

Outputs inspection half CIFAR100

```
library(ggplot2)

## Warning: package 'ggplot2' was built under R version 4.0.5

library(dplyr)

## Warning: package 'dplyr' was built under R version 4.0.5

## 
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
## 
##     filter, lag

## The following objects are masked from 'package:base':
## 
##     intersect, setdiff, setequal, union

library(tidyr)

## Warning: package 'tidyr' was built under R version 4.0.5

library("ggpubr")

## Warning: package 'ggpubr' was built under R version 4.0.5

library(LDATS)

## Warning: package 'LDATS' was built under R version 4.0.5

library(stringr)

source("utils.R")

## Warning: package 'hash' was built under R version 4.0.5

## hash-2.2.6.1 provided by Decision Patterns

## Warning: package 'reticulate' was built under R version 4.0.5
```

```

## Warning: package 'berryFunctions' was built under R version 4.0.5

##
## Attaching package: 'berryFunctions'

## The following object is masked from 'package:dplyr':
##   between

## Warning: package 'purrr' was built under R version 4.0.3

## Warning: package 'reshape2' was built under R version 4.0.3

##
## Attaching package: 'reshape2'

## The following object is masked from 'package:tidyverse':
##   smiths

```

Visualization on CIFAR100. We are using data of three neural networks trained on reduced CIFAR100 training set. Half of the CIFAR100 training set was extracted as a validation set. We then divided both the reduced training set and validation set into 5 disjoint subsets and trained an ensemble on each of them. This was done in 10 replications, each time with random split of the training set into validation and new training set. In this visualization, we are trying to inspect the outputs deeper, mainly to make sense of strange behavior of nll metric for ensemble outputs.

```

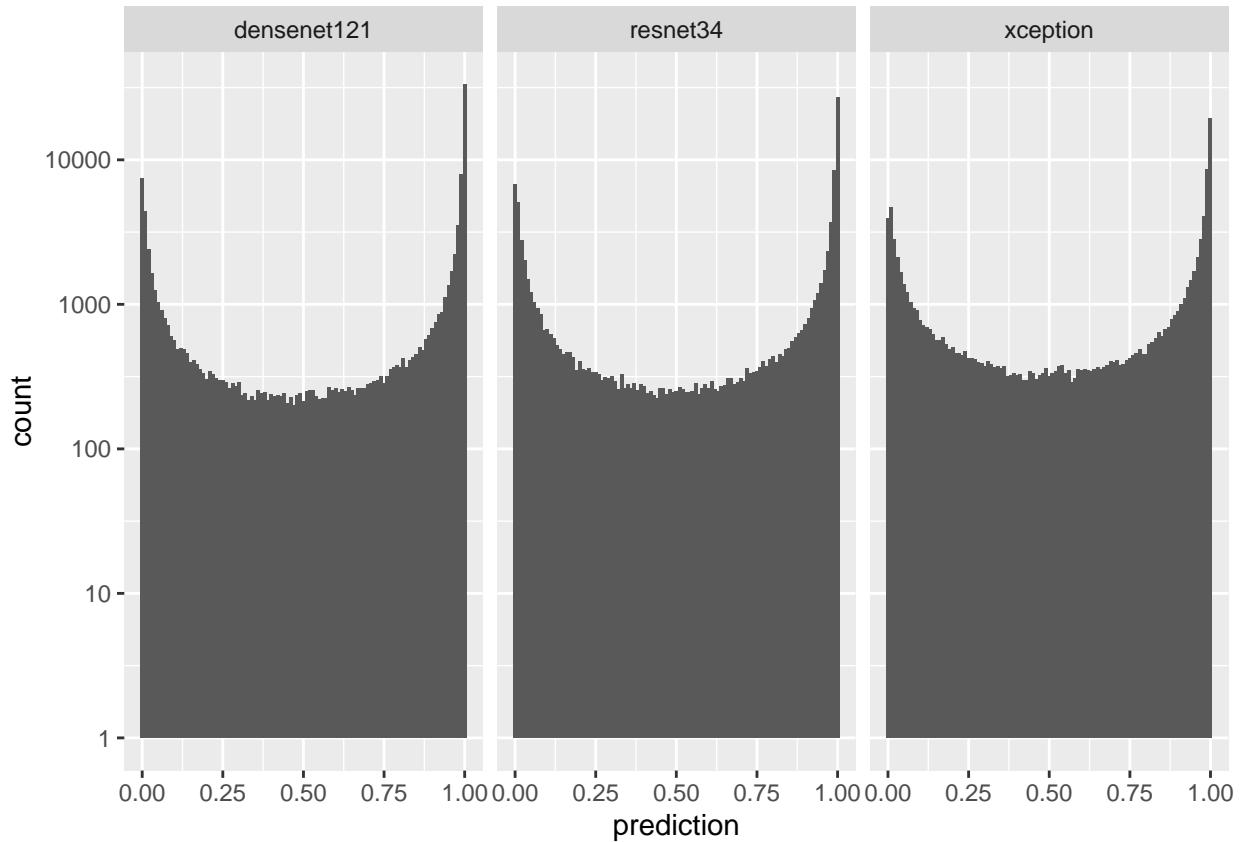
base_dir <- ".../data/data_train_val_half_c100"
repls <- 0:9
folds <- 0:4
classes <- 100

nets_outputs <- load_network_outputs(base_dir, repls)
ens_outputs <- load_ensemble_outputs(base_dir, repls, folds)
net_results <- read.csv(file.path(base_dir, "net_accuracies.csv"))
ens_results <- read.csv(file.path(base_dir, "ensemble_accuracies.csv"))

preds <- nets_outputs$test_outputs
for (ri in repls + 1)
{
  for (net_i in seq_along(nets_outputs[["networks"]]))
  {
    preds[ri, net_i, ,] <- softmax(preds[ri, net_i, , ])
  }
}
nets_test_cor_probs <- gather(preds, 1 + nets_outputs$test_labels[1, ], 3, 4)
nets_test_cor_probs <- melt(nets_test_cor_probs)
nets_test_cor_probs <- nets_test_cor_probs[, c(-3, -4)]
names(nets_test_cor_probs) <- c("replication", "network", "prediction")
nets_test_cor_probs$network <- as.factor(nets_test_cor_probs$network)
levels(nets_test_cor_probs$network) <- nets_outputs$networks

```

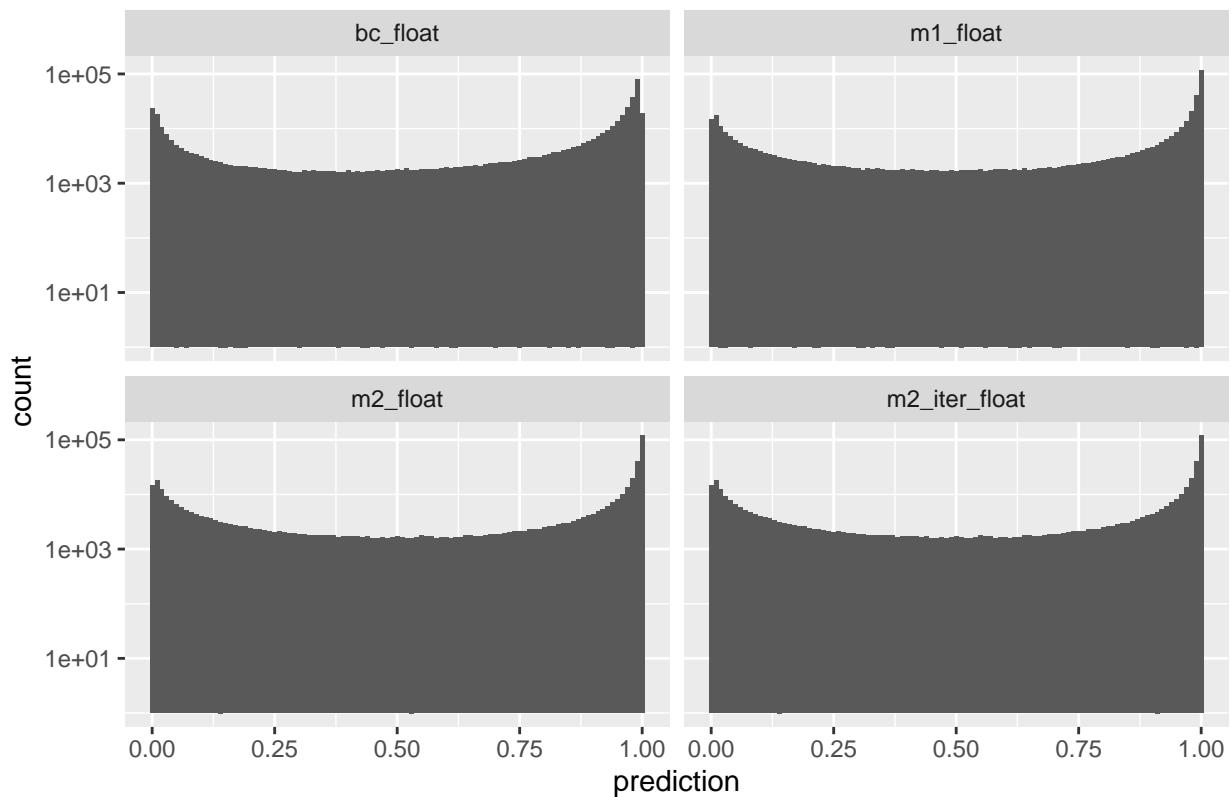
```
nets_cor_preds_histo <- ggplot(data=nets_test_cor_probs) + geom_histogram(mapping=aes(x=prediction), bins=100)
nets_cor_preds_histo
```



```
val_ens_cor_probs <- gather(ens_outputs$val_training, 1 + nets_outputs$test_labels[1, ], 4, 5)
val_ens_cor_probs <- melt(val_ens_cor_probs)
val_ens_cor_probs <- val_ens_cor_probs[, c(-4, -5)]
names(val_ens_cor_probs) <- c("replication", "method", "fold", "prediction")
val_ens_cor_probs$method <- as.factor(val_ens_cor_probs$method)
levels(val_ens_cor_probs$method) <- ens_outputs$methods
```

```
val_ens_cor_preds_histo <- ggplot(data=val_ens_cor_probs) + geom_histogram(mapping=aes(x=prediction), bins=100)
val_ens_cor_preds_histo
```

Probabilities predicted for the correct class – ens trained on val



```
val_ens_zero_counts <- ggplot(data=val_ens_cor_probs[val_ens_cor_probs$prediction <= 0, ]) + geom_hist()
```

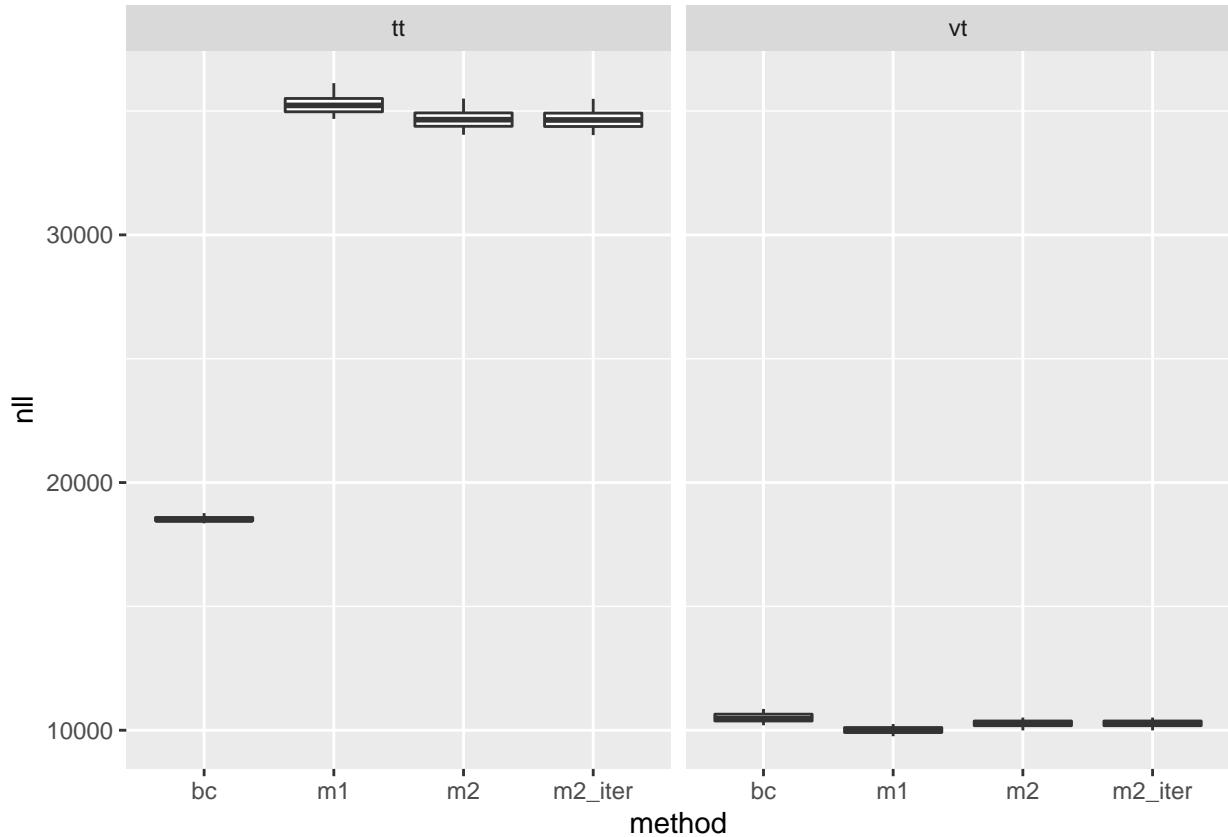
```
## Warning: Ignoring unknown parameters: binwidth, bins, pad
```

```
val_ens_zero_counts
```

count

method

```
val_ens_nll <- ggplot(data=ens_results) + geom_boxplot(mapping=aes(x=method, y=nll)) + facet_wrap(~train)  
val_ens_nll
```



```

train_ens_cor_probs <- gather(ens_outputs$train_training, 1 + nets_outputs$test_labels[1, ], 4, 5)
train_ens_cor_probs <- melt(train_ens_cor_probs)
train_ens_cor_probs <- train_ens_cor_probs[, c(-4, -5)]
names(train_ens_cor_probs) <- c("replication", "method", "fold", "prediction")
train_ens_cor_probs$method <- as.factor(train_ens_cor_probs$method)
levels(train_ens_cor_probs$method) <- ens_outputs$methods

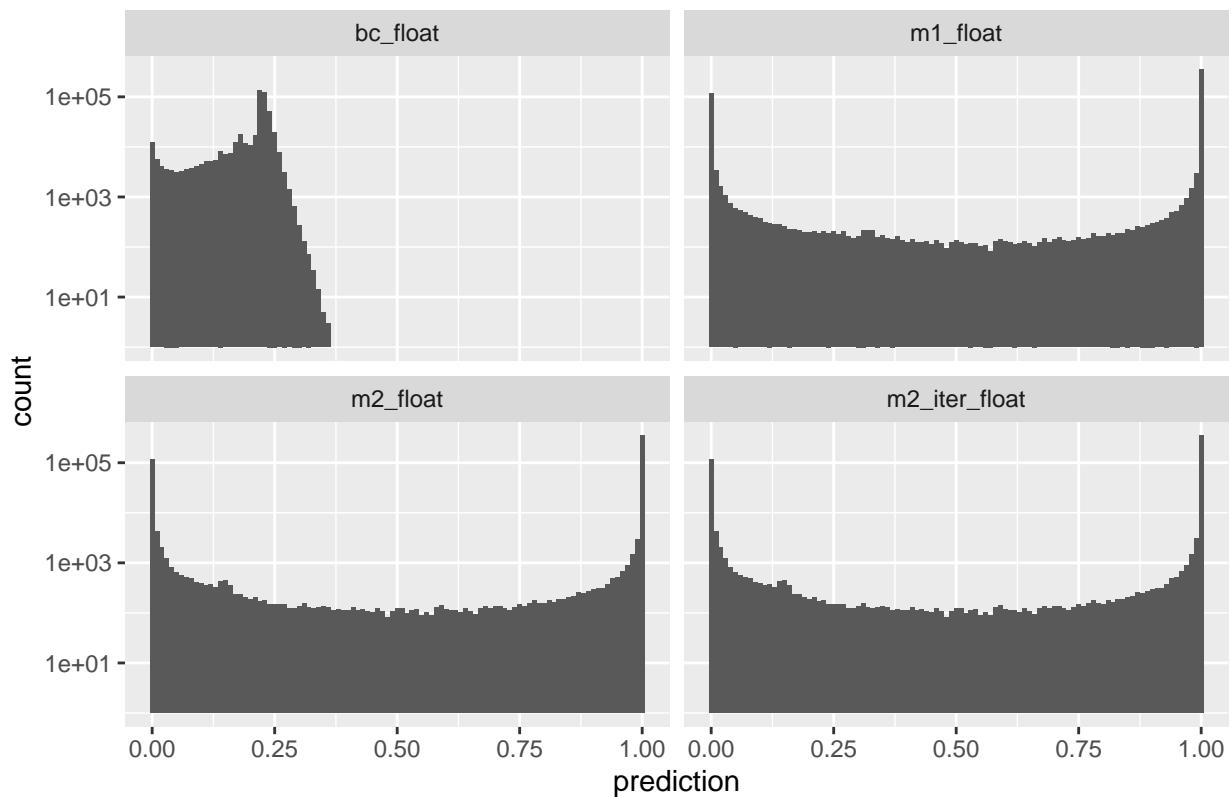
train_ens_cor_preds_histo <- ggplot(data=train_ens_cor_probs) + geom_histogram(mapping=aes(x=prediction))
train_ens_cor_preds_histo

## Warning: Transformation introduced infinite values in continuous y-axis

## Warning: Removed 64 rows containing missing values (geom_bar).

```

Probabilities predicted for the correct class – ens trained on train



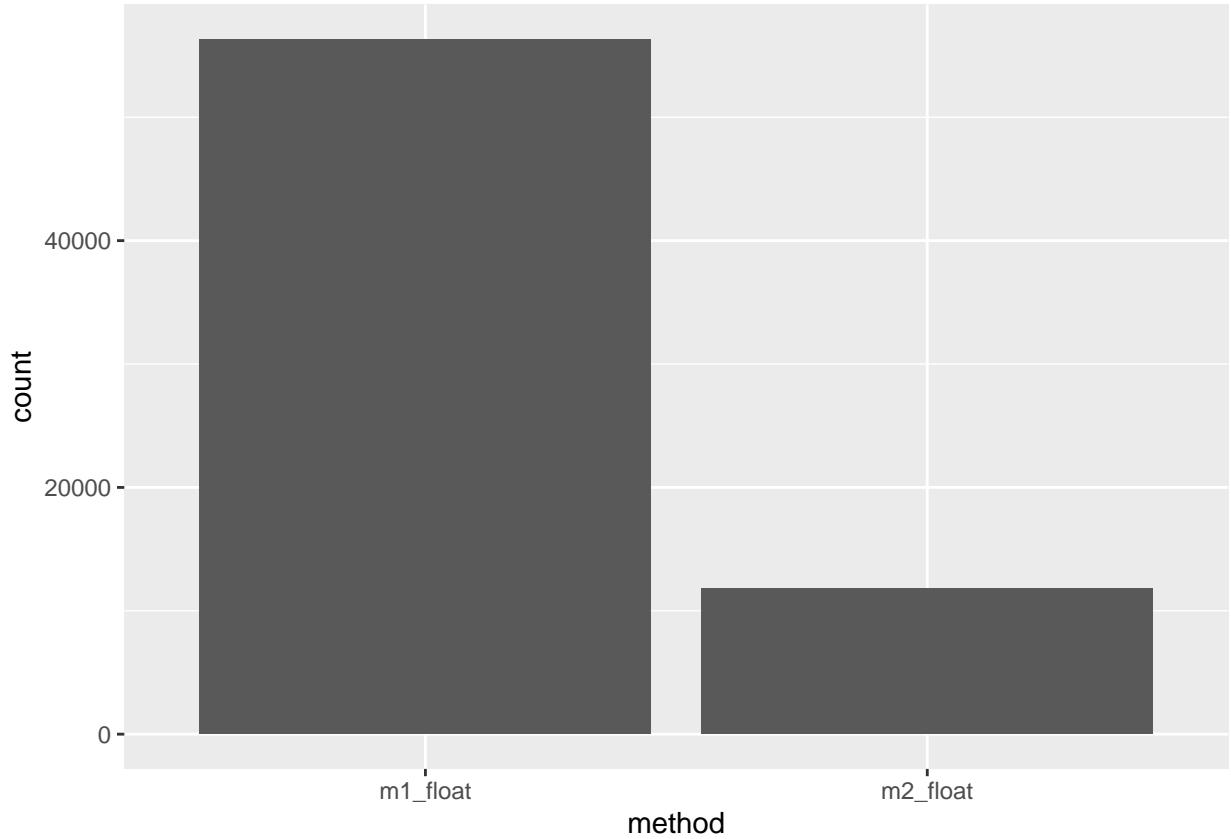
```
train_ens_zero_counts <- ggplot(data=train_ens_cor_probs[train_ens_cor_probs$prediction <= 0, ]) + geom_
```



```
## Warning: Ignoring unknown parameters: binwidth, bins, pad
```



```
train_ens_zero_counts
```



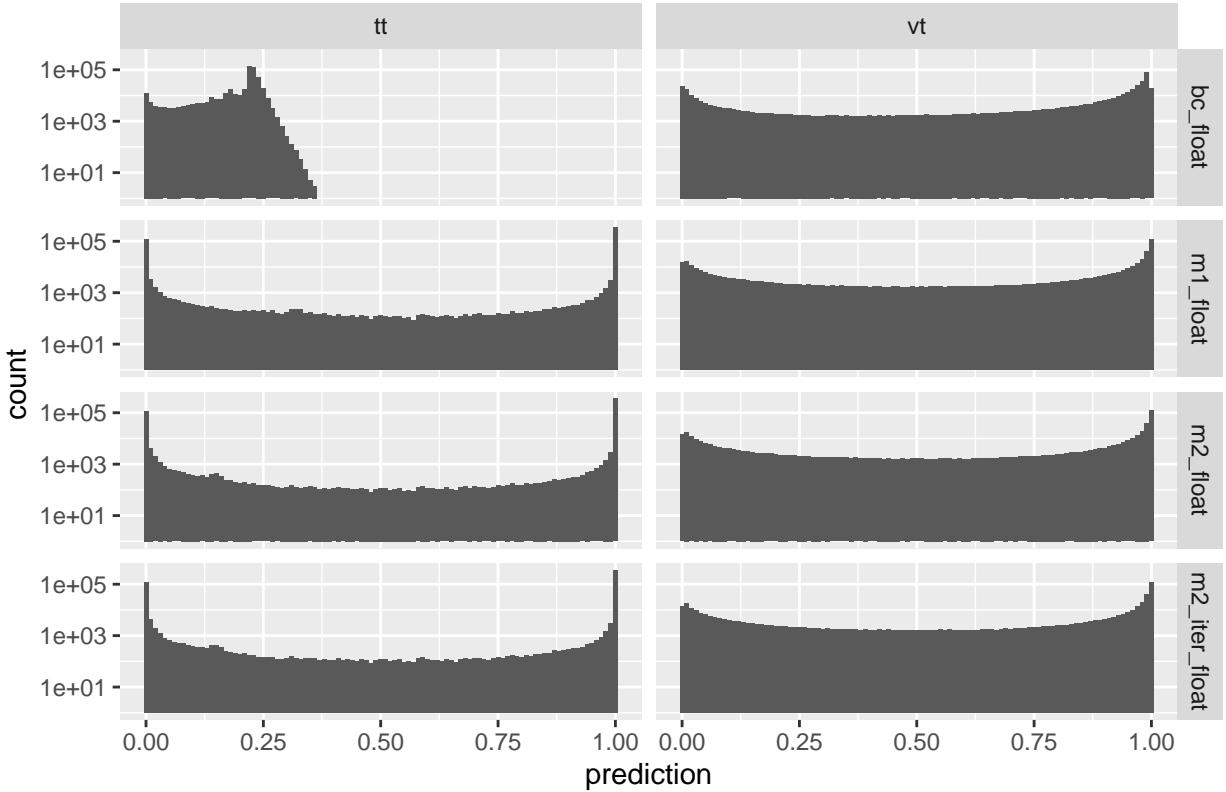
```
val_ens_cor_probs$train_type <- "vt"
train_ens_cor_probs$train_type <- "tt"
ens_cor_probs <- rbind(val_ens_cor_probs, train_ens_cor_probs)

ens_cor_preds_histo <- ggplot(data=ens_cor_probs) + geom_histogram(mapping=aes(x=prediction), binwidth=
ens_cor_preds_histo

## Warning: Transformation introduced infinite values in continuous y-axis

## Warning: Removed 64 rows containing missing values (geom_bar).
```

Probabilities predicted for the correct class



Very strange behavior for the bc method trained on training set. Needs further attention.

```

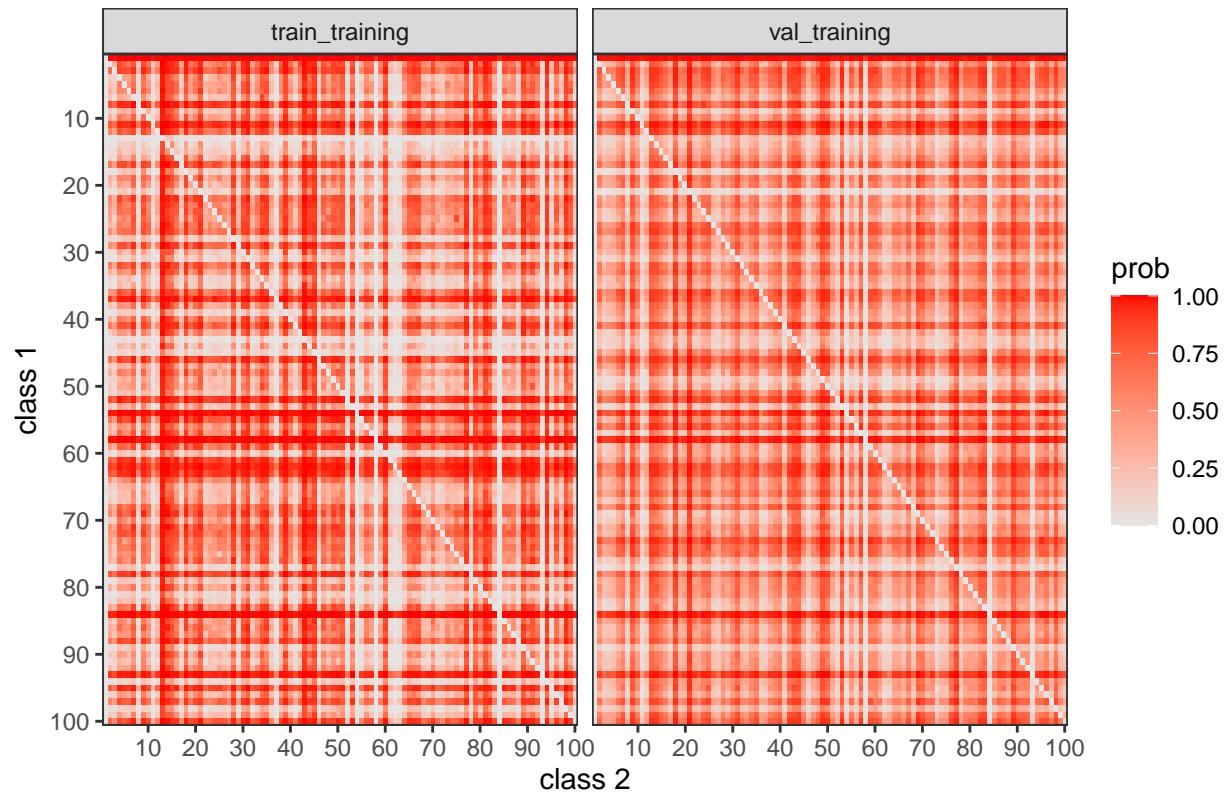
val_aggr_Rs <- np$load(file.path(base_dir, "val_training_class_aggr_R.npy"))
train_aggr_Rs <- np$load(file.path(base_dir, "train_training_class_aggr_R.npy"))
df_val_aggr_Rs <- melt(val_aggr_Rs)
names(df_val_aggr_Rs) <- c("precision", "class", "class1", "class2", "prob")
df_train_aggr_Rs <- melt(train_aggr_Rs)
names(df_train_aggr_Rs) <- c("precision", "class", "class1", "class2", "prob")
df_val_aggr_Rs$train_type <- "val_training"
df_train_aggr_Rs$train_type <- "train_training"
df_aggr_Rs <- rbind(df_val_aggr_Rs, df_train_aggr_Rs)
df_aggr_Rs[, c("class", "class1", "class2")] <- lapply(df_aggr_Rs[, c("class", "class1", "class2")], as
df_aggr_Rs_diff <- df_aggr_Rs %>% pivot_wider(names_from = train_type, values_from = prob) %>% mutate(v

for (cls in 1:classes)
{
  cur_class_Rs <- df_aggr_Rs %>% filter(class == cls)
  plot_cls <- ggplot(cur_class_Rs, aes(x = class2, y = class1)) +
    geom_raster(aes(fill=prob)) +
    facet_wrap(~train_type) +
    scale_fill_gradient(low="grey90", high="red") +
    scale_y_discrete(limits=rev, breaks=seq(0, classes, 10)) +
    scale_x_discrete(breaks=seq(0, classes, 10)) +
    labs(x="class 2", y="class 1", title=paste("Pairwise probabilities - class ", cls)) +
    theme_bw()
}

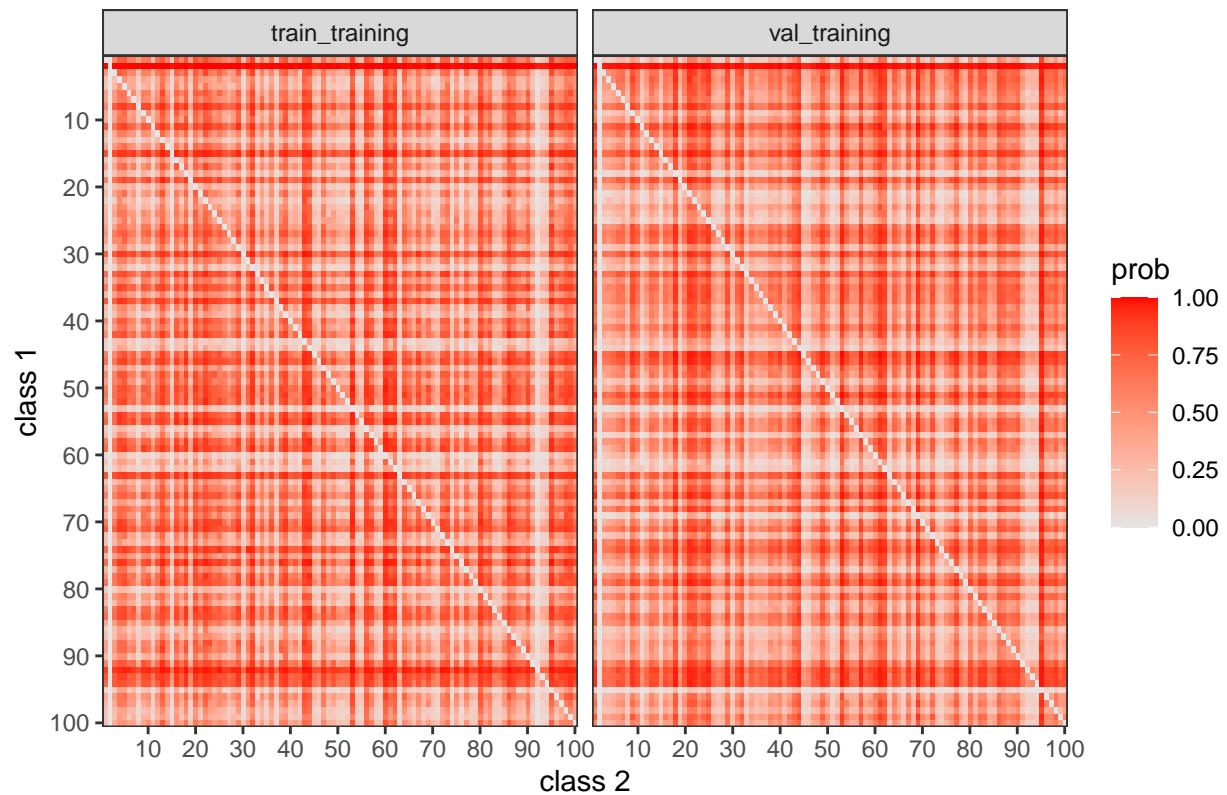
```

```
    print(plot_cls)
}
```

