 4.134e-03; norm: 4.786e-01
## It: 482; obj: 2.518e+00; abs: 1.911e-02; rel: 7.647e-03; norm: 4.753e-01
## It: 483; obj: 2.493e+00; abs: 2.522e-02; rel: 1.001e-02; norm: 4.720e-01
## It: 484; obj: 2.517e+00; abs: 2.357e-02; rel: 9.452e-03; norm: 4.714e-01
## It: 485; obj: 2.493e+00; abs: 2.418e-02; rel: 9.609e-03; norm: 4.716e-01
## It: 486; obj: 2.516e+00; abs: 2.346e-02; rel: 9.411e-03; norm: 4.719e-01
## It: 487; obj: 2.494e+00; abs: 2.204e-02; rel: 8.761e-03; norm: 4.758e-01
## It: 488; obj: 2.515e+00; abs: 2.056e-02; rel: 8.242e-03; norm: 4.744e-01
## It: 489; obj: 2.481e+00; abs: 3.404e-02; rel: 1.354e-02; norm: 4.728e-01
## It: 490; obj: 2.493e+00; abs: 1.265e-02; rel: 5.101e-03; norm: 4.693e-01
## It: 491; obj: 2.489e+00; abs: 3.943e-03; rel: 1.582e-03; norm: 4.582e-01
## It: 492; obj: 2.501e+00; abs: 1.217e-02; rel: 4.890e-03; norm: 4.623e-01
## It: 493; obj: 2.492e+00; abs: 9.571e-03; rel: 3.826e-03; norm: 4.648e-01
## It: 494; obj: 2.496e+00; abs: 4.060e-03; rel: 1.629e-03; norm: 4.692e-01
## It: 495; obj: 2.499e+00; abs: 2.734e-03; rel: 1.095e-03; norm: 4.643e-01
## It: 496; obj: 2.501e+00; abs: 2.394e-03; rel: 9.581e-04; norm: 4.658e-01

```

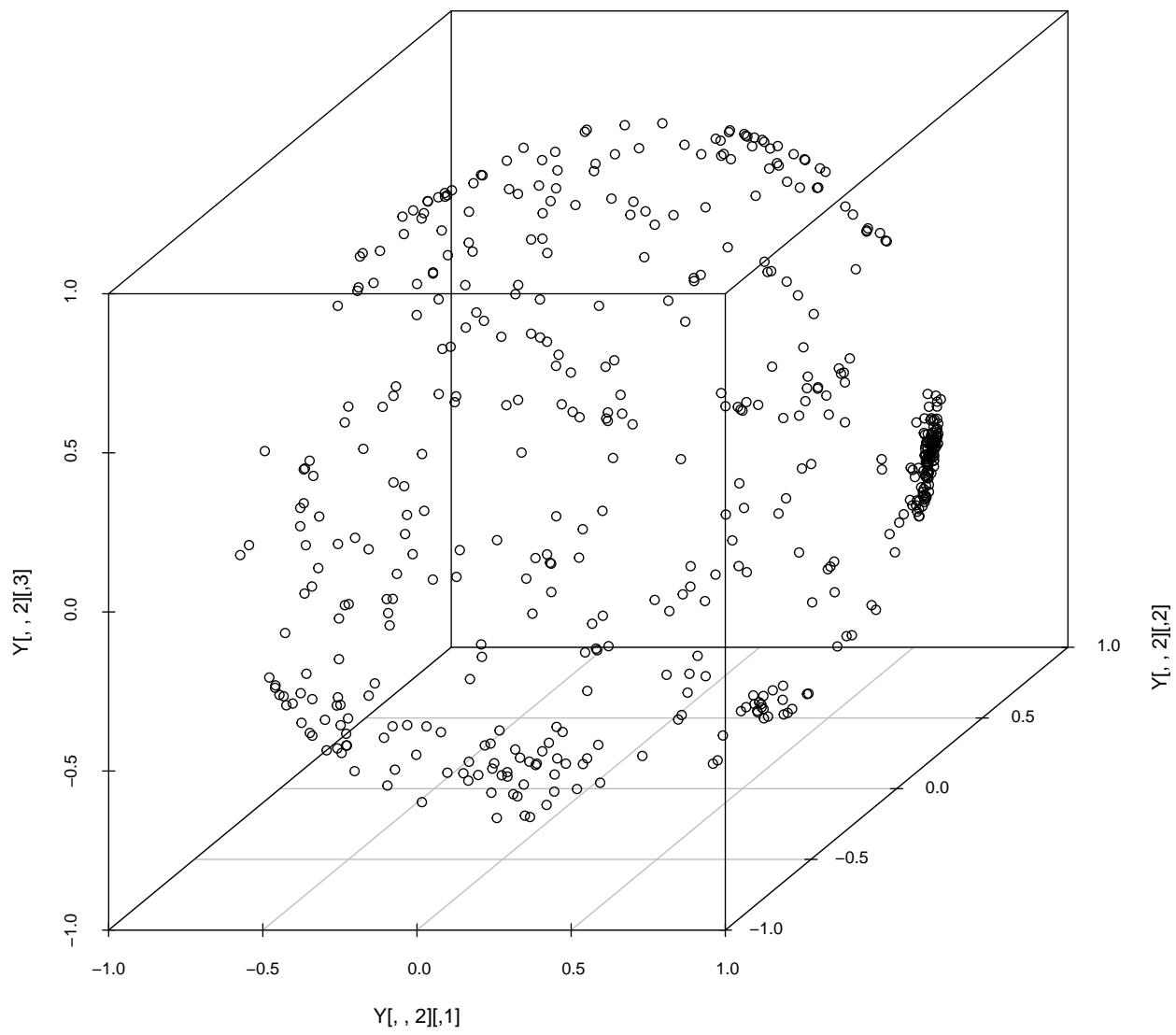
```

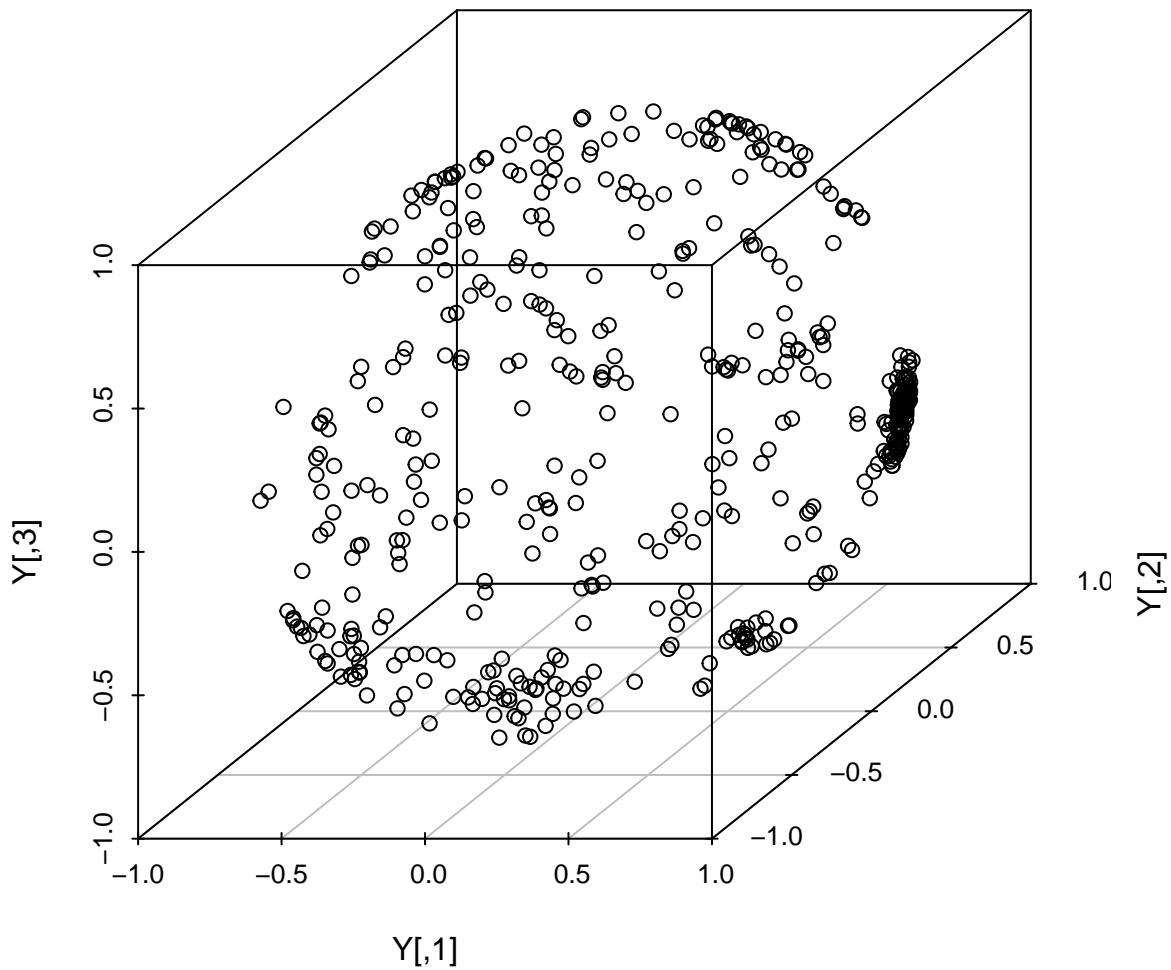
## It: 497; obj: 2.481e+00; abs: 2.029e-02; rel: 8.113e-03; norm: 4.663e-01
## It: 498; obj: 2.497e+00; abs: 1.669e-02; rel: 6.727e-03; norm: 4.624e-01
## It: 499; obj: 2.484e+00; abs: 1.343e-02; rel: 5.376e-03; norm: 4.595e-01
## It: 500; obj: 2.473e+00; abs: 1.077e-02; rel: 4.337e-03; norm: 4.631e-01

```



Iteration 500





Case 4

Playing with belts of points onto the sphere. First, let's generate the data

```
rotate_matrix_z_axis <- function(alpha) {
  deg2rad <- function(deg) {(deg * pi) / (180)}
  rads <- deg2rad(alpha)
  matrix(c(cos(rads), -sin(rads), 0,
          sin(rads), cos(rads), 0,
          0, 0, 1),
         byrow = T, nrow = 3)
}

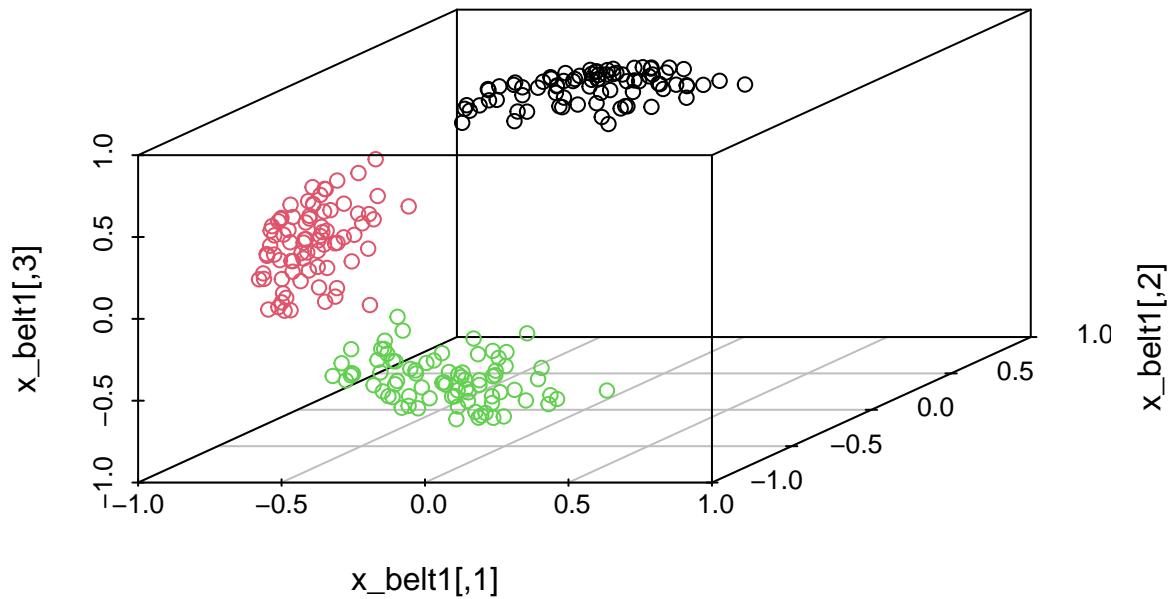
rotate_matrix_x_axis <- function(alpha) {
  deg2rad <- function(deg) {(deg * pi) / (180)}
  rads <- deg2rad(alpha)
  matrix(c(1, 0, 0,
          0, cos(rads), -sin(rads),
          0, sin(rads), cos(rads)),
         byrow = T, nrow = 3)
}
```

```

rotate_matrix_y_axis <- function(alpha) {
  deg2rad <- function(deg) {(deg * pi) / (180)}
  rads <- deg2rad(alpha)
  matrix(c(cos(rads), 0, sin(rads),
          0, 1, 0,
          -sin(rads), 0, cos(rads)),
         byrow = T, nrow = 3)
}

p = 2
set.seed(2)
# A <- matrix(runif((p + 1)^2)*2-0.5, ncol = p + 1)
# sigma <- t(A) %*% A
sigma <- diag(c(10, 2, .5))
n <- 80
# x_1_belt1 <- rotasym::r_ACG(n, sigma)
x_1_belt1 <- sphunif::r_alt(n = n, p = 3, alt = "SC", kappa = 200, nu = 0.9999)[,,1]
rotate_mat_90 <- rotate_matrix_y_axis(90)
x_2_belt1 <- x_1_belt1 %*% rotate_mat_90
rotate_mat_45 <- rotate_matrix_y_axis(60)
x_3_belt1 <- x_2_belt1 %*% rotate_mat_45
x_belt1 <- rbind(x_1_belt1, x_2_belt1, x_3_belt1)
scatterplot3d::scatterplot3d(x_belt1, xlim = c(-1, 1),
                             ylim = c(-1, 1), zlim = c(-1, 1),
                             color = rep(c(1,2,3), each=n))

```



```

rgl::plot3d(0, 0, 0, xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
            radius = 1, type = "s", col = "lightblue",
            lit = FALSE)
rgl::points3d(x_belt1, col = rep(c(1,2,3), each=n))

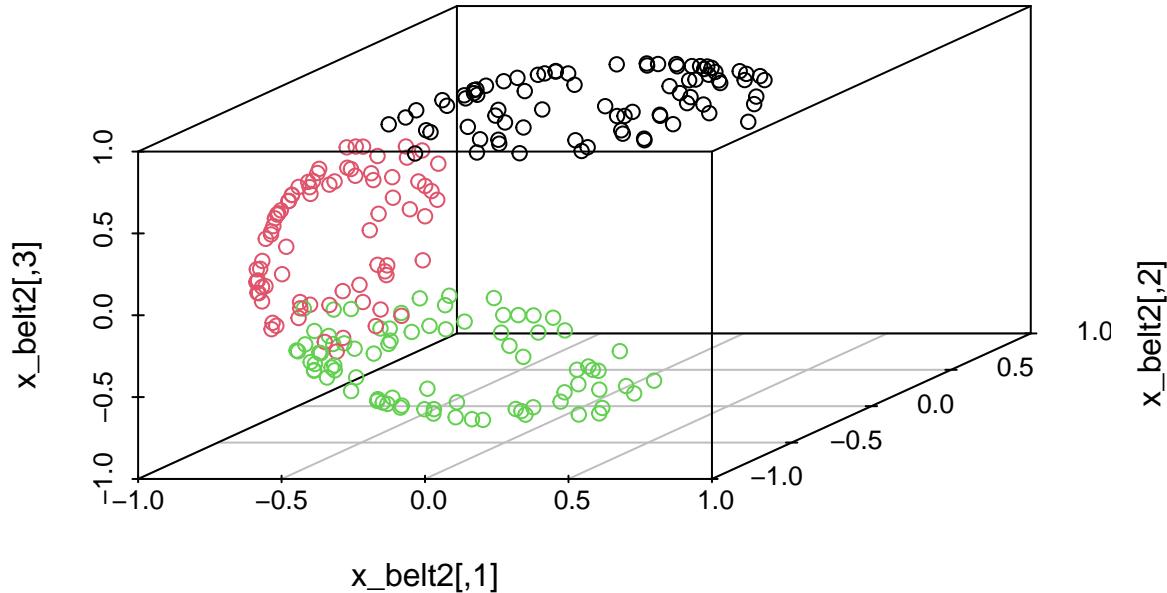
# x_1_belt2 <- rotasym::r_ACG(n, sigma)
x_1_belt2 <- sphunif::r_alt(n = n, p = 3, alt = "SC", kappa = 200, nu = 0.89)[,,1]
x_2_belt2 <- x_1_belt2 %*% rotate_mat_90

```

