2d grid (pi X sigmabeta_sq) optimization

```
library(covdepGE)
library(ggplot2)
source("generate_data.R")
cont <- generate_continuous()
disc <- generate_discrete(same = F)

# continuous data using the value of pi obtained using CS
out.cont_CS <- covdepGE(data_mat = cont$data, Z = cont$covts, tau = 0.56,
    sigmavec = c(0.01, 0.05, 0.1, 0.5, 1, 3, 7, 10), pi_vec = NULL,
    print_time = T)
```

```
## Time difference of 2.567457 secs
```

```
# continuous data using a grid of pi values
out.cont_grid <- covdepGE(data_mat = cont$data, Z = cont$covts, tau = 0.56,
    sigmavec = c(0.01, 0.05, 0.1, 0.5, 1, 3, 7, 10), pi_vec = seq(from = 0.05,
        to = 0.95, by = 0.05), print_time = T)
```

```
## Time difference of 29.05536 secs
```

```
# ELBO from models using pi from CS
out.cont_CS$ELBO
```

```
## $`Response 1`
## $`Response 1`$`sigma^2_beta`
## [1] 0.1
##
## $`Response 1`$pi
## [1] 0.3103964
##
## $`Response 1`$ELBO
## [1] -13817.2
##
##
## $`Response 2`
## $`Response 2`$`sigma^2_beta`
## [1] 0.5
##
## $`Response 2`$pi
## [1] 0.3103964
##
## $`Response 2`$ELBO
## [1] -16816.76
##
```

```
##
## $`Response 3`
## $`Response 3`$`sigma^2_beta`
## [1] 0.5
##
## $`Response 3`$pi
## [1] 0.3103964
##
## $`Response 3`$ELBO
## [1] -17021.3
##
##
## $`Response 4`
## $`Response 4`$`sigma^2_beta`
## [1] 0.05
##
## $`Response 4`$pi
## [1] 0.3103964
##
## $`Response 4`$ELBO
## [1] -16102.02
##
##
## $`Response 5`
## $`Response 5`$`sigma^2_beta`
## [1] 0.05
##
## $`Response 5`$pi
## [1] 0.3103964
##
## $`Response 5`$ELBO
## [1] -16252.47
```

```
# ELBO from models using pi from grid search
out.cont_grid$ELBO
```

```
## $`Response 1`
## $`Response 1`$`sigma^2_beta`
## [1] 0.1
##
## $`Response 1`$pi
## [1] 0.45
##
## $`Response 1`$ELBO
## [1] -13805.7
##
##
## $`Response 2`
## $`Response 2`$`sigma^2_beta`
## [1] 0.5
##
## $`Response 2`$pi
## [1] 0.55
##
```

```
## $`Response 2`$ELBO
## [1] -16765.38
##
##
## $`Response 3`
## $`Response 3`$`sigma^2_beta`
## [1] 0.5
##
## $`Response 3`$pi
## [1] 0.5
##
## $`Response 3`$ELBO
## [1] -16987.87
##
##
## $`Response 4`
## $`Response 4`$`sigma^2_beta`
## [1] 0.1
##
## $`Response 4`$pi
## [1] 0.15
##
## $`Response 4`$ELBO
## [1] -16072.32
##
##
## $`Response 5`
## $`Response 5`$`sigma^2_beta`
## [1] 0.05
##
## $`Response 5`$pi
## [1] 0.35
##
## $`Response 5`$ELBO
## [1] -16251.37
```