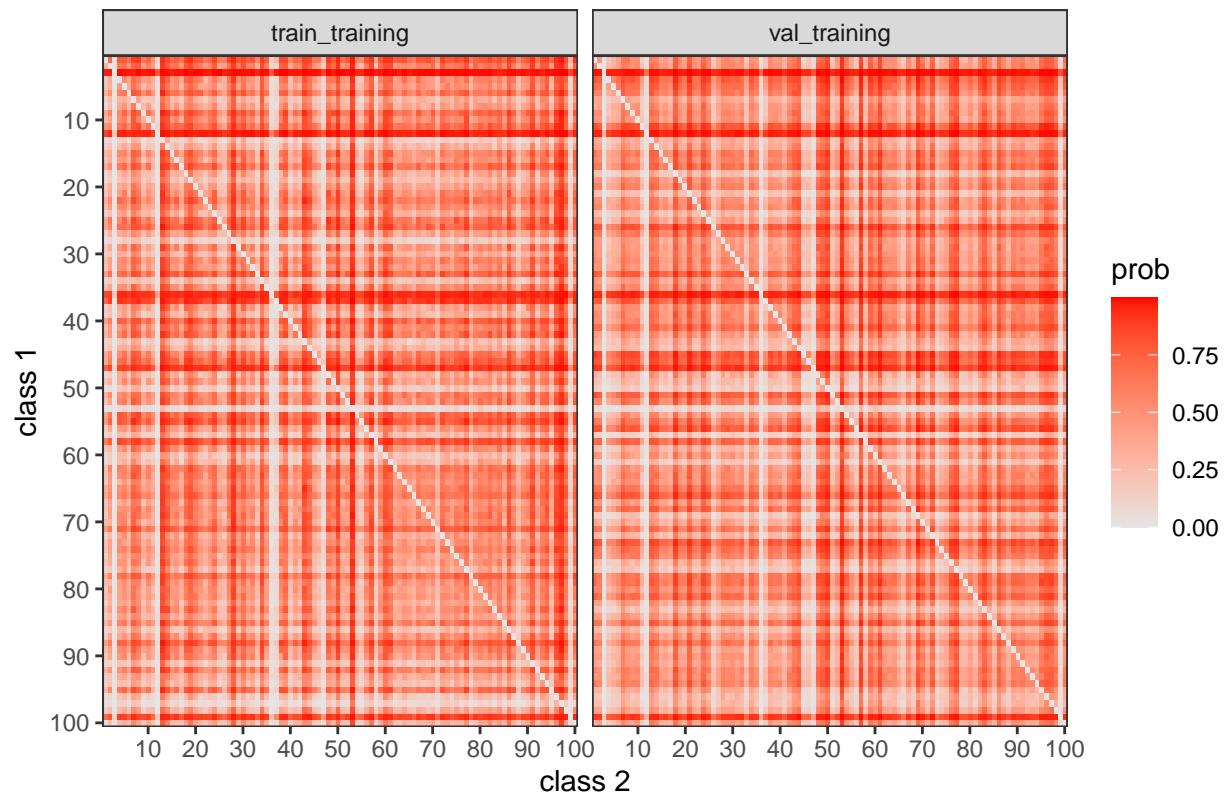
Pairwise probabilities – class 1



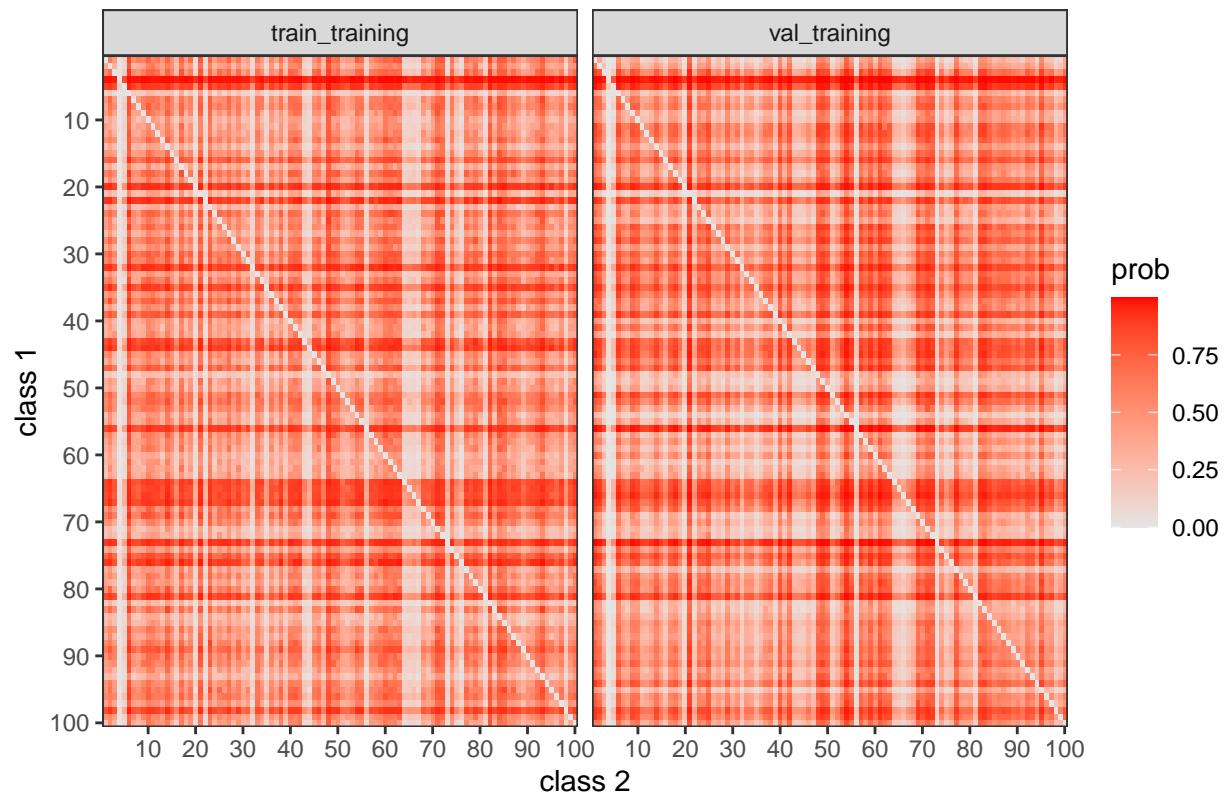
Pairwise probabilities – class 2



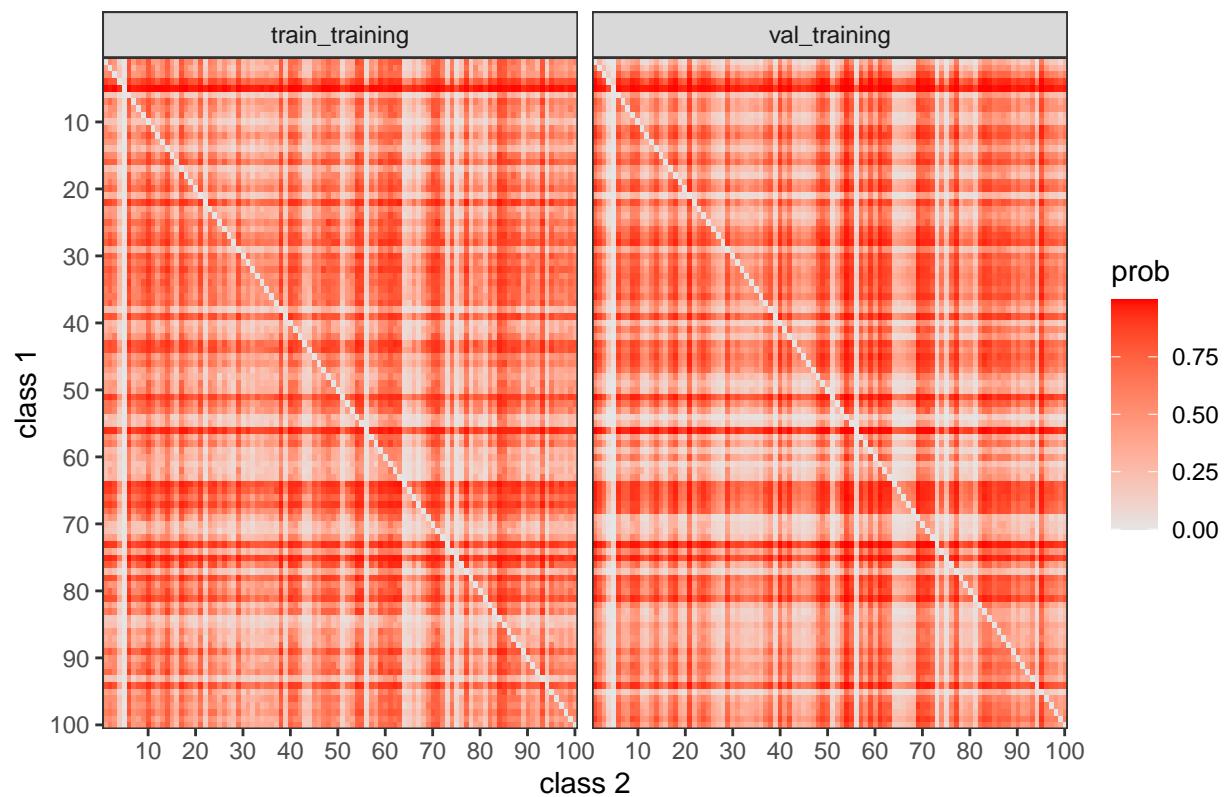
Pairwise probabilities – class 3



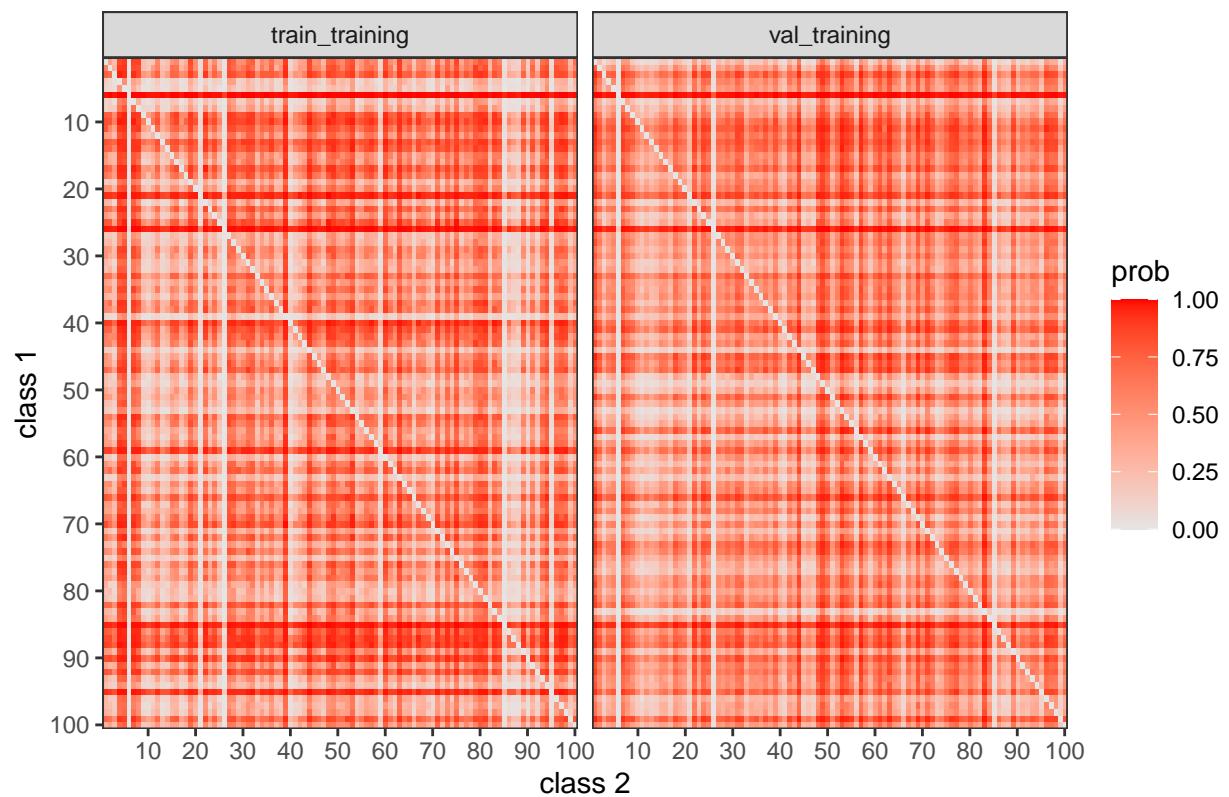
Pairwise probabilities – class 4



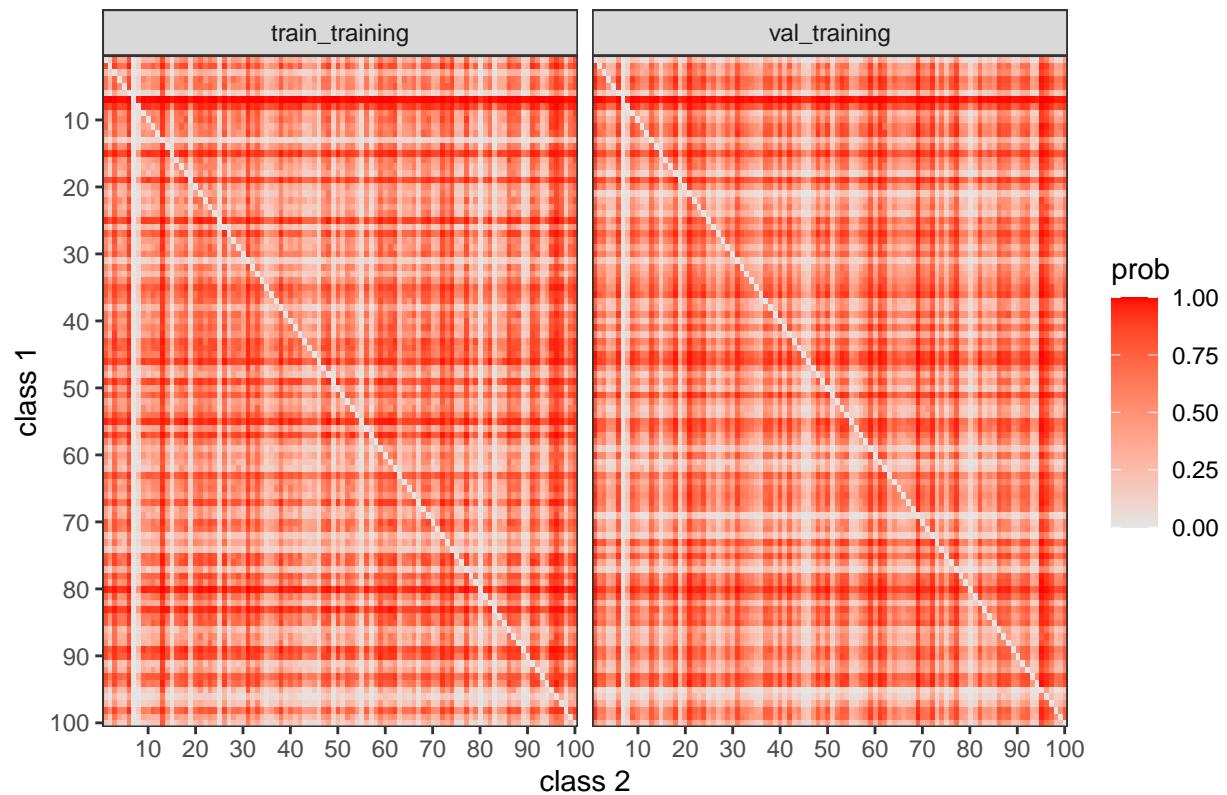
Pairwise probabilities – class 5



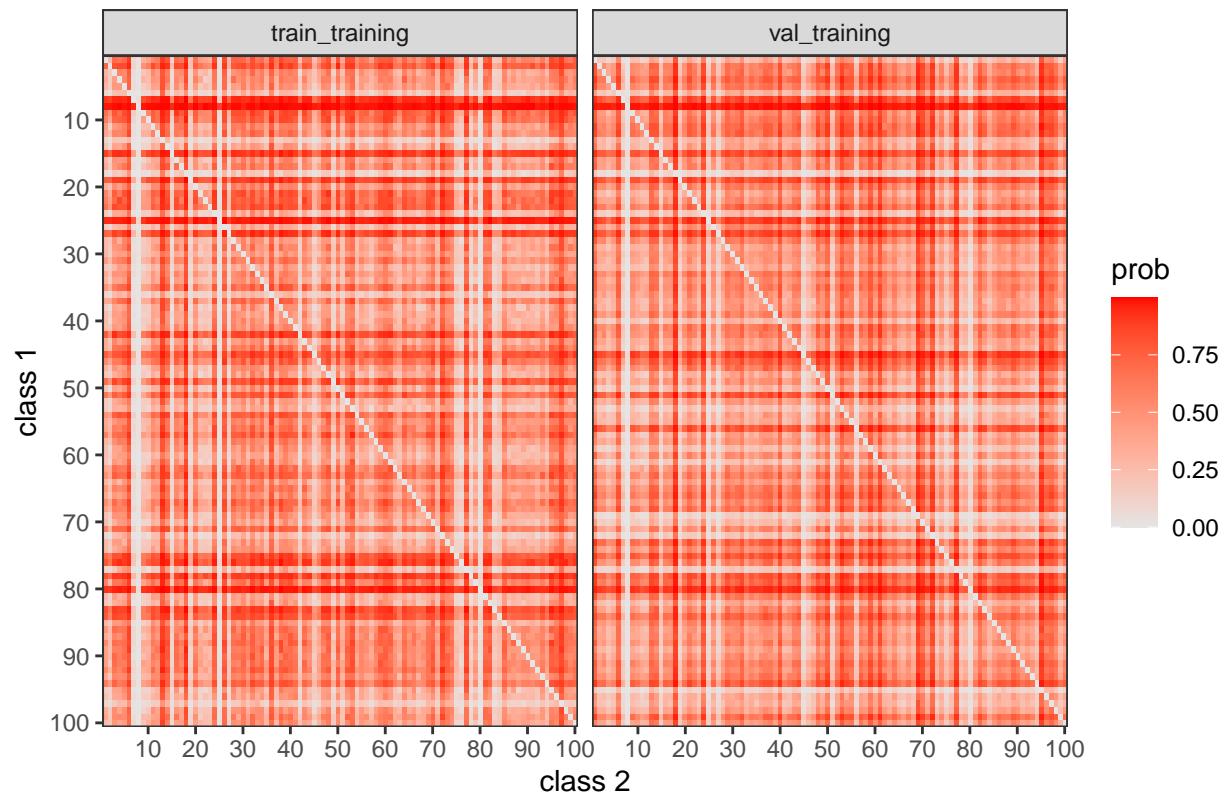
Pairwise probabilities – class 6



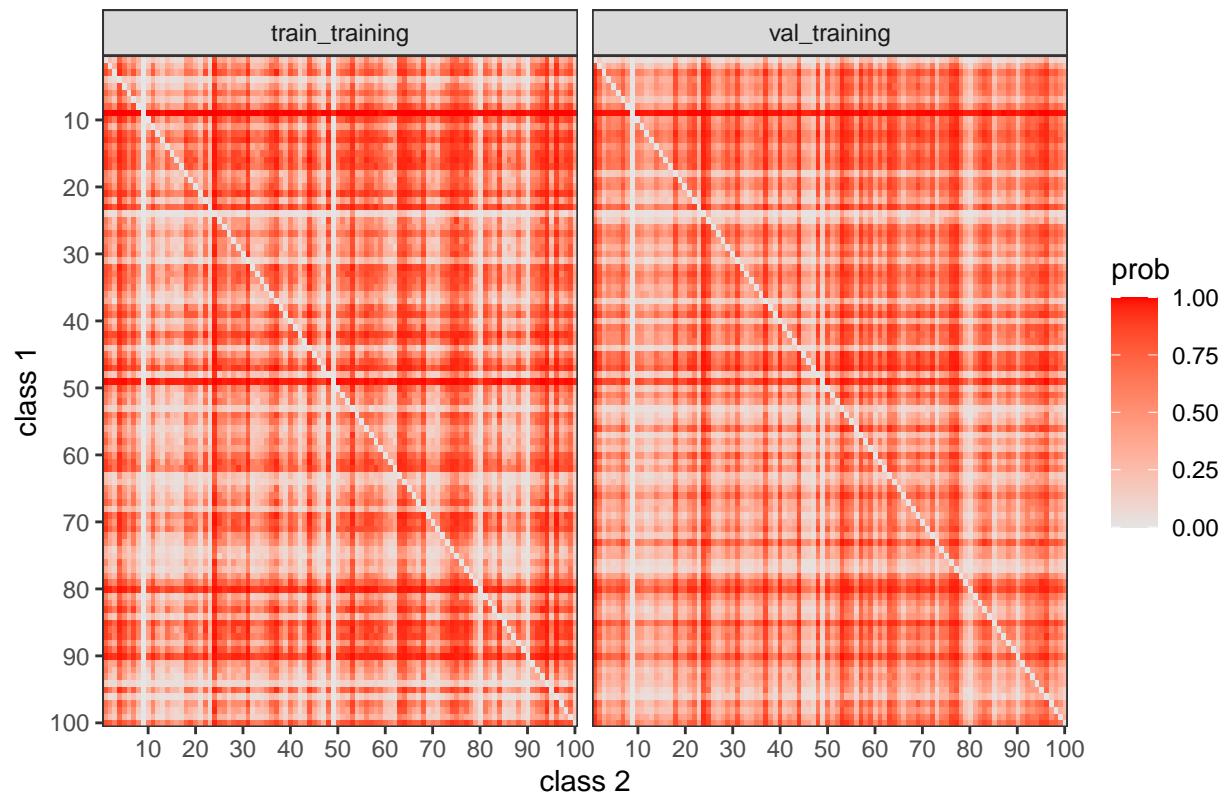
Pairwise probabilities – class 7



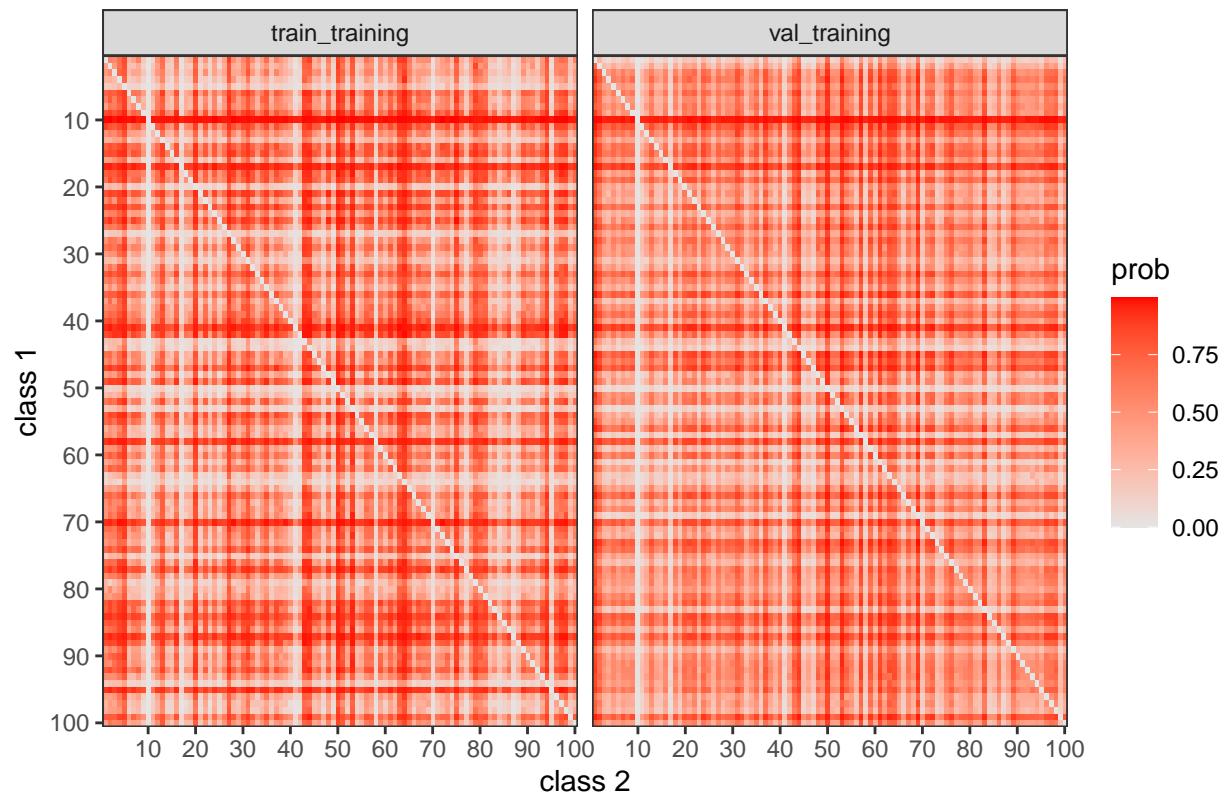
Pairwise probabilities – class 8



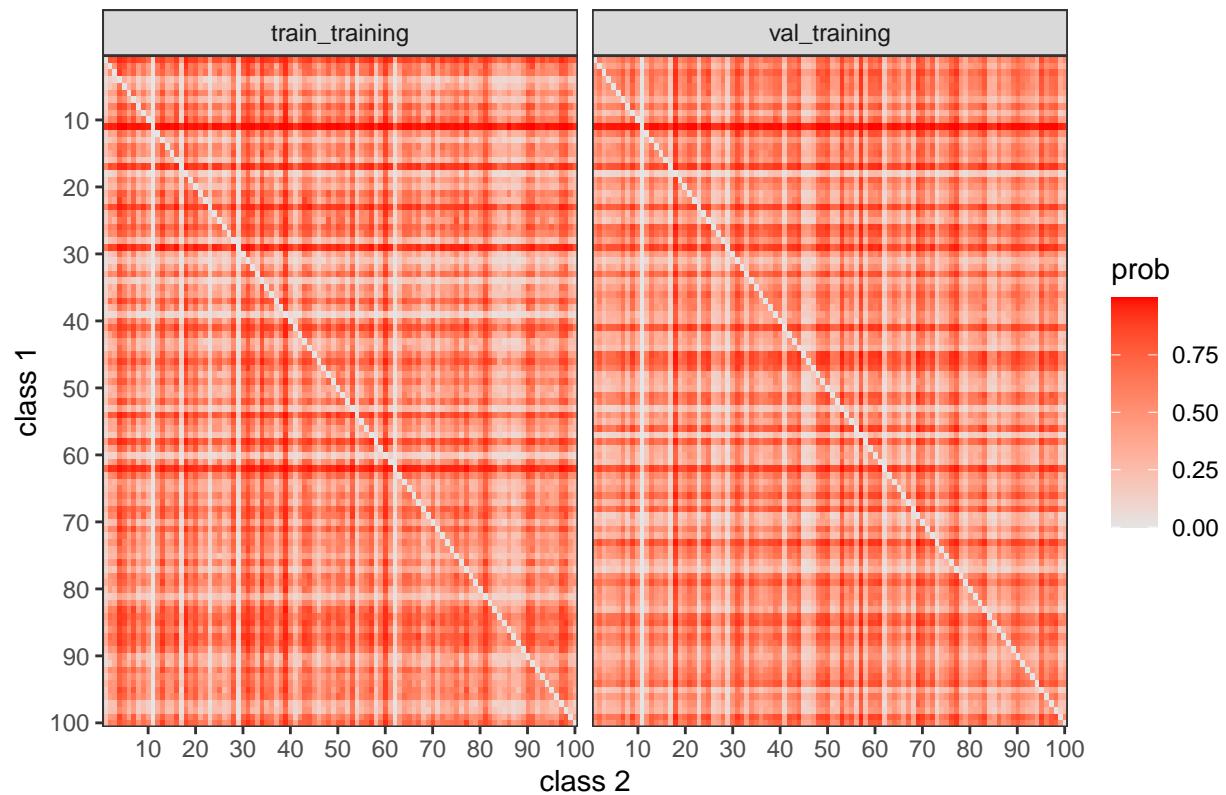
Pairwise probabilities – class 9



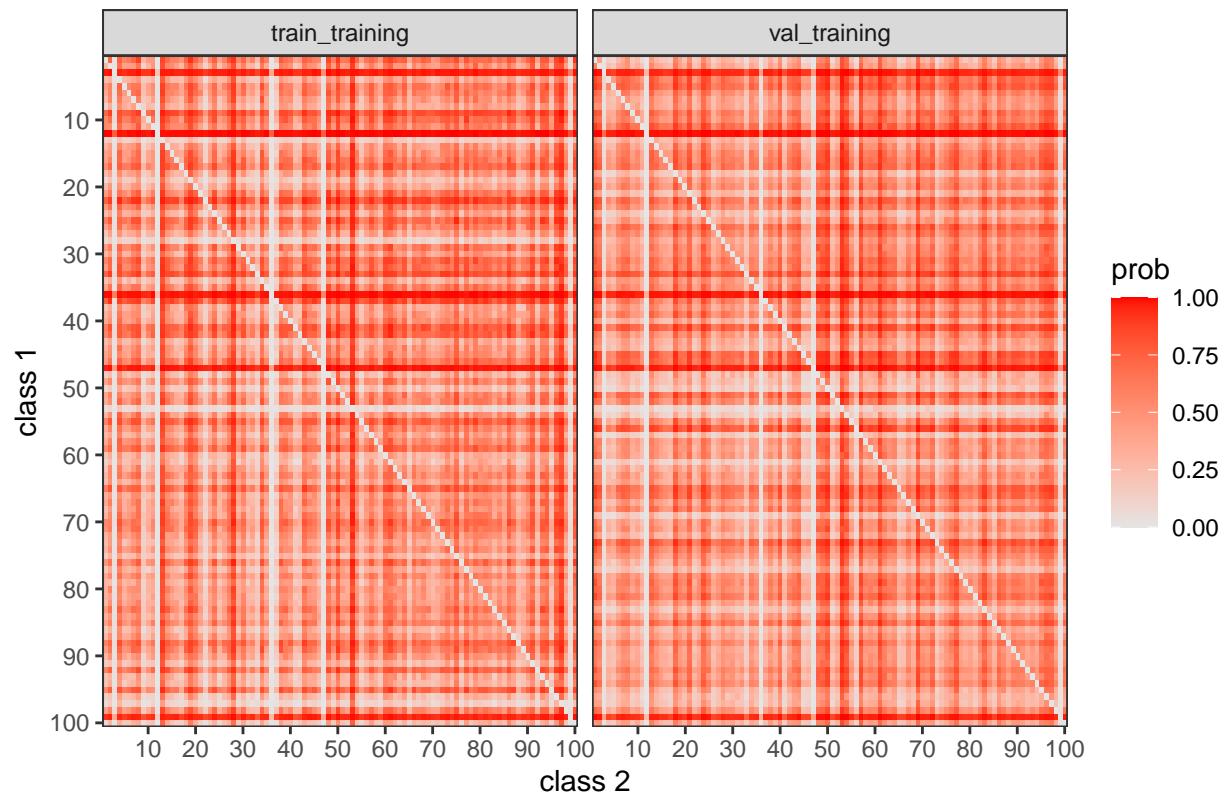
Pairwise probabilities – class 10



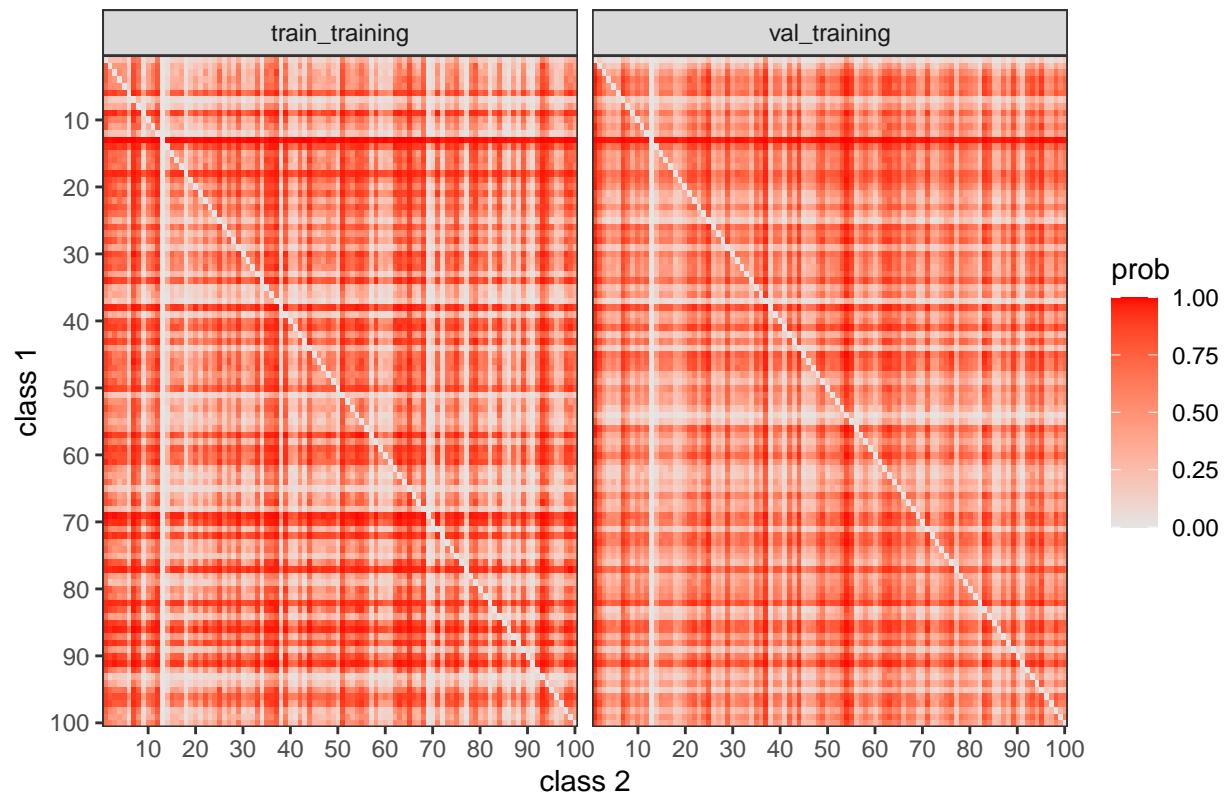
Pairwise probabilities – class 11



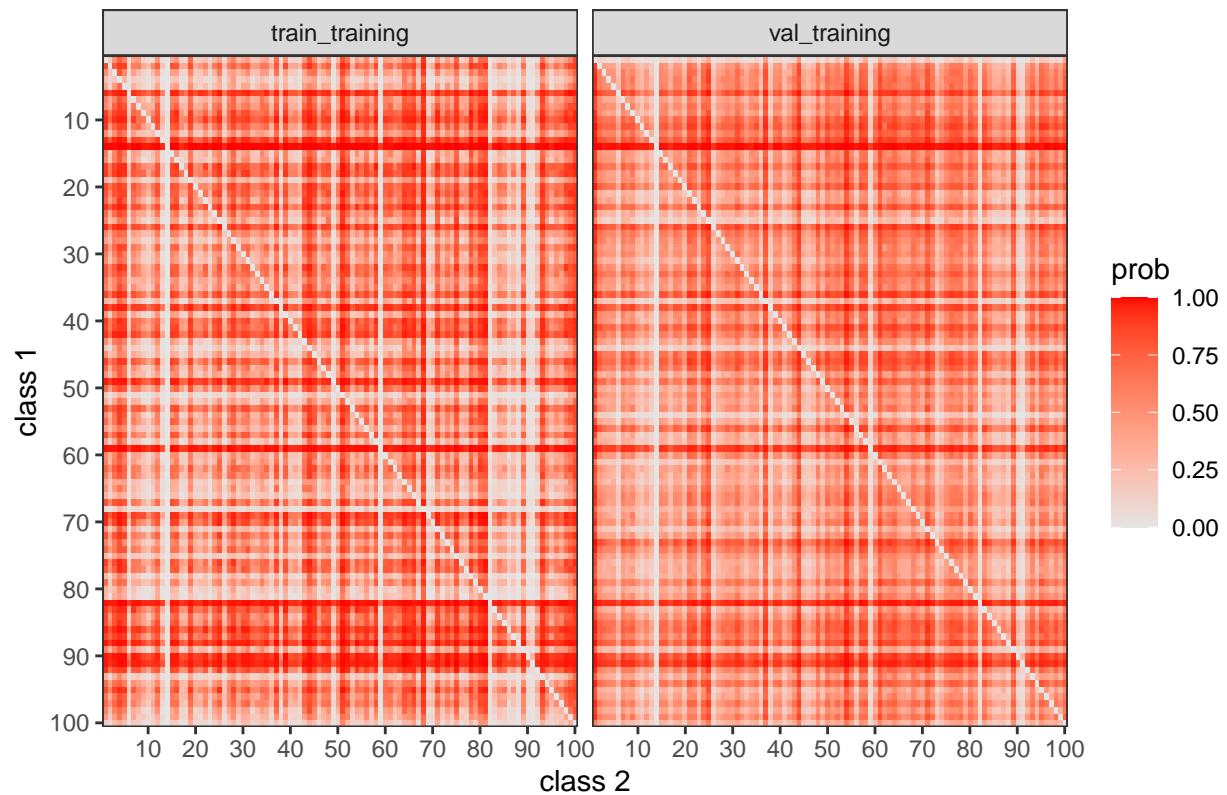
Pairwise probabilities – class 12



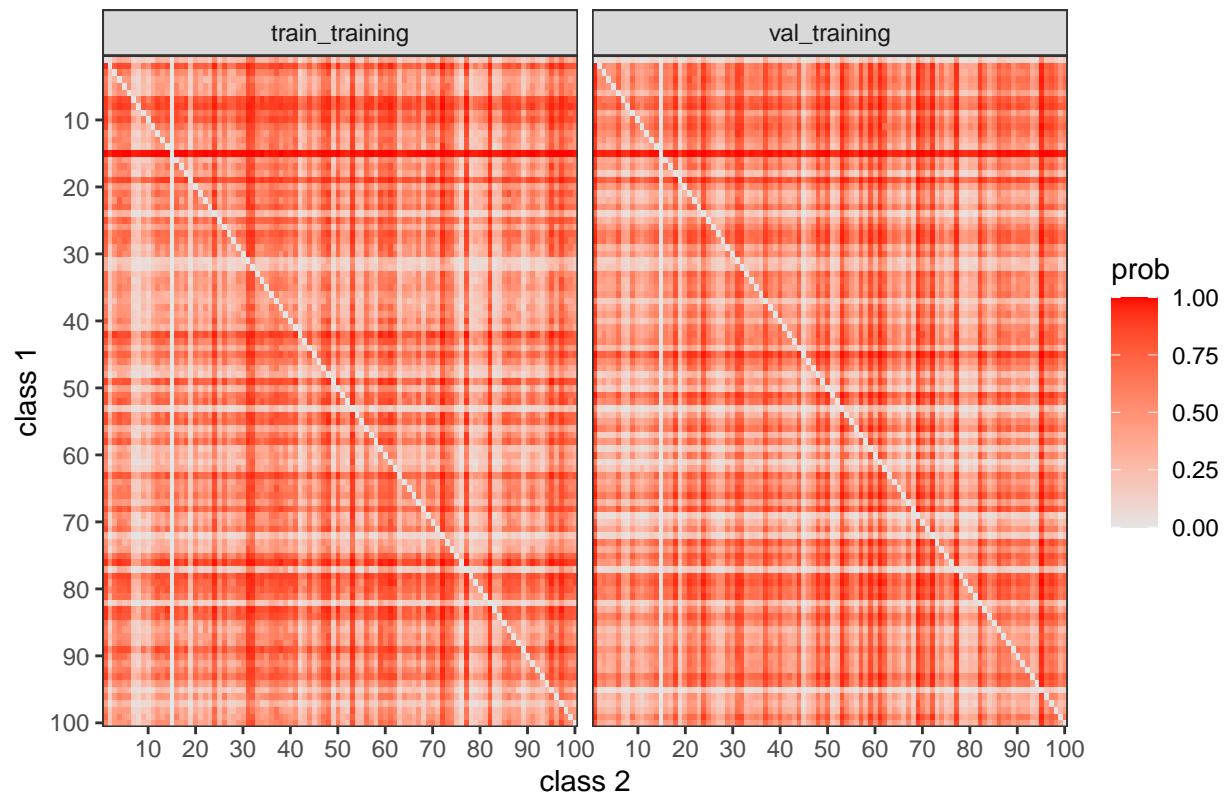
Pairwise probabilities – class 13



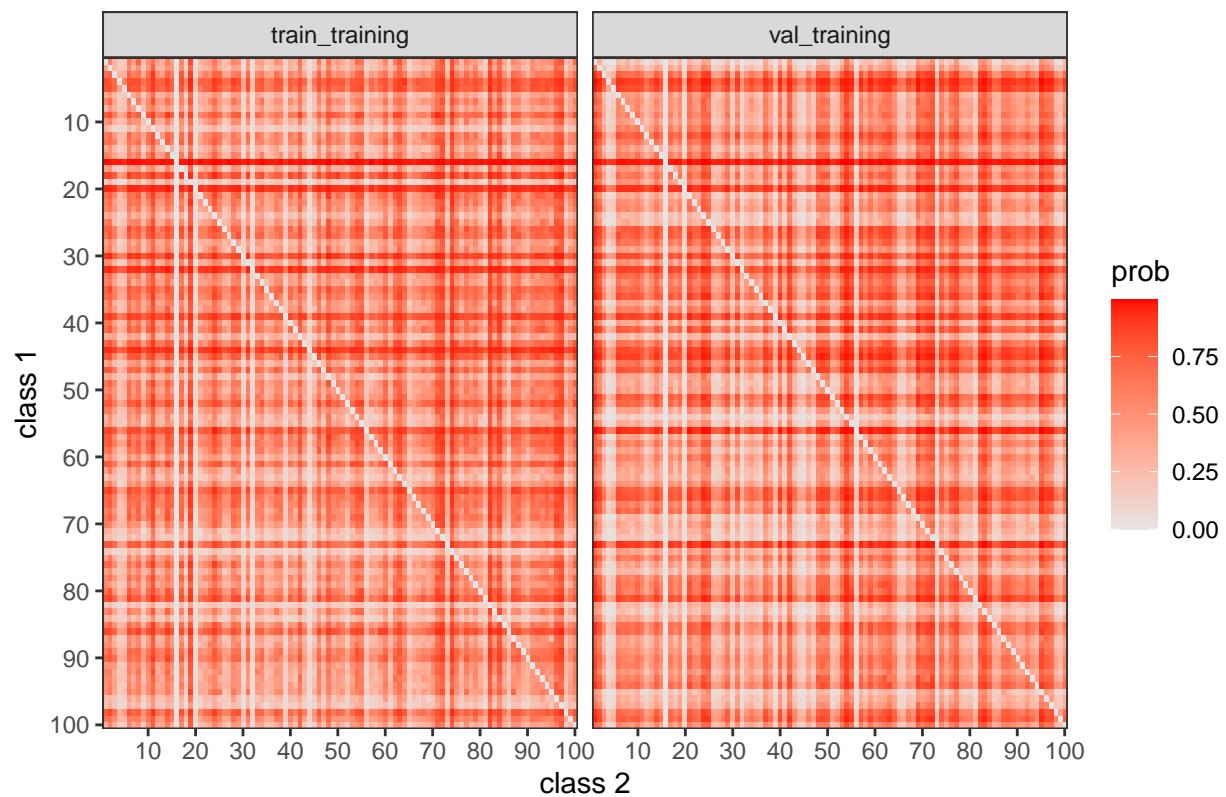
Pairwise probabilities – class 14



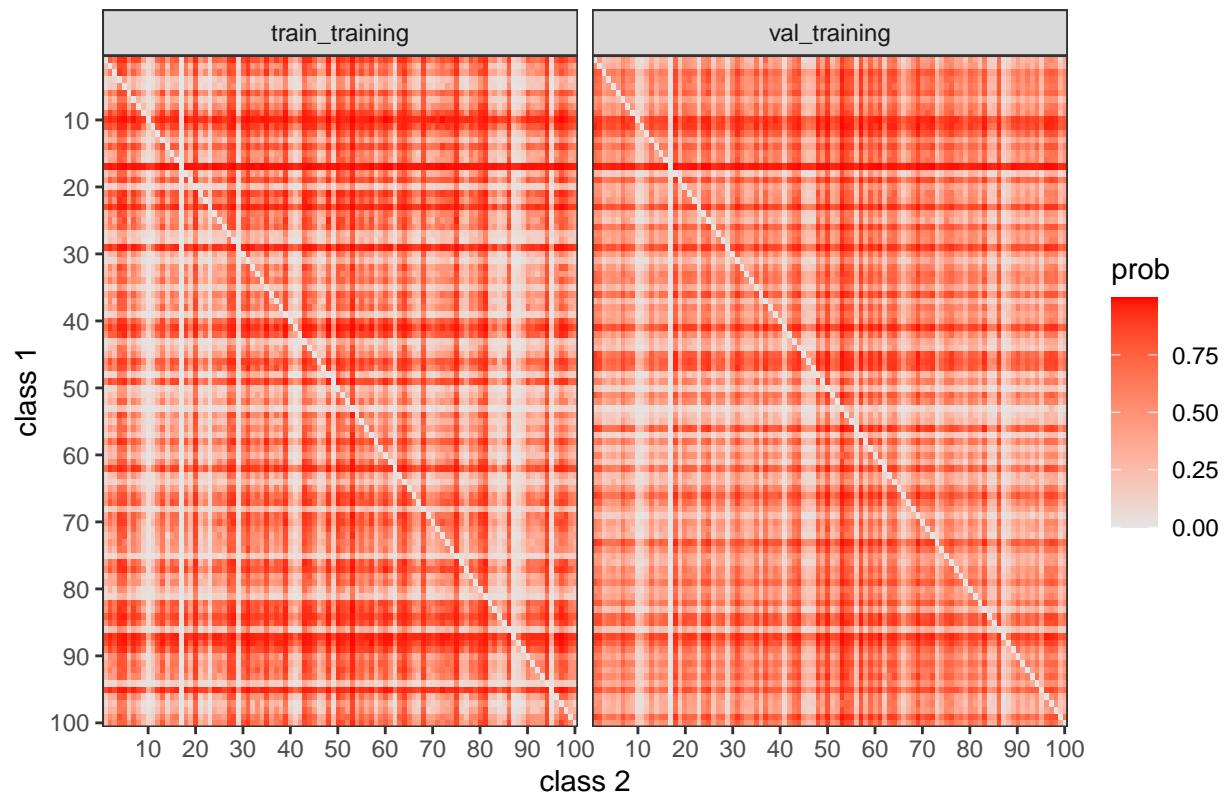
Pairwise probabilities – class 15



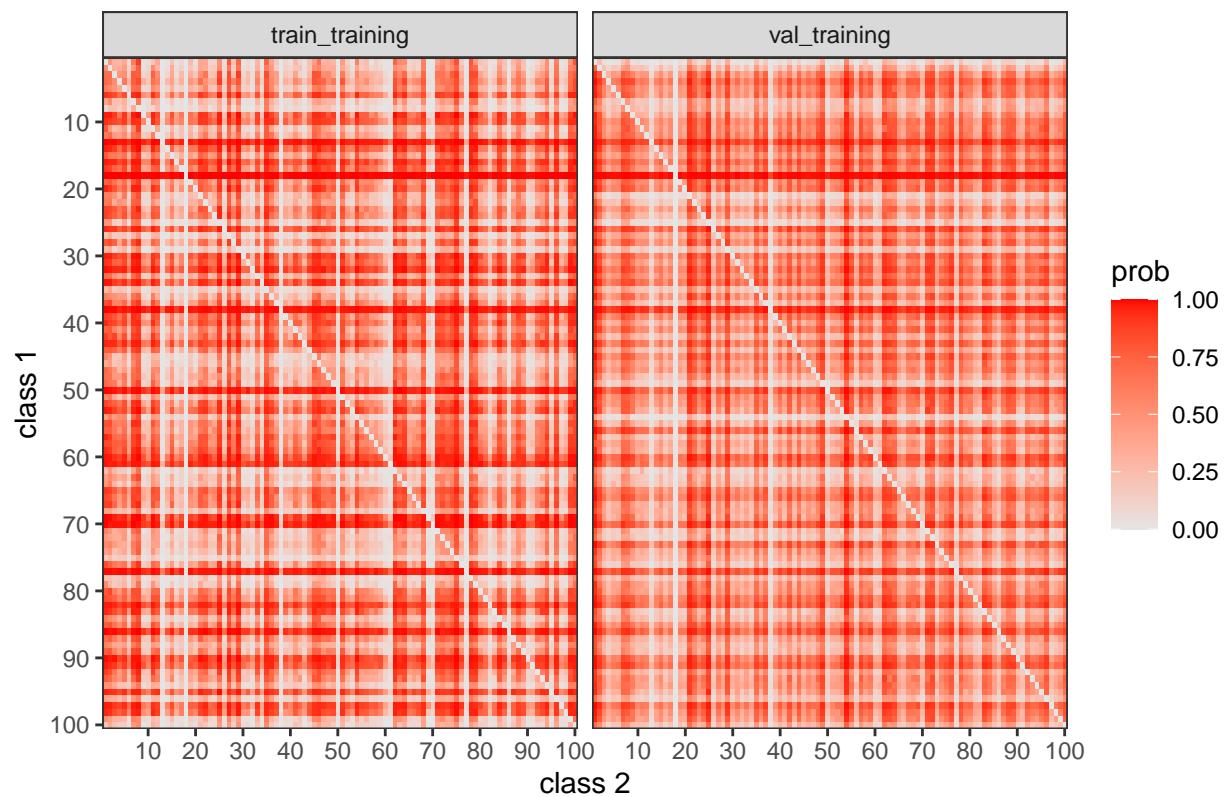
Pairwise probabilities – class 16



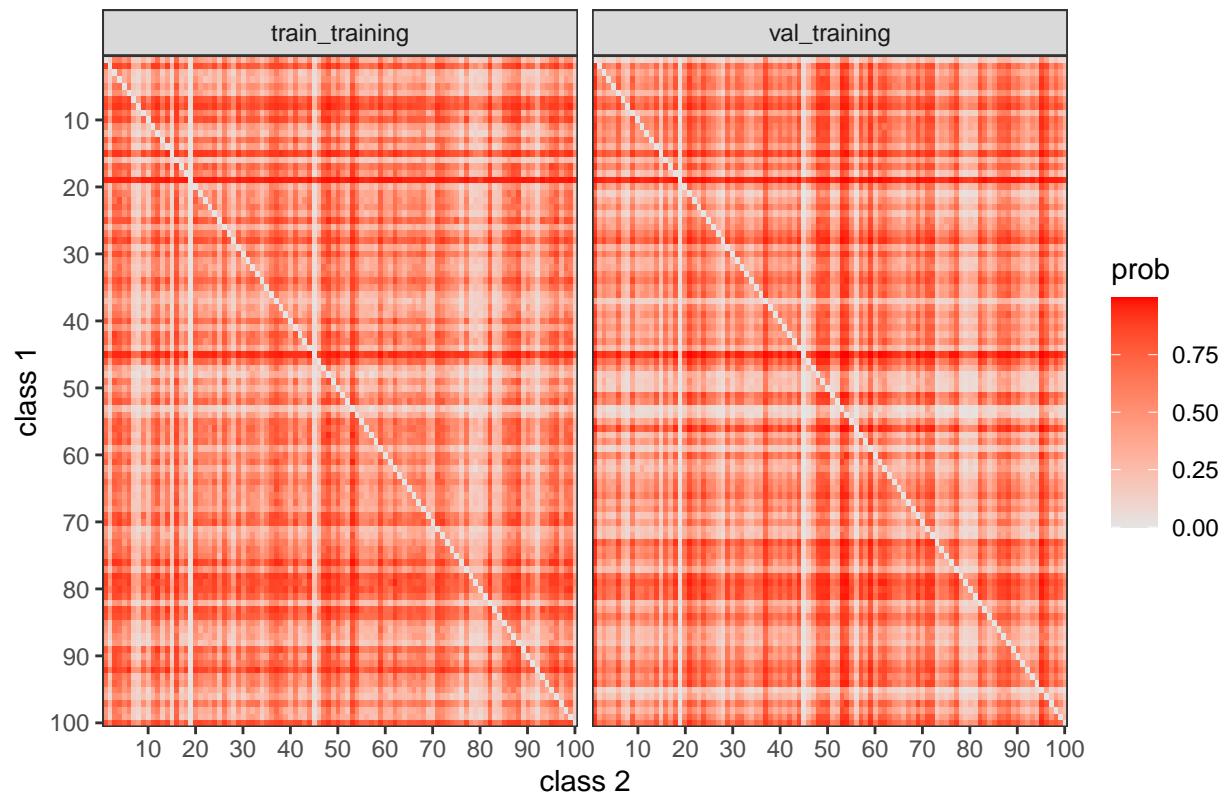
Pairwise probabilities – class 17



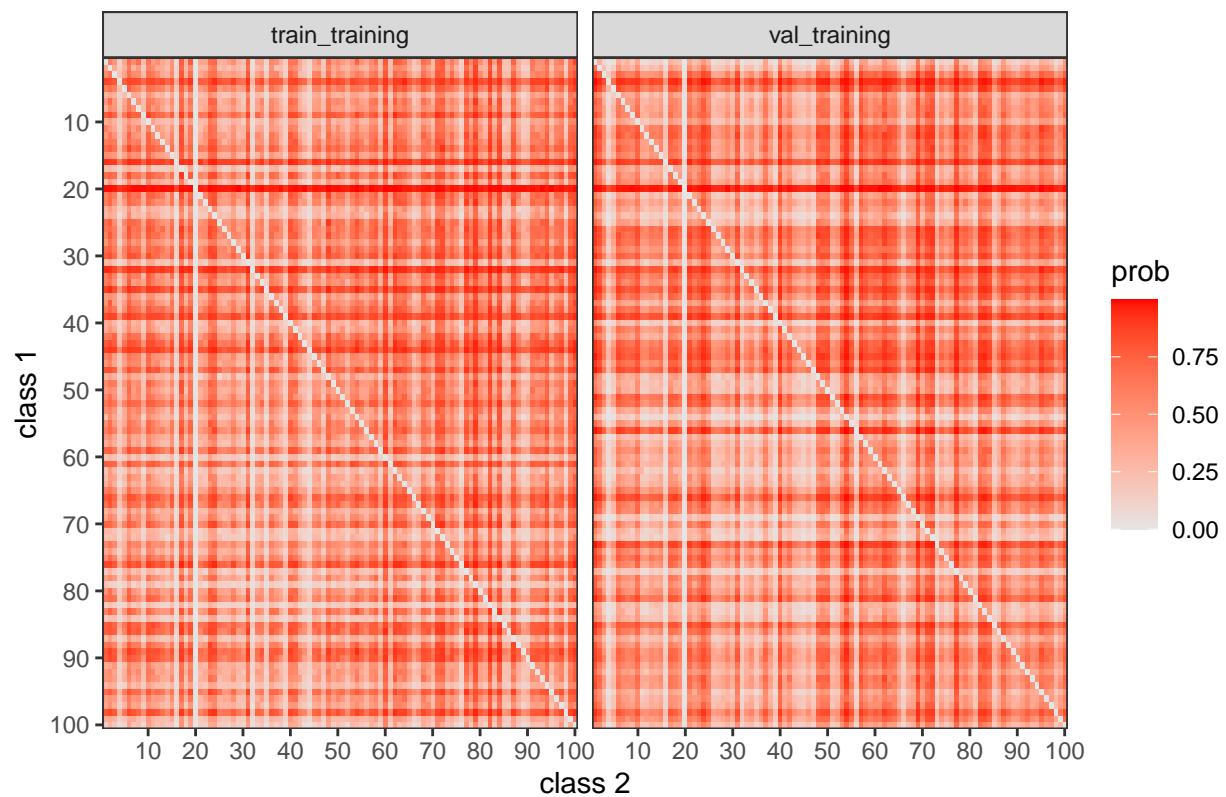
Pairwise probabilities – class 18



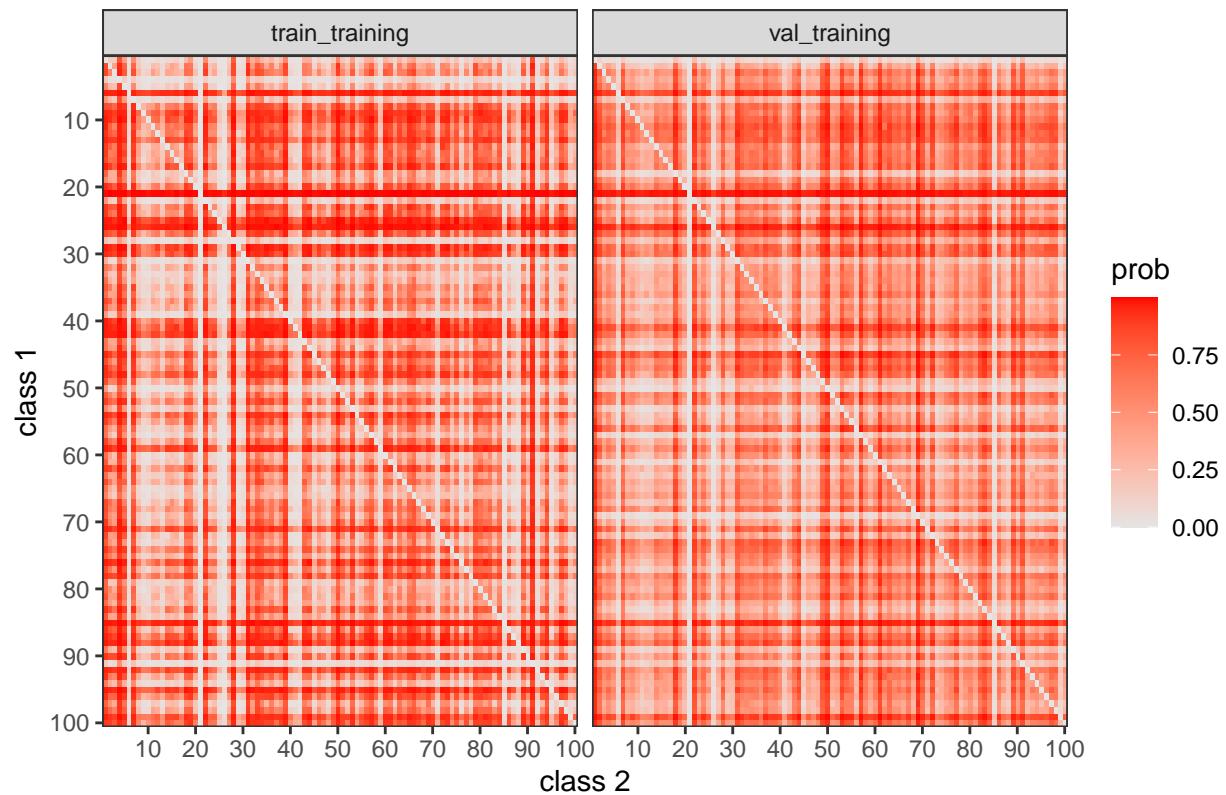
Pairwise probabilities – class 19



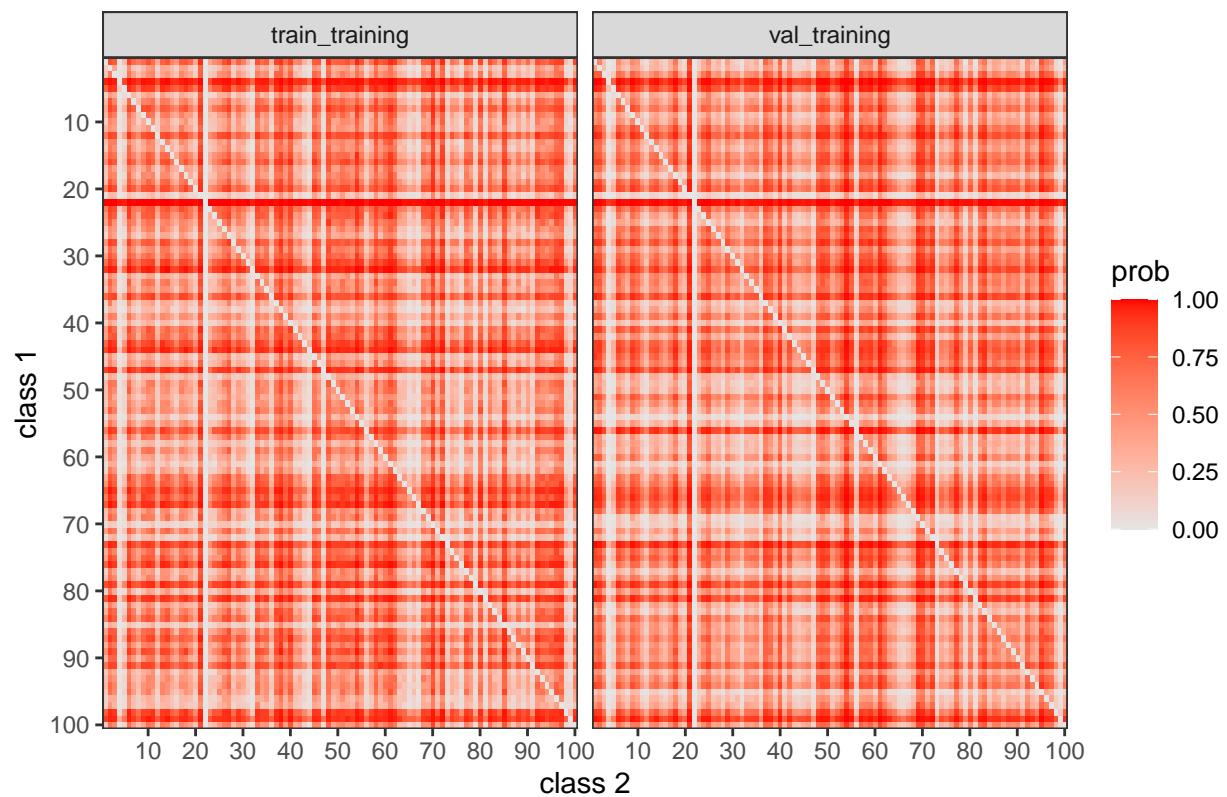
Pairwise probabilities – class 20



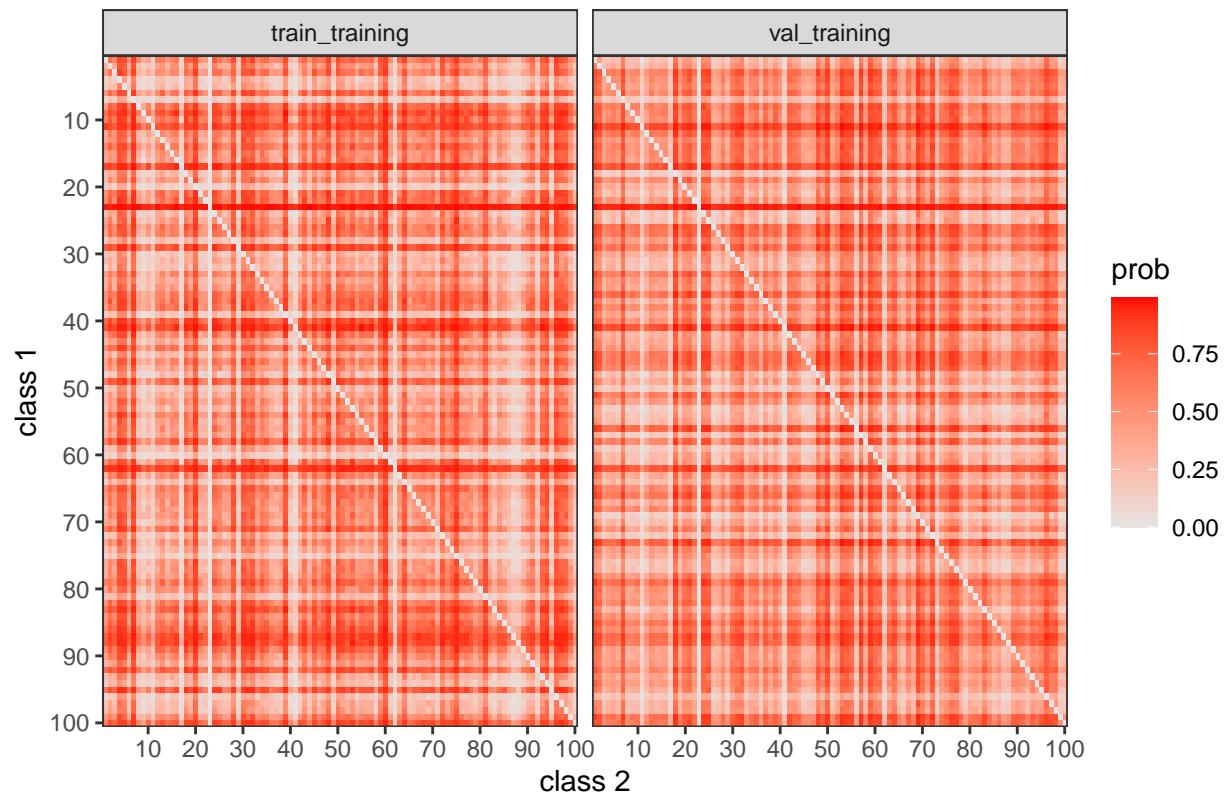
Pairwise probabilities – class 21



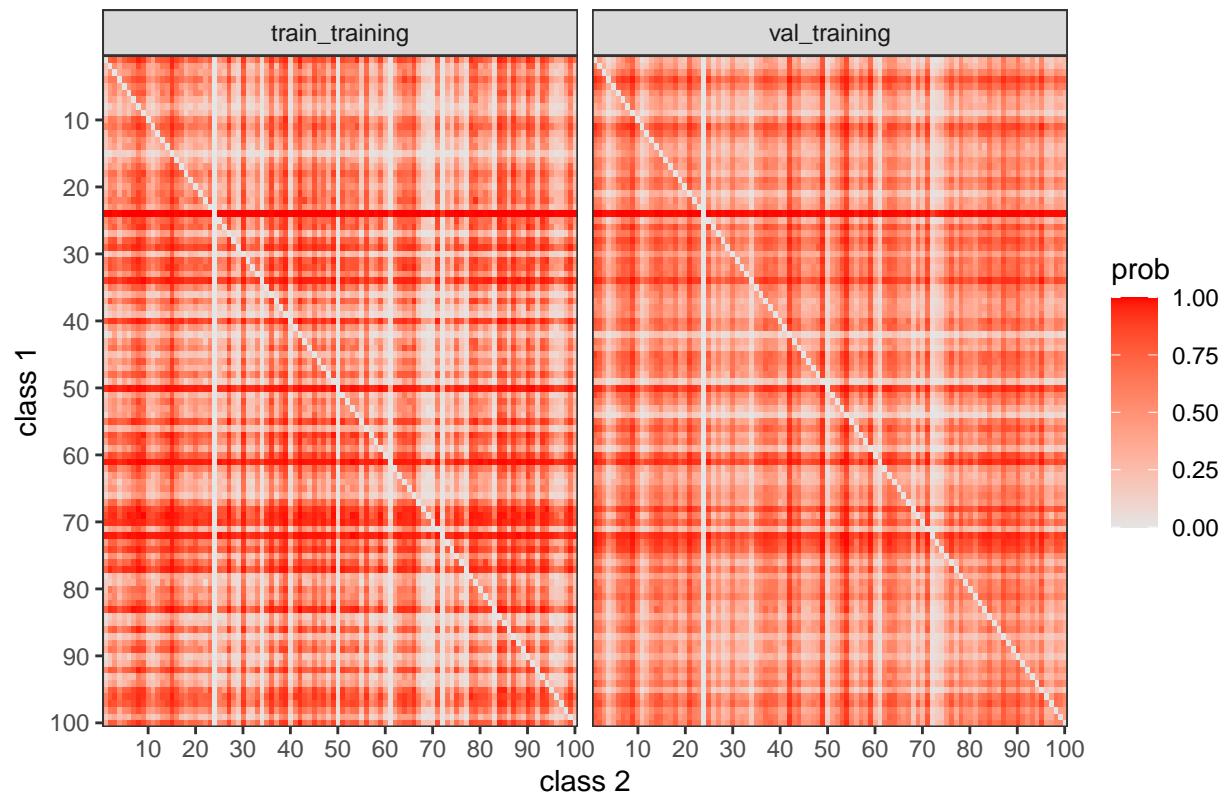
Pairwise probabilities – class 22



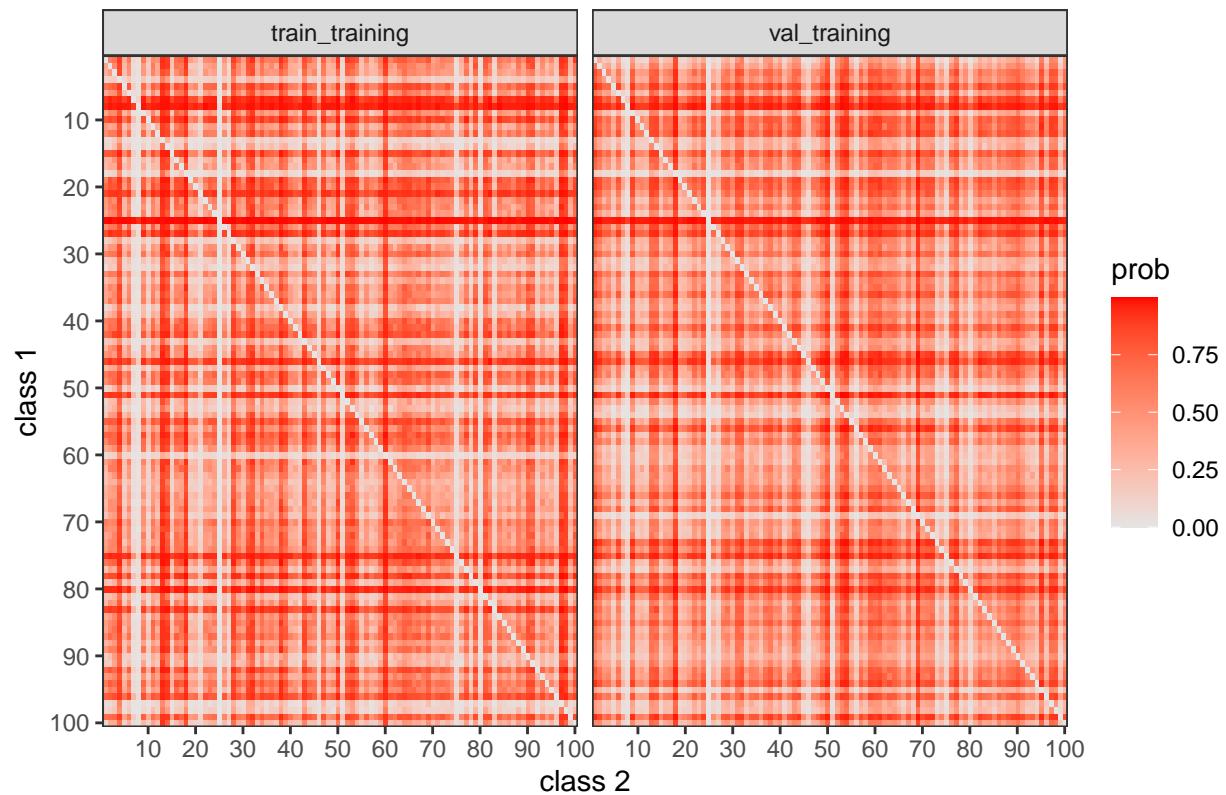
Pairwise probabilities – class 23



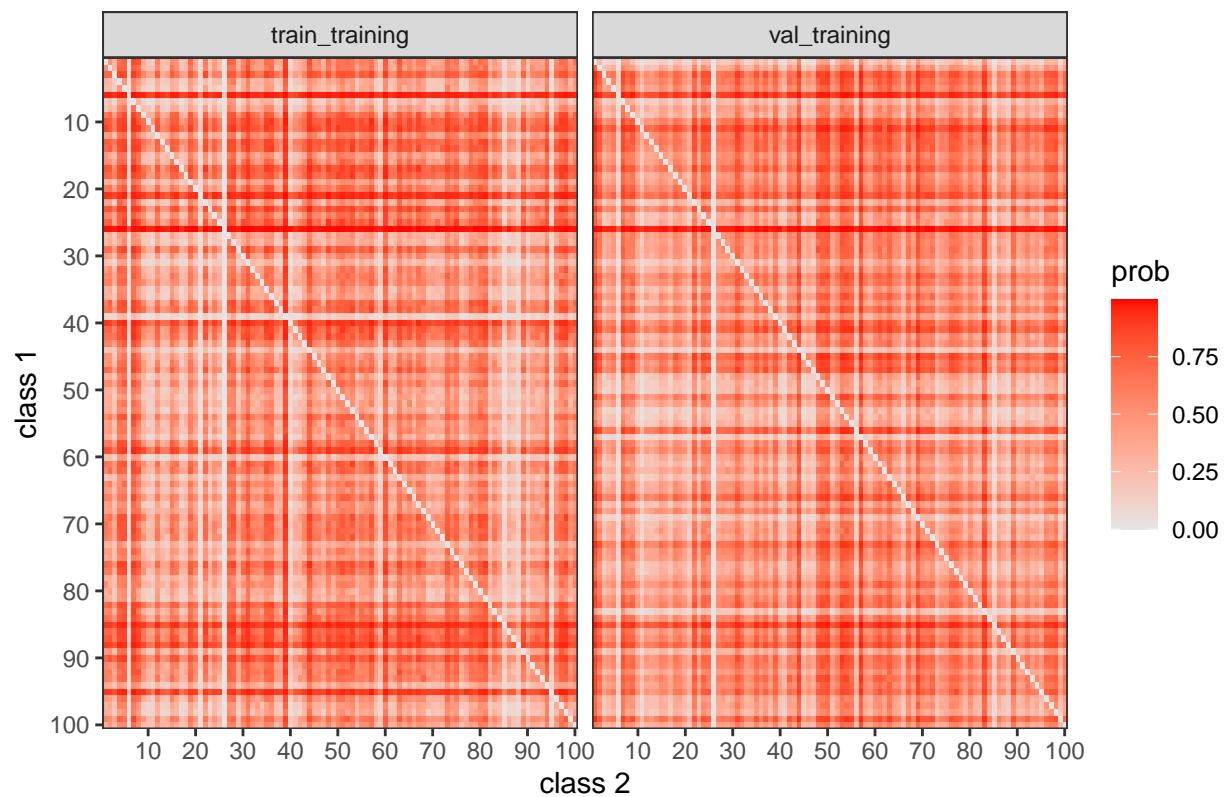
Pairwise probabilities – class 24



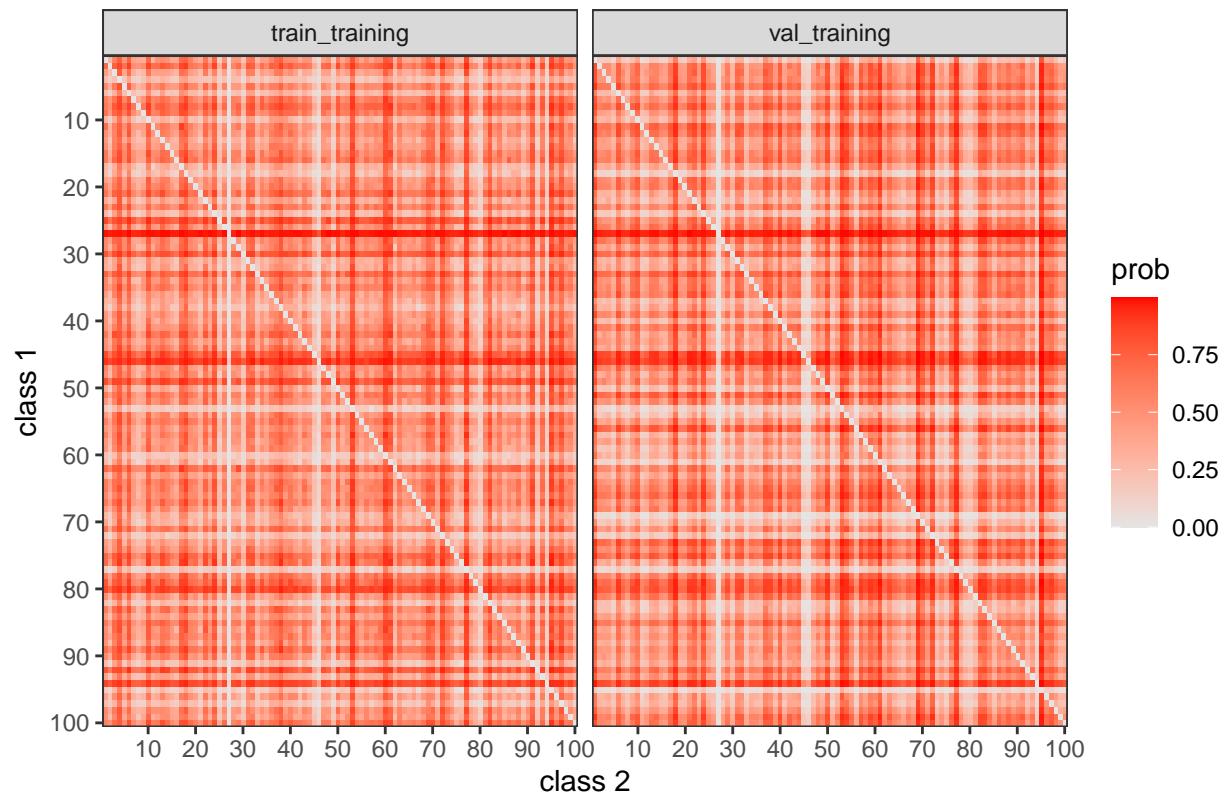
Pairwise probabilities – class 25



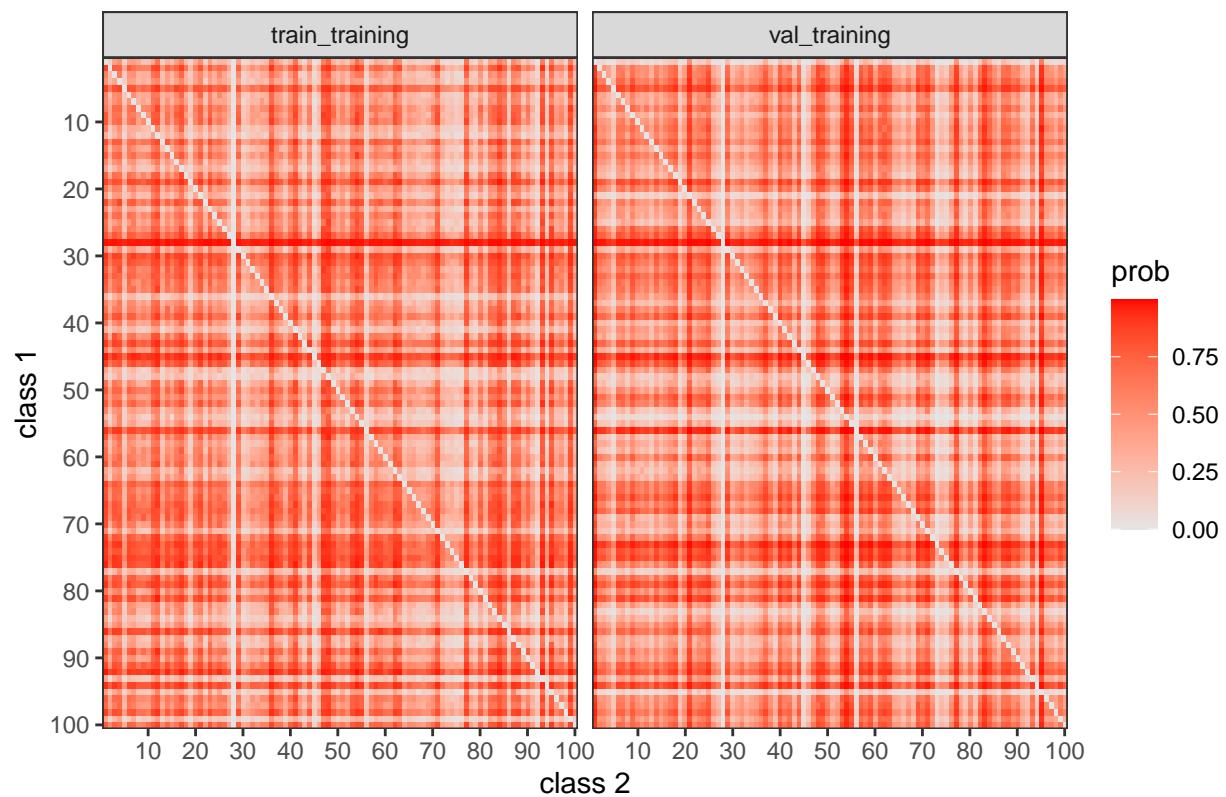