```

x_3_belt2 <- x_2_belt2 %*% rotate_mat_45
x_belt2 <- rbind(x_1_belt2, x_2_belt2, x_3_belt2)
scatterplot3d::scatterplot3d(x_belt2, xlim = c(-1, 1),
                             ylim = c(-1, 1), zlim = c(-1, 1),
                             color = rep(c(1,2,3), each=n))

```

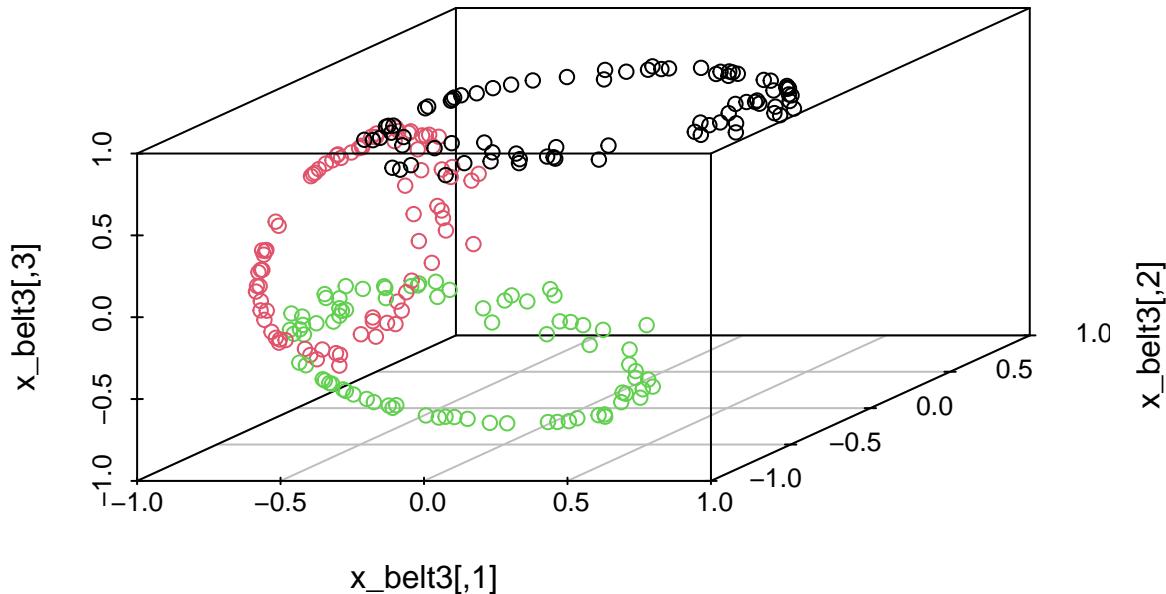


```

rgl::plot3d(0, 0, 0, xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
            radius = 1, type = "s", col = "lightblue",
            lit = FALSE)
rgl::points3d(x_belt2, col = rep(c(1,2,3), each=n))

# x_1_belt3 <- rotasym::r_ACG(n, sigma)
x_1_belt3 <- sphunif::r_alt(n = n, p = 3, alt = "SC", kappa = 400, nu = 0.80)[,1]
x_2_belt3 <- x_1_belt3 %*% rotate_mat_90
x_3_belt3 <- x_2_belt3 %*% rotate_mat_45
x_belt3 <- rbind(x_1_belt3, x_2_belt3, x_3_belt3)
scatterplot3d::scatterplot3d(x_belt3, xlim = c(-1, 1),
                             ylim = c(-1, 1), zlim = c(-1, 1),
                             color = rep(c(1,2,3), each=n))

```



```

rgl::plot3d(0, 0, 0, xlim = c(-1, 1), ylim = c(-1, 1), zlim = c(-1, 1),
            radius = 1, type = "s", col = "lightblue",
            lit = FALSE)
rgl::points3d(x_belt3, col = rep(c(1,2,3), each=n))

n <- n * 3
x_5 <- array(dim = c(n, 3, 3))
x_5[, , 1] <- x_belt1
x_5[, , 2] <- x_belt2
x_5[, , 3] <- x_belt3

indexes <- sample(1:n)
x_5 <- x_5[indexes,,]
colors <- rep(c(1, 2, 3), each = n / 3)[indexes]

```

Let's calculate the rho parameters based on a perplexity of 25:

```
rho_five_perp20 <- rho_optim_bst(x_5, 50)
```

```
## Time difference of 10.2021 secs
```

First, let's reduce to dimension \mathbb{S}^1 then $d = 1$ (circumference):

```
Y <- psc_sne(X=x_5, d=1, rho_psc_list = rho_five_perp20, num_iteration=500, eta = 20,
               visualize_prog = TRUE, colors = colors)
```

```
## It: 1; obj: 1.284e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.250e-01
```

```
## It: 2; obj: 1.270e+01; abs: 1.404e-01; rel: 1.094e-02; norm: 1.504e-01
```

```
## It: 3; obj: 1.250e+01; abs: 1.964e-01; rel: 1.547e-02; norm: 1.919e-01
```

```
## It: 4; obj: 1.226e+01; abs: 2.438e-01; rel: 1.950e-02; norm: 2.466e-01
```

```
## It: 5; obj: 1.199e+01; abs: 2.679e-01; rel: 2.186e-02; norm: 3.205e-01
```

```
## It: 6; obj: 1.172e+01; abs: 2.715e-01; rel: 2.265e-02; norm: 4.018e-01
```

```
## It: 7; obj: 1.145e+01; abs: 2.655e-01; rel: 2.265e-02; norm: 4.753e-01
```

```
## It: 8; obj: 1.114e+01; abs: 3.151e-01; rel: 2.751e-02; norm: 5.501e-01
```

```
## It: 9; obj: 1.072e+01; abs: 4.142e-01; rel: 3.719e-02; norm: 6.349e-01
```

```
## It: 10; obj: 1.027e+01; abs: 4.589e-01; rel: 4.279e-02; norm: 7.405e-01
```

```

## It: 11; obj: 9.886e+00; abs: 3.798e-01; rel: 3.700e-02; norm: 8.754e-01
## It: 12; obj: 9.593e+00; abs: 2.923e-01; rel: 2.957e-02; norm: 1.006e+00
## It: 13; obj: 9.319e+00; abs: 2.747e-01; rel: 2.863e-02; norm: 1.086e+00
## It: 14; obj: 9.120e+00; abs: 1.986e-01; rel: 2.131e-02; norm: 1.142e+00
## It: 15; obj: 9.035e+00; abs: 8.490e-02; rel: 9.309e-03; norm: 1.195e+00
## It: 16; obj: 8.996e+00; abs: 3.929e-02; rel: 4.348e-03; norm: 1.238e+00
## It: 17; obj: 8.989e+00; abs: 6.909e-03; rel: 7.680e-04; norm: 1.263e+00
## It: 18; obj: 8.995e+00; abs: 5.526e-03; rel: 6.148e-04; norm: 1.278e+00
## It: 19; obj: 8.980e+00; abs: 1.460e-02; rel: 1.624e-03; norm: 1.285e+00
## It: 20; obj: 8.972e+00; abs: 8.419e-03; rel: 9.375e-04; norm: 1.290e+00
## It: 21; obj: 8.971e+00; abs: 1.172e-04; rel: 1.307e-05; norm: 1.293e+00
## It: 22; obj: 8.971e+00; abs: 7.463e-04; rel: 8.319e-05; norm: 1.295e+00
## It: 23; obj: 8.969e+00; abs: 1.588e-03; rel: 1.770e-04; norm: 1.296e+00
## It: 24; obj: 8.967e+00; abs: 2.073e-03; rel: 2.312e-04; norm: 1.297e+00
## It: 25; obj: 8.965e+00; abs: 2.429e-03; rel: 2.709e-04; norm: 1.298e+00

## It: 26; obj: 8.962e+00; abs: 2.676e-03; rel: 2.985e-04; norm: 1.299e+00
## It: 27; obj: 8.959e+00; abs: 2.829e-03; rel: 3.157e-04; norm: 1.299e+00
## It: 28; obj: 8.956e+00; abs: 2.887e-03; rel: 3.223e-04; norm: 1.300e+00
## It: 29; obj: 8.953e+00; abs: 2.843e-03; rel: 3.175e-04; norm: 1.301e+00
## It: 30; obj: 8.951e+00; abs: 2.697e-03; rel: 3.012e-04; norm: 1.303e+00
## It: 31; obj: 8.948e+00; abs: 2.459e-03; rel: 2.747e-04; norm: 1.304e+00
## It: 32; obj: 8.946e+00; abs: 2.144e-03; rel: 2.396e-04; norm: 1.305e+00
## It: 33; obj: 8.944e+00; abs: 1.763e-03; rel: 1.971e-04; norm: 1.307e+00
## It: 34; obj: 8.943e+00; abs: 1.319e-03; rel: 1.475e-04; norm: 1.309e+00
## It: 35; obj: 8.942e+00; abs: 8.084e-04; rel: 9.040e-05; norm: 1.311e+00
## It: 36; obj: 8.942e+00; abs: 2.202e-04; rel: 2.463e-05; norm: 1.313e+00
## It: 37; obj: 8.942e+00; abs: 4.585e-04; rel: 5.128e-05; norm: 1.316e+00
## It: 38; obj: 8.944e+00; abs: 1.242e-03; rel: 1.389e-04; norm: 1.319e+00
## It: 39; obj: 8.946e+00; abs: 2.143e-03; rel: 2.396e-04; norm: 1.322e+00
## It: 40; obj: 8.949e+00; abs: 3.165e-03; rel: 3.538e-04; norm: 1.326e+00
## It: 41; obj: 8.953e+00; abs: 4.278e-03; rel: 4.780e-04; norm: 1.329e+00
## It: 42; obj: 8.958e+00; abs: 5.185e-03; rel: 5.791e-04; norm: 1.333e+00
## It: 43; obj: 8.962e+00; abs: 3.666e-03; rel: 4.092e-04; norm: 1.338e+00
## It: 44; obj: 8.951e+00; abs: 1.076e-02; rel: 1.200e-03; norm: 1.343e+00
## It: 45; obj: 8.931e+00; abs: 2.072e-02; rel: 2.315e-03; norm: 1.349e+00
## It: 46; obj: 8.929e+00; abs: 1.362e-03; rel: 1.525e-04; norm: 1.356e+00
## It: 47; obj: 8.936e+00; abs: 6.615e-03; rel: 7.408e-04; norm: 1.363e+00
## It: 48; obj: 8.944e+00; abs: 8.425e-03; rel: 9.428e-04; norm: 1.369e+00
## It: 49; obj: 8.954e+00; abs: 9.816e-03; rel: 1.097e-03; norm: 1.375e+00
## It: 50; obj: 8.965e+00; abs: 1.129e-02; rel: 1.260e-03; norm: 1.382e+00

## It: 51; obj: 8.978e+00; abs: 1.284e-02; rel: 1.432e-03; norm: 1.389e+00
## It: 52; obj: 8.993e+00; abs: 1.452e-02; rel: 1.617e-03; norm: 1.397e+00
## It: 53; obj: 9.009e+00; abs: 1.632e-02; rel: 1.814e-03; norm: 1.404e+00
## It: 54; obj: 9.027e+00; abs: 1.824e-02; rel: 2.024e-03; norm: 1.412e+00
## It: 55; obj: 9.048e+00; abs: 2.027e-02; rel: 2.245e-03; norm: 1.420e+00
## It: 56; obj: 9.070e+00; abs: 2.239e-02; rel: 2.475e-03; norm: 1.429e+00
## It: 57; obj: 9.094e+00; abs: 2.457e-02; rel: 2.708e-03; norm: 1.437e+00
## It: 58; obj: 9.121e+00; abs: 2.672e-02; rel: 2.938e-03; norm: 1.446e+00
## It: 59; obj: 9.150e+00; abs: 2.879e-02; rel: 3.156e-03; norm: 1.455e+00
## It: 60; obj: 9.181e+00; abs: 3.080e-02; rel: 3.366e-03; norm: 1.464e+00
## It: 61; obj: 9.214e+00; abs: 3.288e-02; rel: 3.581e-03; norm: 1.474e+00
## It: 62; obj: 9.249e+00; abs: 3.501e-02; rel: 3.800e-03; norm: 1.483e+00
## It: 63; obj: 9.286e+00; abs: 3.701e-02; rel: 4.001e-03; norm: 1.493e+00