```
# compare the resulting ELBO
ELBO_CS <- unlist(lapply(out.cont_CS$ELBO, `[[`, 3))
ELBO_grid <- unlist(lapply(out.cont_grid$ELBO, `[[`, 3))
cbind.data.frame(ELBO_CS, ELBO_grid, difference = ELBO_grid - ELBO_CS)
```

```
##              ELBO_CS ELBO_grid difference
## Response 1 -13817.20 -13805.70  11.500844
## Response 2 -16816.76 -16765.38  51.375589
## Response 3 -17021.30 -16987.87  33.429070
## Response 4 -16102.02 -16072.32  29.694295
## Response 5 -16252.47 -16251.37   1.100573
```

```
# get probabilities of inclusion for the 45th and 135th
# individual
round(incl.probs.cont_CS45 <- out.cont_CS$inclusion_probs[[45]], 2)
```

```
##      [,1] [,2] [,3] [,4] [,5]
```

```
## [1,] 0.00 1.00 0.09 0.15 0.32
## [2,] 1.00 0.00 1.00 0.19 0.10
## [3,] 0.09 1.00 0.00 0.11 0.10
## [4,] 0.15 0.19 0.11 0.00 0.19
## [5,] 0.32 0.10 0.10 0.19 0.00
```

```
round(incl.probs.cont_grid45 <- out.cont_grid$inclusion_probs[[45]],
    2)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,] 0.00 1.00 0.16 0.15 0.41
## [2,] 1.00 0.00 1.00 0.23 0.16
## [3,] 0.16 1.00 0.00 0.11 0.15
## [4,] 0.15 0.23 0.11 0.00 0.14
## [5,] 0.41 0.16 0.15 0.14 0.00
```

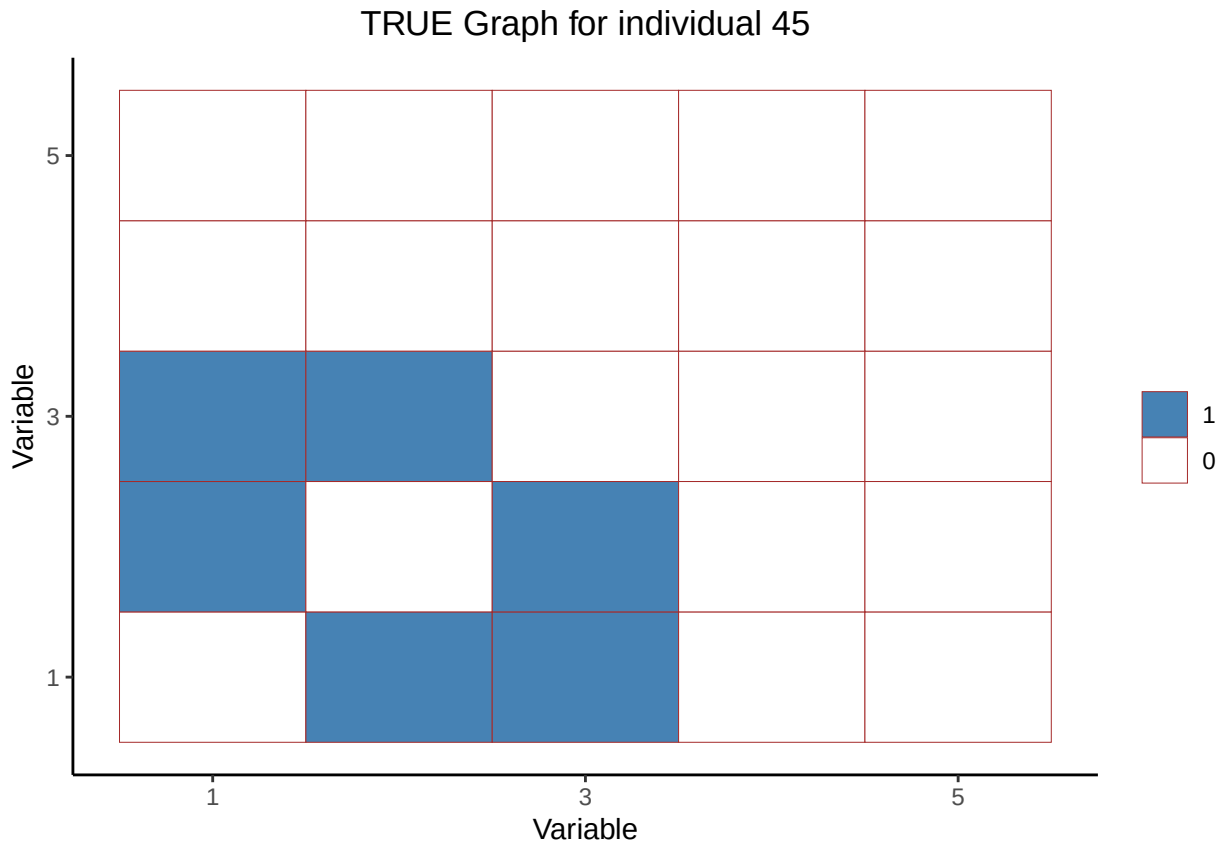
```
round(incl.probs.cont_CS135 <- out.cont_CS$inclusion_probs[[135]],
    2)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,] 0.00 0.07 1.00 0.13 0.46
## [2,] 0.07 0.00 1.00 0.10 0.46
## [3,] 1.00 1.00 0.00 0.11 0.10
## [4,] 0.13 0.10 0.11 0.00 0.99
## [5,] 0.46 0.46 0.10 0.99 0.00
```

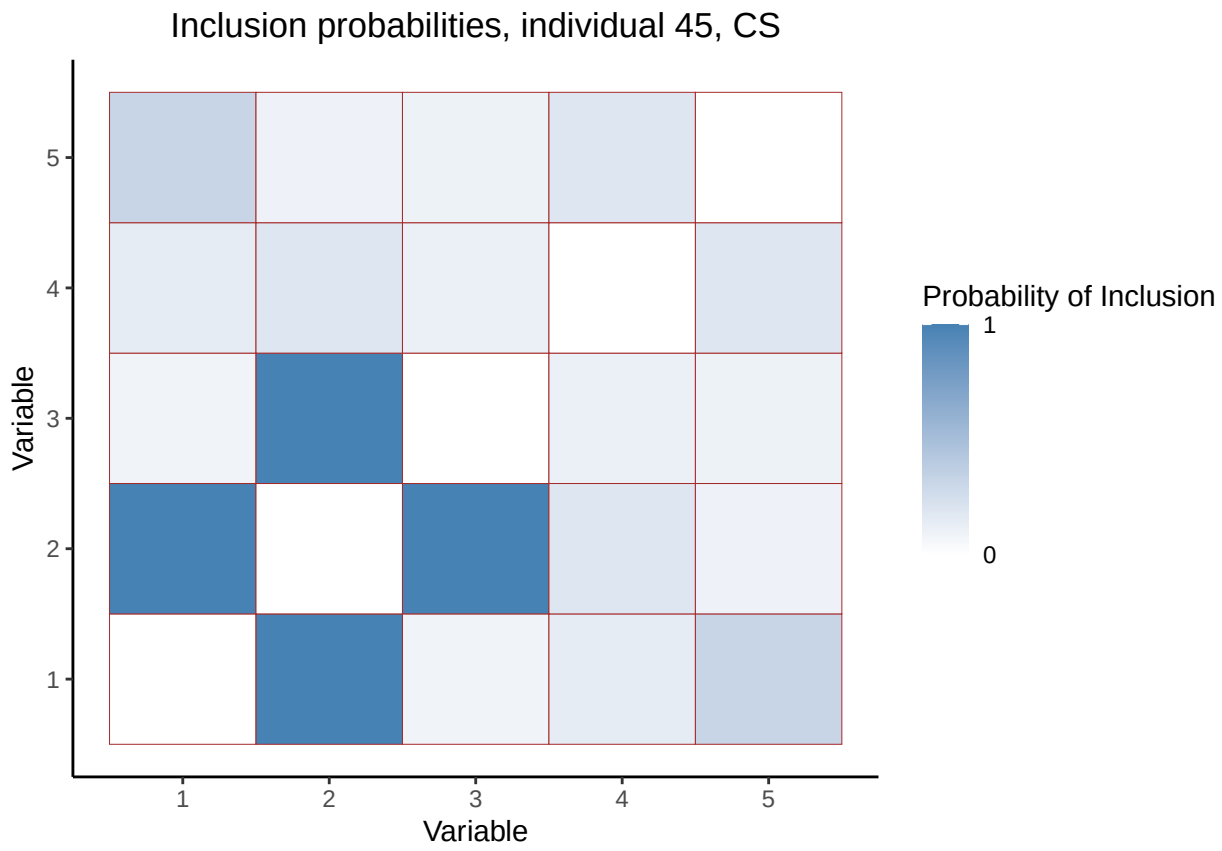
```
round(incl.probs.cont_grid135 <- out.cont_grid$inclusion_probs[[135]],
    2)
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,] 0.00 0.14 1.00 0.12 0.57
## [2,] 0.14 0.00 1.00 0.11 0.60
## [3,] 1.00 1.00 0.00 0.10 0.15
## [4,] 0.12 0.11 0.10 0.00 0.99
## [5,] 0.57 0.60 0.15 0.99 0.00
```

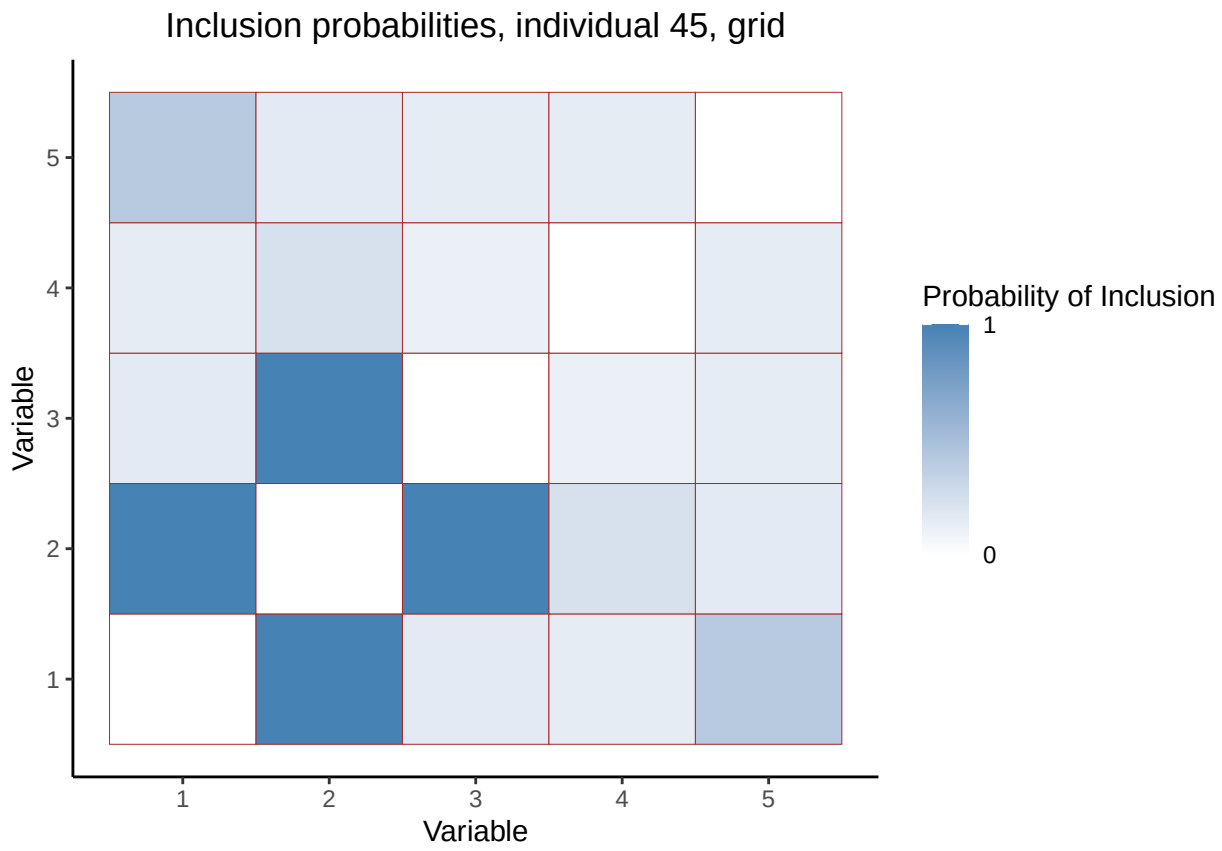
```
# get the true graphs for the 45th and 135th individual
true.graph45 <- cont$true_graphs[[45]]