Pairwise probabilities – class 26



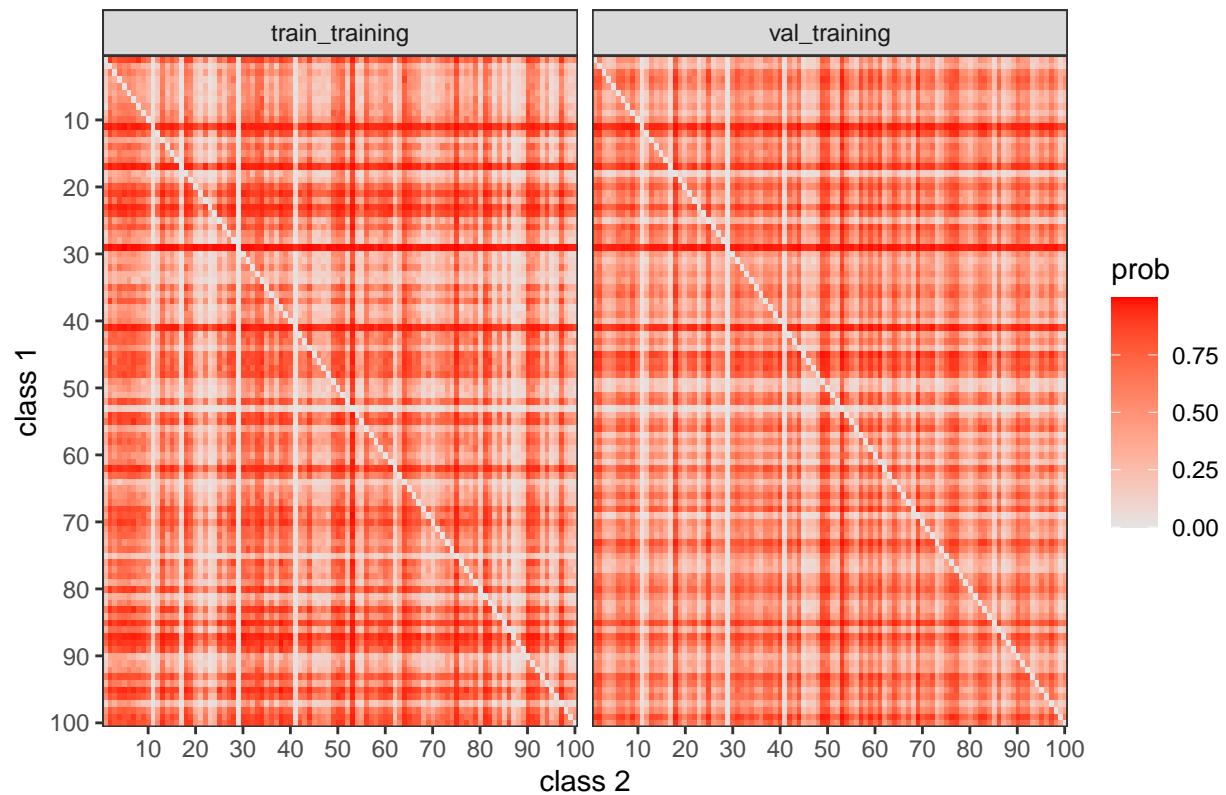
Pairwise probabilities – class 27



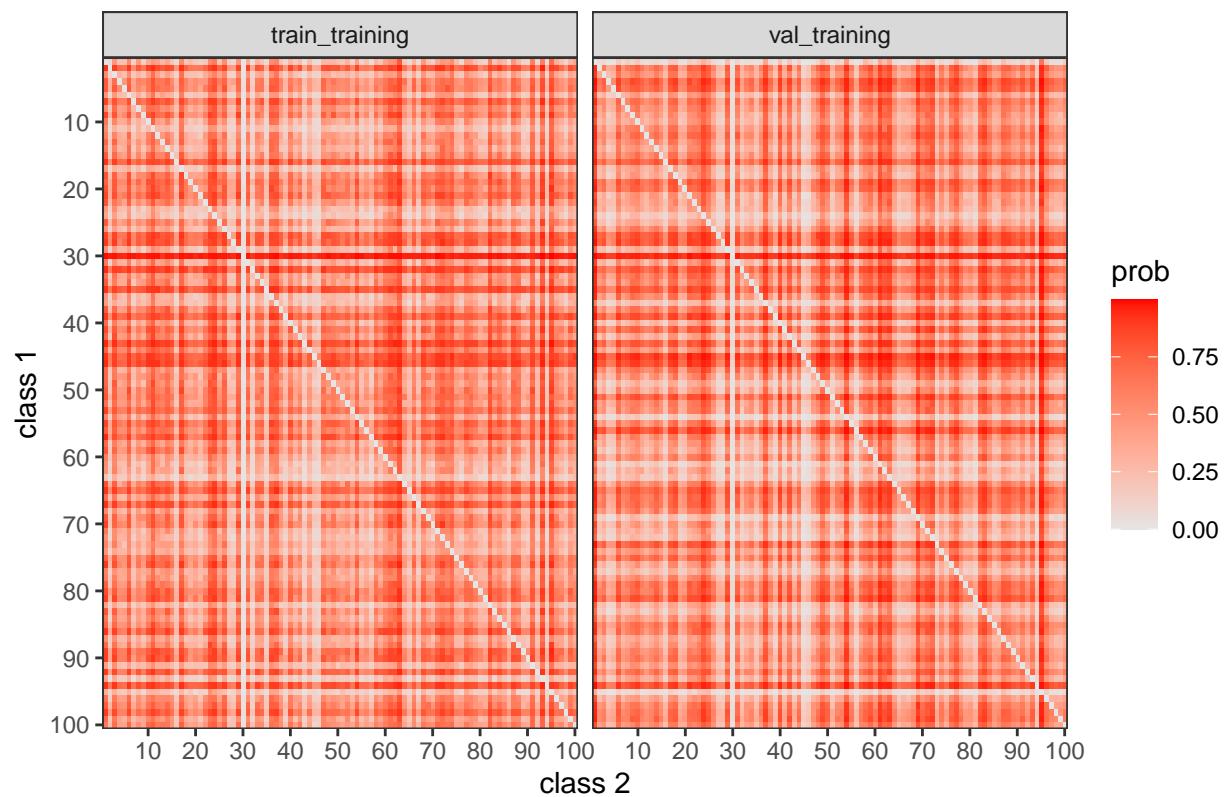
Pairwise probabilities – class 28



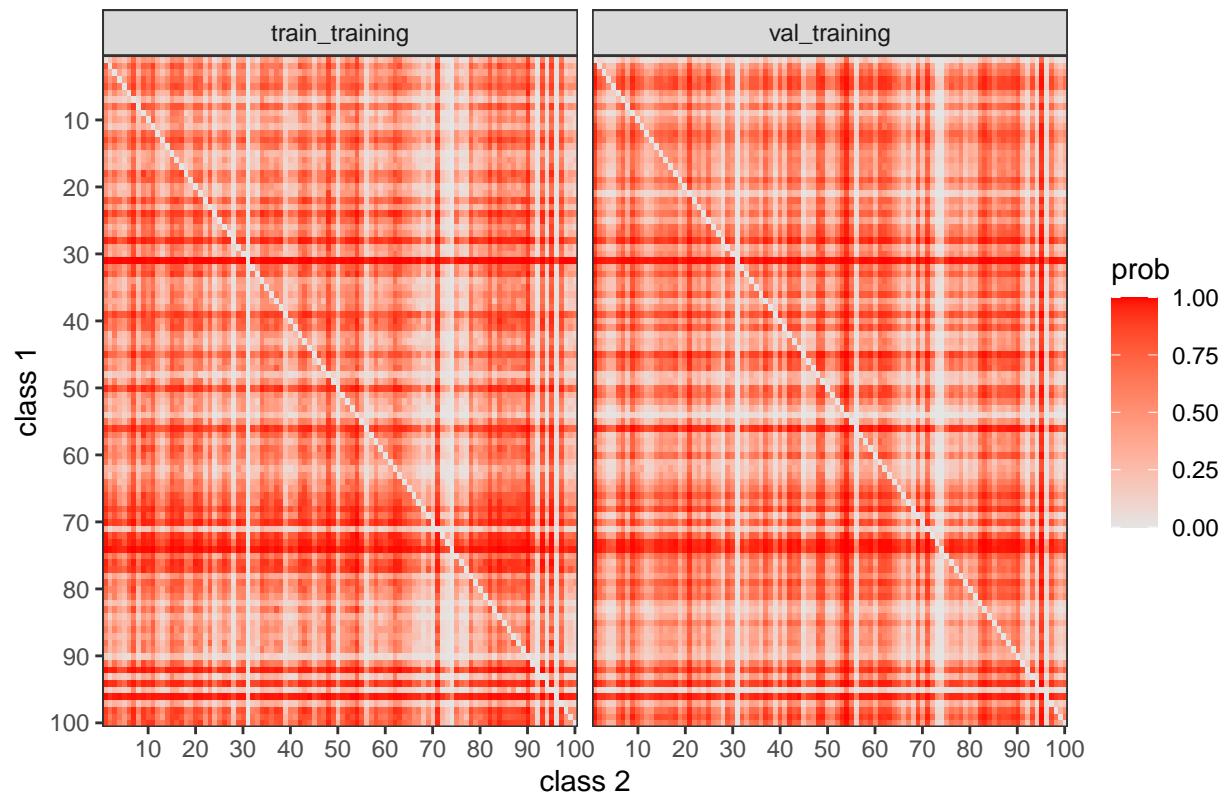
Pairwise probabilities – class 29



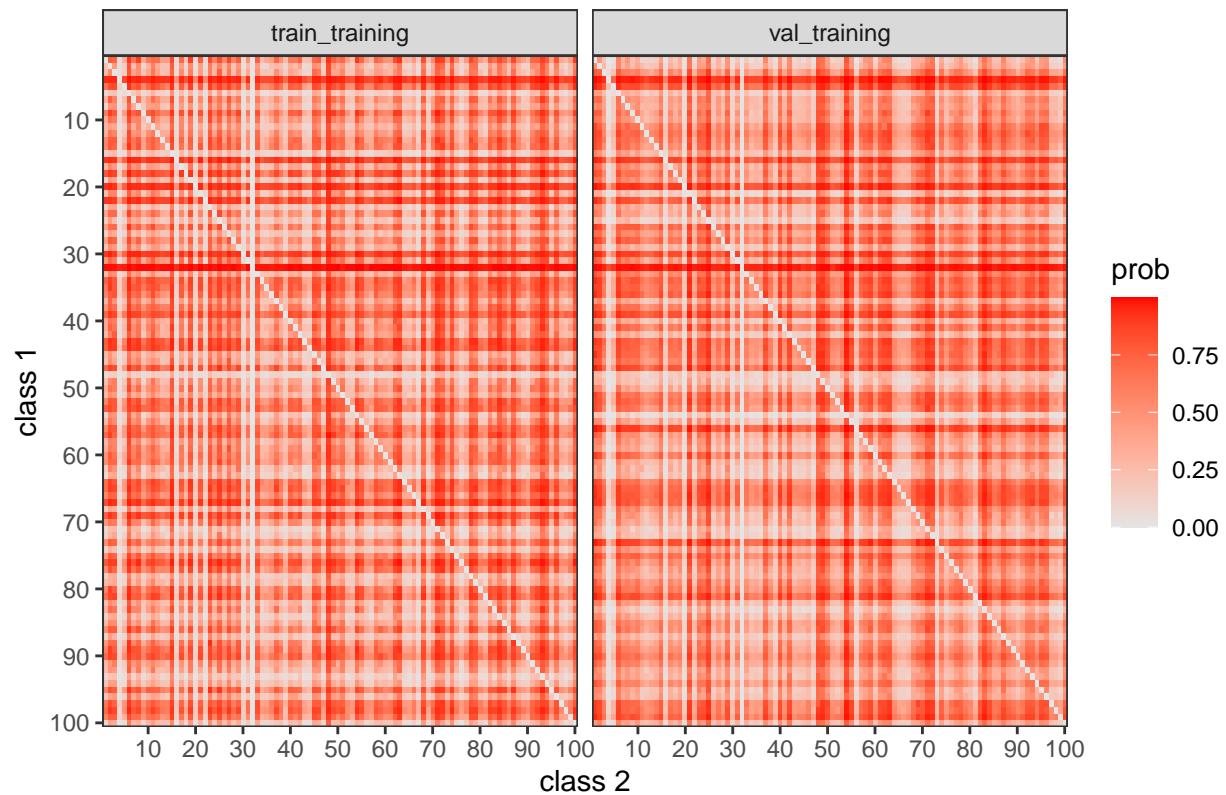
Pairwise probabilities – class 30



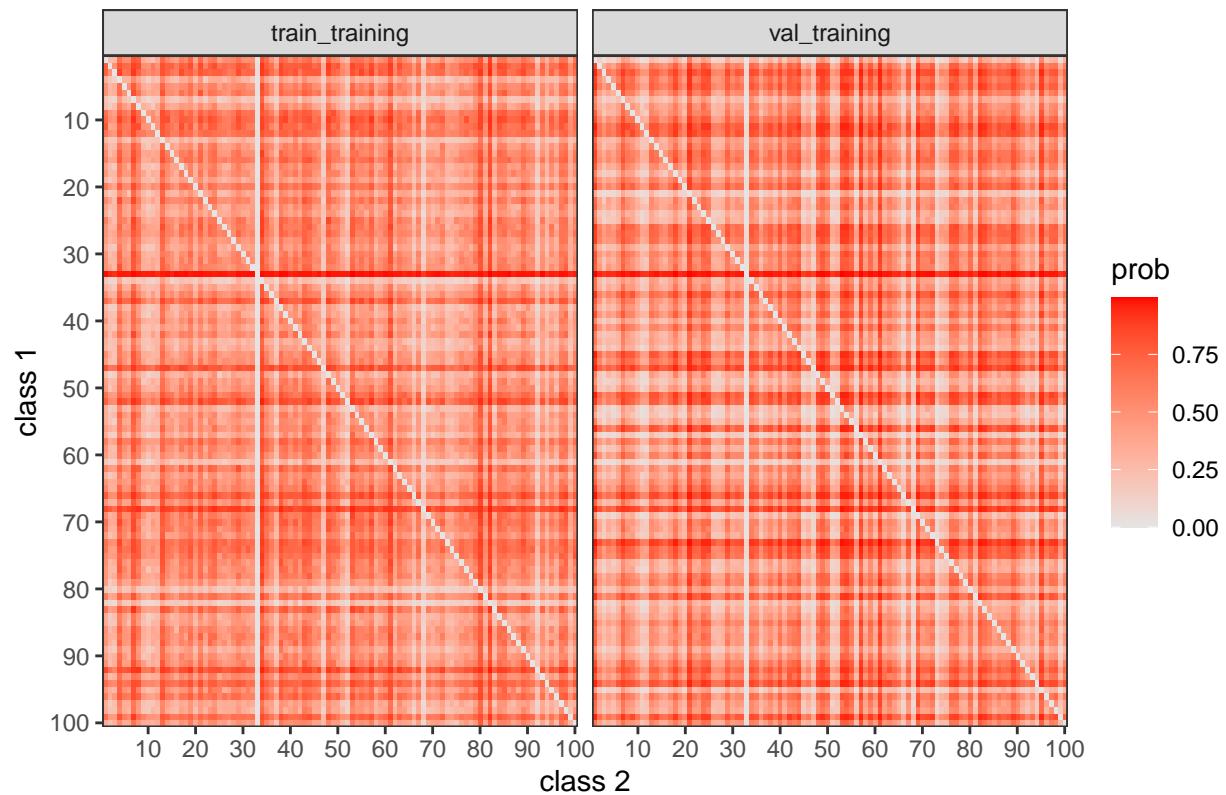
Pairwise probabilities – class 31



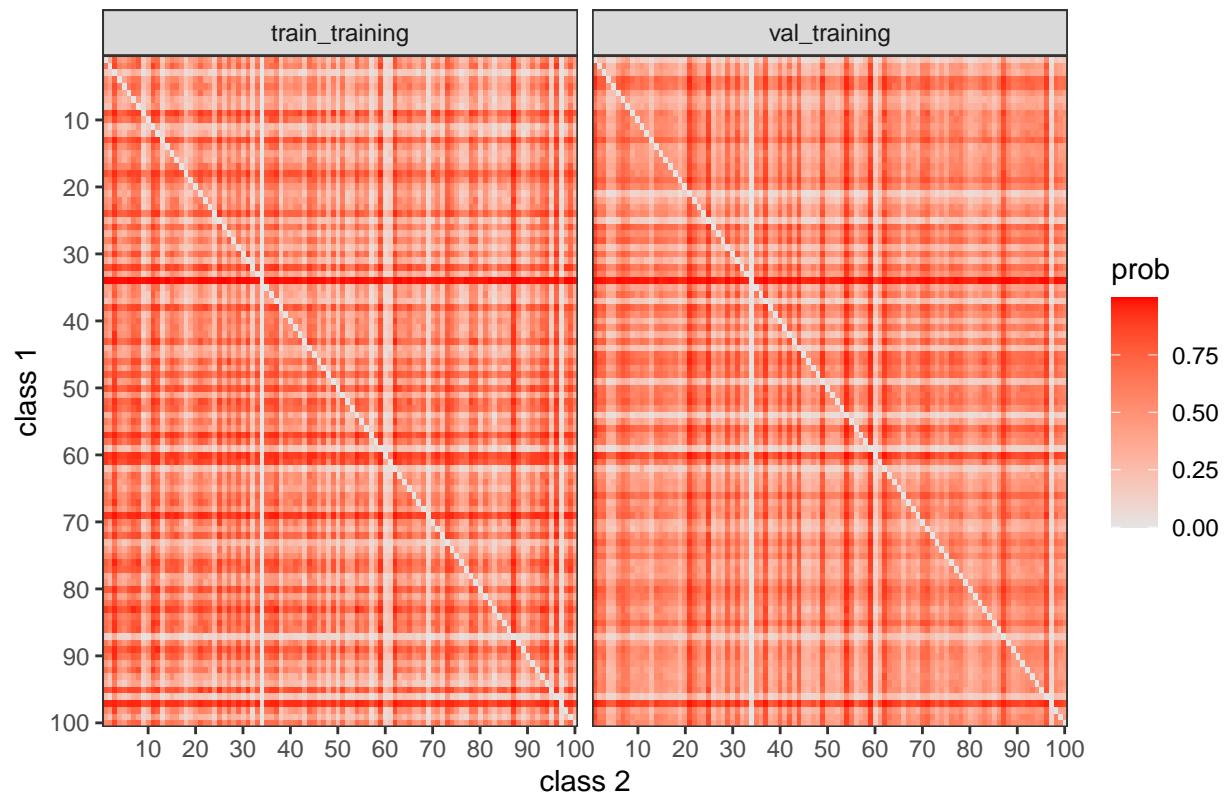
Pairwise probabilities – class 32



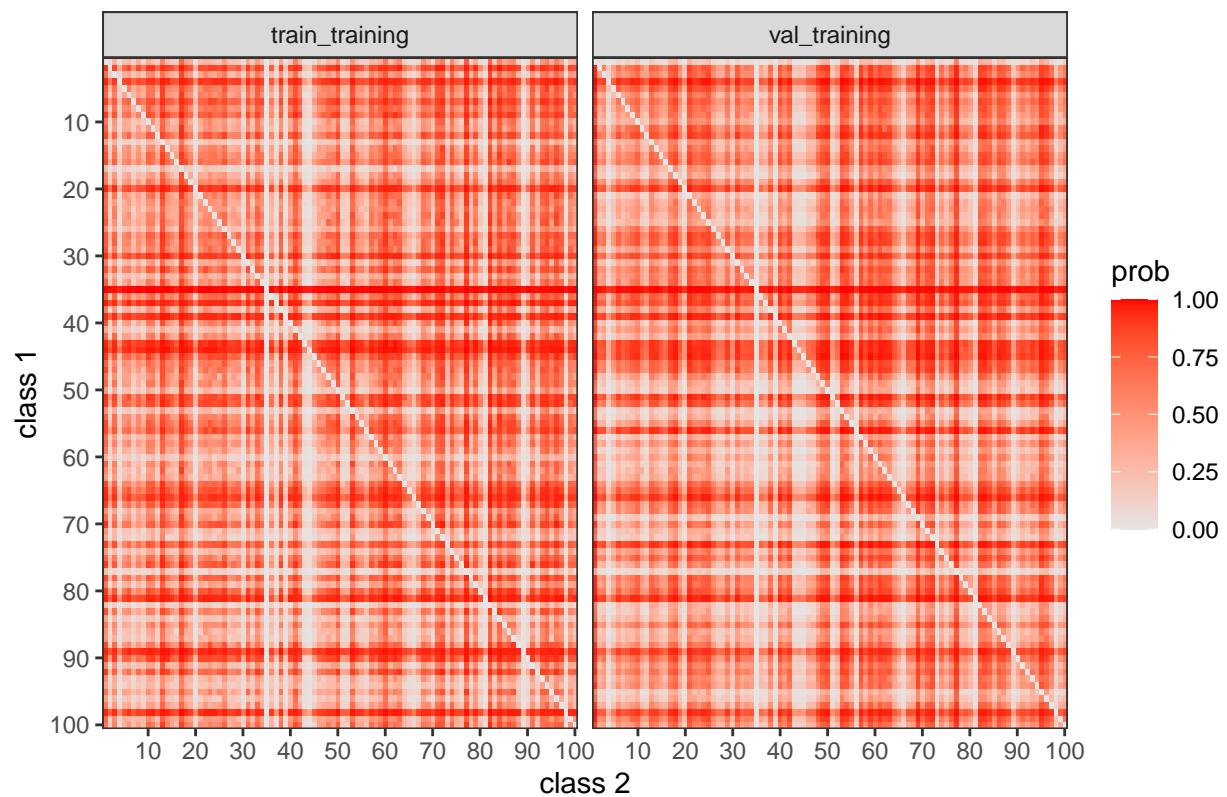
Pairwise probabilities – class 33



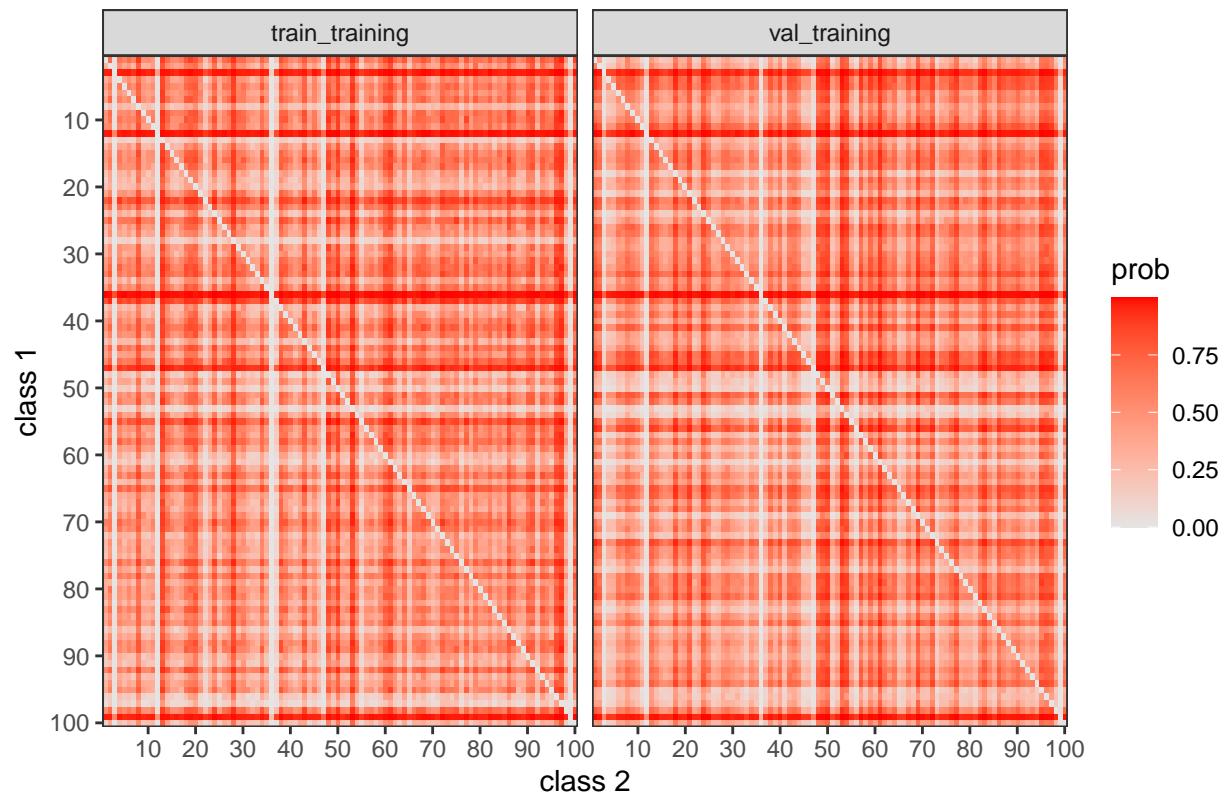
Pairwise probabilities – class 34



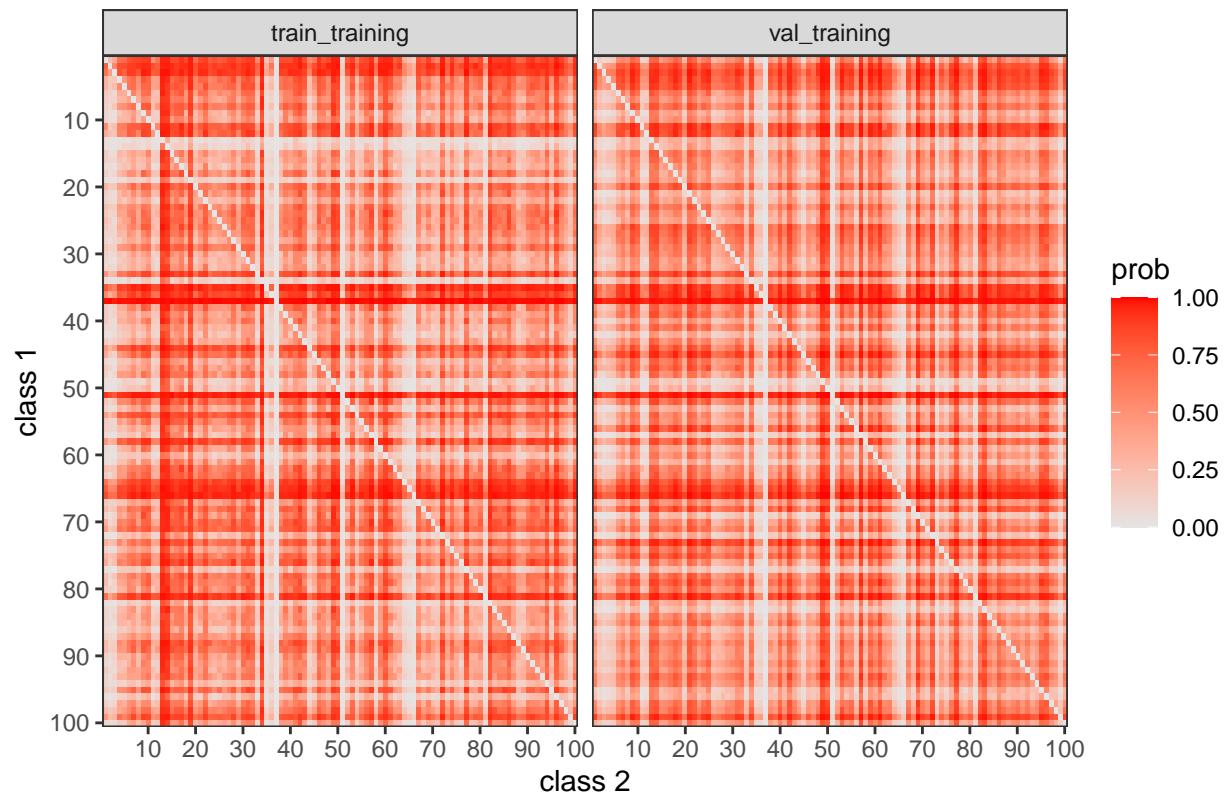
Pairwise probabilities – class 35



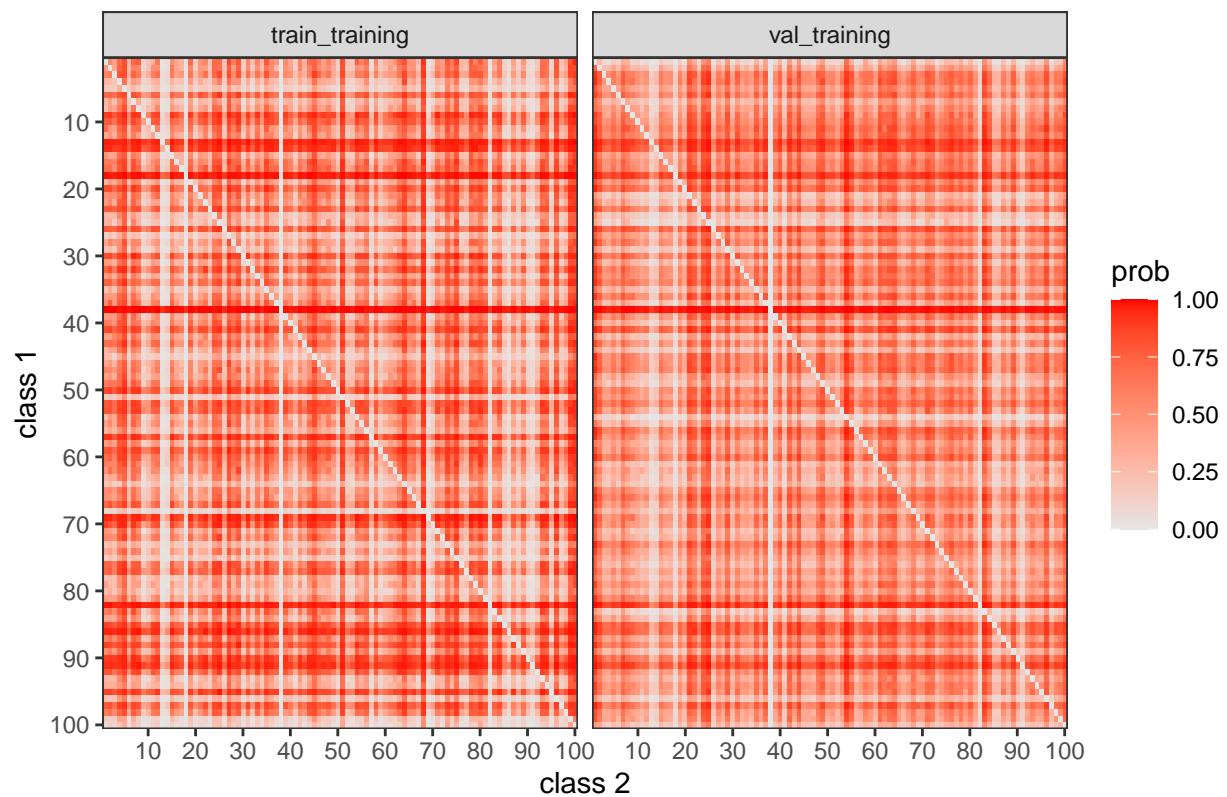
Pairwise probabilities – class 36



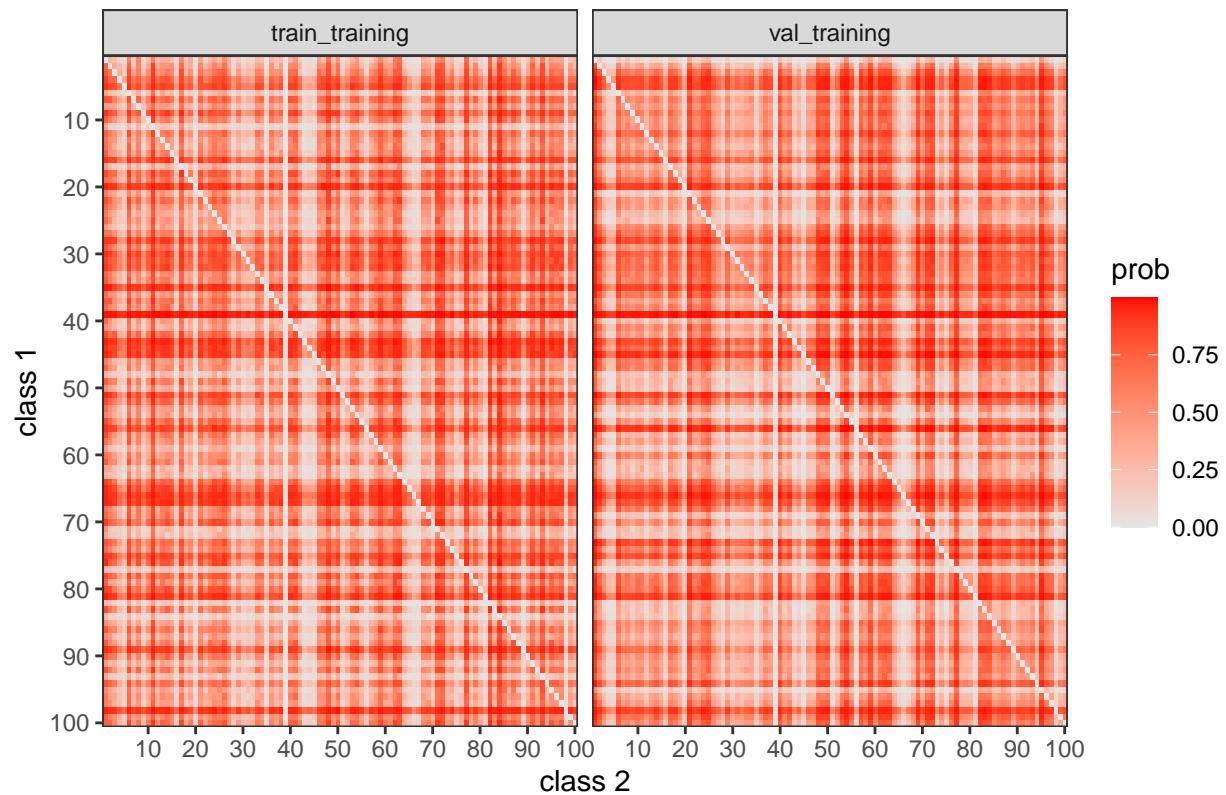
Pairwise probabilities – class 37



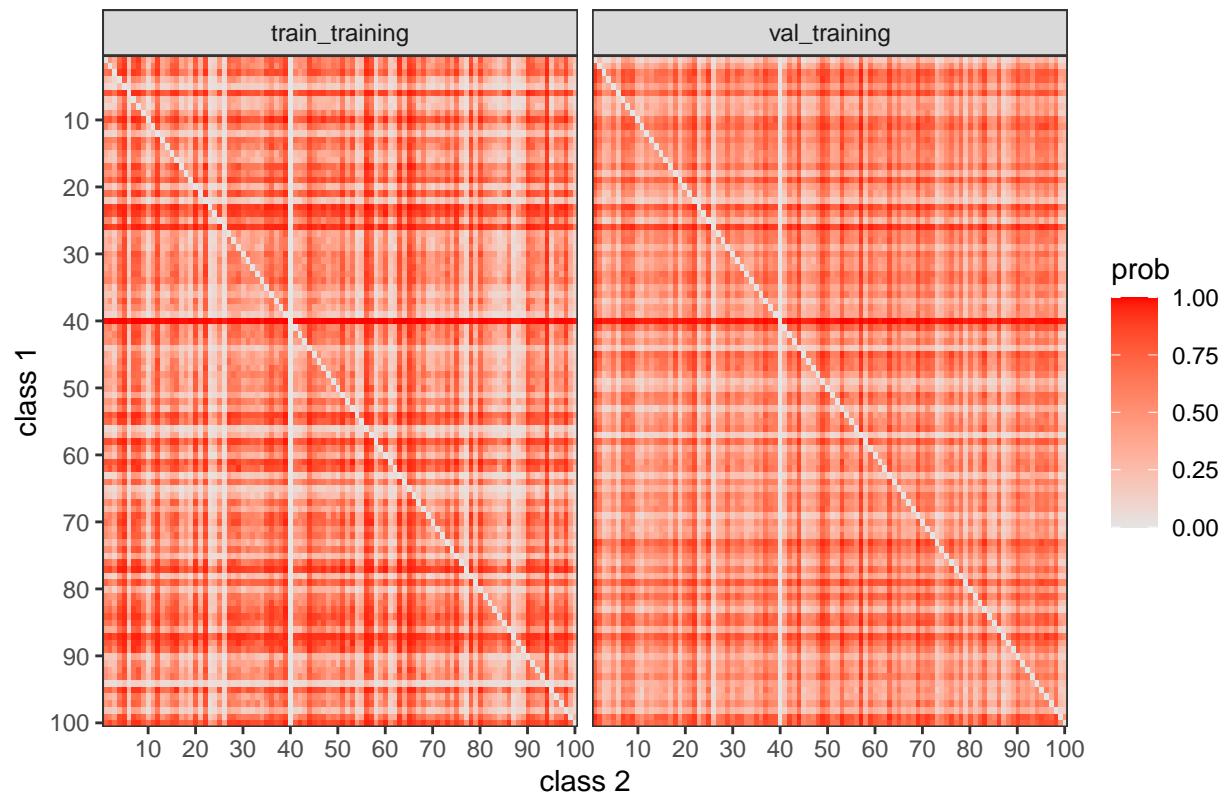
Pairwise probabilities – class 38



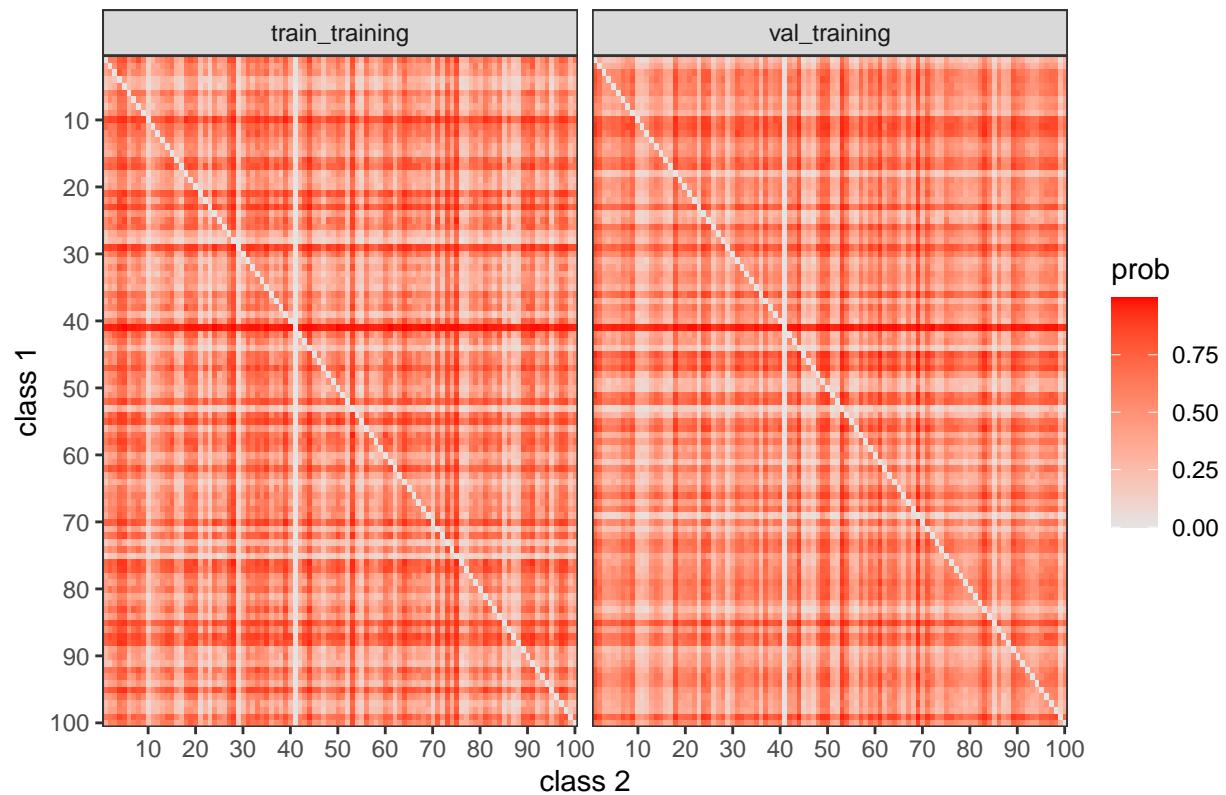
Pairwise probabilities – class 39



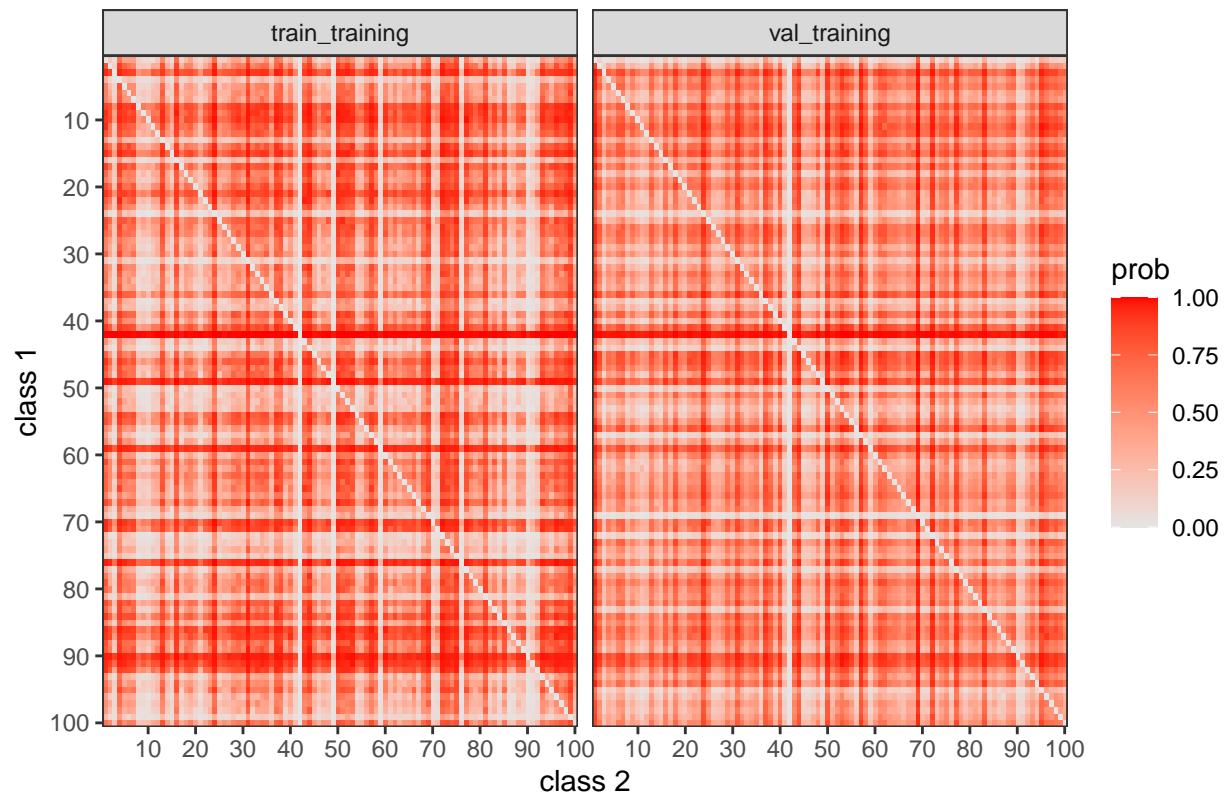
Pairwise probabilities – class 40



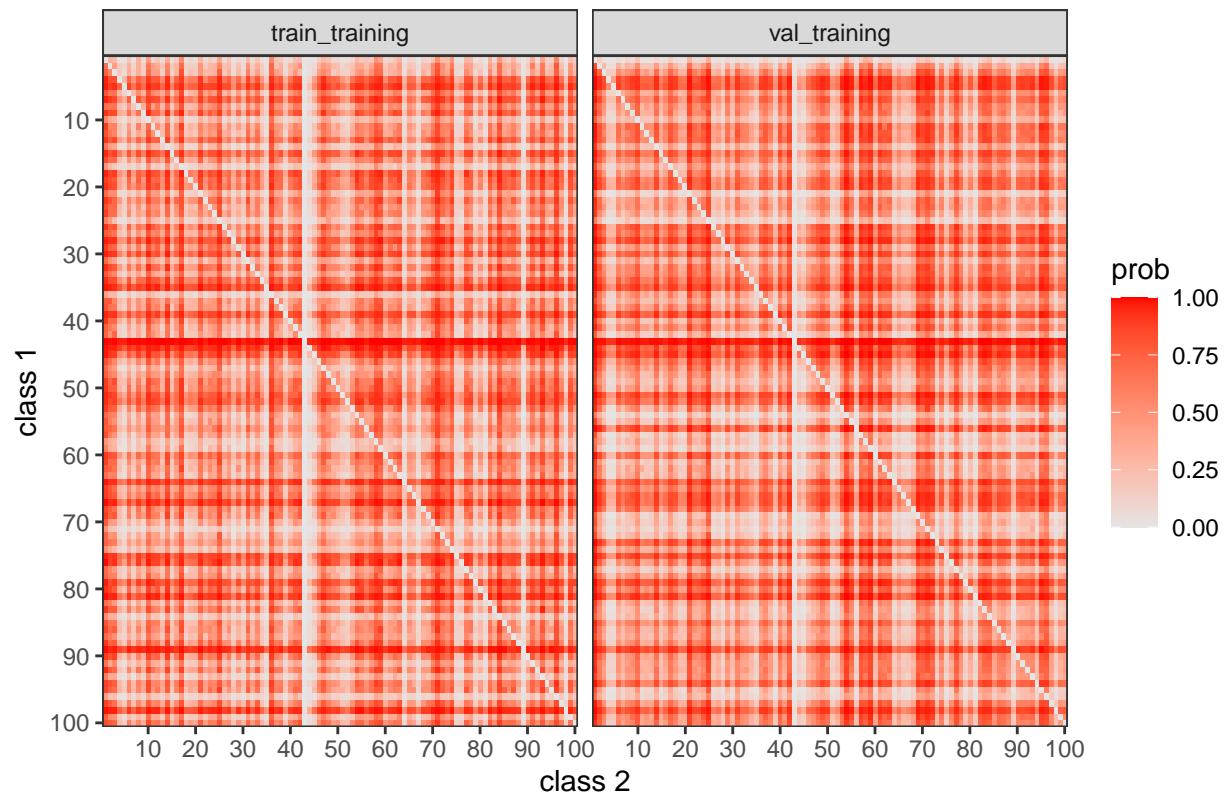
Pairwise probabilities – class 41



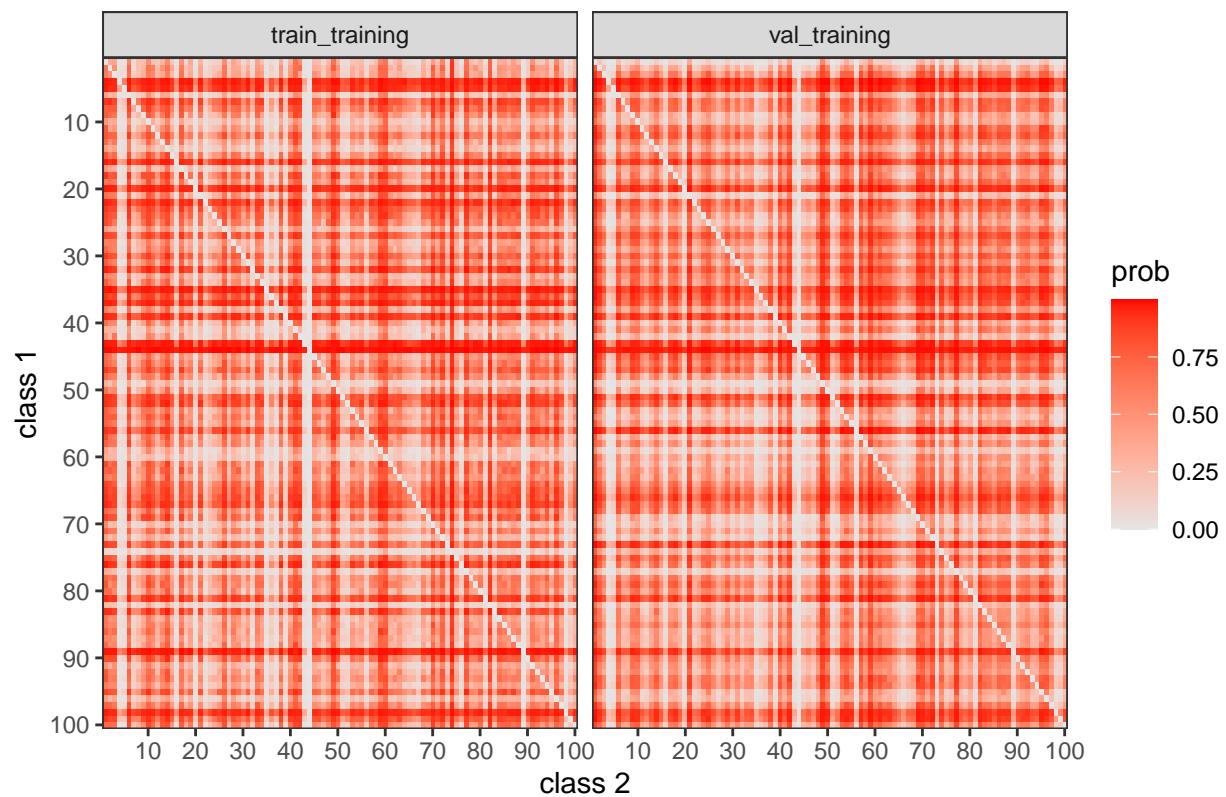
Pairwise probabilities – class 42



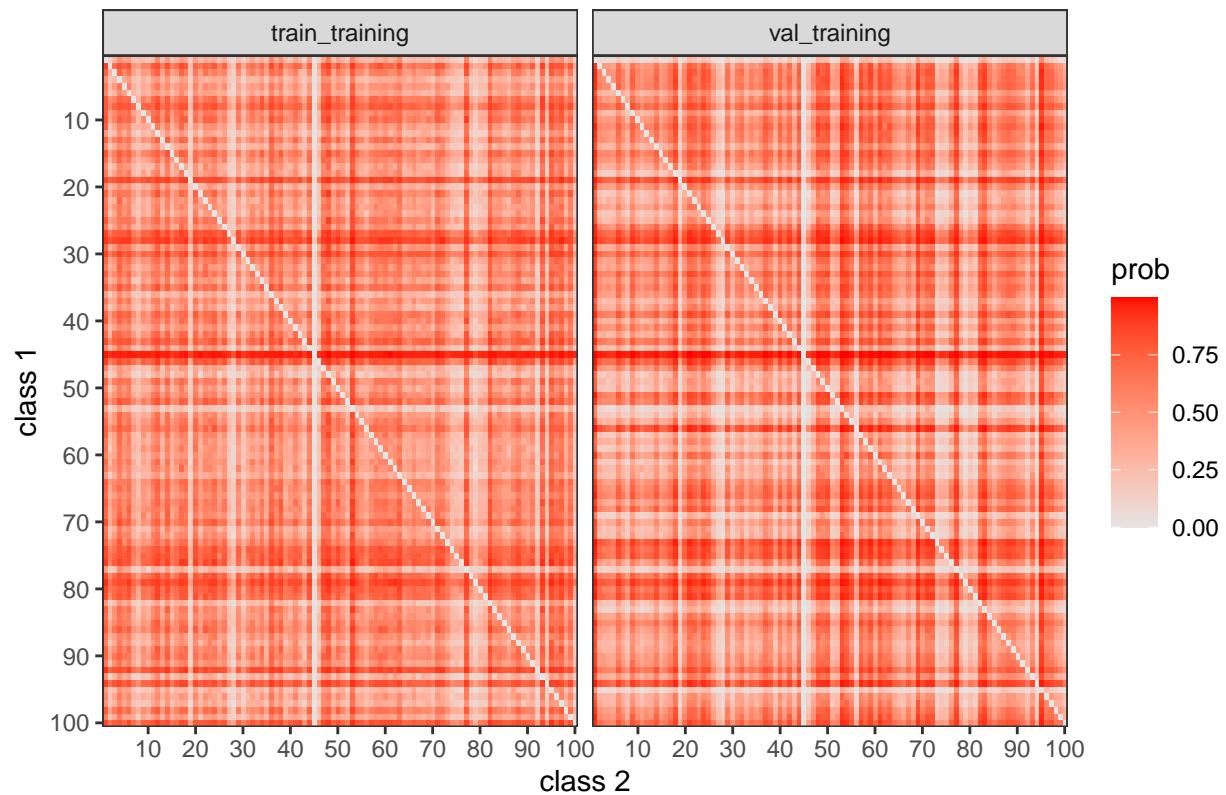
Pairwise probabilities – class 43



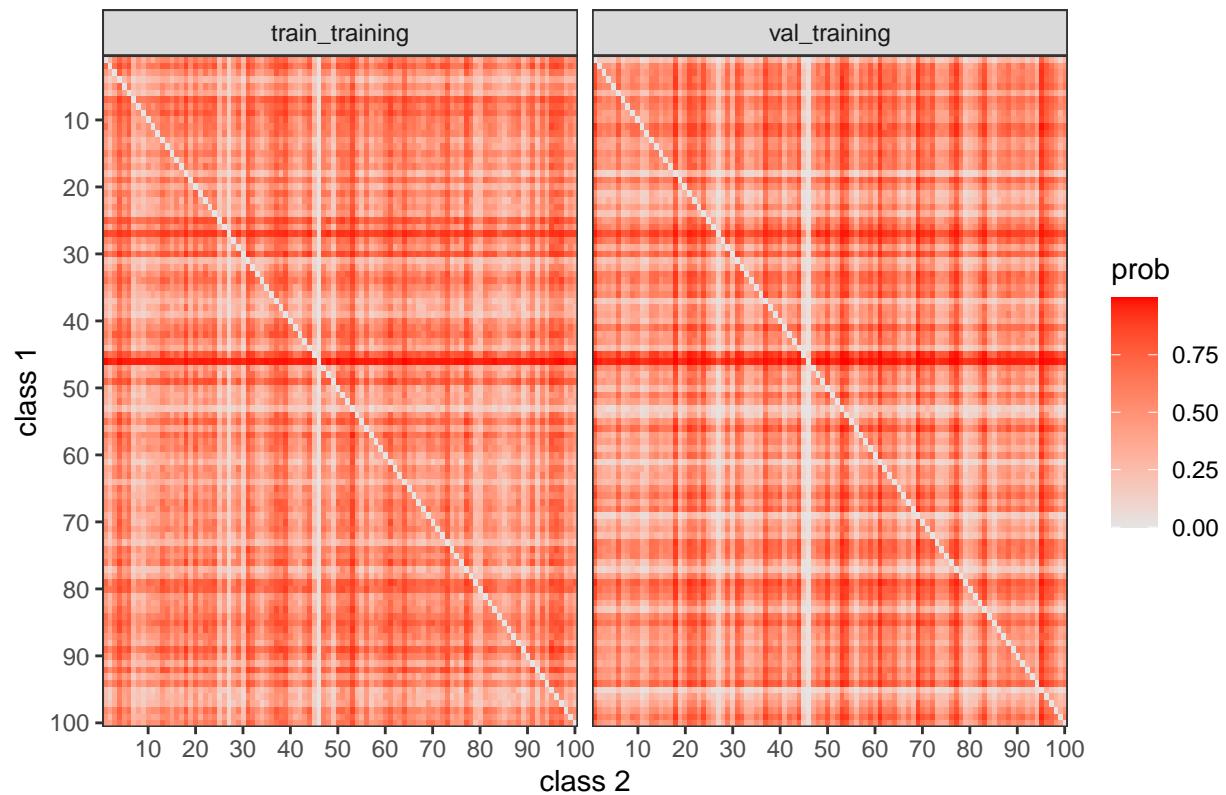
Pairwise probabilities – class 44



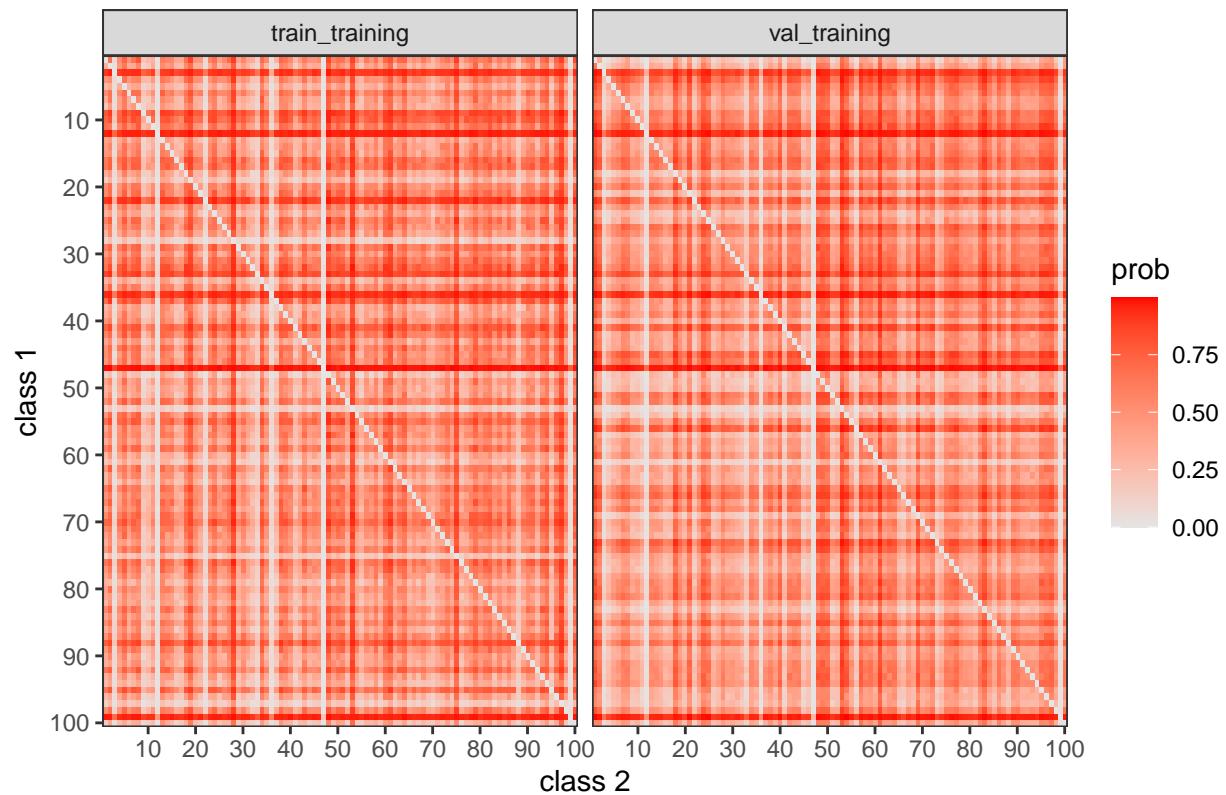
Pairwise probabilities – class 45



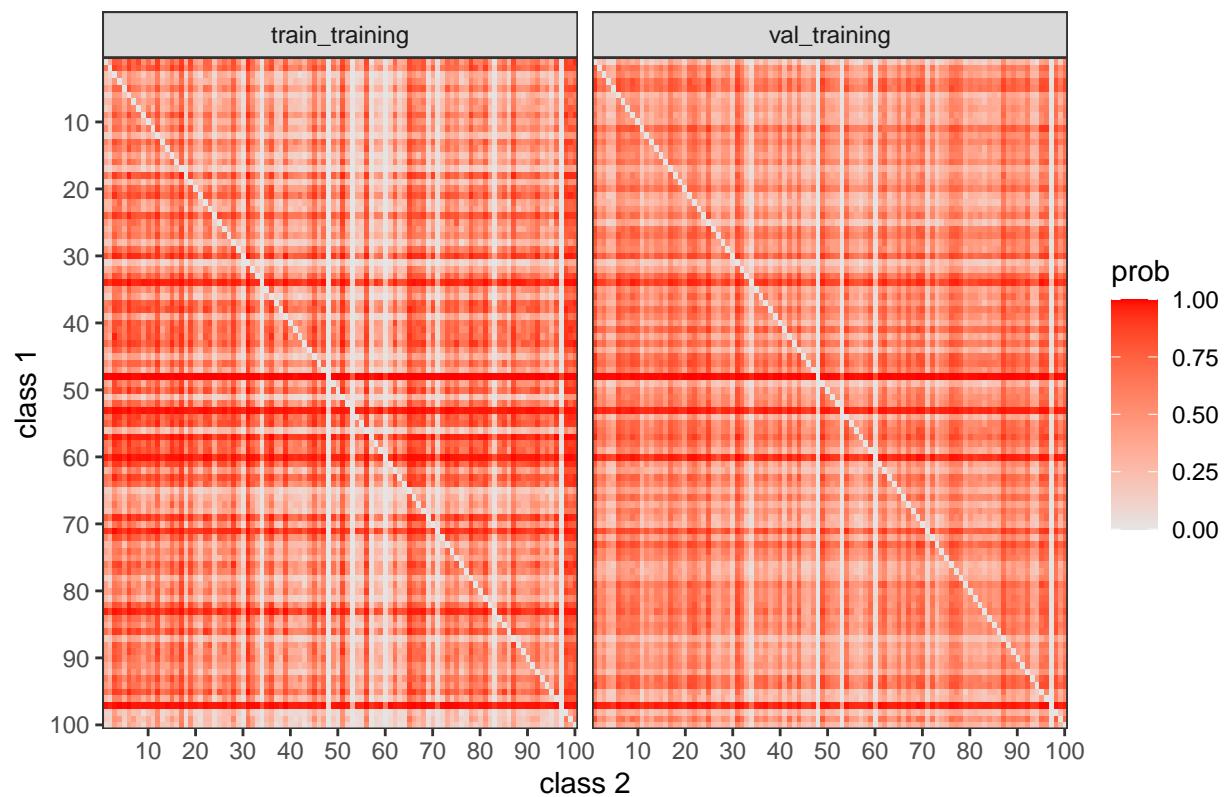
Pairwise probabilities – class 46



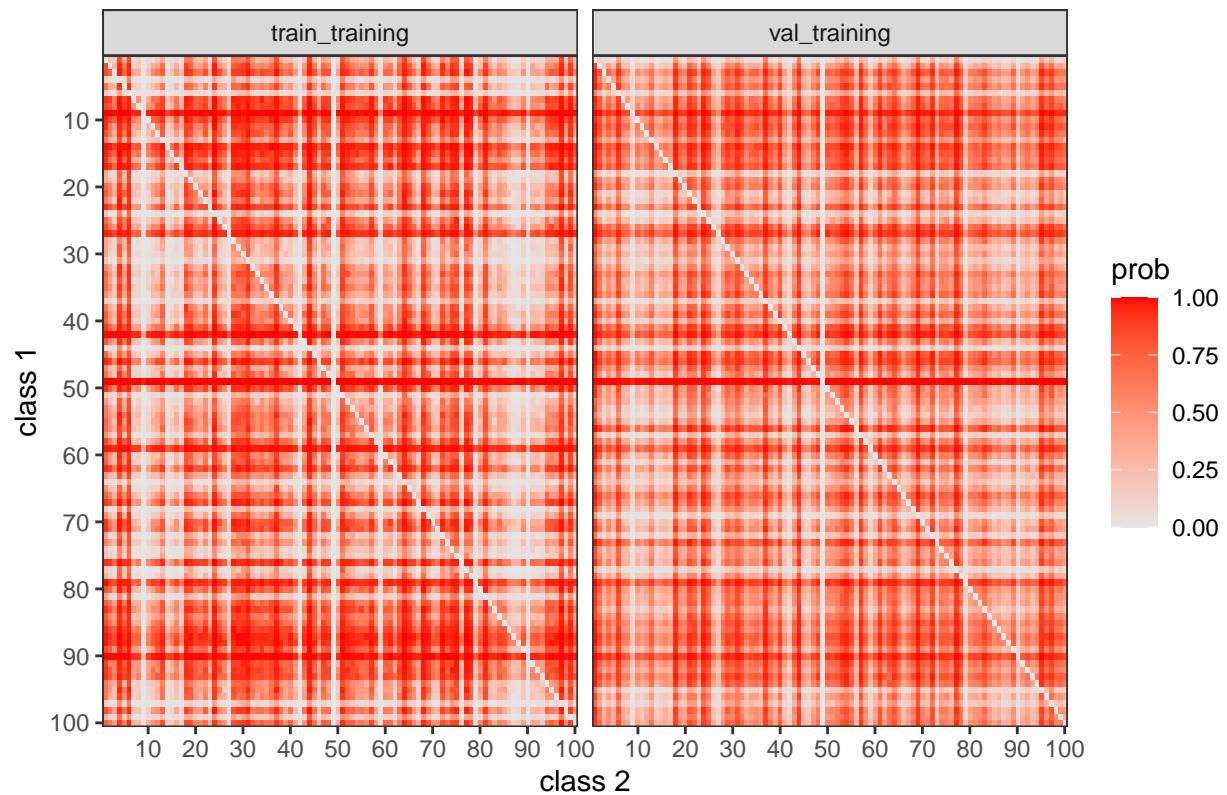
Pairwise probabilities – class 47



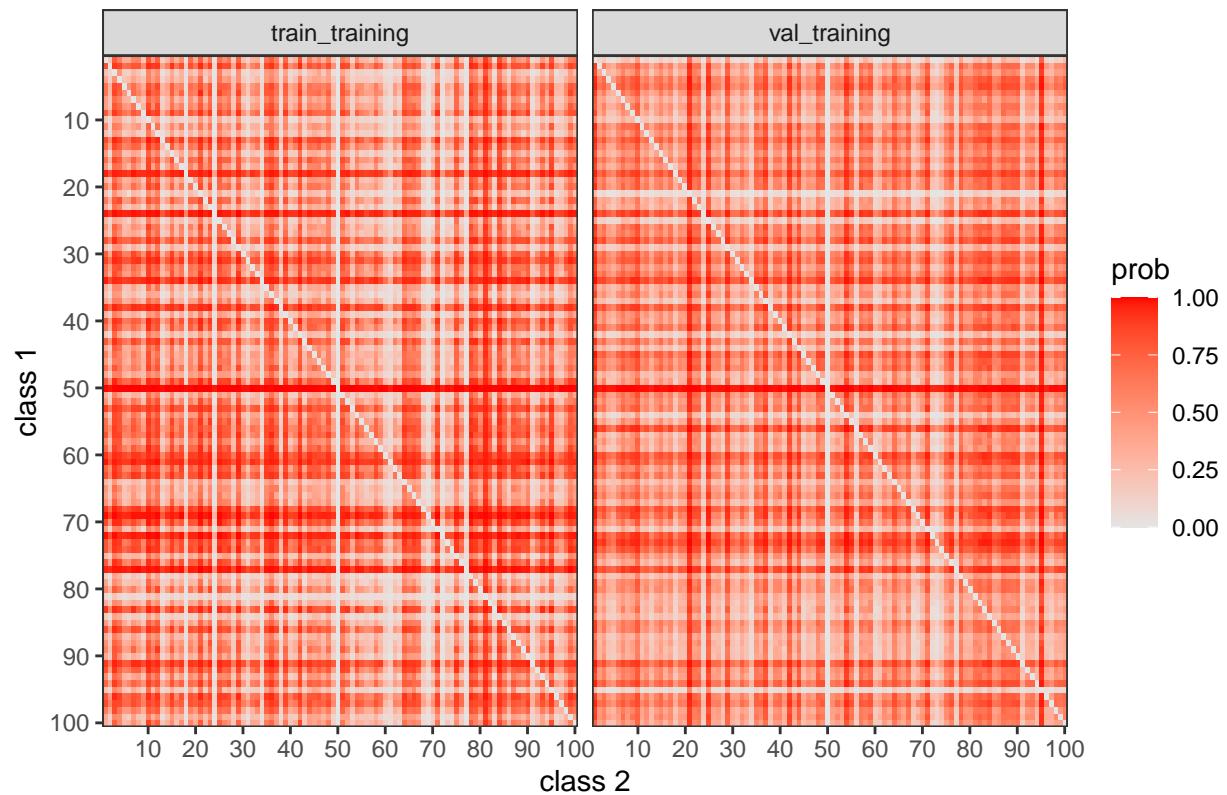
Pairwise probabilities – class 48



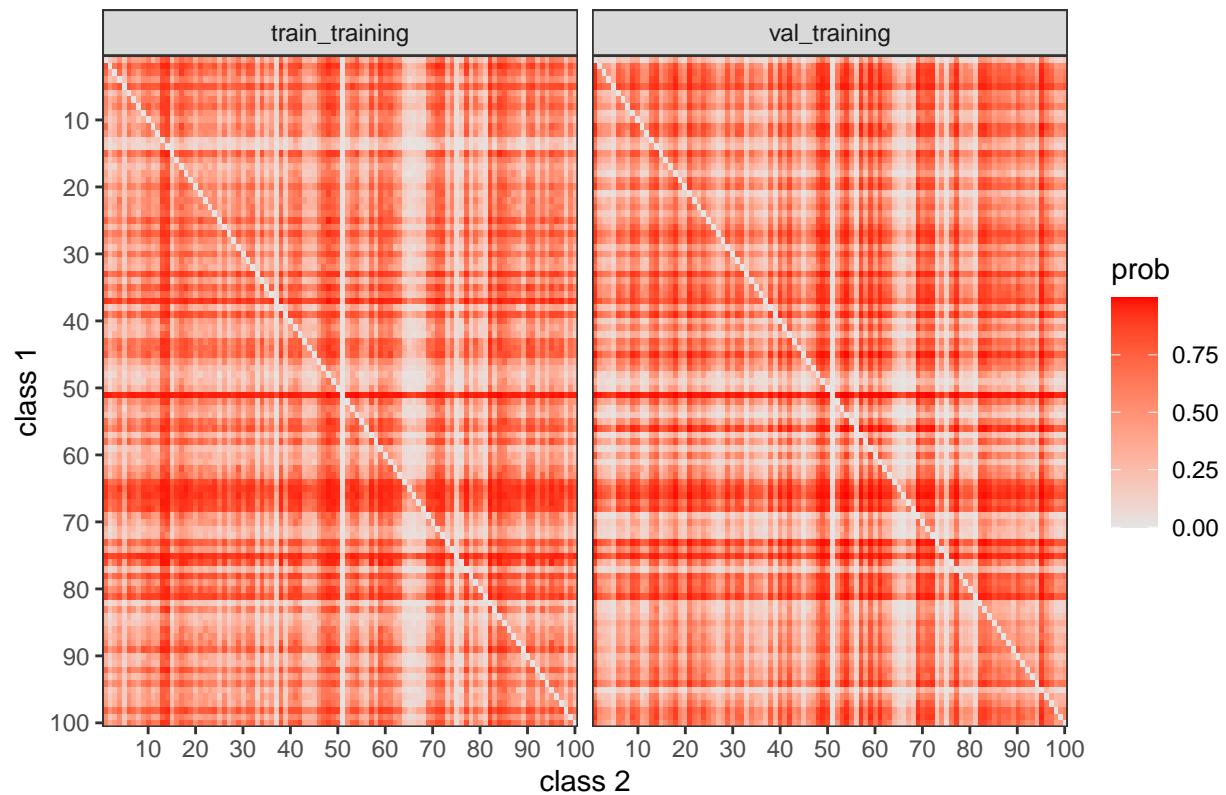
Pairwise probabilities – class 49



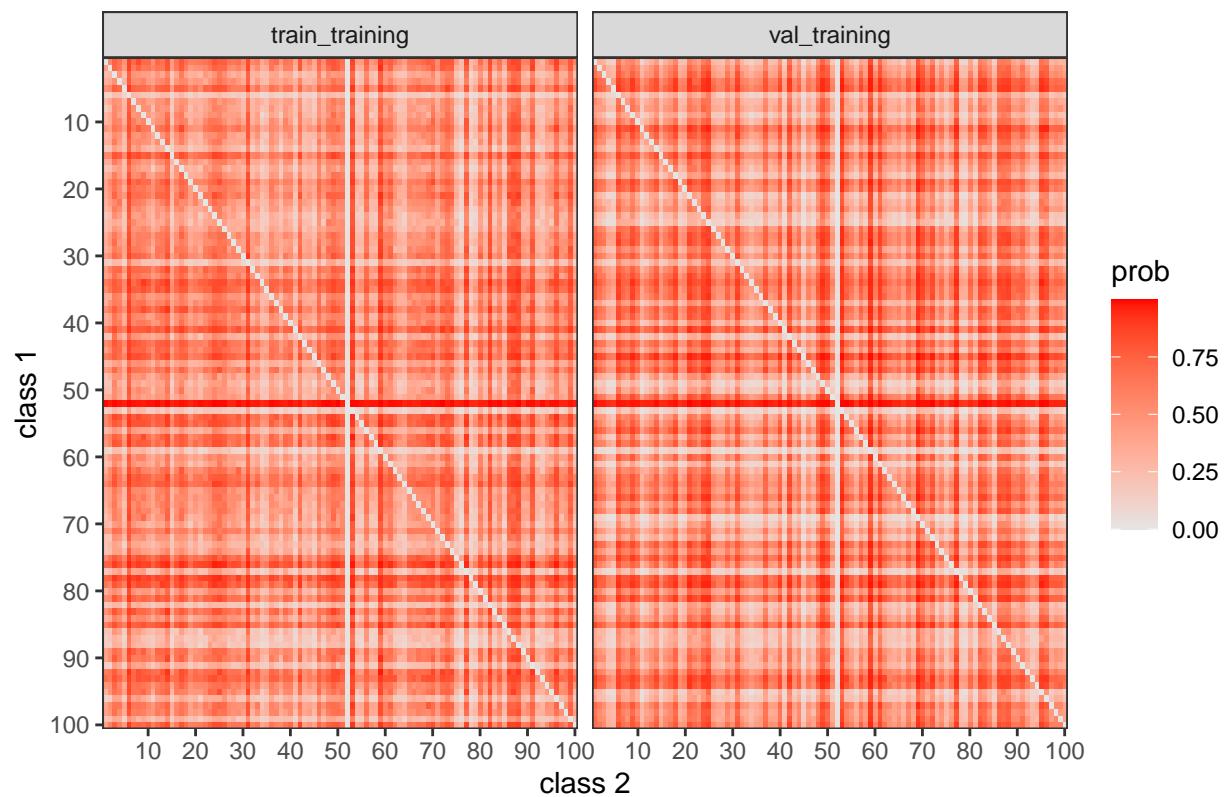
Pairwise probabilities – class 50



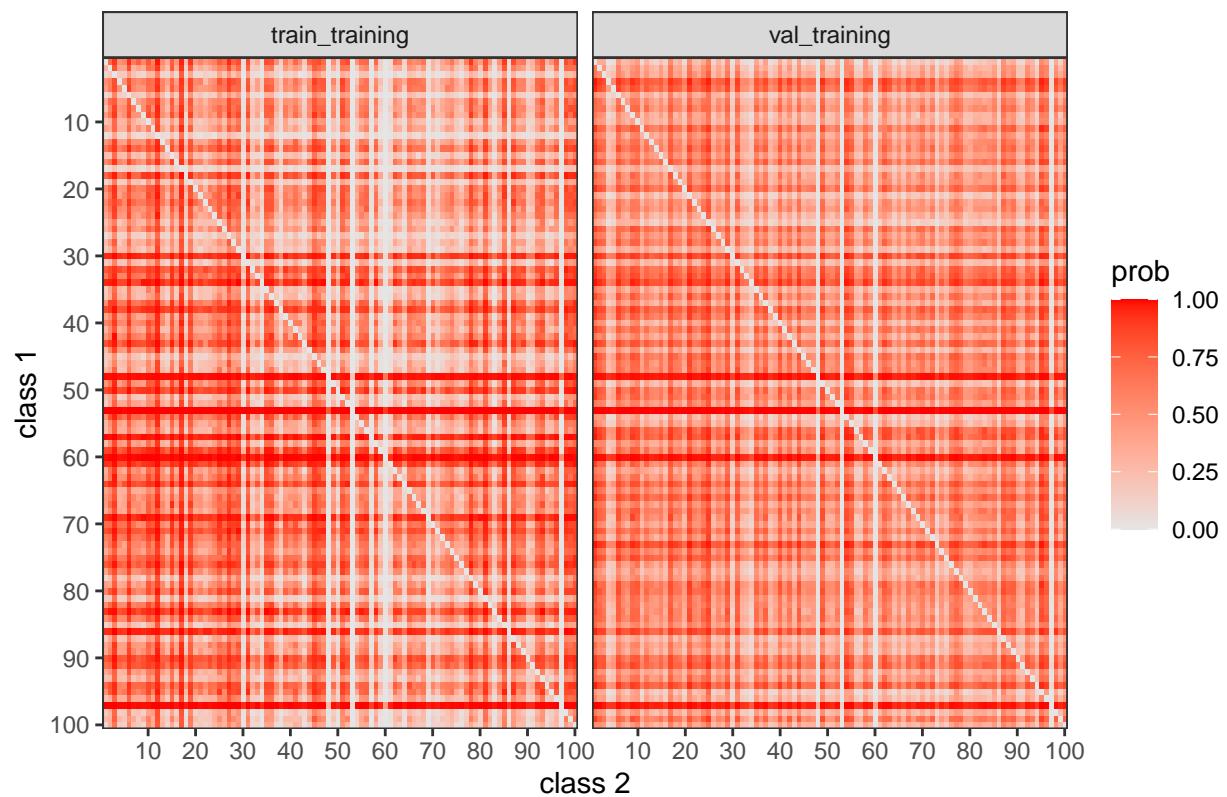