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## It: 64; obj: 9.324e+00; abs: 3.862e-02; rel: 4.159e-03; norm: 1.502e+00
## It: 65; obj: 9.364e+00; abs: 3.955e-02; rel: 4.242e-03; norm: 1.512e+00
## It: 66; obj: 9.403e+00; abs: 3.934e-02; rel: 4.201e-03; norm: 1.522e+00
## It: 67; obj: 9.440e+00; abs: 3.725e-02; rel: 3.961e-03; norm: 1.531e+00
## It: 68; obj: 9.473e+00; abs: 3.232e-02; rel: 3.423e-03; norm: 1.541e+00
## It: 69; obj: 9.496e+00; abs: 2.353e-02; rel: 2.484e-03; norm: 1.551e+00
## It: 70; obj: 9.507e+00; abs: 1.020e-02; rel: 1.074e-03; norm: 1.562e+00
## It: 71; obj: 9.499e+00; abs: 7.316e-03; rel: 7.696e-04; norm: 1.572e+00
## It: 72; obj: 9.473e+00; abs: 2.659e-02; rel: 2.799e-03; norm: 1.582e+00
## It: 73; obj: 9.429e+00; abs: 4.340e-02; rel: 4.582e-03; norm: 1.591e+00
## It: 74; obj: 9.375e+00; abs: 5.418e-02; rel: 5.746e-03; norm: 1.597e+00
## It: 75; obj: 9.317e+00; abs: 5.826e-02; rel: 6.214e-03; norm: 1.600e+00
## It: 76; obj: 9.259e+00; abs: 5.736e-02; rel: 6.157e-03; norm: 1.600e+00
## It: 77; obj: 9.206e+00; abs: 5.368e-02; rel: 5.797e-03; norm: 1.598e+00
## It: 78; obj: 9.157e+00; abs: 4.882e-02; rel: 5.303e-03; norm: 1.594e+00
## It: 79; obj: 9.113e+00; abs: 4.372e-02; rel: 4.775e-03; norm: 1.589e+00
## It: 80; obj: 9.074e+00; abs: 3.886e-02; rel: 4.264e-03; norm: 1.584e+00
## It: 81; obj: 9.040e+00; abs: 3.443e-02; rel: 3.794e-03; norm: 1.579e+00
## It: 82; obj: 9.009e+00; abs: 3.050e-02; rel: 3.374e-03; norm: 1.573e+00
## It: 83; obj: 8.982e+00; abs: 2.706e-02; rel: 3.004e-03; norm: 1.568e+00
## It: 84; obj: 8.958e+00; abs: 2.407e-02; rel: 2.680e-03; norm: 1.562e+00
## It: 85; obj: 8.937e+00; abs: 2.148e-02; rel: 2.398e-03; norm: 1.557e+00
## It: 86; obj: 8.918e+00; abs: 1.923e-02; rel: 2.152e-03; norm: 1.552e+00
## It: 87; obj: 8.900e+00; abs: 1.728e-02; rel: 1.938e-03; norm: 1.547e+00
## It: 88; obj: 8.885e+00; abs: 1.559e-02; rel: 1.751e-03; norm: 1.542e+00
## It: 89; obj: 8.871e+00; abs: 1.411e-02; rel: 1.588e-03; norm: 1.538e+00
## It: 90; obj: 8.858e+00; abs: 1.281e-02; rel: 1.444e-03; norm: 1.533e+00
## It: 91; obj: 8.846e+00; abs: 1.167e-02; rel: 1.318e-03; norm: 1.529e+00
## It: 92; obj: 8.835e+00; abs: 1.067e-02; rel: 1.206e-03; norm: 1.525e+00
## It: 93; obj: 8.826e+00; abs: 9.778e-03; rel: 1.107e-03; norm: 1.522e+00
## It: 94; obj: 8.817e+00; abs: 8.987e-03; rel: 1.018e-03; norm: 1.518e+00
## It: 95; obj: 8.808e+00; abs: 8.282e-03; rel: 9.393e-04; norm: 1.515e+00
## It: 96; obj: 8.801e+00; abs: 7.651e-03; rel: 8.686e-04; norm: 1.511e+00
## It: 97; obj: 8.794e+00; abs: 7.085e-03; rel: 8.050e-04; norm: 1.508e+00
## It: 98; obj: 8.787e+00; abs: 6.575e-03; rel: 7.477e-04; norm: 1.505e+00
## It: 99; obj: 8.781e+00; abs: 6.115e-03; rel: 6.959e-04; norm: 1.502e+00
## It: 100; obj: 8.775e+00; abs: 5.698e-03; rel: 6.489e-04; norm: 1.500e+00
## It: 101; obj: 7.979e-01; abs: 7.977e+00; rel: 9.091e-01; norm: 1.166e-01
## It: 102; obj: 7.872e-01; abs: 1.068e-02; rel: 1.339e-02; norm: 1.145e-01
## It: 103; obj: 7.779e-01; abs: 9.305e-03; rel: 1.182e-02; norm: 1.120e-01
## It: 104; obj: 7.701e-01; abs: 7.766e-03; rel: 9.983e-03; norm: 1.097e-01
## It: 105; obj: 7.635e-01; abs: 6.652e-03; rel: 8.638e-03; norm: 1.080e-01
## It: 106; obj: 7.575e-01; abs: 5.926e-03; rel: 7.762e-03; norm: 1.069e-01
## It: 107; obj: 7.522e-01; abs: 5.386e-03; rel: 7.110e-03; norm: 1.062e-01
## It: 108; obj: 7.473e-01; abs: 4.854e-03; rel: 6.454e-03; norm: 1.059e-01
## It: 109; obj: 7.430e-01; abs: 4.250e-03; rel: 5.687e-03; norm: 1.058e-01
## It: 110; obj: 7.394e-01; abs: 3.597e-03; rel: 4.841e-03; norm: 1.057e-01
## It: 111; obj: 7.365e-01; abs: 2.973e-03; rel: 4.020e-03; norm: 1.056e-01
## It: 112; obj: 7.340e-01; abs: 2.447e-03; rel: 3.322e-03; norm: 1.055e-01
## It: 113; obj: 7.320e-01; abs: 2.054e-03; rel: 2.798e-03; norm: 1.054e-01
## It: 114; obj: 7.302e-01; abs: 1.804e-03; rel: 2.464e-03; norm: 1.055e-01
## It: 115; obj: 7.285e-01; abs: 1.696e-03; rel: 2.323e-03; norm: 1.059e-01
## It: 116; obj: 7.268e-01; abs: 1.726e-03; rel: 2.370e-03; norm: 1.067e-01

```

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## It: 117; obj: 7.249e-01; abs: 1.875e-03; rel: 2.580e-03; norm: 1.075e-01
## It: 118; obj: 7.228e-01; abs: 2.080e-03; rel: 2.870e-03; norm: 1.082e-01
## It: 119; obj: 7.206e-01; abs: 2.230e-03; rel: 3.085e-03; norm: 1.089e-01
## It: 120; obj: 7.184e-01; abs: 2.205e-03; rel: 3.060e-03; norm: 1.096e-01
## It: 121; obj: 7.164e-01; abs: 1.969e-03; rel: 2.741e-03; norm: 1.106e-01
## It: 122; obj: 7.148e-01; abs: 1.594e-03; rel: 2.224e-03; norm: 1.119e-01
## It: 123; obj: 7.136e-01; abs: 1.197e-03; rel: 1.674e-03; norm: 1.134e-01
## It: 124; obj: 7.127e-01; abs: 8.623e-04; rel: 1.208e-03; norm: 1.146e-01
## It: 125; obj: 7.121e-01; abs: 6.169e-04; rel: 8.656e-04; norm: 1.155e-01
## It: 126; obj: 7.117e-01; abs: 4.502e-04; rel: 6.322e-04; norm: 1.162e-01
## It: 127; obj: 7.113e-01; abs: 3.399e-04; rel: 4.776e-04; norm: 1.167e-01
## It: 128; obj: 7.111e-01; abs: 2.658e-04; rel: 3.737e-04; norm: 1.170e-01
## It: 129; obj: 7.109e-01; abs: 2.140e-04; rel: 3.010e-04; norm: 1.172e-01
## It: 130; obj: 7.107e-01; abs: 1.758e-04; rel: 2.473e-04; norm: 1.173e-01
## It: 131; obj: 7.105e-01; abs: 1.462e-04; rel: 2.057e-04; norm: 1.173e-01
## It: 132; obj: 7.104e-01; abs: 1.225e-04; rel: 1.723e-04; norm: 1.174e-01
## It: 133; obj: 7.103e-01; abs: 1.029e-04; rel: 1.449e-04; norm: 1.174e-01
## It: 134; obj: 7.102e-01; abs: 8.671e-05; rel: 1.221e-04; norm: 1.173e-01
## It: 135; obj: 7.101e-01; abs: 7.314e-05; rel: 1.030e-04; norm: 1.173e-01
## It: 136; obj: 7.101e-01; abs: 6.177e-05; rel: 8.698e-05; norm: 1.173e-01
## It: 137; obj: 7.100e-01; abs: 5.222e-05; rel: 7.354e-05; norm: 1.172e-01
## It: 138; obj: 7.100e-01; abs: 4.421e-05; rel: 6.227e-05; norm: 1.172e-01
## It: 139; obj: 7.099e-01; abs: 3.749e-05; rel: 5.280e-05; norm: 1.172e-01
## It: 140; obj: 7.099e-01; abs: 3.184e-05; rel: 4.484e-05; norm: 1.171e-01
## It: 141; obj: 7.099e-01; abs: 2.708e-05; rel: 3.814e-05; norm: 1.171e-01
## It: 142; obj: 7.099e-01; abs: 2.307e-05; rel: 3.249e-05; norm: 1.171e-01
## It: 143; obj: 7.098e-01; abs: 1.968e-05; rel: 2.772e-05; norm: 1.170e-01
## It: 144; obj: 7.098e-01; abs: 1.682e-05; rel: 2.369e-05; norm: 1.170e-01
## It: 145; obj: 7.098e-01; abs: 1.439e-05; rel: 2.027e-05; norm: 1.170e-01
## It: 146; obj: 7.098e-01; abs: 1.233e-05; rel: 1.737e-05; norm: 1.169e-01
## It: 147; obj: 7.098e-01; abs: 1.058e-05; rel: 1.490e-05; norm: 1.169e-01
## It: 148; obj: 7.098e-01; abs: 9.087e-06; rel: 1.280e-05; norm: 1.169e-01
## It: 149; obj: 7.098e-01; abs: 7.814e-06; rel: 1.101e-05; norm: 1.169e-01
## It: 150; obj: 7.098e-01; abs: 6.727e-06; rel: 9.477e-06; norm: 1.168e-01
## It: 151; obj: 7.098e-01; abs: 5.797e-06; rel: 8.167e-06; norm: 1.168e-01
## It: 152; obj: 7.098e-01; abs: 4.999e-06; rel: 7.044e-06; norm: 1.168e-01
## It: 153; obj: 7.098e-01; abs: 4.316e-06; rel: 6.080e-06; norm: 1.168e-01
## It: 154; obj: 7.098e-01; abs: 3.728e-06; rel: 5.253e-06; norm: 1.168e-01
## It: 155; obj: 7.097e-01; abs: 3.223e-06; rel: 4.541e-06; norm: 1.168e-01
## It: 156; obj: 7.097e-01; abs: 2.788e-06; rel: 3.928e-06; norm: 1.168e-01
## It: 157; obj: 7.097e-01; abs: 2.413e-06; rel: 3.400e-06; norm: 1.168e-01
## It: 158; obj: 7.097e-01; abs: 2.090e-06; rel: 2.944e-06; norm: 1.167e-01
## It: 159; obj: 7.097e-01; abs: 1.811e-06; rel: 2.551e-06; norm: 1.167e-01
## It: 160; obj: 7.097e-01; abs: 1.570e-06; rel: 2.212e-06; norm: 1.167e-01
## It: 161; obj: 7.097e-01; abs: 1.361e-06; rel: 1.918e-06; norm: 1.167e-01
## It: 162; obj: 7.097e-01; abs: 1.181e-06; rel: 1.664e-06; norm: 1.167e-01
## It: 163; obj: 7.097e-01; abs: 1.025e-06; rel: 1.444e-06; norm: 1.167e-01
## It: 164; obj: 7.097e-01; abs: 8.900e-07; rel: 1.254e-06; norm: 1.167e-01
## It: 165; obj: 7.097e-01; abs: 7.729e-07; rel: 1.089e-06; norm: 1.167e-01
## It: 166; obj: 7.097e-01; abs: 6.715e-07; rel: 9.461e-07; norm: 1.167e-01
## It: 167; obj: 7.097e-01; abs: 5.835e-07; rel: 8.221e-07; norm: 1.167e-01
## It: 168; obj: 7.097e-01; abs: 5.071e-07; rel: 7.145e-07; norm: 1.167e-01
## It: 169; obj: 7.097e-01; abs: 4.409e-07; rel: 6.212e-07; norm: 1.167e-01

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## It: 170; obj: 7.097e-01; abs: 3.834e-07; rel: 5.401e-07; norm: 1.167e-01
## It: 171; obj: 7.097e-01; abs: 3.334e-07; rel: 4.698e-07; norm: 1.167e-01
## It: 172; obj: 7.097e-01; abs: 2.900e-07; rel: 4.086e-07; norm: 1.167e-01
## It: 173; obj: 7.097e-01; abs: 2.523e-07; rel: 3.555e-07; norm: 1.167e-01
## It: 174; obj: 7.097e-01; abs: 2.195e-07; rel: 3.093e-07; norm: 1.167e-01
## It: 175; obj: 7.097e-01; abs: 1.911e-07; rel: 2.692e-07; norm: 1.167e-01
## It: 176; obj: 7.097e-01; abs: 1.663e-07; rel: 2.343e-07; norm: 1.167e-01
## It: 177; obj: 7.097e-01; abs: 1.448e-07; rel: 2.040e-07; norm: 1.167e-01
## It: 178; obj: 7.097e-01; abs: 1.260e-07; rel: 1.776e-07; norm: 1.167e-01
## It: 179; obj: 7.097e-01; abs: 1.097e-07; rel: 1.546e-07; norm: 1.167e-01
## It: 180; obj: 7.097e-01; abs: 9.554e-08; rel: 1.346e-07; norm: 1.167e-01
## It: 181; obj: 7.097e-01; abs: 8.320e-08; rel: 1.172e-07; norm: 1.167e-01
## It: 182; obj: 7.097e-01; abs: 7.246e-08; rel: 1.021e-07; norm: 1.167e-01
## It: 183; obj: 7.097e-01; abs: 6.312e-08; rel: 8.893e-08; norm: 1.167e-01
## It: 184; obj: 7.097e-01; abs: 5.498e-08; rel: 7.746e-08; norm: 1.167e-01
## It: 185; obj: 7.097e-01; abs: 4.789e-08; rel: 6.748e-08; norm: 1.167e-01
## It: 186; obj: 7.097e-01; abs: 4.172e-08; rel: 5.879e-08; norm: 1.167e-01
## It: 187; obj: 7.097e-01; abs: 3.635e-08; rel: 5.122e-08; norm: 1.167e-01
## It: 188; obj: 7.097e-01; abs: 3.167e-08; rel: 4.463e-08; norm: 1.167e-01
## It: 189; obj: 7.097e-01; abs: 2.760e-08; rel: 3.888e-08; norm: 1.167e-01
## It: 190; obj: 7.097e-01; abs: 2.405e-08; rel: 3.388e-08; norm: 1.167e-01
## It: 191; obj: 7.097e-01; abs: 2.096e-08; rel: 2.953e-08; norm: 1.167e-01
## It: 192; obj: 7.097e-01; abs: 1.826e-08; rel: 2.573e-08; norm: 1.167e-01
## It: 193; obj: 7.097e-01; abs: 1.592e-08; rel: 2.243e-08; norm: 1.167e-01
## It: 194; obj: 7.097e-01; abs: 1.387e-08; rel: 1.954e-08; norm: 1.167e-01
## It: 195; obj: 7.097e-01; abs: 1.209e-08; rel: 1.703e-08; norm: 1.167e-01
## It: 196; obj: 7.097e-01; abs: 1.054e-08; rel: 1.485e-08; norm: 1.167e-01
## It: 197; obj: 7.097e-01; abs: 9.185e-09; rel: 1.294e-08; norm: 1.167e-01
## It: 198; obj: 7.097e-01; abs: 8.007e-09; rel: 1.128e-08; norm: 1.166e-01
## It: 199; obj: 7.097e-01; abs: 6.979e-09; rel: 9.834e-09; norm: 1.166e-01
## It: 200; obj: 7.097e-01; abs: 6.084e-09; rel: 8.572e-09; norm: 1.166e-01
## It: 201; obj: 7.097e-01; abs: 5.304e-09; rel: 7.473e-09; norm: 1.166e-01
## It: 202; obj: 7.097e-01; abs: 4.624e-09; rel: 6.515e-09; norm: 1.166e-01
## It: 203; obj: 7.097e-01; abs: 4.031e-09; rel: 5.679e-09; norm: 1.166e-01
## It: 204; obj: 7.097e-01; abs: 3.514e-09; rel: 4.951e-09; norm: 1.166e-01
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## It: 206; obj: 7.097e-01; abs: 2.671e-09; rel: 3.764e-09; norm: 1.166e-01
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## It: 283; obj: 7.097e-01; abs: 6.328e-15; rel: 8.917e-15; norm: 1.166e-01

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## It: 287; obj: 7.097e-01; abs: 1.110e-16; rel: 1.564e-16; norm: 1.166e-01
## It: 288; obj: 7.097e-01; abs: 6.772e-15; rel: 9.542e-15; norm: 1.166e-01
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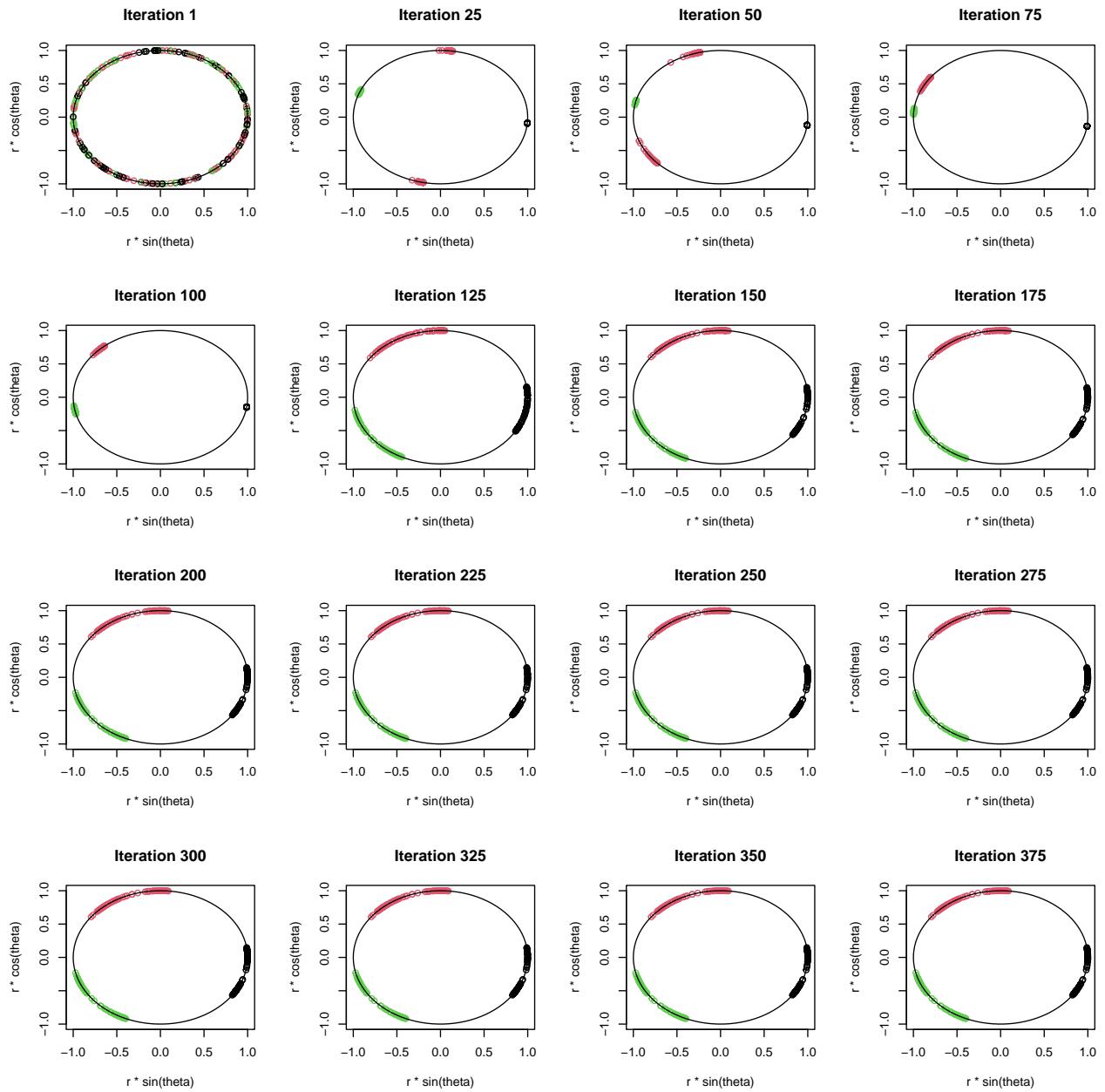
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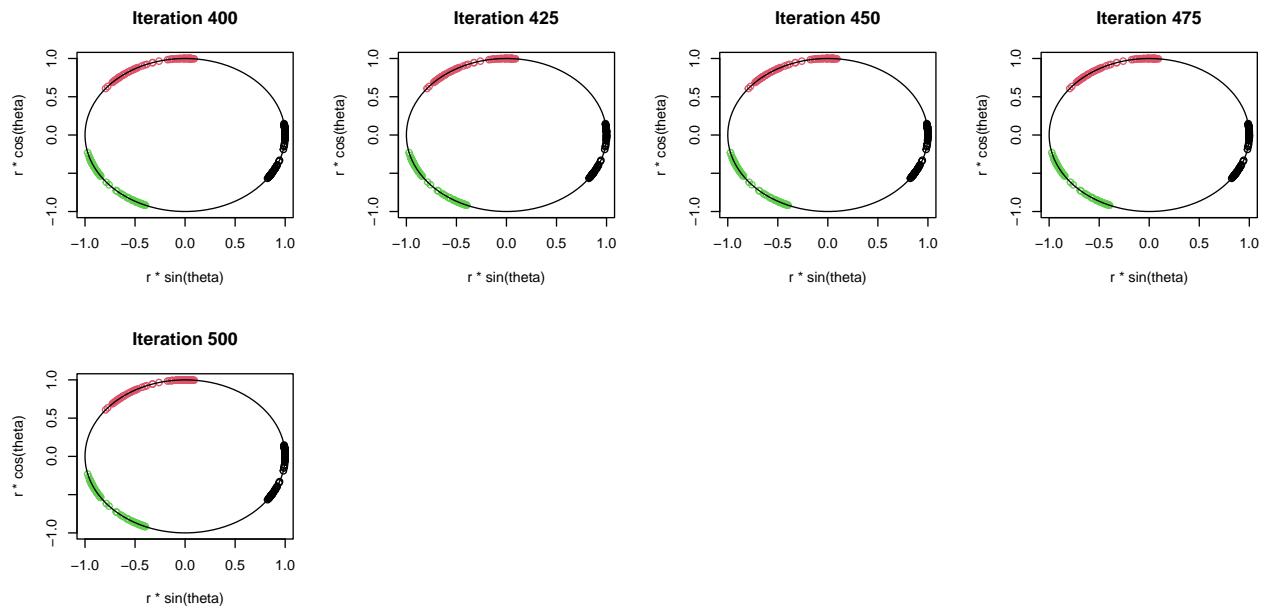
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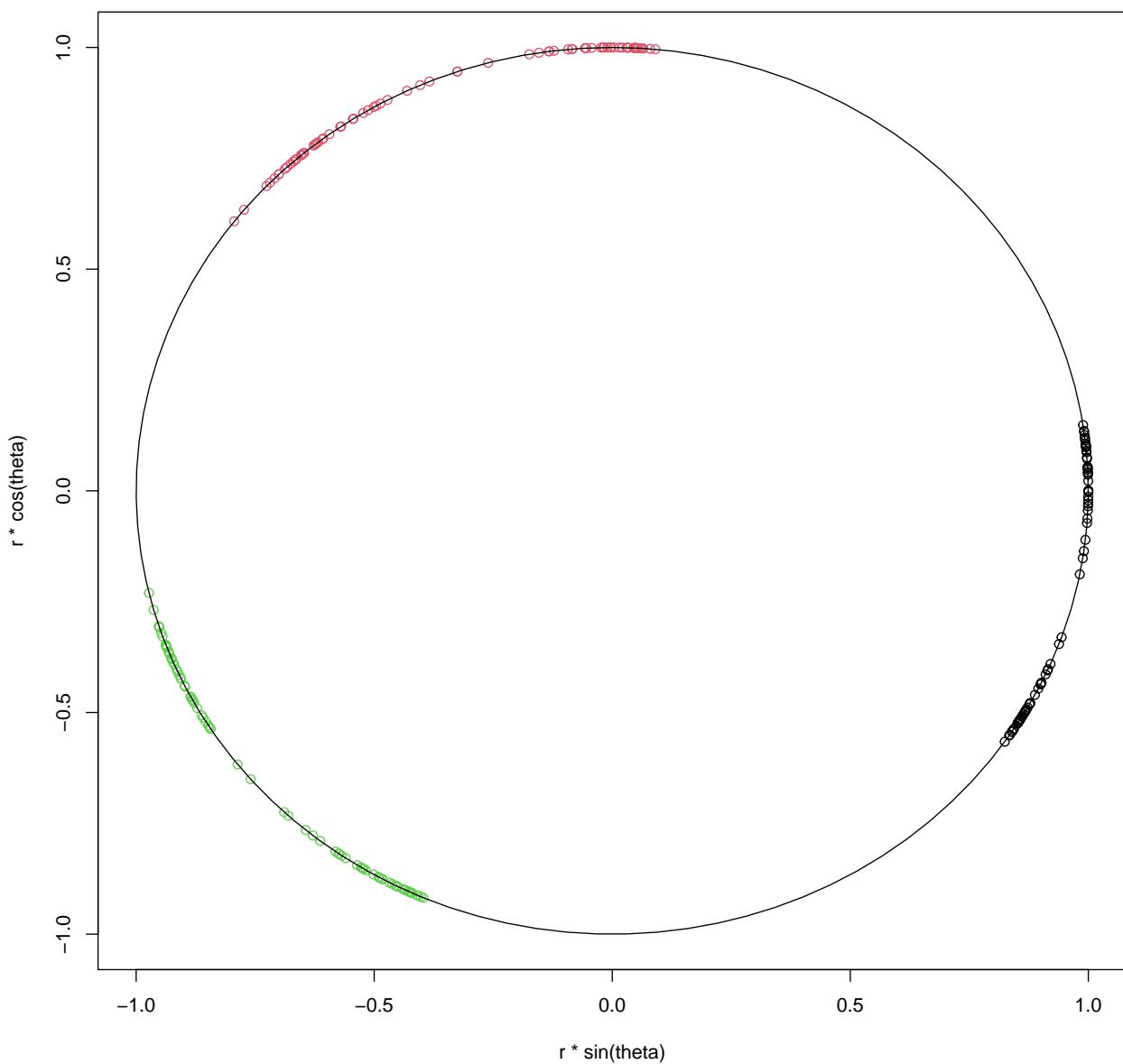
```