true.graph135 <- cont$true_graphs[[135]]

# visualize the probabilities of inclusion and true graphs

# true graph individual 45
(ggplot(reshape2::melt(true.graph45), aes(x = Var1, y = Var2, fill = value)) +
    geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + guides(fill = guide_legend(title = "")) +
    theme_classic() + xlab("Variable") + ylab("Variable") + scale_x_continuous(breaks = seq(1,
    ncol(disc$data), 2)) + scale_y_continuous(breaks = seq(1, ncol(disc$data),
    2)) + ggtitle("TRUE Graph for individual 45") + theme(plot.title = element_text(hjust = 0.5)))
```



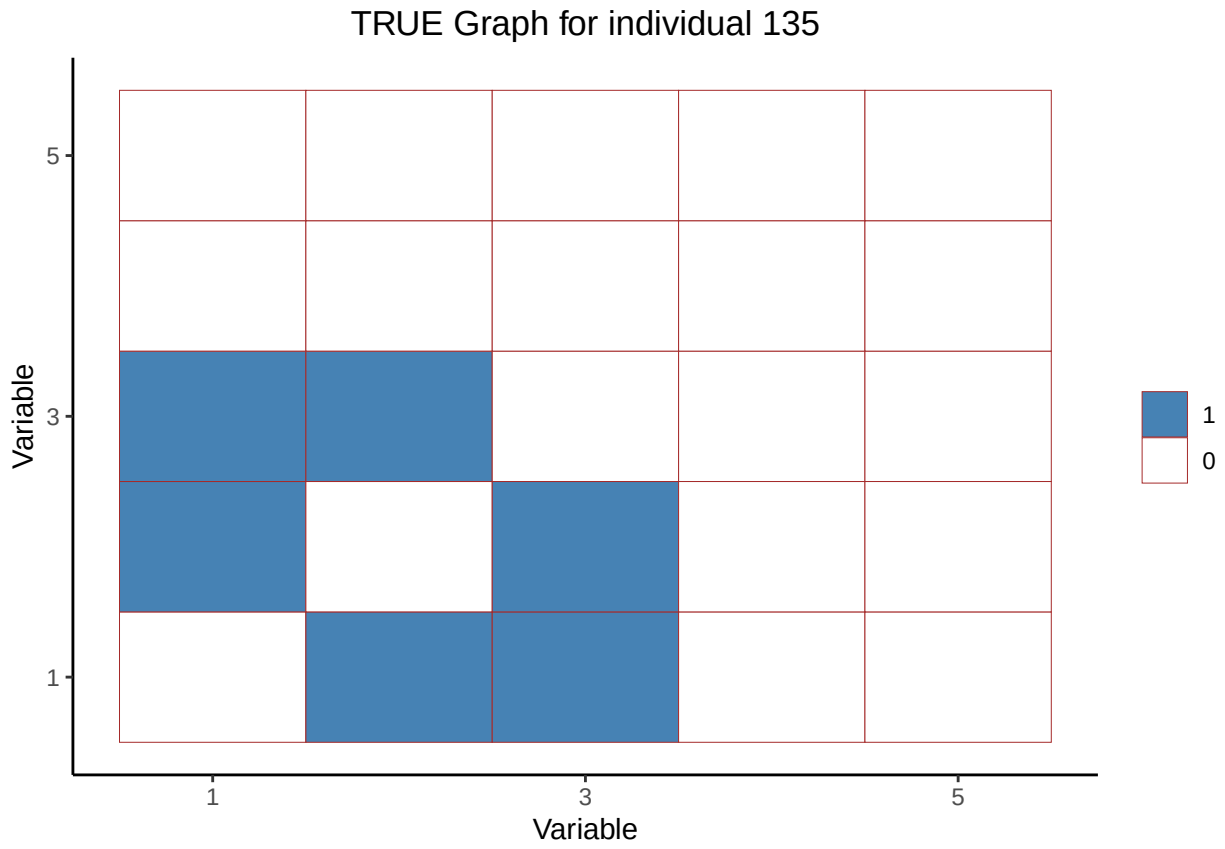

```
# continuous individual 45, CS
(ggplot(reshape2::melt(incl.probs.cont_CS45), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, individual
    theme(plot.title = element_text(hjust = 0.5)))
```



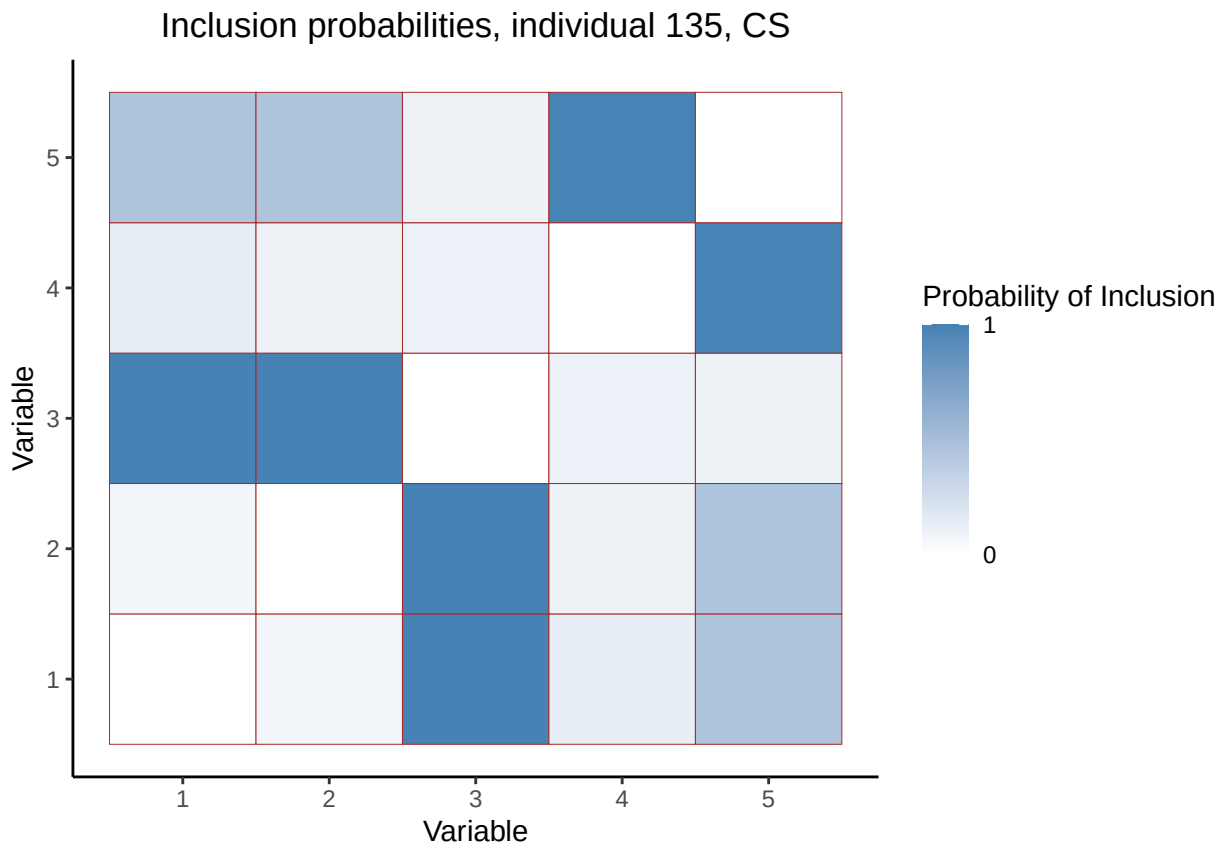

```
# continuous individual 45, grid
(ggplot(reshape2::melt(incl.probs.cont_grid45), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, individual
    theme(plot.title = element_text(hjust = 0.5)))
```



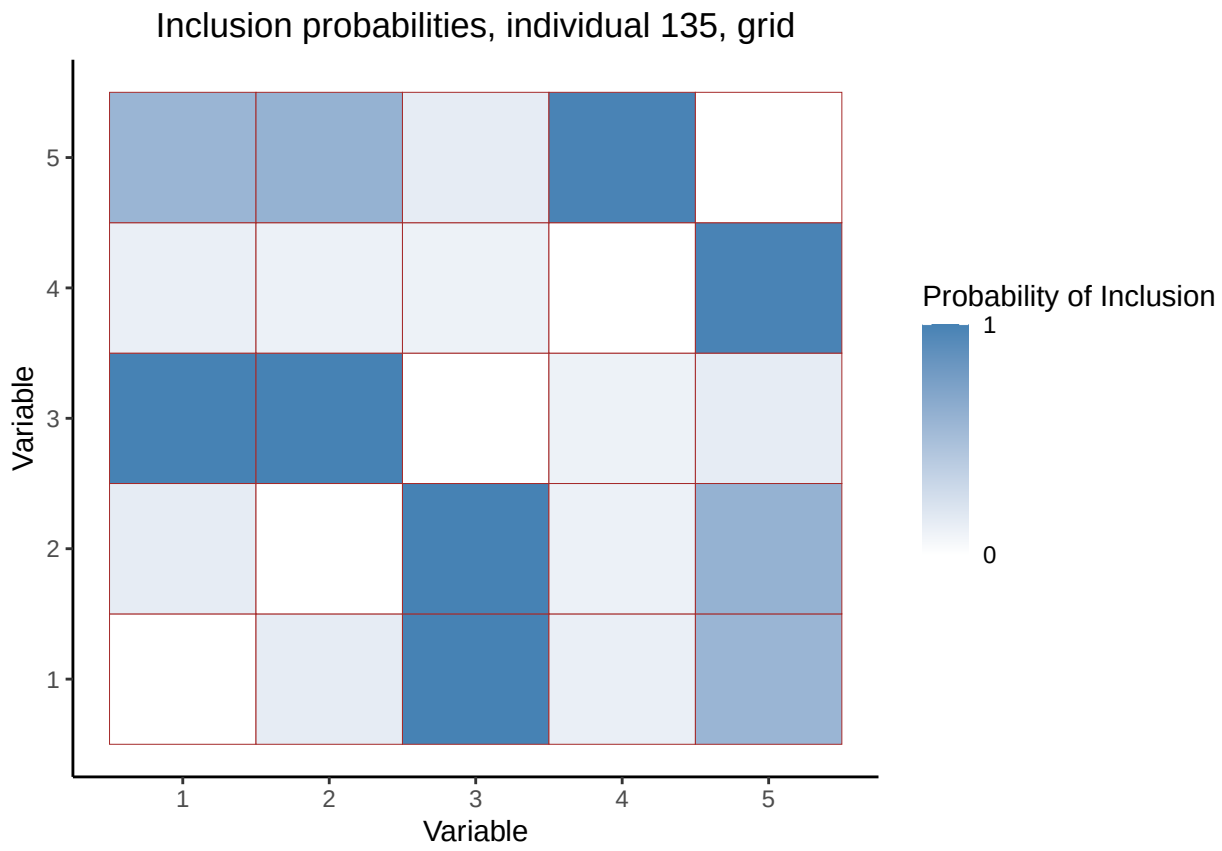

```
# true graph individual 135
(ggplot(reshape2::melt(true.graph135), aes(x = Var1, y = Var2, fill = value)) +
    geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + guides(fill = guide_legend(title = "")) +
    theme_classic() + xlab("Variable") + ylab("Variable") + scale_x_continuous(breaks = seq(1,
    ncol(disc$data), 2)) + scale_y_continuous(breaks = seq(1, ncol(disc$data),
    2)) + ggtitle("TRUE Graph for individual 135") + theme(plot.title = element_text(hjust = 0.5)))
```




```
# continuous individual 135, CS
(ggplot(reshape2::melt(incl.probs.cont_CS135), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, individual
    theme(plot.title = element_text(hjust = 0.5)))
```




```
# continuous individual 135, grid
(ggplot(reshape2::melt(incl.probs.cont_grid135), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, individual
    theme(plot.title = element_text(hjust = 0.5)))
```




```
# discrete data using the value of pi obtained using CS
out.disc_CS <- covdepGE(data_mat = disc$data, Z = disc$covts, tau = 0.1,