Pairwise probabilities – class 51



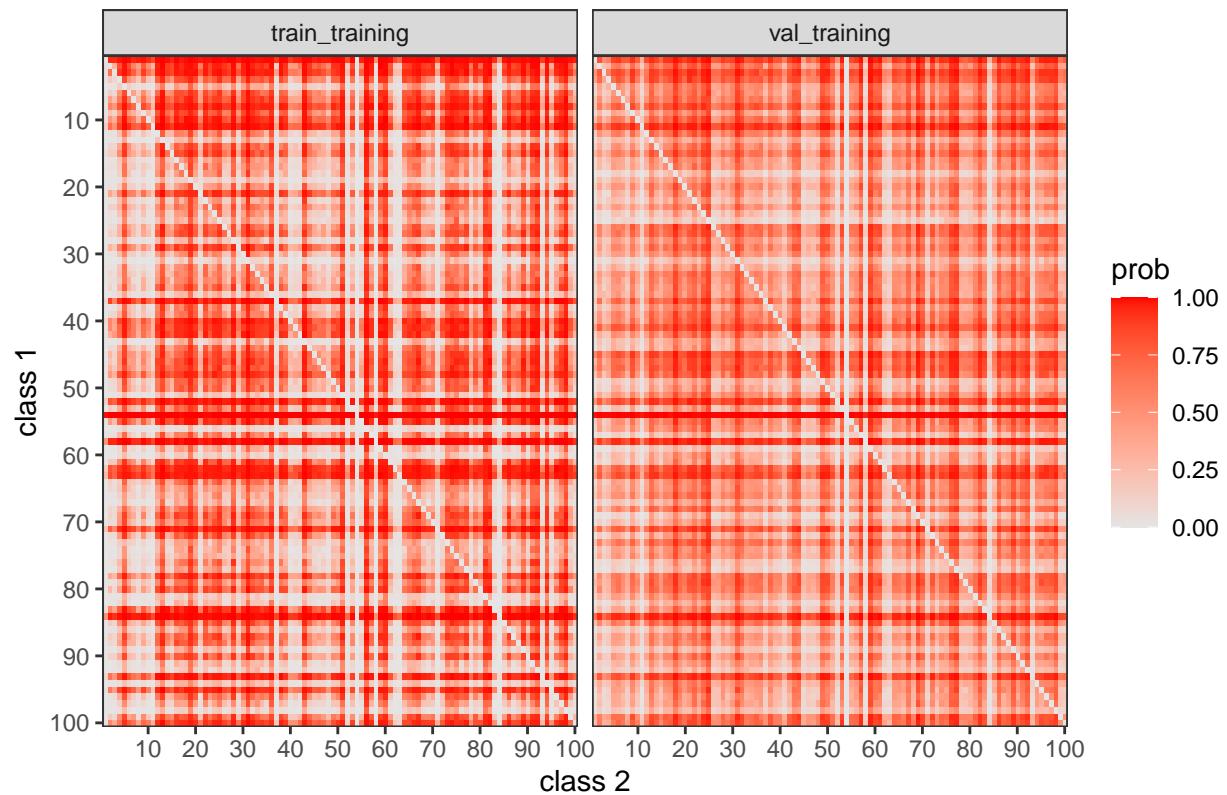
Pairwise probabilities – class 52



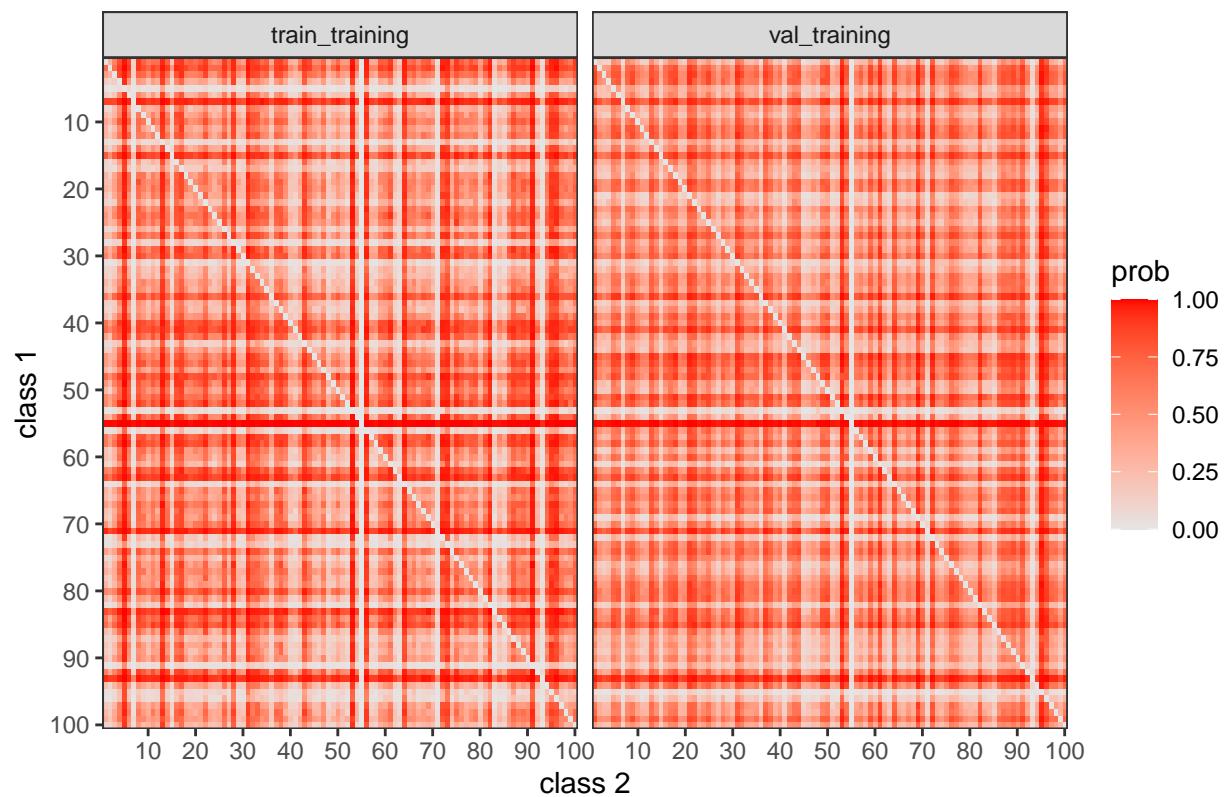
Pairwise probabilities – class 53



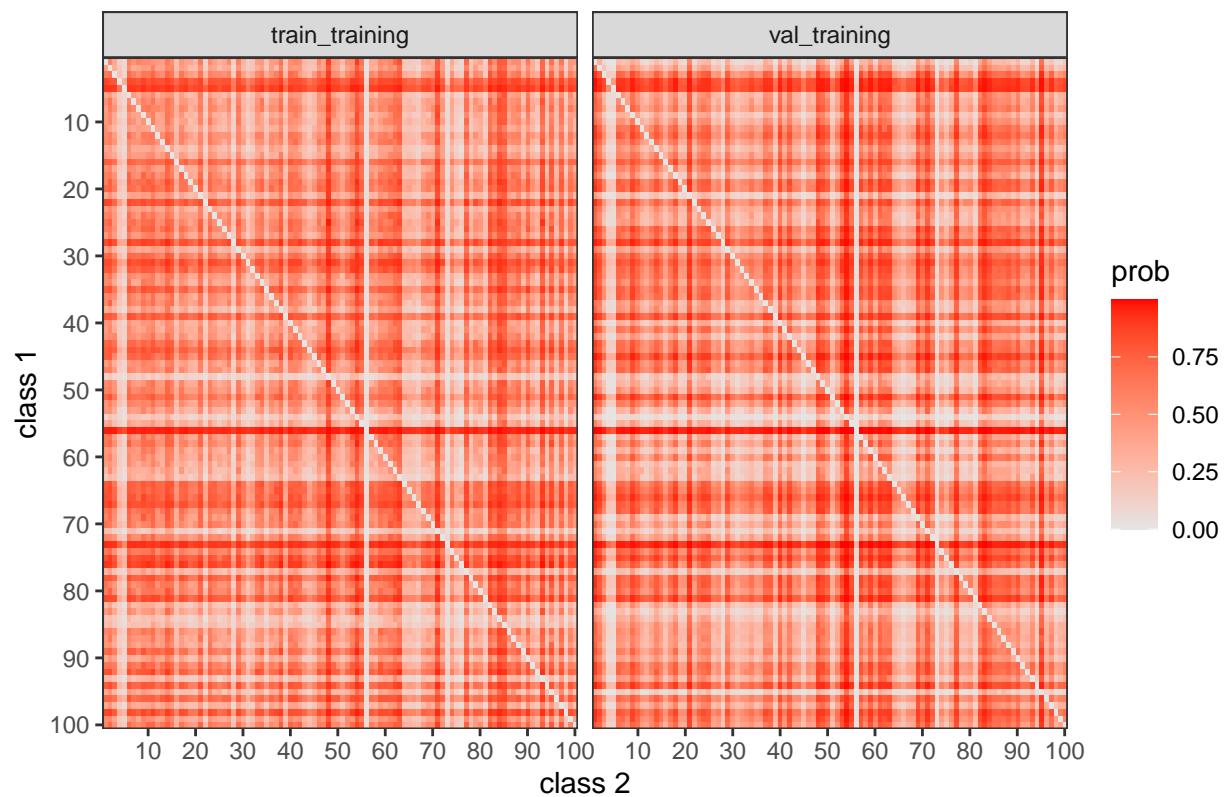
Pairwise probabilities – class 54



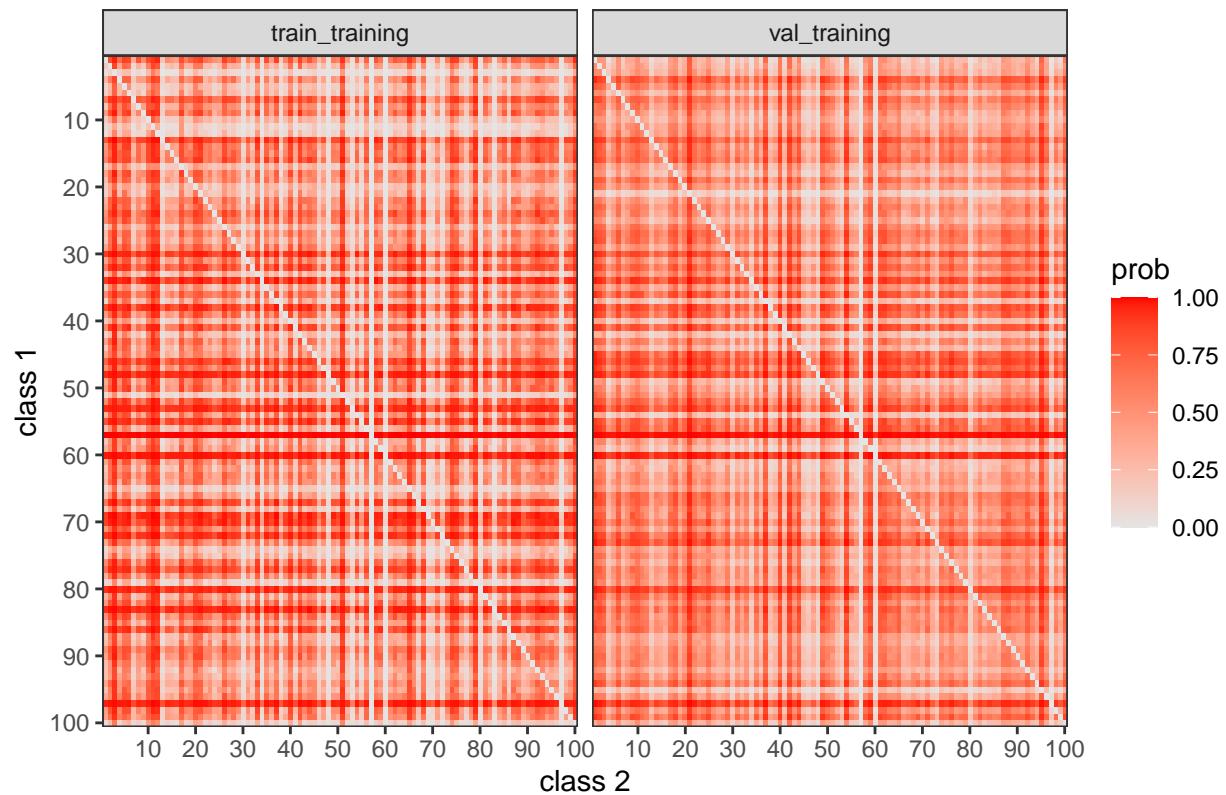
Pairwise probabilities – class 55



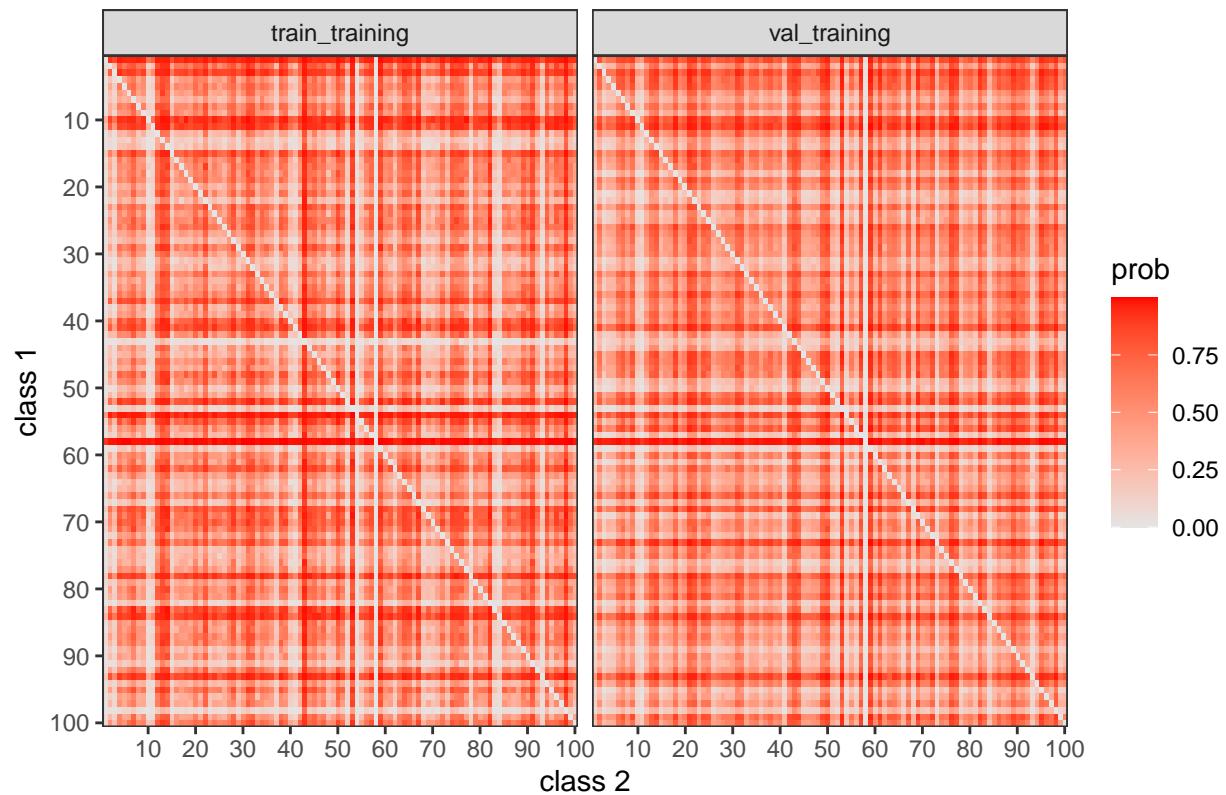
Pairwise probabilities – class 56



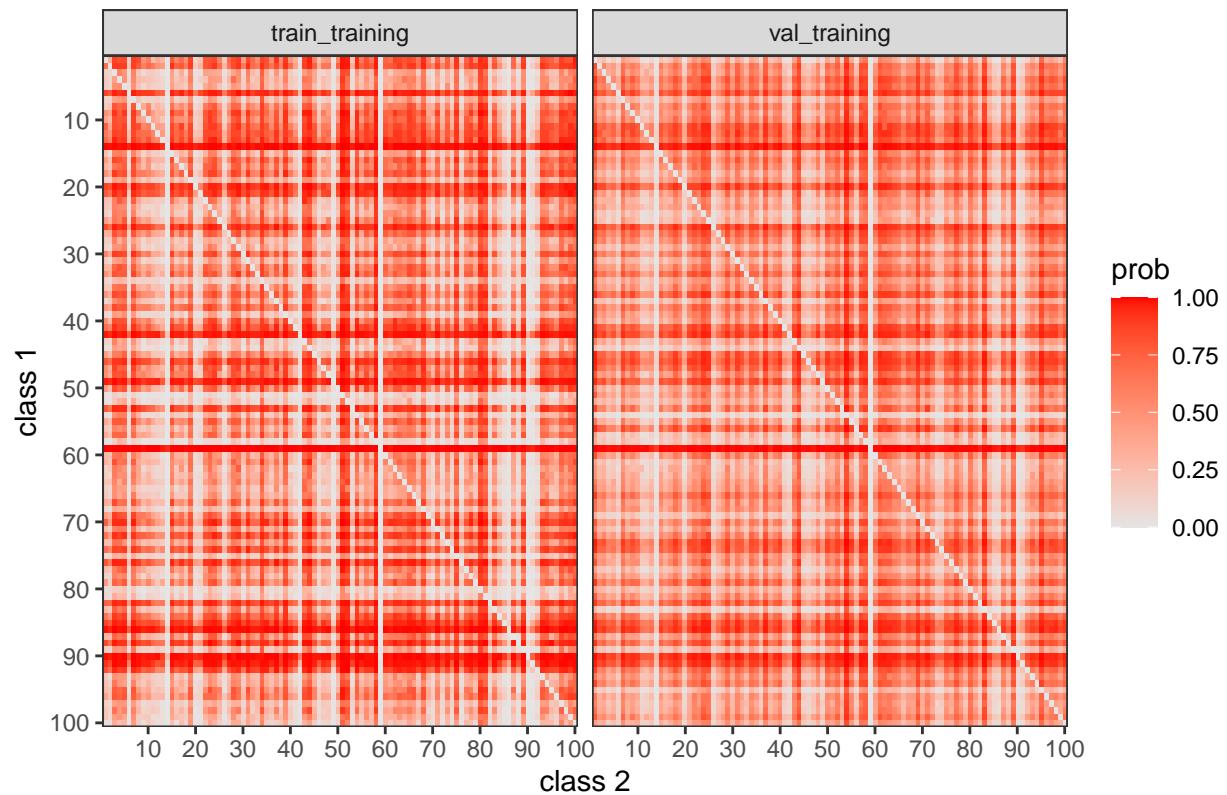
Pairwise probabilities – class 57



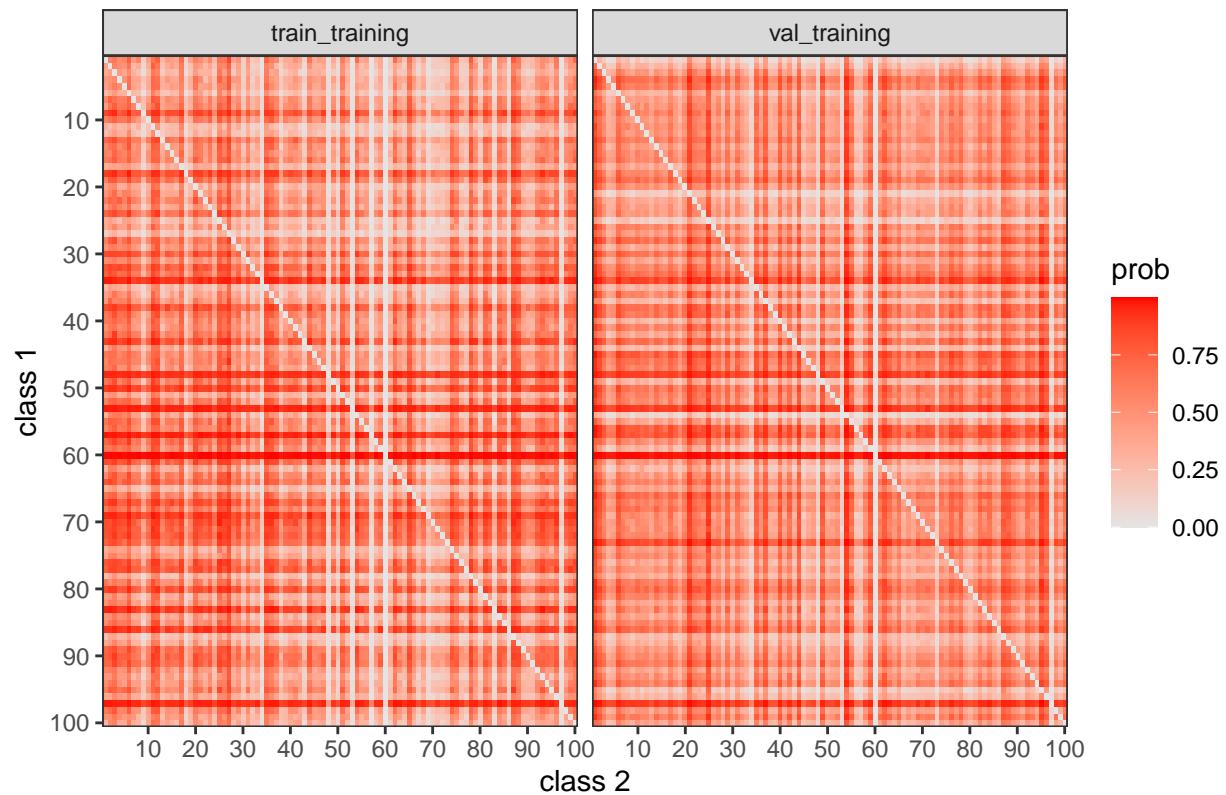
Pairwise probabilities – class 58



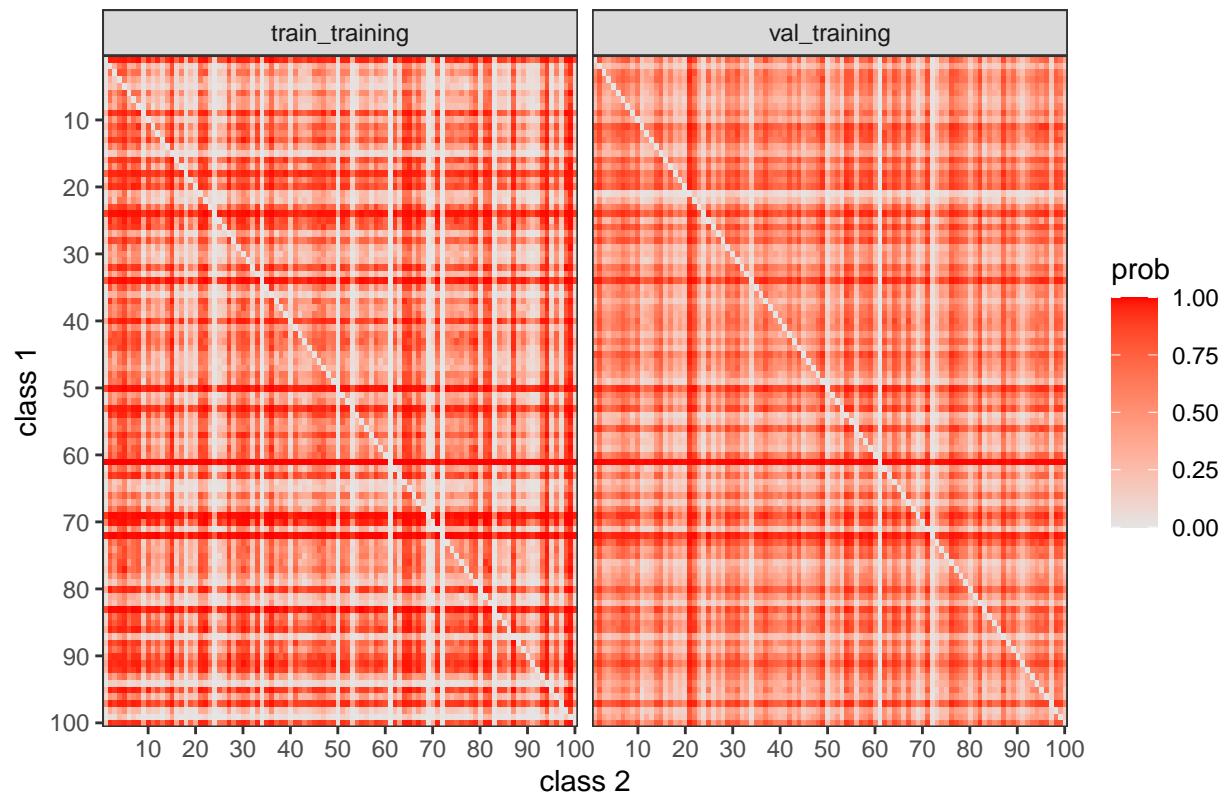
Pairwise probabilities – class 59



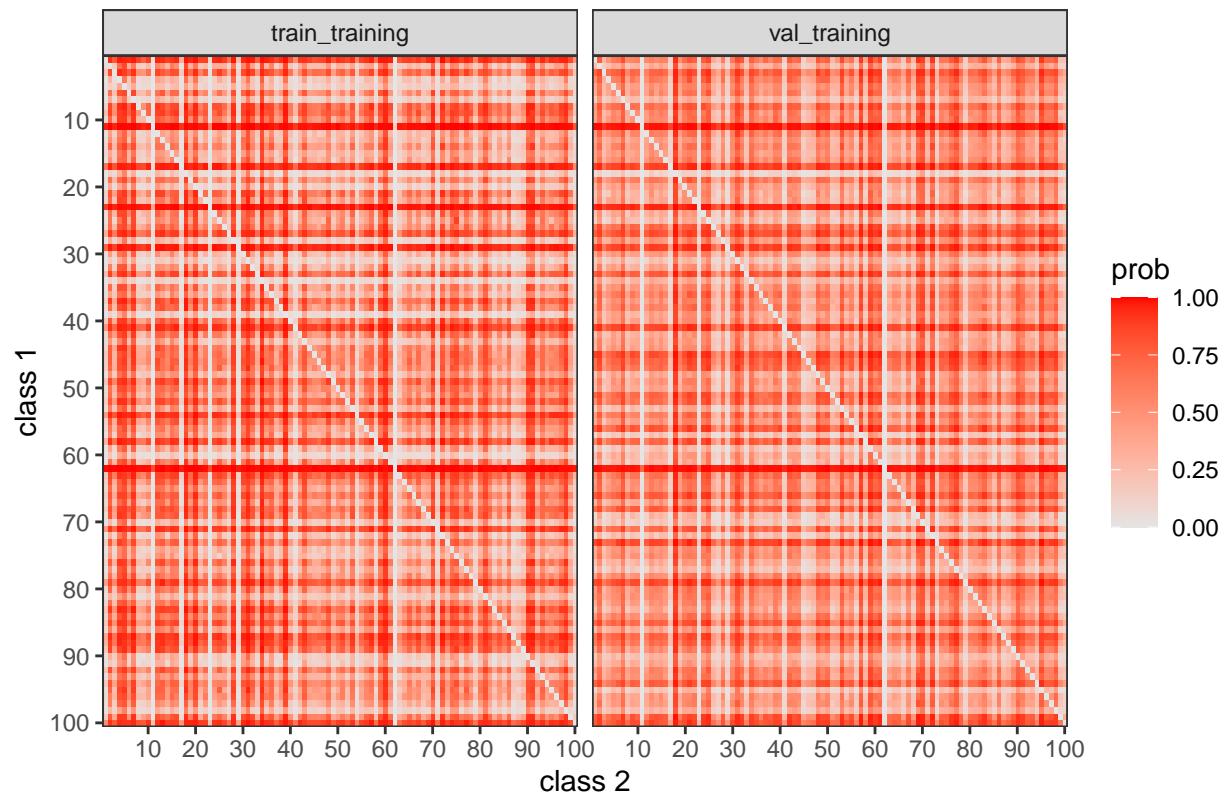
Pairwise probabilities – class 60



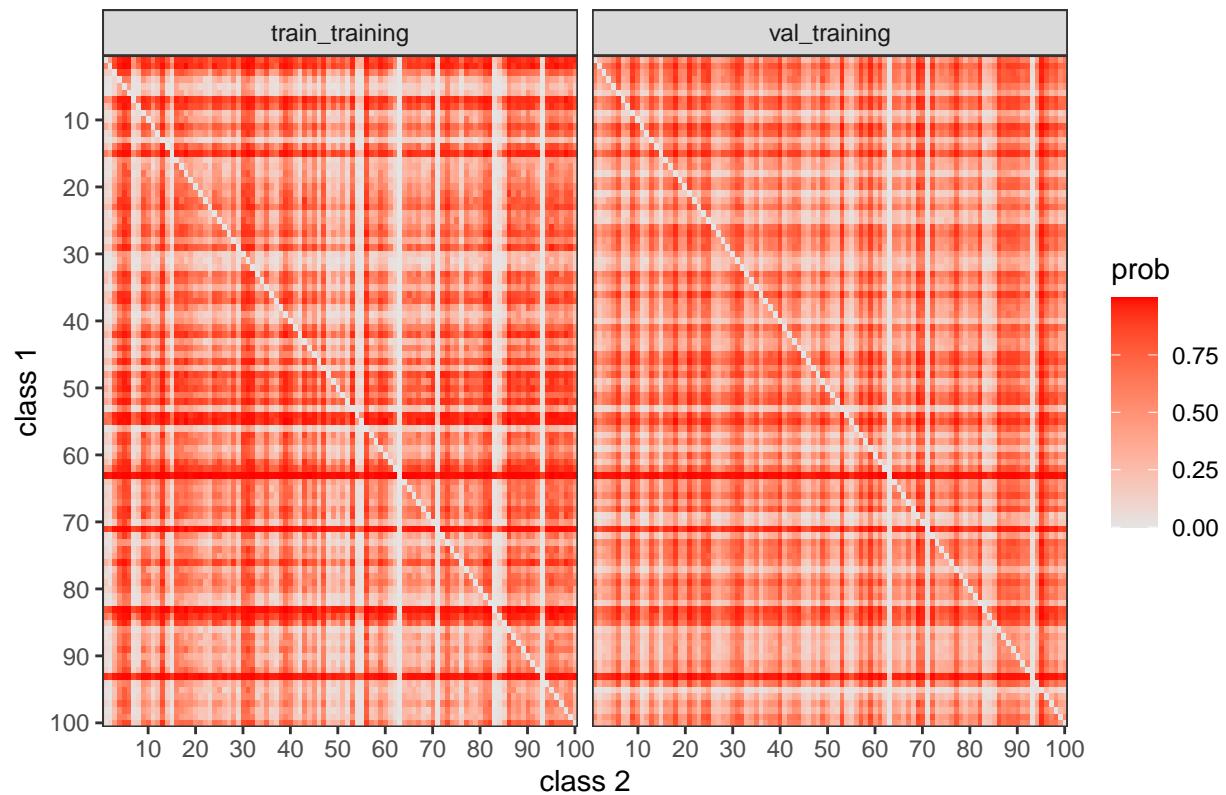
Pairwise probabilities – class 61



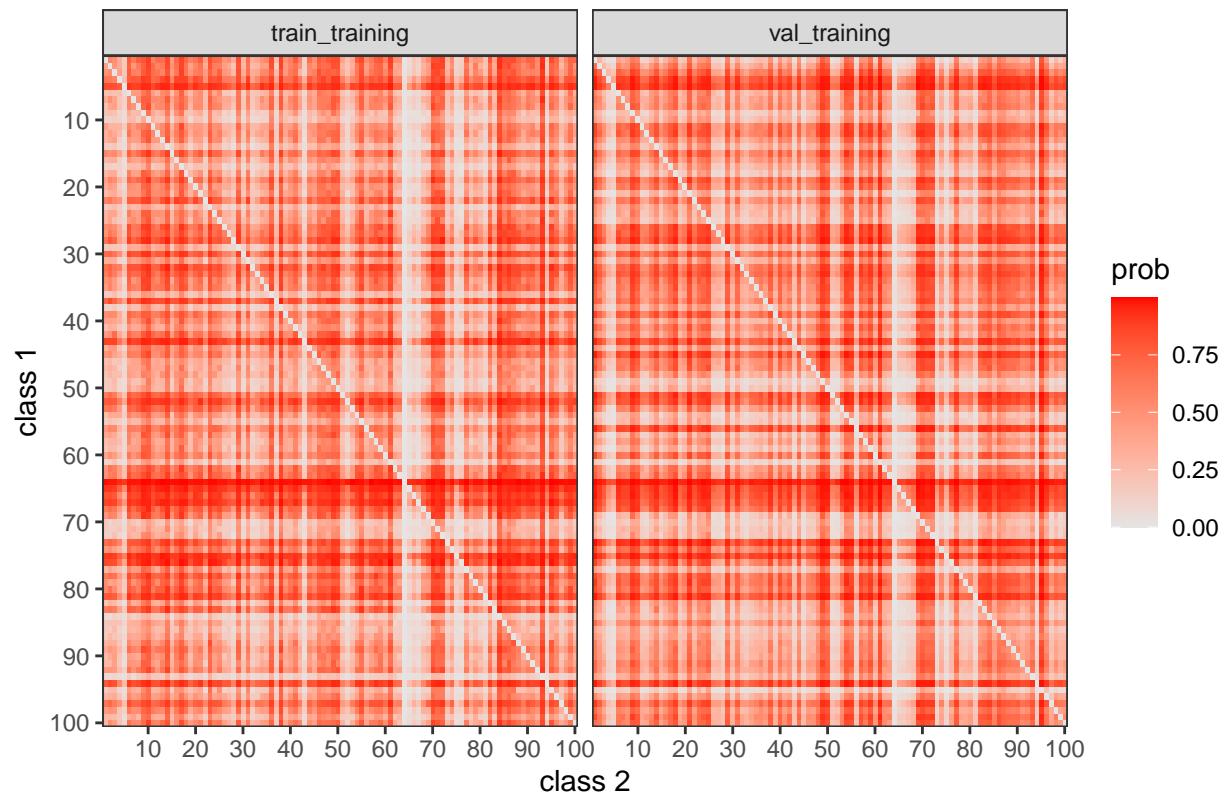
Pairwise probabilities – class 62



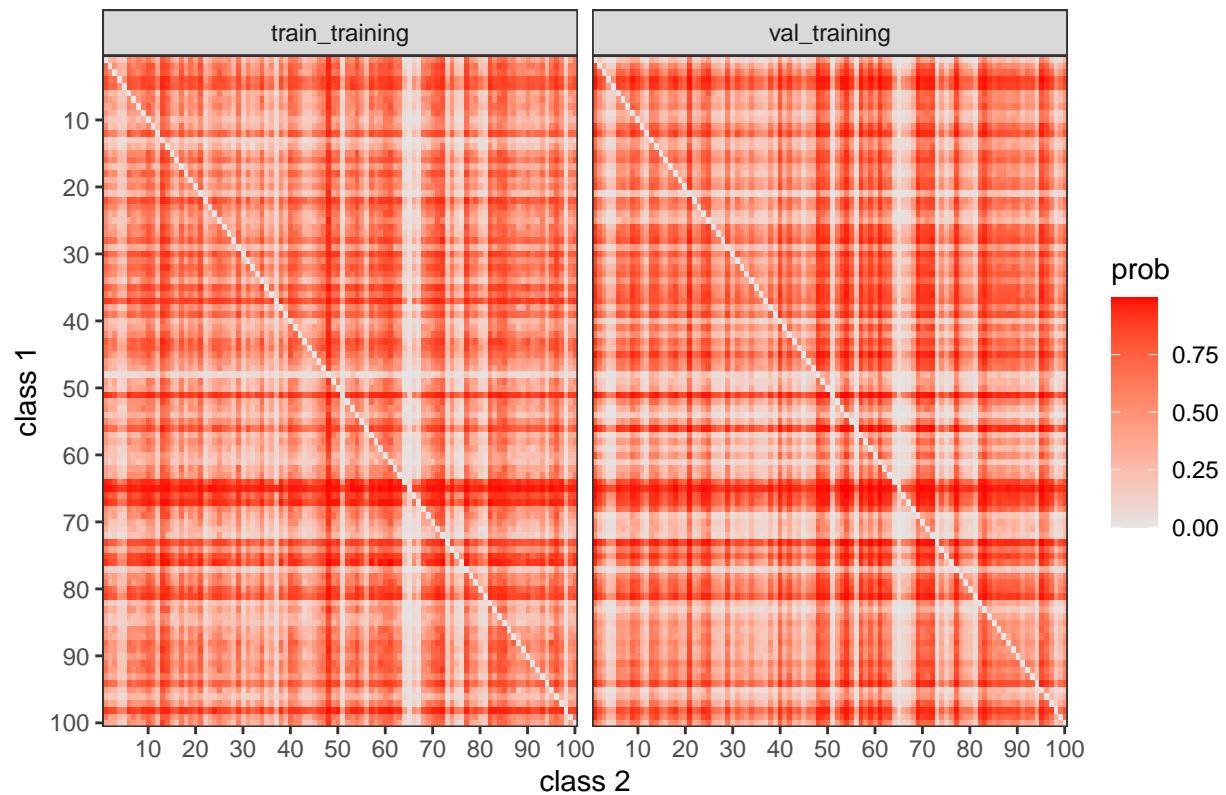
Pairwise probabilities – class 63



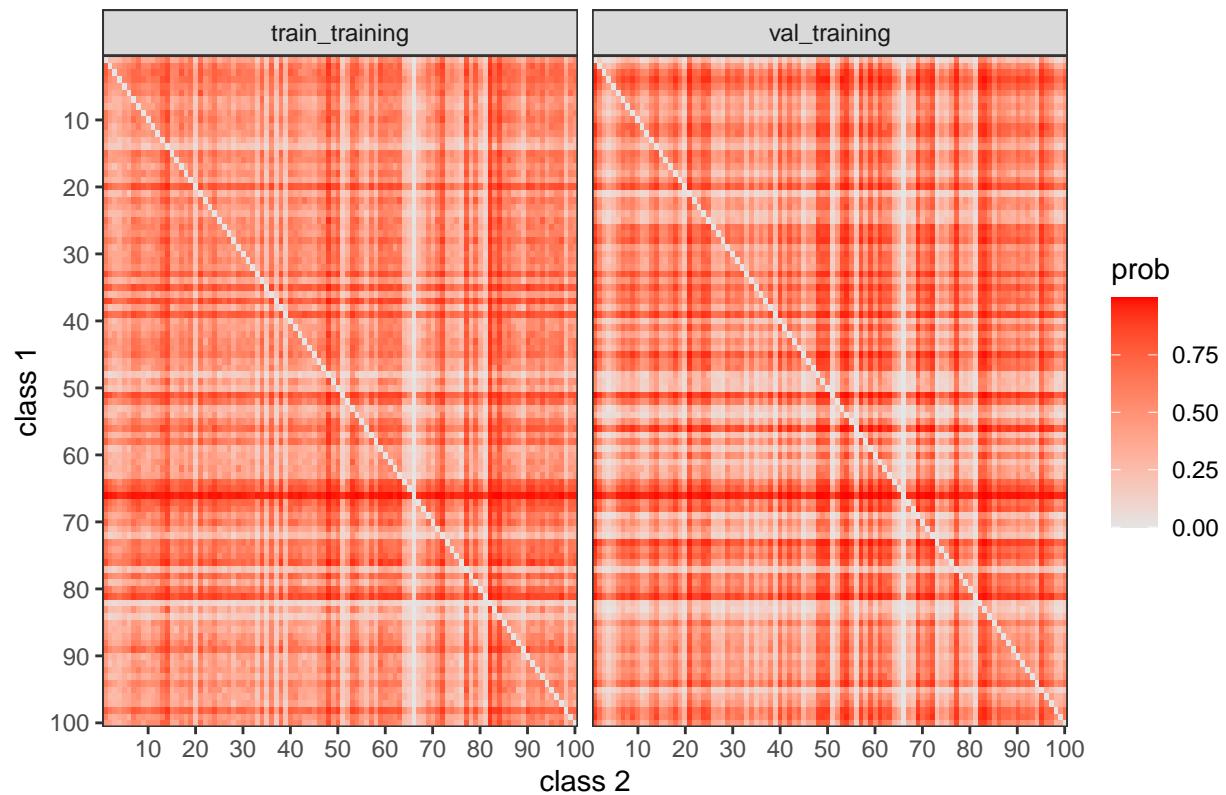
Pairwise probabilities – class 64



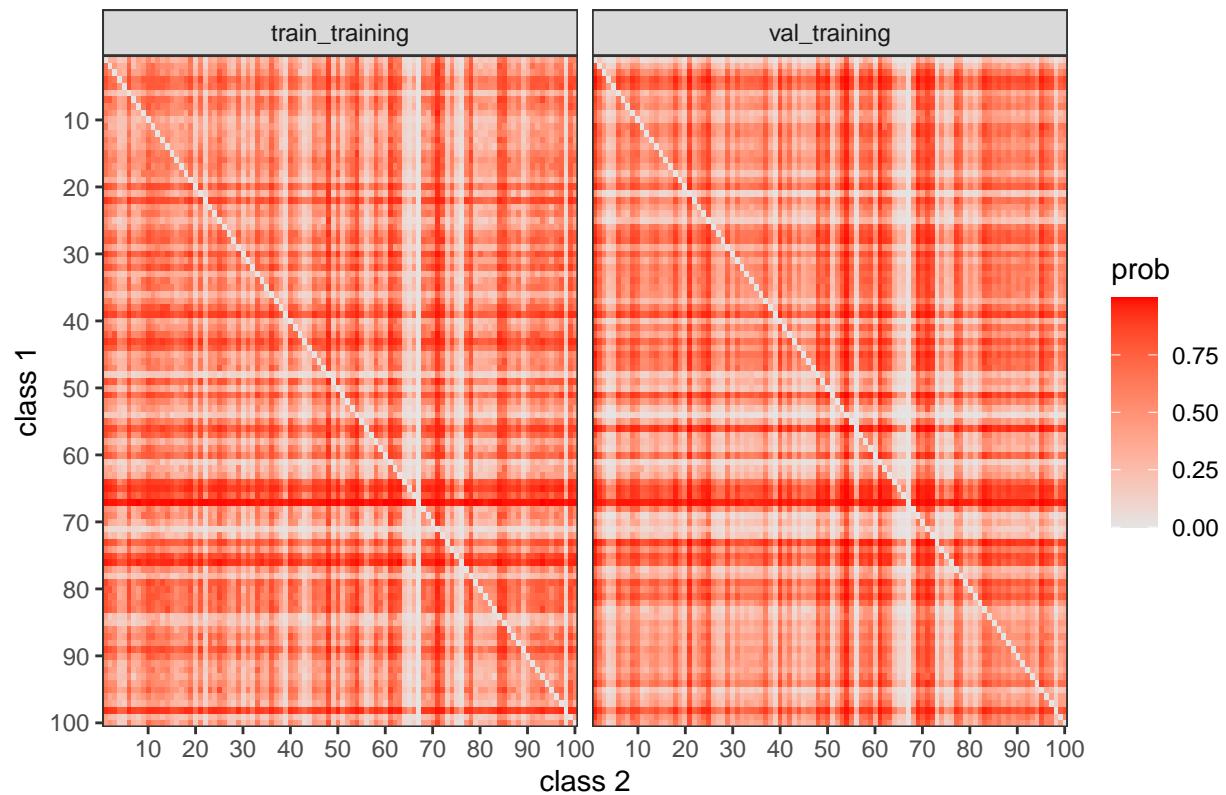
Pairwise probabilities – class 65



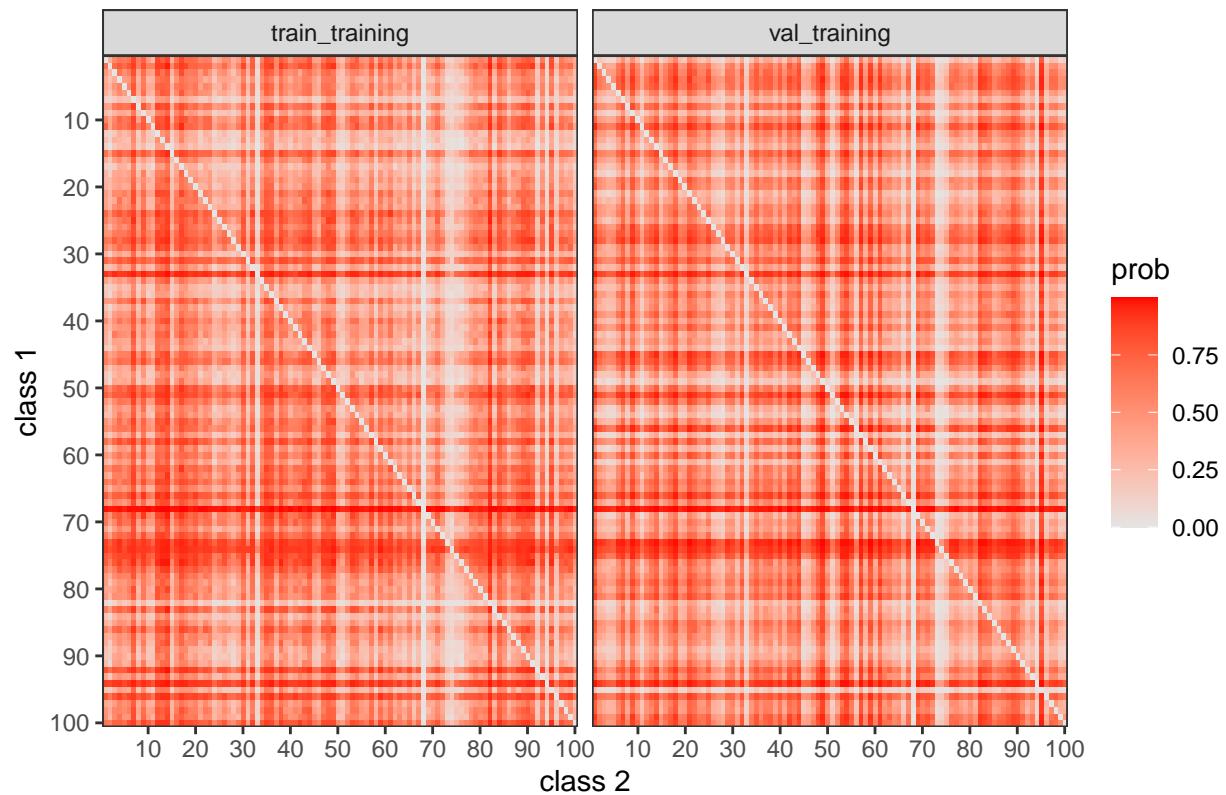
Pairwise probabilities – class 66



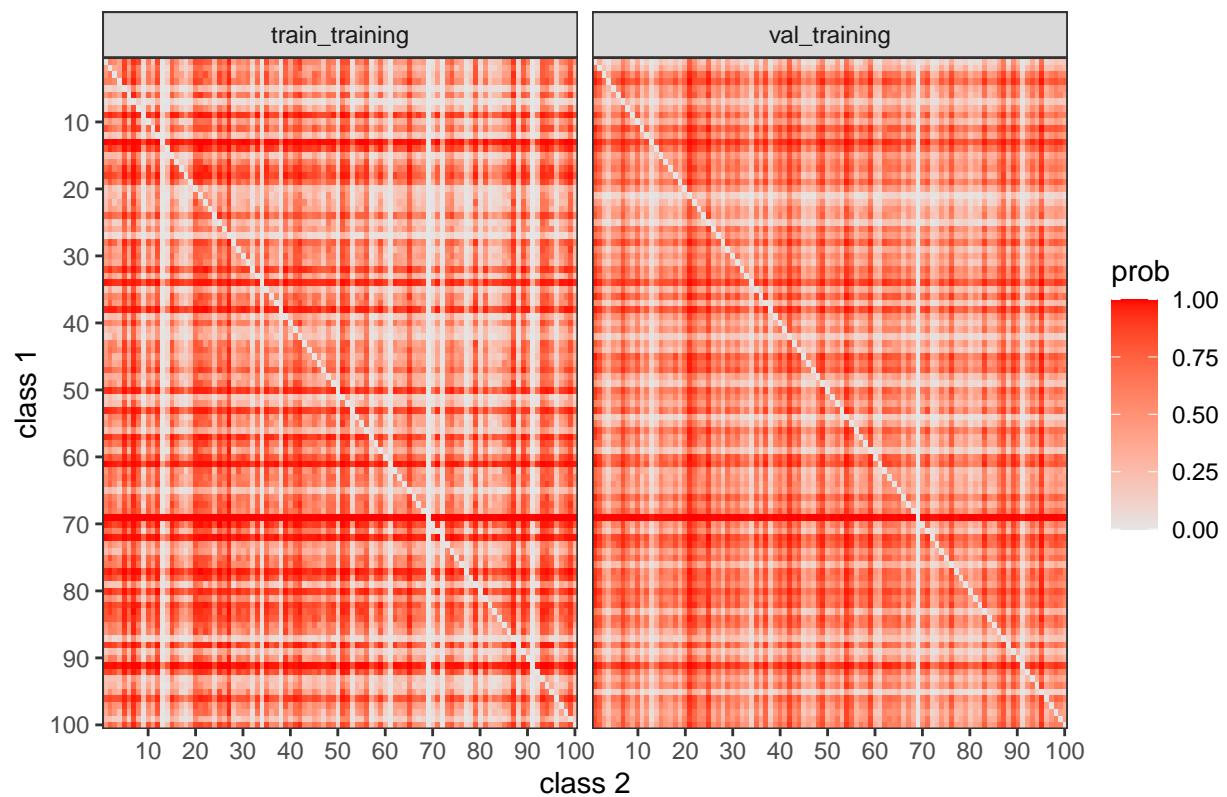
Pairwise probabilities – class 67



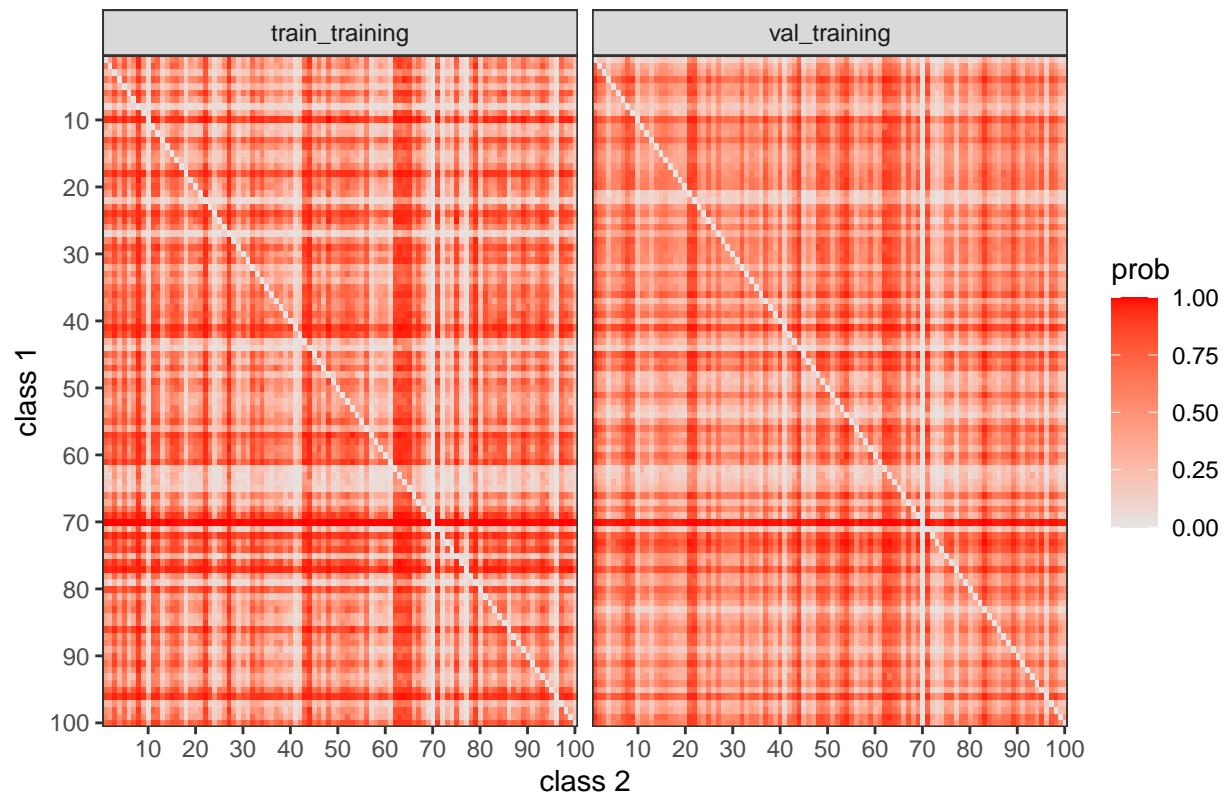
Pairwise probabilities – class 68



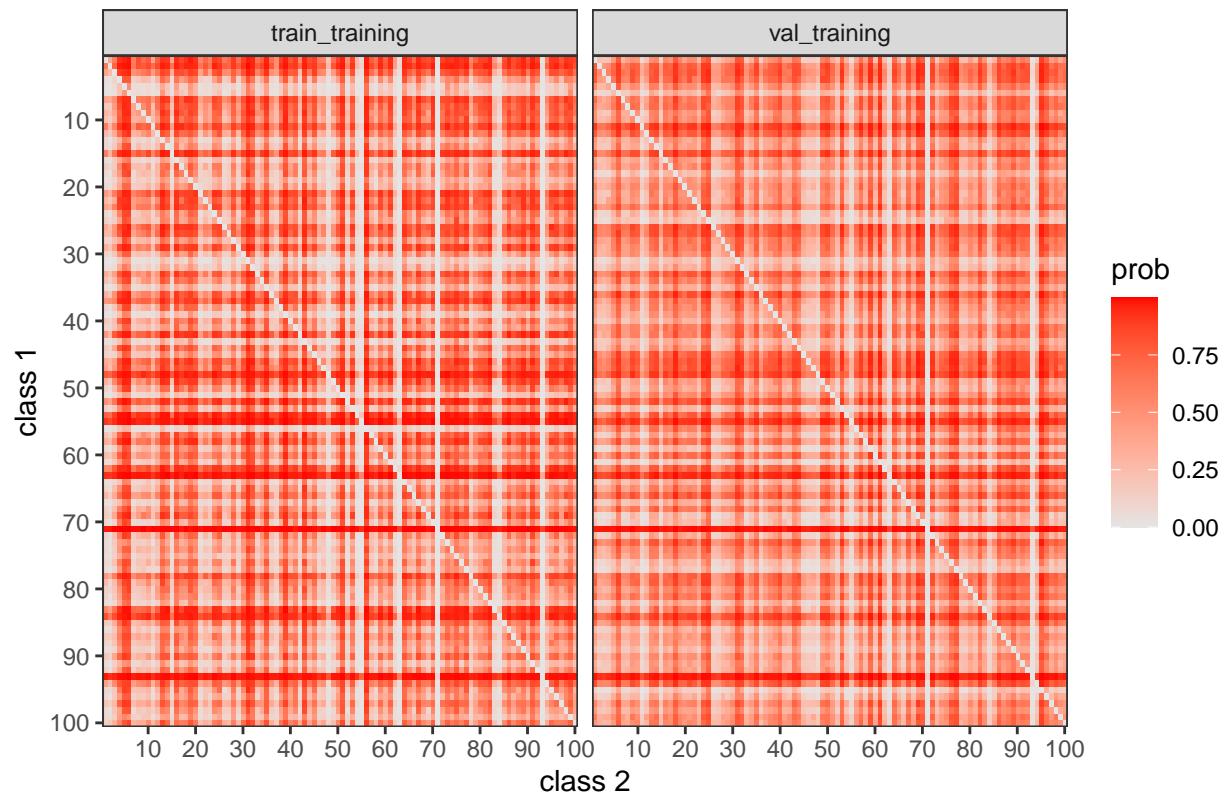
Pairwise probabilities – class 69



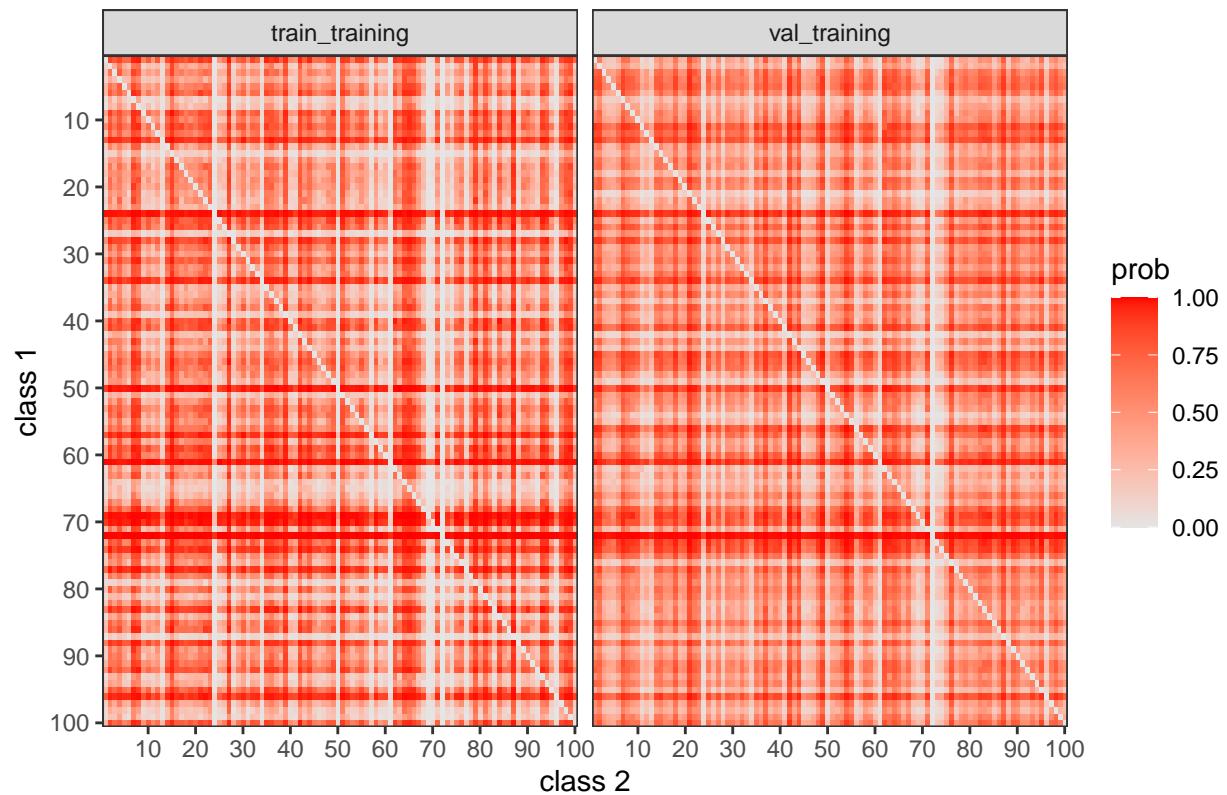
Pairwise probabilities – class 70



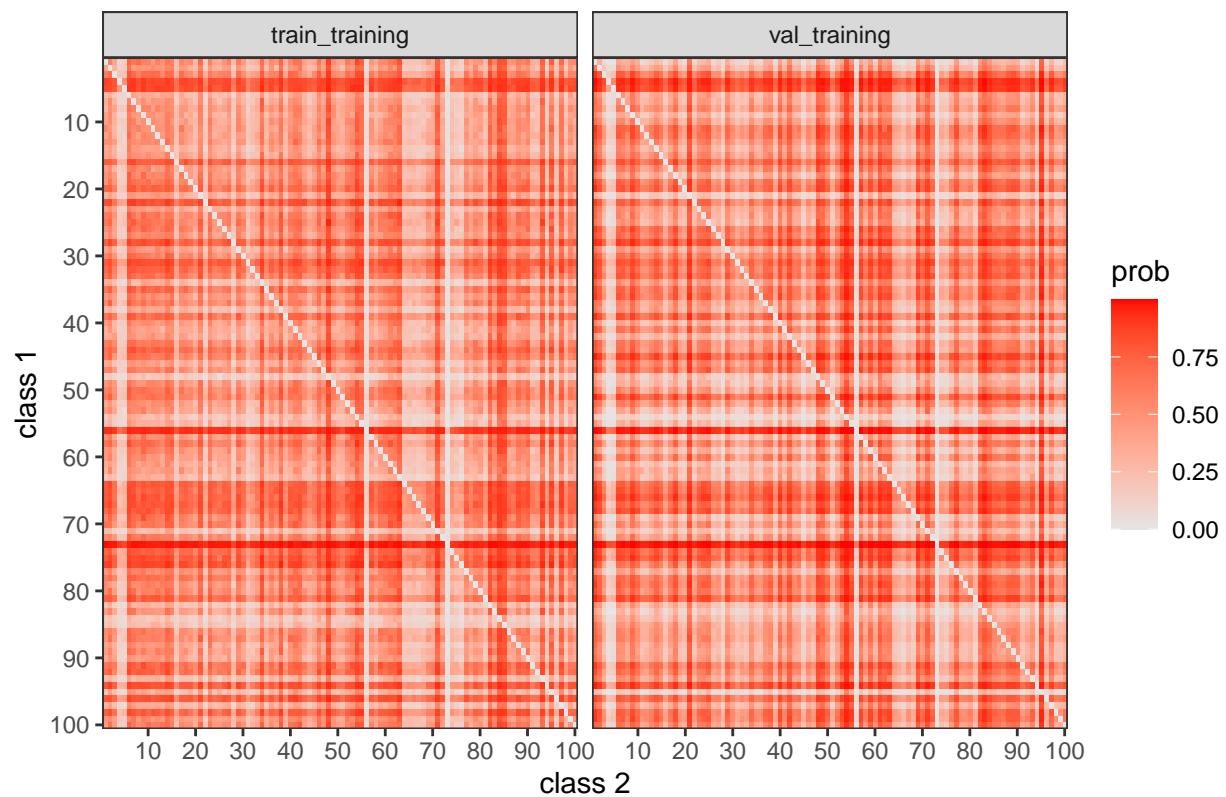
Pairwise probabilities – class 71



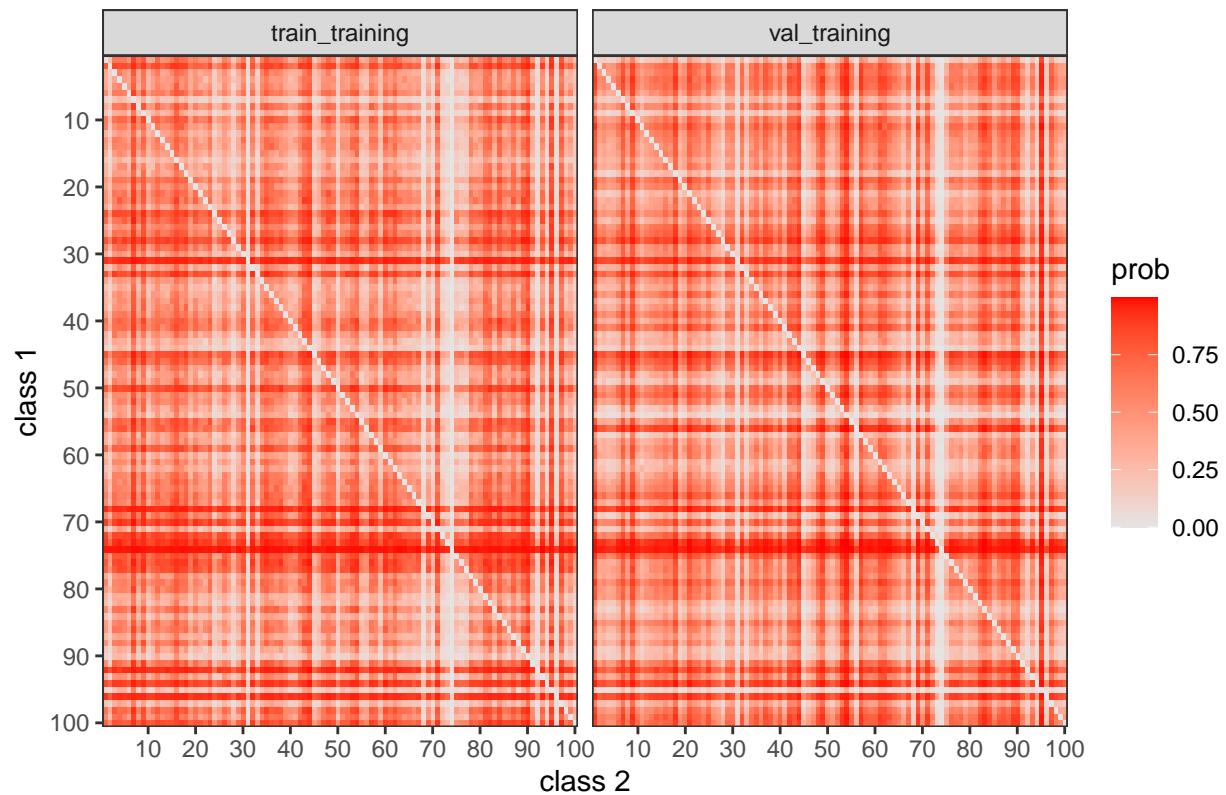
Pairwise probabilities – class 72



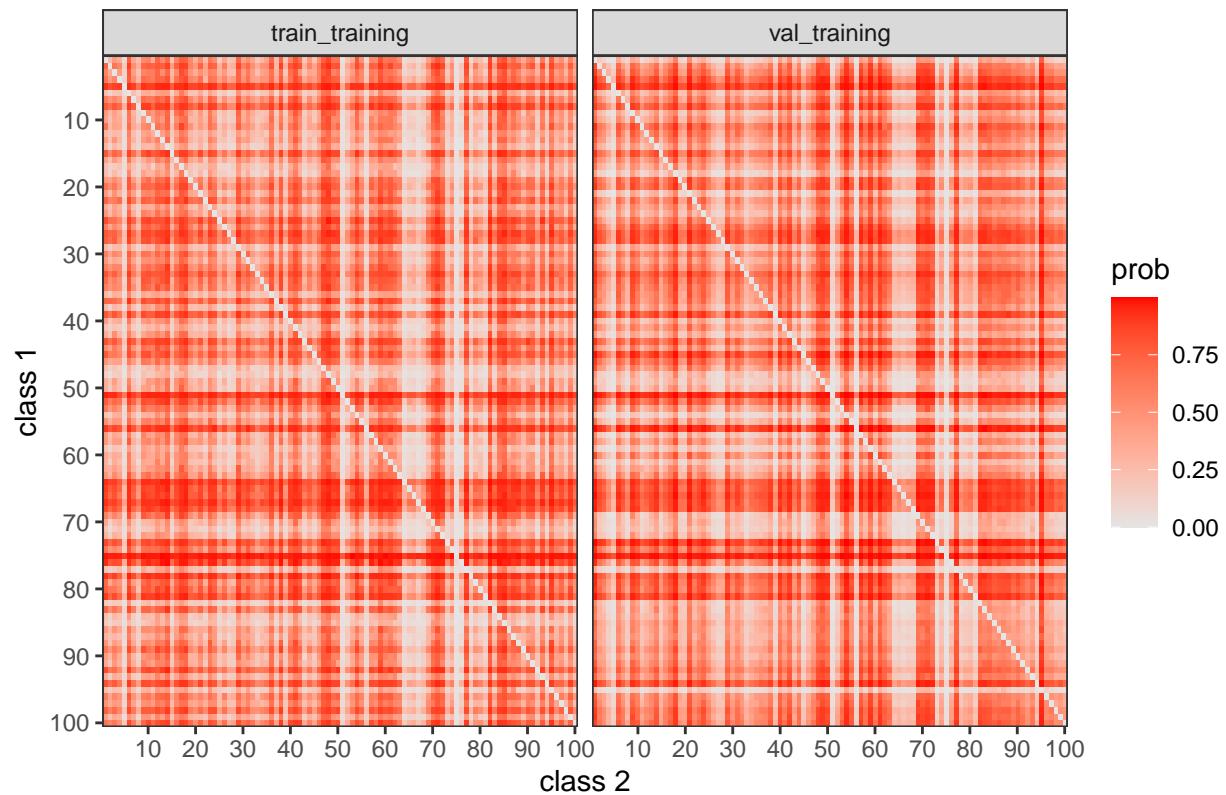
Pairwise probabilities – class 73



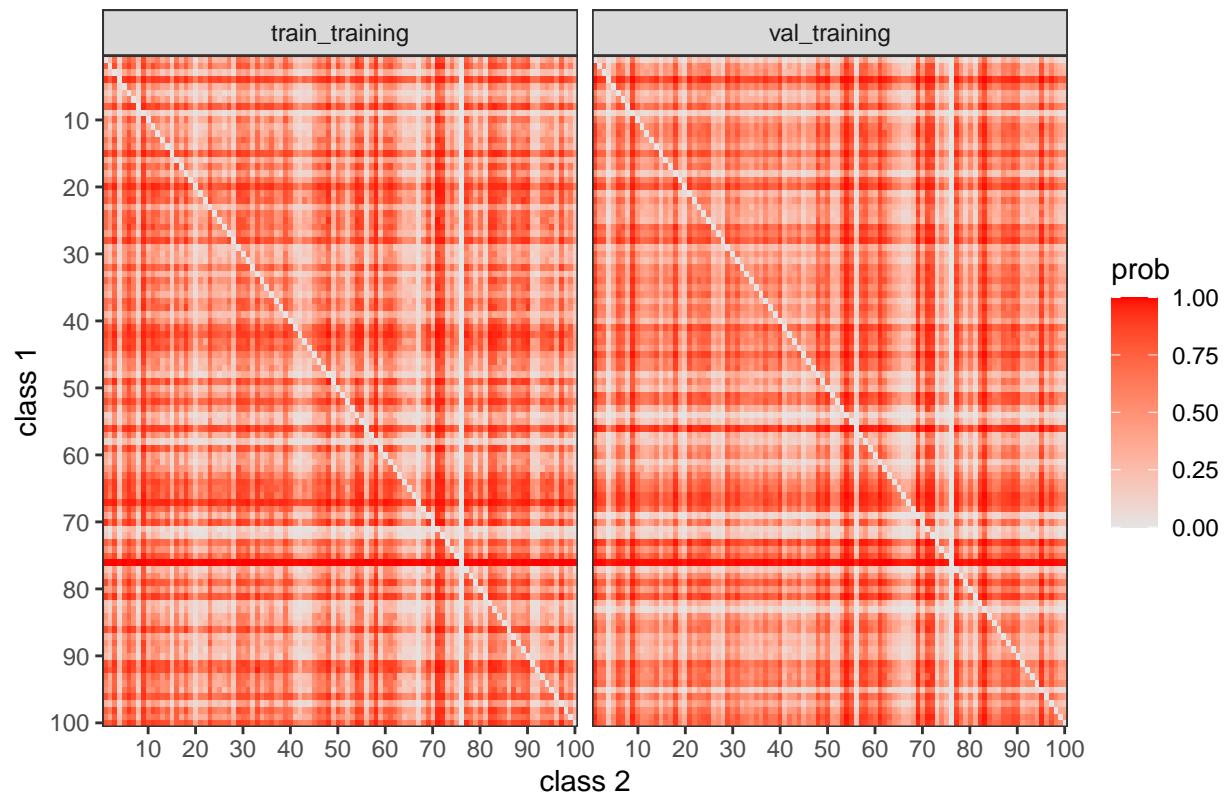
Pairwise probabilities – class 74



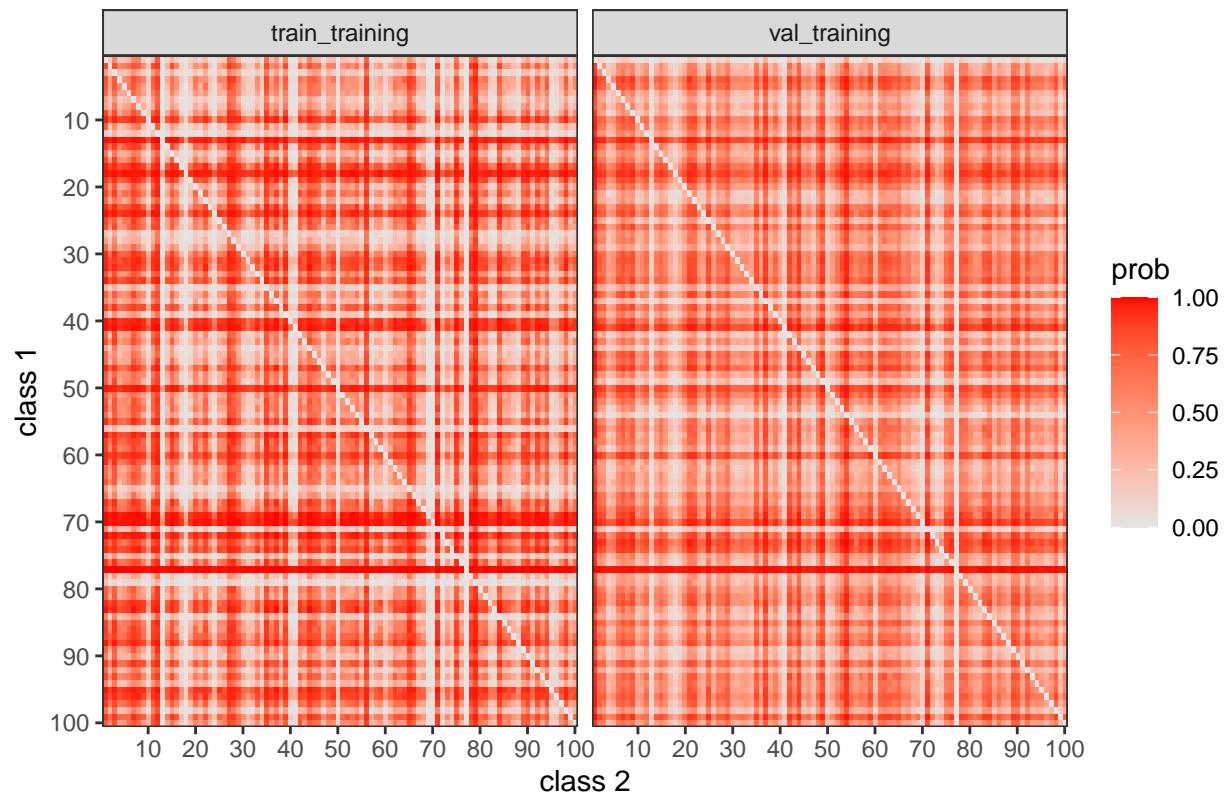
Pairwise probabilities – class 75



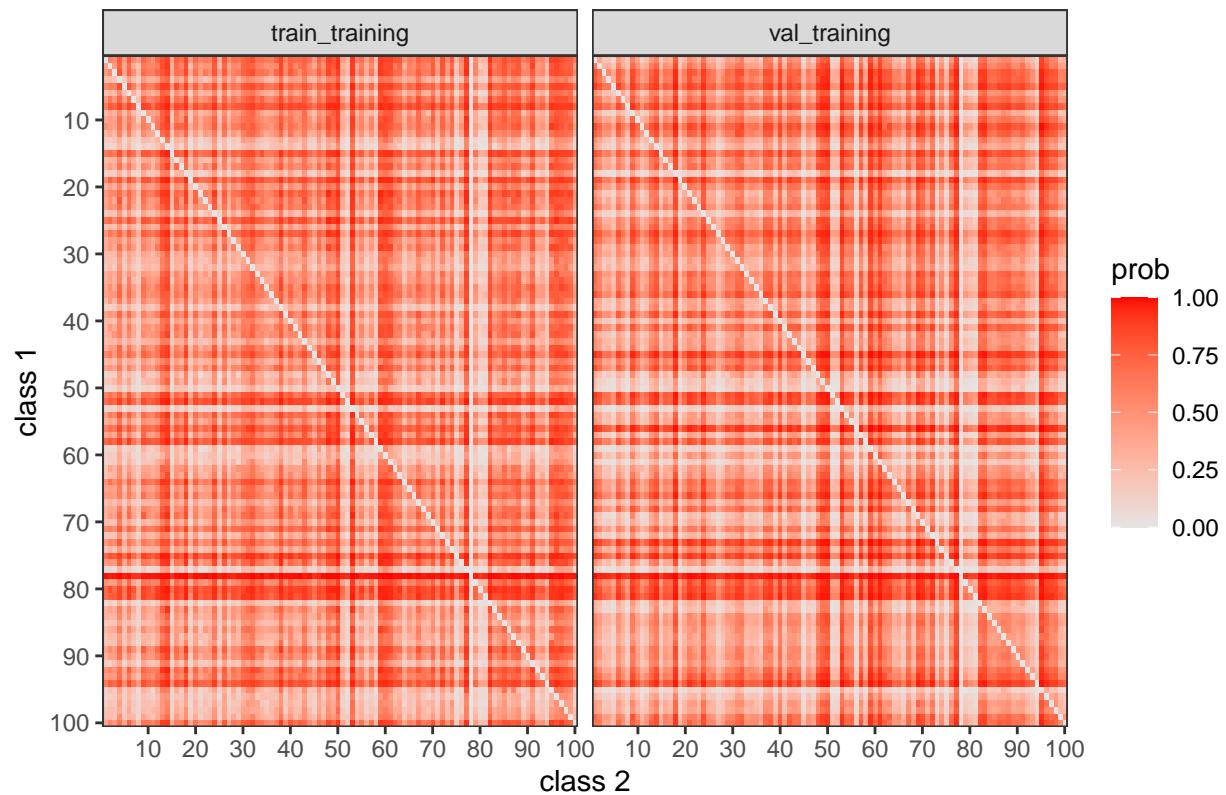
Pairwise probabilities – class 76