## It: 496; obj: 7.097e-01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.166e-01
## It: 497; obj: 7.097e-01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.166e-01
## It: 498; obj: 7.097e-01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.166e-01
## It: 499; obj: 7.097e-01; abs: 1.110e-16; rel: 1.564e-16; norm: 1.166e-01
## It: 500; obj: 7.097e-01; abs: 2.220e-16; rel: 3.129e-16; norm: 1.166e-01

```



Iteration 500

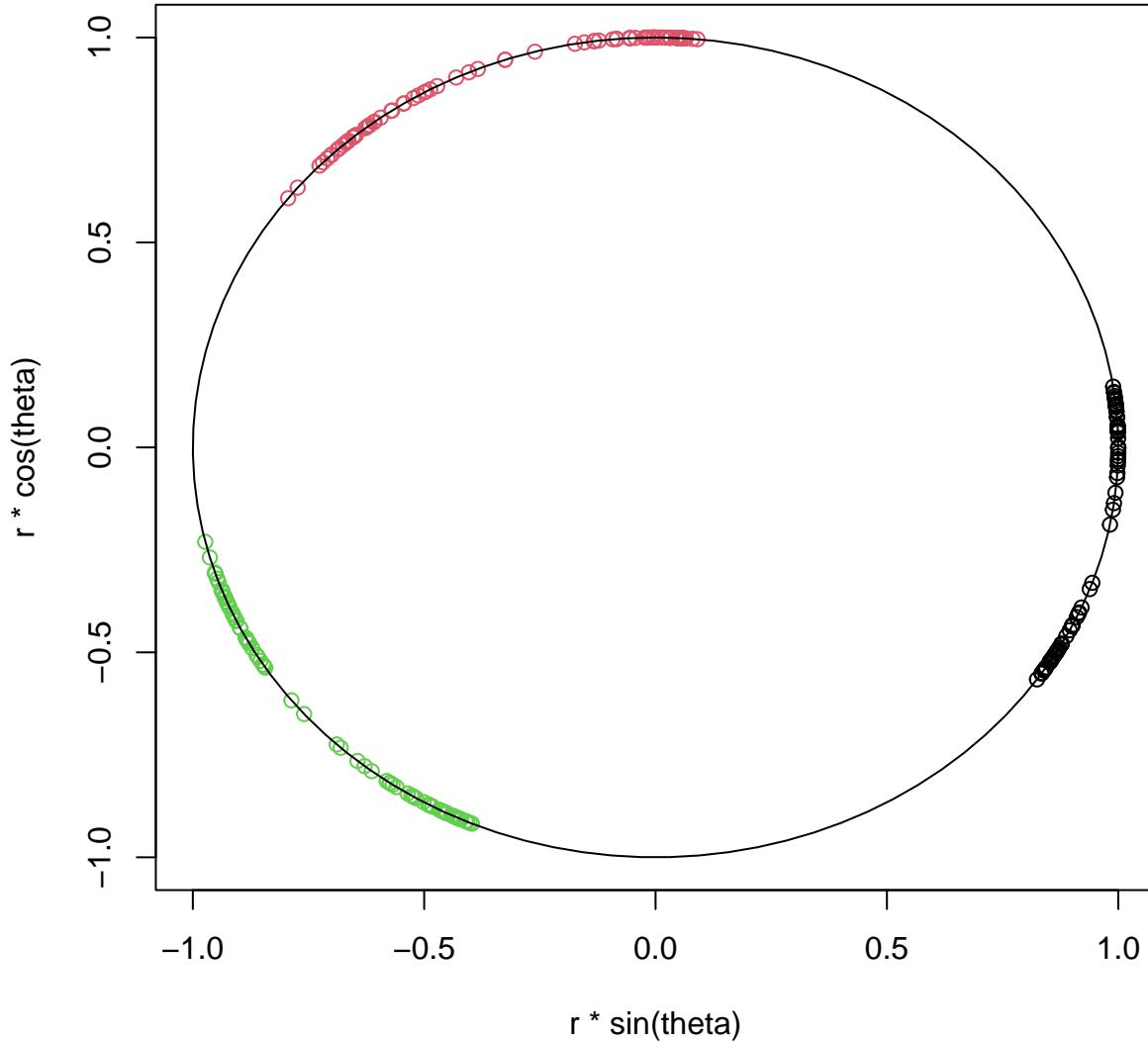


```

Y_rad <- DirStats:::to_rad(Y)
r <- 1
theta <- Y_rad
plot(r*sin(theta),
     r*cos(theta),
     col=colors,
     xlim=c(-max(r),max(r)),
     ylim=c(-max(r),max(r)))

polygon(max(r)*sin(seq(0,2*pi,length.out=100)),max(r)*cos(seq(0,2*pi,length.out=100)))

```



Now we are going to reduce to dimension \mathbb{S}^2 then $d = 2$ (sphere):

```
Y <- psc_sne(X=x_5, d=2, rho_psc_list = rho_five_perp20, num_iteration=500, eta = 400,
visualize_prog = TRUE, colors = colors)
```

```
## It: 1; obj: 1.275e+01; abs: 0.000e+00; rel: 0.000e+00; norm: 1.405e-01
## It: 2; obj: 8.117e+00; abs: 4.630e+00; rel: 3.632e-01; norm: 5.028e-01
## It: 3; obj: 7.320e+00; abs: 7.966e-01; rel: 9.815e-02; norm: 1.492e+00
## It: 4; obj: 7.384e+00; abs: 6.401e-02; rel: 8.745e-03; norm: 2.017e+00
## It: 5; obj: 7.522e+00; abs: 1.383e-01; rel: 1.872e-02; norm: 2.249e+00
## It: 6; obj: 7.655e+00; abs: 1.332e-01; rel: 1.770e-02; norm: 2.382e+00
## It: 7; obj: 7.756e+00; abs: 1.005e-01; rel: 1.313e-02; norm: 2.461e+00
## It: 8; obj: 7.821e+00; abs: 6.475e-02; rel: 8.348e-03; norm: 2.506e+00
## It: 9; obj: 7.860e+00; abs: 3.893e-02; rel: 4.978e-03; norm: 2.535e+00
## It: 10; obj: 7.882e+00; abs: 2.276e-02; rel: 2.896e-03; norm: 2.555e+00
## It: 11; obj: 7.895e+00; abs: 1.308e-02; rel: 1.659e-03; norm: 2.571e+00
## It: 12; obj: 7.903e+00; abs: 7.397e-03; rel: 9.368e-04; norm: 2.585e+00
## It: 13; obj: 7.907e+00; abs: 4.125e-03; rel: 5.220e-04; norm: 2.598e+00
## It: 14; obj: 7.909e+00; abs: 2.304e-03; rel: 2.915e-04; norm: 2.610e+00
## It: 15; obj: 7.911e+00; abs: 1.358e-03; rel: 1.717e-04; norm: 2.622e+00
```