    sigmavec = c(0.01, 0.05, 0.1, 0.5, 1, 3, 7, 10), pi_vec = NULL,
    print_time = T)
```

```
## Time difference of 3.827519 secs
```

```
# continuous data using a grid of pi values
out.disc_grid <- covdepGE(data_mat = disc$data, Z = disc$covts, tau = 0.1,
    sigmavec = c(0.01, 0.05, 0.1, 0.5, 1, 3, 7, 10), pi_vec = seq(from = 0.05,
        to = 0.95, by = 0.05), print_time = T)
```

```
## Time difference of 1.02237 mins
```

```
# ELBO from models using pi from CS
out.disc_CS$ELBO
```

```
## $`Response 1`
## $`Response 1`$`sigma^2_beta`
## [1] 7
##
## $`Response 1`$pi
## [1] 0.2689414
##
```

```
## $`Response 1`$ELBO
## [1] -4452.474
##
##
## $`Response 2`
## $`Response 2`$`sigma^2_beta`
## [1] 3
##
## $`Response 2`$pi
## [1] 0.2689414
##
## $`Response 2`$ELBO
## [1] -3248.423
##
##
## $`Response 3`
## $`Response 3`$`sigma^2_beta`
## [1] 3
##
## $`Response 3`$pi
## [1] 0.2689414
##
## $`Response 3`$ELBO
## [1] -3478.464
##
##
## $`Response 4`
## $`Response 4`$`sigma^2_beta`
## [1] 7
##
## $`Response 4`$pi
## [1] 0.2689414
##
## $`Response 4`$ELBO
## [1] -4022.145
##
##
## $`Response 5`
## $`Response 5`$`sigma^2_beta`
## [1] 7
##
## $`Response 5`$pi
## [1] 0.2689414
##
## $`Response 5`$ELBO
## [1] -4126.47
##
##
## $`Response 6`
## $`Response 6`$`sigma^2_beta`
## [1] 7
##
## $`Response 6`$pi
## [1] 0.2689414
```

```
##
## $`Response 6`$ELBO
## [1] -3855.17
##
##
## $`Response 7`
## $`Response 7`$`sigma^2_beta`
## [1] 7
##
## $`Response 7`$pi
## [1] 0.2689414
##
## $`Response 7`$ELBO
## [1] -3991.963
##
##
## $`Response 8`
## $`Response 8`$`sigma^2_beta`
## [1] 7
##
## $`Response 8`$pi
## [1] 0.2689414
##
## $`Response 8`$ELBO
## [1] -4267.55
##
##
## $`Response 9`
## $`Response 9`$`sigma^2_beta`
## [1] 0.5
##
## $`Response 9`$pi
## [1] 0.2689414
##
## $`Response 9`$ELBO
## [1] -5008.113
##
##
## $`Response 10`
## $`Response 10`$`sigma^2_beta`
## [1] 7
##
## $`Response 10`$pi
## [1] 0.2689414
##
## $`Response 10`$ELBO
## [1] -3243.747
##
##
## $`Response 11`
## $`Response 11`$`sigma^2_beta`
## [1] 7
##
## $`Response 11`$pi
```

```
## [1] 0.2689414
##
## $`Response 11`$ELBO
## [1] -4400.611
```