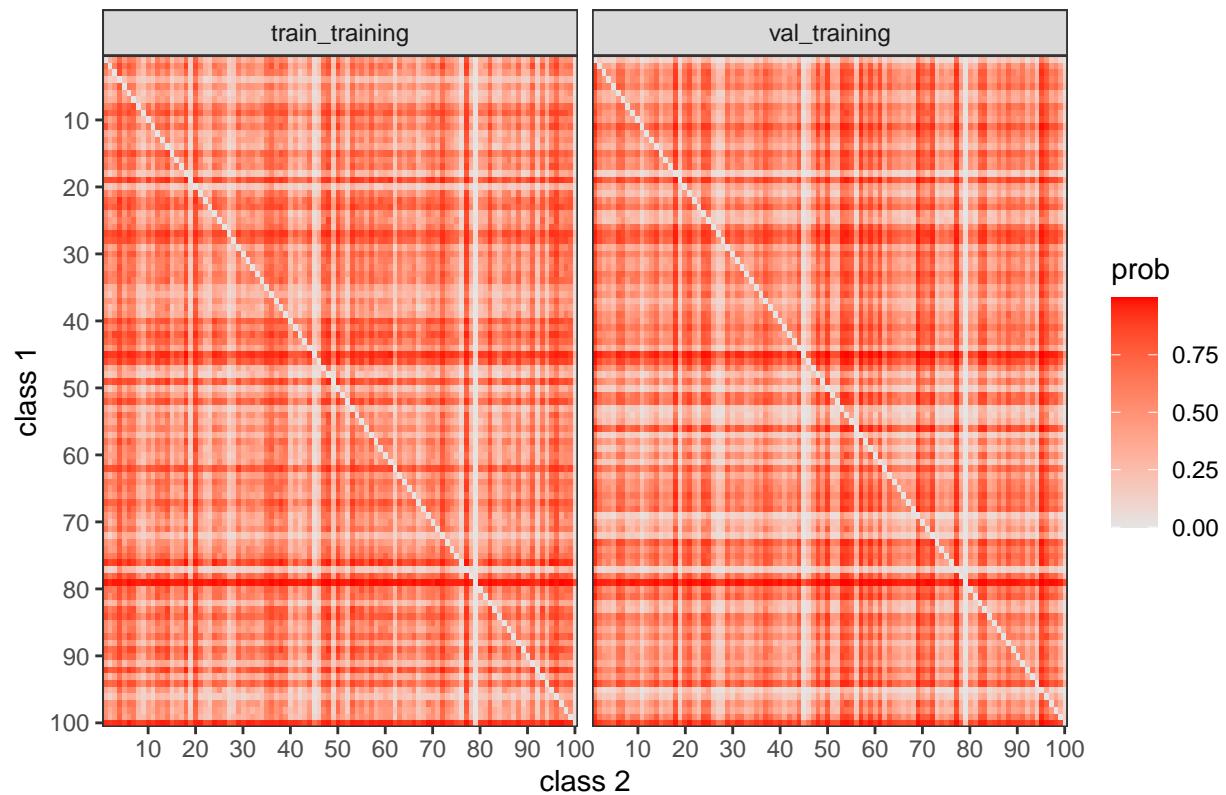
Pairwise probabilities – class 77



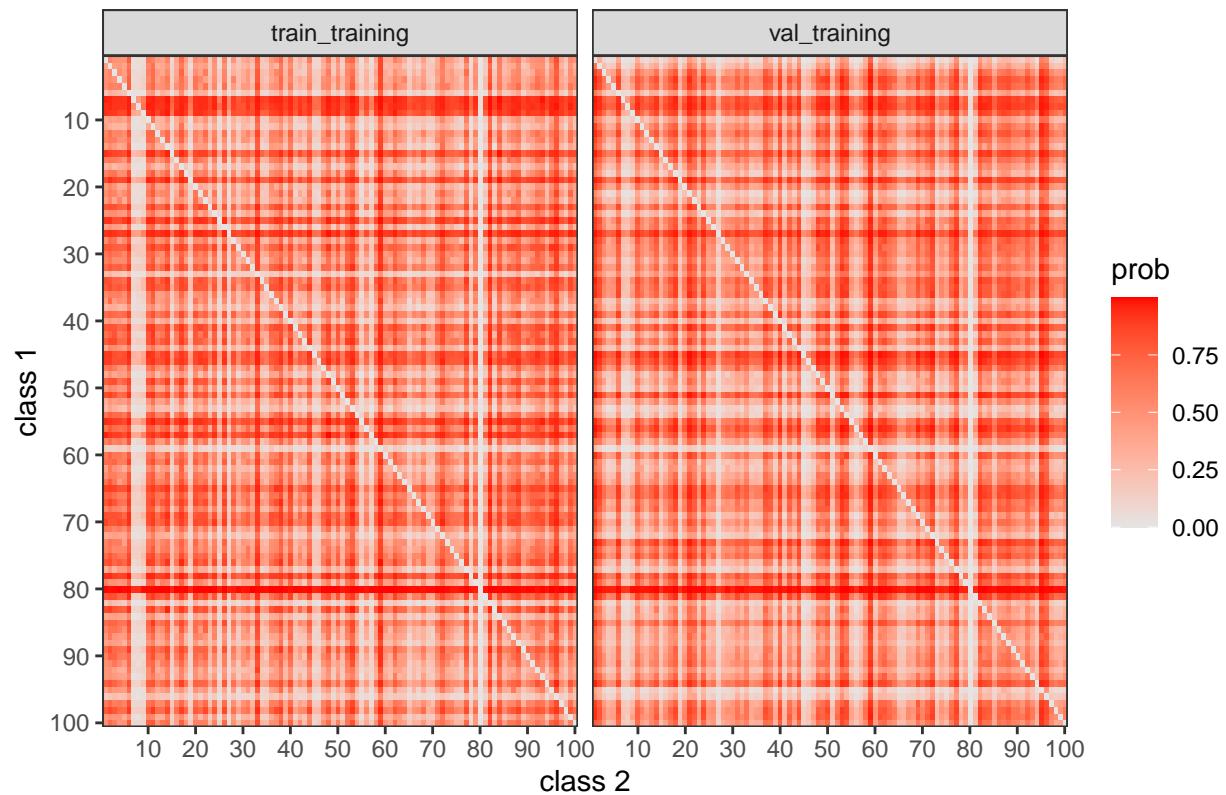
Pairwise probabilities – class 78



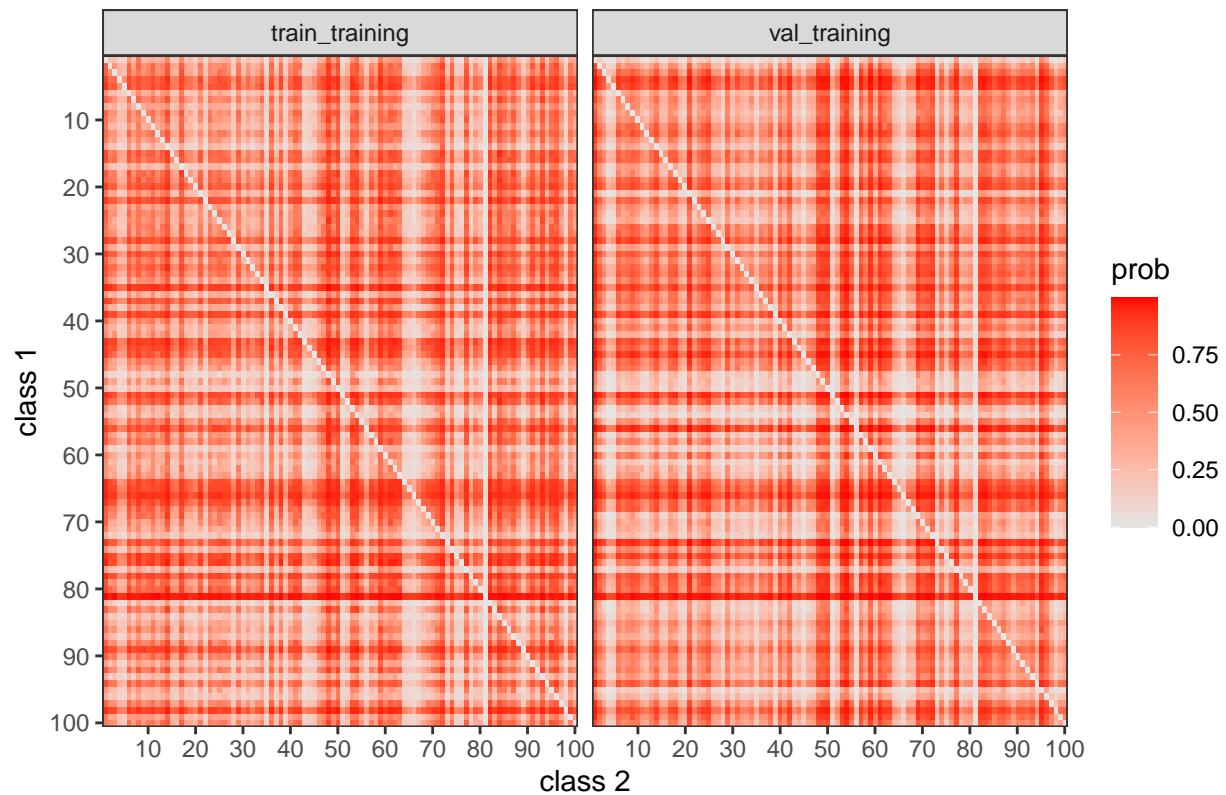
Pairwise probabilities – class 79



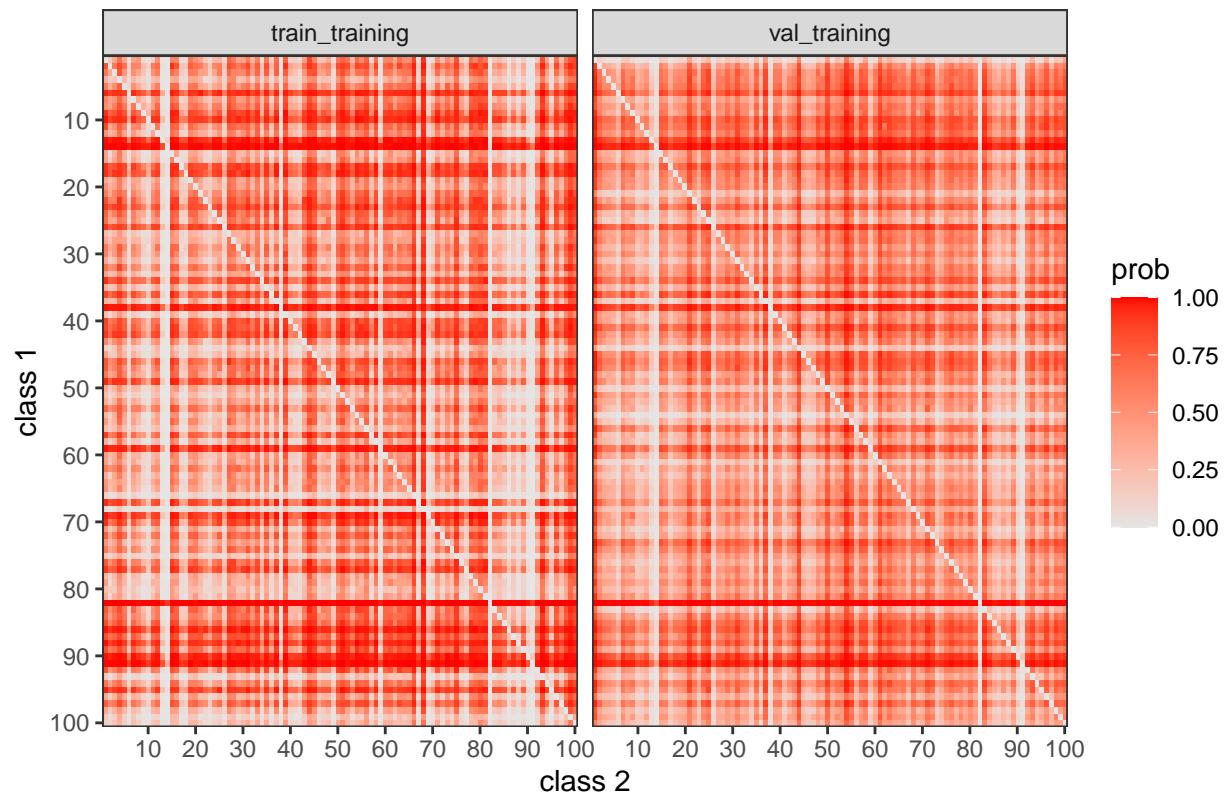
Pairwise probabilities – class 80



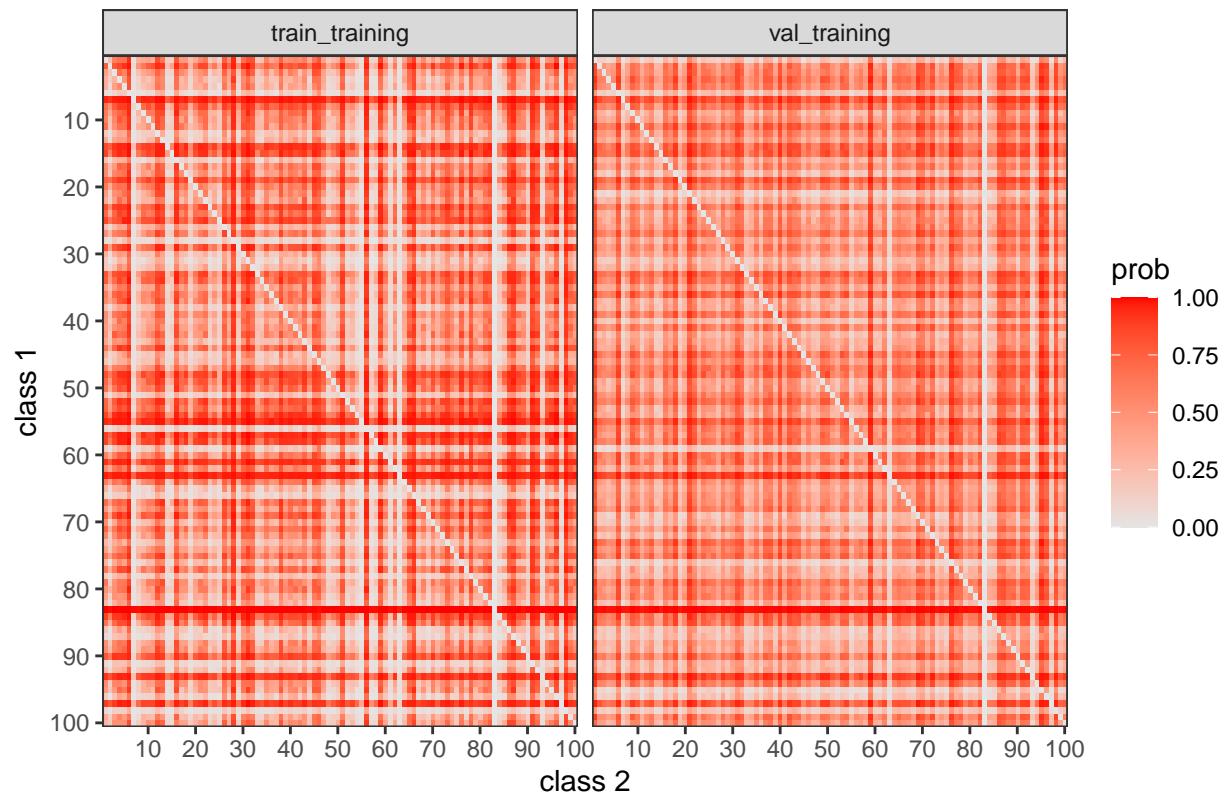
Pairwise probabilities – class 81



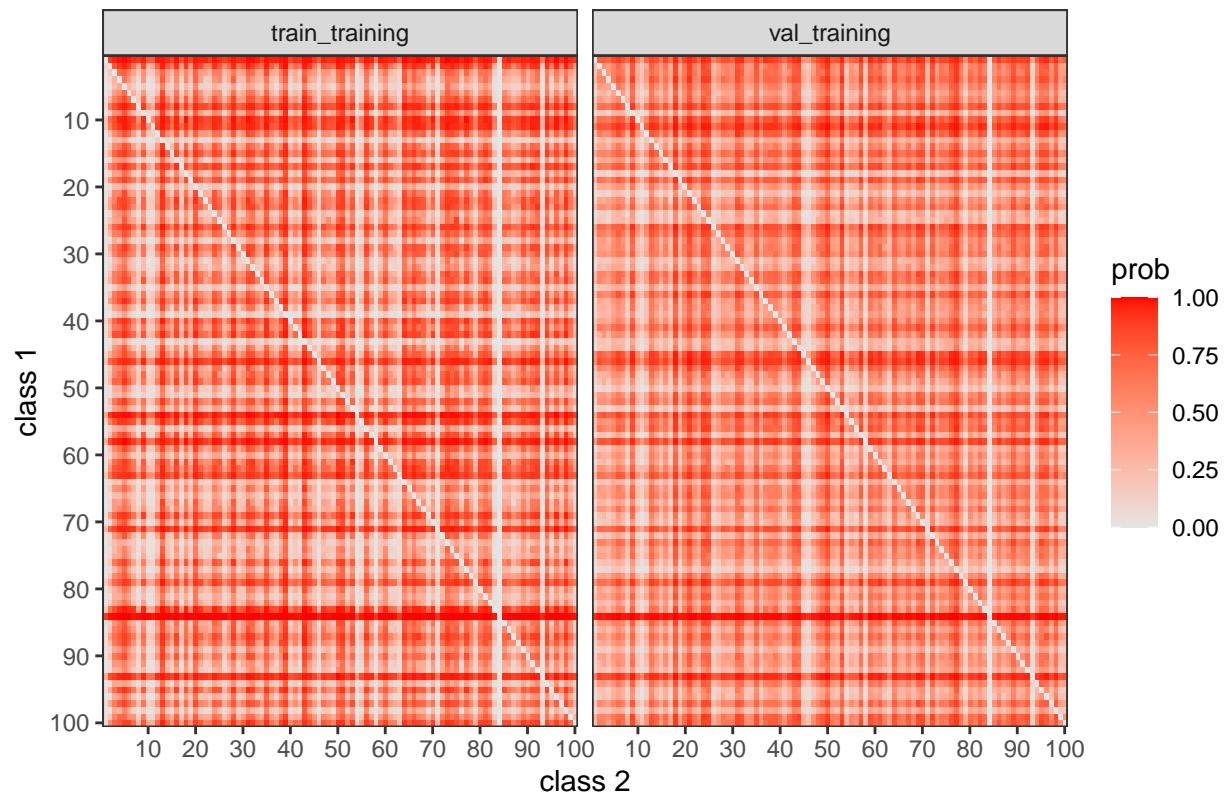
Pairwise probabilities – class 82



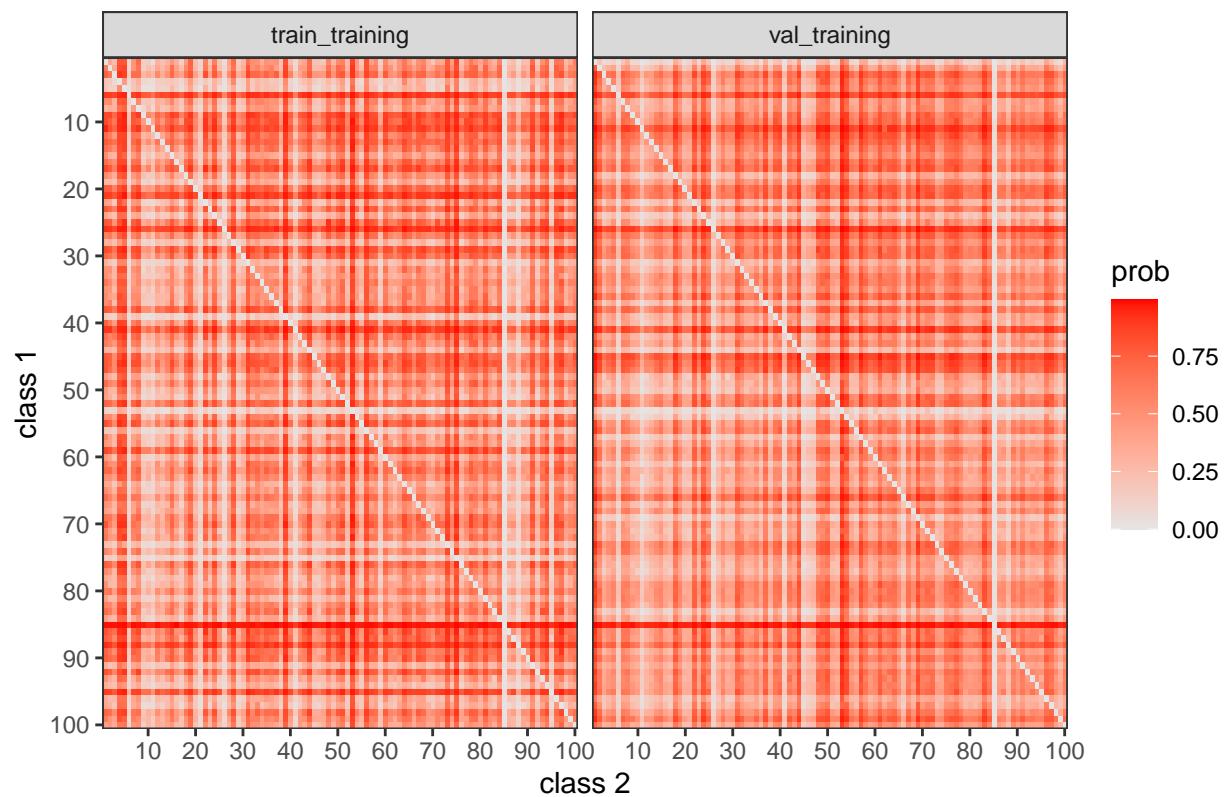
Pairwise probabilities – class 83



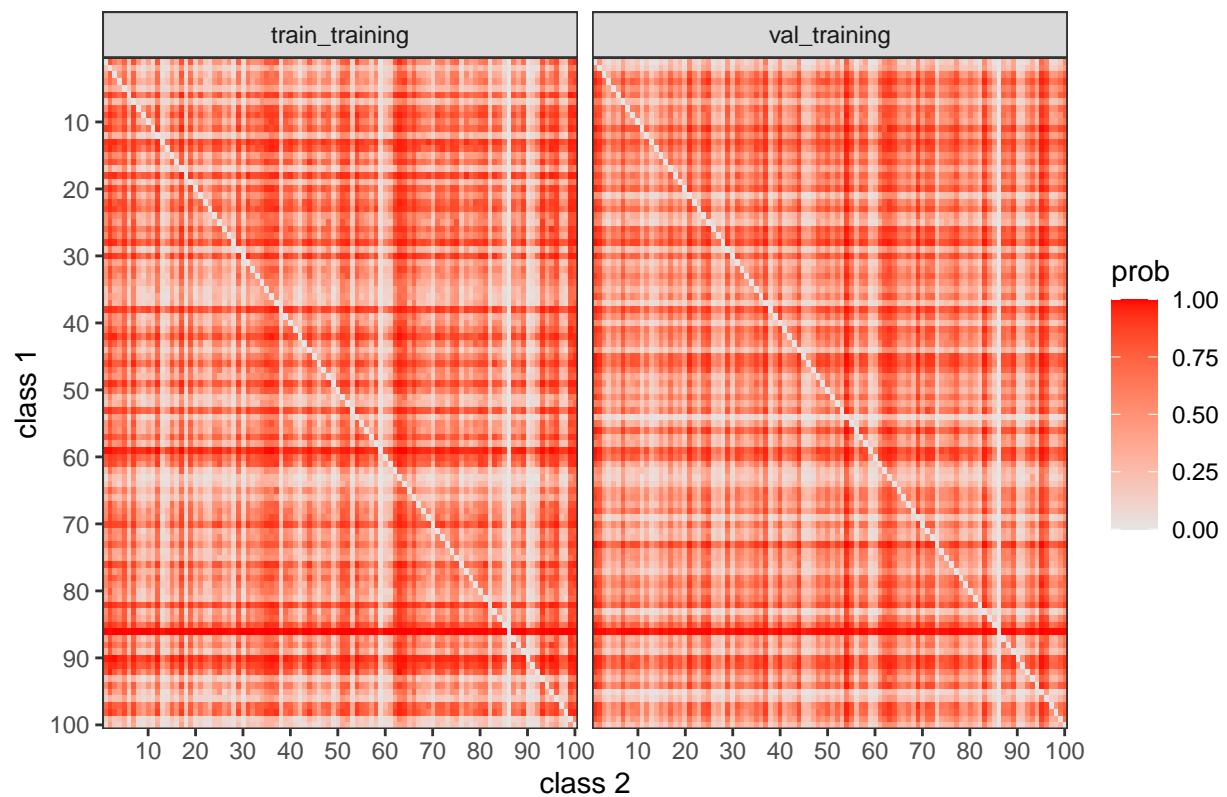
Pairwise probabilities – class 84



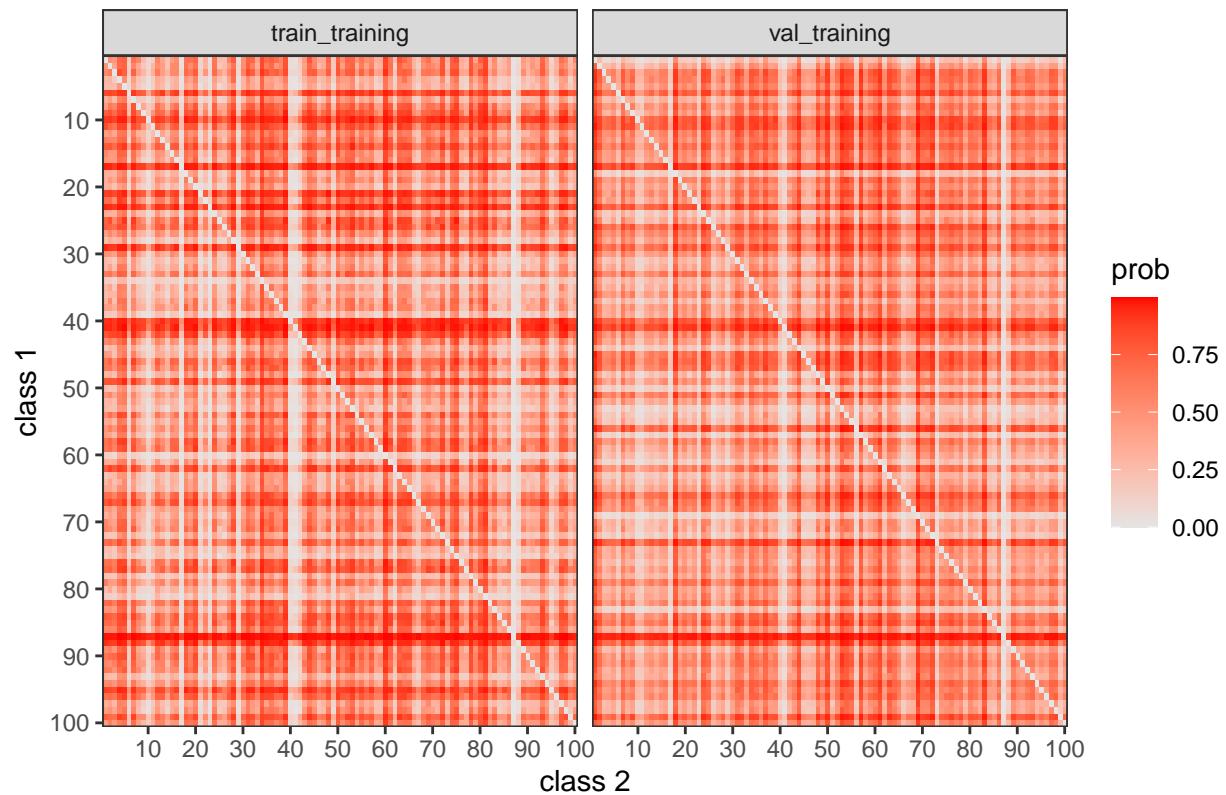
Pairwise probabilities – class 85



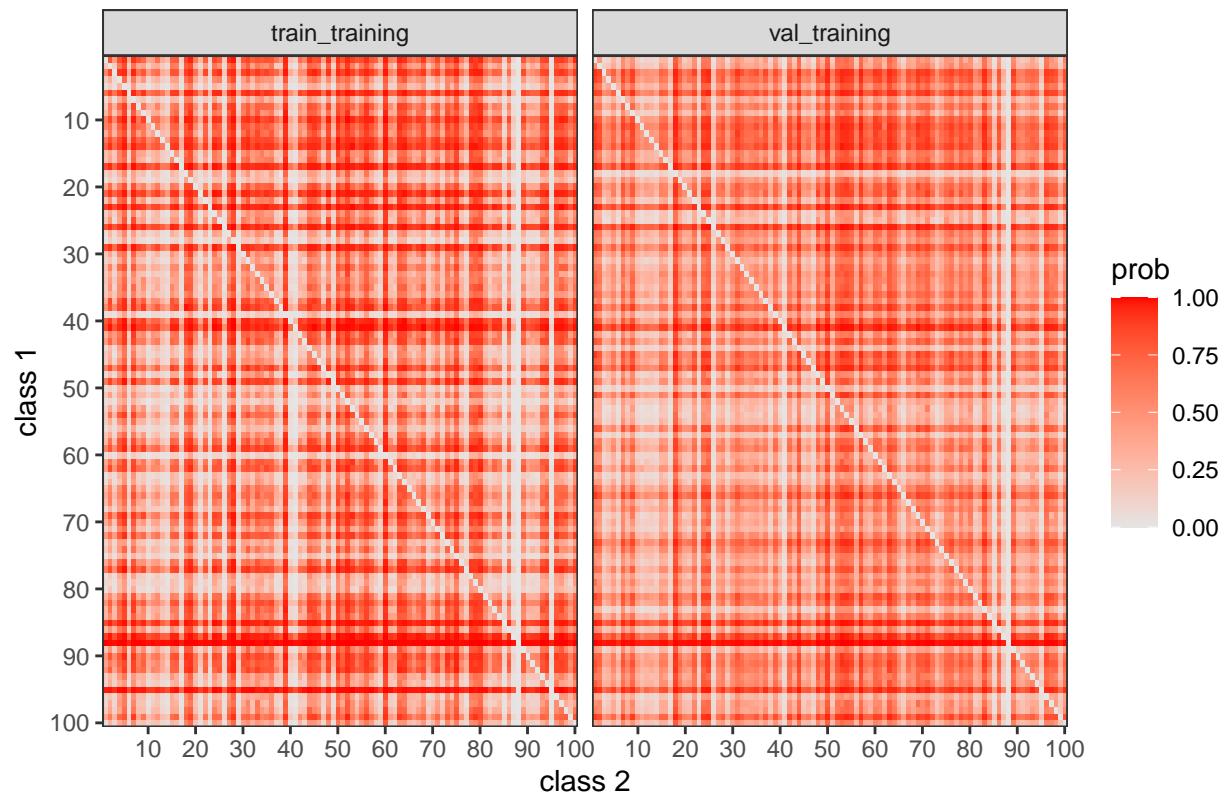
Pairwise probabilities – class 86



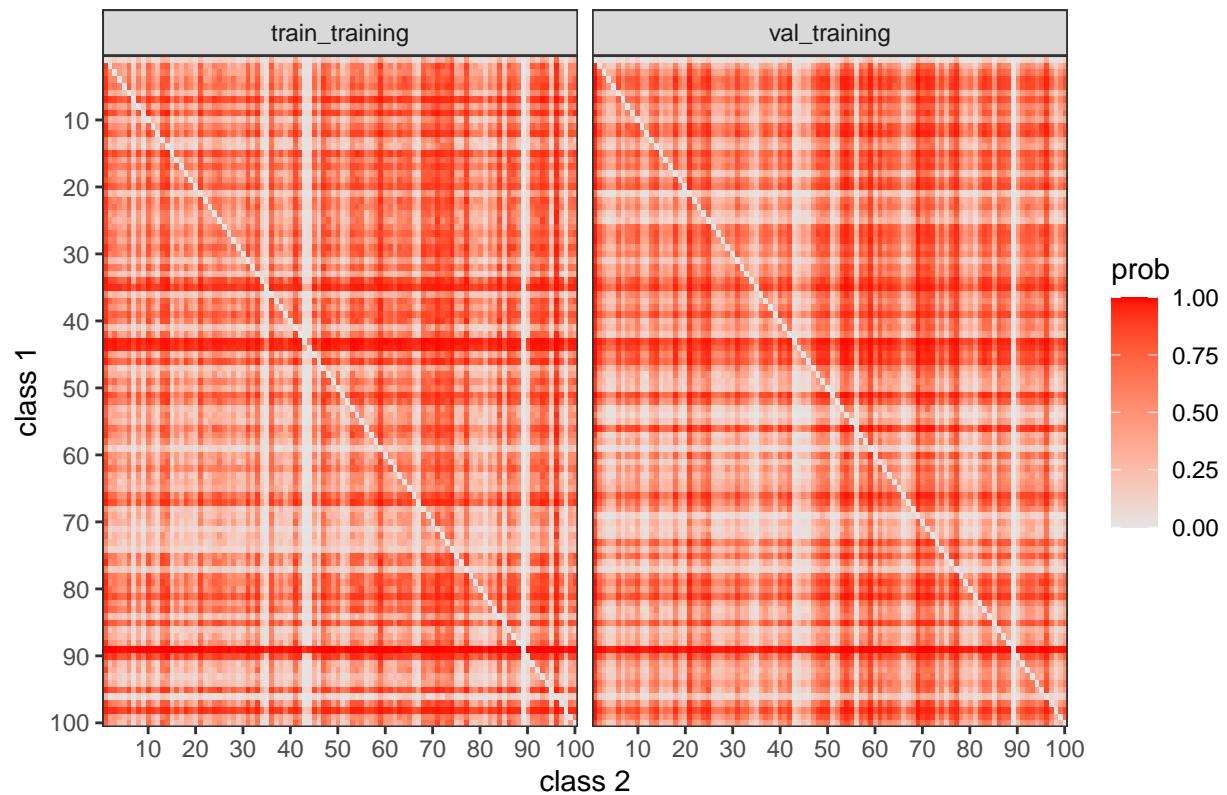
Pairwise probabilities – class 87



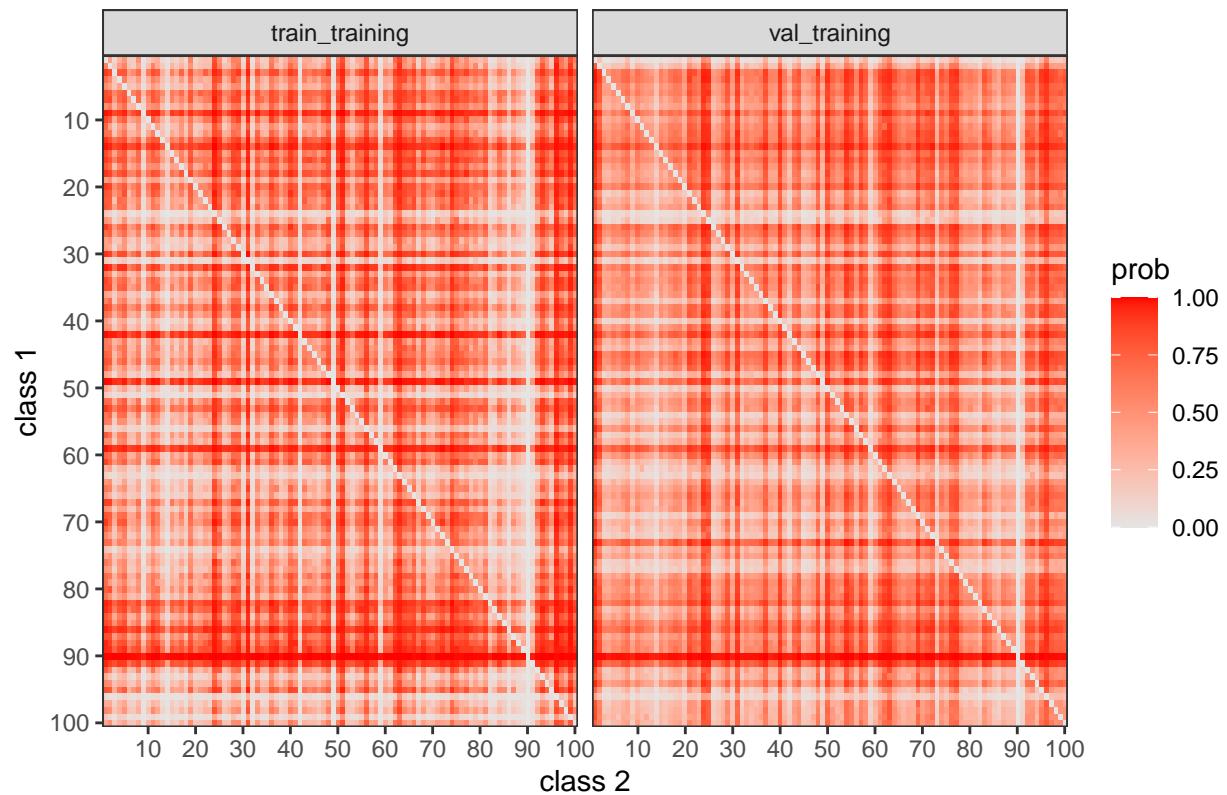
Pairwise probabilities – class 88



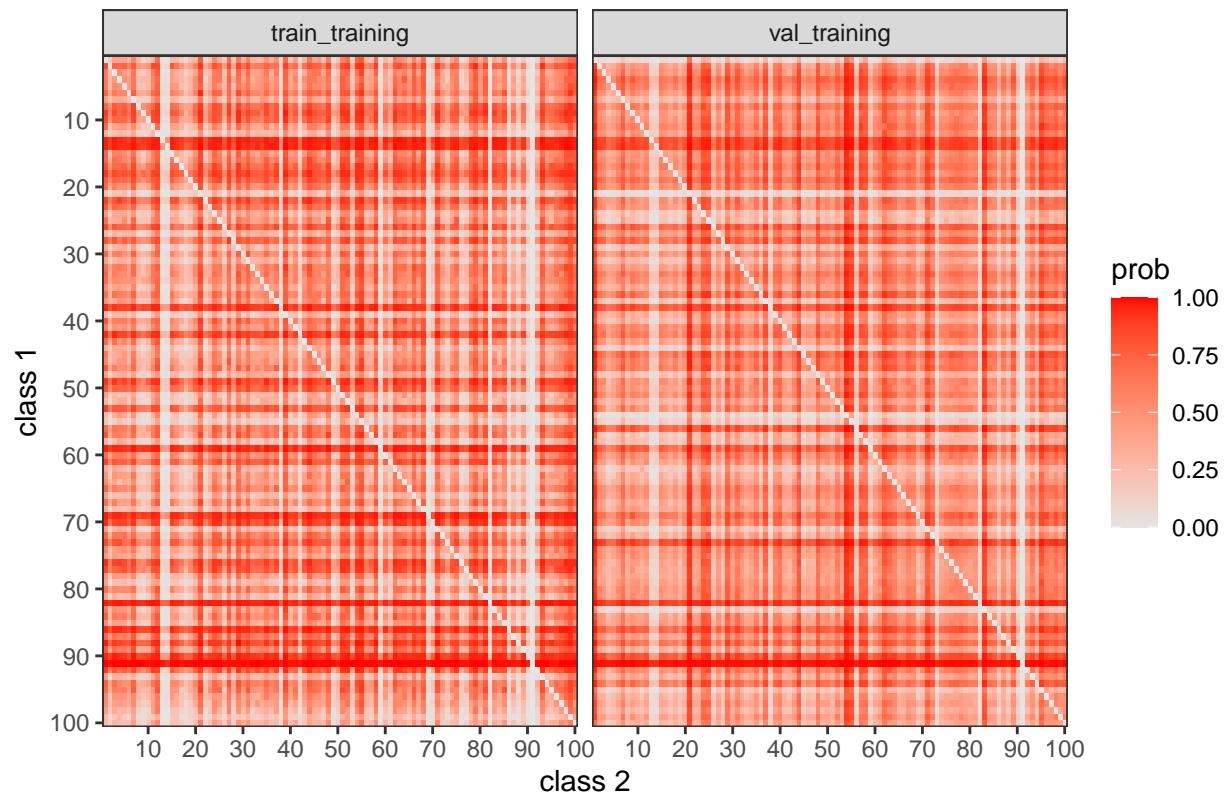
Pairwise probabilities – class 89



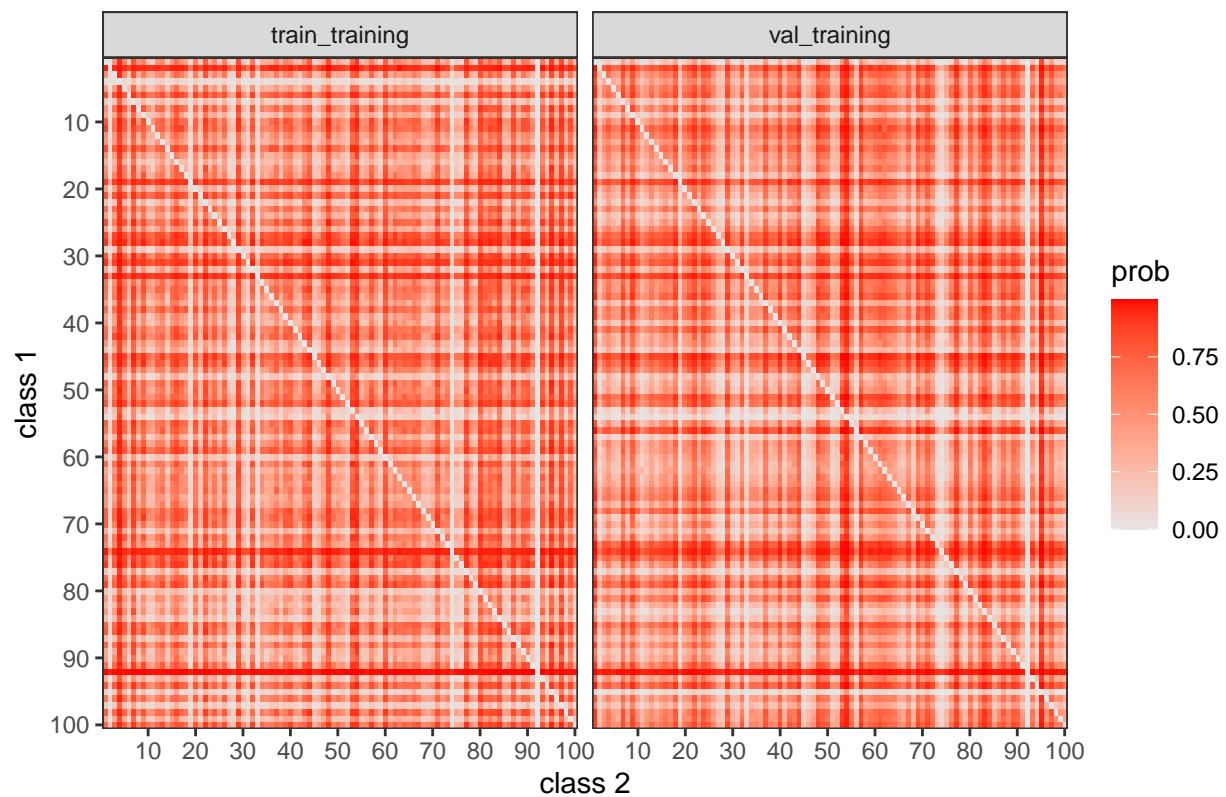
Pairwise probabilities – class 90



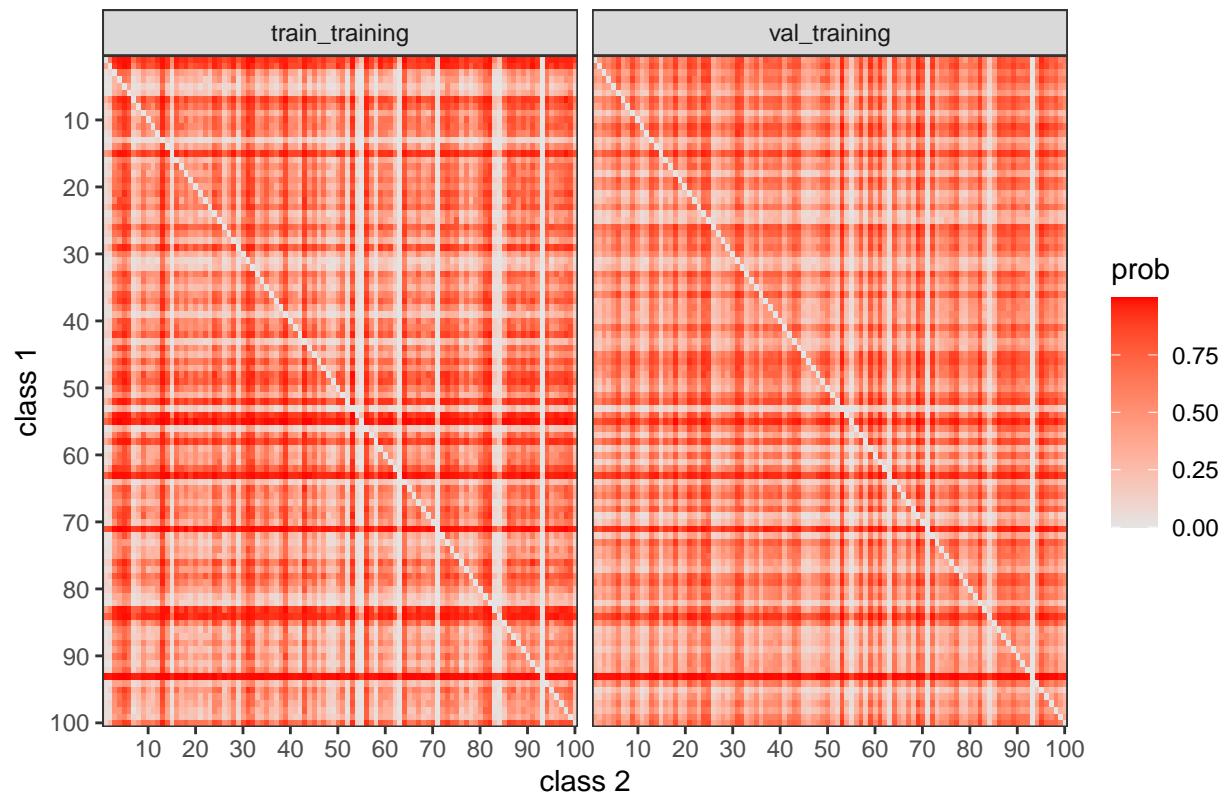
Pairwise probabilities – class 91



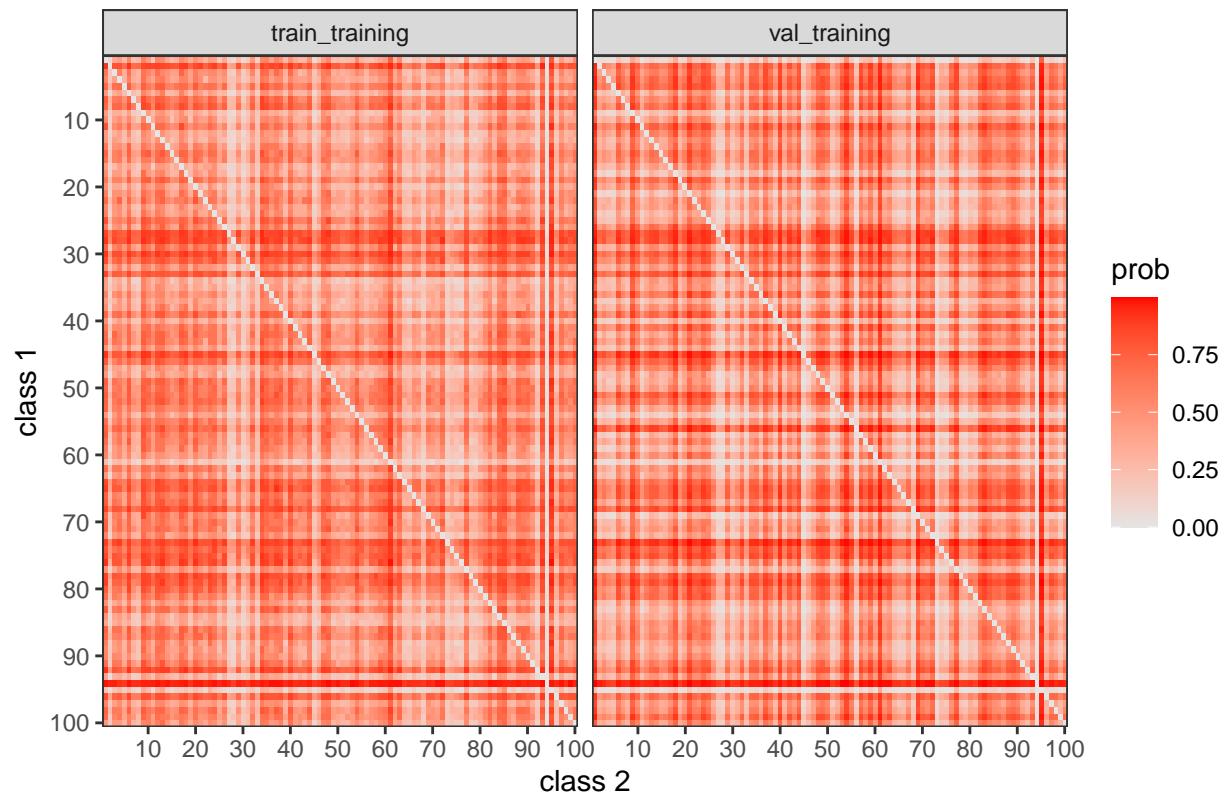
Pairwise probabilities – class 92



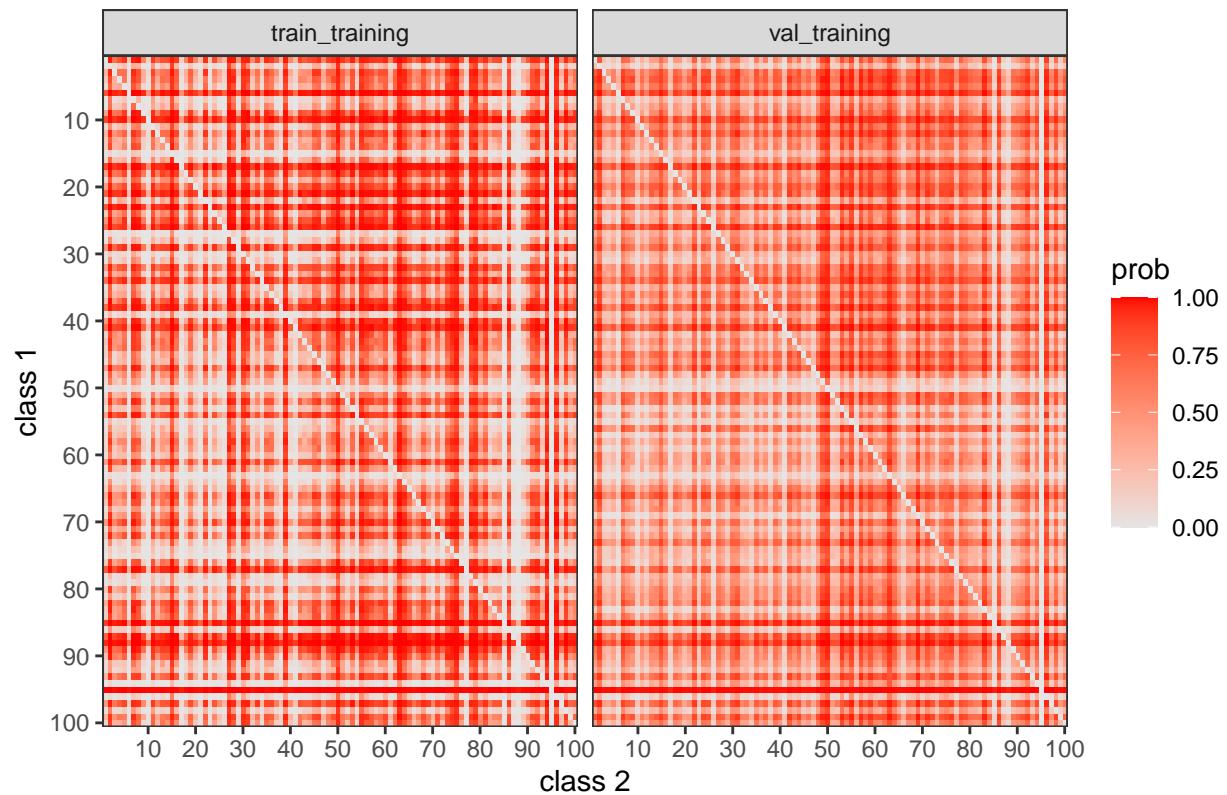
Pairwise probabilities – class 93



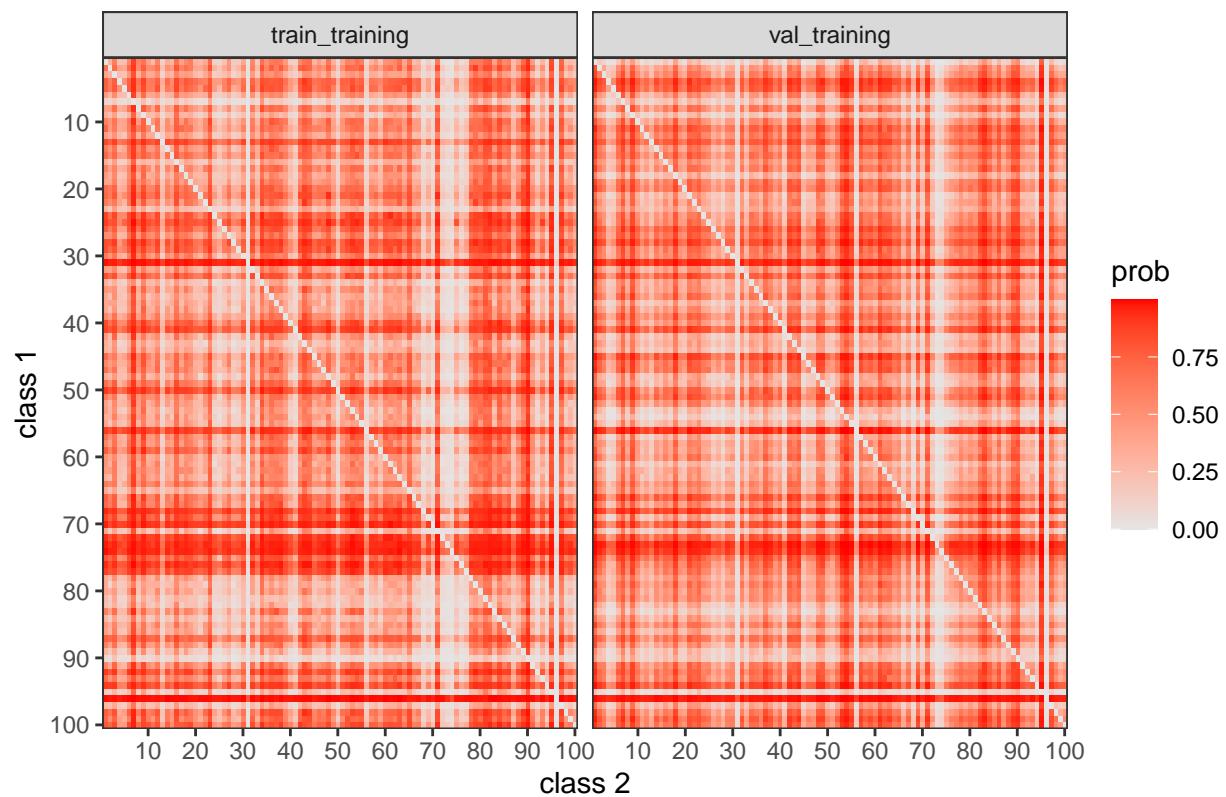
Pairwise probabilities – class 94



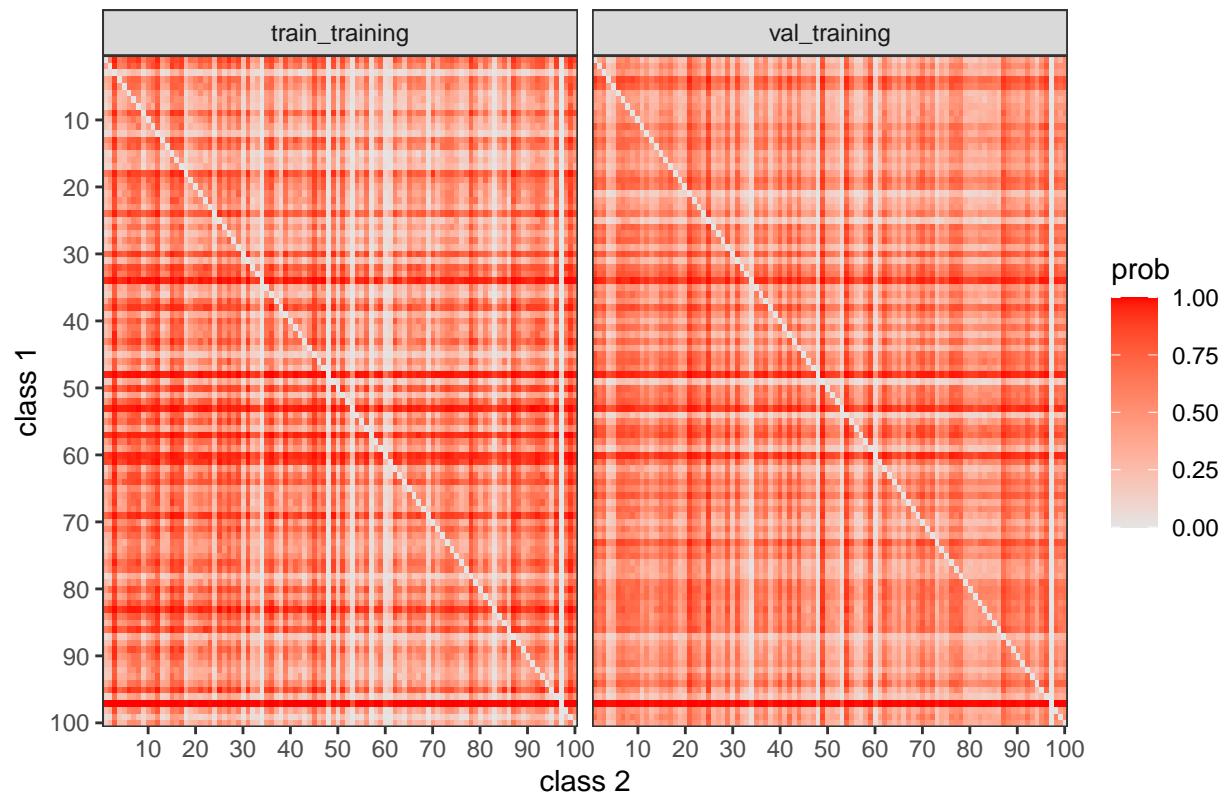
Pairwise probabilities – class 95



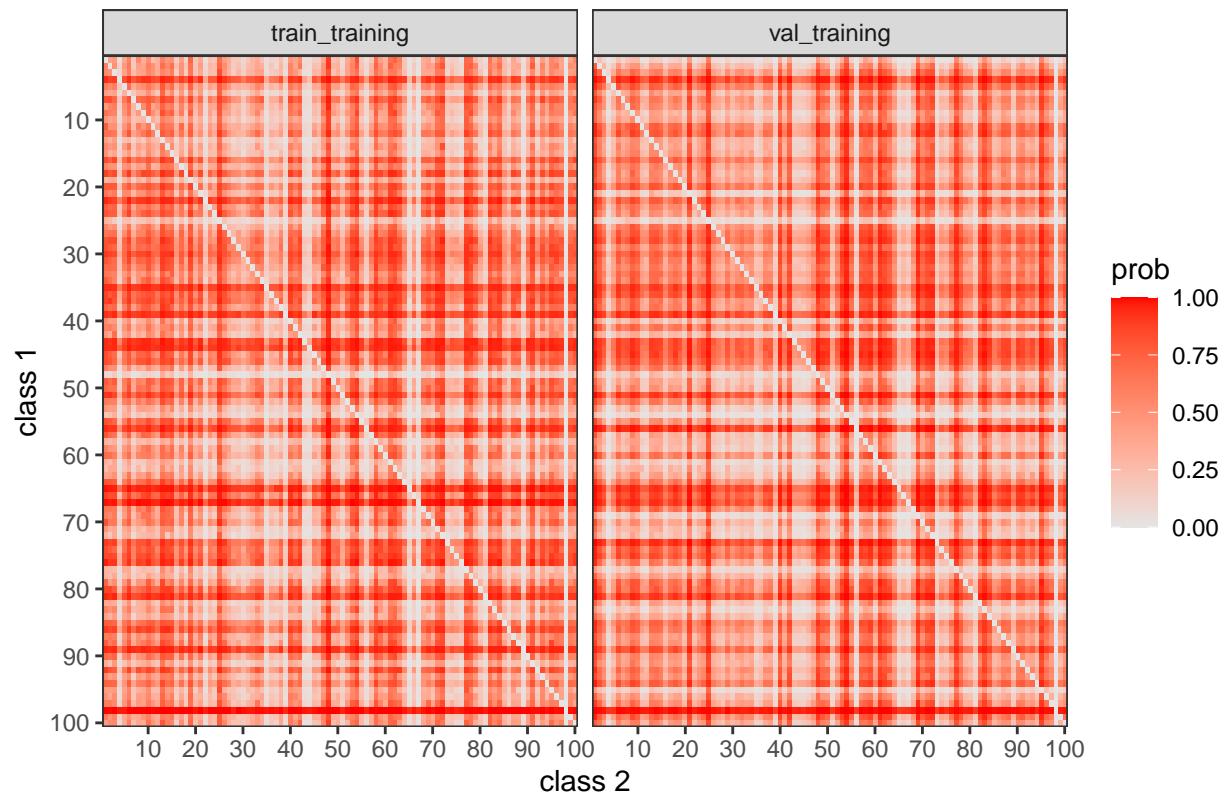
Pairwise probabilities – class 96



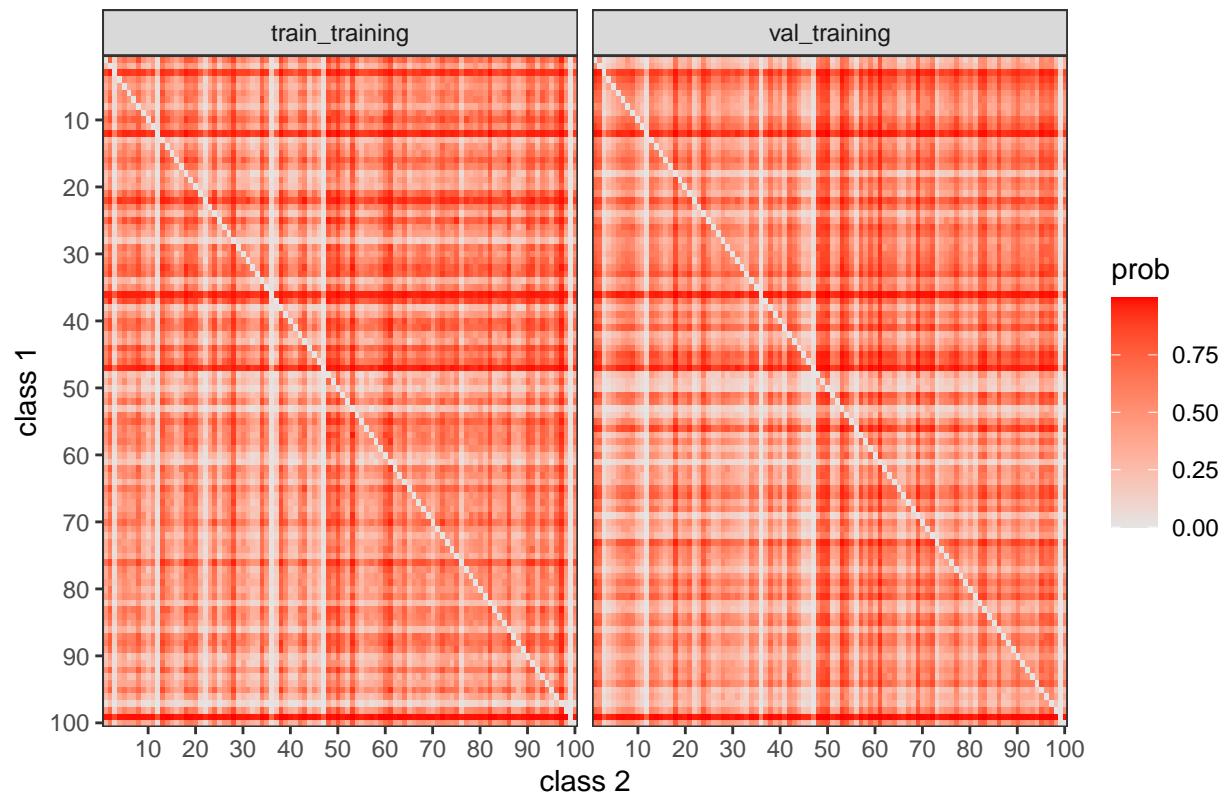
Pairwise probabilities – class 97



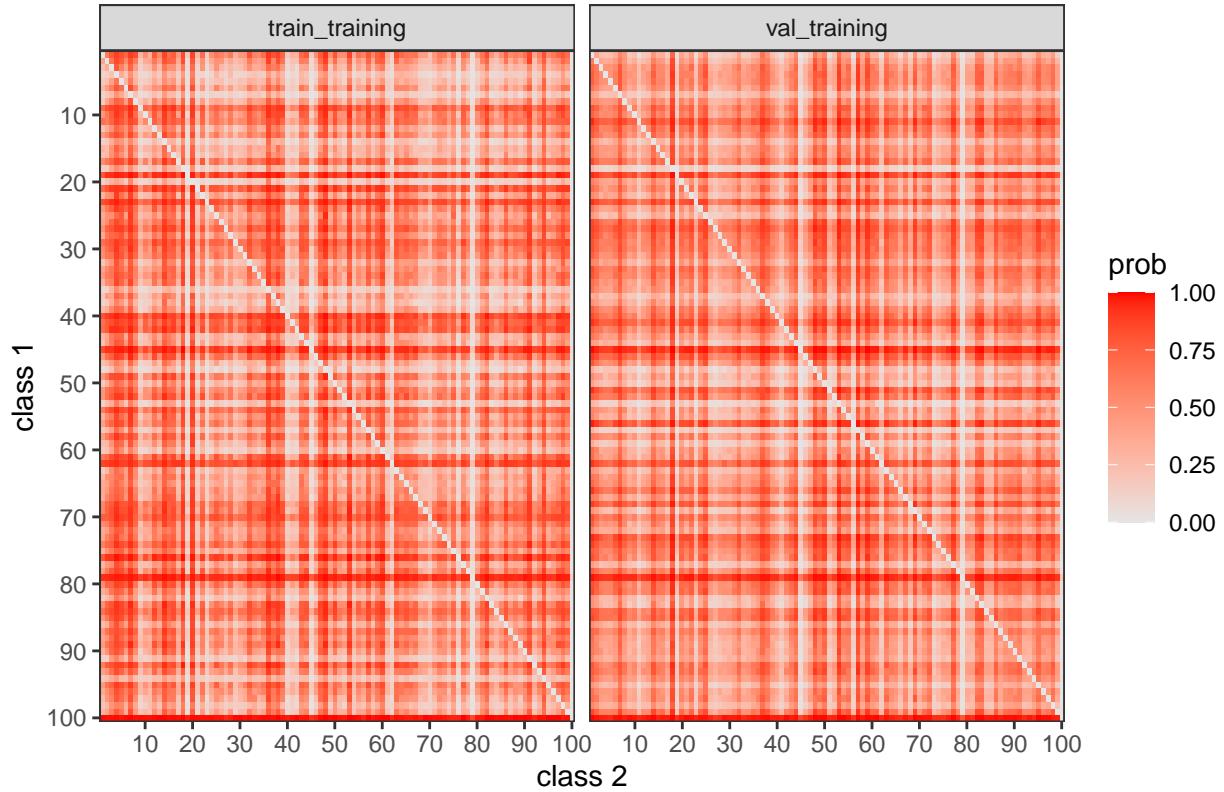
Pairwise probabilities – class 98



Pairwise probabilities – class 99



Pairwise probabilities – class 100

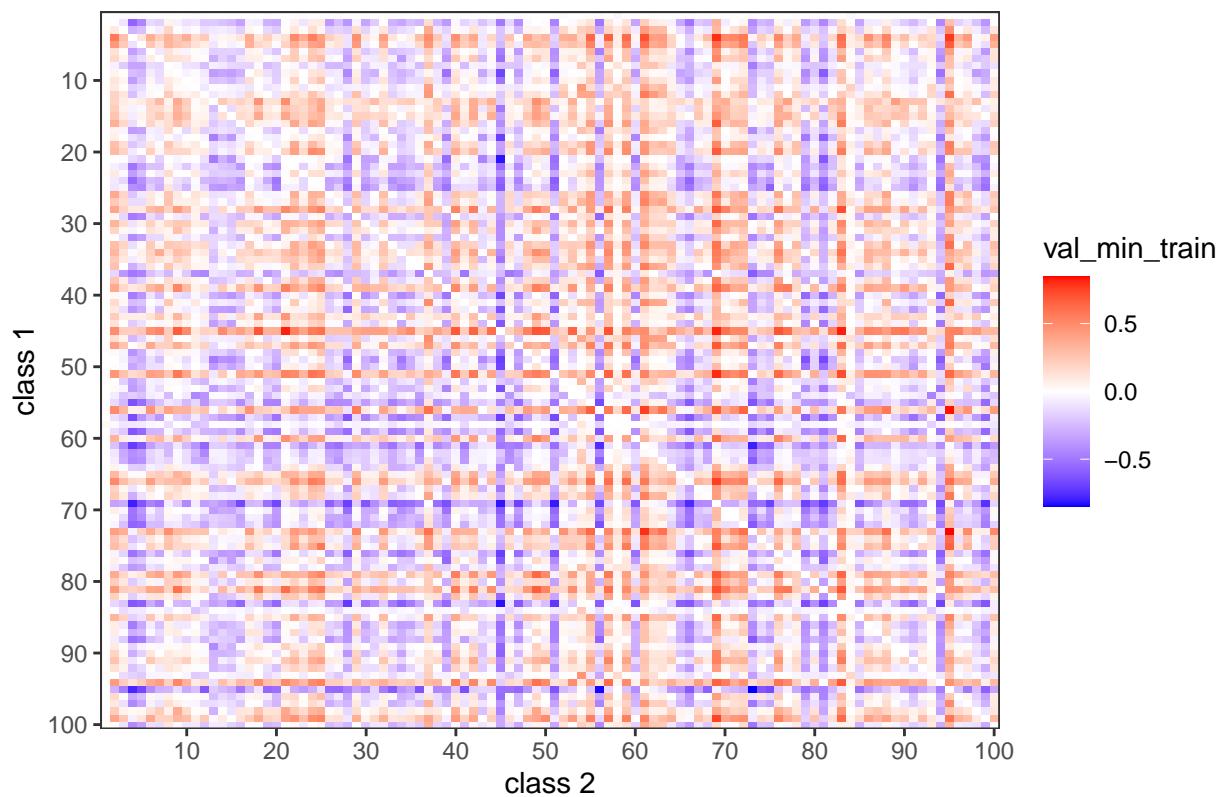


Difference between these two LDA training methodologies are not well visible, so we will plot just the differences.