```

## It: 16; obj: 7.912e+00; abs: 9.370e-04; rel: 1.184e-04; norm: 2.633e+00
## It: 17; obj: 7.912e+00; abs: 8.306e-04; rel: 1.050e-04; norm: 2.645e+00
## It: 18; obj: 7.913e+00; abs: 9.111e-04; rel: 1.151e-04; norm: 2.656e+00
## It: 19; obj: 7.914e+00; abs: 1.101e-03; rel: 1.391e-04; norm: 2.667e+00
## It: 20; obj: 7.916e+00; abs: 1.354e-03; rel: 1.710e-04; norm: 2.678e+00
## It: 21; obj: 7.917e+00; abs: 1.640e-03; rel: 2.072e-04; norm: 2.689e+00
## It: 22; obj: 7.919e+00; abs: 1.944e-03; rel: 2.456e-04; norm: 2.700e+00
## It: 23; obj: 7.922e+00; abs: 2.254e-03; rel: 2.847e-04; norm: 2.710e+00
## It: 24; obj: 7.924e+00; abs: 2.564e-03; rel: 3.236e-04; norm: 2.721e+00
## It: 25; obj: 7.927e+00; abs: 2.867e-03; rel: 3.618e-04; norm: 2.731e+00
## It: 26; obj: 7.930e+00; abs: 3.161e-03; rel: 3.988e-04; norm: 2.741e+00
## It: 27; obj: 7.934e+00; abs: 3.442e-03; rel: 4.340e-04; norm: 2.751e+00
## It: 28; obj: 7.937e+00; abs: 3.707e-03; rel: 4.673e-04; norm: 2.761e+00
## It: 29; obj: 7.941e+00; abs: 3.954e-03; rel: 4.982e-04; norm: 2.770e+00
## It: 30; obj: 7.945e+00; abs: 4.181e-03; rel: 5.264e-04; norm: 2.779e+00
## It: 31; obj: 7.950e+00; abs: 4.384e-03; rel: 5.517e-04; norm: 2.788e+00
## It: 32; obj: 7.954e+00; abs: 4.561e-03; rel: 5.738e-04; norm: 2.796e+00
## It: 33; obj: 7.959e+00; abs: 4.712e-03; rel: 5.924e-04; norm: 2.804e+00
## It: 34; obj: 7.964e+00; abs: 4.834e-03; rel: 6.074e-04; norm: 2.812e+00
## It: 35; obj: 7.969e+00; abs: 4.927e-03; rel: 6.187e-04; norm: 2.820e+00
## It: 36; obj: 7.974e+00; abs: 4.991e-03; rel: 6.263e-04; norm: 2.827e+00
## It: 37; obj: 7.979e+00; abs: 5.025e-03; rel: 6.302e-04; norm: 2.834e+00
## It: 38; obj: 7.984e+00; abs: 5.031e-03; rel: 6.305e-04; norm: 2.841e+00
## It: 39; obj: 7.989e+00; abs: 5.008e-03; rel: 6.273e-04; norm: 2.847e+00
## It: 40; obj: 7.994e+00; abs: 4.960e-03; rel: 6.208e-04; norm: 2.853e+00
## It: 41; obj: 7.999e+00; abs: 4.887e-03; rel: 6.113e-04; norm: 2.858e+00
## It: 42; obj: 8.004e+00; abs: 4.791e-03; rel: 5.990e-04; norm: 2.864e+00
## It: 43; obj: 8.008e+00; abs: 4.677e-03; rel: 5.843e-04; norm: 2.869e+00
## It: 44; obj: 8.013e+00; abs: 4.544e-03; rel: 5.675e-04; norm: 2.874e+00
## It: 45; obj: 8.017e+00; abs: 4.398e-03; rel: 5.488e-04; norm: 2.878e+00
## It: 46; obj: 8.021e+00; abs: 4.239e-03; rel: 5.287e-04; norm: 2.882e+00
## It: 47; obj: 8.025e+00; abs: 4.071e-03; rel: 5.075e-04; norm: 2.886e+00
## It: 48; obj: 8.029e+00; abs: 3.895e-03; rel: 4.854e-04; norm: 2.890e+00
## It: 49; obj: 8.033e+00; abs: 3.715e-03; rel: 4.627e-04; norm: 2.893e+00
## It: 50; obj: 8.037e+00; abs: 3.532e-03; rel: 4.397e-04; norm: 2.896e+00
## It: 51; obj: 8.040e+00; abs: 3.349e-03; rel: 4.167e-04; norm: 2.899e+00
## It: 52; obj: 8.043e+00; abs: 3.166e-03; rel: 3.938e-04; norm: 2.902e+00
## It: 53; obj: 8.046e+00; abs: 2.986e-03; rel: 3.712e-04; norm: 2.905e+00
## It: 54; obj: 8.049e+00; abs: 2.809e-03; rel: 3.491e-04; norm: 2.907e+00
## It: 55; obj: 8.052e+00; abs: 2.636e-03; rel: 3.275e-04; norm: 2.909e+00
## It: 56; obj: 8.054e+00; abs: 2.470e-03; rel: 3.067e-04; norm: 2.911e+00
## It: 57; obj: 8.056e+00; abs: 2.309e-03; rel: 2.867e-04; norm: 2.913e+00
## It: 58; obj: 8.058e+00; abs: 2.155e-03; rel: 2.674e-04; norm: 2.915e+00
## It: 59; obj: 8.060e+00; abs: 2.007e-03; rel: 2.491e-04; norm: 2.916e+00
## It: 60; obj: 8.062e+00; abs: 1.867e-03; rel: 2.316e-04; norm: 2.918e+00
## It: 61; obj: 8.064e+00; abs: 1.734e-03; rel: 2.151e-04; norm: 2.919e+00
## It: 62; obj: 8.066e+00; abs: 1.609e-03; rel: 1.995e-04; norm: 2.921e+00
## It: 63; obj: 8.067e+00; abs: 1.490e-03; rel: 1.848e-04; norm: 2.922e+00
## It: 64; obj: 8.069e+00; abs: 1.379e-03; rel: 1.710e-04; norm: 2.923e+00
## It: 65; obj: 8.070e+00; abs: 1.275e-03; rel: 1.580e-04; norm: 2.924e+00
## It: 66; obj: 8.071e+00; abs: 1.177e-03; rel: 1.459e-04; norm: 2.925e+00
## It: 67; obj: 8.072e+00; abs: 1.086e-03; rel: 1.345e-04; norm: 2.926e+00
## It: 68; obj: 8.073e+00; abs: 1.001e-03; rel: 1.240e-04; norm: 2.926e+00

```

```

## It: 69; obj: 8.074e+00; abs: 9.217e-04; rel: 1.142e-04; norm: 2.927e+00
## It: 70; obj: 8.075e+00; abs: 8.481e-04; rel: 1.050e-04; norm: 2.928e+00
## It: 71; obj: 8.076e+00; abs: 7.798e-04; rel: 9.658e-05; norm: 2.929e+00
## It: 72; obj: 8.076e+00; abs: 7.165e-04; rel: 8.873e-05; norm: 2.929e+00
## It: 73; obj: 8.077e+00; abs: 6.579e-04; rel: 8.146e-05; norm: 2.930e+00
## It: 74; obj: 8.078e+00; abs: 6.037e-04; rel: 7.474e-05; norm: 2.930e+00
## It: 75; obj: 8.078e+00; abs: 5.536e-04; rel: 6.853e-05; norm: 2.931e+00
## It: 76; obj: 8.079e+00; abs: 5.073e-04; rel: 6.280e-05; norm: 2.931e+00
## It: 77; obj: 8.079e+00; abs: 4.646e-04; rel: 5.751e-05; norm: 2.931e+00
## It: 78; obj: 8.080e+00; abs: 4.253e-04; rel: 5.264e-05; norm: 2.932e+00
## It: 79; obj: 8.080e+00; abs: 3.890e-04; rel: 4.814e-05; norm: 2.932e+00
## It: 80; obj: 8.080e+00; abs: 3.556e-04; rel: 4.401e-05; norm: 2.933e+00
## It: 81; obj: 8.081e+00; abs: 3.249e-04; rel: 4.021e-05; norm: 2.933e+00
## It: 82; obj: 8.081e+00; abs: 2.966e-04; rel: 3.671e-05; norm: 2.933e+00
## It: 83; obj: 8.081e+00; abs: 2.706e-04; rel: 3.349e-05; norm: 2.933e+00
## It: 84; obj: 8.081e+00; abs: 2.468e-04; rel: 3.054e-05; norm: 2.934e+00
## It: 85; obj: 8.082e+00; abs: 2.248e-04; rel: 2.782e-05; norm: 2.934e+00
## It: 86; obj: 8.082e+00; abs: 2.047e-04; rel: 2.533e-05; norm: 2.934e+00
## It: 87; obj: 8.082e+00; abs: 1.862e-04; rel: 2.304e-05; norm: 2.934e+00
## It: 88; obj: 8.082e+00; abs: 1.692e-04; rel: 2.094e-05; norm: 2.935e+00
## It: 89; obj: 8.082e+00; abs: 1.537e-04; rel: 1.901e-05; norm: 2.935e+00
## It: 90; obj: 8.083e+00; abs: 1.394e-04; rel: 1.725e-05; norm: 2.935e+00
## It: 91; obj: 8.083e+00; abs: 1.263e-04; rel: 1.563e-05; norm: 2.935e+00
## It: 92; obj: 8.083e+00; abs: 1.143e-04; rel: 1.414e-05; norm: 2.935e+00
## It: 93; obj: 8.083e+00; abs: 1.033e-04; rel: 1.278e-05; norm: 2.935e+00
## It: 94; obj: 8.083e+00; abs: 9.325e-05; rel: 1.154e-05; norm: 2.935e+00
## It: 95; obj: 8.083e+00; abs: 8.402e-05; rel: 1.039e-05; norm: 2.936e+00
## It: 96; obj: 8.083e+00; abs: 7.556e-05; rel: 9.348e-06; norm: 2.936e+00
## It: 97; obj: 8.083e+00; abs: 6.781e-05; rel: 8.390e-06; norm: 2.936e+00
## It: 98; obj: 8.083e+00; abs: 6.072e-05; rel: 7.512e-06; norm: 2.936e+00
## It: 99; obj: 8.083e+00; abs: 5.423e-05; rel: 6.709e-06; norm: 2.936e+00
## It: 100; obj: 8.083e+00; abs: 4.828e-05; rel: 5.973e-06; norm: 2.936e+00
## It: 101; obj: 1.211e+00; abs: 6.873e+00; rel: 8.502e-01; norm: 1.152e-01
## It: 102; obj: 1.399e+00; abs: 1.887e-01; rel: 1.559e-01; norm: 3.786e-01
## It: 103; obj: 1.314e+00; abs: 8.485e-02; rel: 6.064e-02; norm: 3.968e-01
## It: 104; obj: 1.276e+00; abs: 3.891e-02; rel: 2.960e-02; norm: 4.484e-01
## It: 105; obj: 1.285e+00; abs: 9.096e-03; rel: 7.132e-03; norm: 4.287e-01
## It: 106; obj: 1.394e+00; abs: 1.094e-01; rel: 8.518e-02; norm: 4.251e-01
## It: 107; obj: 1.471e+00; abs: 7.745e-02; rel: 5.556e-02; norm: 4.635e-01
## It: 108; obj: 1.652e+00; abs: 1.806e-01; rel: 1.227e-01; norm: 5.133e-01
## It: 109; obj: 1.673e+00; abs: 2.114e-02; rel: 1.280e-02; norm: 5.922e-01
## It: 110; obj: 1.692e+00; abs: 1.852e-02; rel: 1.107e-02; norm: 6.409e-01
## It: 111; obj: 1.596e+00; abs: 9.579e-02; rel: 5.662e-02; norm: 6.692e-01
## It: 112; obj: 1.594e+00; abs: 2.218e-03; rel: 1.389e-03; norm: 6.579e-01
## It: 113; obj: 1.562e+00; abs: 3.145e-02; rel: 1.973e-02; norm: 6.504e-01
## It: 114; obj: 1.555e+00; abs: 7.167e-03; rel: 4.588e-03; norm: 6.498e-01
## It: 115; obj: 1.550e+00; abs: 5.081e-03; rel: 3.267e-03; norm: 6.490e-01
## It: 116; obj: 1.529e+00; abs: 2.062e-02; rel: 1.330e-02; norm: 6.468e-01
## It: 117; obj: 1.543e+00; abs: 1.389e-02; rel: 9.083e-03; norm: 6.434e-01
## It: 118; obj: 1.535e+00; abs: 8.173e-03; rel: 5.296e-03; norm: 6.406e-01
## It: 119; obj: 1.552e+00; abs: 1.691e-02; rel: 1.102e-02; norm: 6.390e-01
## It: 120; obj: 1.553e+00; abs: 1.320e-03; rel: 8.502e-04; norm: 6.363e-01
## It: 121; obj: 1.525e+00; abs: 2.791e-02; rel: 1.797e-02; norm: 6.516e-01

```

```

## It: 122; obj: 1.515e+00; abs: 1.028e-02; rel: 6.738e-03; norm: 6.360e-01
## It: 123; obj: 1.543e+00; abs: 2.817e-02; rel: 1.859e-02; norm: 6.372e-01
## It: 124; obj: 1.523e+00; abs: 2.041e-02; rel: 1.322e-02; norm: 6.269e-01
## It: 125; obj: 1.537e+00; abs: 1.384e-02; rel: 9.084e-03; norm: 6.361e-01
## It: 126; obj: 1.523e+00; abs: 1.403e-02; rel: 9.126e-03; norm: 6.313e-01
## It: 127; obj: 1.529e+00; abs: 5.780e-03; rel: 3.796e-03; norm: 6.384e-01
## It: 128; obj: 1.488e+00; abs: 4.062e-02; rel: 2.657e-02; norm: 6.285e-01
## It: 129; obj: 1.517e+00; abs: 2.947e-02; rel: 1.981e-02; norm: 6.370e-01
## It: 130; obj: 1.490e+00; abs: 2.777e-02; rel: 1.830e-02; norm: 6.195e-01
## It: 131; obj: 1.521e+00; abs: 3.089e-02; rel: 2.074e-02; norm: 6.302e-01
## It: 132; obj: 1.472e+00; abs: 4.829e-02; rel: 3.176e-02; norm: 6.240e-01
## It: 133; obj: 1.517e+00; abs: 4.498e-02; rel: 3.056e-02; norm: 6.294e-01
## It: 134; obj: 1.473e+00; abs: 4.412e-02; rel: 2.908e-02; norm: 6.140e-01
## It: 135; obj: 1.516e+00; abs: 4.315e-02; rel: 2.929e-02; norm: 6.295e-01
## It: 136; obj: 1.477e+00; abs: 3.950e-02; rel: 2.605e-02; norm: 6.129e-01
## It: 137; obj: 1.510e+00; abs: 3.321e-02; rel: 2.249e-02; norm: 6.187e-01
## It: 138; obj: 1.460e+00; abs: 4.961e-02; rel: 3.285e-02; norm: 6.081e-01
## It: 139; obj: 1.515e+00; abs: 5.474e-02; rel: 3.749e-02; norm: 6.210e-01
## It: 140; obj: 1.442e+00; abs: 7.304e-02; rel: 4.821e-02; norm: 6.073e-01
## It: 141; obj: 1.529e+00; abs: 8.731e-02; rel: 6.055e-02; norm: 6.071e-01
## It: 142; obj: 1.506e+00; abs: 2.362e-02; rel: 1.544e-02; norm: 5.979e-01
## It: 143; obj: 1.549e+00; abs: 4.341e-02; rel: 2.883e-02; norm: 6.292e-01
## It: 144; obj: 1.493e+00; abs: 5.571e-02; rel: 3.596e-02; norm: 6.205e-01
## It: 145; obj: 1.527e+00; abs: 3.388e-02; rel: 2.269e-02; norm: 6.339e-01
## It: 146; obj: 1.539e+00; abs: 1.154e-02; rel: 7.559e-03; norm: 6.067e-01
## It: 147; obj: 1.563e+00; abs: 2.459e-02; rel: 1.598e-02; norm: 6.269e-01
## It: 148; obj: 1.518e+00; abs: 4.545e-02; rel: 2.907e-02; norm: 6.229e-01
## It: 149; obj: 1.559e+00; abs: 4.134e-02; rel: 2.723e-02; norm: 6.405e-01
## It: 150; obj: 1.494e+00; abs: 6.548e-02; rel: 4.199e-02; norm: 6.215e-01
## It: 151; obj: 1.540e+00; abs: 4.662e-02; rel: 3.121e-02; norm: 6.188e-01
## It: 152; obj: 1.524e+00; abs: 1.659e-02; rel: 1.077e-02; norm: 6.018e-01
## It: 153; obj: 1.561e+00; abs: 3.679e-02; rel: 2.414e-02; norm: 6.201e-01
## It: 154; obj: 1.520e+00; abs: 4.036e-02; rel: 2.586e-02; norm: 6.236e-01
## It: 155; obj: 1.530e+00; abs: 9.985e-03; rel: 6.568e-03; norm: 6.362e-01
## It: 156; obj: 1.505e+00; abs: 2.538e-02; rel: 1.658e-02; norm: 6.110e-01
## It: 157; obj: 1.528e+00; abs: 2.279e-02; rel: 1.514e-02; norm: 6.151e-01
## It: 158; obj: 1.523e+00; abs: 4.881e-03; rel: 3.195e-03; norm: 6.098e-01
## It: 159; obj: 1.526e+00; abs: 3.123e-03; rel: 2.051e-03; norm: 6.211e-01
## It: 160; obj: 1.524e+00; abs: 1.603e-03; rel: 1.050e-03; norm: 6.075e-01
## It: 161; obj: 1.520e+00; abs: 3.955e-03; rel: 2.595e-03; norm: 6.132e-01
## It: 162; obj: 1.490e+00; abs: 3.042e-02; rel: 2.001e-02; norm: 6.071e-01
## It: 163; obj: 1.511e+00; abs: 2.053e-02; rel: 1.378e-02; norm: 6.032e-01
## It: 164; obj: 1.519e+00; abs: 7.990e-03; rel: 5.290e-03; norm: 5.919e-01
## It: 165; obj: 1.526e+00; abs: 7.689e-03; rel: 5.064e-03; norm: 6.077e-01
## It: 166; obj: 1.513e+00; abs: 1.307e-02; rel: 8.561e-03; norm: 6.048e-01
## It: 167; obj: 1.526e+00; abs: 1.267e-02; rel: 8.372e-03; norm: 6.115e-01
## It: 168; obj: 1.515e+00; abs: 1.064e-02; rel: 6.973e-03; norm: 5.990e-01
## It: 169; obj: 1.504e+00; abs: 1.154e-02; rel: 7.615e-03; norm: 6.097e-01
## It: 170; obj: 1.512e+00; abs: 8.875e-03; rel: 5.902e-03; norm: 6.009e-01
## It: 171; obj: 1.538e+00; abs: 2.532e-02; rel: 1.674e-02; norm: 6.041e-01
## It: 172; obj: 1.519e+00; abs: 1.847e-02; rel: 1.201e-02; norm: 6.010e-01
## It: 173; obj: 1.548e+00; abs: 2.891e-02; rel: 1.903e-02; norm: 6.087e-01
## It: 174; obj: 1.502e+00; abs: 4.660e-02; rel: 3.010e-02; norm: 6.026e-01

```