```
# ELBO from models using pi from grid search
out.disc_grid$ELBO
```

```
## $`Response 1`
## $`Response 1`$`sigma^2_beta`
## [1] 7
##
## $`Response 1`$pi
## [1] 0.3
##
## $`Response 1`$ELBO
## [1] -4451.091
##
##
## $`Response 2`
## $`Response 2`$`sigma^2_beta`
## [1] 3
##
## $`Response 2`$pi
## [1] 0.25
##
## $`Response 2`$ELBO
## [1] -3248.921
##
##
## $`Response 3`
## $`Response 3`$`sigma^2_beta`
## [1] 3
##
## $`Response 3`$pi
## [1] 0.35
##
## $`Response 3`$ELBO
## [1] -3466.066
##
##
## $`Response 4`
## $`Response 4`$`sigma^2_beta`
## [1] 7
##
## $`Response 4`$pi
## [1] 0.2
##
## $`Response 4`$ELBO
## [1] -4017.093
##
##
## $`Response 5`
## $`Response 5`$`sigma^2_beta`
```

```
## [1] 7
##
## $`Response 5`$pi
## [1] 0.4
##
## $`Response 5`$ELBO
## [1] -4092.564
##
##
## $`Response 6`
## $`Response 6`$`sigma^2_beta`
## [1] 3
##
## $`Response 6`$pi
## [1] 0.6
##
## $`Response 6`$ELBO
## [1] -3778.189
##
##
## $`Response 7`
## $`Response 7`$`sigma^2_beta`
## [1] 7
##
## $`Response 7`$pi
## [1] 0.4
##
## $`Response 7`$ELBO
## [1] -3963.496
##
##
## $`Response 8`
## $`Response 8`$`sigma^2_beta`
## [1] 7
##
## $`Response 8`$pi
## [1] 0.4
##
## $`Response 8`$ELBO
## [1] -4237.759
##
##
## $`Response 9`
## $`Response 9`$`sigma^2_beta`
## [1] 3
##
## $`Response 9`$pi
## [1] 0.6
##
## $`Response 9`$ELBO
## [1] -4594.767
##
##
## $`Response 10`
```

```
## $`Response 10`$`sigma^2_beta`
## [1] 7
##
## $`Response 10`$pi
## [1] 0.35
##
## $`Response 10`$ELBO
## [1] -3228.658
##
##
## $`Response 11`
## $`Response 11`$`sigma^2_beta`
## [1] 7
##
## $`Response 11`$pi
## [1] 0.45
##
## $`Response 11`$ELBO
## [1] -4348.536
```

```
# compare the resulting ELBO
ELBO_CS <- unlist(lapply(out.disc_CS$ELBO, `[[`, 3))
ELBO_grid <- unlist(lapply(out.disc_grid$ELBO, `[[`, 3))
cbind.data.frame(ELBO_CS, ELBO_grid, difference = ELBO_grid - ELBO_CS)
```

```