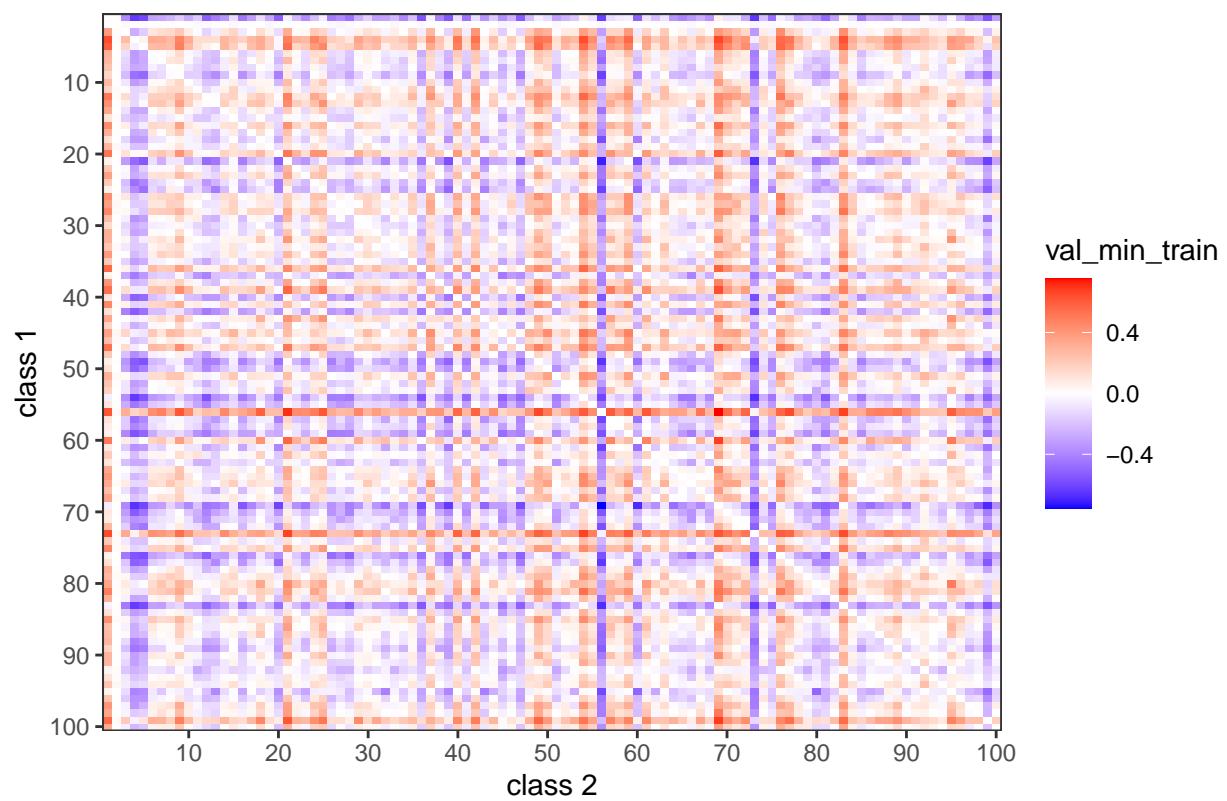
```
for (cls in 1:classes)
{
  cur_class_Rs <- df_aggr_Rs_diff %>% filter(class == cls)
  plot_cls <- ggplot(cur_class_Rs, aes(x = class2, y = class1)) +
    geom_raster(aes(fill=val_min_train)) +
    scale_fill_gradient2(low="blue", high="red", mid="white", midpoint=0) +
    scale_y_discrete(limits=rev, breaks=seq(0, classes, 10)) +
    scale_x_discrete(breaks=seq(0, classes, 10)) +
    labs(x="class 2", y="class 1", title=paste("Pairwise probabilities differences - class ", cls)) +
    theme_bw()

  print(plot_cls)
}
```

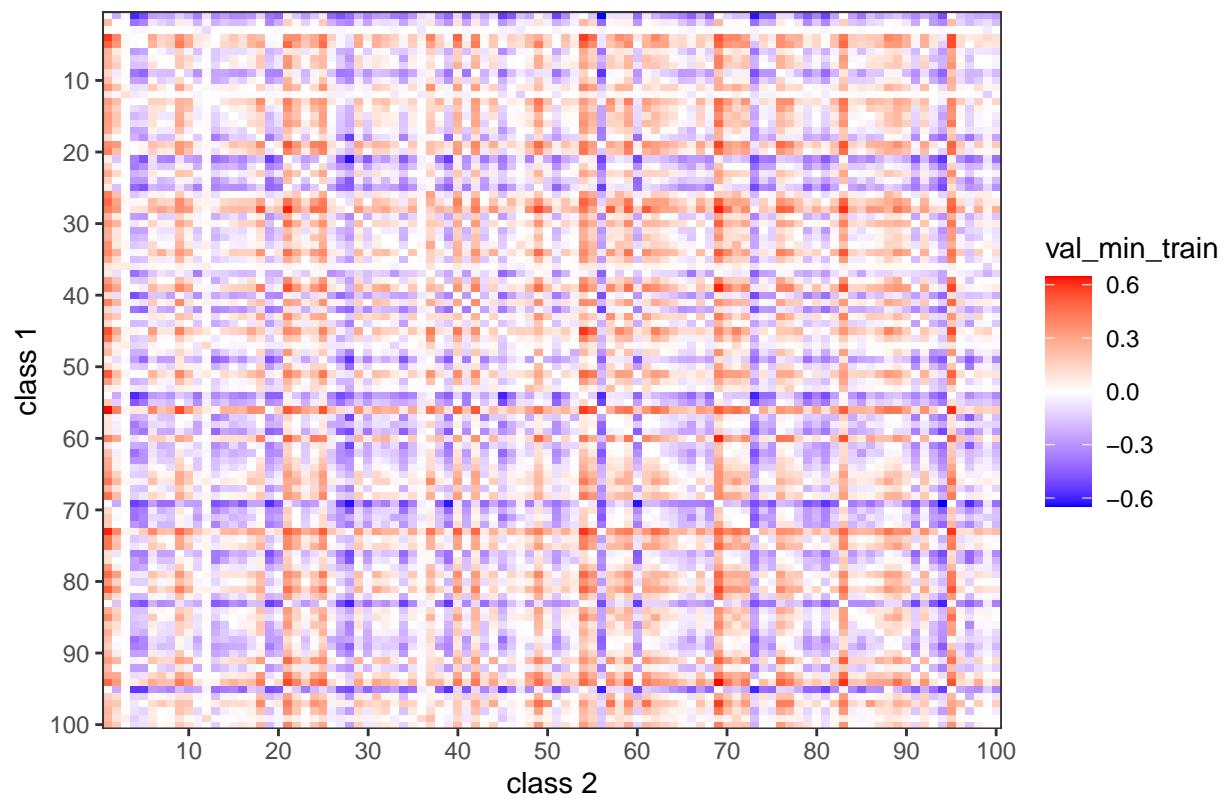
Pairwise probabilities differences – class 1



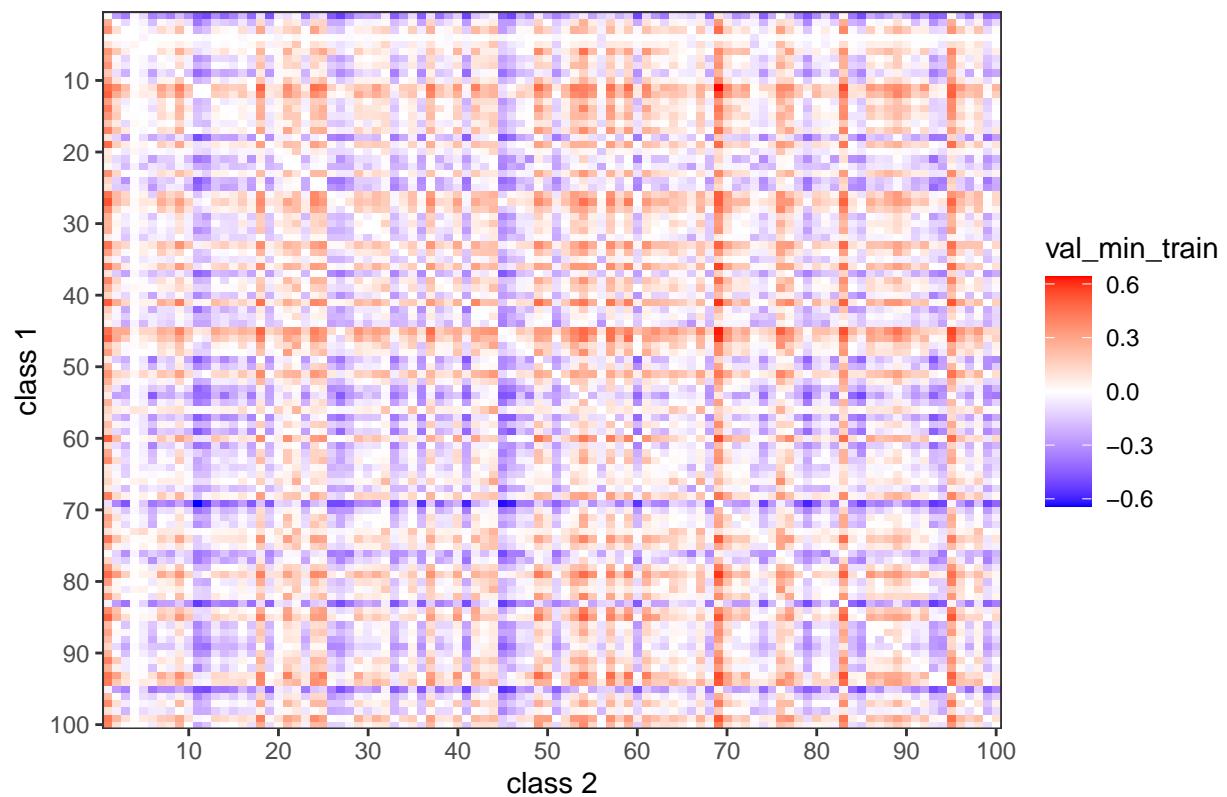
Pairwise probabilities differences – class 2



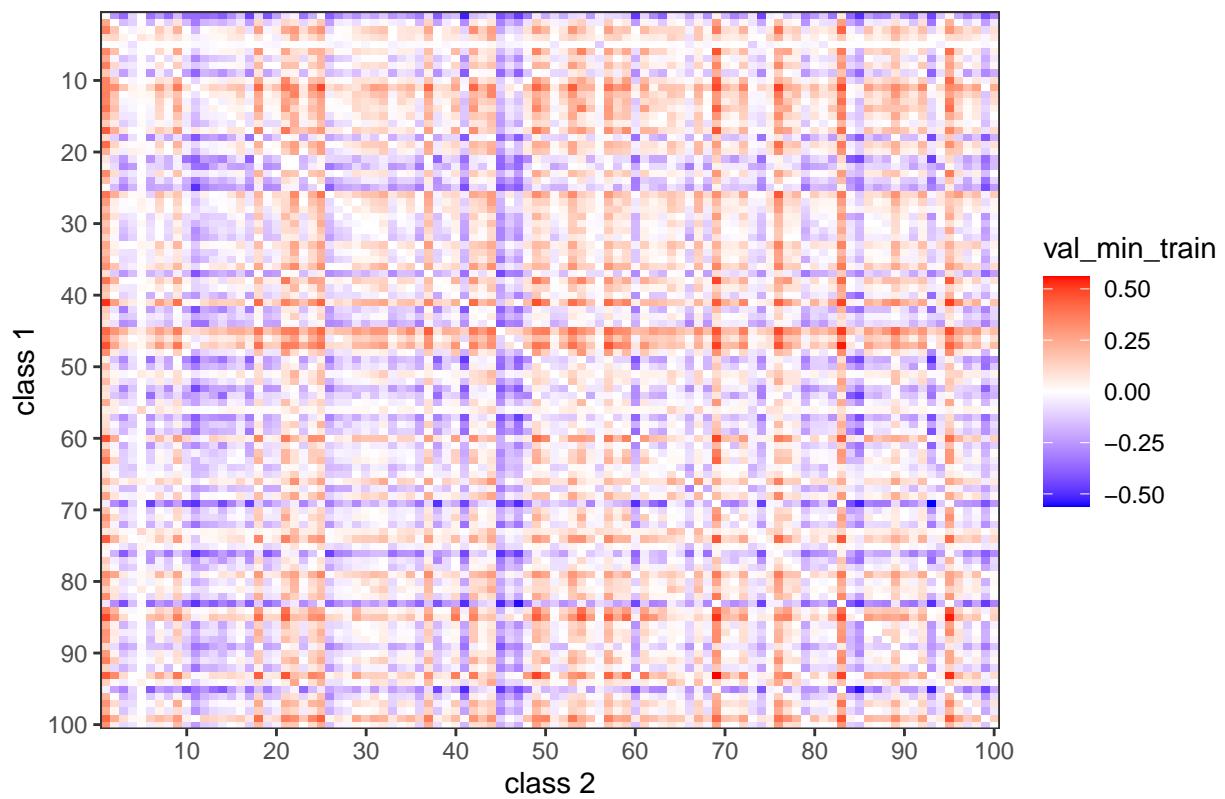
Pairwise probabilities differences – class 3



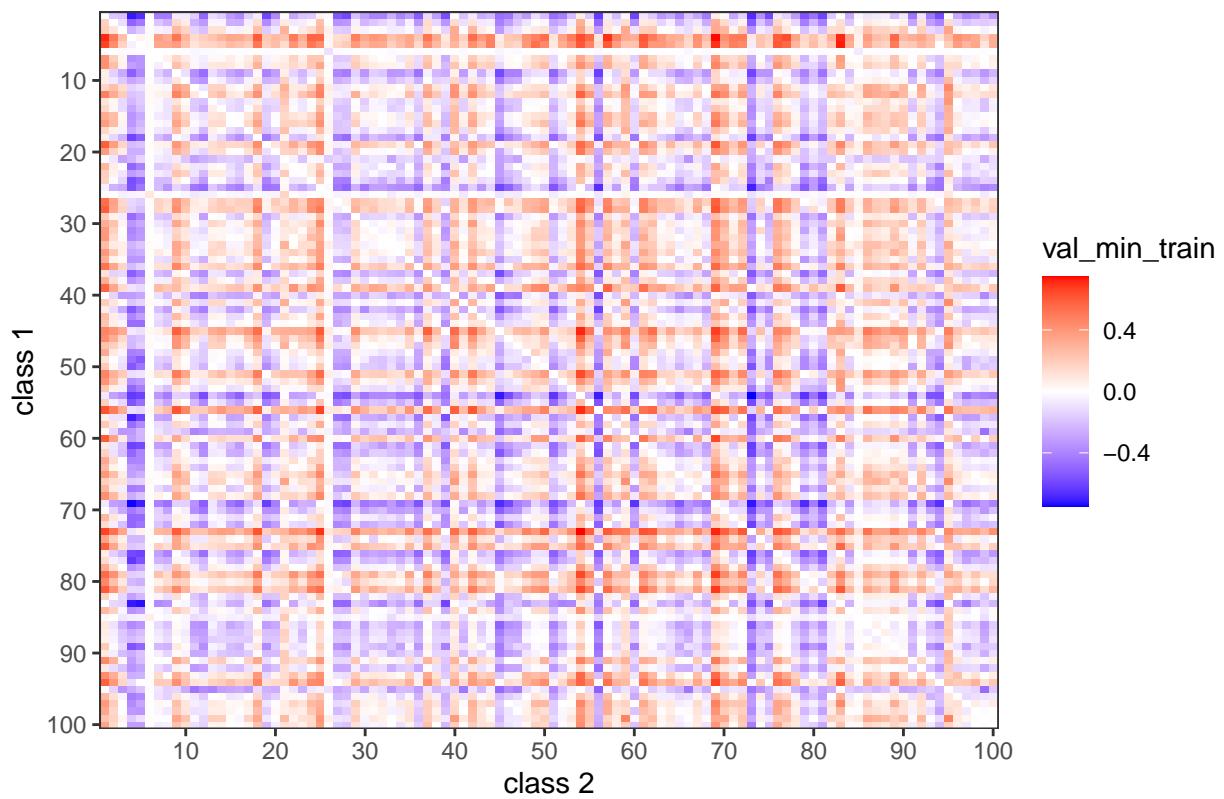
Pairwise probabilities differences – class 4



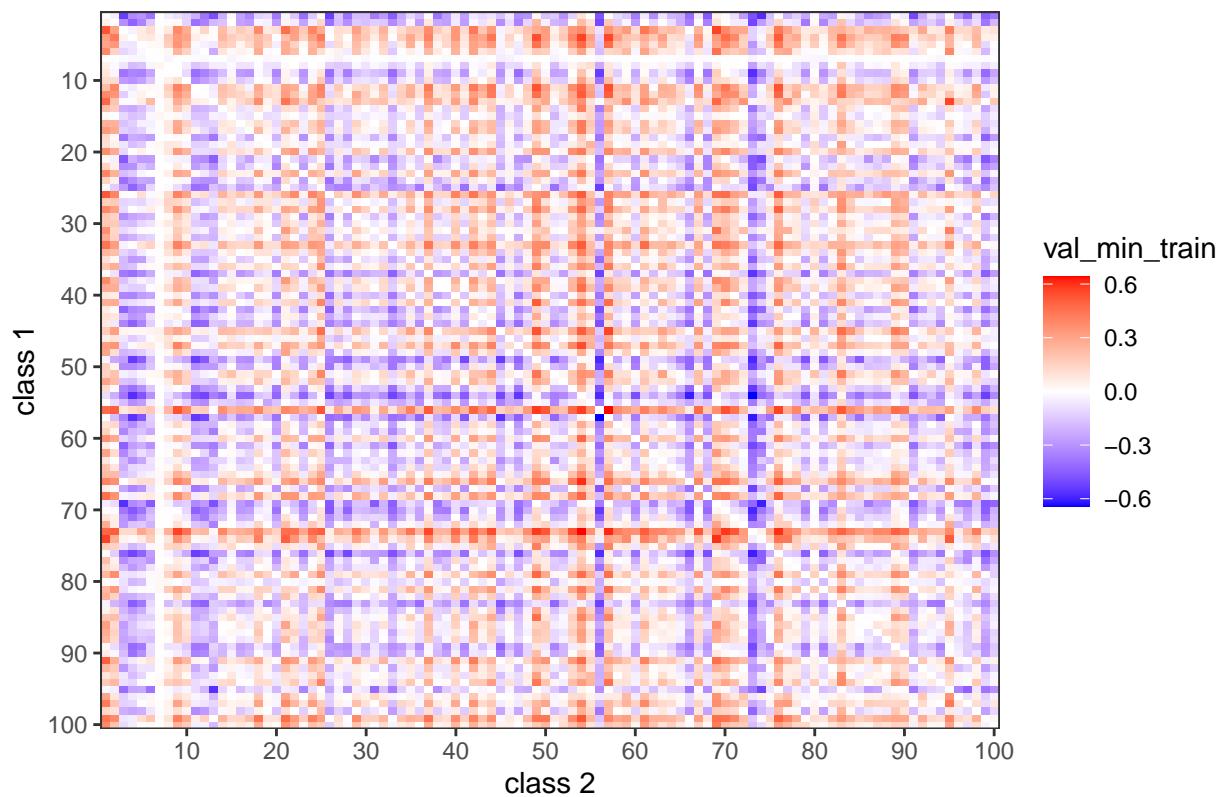
Pairwise probabilities differences – class 5



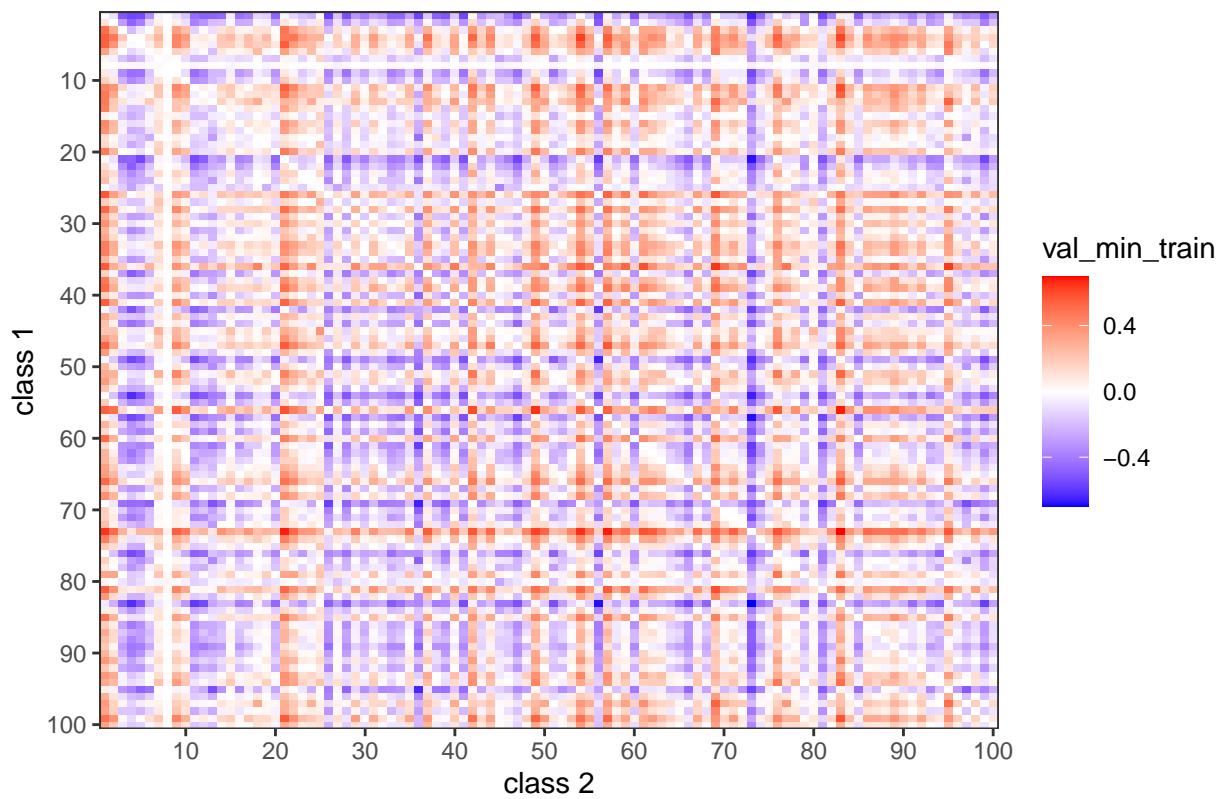
Pairwise probabilities differences – class 6



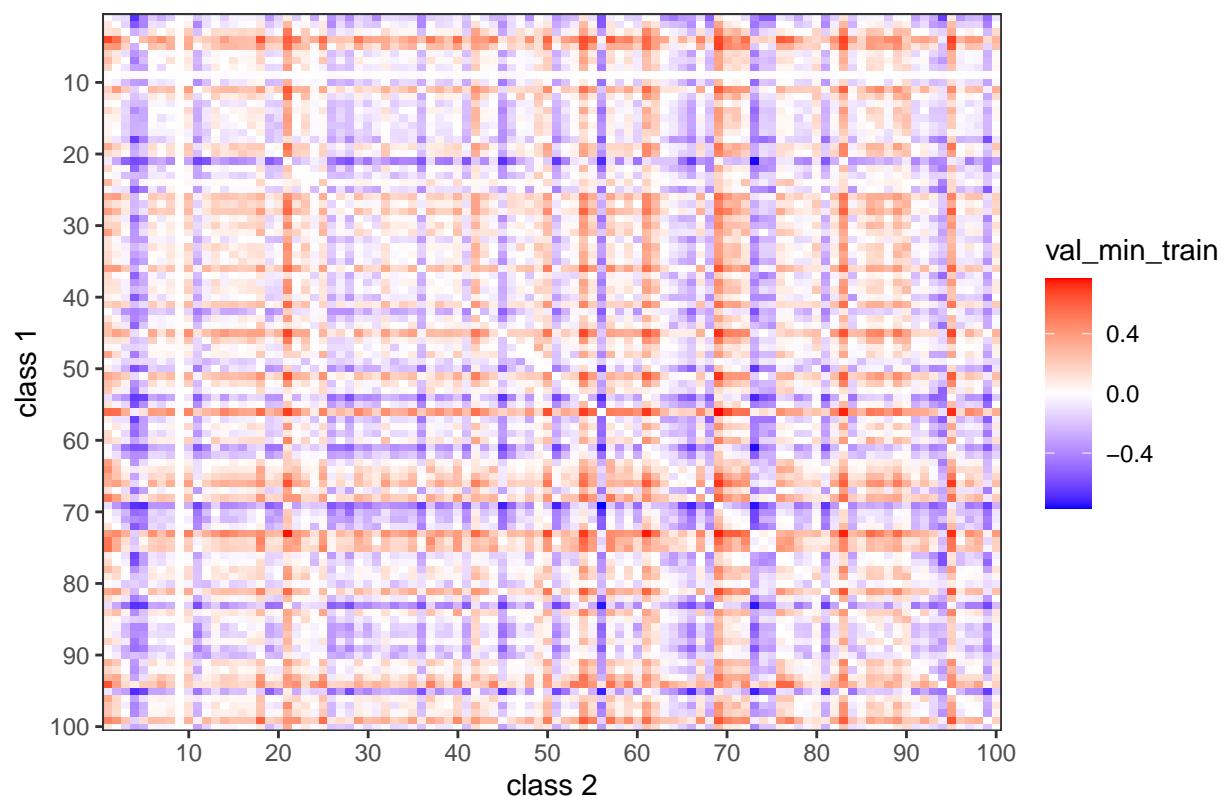
Pairwise probabilities differences – class 7



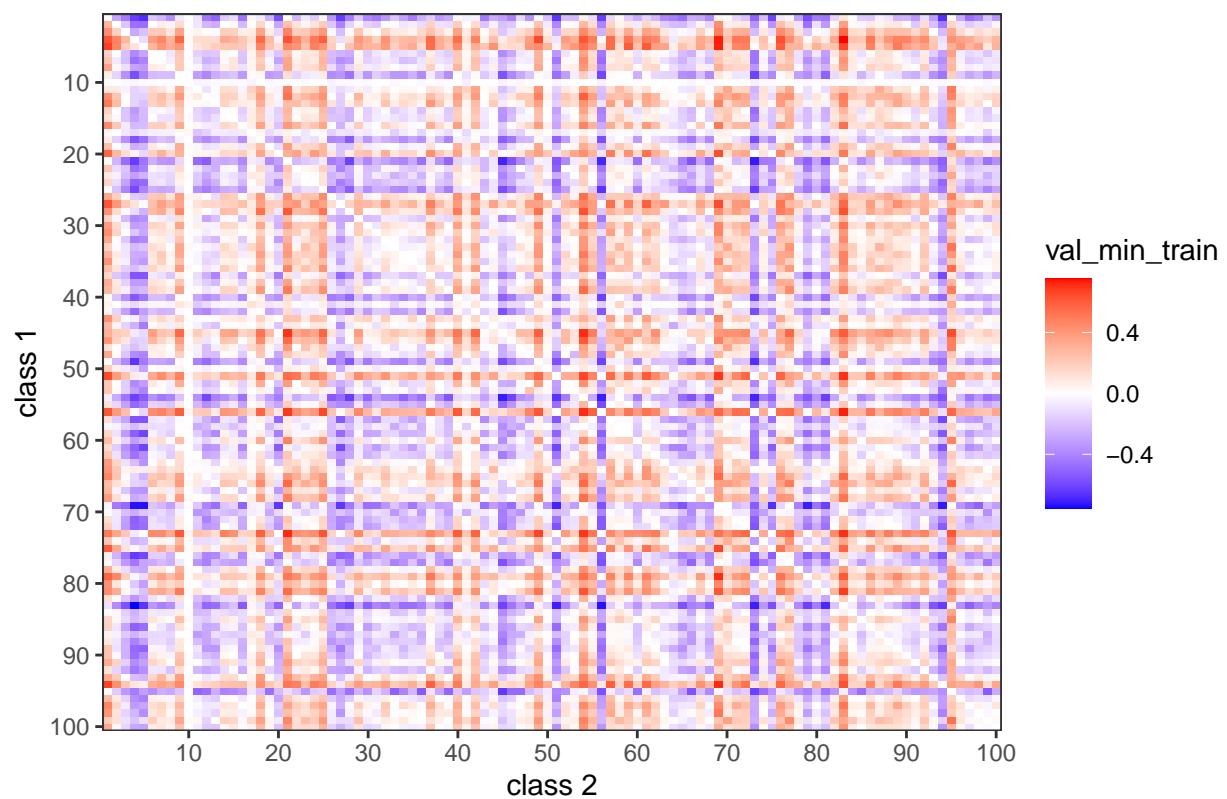
Pairwise probabilities differences – class 8



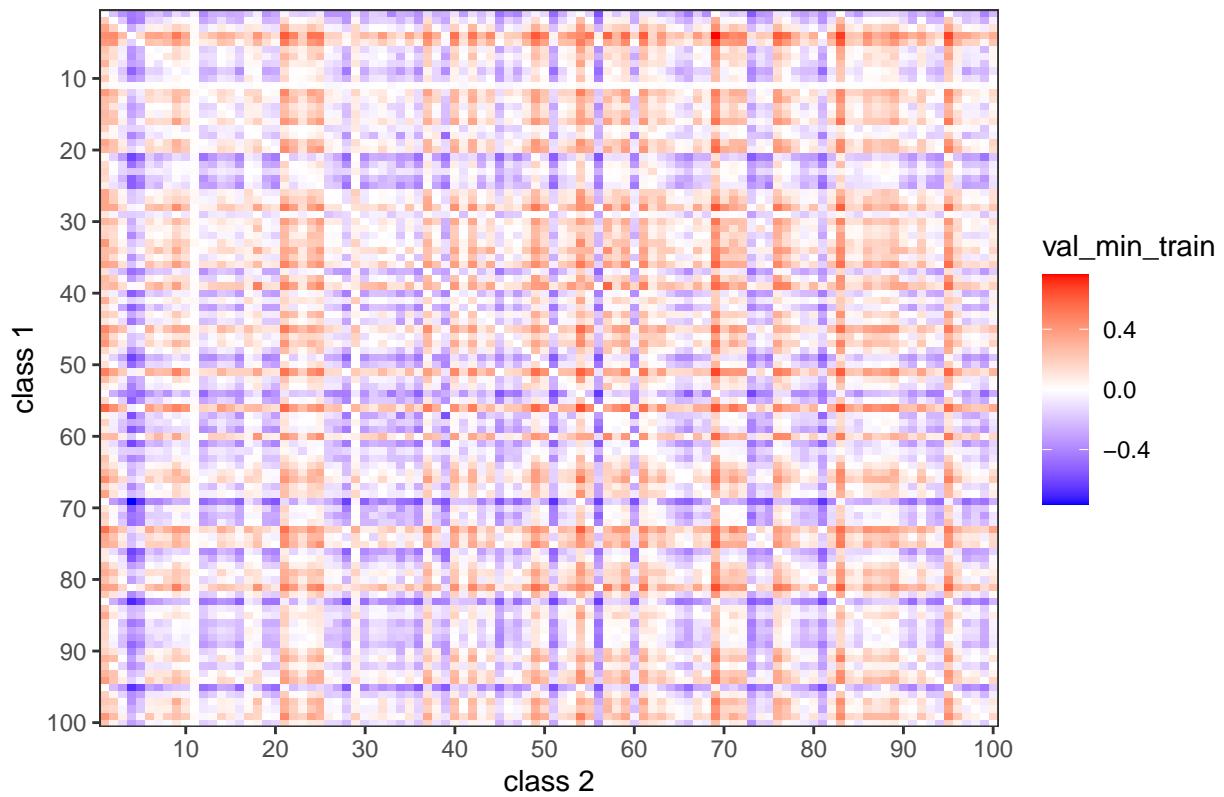
Pairwise probabilities differences – class 9



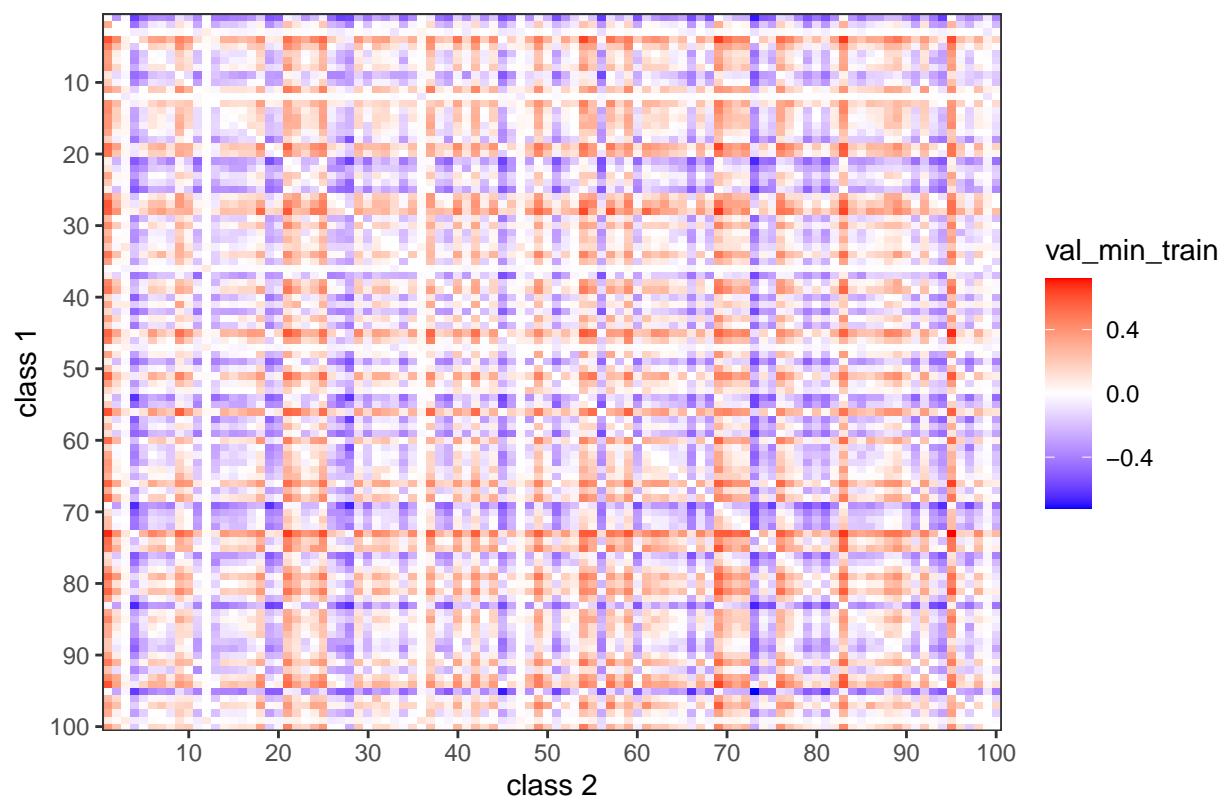
Pairwise probabilities differences – class 10



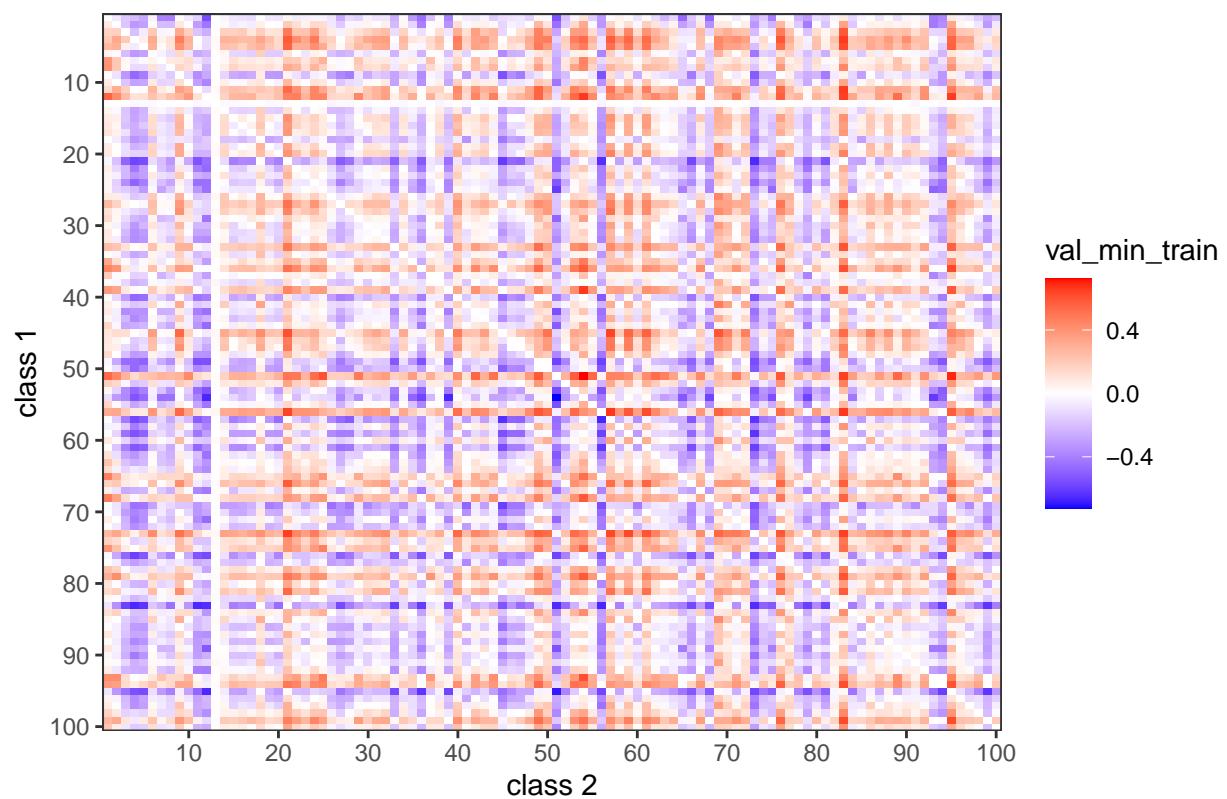
Pairwise probabilities differences – class 11



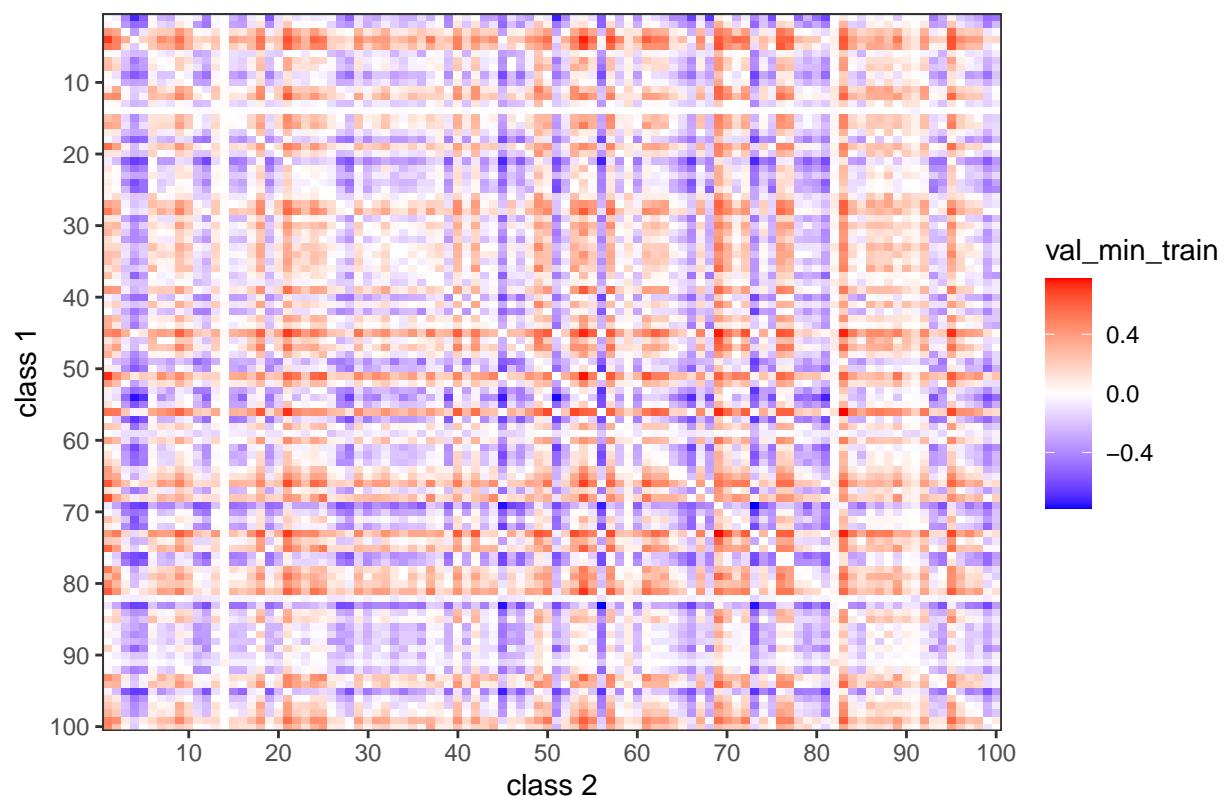
Pairwise probabilities differences – class 12



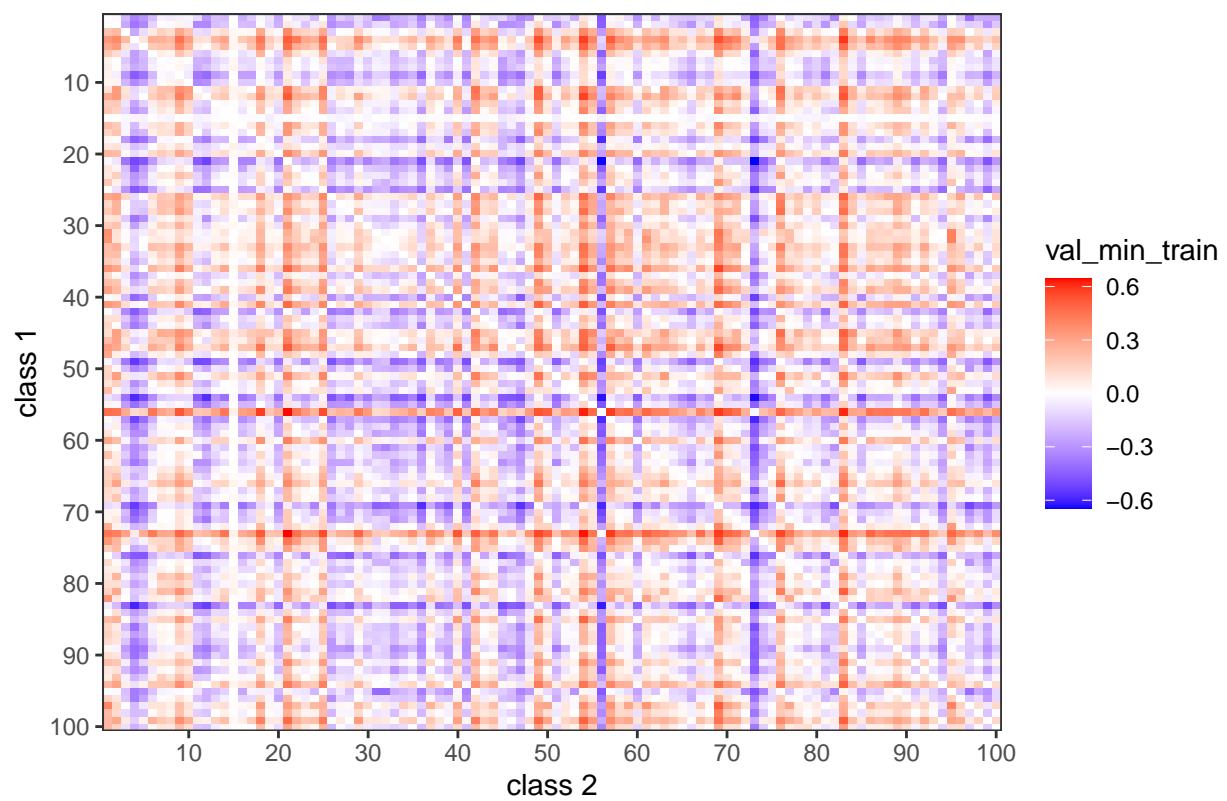
Pairwise probabilities differences – class 13



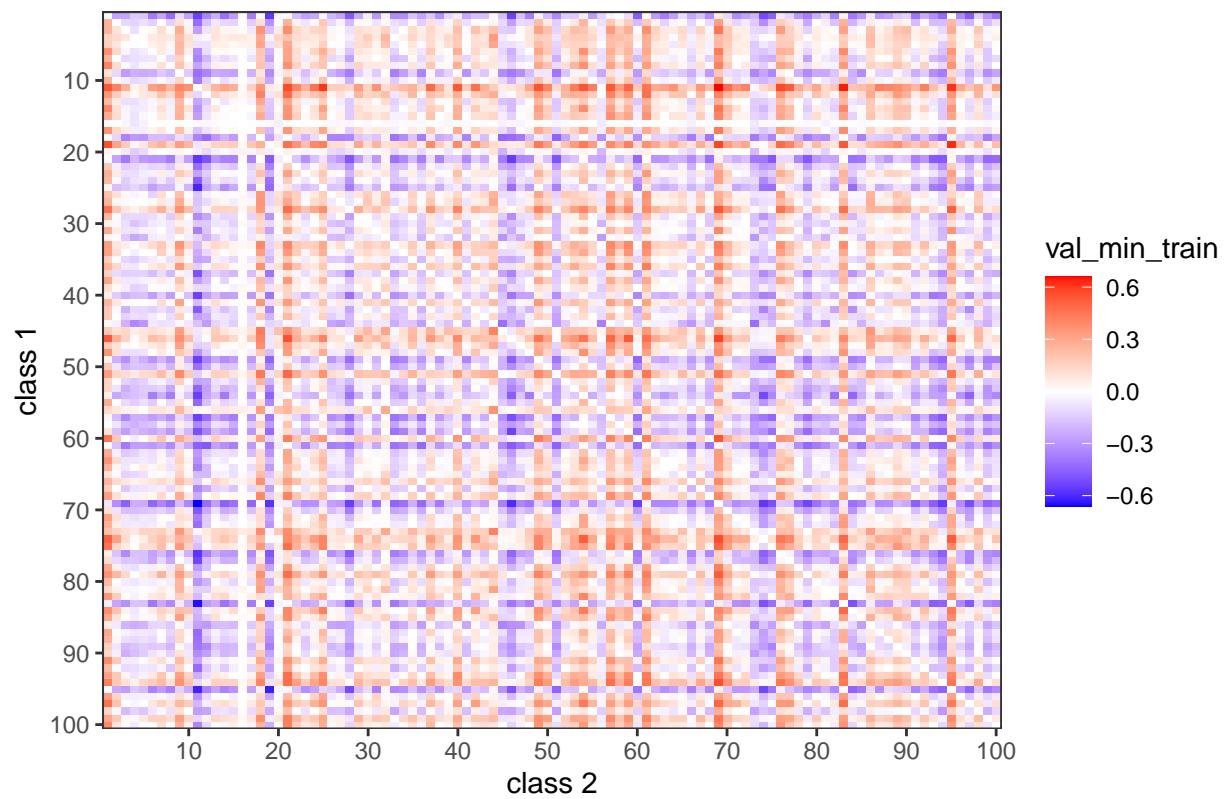
Pairwise probabilities differences – class 14



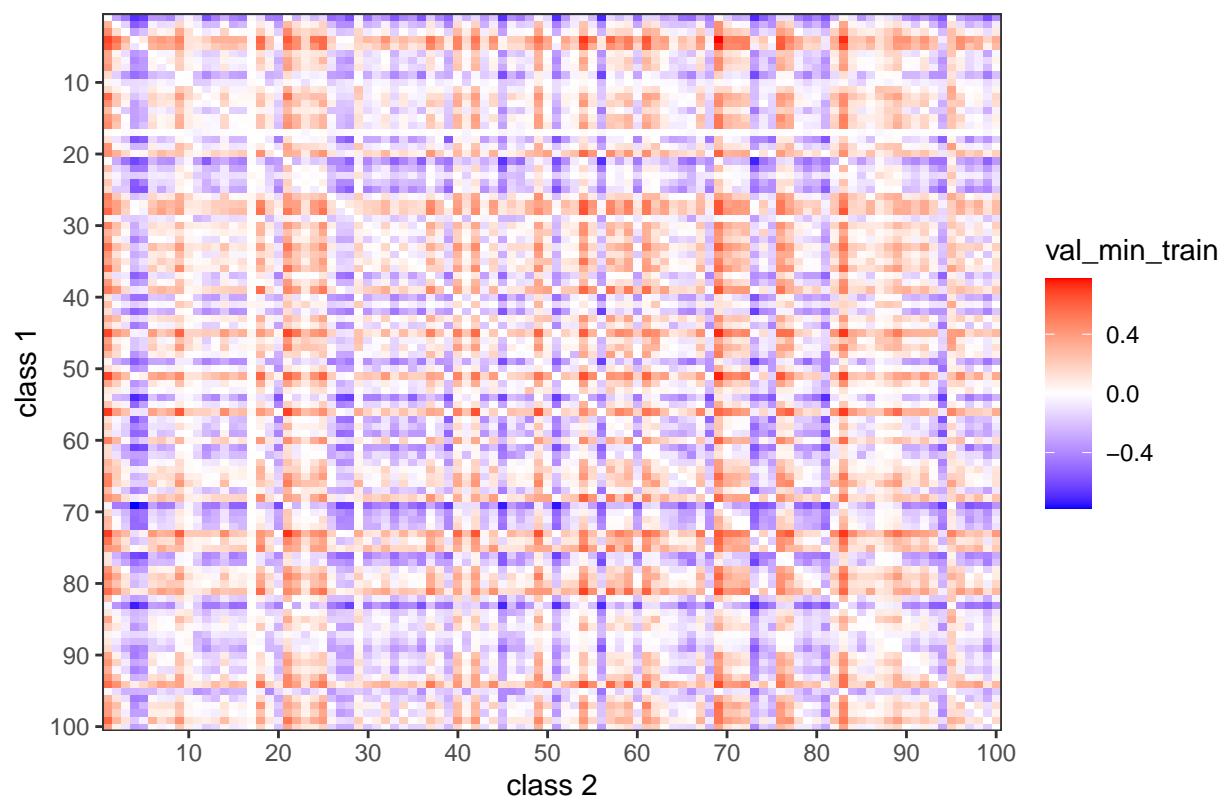
Pairwise probabilities differences – class 15



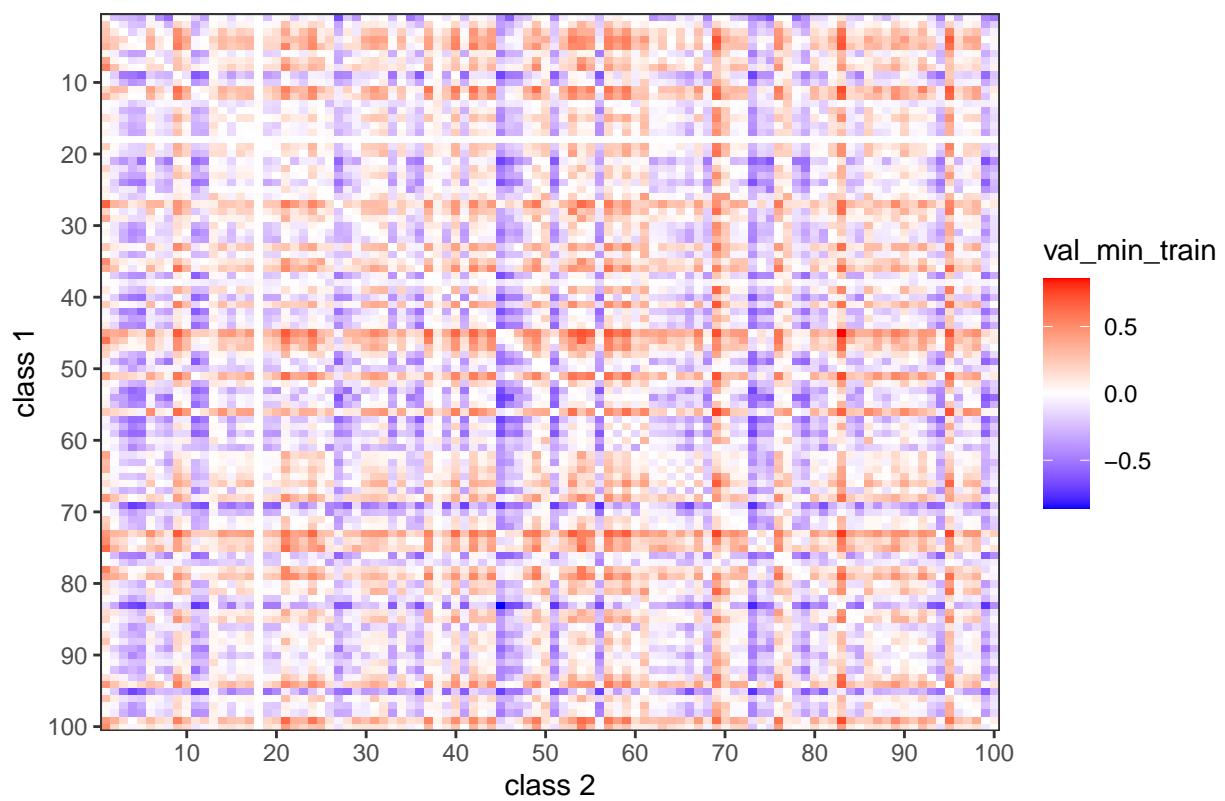
Pairwise probabilities differences – class 16



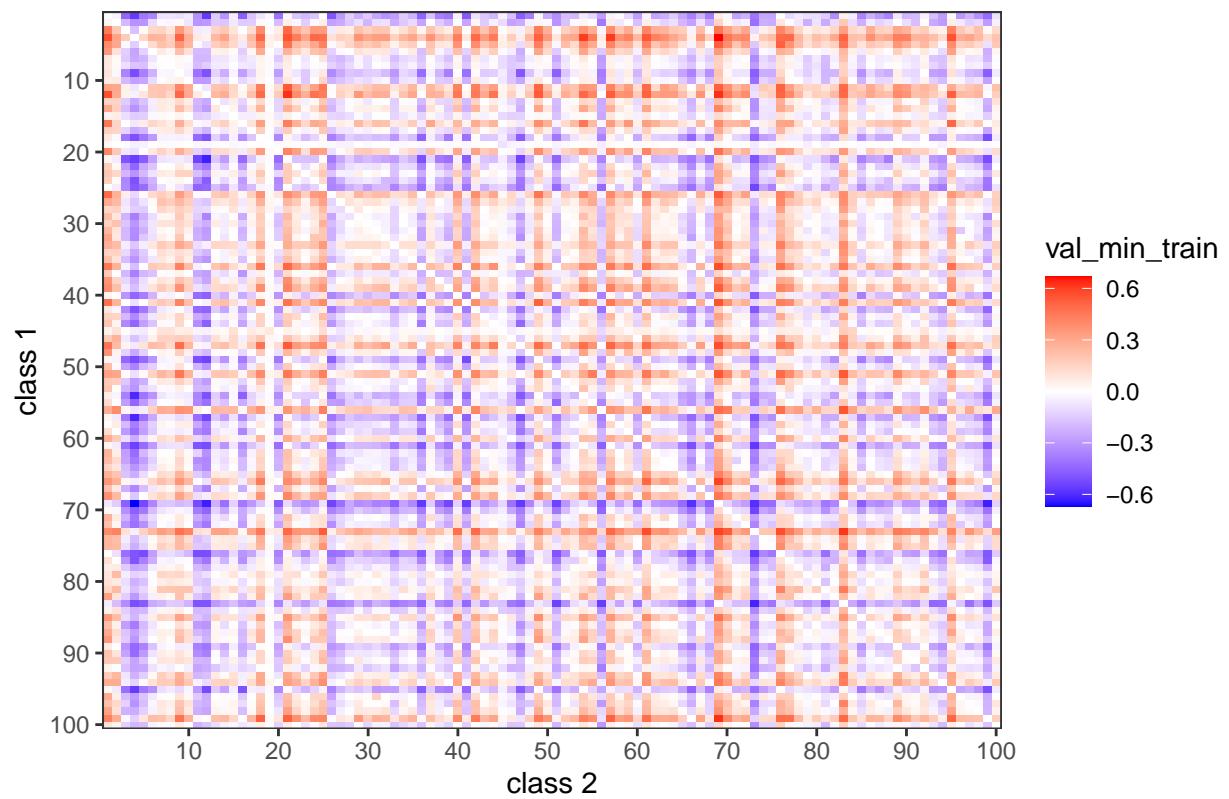
Pairwise probabilities differences – class 17



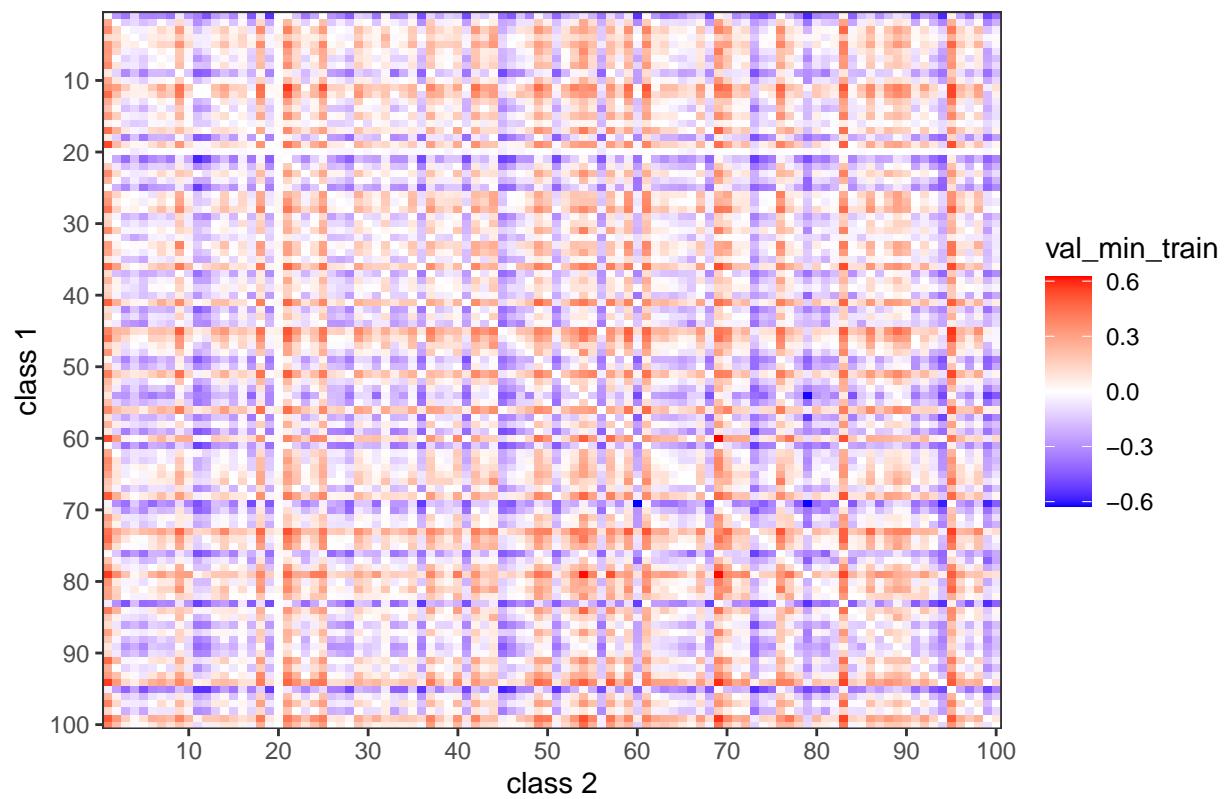
Pairwise probabilities differences – class 18



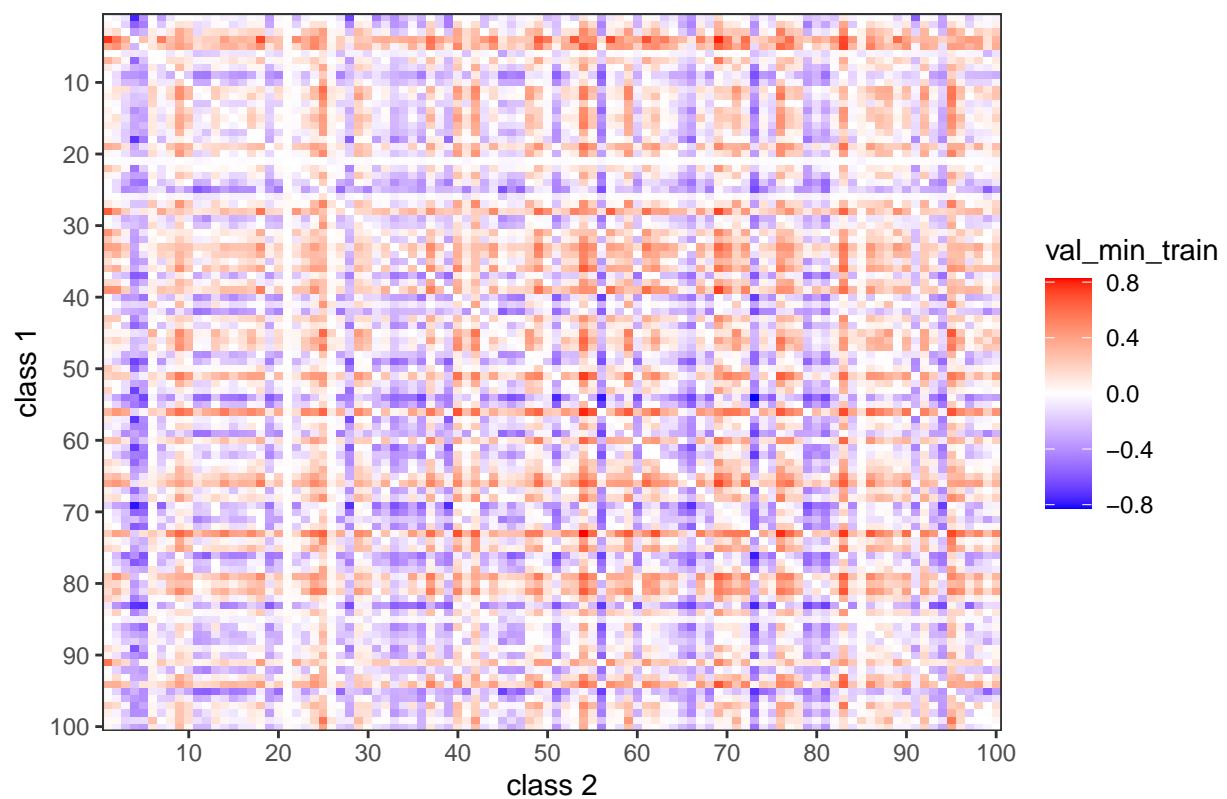
Pairwise probabilities differences – class 19