```

## It: 175; obj: 1.515e+00; abs: 1.382e-02; rel: 9.200e-03; norm: 6.033e-01
## It: 176; obj: 1.535e+00; abs: 1.957e-02; rel: 1.292e-02; norm: 5.901e-01
## It: 177; obj: 1.554e+00; abs: 1.846e-02; rel: 1.203e-02; norm: 6.111e-01
## It: 178; obj: 1.535e+00; abs: 1.858e-02; rel: 1.196e-02; norm: 6.107e-01
## It: 179; obj: 1.545e+00; abs: 1.005e-02; rel: 6.546e-03; norm: 6.242e-01
## It: 180; obj: 1.559e+00; abs: 1.373e-02; rel: 8.888e-03; norm: 6.122e-01
## It: 181; obj: 1.564e+00; abs: 5.646e-03; rel: 3.622e-03; norm: 6.245e-01
## It: 182; obj: 1.550e+00; abs: 1.411e-02; rel: 9.017e-03; norm: 6.233e-01
## It: 183; obj: 1.556e+00; abs: 6.068e-03; rel: 3.914e-03; norm: 6.237e-01
## It: 184; obj: 1.553e+00; abs: 2.978e-03; rel: 1.913e-03; norm: 6.159e-01
## It: 185; obj: 1.561e+00; abs: 7.893e-03; rel: 5.081e-03; norm: 6.234e-01
## It: 186; obj: 1.564e+00; abs: 2.755e-03; rel: 1.765e-03; norm: 6.175e-01
## It: 187; obj: 1.552e+00; abs: 1.227e-02; rel: 7.846e-03; norm: 6.194e-01
## It: 188; obj: 1.554e+00; abs: 2.358e-03; rel: 1.520e-03; norm: 6.164e-01
## It: 189; obj: 1.604e+00; abs: 5.007e-02; rel: 3.222e-02; norm: 6.111e-01
## It: 190; obj: 1.572e+00; abs: 3.205e-02; rel: 1.998e-02; norm: 6.232e-01
## It: 191; obj: 1.535e+00; abs: 3.678e-02; rel: 2.340e-02; norm: 6.406e-01
## It: 192; obj: 1.562e+00; abs: 2.659e-02; rel: 1.732e-02; norm: 6.137e-01
## It: 193; obj: 1.561e+00; abs: 1.006e-03; rel: 6.441e-04; norm: 6.154e-01
## It: 194; obj: 1.557e+00; abs: 3.489e-03; rel: 2.235e-03; norm: 6.219e-01
## It: 195; obj: 1.554e+00; abs: 3.512e-03; rel: 2.255e-03; norm: 6.180e-01
## It: 196; obj: 1.570e+00; abs: 1.618e-02; rel: 1.041e-02; norm: 6.103e-01
## It: 197; obj: 1.592e+00; abs: 2.172e-02; rel: 1.383e-02; norm: 6.182e-01
## It: 198; obj: 1.569e+00; abs: 2.238e-02; rel: 1.406e-02; norm: 6.208e-01
## It: 199; obj: 1.543e+00; abs: 2.622e-02; rel: 1.670e-02; norm: 6.286e-01
## It: 200; obj: 1.546e+00; abs: 2.716e-03; rel: 1.760e-03; norm: 6.163e-01
## It: 201; obj: 1.549e+00; abs: 3.143e-03; rel: 2.033e-03; norm: 6.191e-01
## It: 202; obj: 1.548e+00; abs: 9.296e-04; rel: 6.001e-04; norm: 6.062e-01
## It: 203; obj: 1.562e+00; abs: 1.400e-02; rel: 9.041e-03; norm: 6.161e-01
## It: 204; obj: 1.550e+00; abs: 1.257e-02; rel: 8.046e-03; norm: 6.113e-01
## It: 205; obj: 1.568e+00; abs: 1.883e-02; rel: 1.215e-02; norm: 6.208e-01
## It: 206; obj: 1.549e+00; abs: 1.921e-02; rel: 1.225e-02; norm: 6.161e-01
## It: 207; obj: 1.562e+00; abs: 1.239e-02; rel: 7.995e-03; norm: 6.160e-01
## It: 208; obj: 1.544e+00; abs: 1.721e-02; rel: 1.102e-02; norm: 6.165e-01
## It: 209; obj: 1.564e+00; abs: 2.008e-02; rel: 1.300e-02; norm: 6.171e-01
## It: 210; obj: 1.541e+00; abs: 2.341e-02; rel: 1.496e-02; norm: 6.104e-01
## It: 211; obj: 1.597e+00; abs: 5.551e-02; rel: 3.602e-02; norm: 6.146e-01
## It: 212; obj: 1.540e+00; abs: 5.693e-02; rel: 3.566e-02; norm: 6.186e-01
## It: 213; obj: 1.581e+00; abs: 4.129e-02; rel: 2.682e-02; norm: 6.229e-01
## It: 214; obj: 1.546e+00; abs: 3.496e-02; rel: 2.211e-02; norm: 6.156e-01
## It: 215; obj: 1.585e+00; abs: 3.912e-02; rel: 2.530e-02; norm: 6.168e-01
## It: 216; obj: 1.539e+00; abs: 4.565e-02; rel: 2.880e-02; norm: 6.183e-01
## It: 217; obj: 1.578e+00; abs: 3.847e-02; rel: 2.499e-02; norm: 6.206e-01
## It: 218; obj: 1.527e+00; abs: 5.053e-02; rel: 3.203e-02; norm: 6.174e-01
## It: 219; obj: 1.572e+00; abs: 4.459e-02; rel: 2.919e-02; norm: 6.202e-01
## It: 220; obj: 1.583e+00; abs: 1.061e-02; rel: 6.751e-03; norm: 6.096e-01
## It: 221; obj: 1.592e+00; abs: 9.545e-03; rel: 6.031e-03; norm: 6.175e-01
## It: 222; obj: 1.559e+00; abs: 3.343e-02; rel: 2.100e-02; norm: 6.296e-01
## It: 223; obj: 1.578e+00; abs: 1.948e-02; rel: 1.250e-02; norm: 6.279e-01
## It: 224; obj: 1.563e+00; abs: 1.560e-02; rel: 9.882e-03; norm: 6.117e-01
## It: 225; obj: 1.578e+00; abs: 1.545e-02; rel: 9.891e-03; norm: 6.167e-01
## It: 226; obj: 1.554e+00; abs: 2.411e-02; rel: 1.528e-02; norm: 6.282e-01

```

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## It: 227; obj: 1.570e+00; abs: 1.573e-02; rel: 1.012e-02; norm: 6.216e-01
## It: 228; obj: 1.573e+00; abs: 3.264e-03; rel: 2.080e-03; norm: 6.045e-01
## It: 229; obj: 1.598e+00; abs: 2.513e-02; rel: 1.598e-02; norm: 6.215e-01
## It: 230; obj: 1.549e+00; abs: 4.920e-02; rel: 3.079e-02; norm: 6.253e-01
## It: 231; obj: 1.574e+00; abs: 2.505e-02; rel: 1.618e-02; norm: 6.257e-01
## It: 232; obj: 1.562e+00; abs: 1.211e-02; rel: 7.693e-03; norm: 6.164e-01
## It: 233; obj: 1.582e+00; abs: 2.047e-02; rel: 1.311e-02; norm: 6.162e-01
## It: 234; obj: 1.571e+00; abs: 1.129e-02; rel: 7.135e-03; norm: 6.196e-01
## It: 235; obj: 1.581e+00; abs: 9.710e-03; rel: 6.181e-03; norm: 6.202e-01
## It: 236; obj: 1.585e+00; abs: 4.446e-03; rel: 2.813e-03; norm: 6.105e-01
## It: 237; obj: 1.571e+00; abs: 1.380e-02; rel: 8.703e-03; norm: 6.174e-01
## It: 238; obj: 1.548e+00; abs: 2.324e-02; rel: 1.479e-02; norm: 6.190e-01
## It: 239; obj: 1.606e+00; abs: 5.748e-02; rel: 3.713e-02; norm: 6.061e-01
## It: 240; obj: 1.578e+00; abs: 2.742e-02; rel: 1.708e-02; norm: 6.067e-01
## It: 241; obj: 1.572e+00; abs: 6.002e-03; rel: 3.803e-03; norm: 6.271e-01
## It: 242; obj: 1.571e+00; abs: 1.297e-03; rel: 8.251e-04; norm: 6.130e-01
## It: 243; obj: 1.592e+00; abs: 2.124e-02; rel: 1.352e-02; norm: 6.162e-01
## It: 244; obj: 1.552e+00; abs: 3.994e-02; rel: 2.508e-02; norm: 6.210e-01
## It: 245; obj: 1.558e+00; abs: 5.904e-03; rel: 3.804e-03; norm: 6.250e-01
## It: 246; obj: 1.572e+00; abs: 1.407e-02; rel: 9.030e-03; norm: 6.034e-01
## It: 247; obj: 1.583e+00; abs: 1.090e-02; rel: 6.933e-03; norm: 6.162e-01
## It: 248; obj: 1.521e+00; abs: 6.243e-02; rel: 3.944e-02; norm: 6.168e-01
## It: 249; obj: 1.572e+00; abs: 5.163e-02; rel: 3.395e-02; norm: 6.041e-01
## It: 250; obj: 1.528e+00; abs: 4.390e-02; rel: 2.792e-02; norm: 5.965e-01

## It: 251; obj: 1.587e+00; abs: 5.875e-02; rel: 3.844e-02; norm: 6.048e-01
## It: 252; obj: 1.517e+00; abs: 7.033e-02; rel: 4.431e-02; norm: 5.993e-01
## It: 253; obj: 1.561e+00; abs: 4.418e-02; rel: 2.913e-02; norm: 6.136e-01
## It: 254; obj: 1.515e+00; abs: 4.570e-02; rel: 2.928e-02; norm: 5.931e-01
## It: 255; obj: 1.565e+00; abs: 4.993e-02; rel: 3.295e-02; norm: 5.995e-01
## It: 256; obj: 1.519e+00; abs: 4.661e-02; rel: 2.978e-02; norm: 6.043e-01
## It: 257; obj: 1.565e+00; abs: 4.677e-02; rel: 3.080e-02; norm: 6.026e-01
## It: 258; obj: 1.533e+00; abs: 3.213e-02; rel: 2.053e-02; norm: 5.957e-01
## It: 259; obj: 1.579e+00; abs: 4.573e-02; rel: 2.983e-02; norm: 6.095e-01
## It: 260; obj: 1.527e+00; abs: 5.202e-02; rel: 3.295e-02; norm: 6.024e-01
## It: 261; obj: 1.561e+00; abs: 3.418e-02; rel: 2.238e-02; norm: 6.111e-01
## It: 262; obj: 1.527e+00; abs: 3.385e-02; rel: 2.169e-02; norm: 6.002e-01
## It: 263; obj: 1.614e+00; abs: 8.672e-02; rel: 5.679e-02; norm: 6.003e-01
## It: 264; obj: 1.536e+00; abs: 7.841e-02; rel: 4.858e-02; norm: 6.113e-01
## It: 265; obj: 1.573e+00; abs: 3.720e-02; rel: 2.423e-02; norm: 6.345e-01
## It: 266; obj: 1.536e+00; abs: 3.638e-02; rel: 2.313e-02; norm: 6.033e-01
## It: 267; obj: 1.554e+00; abs: 1.807e-02; rel: 1.176e-02; norm: 6.063e-01
## It: 268; obj: 1.514e+00; abs: 4.067e-02; rel: 2.616e-02; norm: 6.035e-01
## It: 269; obj: 1.571e+00; abs: 5.756e-02; rel: 3.802e-02; norm: 6.082e-01
## It: 270; obj: 1.513e+00; abs: 5.796e-02; rel: 3.688e-02; norm: 5.962e-01
## It: 271; obj: 1.568e+00; abs: 5.456e-02; rel: 3.606e-02; norm: 6.080e-01
## It: 272; obj: 1.514e+00; abs: 5.422e-02; rel: 3.458e-02; norm: 5.902e-01
## It: 273; obj: 1.552e+00; abs: 3.785e-02; rel: 2.501e-02; norm: 6.057e-01
## It: 274; obj: 1.499e+00; abs: 5.222e-02; rel: 3.366e-02; norm: 6.024e-01
## It: 275; obj: 1.590e+00; abs: 9.092e-02; rel: 6.064e-02; norm: 5.965e-01

## It: 276; obj: 1.491e+00; abs: 9.899e-02; rel: 6.225e-02; norm: 5.955e-01
## It: 277; obj: 1.571e+00; abs: 8.007e-02; rel: 5.369e-02; norm: 6.085e-01
## It: 278; obj: 1.498e+00; abs: 7.350e-02; rel: 4.678e-02; norm: 5.928e-01
## It: 279; obj: 1.562e+00; abs: 6.445e-02; rel: 4.303e-02; norm: 6.014e-01