##               ELBO_CS ELBO_grid  difference
## Response 1  -4452.474 -4451.091   1.3822349
## Response 2  -3248.423 -3248.921  -0.4987177
## Response 3  -3478.464 -3466.066  12.3980299
## Response 4  -4022.145 -4017.093   5.0523729
## Response 5  -4126.470 -4092.564  33.9062357
## Response 6  -3855.170 -3778.189  76.9807369
## Response 7  -3991.963 -3963.496  28.4671521
## Response 8  -4267.550 -4237.759  29.7909252
## Response 9  -5008.113 -4594.767 413.3465864
## Response 10 -3243.747 -3228.658  15.0892236
## Response 11 -4400.611 -4348.536  52.0755414
```

```
# get probabilities of inclusion for covariate level 1 and 2
round(incl.probs.disc_CS1 <- out.disc_CS$inclusion_probs[[1]], 2)
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11]
##  [1,] 0.00 1.00 1.00 1.00 0.12 0.08 0.08 0.05 0.46  0.05  0.05
##  [2,] 1.00 0.00 1.00 1.00 0.06 0.41 0.06 0.08 0.17  0.05  0.25
##  [3,] 1.00 1.00 0.00 1.00 0.05 0.06 0.10 0.17 0.12  0.06  0.18
##  [4,] 1.00 1.00 1.00 0.00 0.05 0.06 0.05 0.05 0.12  0.05  0.05
##  [5,] 0.12 0.06 0.05 0.05 0.00 0.13 0.05 0.04 0.10  0.05  0.64
##  [6,] 0.08 0.41 0.06 0.06 0.13 0.00 0.10 0.28 0.33  0.06  0.06
##  [7,] 0.08 0.06 0.10 0.05 0.05 0.10 0.00 0.07 0.62  0.08  0.05
##  [8,] 0.05 0.08 0.17 0.05 0.04 0.28 0.07 0.00 0.14  0.09  0.04
##  [9,] 0.46 0.17 0.12 0.12 0.10 0.33 0.62 0.14 0.00  0.43  0.09
## [10,] 0.05 0.05 0.06 0.05 0.05 0.06 0.08 0.09 0.43  0.00  0.05
## [11,] 0.05 0.25 0.18 0.05 0.64 0.06 0.05 0.04 0.09  0.05  0.00
```

```
round(incl.probs.disc_grid1 <- out.disc_grid$inclusion_probs[[1]],
    2)
```

```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11]
##  [1,] 0.00 1.00 1.00 1.00 0.20 0.21 0.12 0.07 0.52  0.07  0.09
##  [2,] 1.00 0.00 1.00 1.00 0.07 0.53 0.08 0.11 0.18  0.06  0.36
##  [3,] 1.00 1.00 0.00 1.00 0.08 0.16 0.15 0.25 0.19  0.09  0.23
##  [4,] 1.00 1.00 1.00 0.00 0.07 0.15 0.07 0.06 0.16  0.06  0.07
##  [5,] 0.20 0.07 0.08 0.07 0.00 0.40 0.08 0.07 0.19  0.08  0.80
##  [6,] 0.21 0.53 0.16 0.15 0.40 0.00 0.28 0.64 0.82  0.25  0.26
##  [7,] 0.12 0.08 0.15 0.07 0.08 0.28 0.00 0.12 0.76  0.13  0.10
##  [8,] 0.07 0.11 0.25 0.06 0.07 0.64 0.12 0.00 0.28  0.14  0.08
##  [9,] 0.52 0.18 0.19 0.16 0.19 0.82 0.76 0.28 0.00  0.57  0.17
## [10,] 0.07 0.06 0.09 0.06 0.08 0.25 0.13 0.14 0.57  0.00  0.08
## [11,] 0.09 0.36 0.23 0.07 0.80 0.26 0.10 0.08 0.17  0.08  0.00
```

```
round(incl.probs.disc_CS2 <- out.disc_CS$inclusion_probs[[nrow(disc$data)]],