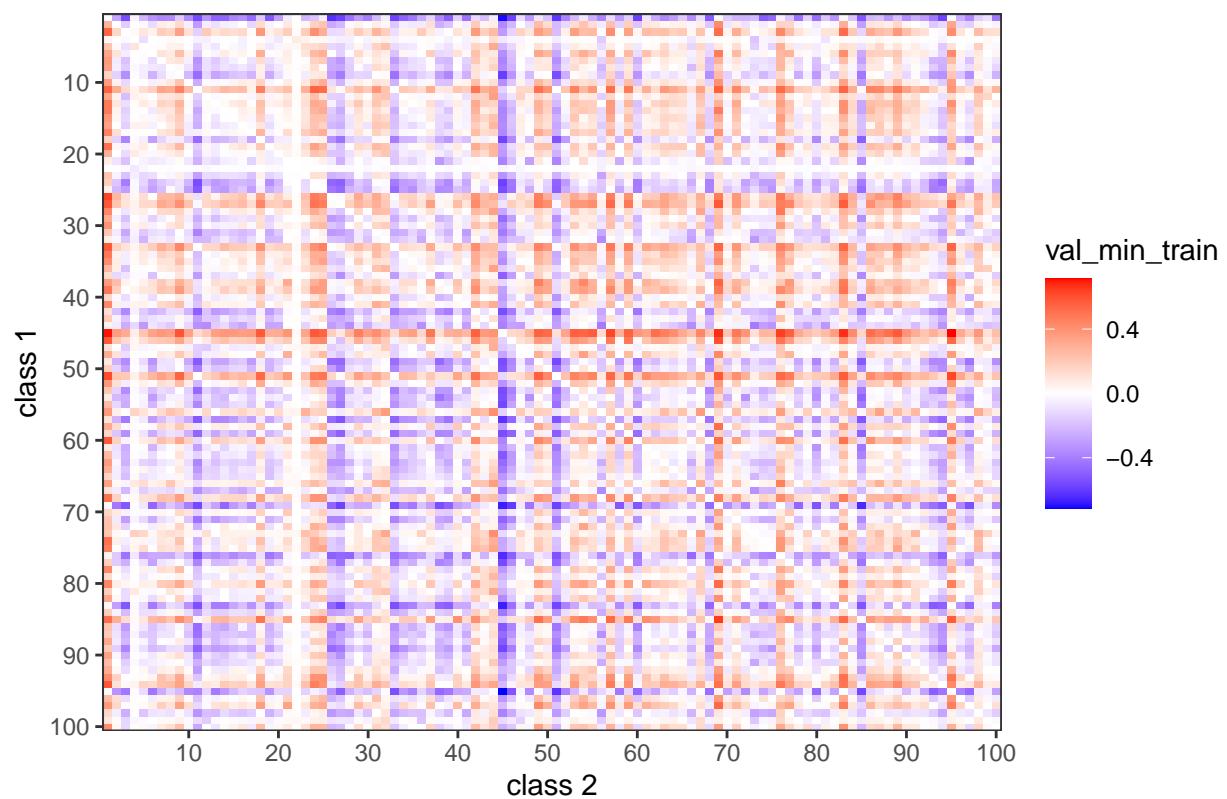
Pairwise probabilities differences – class 20



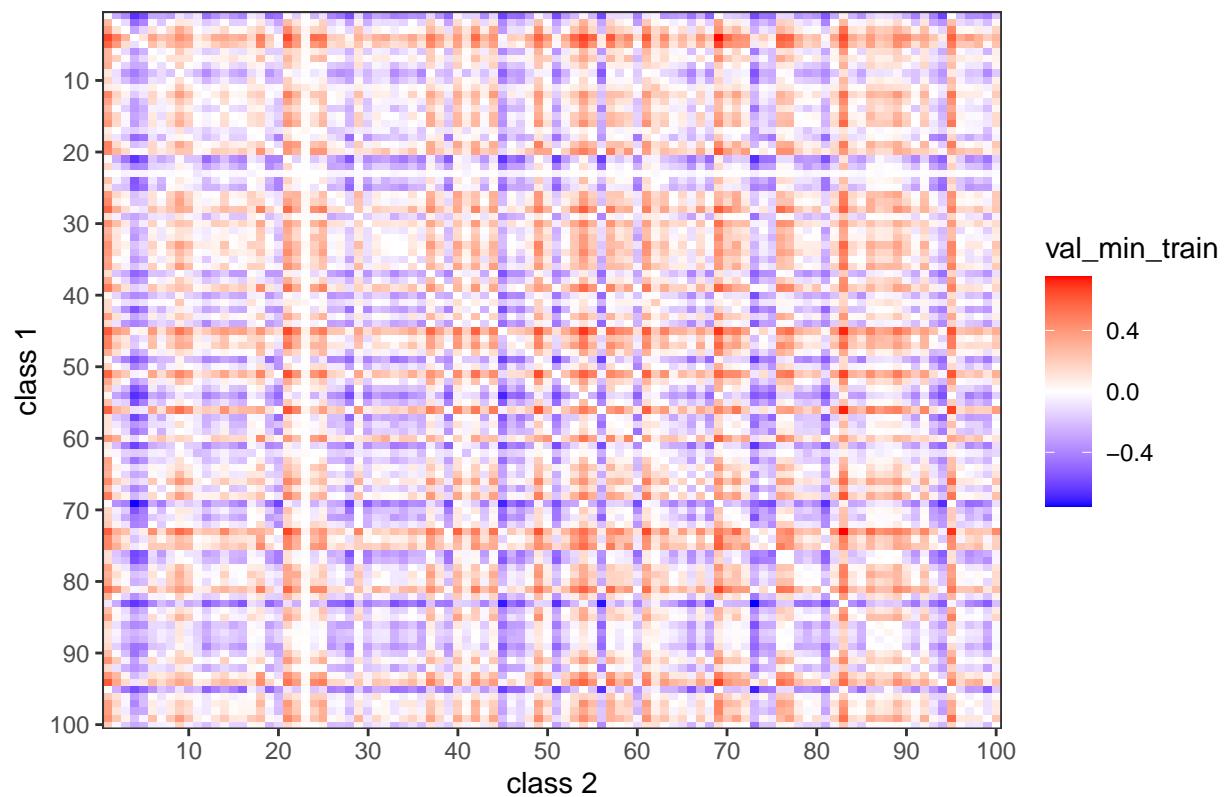
Pairwise probabilities differences – class 21



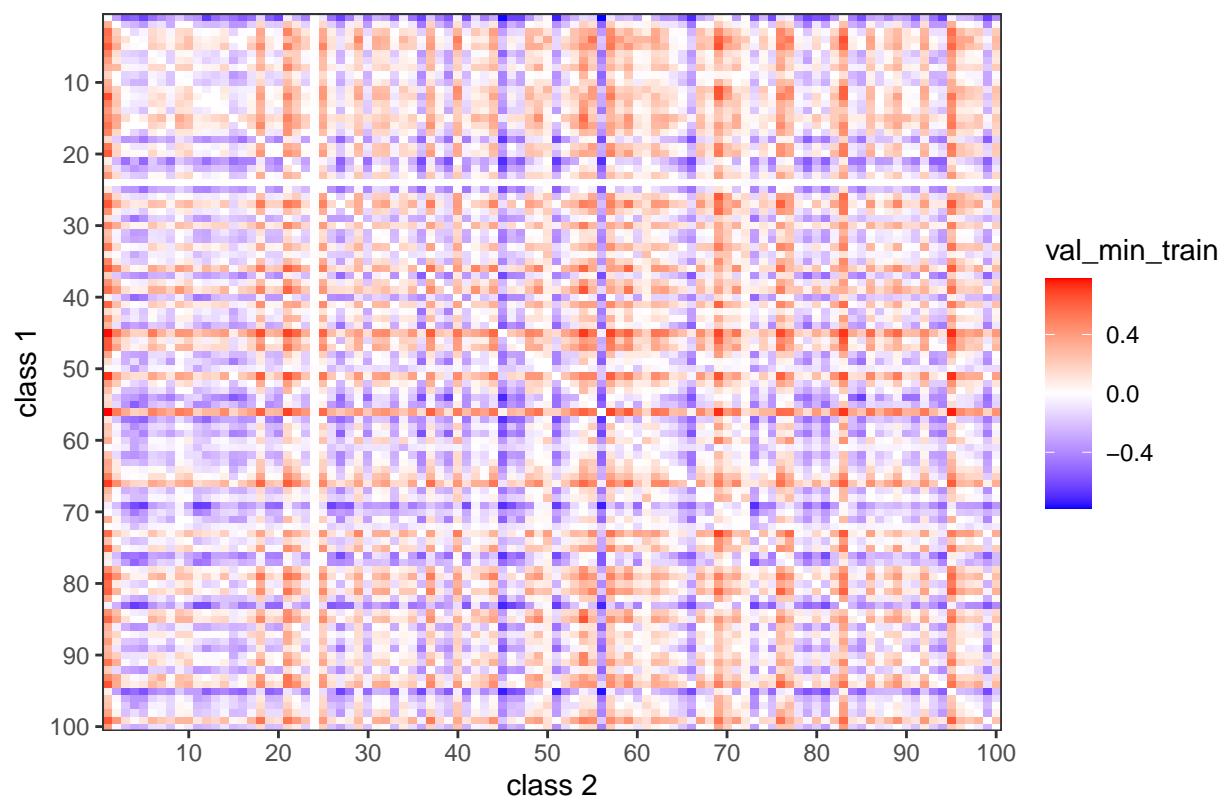
Pairwise probabilities differences – class 22



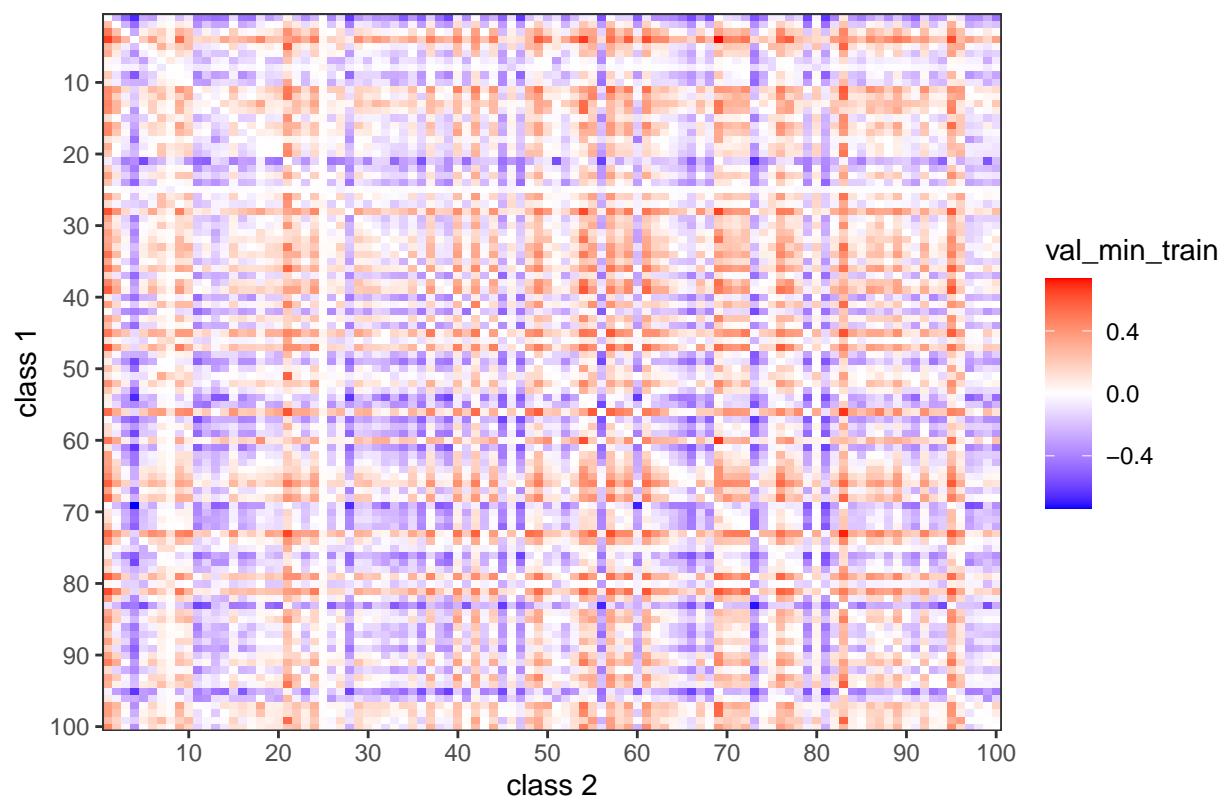
Pairwise probabilities differences – class 23



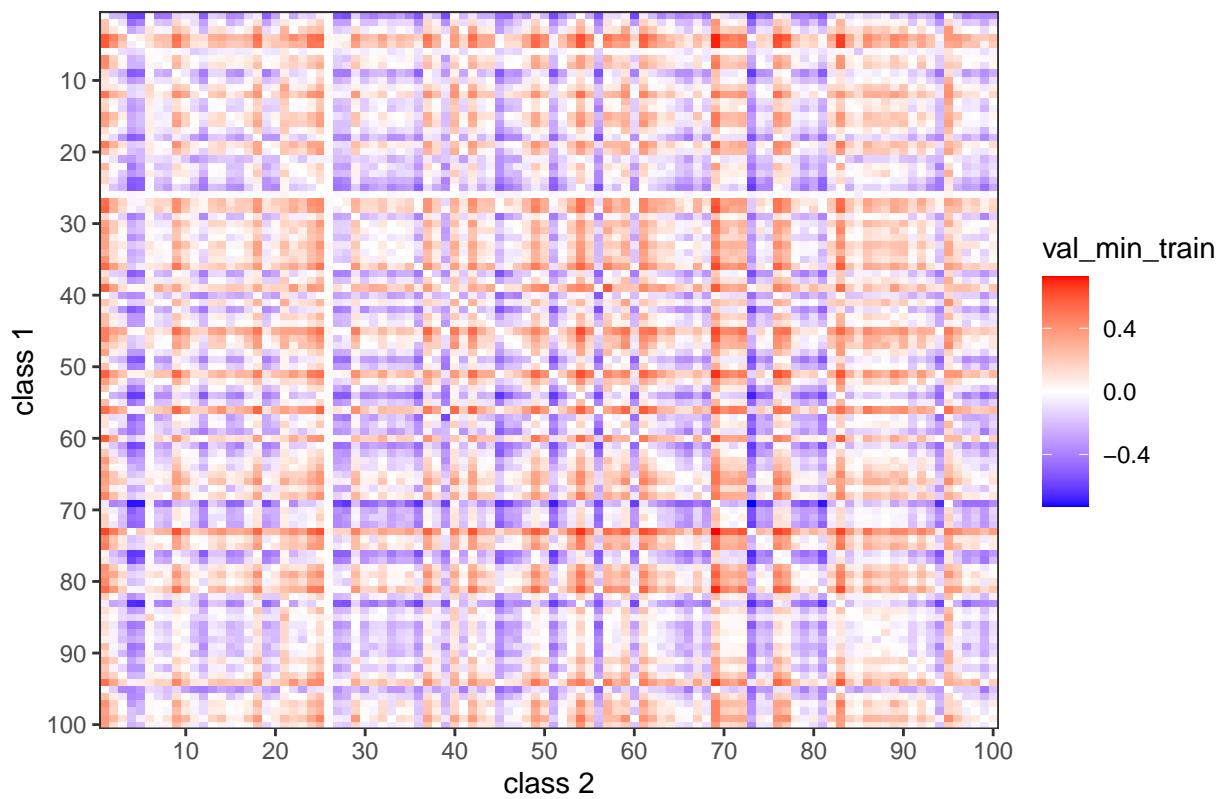
Pairwise probabilities differences – class 24



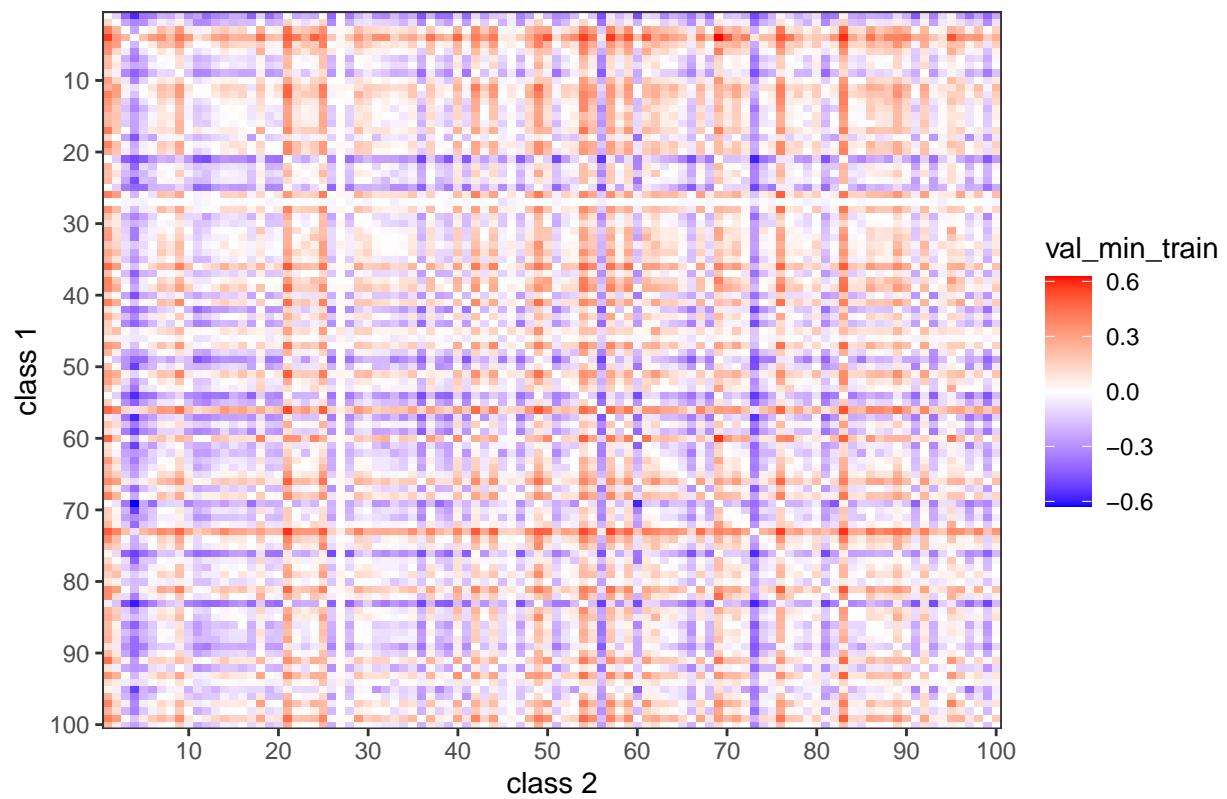
Pairwise probabilities differences – class 25



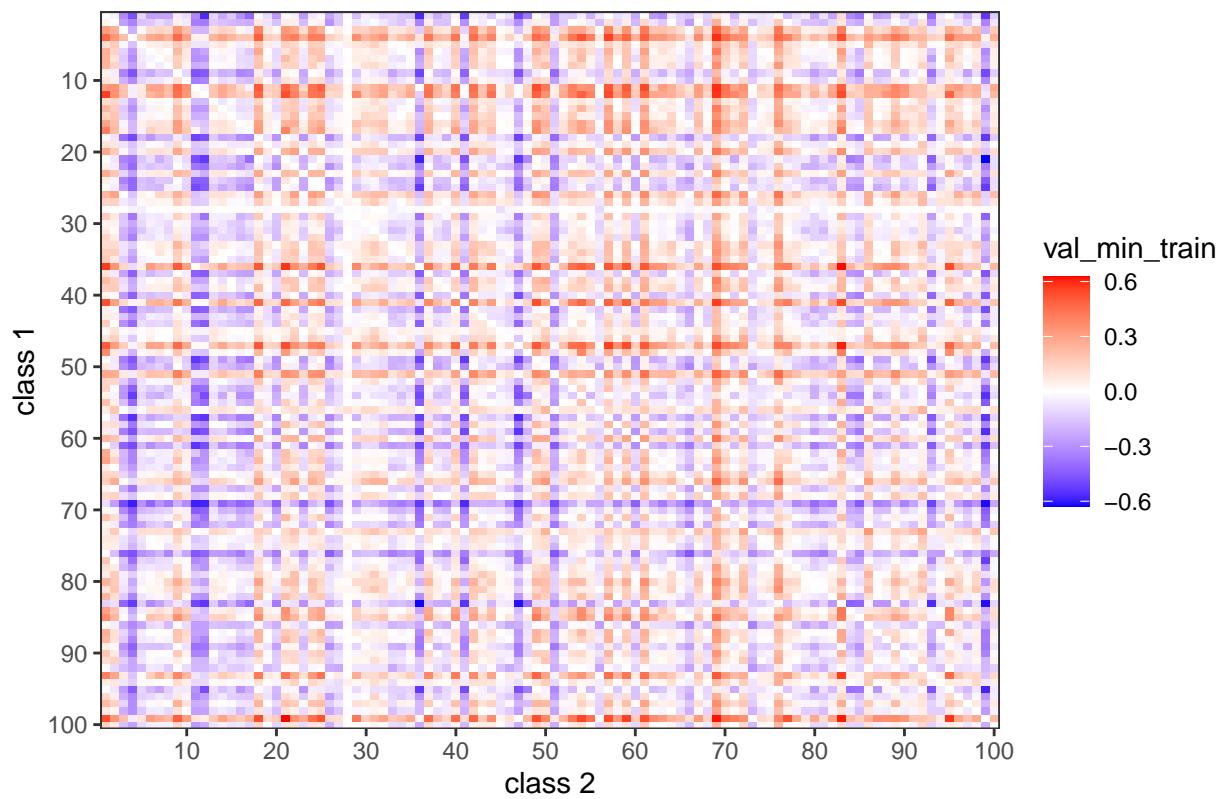
Pairwise probabilities differences – class 26



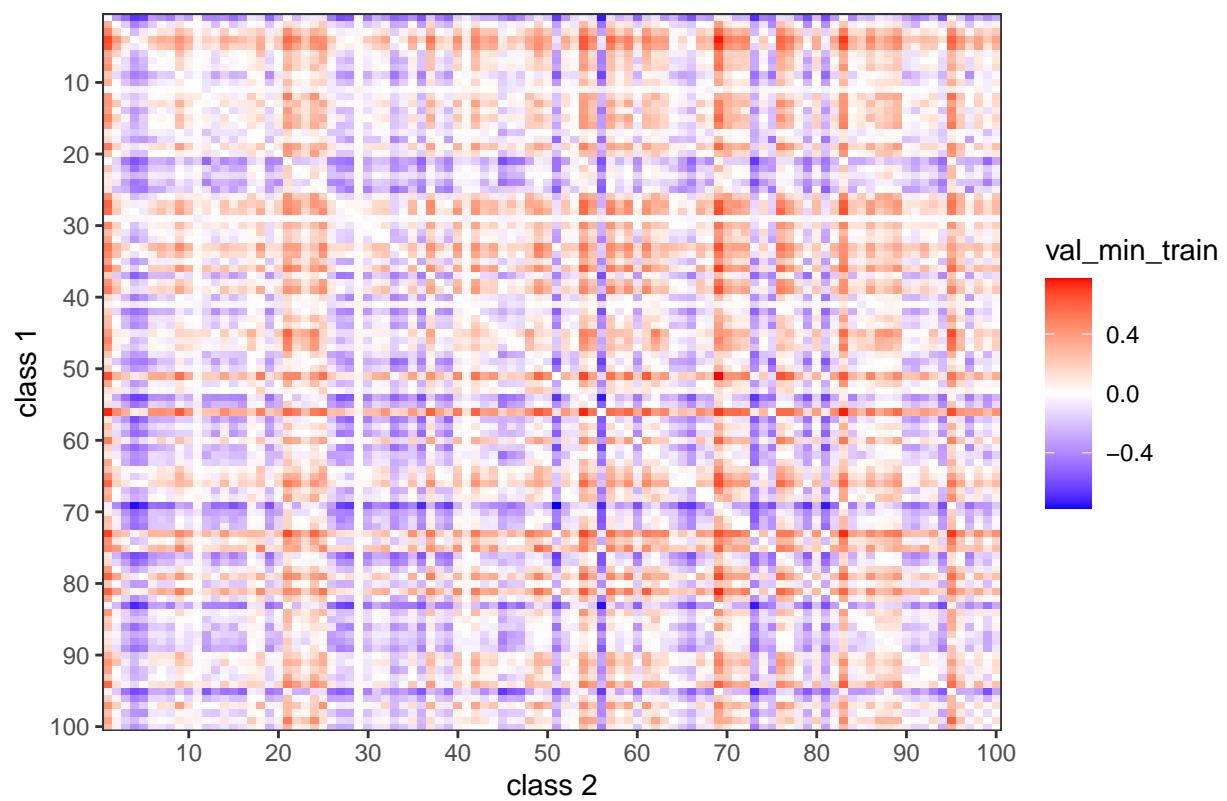
Pairwise probabilities differences – class 27



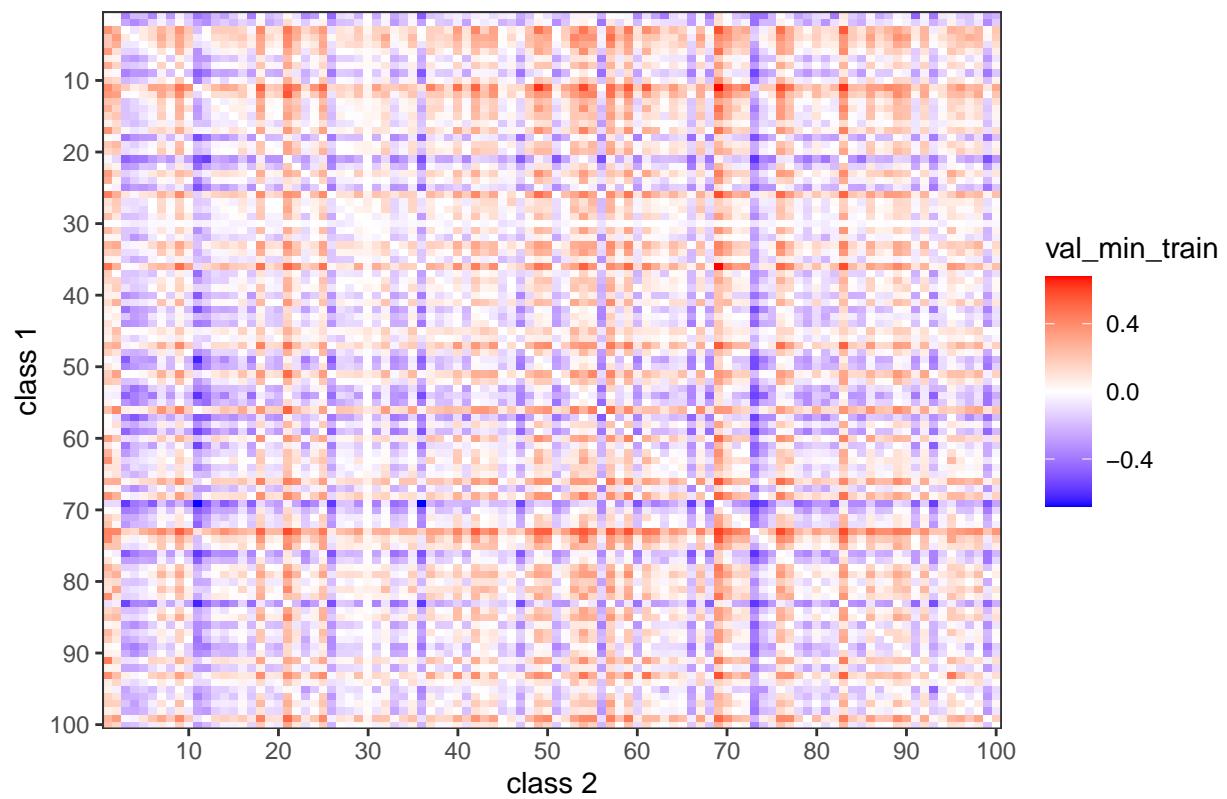
Pairwise probabilities differences – class 28



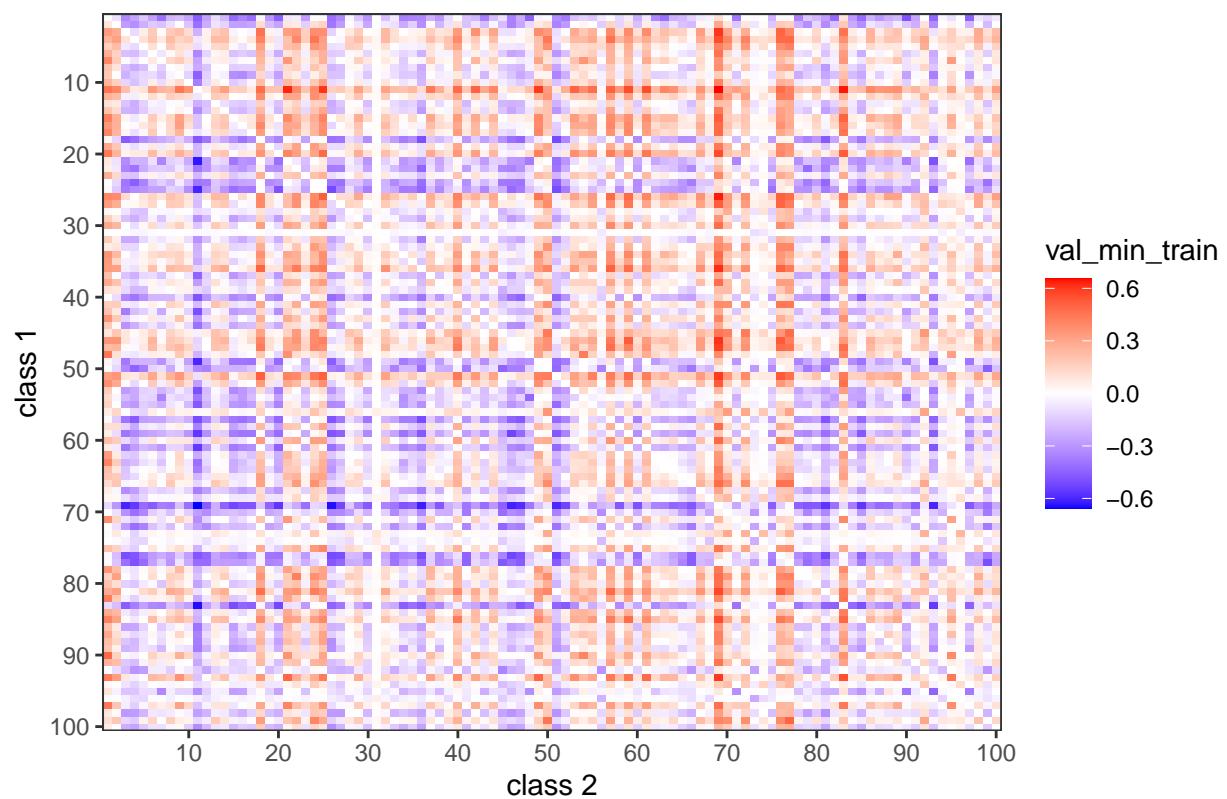
Pairwise probabilities differences – class 29



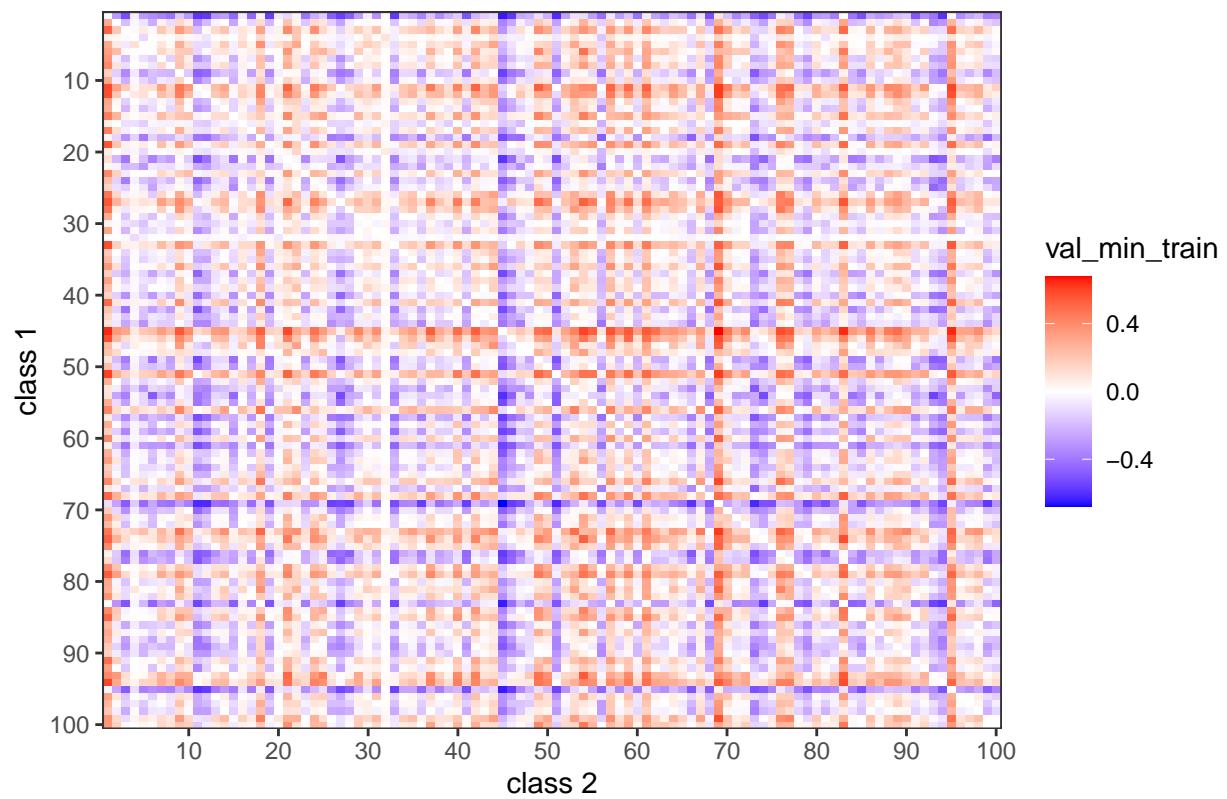
Pairwise probabilities differences – class 30



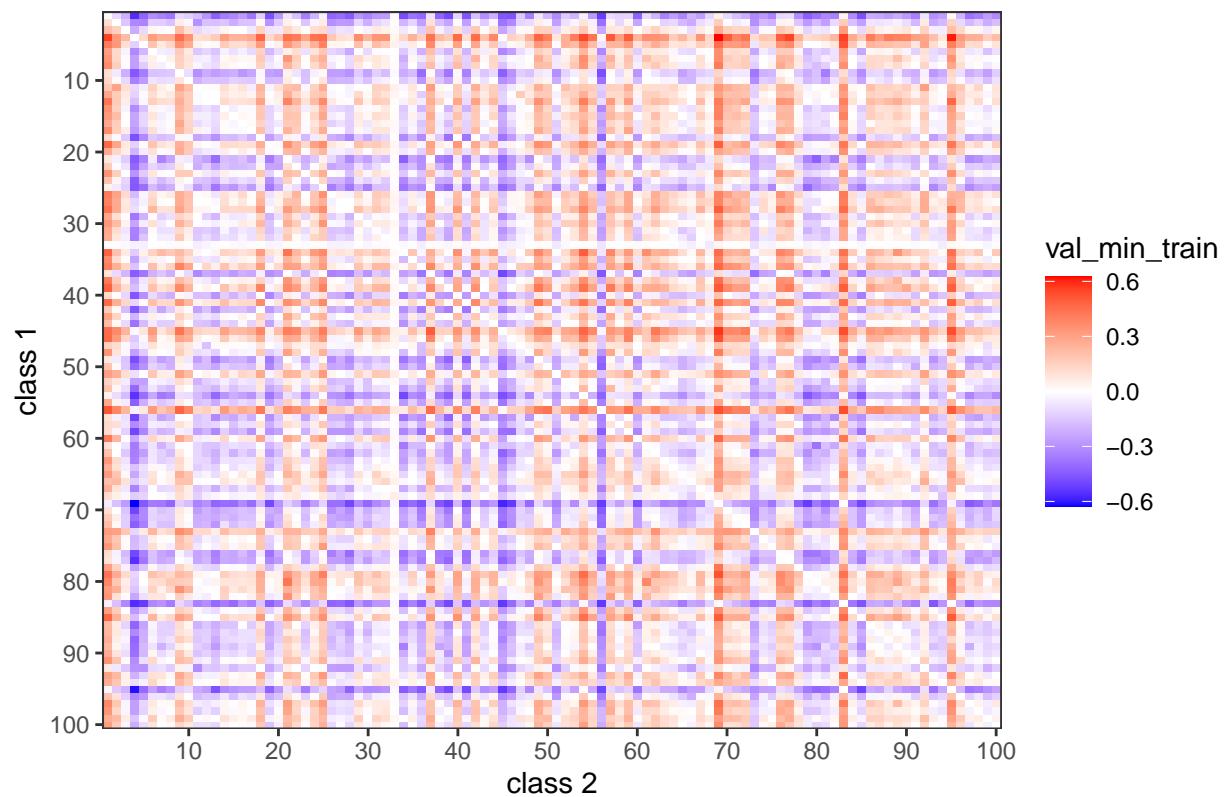
Pairwise probabilities differences – class 31



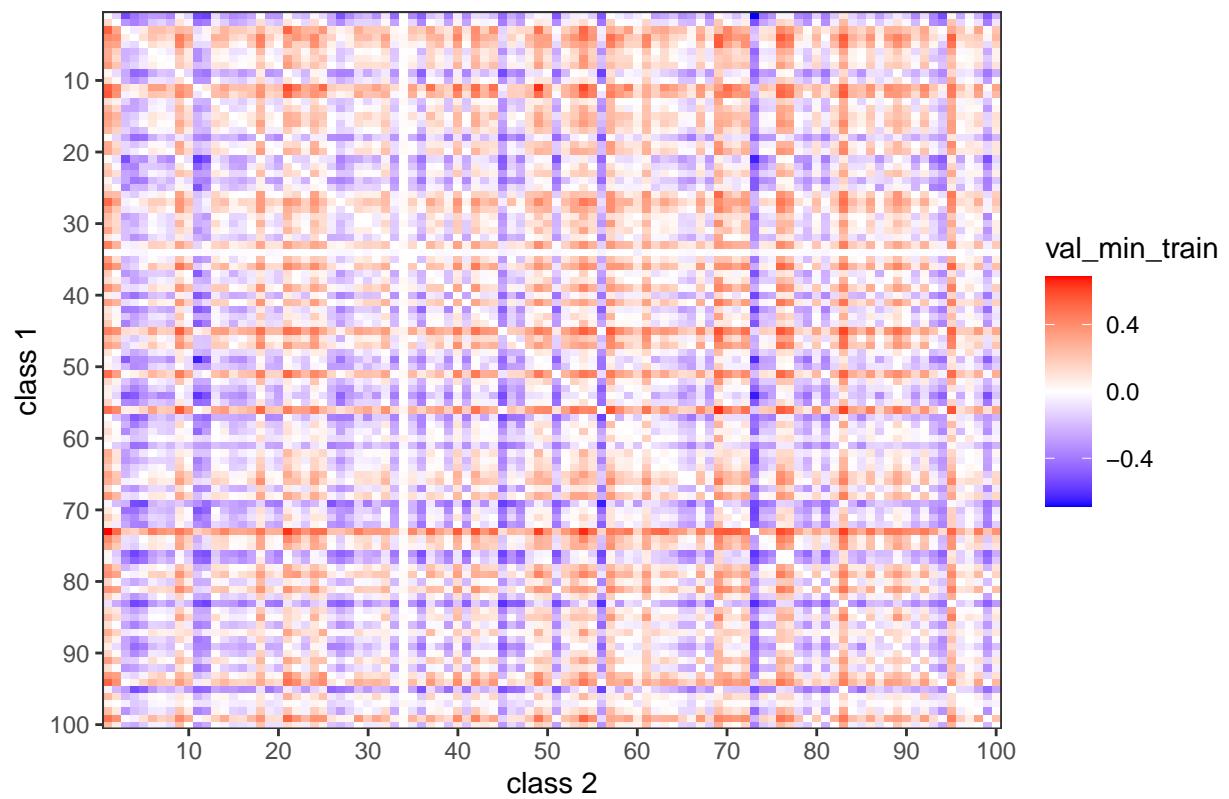
Pairwise probabilities differences – class 32



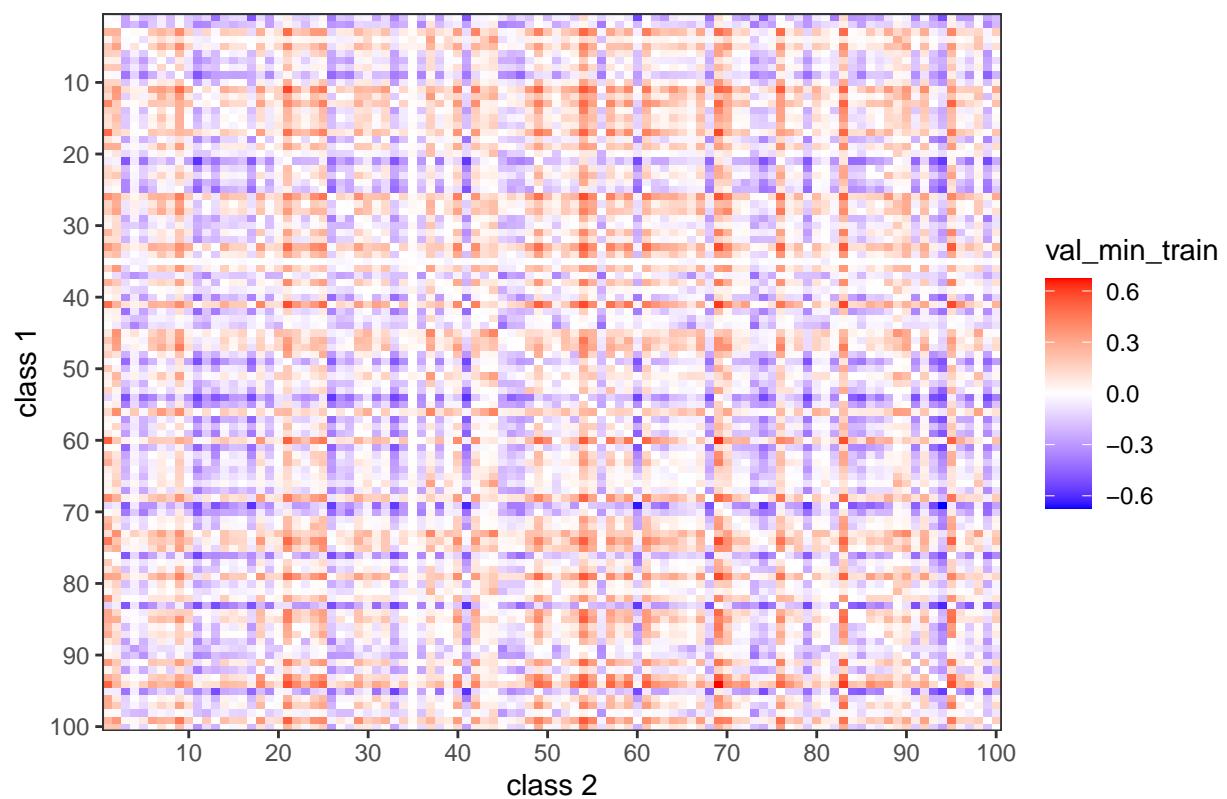
Pairwise probabilities differences – class 33



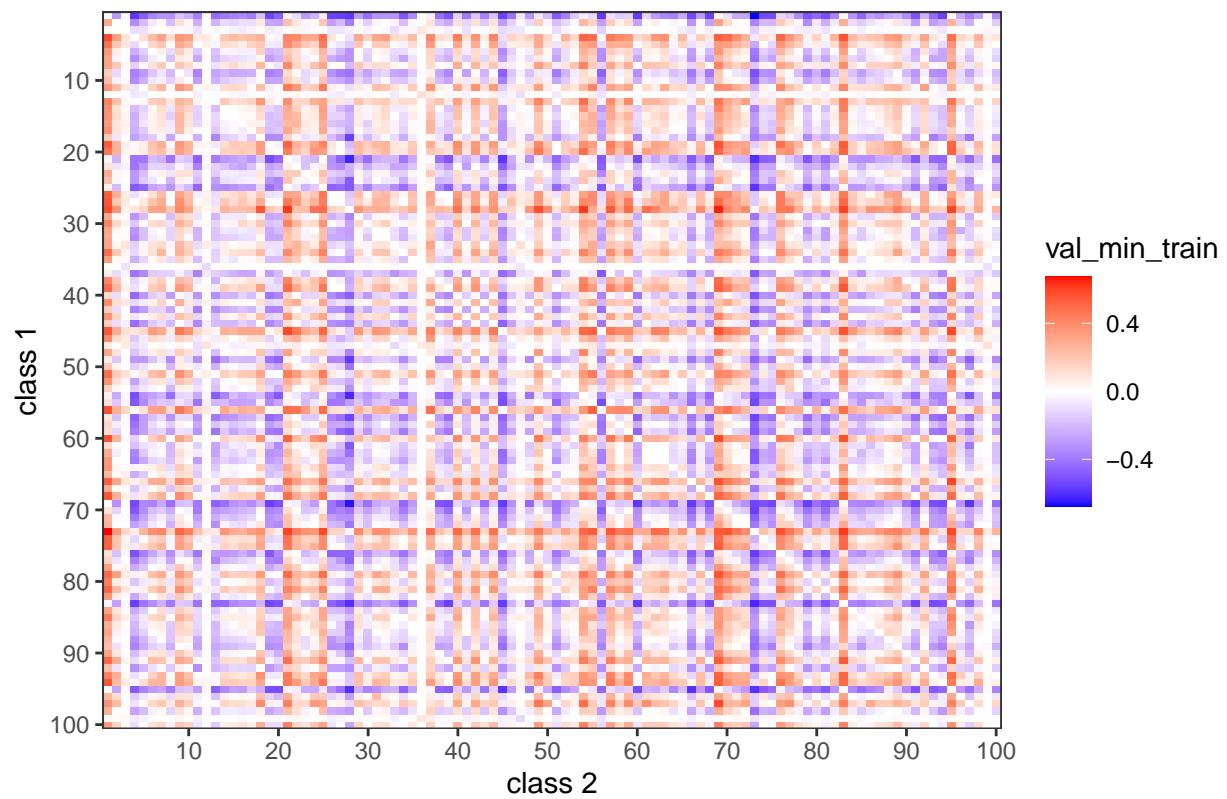
Pairwise probabilities differences – class 34



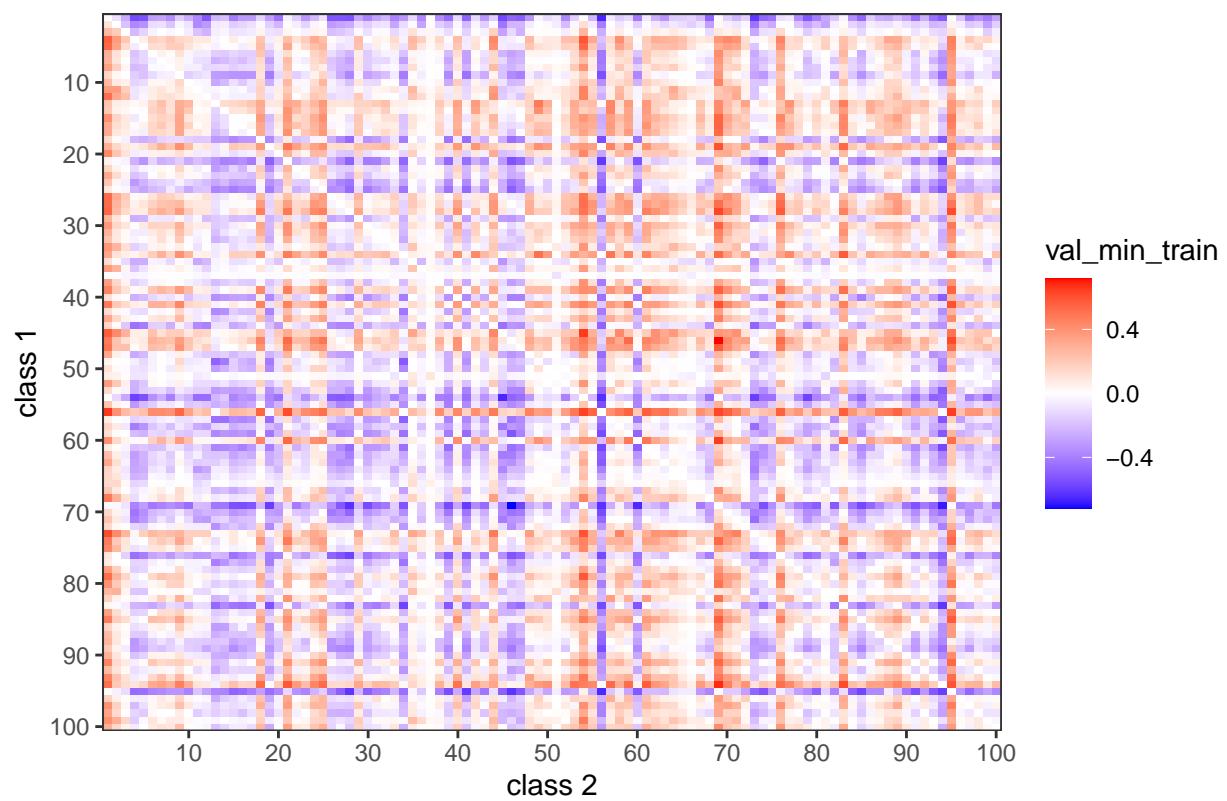
Pairwise probabilities differences – class 35



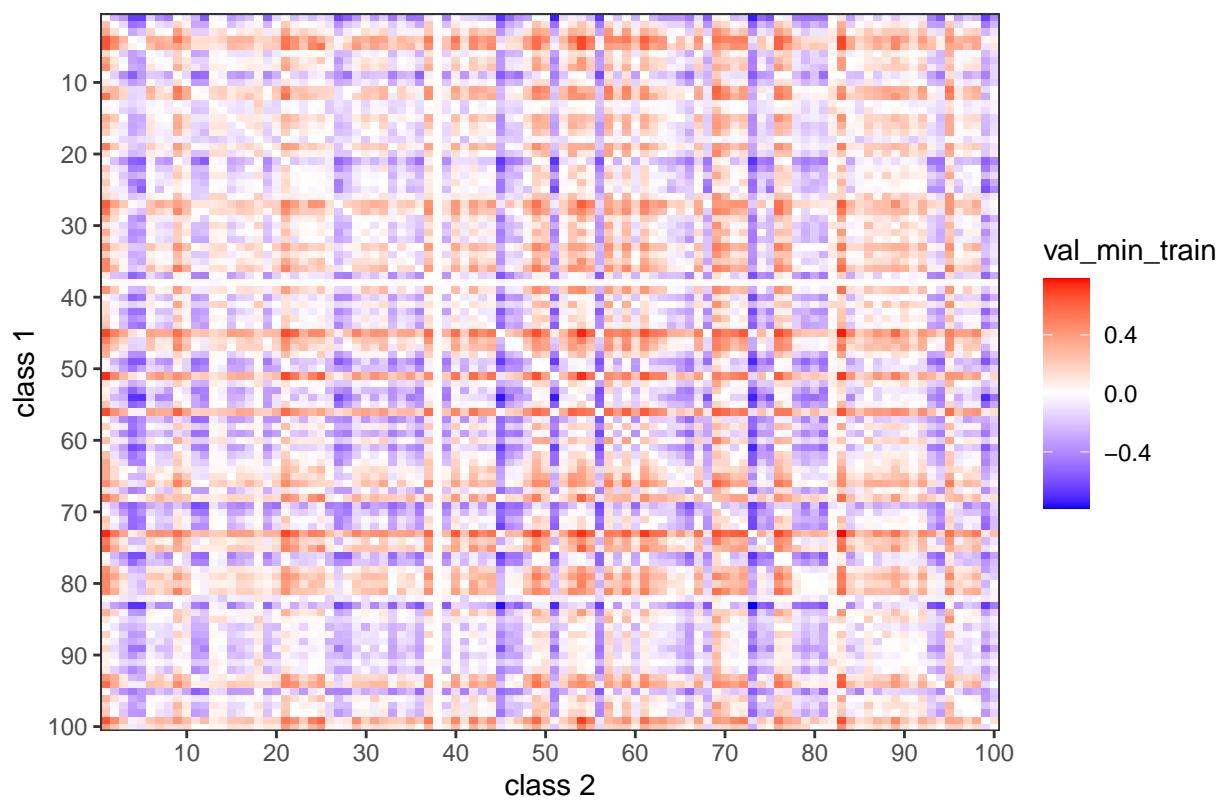
Pairwise probabilities differences – class 36



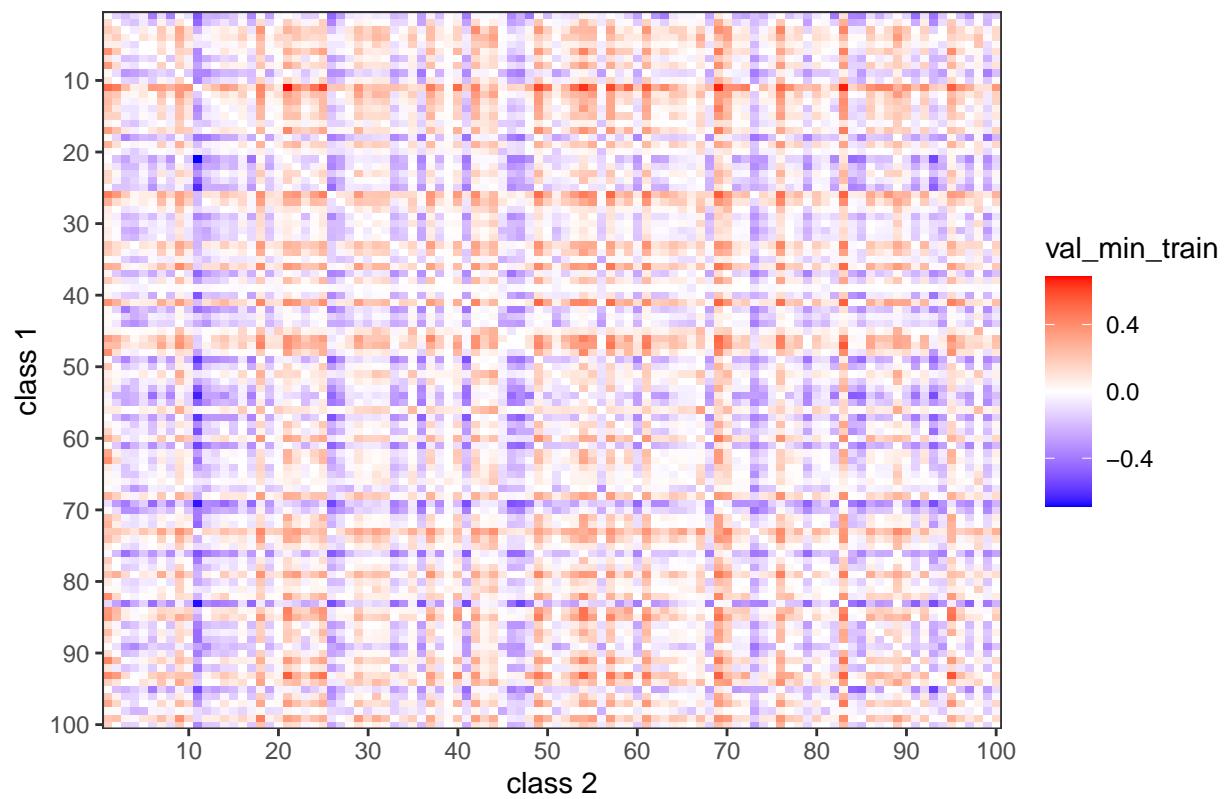
Pairwise probabilities differences – class 37



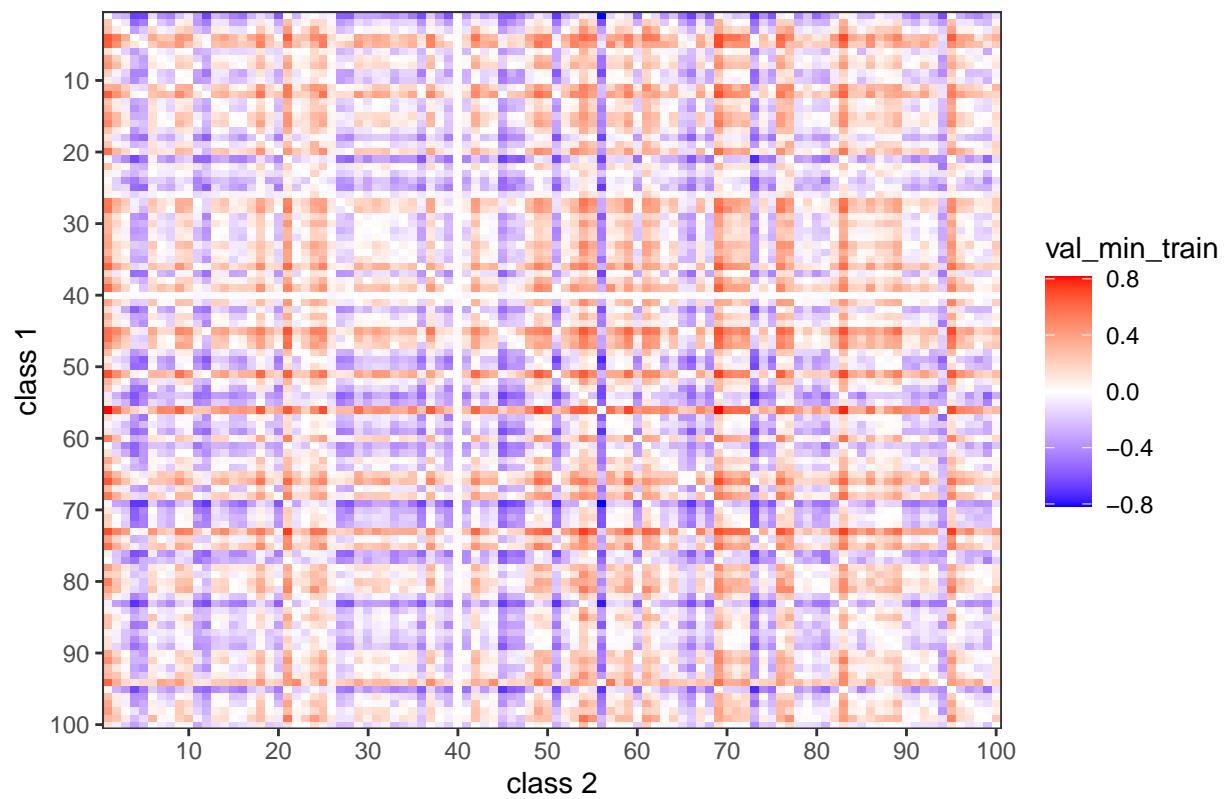
Pairwise probabilities differences – class 38



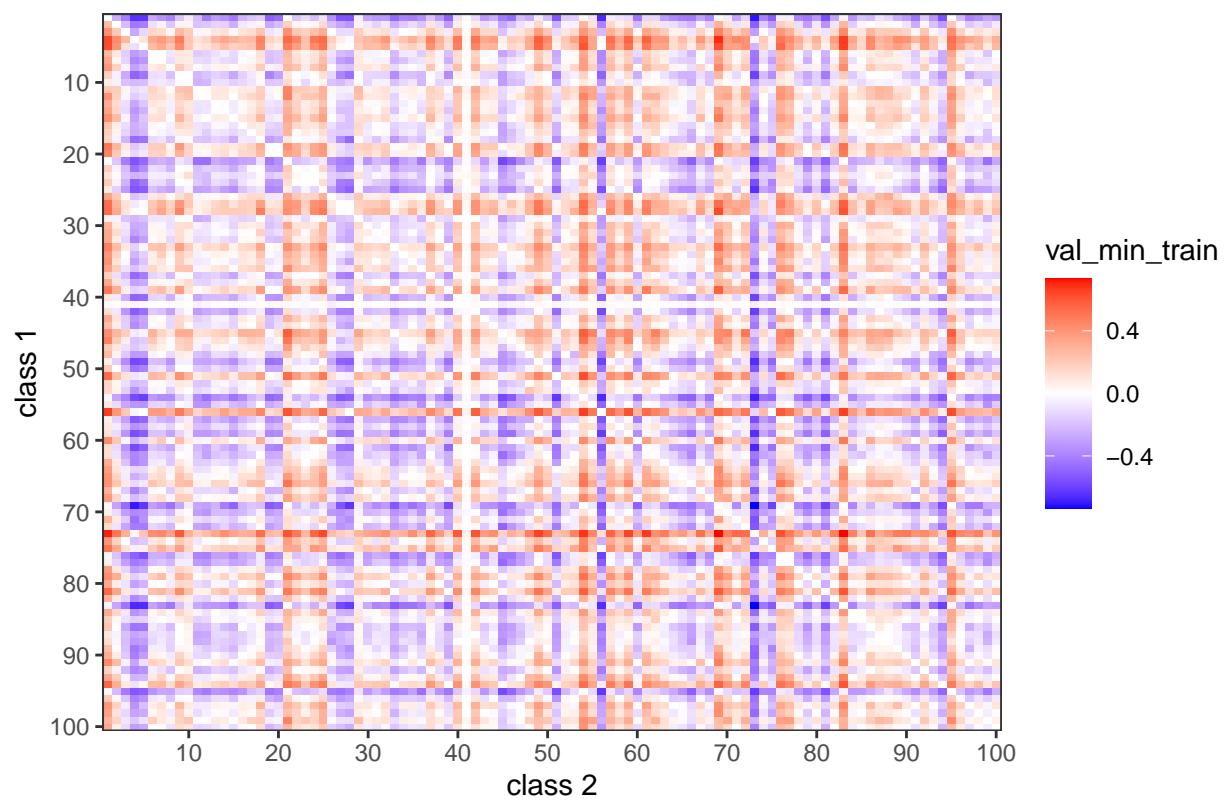
Pairwise probabilities differences – class 39



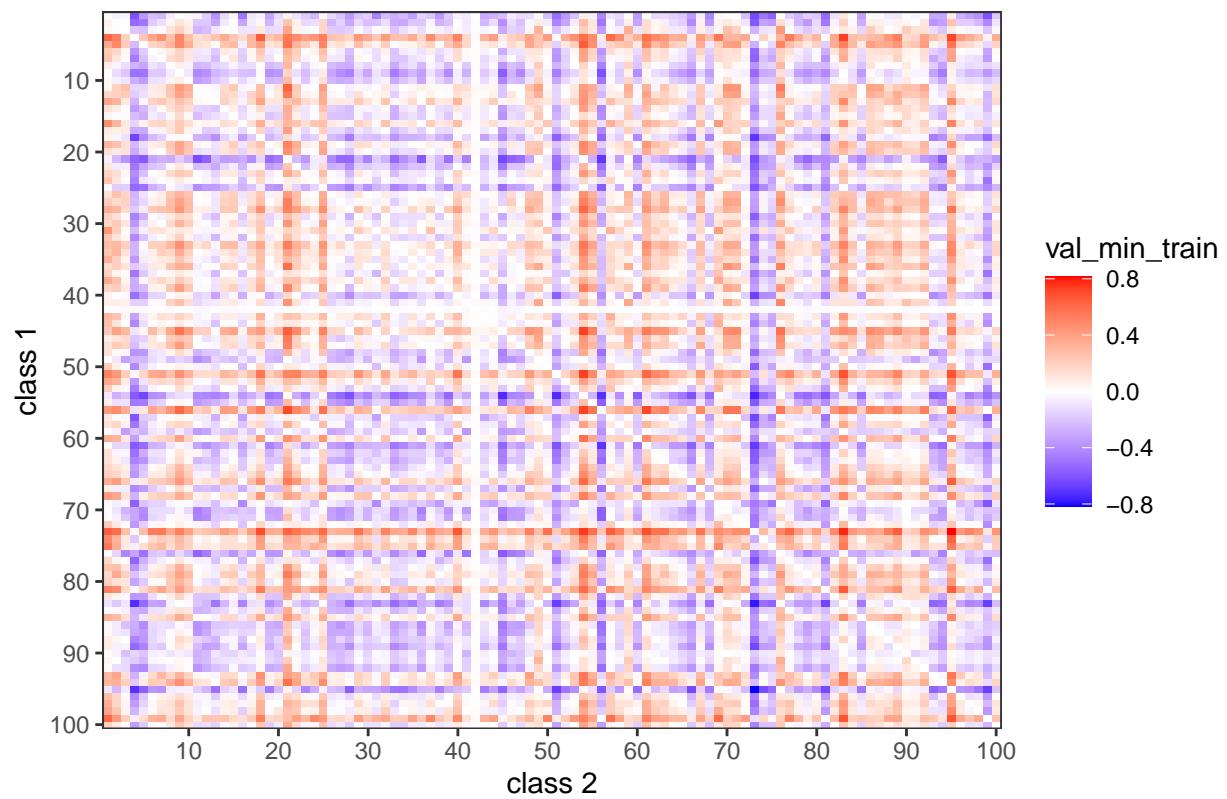
Pairwise probabilities differences – class 40