```

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## It: 280; obj: 1.512e+00; abs: 5.001e-02; rel: 3.201e-02; norm: 5.951e-01
## It: 281; obj: 1.594e+00; abs: 8.128e-02; rel: 5.375e-02; norm: 6.023e-01
## It: 282; obj: 1.491e+00; abs: 1.022e-01; rel: 6.413e-02; norm: 6.022e-01
## It: 283; obj: 1.569e+00; abs: 7.751e-02; rel: 5.197e-02; norm: 6.139e-01
## It: 284; obj: 1.519e+00; abs: 4.962e-02; rel: 3.163e-02; norm: 5.934e-01
## It: 285; obj: 1.567e+00; abs: 4.749e-02; rel: 3.126e-02; norm: 6.006e-01
## It: 286; obj: 1.484e+00; abs: 8.298e-02; rel: 5.297e-02; norm: 6.056e-01
## It: 287; obj: 1.576e+00; abs: 9.240e-02; rel: 6.227e-02; norm: 6.007e-01
## It: 288; obj: 1.513e+00; abs: 6.322e-02; rel: 4.011e-02; norm: 5.900e-01
## It: 289; obj: 1.568e+00; abs: 5.485e-02; rel: 3.626e-02; norm: 6.039e-01
## It: 290; obj: 1.490e+00; abs: 7.757e-02; rel: 4.948e-02; norm: 5.969e-01
## It: 291; obj: 1.551e+00; abs: 6.070e-02; rel: 4.074e-02; norm: 6.025e-01
## It: 292; obj: 1.522e+00; abs: 2.907e-02; rel: 1.875e-02; norm: 5.950e-01
## It: 293; obj: 1.549e+00; abs: 2.677e-02; rel: 1.759e-02; norm: 5.980e-01
## It: 294; obj: 1.522e+00; abs: 2.630e-02; rel: 1.698e-02; norm: 6.007e-01
## It: 295; obj: 1.524e+00; abs: 1.736e-03; rel: 1.140e-03; norm: 6.062e-01
## It: 296; obj: 1.502e+00; abs: 2.196e-02; rel: 1.441e-02; norm: 5.956e-01
## It: 297; obj: 1.547e+00; abs: 4.506e-02; rel: 3.000e-02; norm: 5.955e-01
## It: 298; obj: 1.519e+00; abs: 2.794e-02; rel: 1.806e-02; norm: 5.973e-01
## It: 299; obj: 1.532e+00; abs: 1.247e-02; rel: 8.208e-03; norm: 6.022e-01
## It: 300; obj: 1.522e+00; abs: 9.359e-03; rel: 6.110e-03; norm: 5.984e-01

## It: 301; obj: 1.530e+00; abs: 7.997e-03; rel: 5.254e-03; norm: 6.045e-01
## It: 302; obj: 1.520e+00; abs: 1.046e-02; rel: 6.834e-03; norm: 5.960e-01
## It: 303; obj: 1.550e+00; abs: 3.013e-02; rel: 1.983e-02; norm: 5.983e-01
## It: 304; obj: 1.512e+00; abs: 3.815e-02; rel: 2.461e-02; norm: 6.040e-01
## It: 305; obj: 1.537e+00; abs: 2.509e-02; rel: 1.659e-02; norm: 5.994e-01
## It: 306; obj: 1.511e+00; abs: 2.544e-02; rel: 1.656e-02; norm: 6.022e-01
## It: 307; obj: 1.526e+00; abs: 1.484e-02; rel: 9.816e-03; norm: 6.037e-01
## It: 308; obj: 1.529e+00; abs: 3.045e-03; rel: 1.995e-03; norm: 5.936e-01
## It: 309; obj: 1.512e+00; abs: 1.763e-02; rel: 1.153e-02; norm: 6.028e-01
## It: 310; obj: 1.515e+00; abs: 2.922e-03; rel: 1.933e-03; norm: 5.998e-01
## It: 311; obj: 1.540e+00; abs: 2.570e-02; rel: 1.697e-02; norm: 5.926e-01
## It: 312; obj: 1.534e+00; abs: 6.130e-03; rel: 3.980e-03; norm: 6.038e-01
## It: 313; obj: 1.507e+00; abs: 2.688e-02; rel: 1.752e-02; norm: 6.128e-01
## It: 314; obj: 1.537e+00; abs: 2.933e-02; rel: 1.946e-02; norm: 5.949e-01
## It: 315; obj: 1.538e+00; abs: 9.680e-04; rel: 6.299e-04; norm: 5.987e-01
## It: 316; obj: 1.519e+00; abs: 1.815e-02; rel: 1.180e-02; norm: 6.052e-01
## It: 317; obj: 1.539e+00; abs: 1.911e-02; rel: 1.258e-02; norm: 5.994e-01
## It: 318; obj: 1.542e+00; abs: 3.054e-03; rel: 1.985e-03; norm: 6.003e-01
## It: 319; obj: 1.518e+00; abs: 2.371e-02; rel: 1.538e-02; norm: 6.083e-01
## It: 320; obj: 1.537e+00; abs: 1.861e-02; rel: 1.226e-02; norm: 5.995e-01
## It: 321; obj: 1.495e+00; abs: 4.195e-02; rel: 2.730e-02; norm: 6.036e-01
## It: 322; obj: 1.533e+00; abs: 3.873e-02; rel: 2.591e-02; norm: 5.985e-01
## It: 323; obj: 1.512e+00; abs: 2.174e-02; rel: 1.418e-02; norm: 5.930e-01
## It: 324; obj: 1.520e+00; abs: 8.034e-03; rel: 5.315e-03; norm: 6.042e-01
## It: 325; obj: 1.531e+00; abs: 1.184e-02; rel: 7.791e-03; norm: 6.007e-01

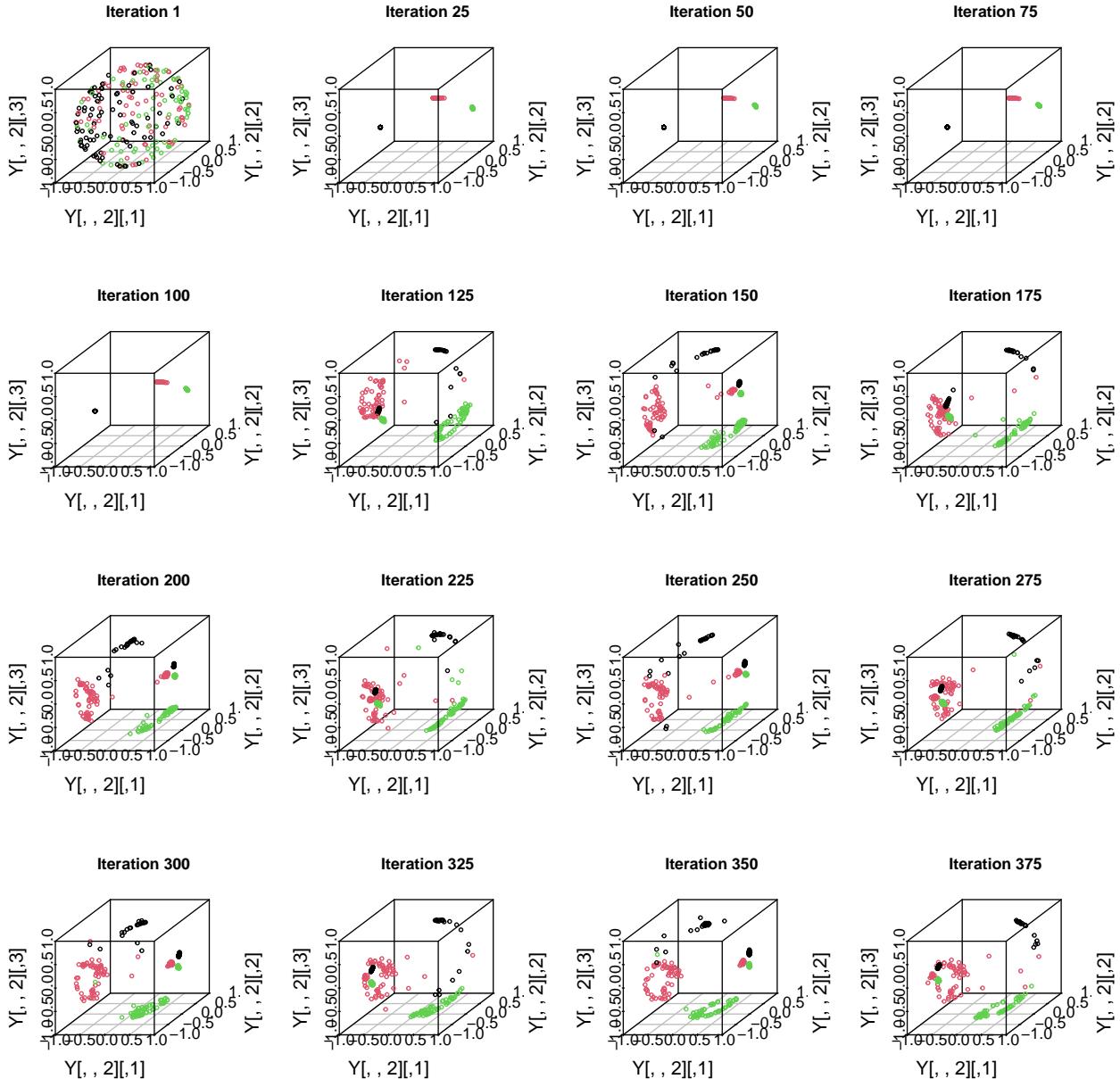
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## It: 327; obj: 1.512e+00; abs: 1.597e-02; rel: 1.045e-02; norm: 6.065e-01
## It: 328; obj: 1.543e+00; abs: 3.148e-02; rel: 2.082e-02; norm: 6.039e-01
## It: 329; obj: 1.536e+00; abs: 7.850e-03; rel: 5.086e-03; norm: 6.053e-01
## It: 330; obj: 1.543e+00; abs: 7.785e-03; rel: 5.069e-03; norm: 6.069e-01
## It: 331; obj: 1.537e+00; abs: 6.498e-03; rel: 4.210e-03; norm: 6.141e-01
## It: 332; obj: 1.571e+00; abs: 3.379e-02; rel: 2.198e-02; norm: 6.102e-01

```

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## It: 333; obj: 1.506e+00; abs: 6.445e-02; rel: 4.103e-02; norm: 6.102e-01
## It: 334; obj: 1.525e+00; abs: 1.889e-02; rel: 1.254e-02; norm: 6.193e-01
## It: 335; obj: 1.523e+00; abs: 2.545e-03; rel: 1.668e-03; norm: 6.069e-01
## It: 336; obj: 1.549e+00; abs: 2.647e-02; rel: 1.738e-02; norm: 6.029e-01
## It: 337; obj: 1.482e+00; abs: 6.755e-02; rel: 4.361e-02; norm: 6.158e-01
## It: 338; obj: 1.539e+00; abs: 5.732e-02; rel: 3.869e-02; norm: 6.051e-01
## It: 339; obj: 1.503e+00; abs: 3.555e-02; rel: 2.310e-02; norm: 5.992e-01
## It: 340; obj: 1.519e+00; abs: 1.522e-02; rel: 1.012e-02; norm: 6.061e-01
## It: 341; obj: 1.521e+00; abs: 2.290e-03; rel: 1.508e-03; norm: 5.969e-01
## It: 342; obj: 1.536e+00; abs: 1.482e-02; rel: 9.744e-03; norm: 6.033e-01
## It: 343; obj: 1.494e+00; abs: 4.182e-02; rel: 2.723e-02; norm: 6.127e-01
## It: 344; obj: 1.523e+00; abs: 2.931e-02; rel: 1.962e-02; norm: 6.091e-01
## It: 345; obj: 1.518e+00; abs: 5.516e-03; rel: 3.621e-03; norm: 5.992e-01
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## It: 347; obj: 1.505e+00; abs: 1.426e-02; rel: 9.382e-03; norm: 6.075e-01
## It: 348; obj: 1.519e+00; abs: 1.429e-02; rel: 9.497e-03; norm: 5.970e-01
## It: 349; obj: 1.500e+00; abs: 1.899e-02; rel: 1.250e-02; norm: 6.060e-01
## It: 350; obj: 1.497e+00; abs: 3.562e-03; rel: 2.374e-03; norm: 6.068e-01
## It: 351; obj: 1.528e+00; abs: 3.090e-02; rel: 2.064e-02; norm: 5.963e-01
## It: 352; obj: 1.538e+00; abs: 1.069e-02; rel: 6.997e-03; norm: 5.907e-01
## It: 353; obj: 1.515e+00; abs: 2.314e-02; rel: 1.504e-02; norm: 6.069e-01
## It: 354; obj: 1.496e+00; abs: 1.960e-02; rel: 1.294e-02; norm: 6.077e-01
## It: 355; obj: 1.537e+00; abs: 4.179e-02; rel: 2.794e-02; norm: 6.007e-01
## It: 356; obj: 1.511e+00; abs: 2.676e-02; rel: 1.741e-02; norm: 5.970e-01
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## It: 358; obj: 1.525e+00; abs: 1.738e-02; rel: 1.152e-02; norm: 5.949e-01
## It: 359; obj: 1.509e+00; abs: 1.672e-02; rel: 1.096e-02; norm: 6.016e-01
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## It: 361; obj: 1.537e+00; abs: 3.132e-02; rel: 2.081e-02; norm: 5.985e-01
## It: 362; obj: 1.504e+00; abs: 3.295e-02; rel: 2.144e-02; norm: 6.037e-01
## It: 363; obj: 1.532e+00; abs: 2.768e-02; rel: 1.841e-02; norm: 6.122e-01
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## It: 366; obj: 1.524e+00; abs: 3.250e-02; rel: 2.088e-02; norm: 6.213e-01
## It: 367; obj: 1.535e+00; abs: 1.145e-02; rel: 7.514e-03; norm: 6.277e-01
## It: 368; obj: 1.501e+00; abs: 3.381e-02; rel: 2.202e-02; norm: 6.119e-01
## It: 369; obj: 1.530e+00; abs: 2.852e-02; rel: 1.900e-02; norm: 6.100e-01
## It: 370; obj: 1.507e+00; abs: 2.314e-02; rel: 1.512e-02; norm: 5.938e-01
## It: 371; obj: 1.551e+00; abs: 4.462e-02; rel: 2.961e-02; norm: 6.127e-01
## It: 372; obj: 1.510e+00; abs: 4.198e-02; rel: 2.706e-02; norm: 6.076e-01
## It: 373; obj: 1.539e+00; abs: 2.931e-02; rel: 1.941e-02; norm: 6.104e-01
## It: 374; obj: 1.504e+00; abs: 3.443e-02; rel: 2.237e-02; norm: 6.005e-01
## It: 375; obj: 1.547e+00; abs: 4.289e-02; rel: 2.851e-02; norm: 5.990e-01

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## It: 376; obj: 1.529e+00; abs: 1.871e-02; rel: 1.209e-02; norm: 5.963e-01
## It: 377; obj: 1.530e+00; abs: 1.783e-03; rel: 1.167e-03; norm: 6.143e-01
## It: 378; obj: 1.525e+00; abs: 5.535e-03; rel: 3.617e-03; norm: 6.041e-01
## It: 379; obj: 1.532e+00; abs: 7.277e-03; rel: 4.772e-03; norm: 6.110e-01
## It: 380; obj: 1.502e+00; abs: 2.962e-02; rel: 1.933e-02; norm: 6.036e-01
## It: 381; obj: 1.532e+00; abs: 2.928e-02; rel: 1.949e-02; norm: 6.034e-01
## It: 382; obj: 1.518e+00; abs: 1.376e-02; rel: 8.985e-03; norm: 5.935e-01
## It: 383; obj: 1.513e+00; abs: 5.289e-03; rel: 3.484e-03; norm: 6.119e-01
## It: 384; obj: 1.476e+00; abs: 3.669e-02; rel: 2.425e-02; norm: 5.983e-01
## It: 385; obj: 1.525e+00; abs: 4.926e-02; rel: 3.338e-02; norm: 5.927e-01
## It: 386; obj: 1.487e+00; abs: 3.782e-02; rel: 2.479e-02; norm: 5.917e-01
## It: 387; obj: 1.528e+00; abs: 4.027e-02; rel: 2.707e-02; norm: 6.074e-01
## It: 388; obj: 1.520e+00; abs: 7.716e-03; rel: 5.050e-03; norm: 5.992e-01
## It: 389; obj: 1.539e+00; abs: 1.902e-02; rel: 1.252e-02; norm: 6.138e-01
## It: 390; obj: 1.535e+00; abs: 4.347e-03; rel: 2.824e-03; norm: 6.038e-01

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## It: 391; obj: 1.548e+00; abs: 1.303e-02; rel: 8.489e-03; norm: 6.144e-01
## It: 392; obj: 1.556e+00; abs: 7.799e-03; rel: 5.039e-03; norm: 6.161e-01
## It: 393; obj: 1.555e+00; abs: 1.349e-04; rel: 8.675e-05; norm: 6.195e-01
## It: 394; obj: 1.533e+00; abs: 2.219e-02; rel: 1.427e-02; norm: 6.192e-01
## It: 395; obj: 1.517e+00; abs: 1.630e-02; rel: 1.063e-02; norm: 6.264e-01
## It: 396; obj: 1.530e+00; abs: 1.284e-02; rel: 8.462e-03; norm: 6.093e-01
## It: 397; obj: 1.517e+00; abs: 1.231e-02; rel: 8.046e-03; norm: 6.119e-01
## It: 398; obj: 1.544e+00; abs: 2.634e-02; rel: 1.736e-02; norm: 6.122e-01
## It: 399; obj: 1.539e+00; abs: 4.986e-03; rel: 3.230e-03; norm: 6.203e-01
## It: 400; obj: 1.554e+00; abs: 1.477e-02; rel: 9.598e-03; norm: 6.178e-01

## It: 401; obj: 1.529e+00; abs: 2.461e-02; rel: 1.584e-02; norm: 6.256e-01
## It: 402; obj: 1.550e+00; abs: 2.106e-02; rel: 1.377e-02; norm: 6.163e-01
## It: 403; obj: 1.536e+00; abs: 1.447e-02; rel: 9.337e-03; norm: 6.241e-01
## It: 404; obj: 1.527e+00; abs: 8.146e-03; rel: 5.305e-03; norm: 6.189e-01
## It: 405; obj: 1.531e+00; abs: 3.674e-03; rel: 2.406e-03; norm: 6.212e-01
## It: 406; obj: 1.552e+00; abs: 2.114e-02; rel: 1.380e-02; norm: 6.126e-01
## It: 407; obj: 1.506e+00; abs: 4.654e-02; rel: 2.998e-02; norm: 6.255e-01
## It: 408; obj: 1.546e+00; abs: 4.009e-02; rel: 2.663e-02; norm: 6.159e-01
## It: 409; obj: 1.499e+00; abs: 4.684e-02; rel: 3.030e-02; norm: 6.183e-01
## It: 410; obj: 1.572e+00; abs: 7.336e-02; rel: 4.894e-02; norm: 6.054e-01
## It: 411; obj: 1.540e+00; abs: 3.177e-02; rel: 2.021e-02; norm: 6.144e-01
## It: 412; obj: 1.517e+00; abs: 2.317e-02; rel: 1.504e-02; norm: 6.225e-01
## It: 413; obj: 1.512e+00; abs: 5.756e-03; rel: 3.793e-03; norm: 6.236e-01
## It: 414; obj: 1.535e+00; abs: 2.303e-02; rel: 1.523e-02; norm: 6.055e-01
## It: 415; obj: 1.536e+00; abs: 1.891e-03; rel: 1.233e-03; norm: 6.170e-01
## It: 416; obj: 1.528e+00; abs: 8.029e-03; rel: 5.226e-03; norm: 6.136e-01
## It: 417; obj: 1.529e+00; abs: 1.004e-03; rel: 6.568e-04; norm: 6.140e-01
## It: 418; obj: 1.539e+00; abs: 9.662e-03; rel: 6.317e-03; norm: 6.128e-01
## It: 419; obj: 1.507e+00; abs: 3.236e-02; rel: 2.103e-02; norm: 6.210e-01
## It: 420; obj: 1.546e+00; abs: 3.926e-02; rel: 2.606e-02; norm: 6.073e-01
## It: 421; obj: 1.529e+00; abs: 1.697e-02; rel: 1.098e-02; norm: 6.101e-01
## It: 422; obj: 1.551e+00; abs: 2.174e-02; rel: 1.422e-02; norm: 6.153e-01
## It: 423; obj: 1.525e+00; abs: 2.553e-02; rel: 1.646e-02; norm: 6.174e-01
## It: 424; obj: 1.536e+00; abs: 1.101e-02; rel: 7.221e-03; norm: 6.075e-01
## It: 425; obj: 1.518e+00; abs: 1.862e-02; rel: 1.212e-02; norm: 6.201e-01

## It: 426; obj: 1.537e+00; abs: 1.950e-02; rel: 1.285e-02; norm: 6.077e-01
## It: 427; obj: 1.551e+00; abs: 1.399e-02; rel: 9.104e-03; norm: 6.054e-01
## It: 428; obj: 1.540e+00; abs: 1.104e-02; rel: 7.115e-03; norm: 6.163e-01
## It: 429; obj: 1.519e+00; abs: 2.095e-02; rel: 1.360e-02; norm: 6.284e-01
## It: 430; obj: 1.532e+00; abs: 1.286e-02; rel: 8.467e-03; norm: 6.074e-01
## It: 431; obj: 1.537e+00; abs: 5.394e-03; rel: 3.521e-03; norm: 6.152e-01
## It: 432; obj: 1.519e+00; abs: 1.807e-02; rel: 1.175e-02; norm: 6.111e-01
## It: 433; obj: 1.521e+00; abs: 1.835e-03; rel: 1.208e-03; norm: 6.172e-01
## It: 434; obj: 1.528e+00; abs: 7.082e-03; rel: 4.656e-03; norm: 6.060e-01
## It: 435; obj: 1.527e+00; abs: 1.567e-03; rel: 1.025e-03; norm: 6.149e-01
## It: 436; obj: 1.552e+00; abs: 2.555e-02; rel: 1.674e-02; norm: 6.073e-01
## It: 437; obj: 1.518e+00; abs: 3.430e-02; rel: 2.210e-02; norm: 6.178e-01
## It: 438; obj: 1.558e+00; abs: 4.030e-02; rel: 2.655e-02; norm: 6.138e-01
## It: 439; obj: 1.536e+00; abs: 2.235e-02; rel: 1.434e-02; norm: 6.159e-01
## It: 440; obj: 1.537e+00; abs: 1.504e-03; rel: 9.793e-04; norm: 6.179e-01
## It: 441; obj: 1.533e+00; abs: 3.934e-03; rel: 2.559e-03; norm: 6.230e-01
## It: 442; obj: 1.534e+00; abs: 2.546e-04; rel: 1.661e-04; norm: 6.111e-01
## It: 443; obj: 1.535e+00; abs: 1.376e-03; rel: 8.975e-04; norm: 6.112e-01