    2)
```

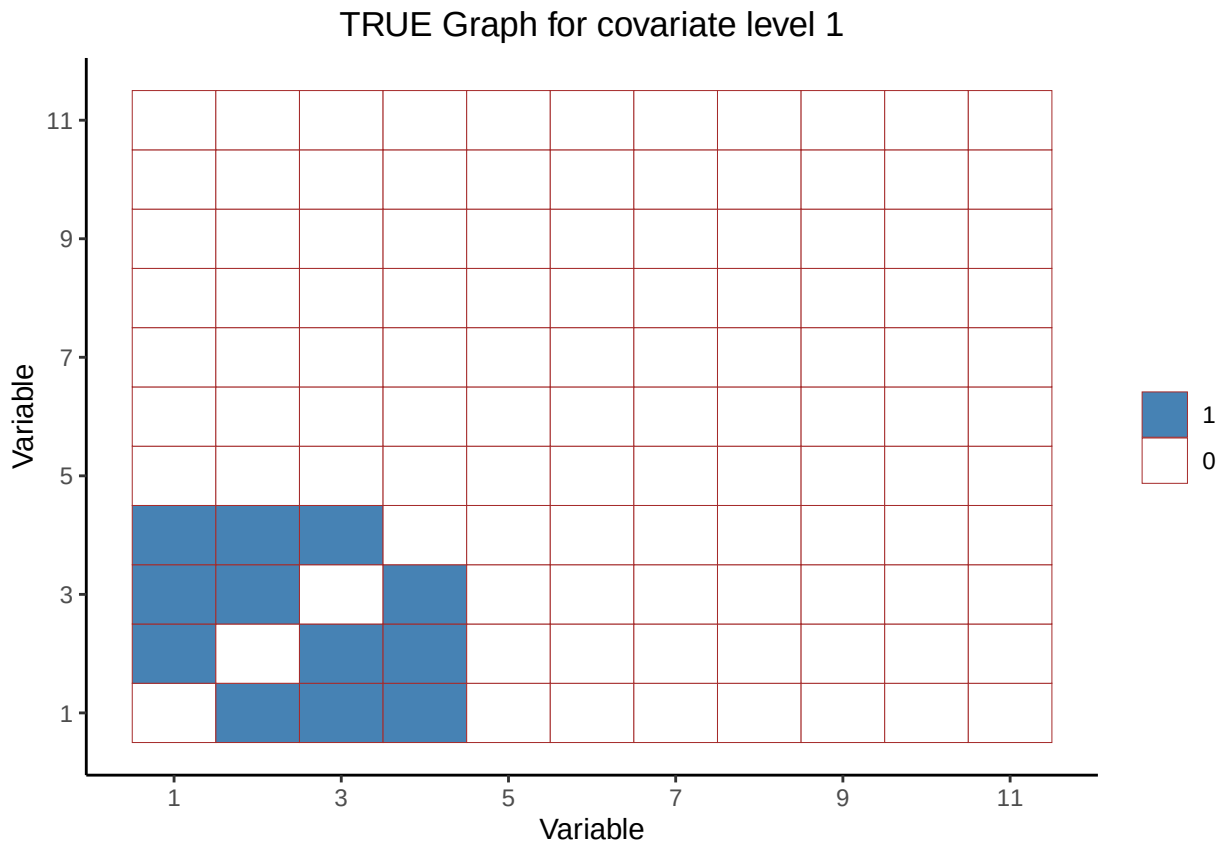
```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11]
##  [1,] 0.00 0.05 0.85 0.10 0.05 0.10 0.04 0.07 0.61  0.07  0.10
##  [2,] 0.05 0.00 0.97 0.05 0.05 0.05 0.15 0.06 0.15  0.05  0.07
##  [3,] 0.85 0.97 0.00 0.30 0.06 0.31 0.06 0.06 0.12  0.05  0.06
##  [4,] 0.10 0.05 0.30 0.00 0.14 0.04 0.04 0.04 0.10  0.04  0.18
##  [5,] 0.05 0.05 0.06 0.14 0.00 1.00 1.00 1.00 0.57  1.00  1.00
##  [6,] 0.10 0.05 0.31 0.04 1.00 0.00 1.00 1.00 0.68  1.00  1.00
##  [7,] 0.04 0.15 0.06 0.04 1.00 1.00 0.00 1.00 0.87  1.00  1.00
##  [8,] 0.07 0.06 0.06 0.04 1.00 1.00 1.00 0.00 0.91  1.00  1.00
##  [9,] 0.61 0.15 0.12 0.10 0.57 0.68 0.87 0.91 0.00  0.74  0.58
## [10,] 0.07 0.05 0.05 0.04 1.00 1.00 1.00 1.00 0.74  0.00  1.00
## [11,] 0.10 0.07 0.06 0.18 1.00 1.00 1.00 1.00 0.58  1.00  0.00
```

```
round(incl.probs.disc_grid2 <- out.disc_grid$inclusion_probs[[nrow(disc$data)]],
    2)
```

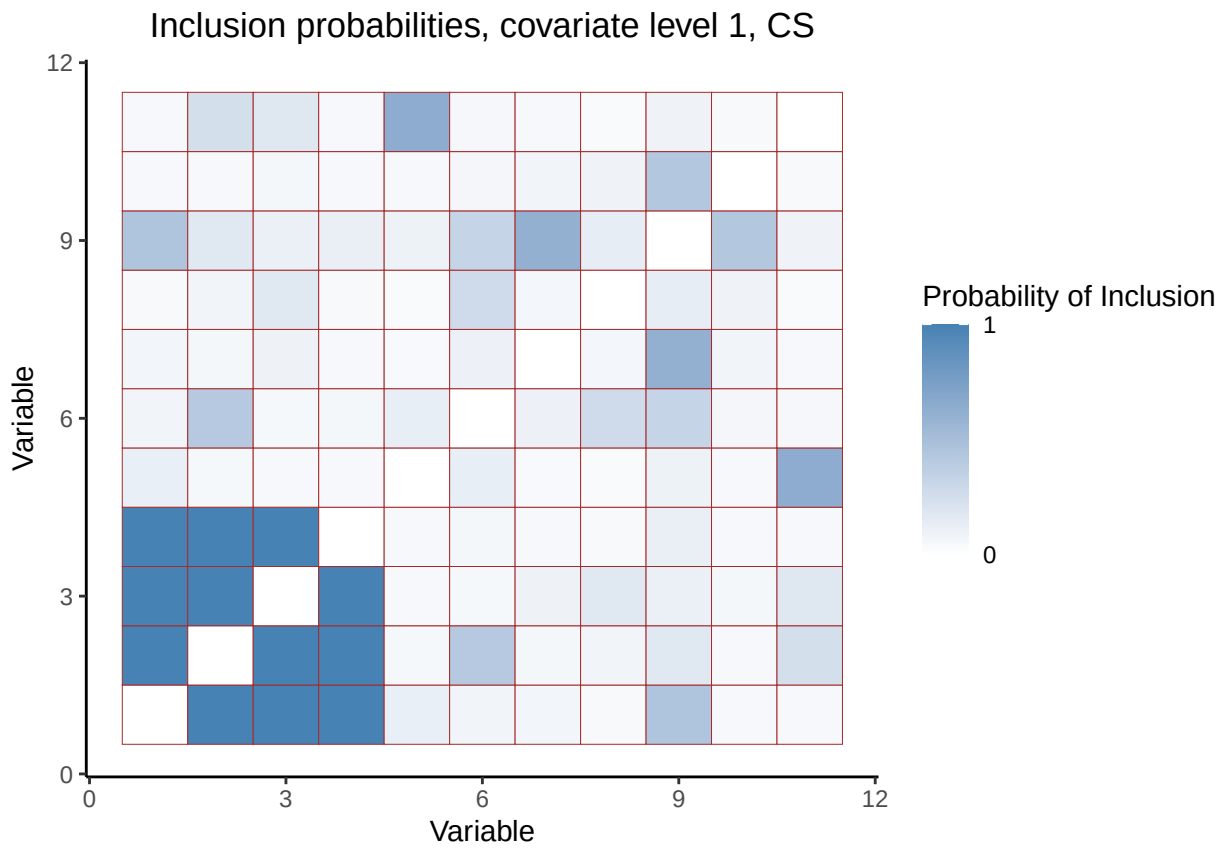
```
##       [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8] [,9] [,10] [,11]
##  [1,] 0.00 0.05 0.88 0.09 0.07 0.19 0.06 0.09 0.54  0.08  0.13
##  [2,] 0.05 0.00 0.97 0.04 0.06 0.12 0.16 0.07 0.17  0.06  0.08
##  [3,] 0.88 0.97 0.00 0.30 0.09 0.45 0.09 0.09 0.16  0.08  0.10
##  [4,] 0.09 0.04 0.30 0.00 0.13 0.12 0.05 0.05 0.13  0.04  0.17
##  [5,] 0.07 0.06 0.09 0.13 0.00 1.00 1.00 1.00 1.00  1.00  1.00
##  [6,] 0.19 0.12 0.45 0.12 1.00 0.00 1.00 1.00 1.00  1.00  1.00
##  [7,] 0.06 0.16 0.09 0.05 1.00 1.00 0.00 1.00 1.00  1.00  1.00
##  [8,] 0.09 0.07 0.09 0.05 1.00 1.00 1.00 0.00 1.00  1.00  1.00
##  [9,] 0.54 0.17 0.16 0.13 1.00 1.00 1.00 1.00 0.00  1.00  1.00
## [10,] 0.08 0.06 0.08 0.04 1.00 1.00 1.00 1.00 1.00  0.00  1.00
## [11,] 0.13 0.08 0.10 0.17 1.00 1.00 1.00 1.00 1.00  1.00  0.00
```

```
# get the true graphs for covariate level 1 and 2
true.graph1 <- disc$true_graphs[[1]]
true.graph2 <- disc$true_graphs[[2]]
```

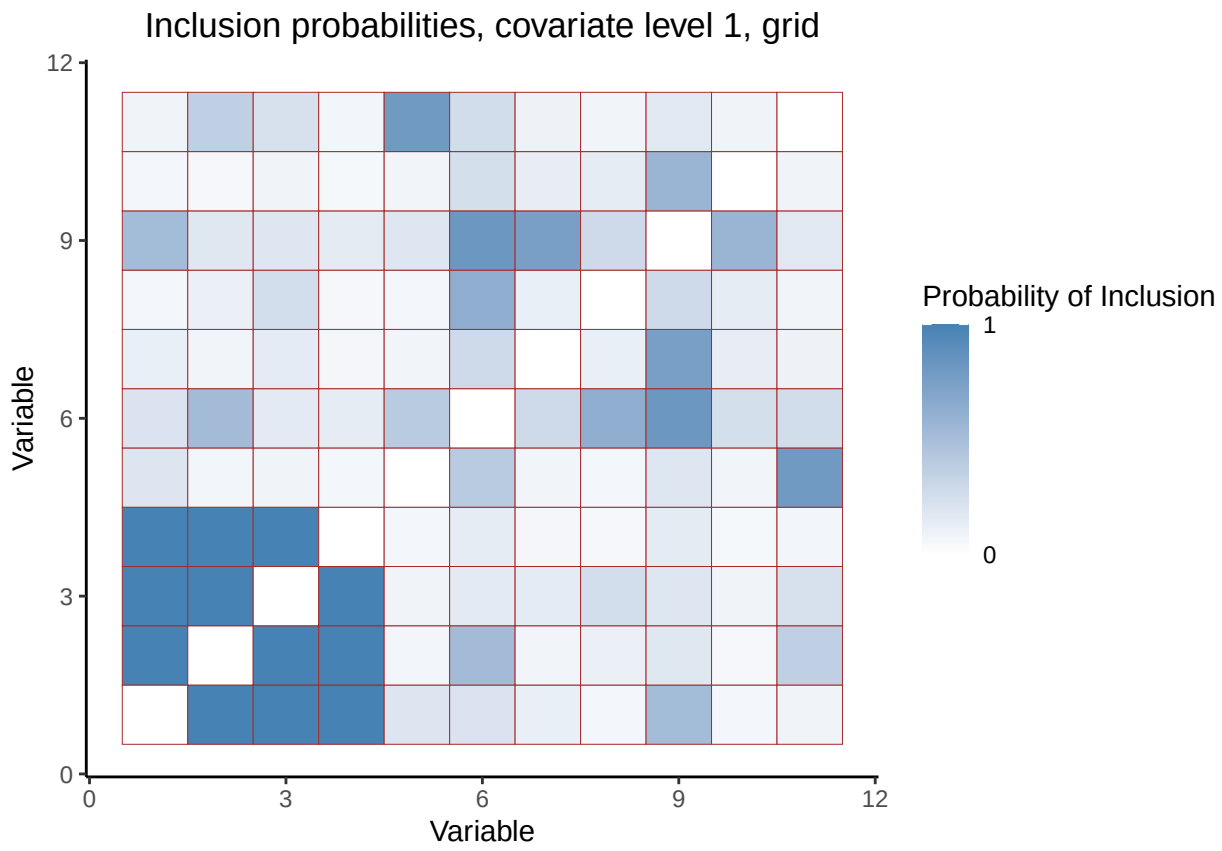
```
# visualize the probabilities of inclusion and true graphs

# true graph, covariate level 1
(ggplot(reshape2::melt(true.graph1), aes(x = Var1, y = Var2, fill = value)) +
    geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + guides(fill = guide_legend(title = "")) +
    theme_classic() + xlab("Variable") + ylab("Variable") + scale_x_continuous(breaks = seq(1,
    ncol(disc$data), 2)) + scale_y_continuous(breaks = seq(1, ncol(disc$data),
    2)) + ggtitle("TRUE Graph for covariate level 1") + theme(plot.title = element_text(hjust = 0.5)))
```



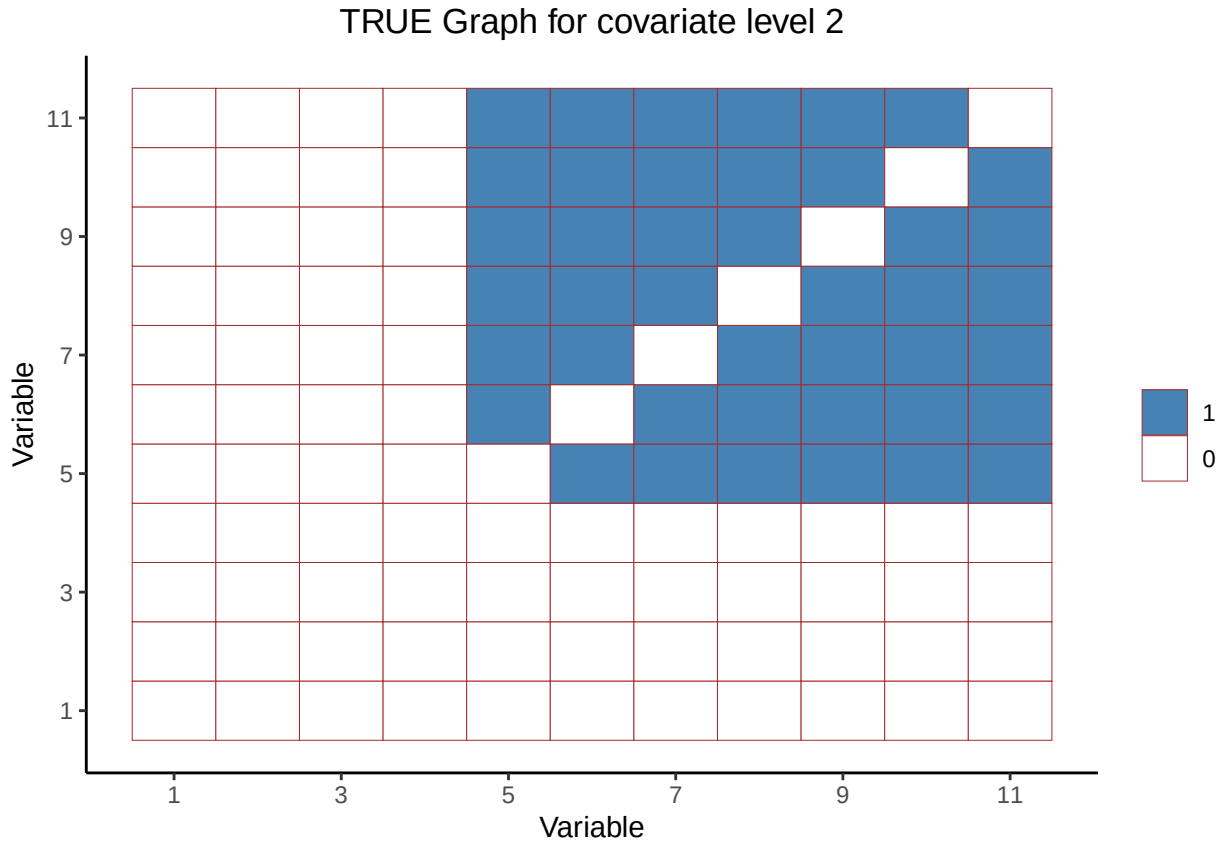

```
# covariate level 1, CS
(ggplot(reshape2::melt(incl.probs.disc_CS1), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, covariate
    theme(plot.title = element_text(hjust = 0.5)))
```



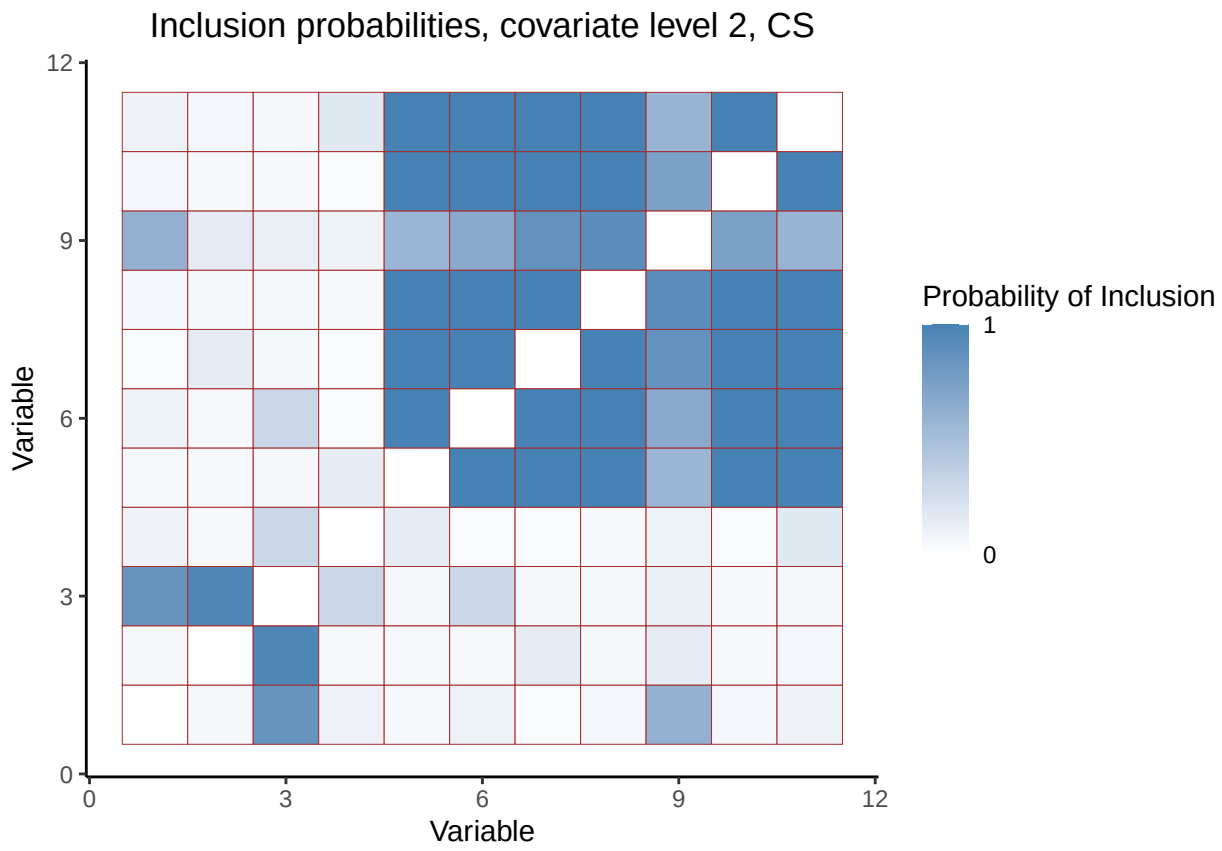

```
# covariate level 1, grid
(ggplot(reshape2::melt(incl.probs.disc_grid1), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, covariate
    theme(plot.title = element_text(hjust = 0.5)))
```



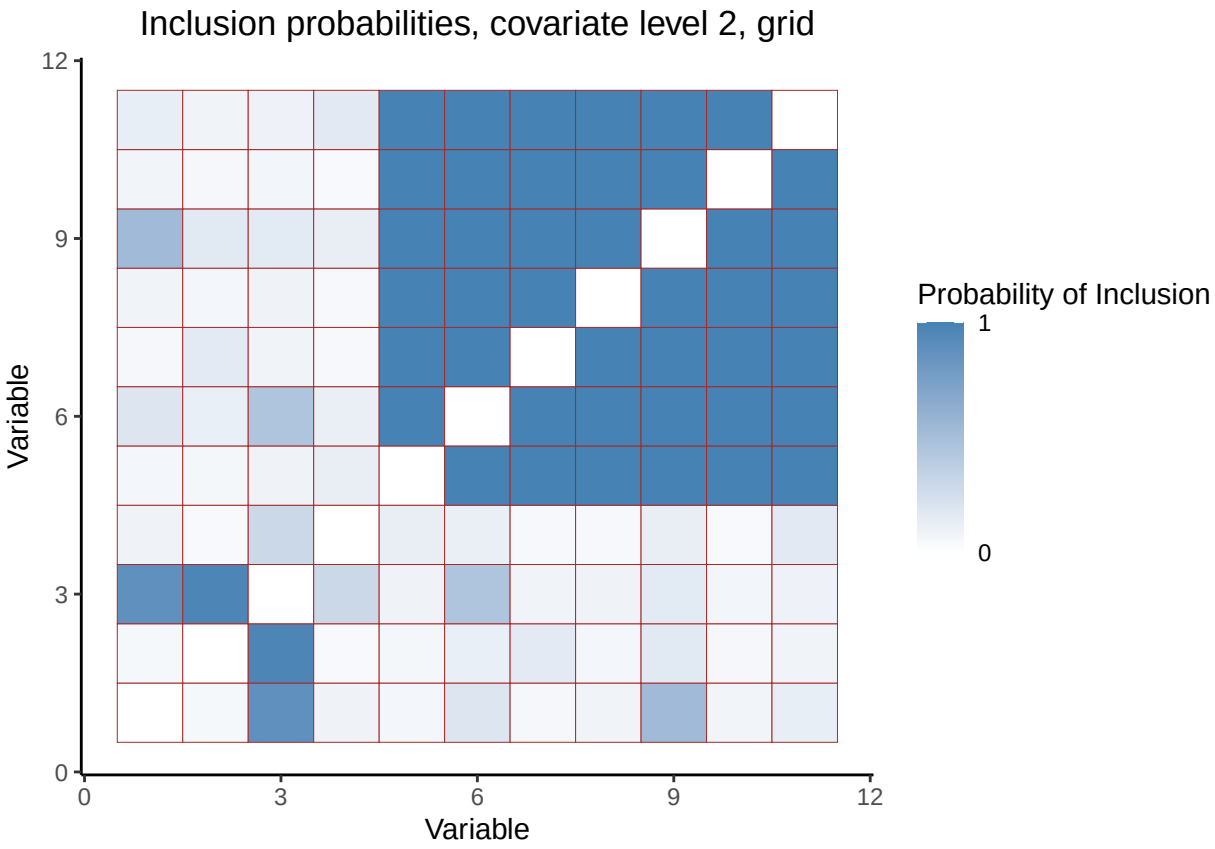

```
# true graph, covariate level 2
(ggplot(reshape2::melt(true.graph2), aes(x = Var1, y = Var2, fill = value)) +
    geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + guides(fill = guide_legend(title = "")) +
    theme_classic() + xlab("Variable") + ylab("Variable") + scale_x_continuous(breaks = seq(1,
    ncol(disc$data), 2)) + scale_y_continuous(breaks = seq(1, ncol(disc$data),
    2)) + ggtitle("TRUE Graph for covariate level 2") + theme(plot.title = element_text(hjust = 0.5)))
```




```
# covariate level 2, CS
(ggplot(reshape2::melt(incl.probs.disc_CS2), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, covariate
    theme(plot.title = element_text(hjust = 0.5)))
```




```
# covariate level 2, grid
(ggplot(reshape2::melt(incl.probs.disc_grid2), aes(x = Var1, y = Var2,
    fill = value)) + geom_tile(color = "brown") + scale_fill_gradient(low = "white",
    high = "steelblue", breaks = c(1, 0)) + labs(fill = "Probability of Inclusion") +
    theme_classic() + xlab("Variable") + ylab("Variable") + ggtitle("Inclusion probabilities, covariate
    theme(plot.title = element_text(hjust = 0.5)))
```


Inclusion probabilities, covariate level 2, grid
Variable
Variable
0
3
6
9
12
Probability of Inclusion
1
0