```

```

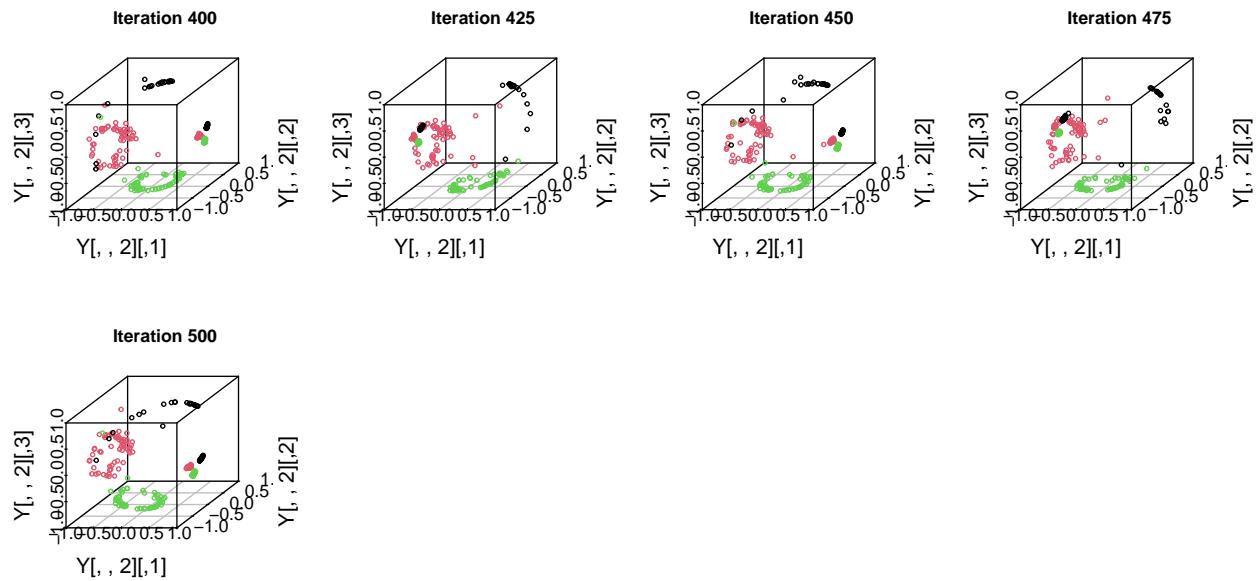
## It: 444; obj: 1.517e+00; abs: 1.796e-02; rel: 1.170e-02; norm: 6.131e-01
## It: 445; obj: 1.533e+00; abs: 1.579e-02; rel: 1.041e-02; norm: 6.146e-01
## It: 446; obj: 1.528e+00; abs: 5.098e-03; rel: 3.326e-03; norm: 6.053e-01
## It: 447; obj: 1.534e+00; abs: 6.268e-03; rel: 4.103e-03; norm: 6.181e-01
## It: 448; obj: 1.532e+00; abs: 2.522e-03; rel: 1.644e-03; norm: 6.071e-01
## It: 449; obj: 1.524e+00; abs: 7.664e-03; rel: 5.004e-03; norm: 6.150e-01
## It: 450; obj: 1.513e+00; abs: 1.057e-02; rel: 6.938e-03; norm: 6.097e-01
## It: 451; obj: 1.542e+00; abs: 2.841e-02; rel: 1.877e-02; norm: 6.114e-01
## It: 452; obj: 1.519e+00; abs: 2.272e-02; rel: 1.474e-02; norm: 6.072e-01
## It: 453; obj: 1.536e+00; abs: 1.678e-02; rel: 1.105e-02; norm: 6.106e-01
## It: 454; obj: 1.503e+00; abs: 3.256e-02; rel: 2.120e-02; norm: 6.069e-01
## It: 455; obj: 1.537e+00; abs: 3.352e-02; rel: 2.230e-02; norm: 6.173e-01
## It: 456; obj: 1.494e+00; abs: 4.280e-02; rel: 2.785e-02; norm: 6.060e-01
## It: 457; obj: 1.547e+00; abs: 5.328e-02; rel: 3.566e-02; norm: 6.100e-01
## It: 458; obj: 1.500e+00; abs: 4.715e-02; rel: 3.047e-02; norm: 6.116e-01
## It: 459; obj: 1.523e+00; abs: 2.335e-02; rel: 1.556e-02; norm: 6.206e-01
## It: 460; obj: 1.535e+00; abs: 1.122e-02; rel: 7.368e-03; norm: 6.014e-01
## It: 461; obj: 1.526e+00; abs: 8.879e-03; rel: 5.785e-03; norm: 6.228e-01
## It: 462; obj: 1.515e+00; abs: 1.108e-02; rel: 7.261e-03; norm: 6.123e-01
## It: 463; obj: 1.524e+00; abs: 8.986e-03; rel: 5.932e-03; norm: 6.136e-01
## It: 464; obj: 1.514e+00; abs: 9.736e-03; rel: 6.389e-03; norm: 6.084e-01
## It: 465; obj: 1.511e+00; abs: 3.295e-03; rel: 2.177e-03; norm: 6.177e-01
## It: 466; obj: 1.538e+00; abs: 2.683e-02; rel: 1.776e-02; norm: 6.073e-01
## It: 467; obj: 1.526e+00; abs: 1.140e-02; rel: 7.416e-03; norm: 6.149e-01
## It: 468; obj: 1.537e+00; abs: 1.053e-02; rel: 6.901e-03; norm: 6.151e-01
## It: 469; obj: 1.530e+00; abs: 6.792e-03; rel: 4.420e-03; norm: 6.262e-01
## It: 470; obj: 1.511e+00; abs: 1.911e-02; rel: 1.249e-02; norm: 6.131e-01
## It: 471; obj: 1.531e+00; abs: 2.014e-02; rel: 1.333e-02; norm: 6.122e-01
## It: 472; obj: 1.517e+00; abs: 1.380e-02; rel: 9.013e-03; norm: 6.026e-01
## It: 473; obj: 1.504e+00; abs: 1.353e-02; rel: 8.918e-03; norm: 6.141e-01
## It: 474; obj: 1.524e+00; abs: 2.063e-02; rel: 1.372e-02; norm: 6.015e-01
## It: 475; obj: 1.494e+00; abs: 2.973e-02; rel: 1.951e-02; norm: 6.064e-01
## It: 476; obj: 1.487e+00; abs: 7.148e-03; rel: 4.783e-03; norm: 6.082e-01
## It: 477; obj: 1.508e+00; abs: 2.105e-02; rel: 1.415e-02; norm: 6.055e-01
## It: 478; obj: 1.515e+00; abs: 6.695e-03; rel: 4.439e-03; norm: 5.958e-01
## It: 479; obj: 1.487e+00; abs: 2.784e-02; rel: 1.837e-02; norm: 6.123e-01
## It: 480; obj: 1.513e+00; abs: 2.600e-02; rel: 1.748e-02; norm: 6.031e-01
## It: 481; obj: 1.493e+00; abs: 2.036e-02; rel: 1.345e-02; norm: 6.061e-01
## It: 482; obj: 1.502e+00; abs: 9.107e-03; rel: 6.101e-03; norm: 6.047e-01
## It: 483; obj: 1.505e+00; abs: 2.988e-03; rel: 1.989e-03; norm: 6.029e-01
## It: 484; obj: 1.532e+00; abs: 2.710e-02; rel: 1.801e-02; norm: 6.000e-01
## It: 485; obj: 1.495e+00; abs: 3.694e-02; rel: 2.411e-02; norm: 6.144e-01
## It: 486; obj: 1.515e+00; abs: 1.959e-02; rel: 1.310e-02; norm: 6.018e-01
## It: 487; obj: 1.497e+00; abs: 1.788e-02; rel: 1.180e-02; norm: 6.060e-01
## It: 488; obj: 1.508e+00; abs: 1.146e-02; rel: 7.656e-03; norm: 6.054e-01
## It: 489; obj: 1.508e+00; abs: 7.143e-04; rel: 4.736e-04; norm: 6.063e-01
## It: 490; obj: 1.535e+00; abs: 2.721e-02; rel: 1.805e-02; norm: 6.050e-01
## It: 491; obj: 1.521e+00; abs: 1.380e-02; rel: 8.993e-03; norm: 6.205e-01
## It: 492; obj: 1.539e+00; abs: 1.771e-02; rel: 1.164e-02; norm: 6.127e-01
## It: 493; obj: 1.533e+00; abs: 5.586e-03; rel: 3.630e-03; norm: 6.222e-01
## It: 494; obj: 1.518e+00; abs: 1.511e-02; rel: 9.855e-03; norm: 6.198e-01
## It: 495; obj: 1.515e+00; abs: 2.684e-03; rel: 1.768e-03; norm: 6.254e-01
## It: 496; obj: 1.550e+00; abs: 3.426e-02; rel: 2.261e-02; norm: 6.100e-01

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## It: 497; obj: 1.492e+00; abs: 5.767e-02; rel: 3.721e-02; norm: 6.229e-01
## It: 498; obj: 1.550e+00; abs: 5.778e-02; rel: 3.873e-02; norm: 6.132e-01
## It: 499; obj: 1.492e+00; abs: 5.736e-02; rel: 3.701e-02; norm: 6.169e-01
## It: 500; obj: 1.526e+00; abs: 3.371e-02; rel: 2.259e-02; norm: 6.192e-01

```



Iteration 500