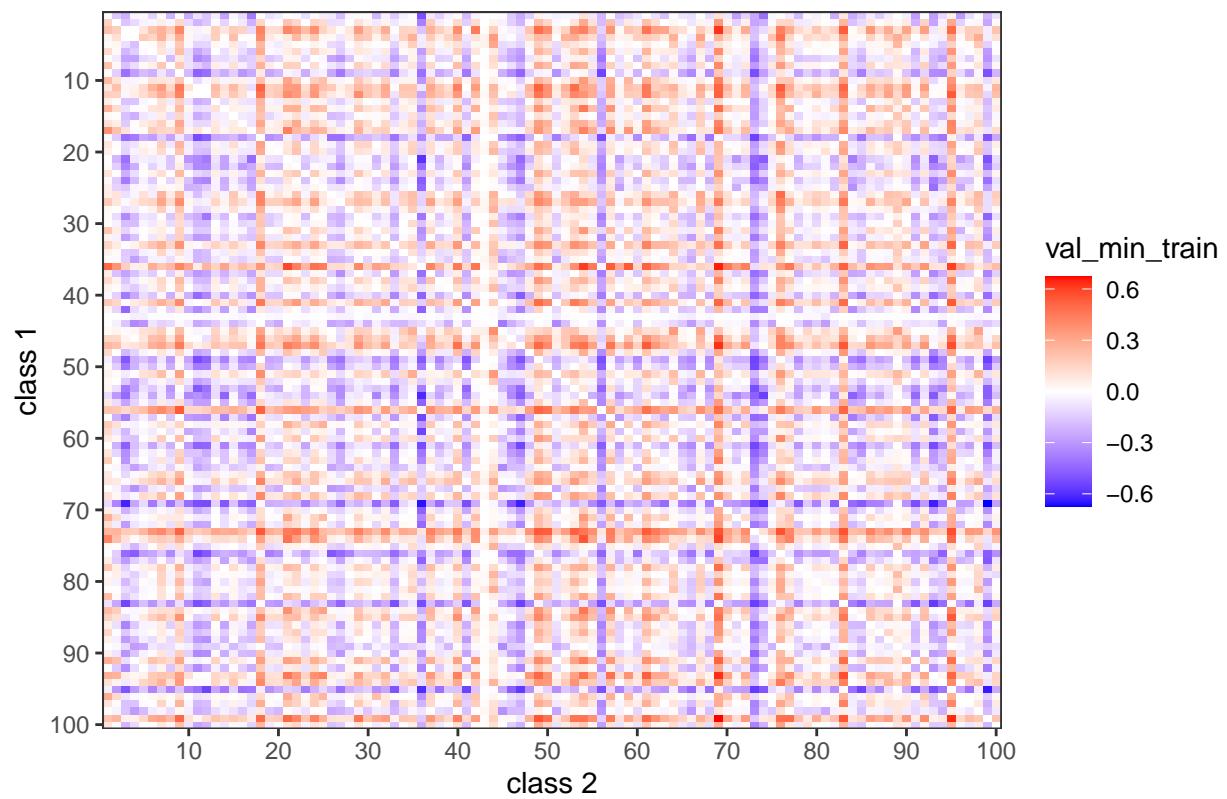
Pairwise probabilities differences – class 41



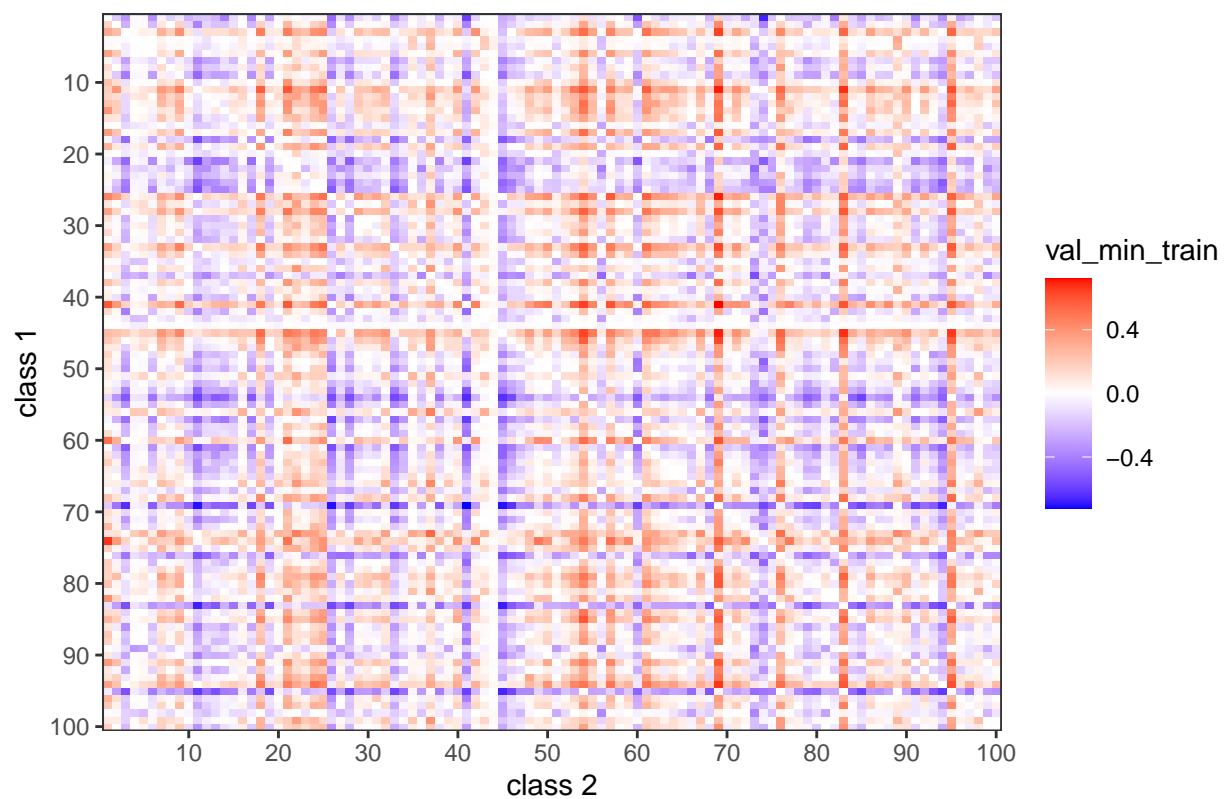
Pairwise probabilities differences – class 42



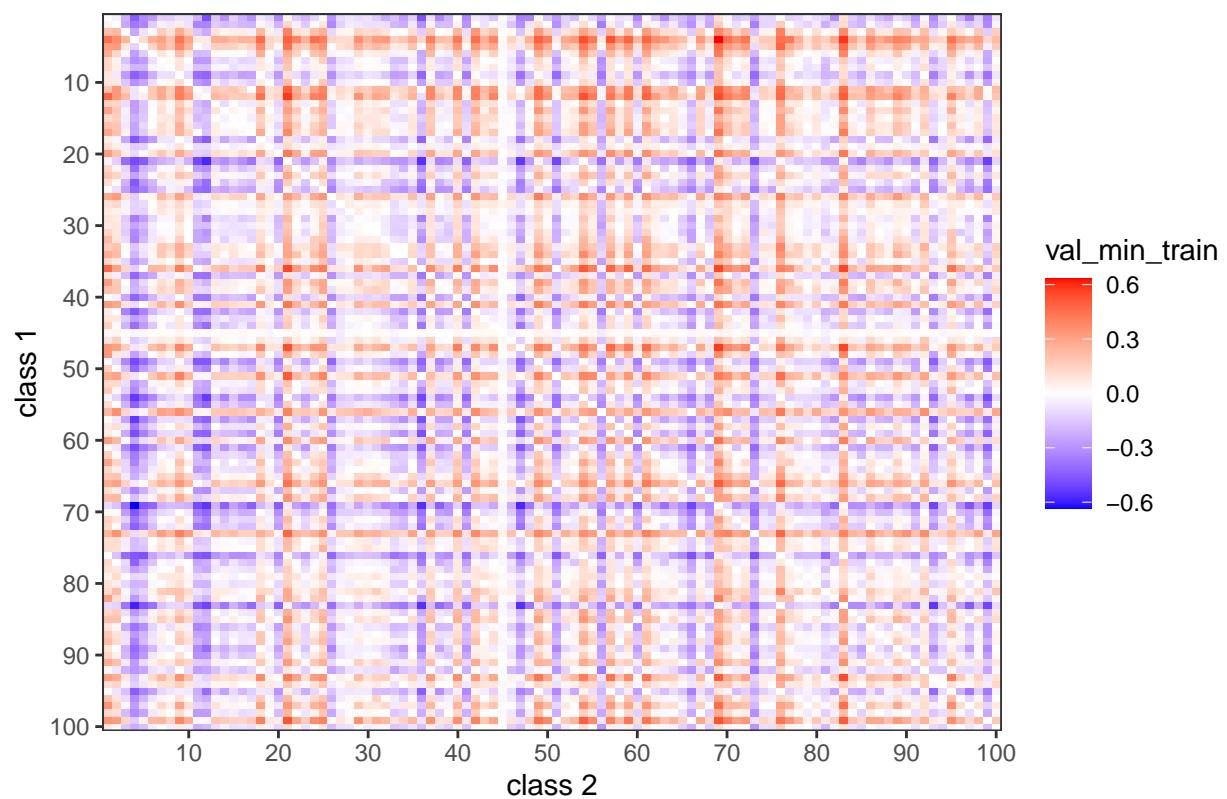
Pairwise probabilities differences – class 43



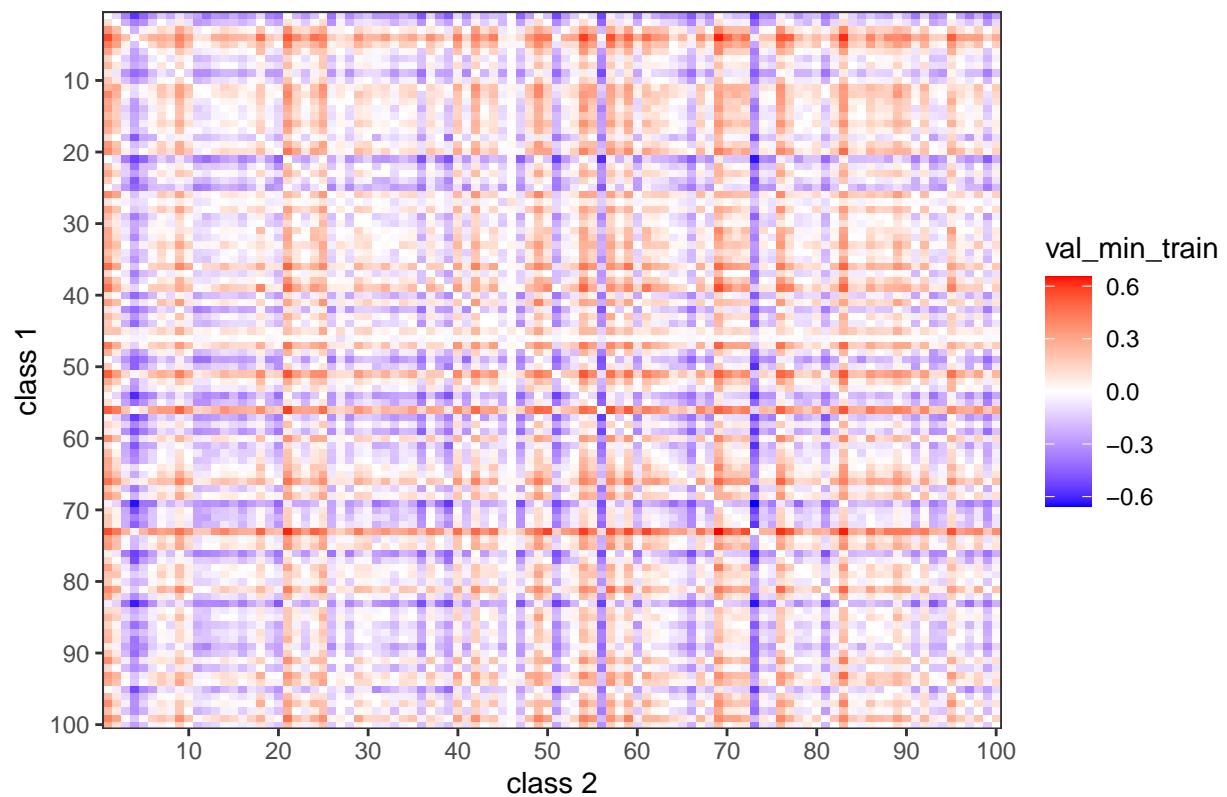
Pairwise probabilities differences – class 44



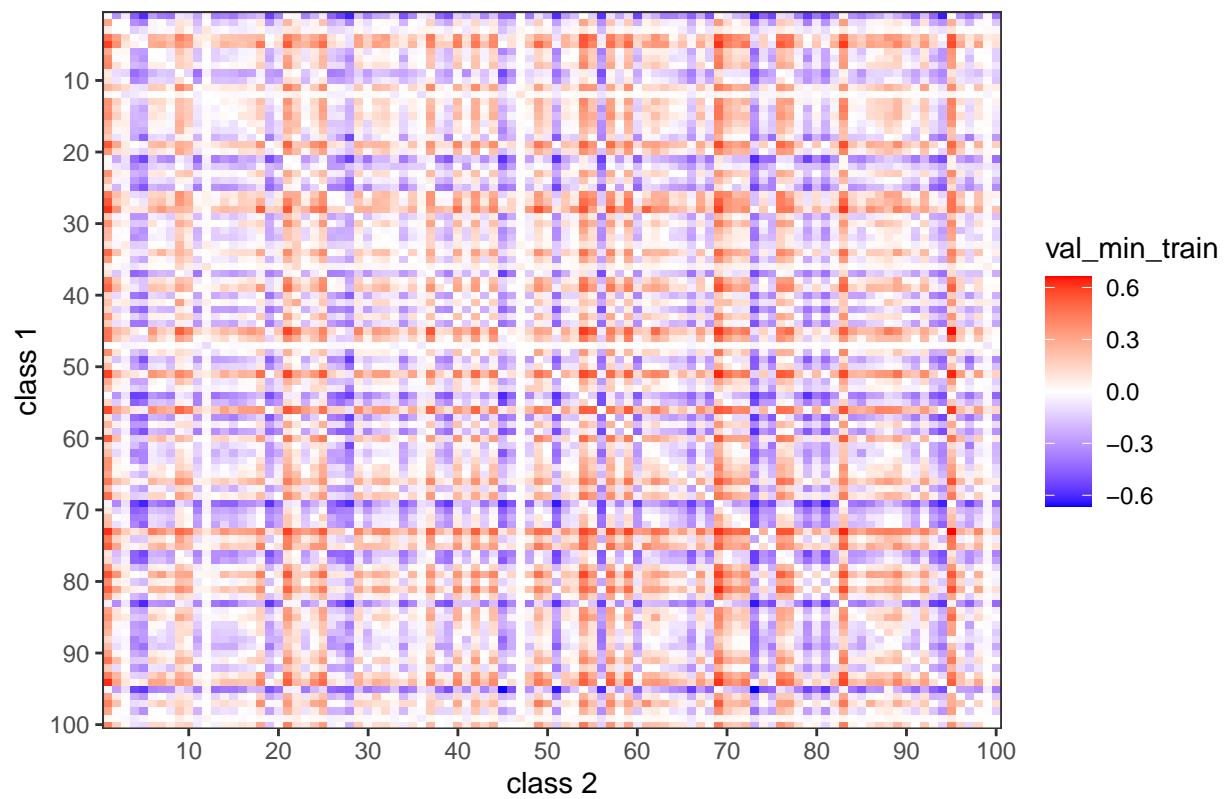
Pairwise probabilities differences – class 45



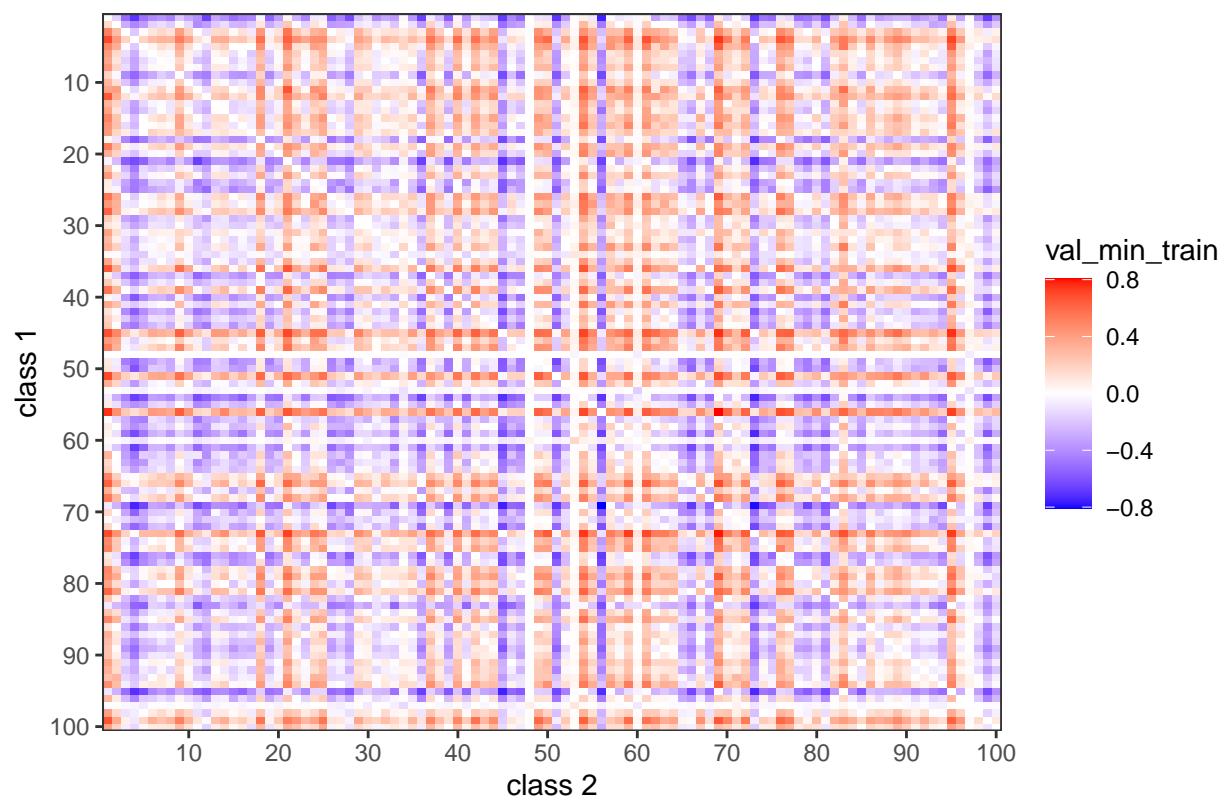
Pairwise probabilities differences – class 46



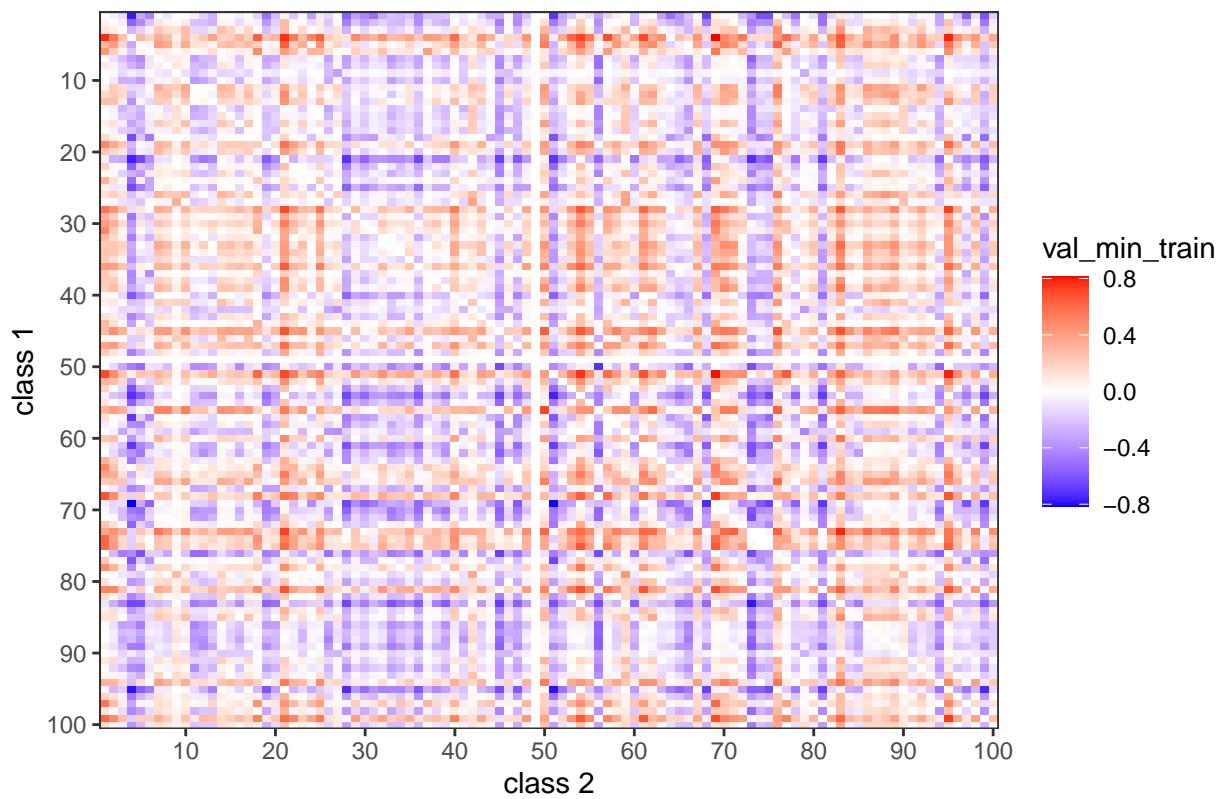
Pairwise probabilities differences – class 47



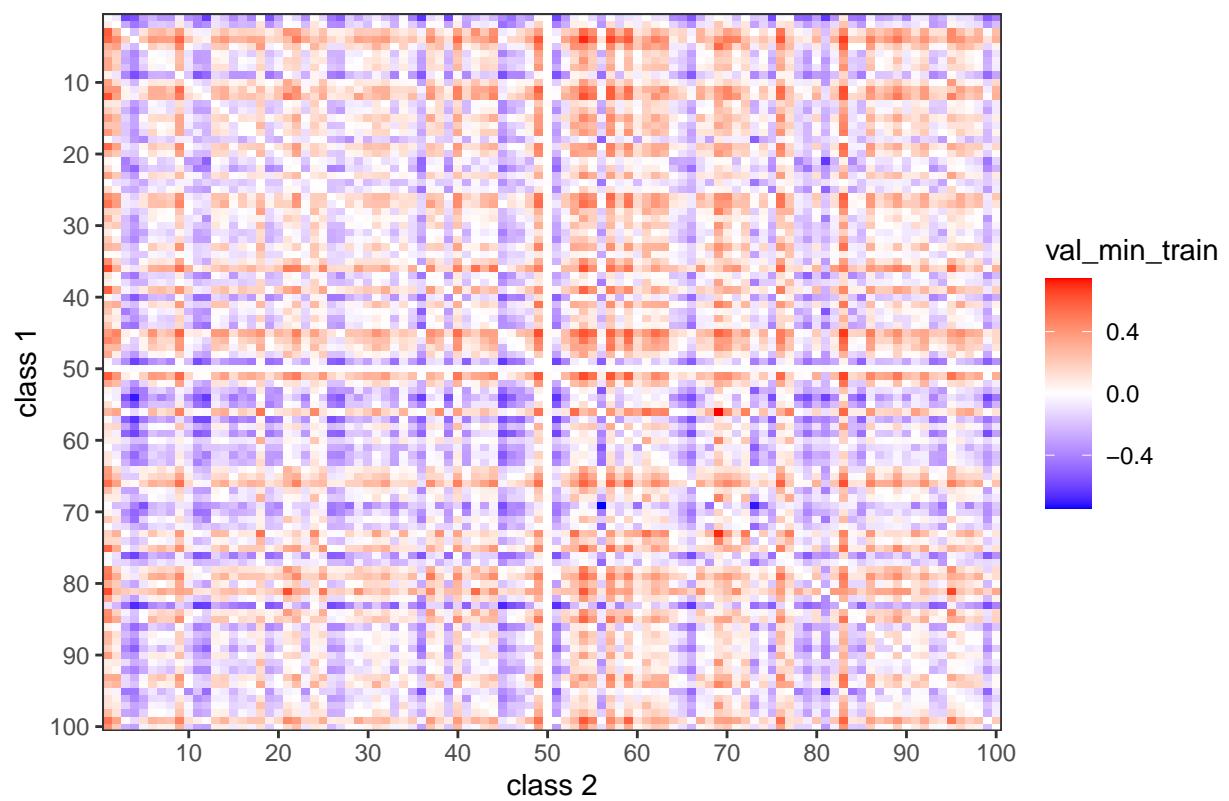
Pairwise probabilities differences – class 48



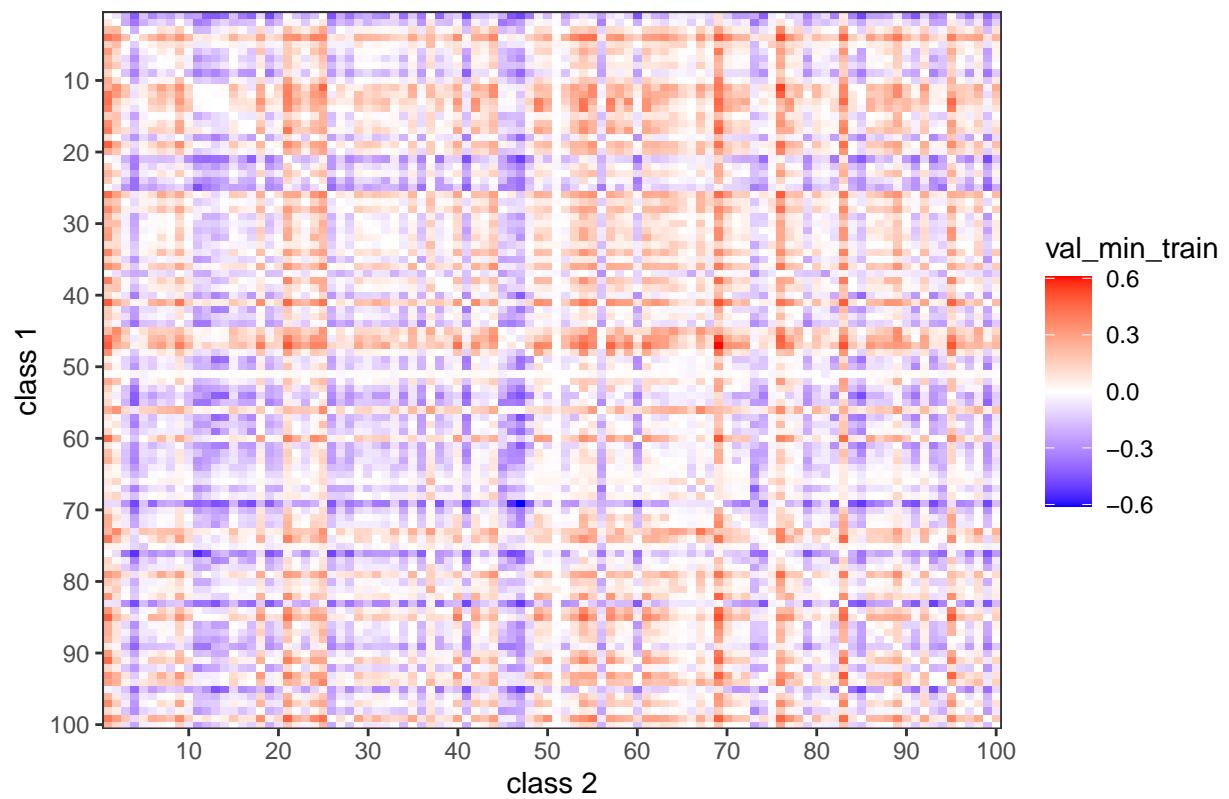
Pairwise probabilities differences – class 49



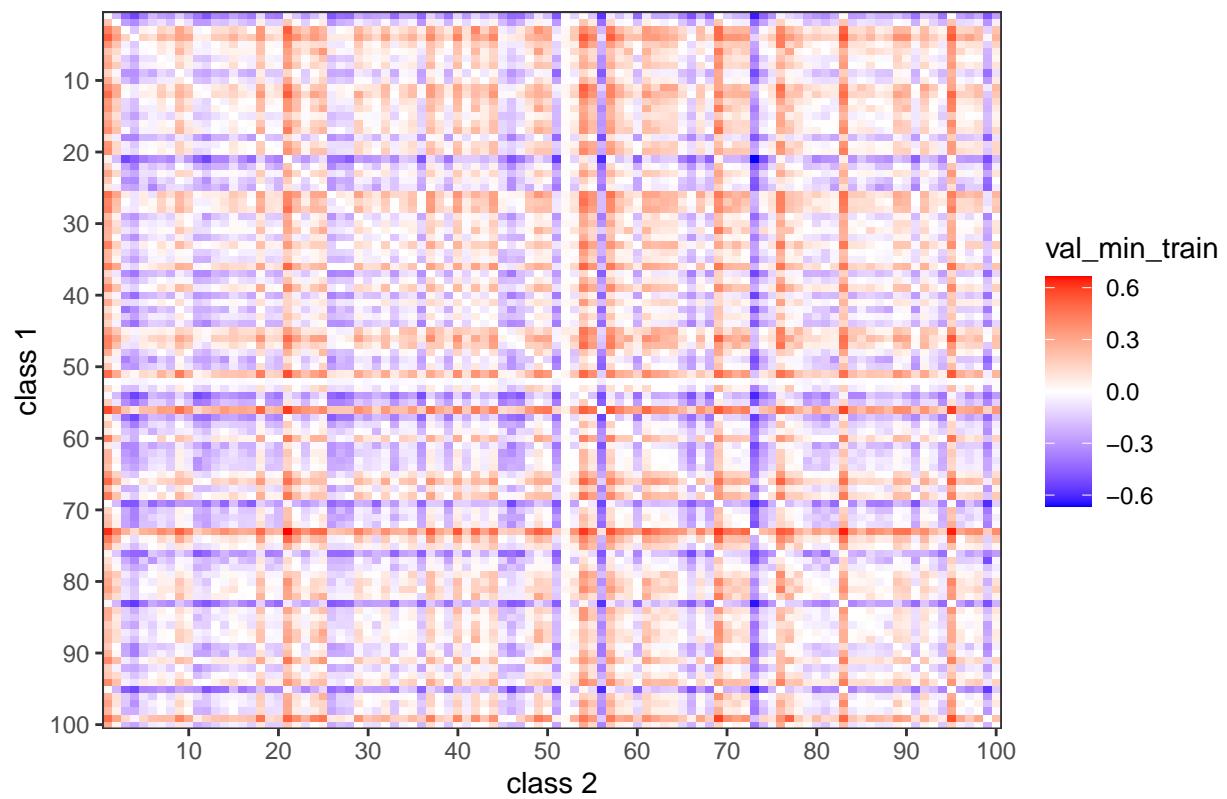
Pairwise probabilities differences – class 50



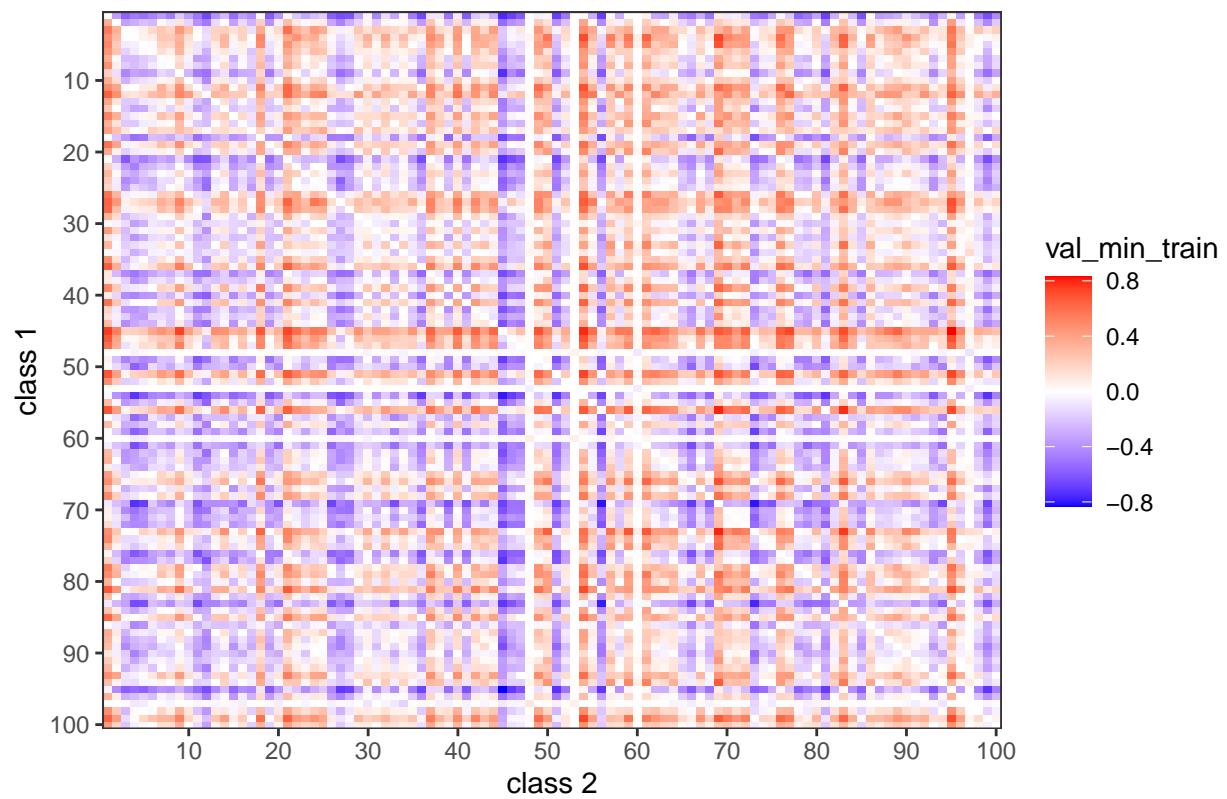
Pairwise probabilities differences – class 51



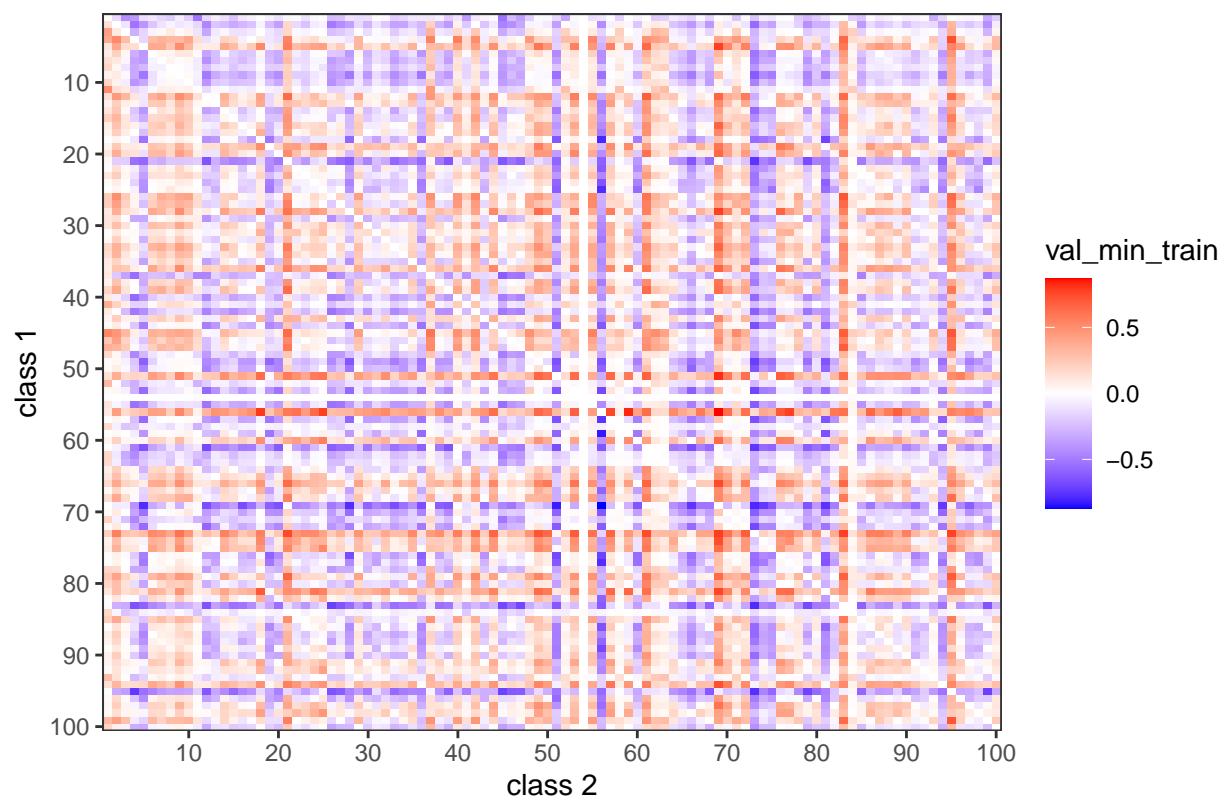
Pairwise probabilities differences – class 52



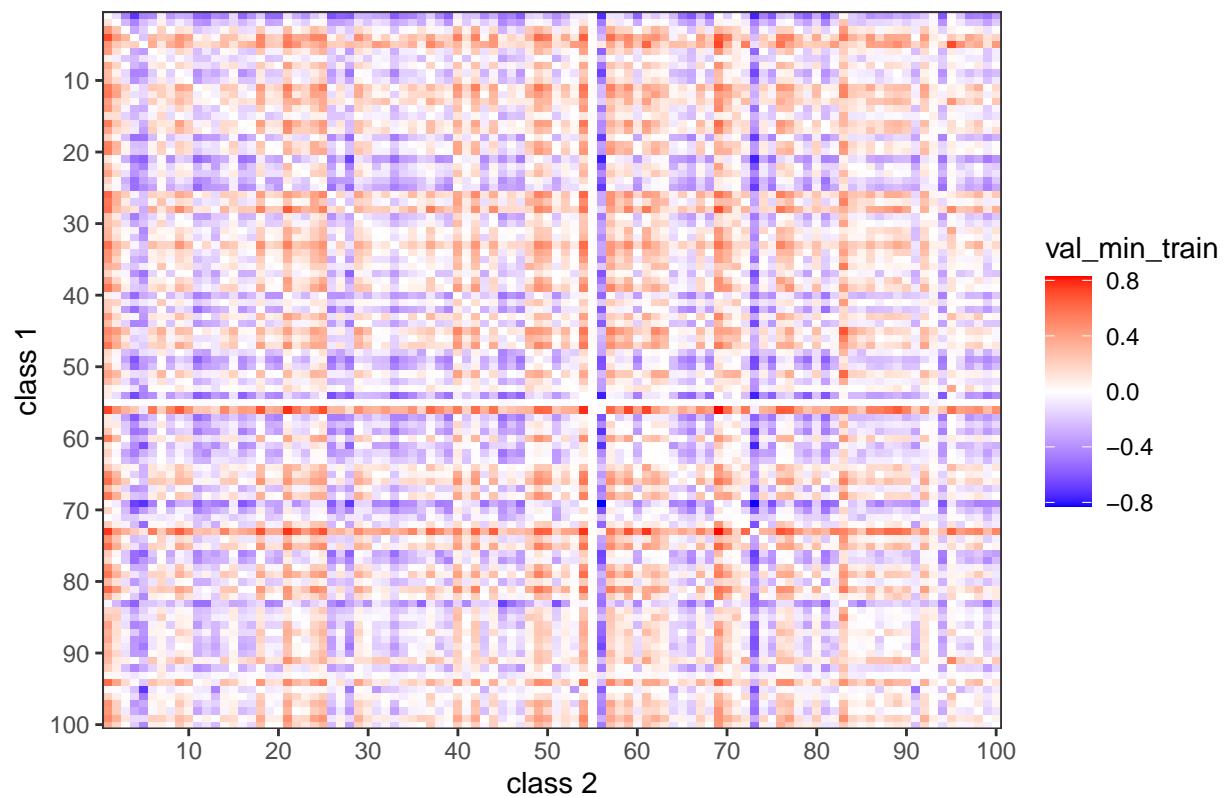
Pairwise probabilities differences – class 53



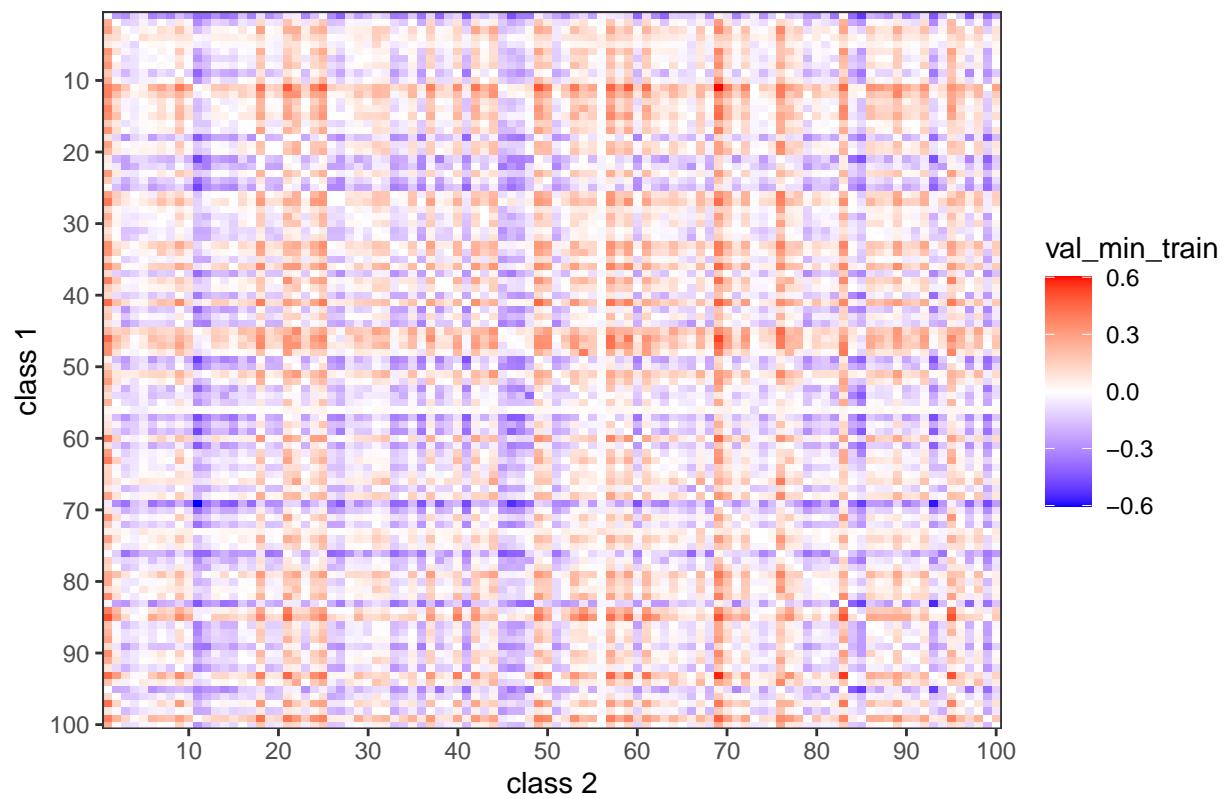
Pairwise probabilities differences – class 54



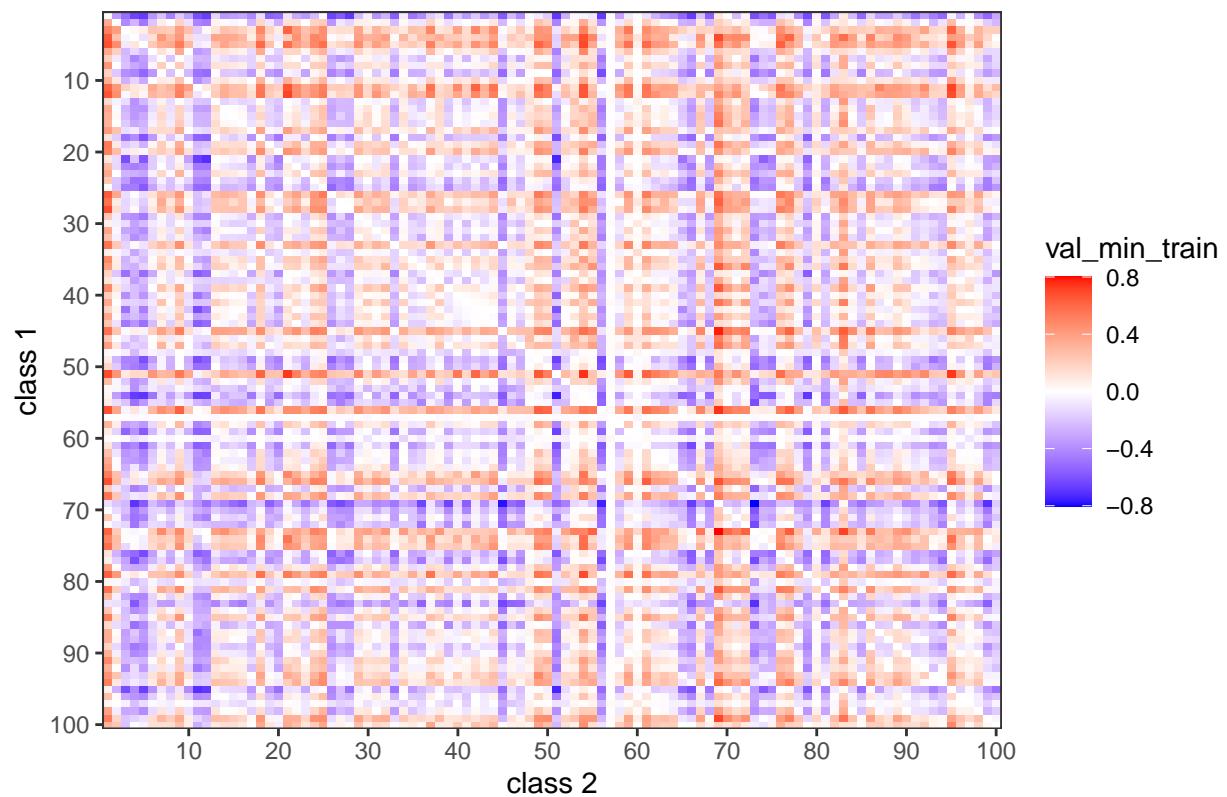
Pairwise probabilities differences – class 55



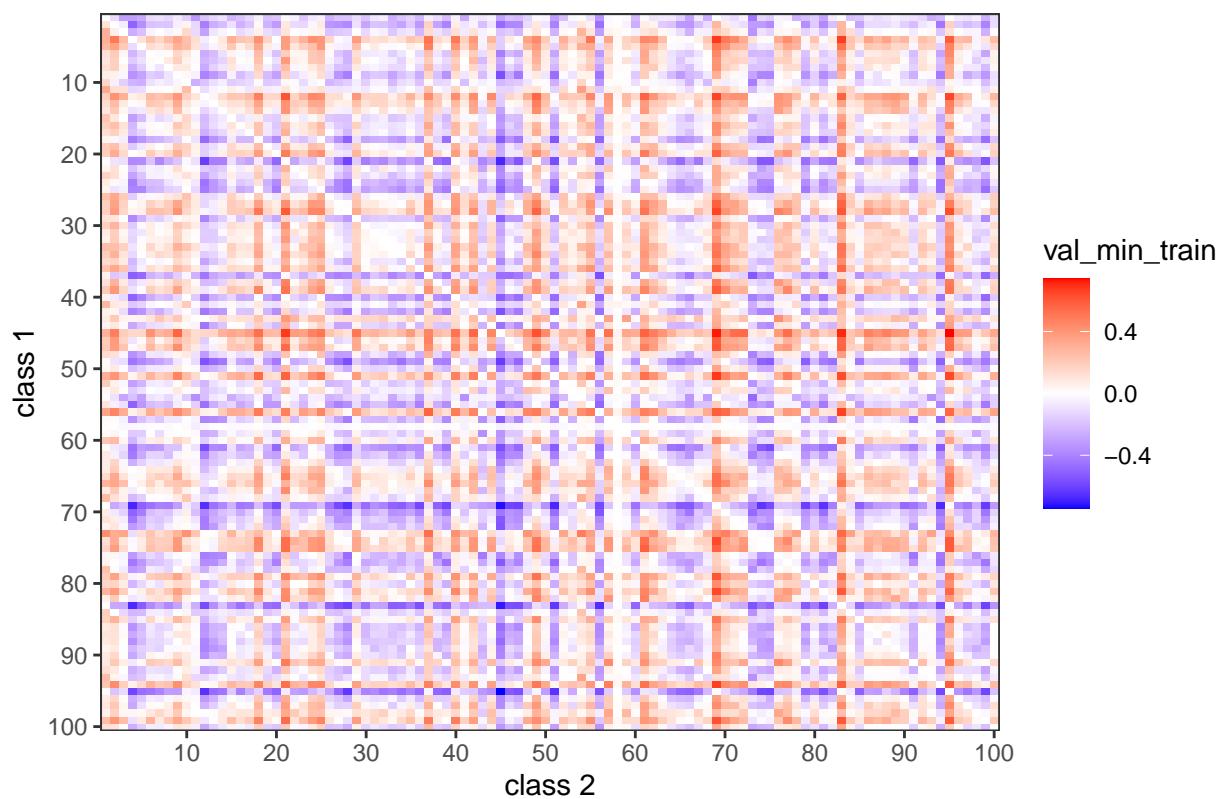
Pairwise probabilities differences – class 56



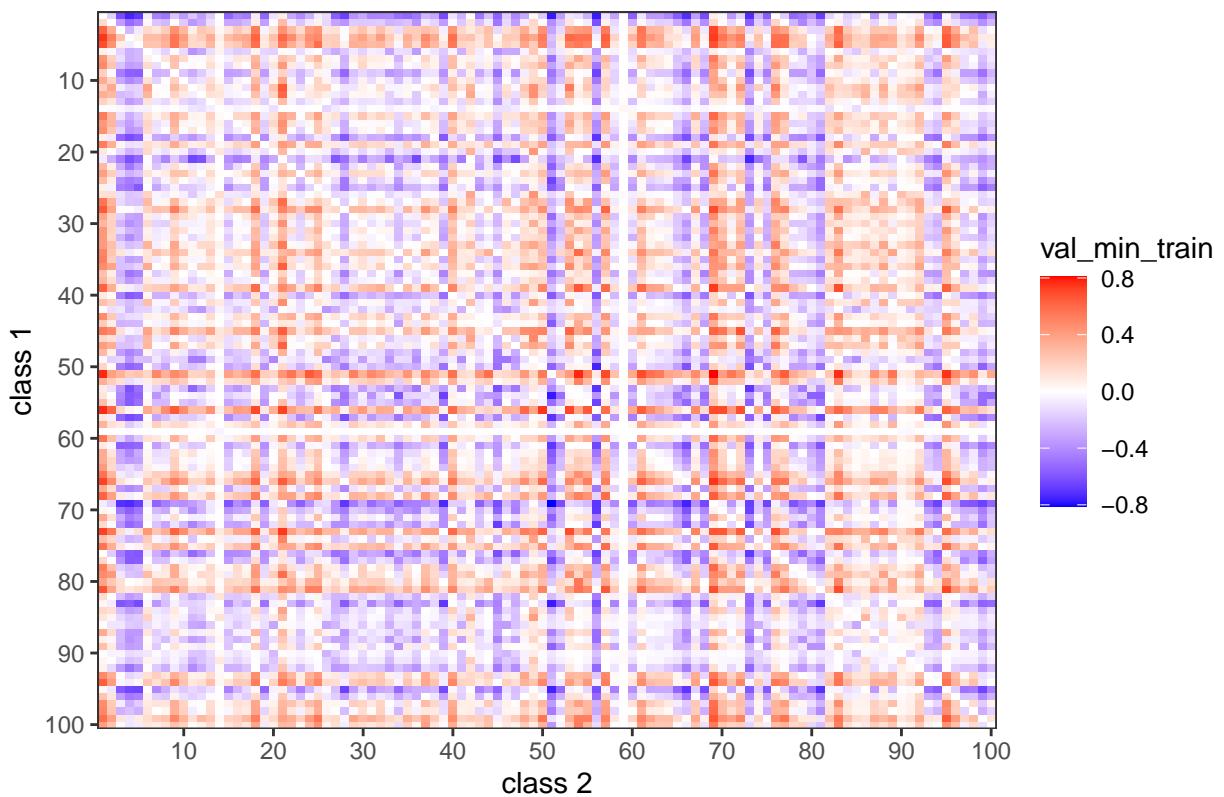
Pairwise probabilities differences – class 57



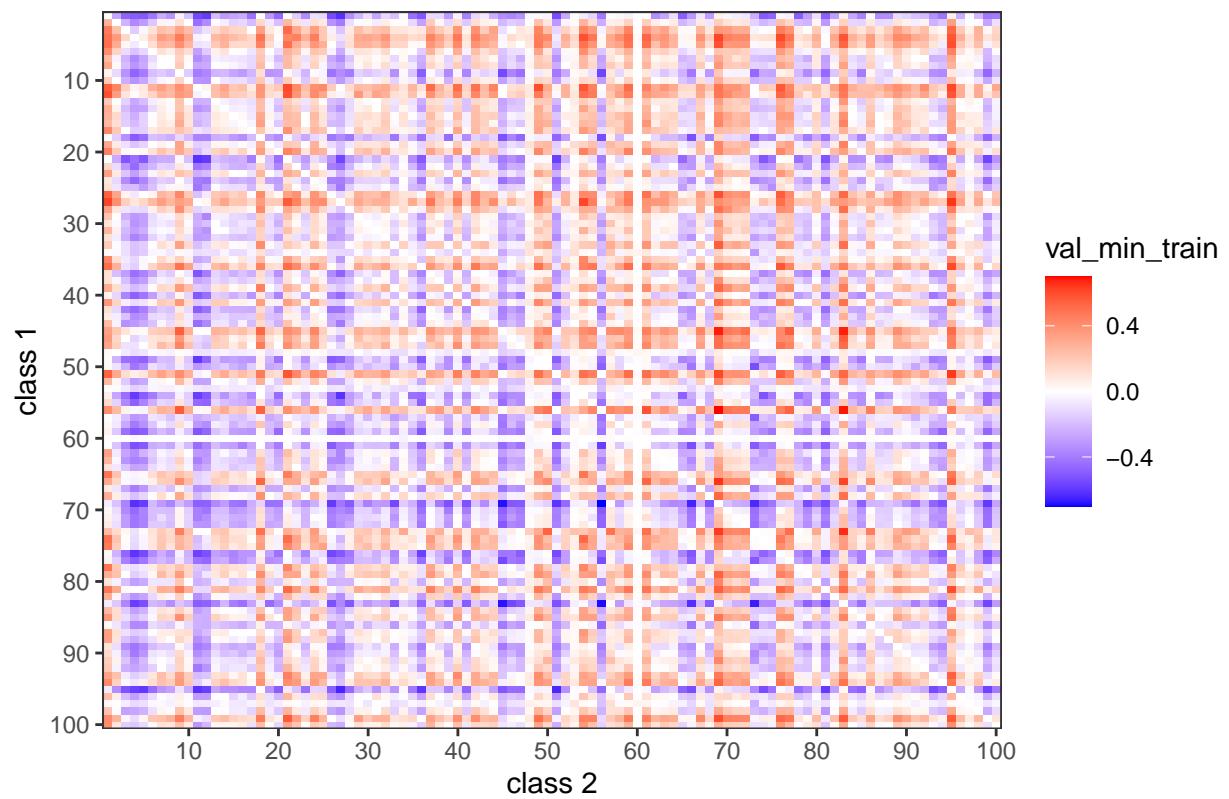
Pairwise probabilities differences – class 58



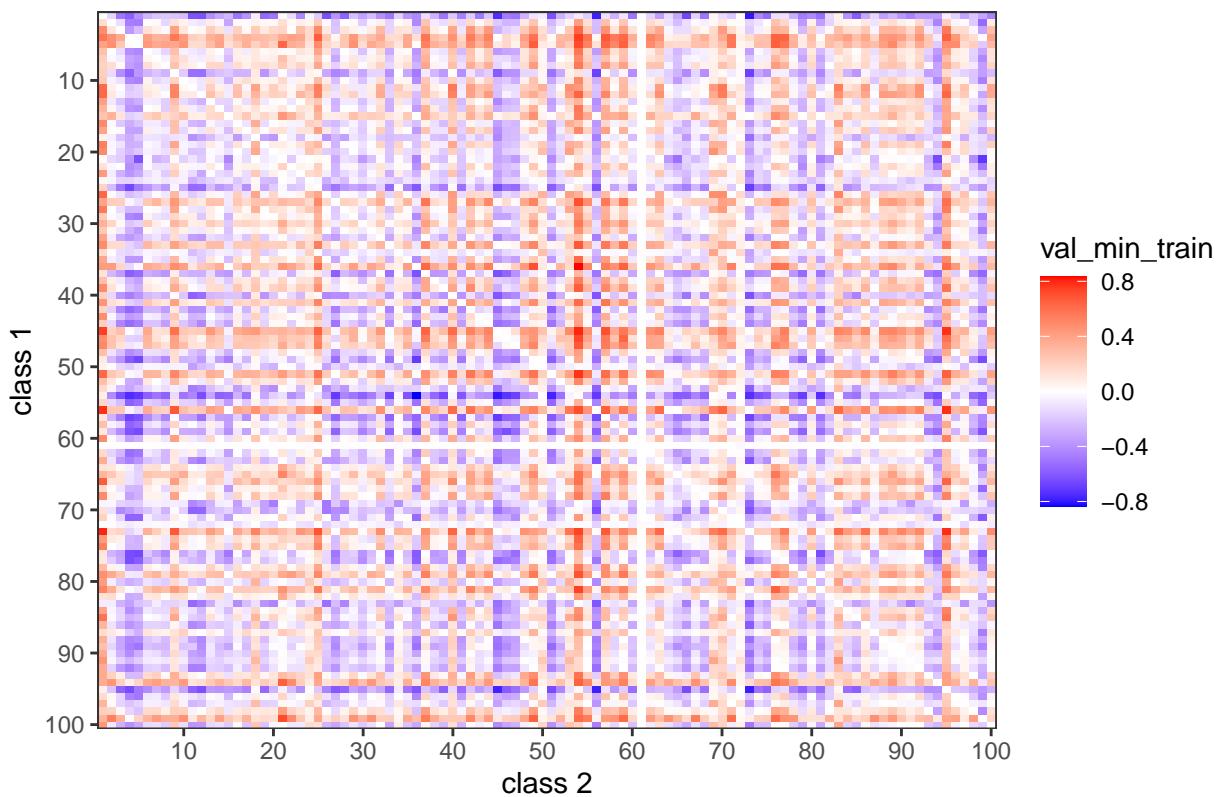
Pairwise probabilities differences – class 59



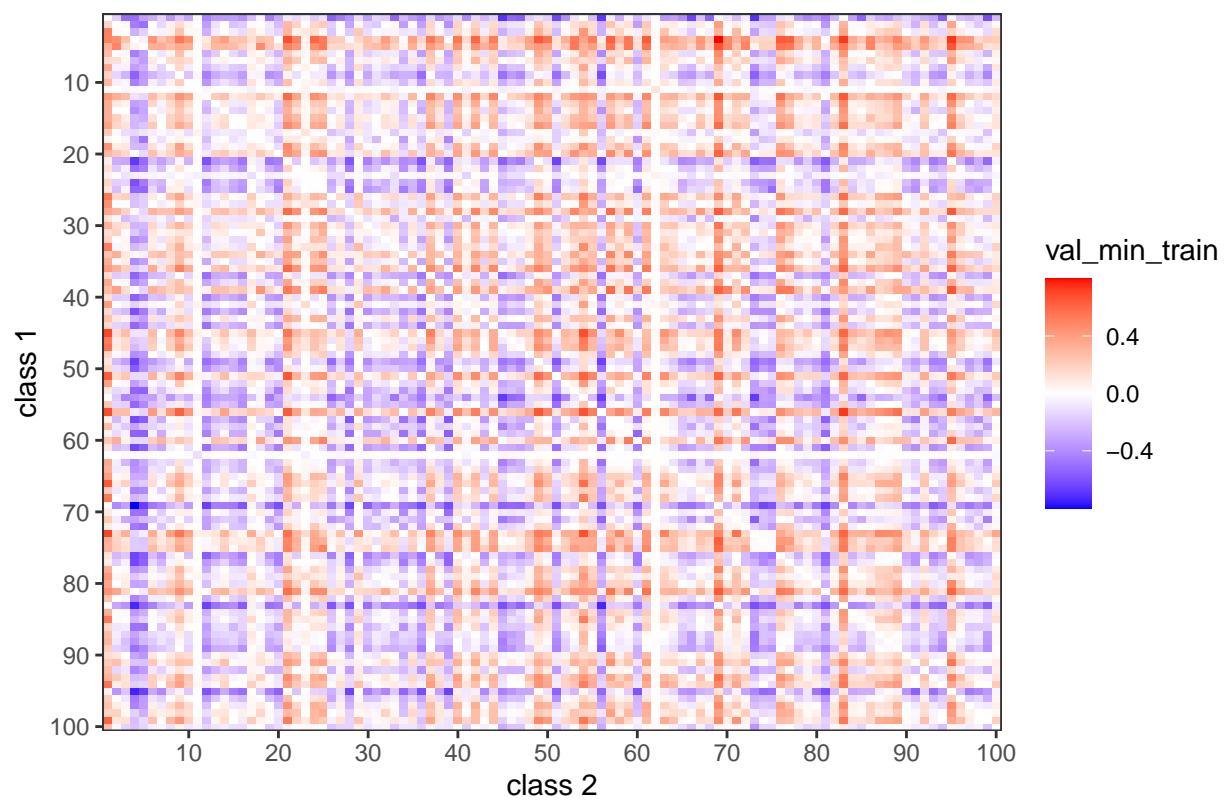
Pairwise probabilities differences – class 60



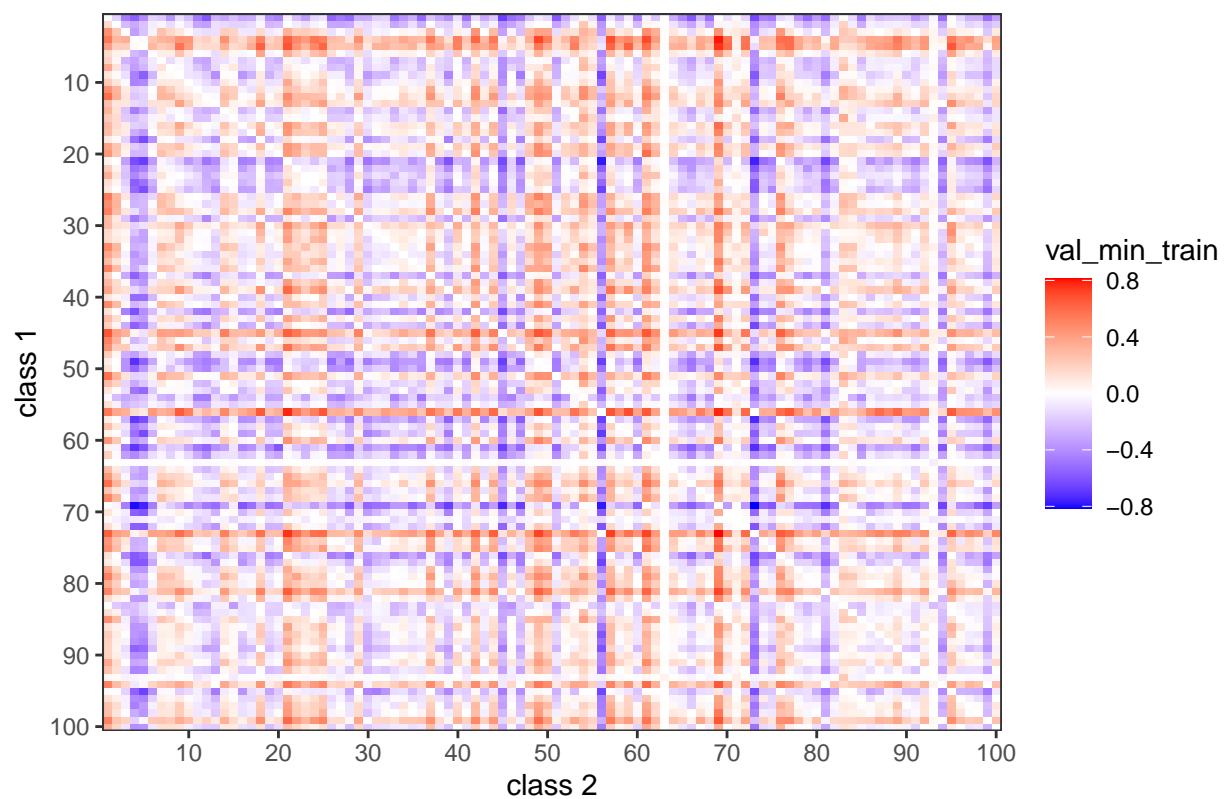
Pairwise probabilities differences – class 61



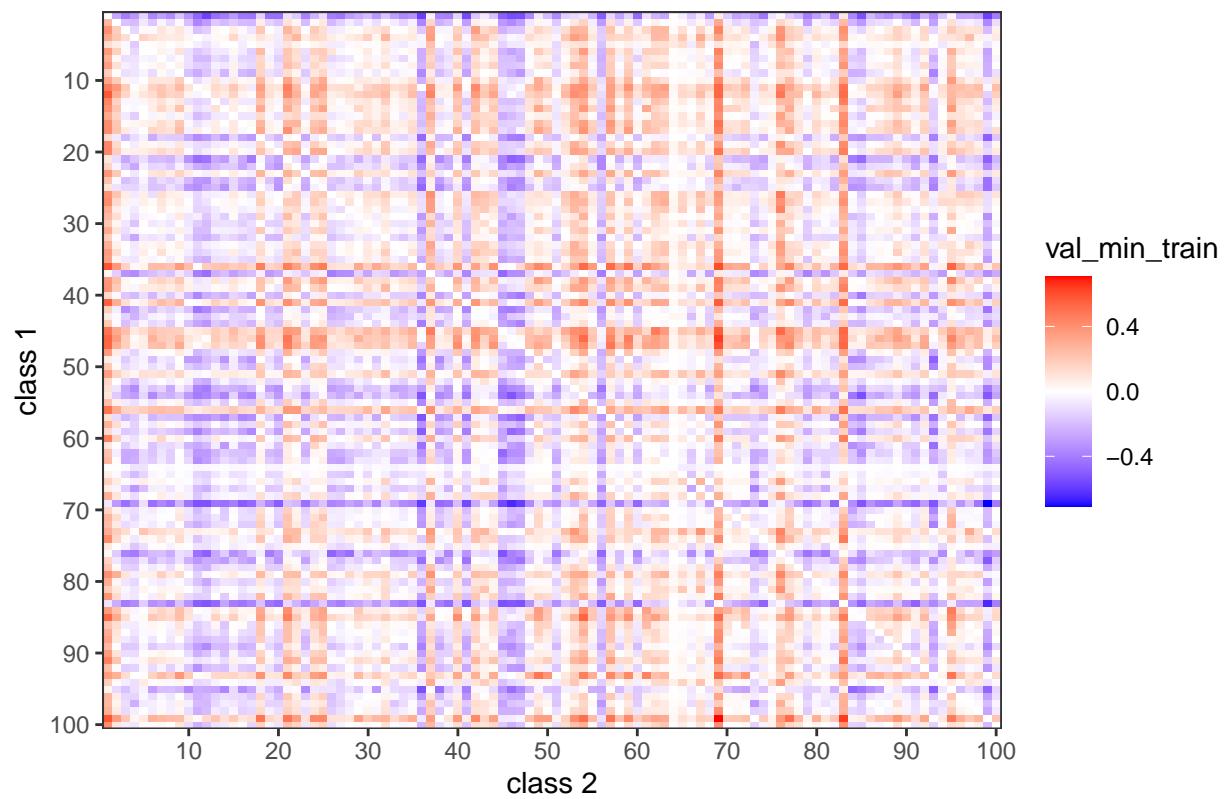
Pairwise probabilities differences – class 62



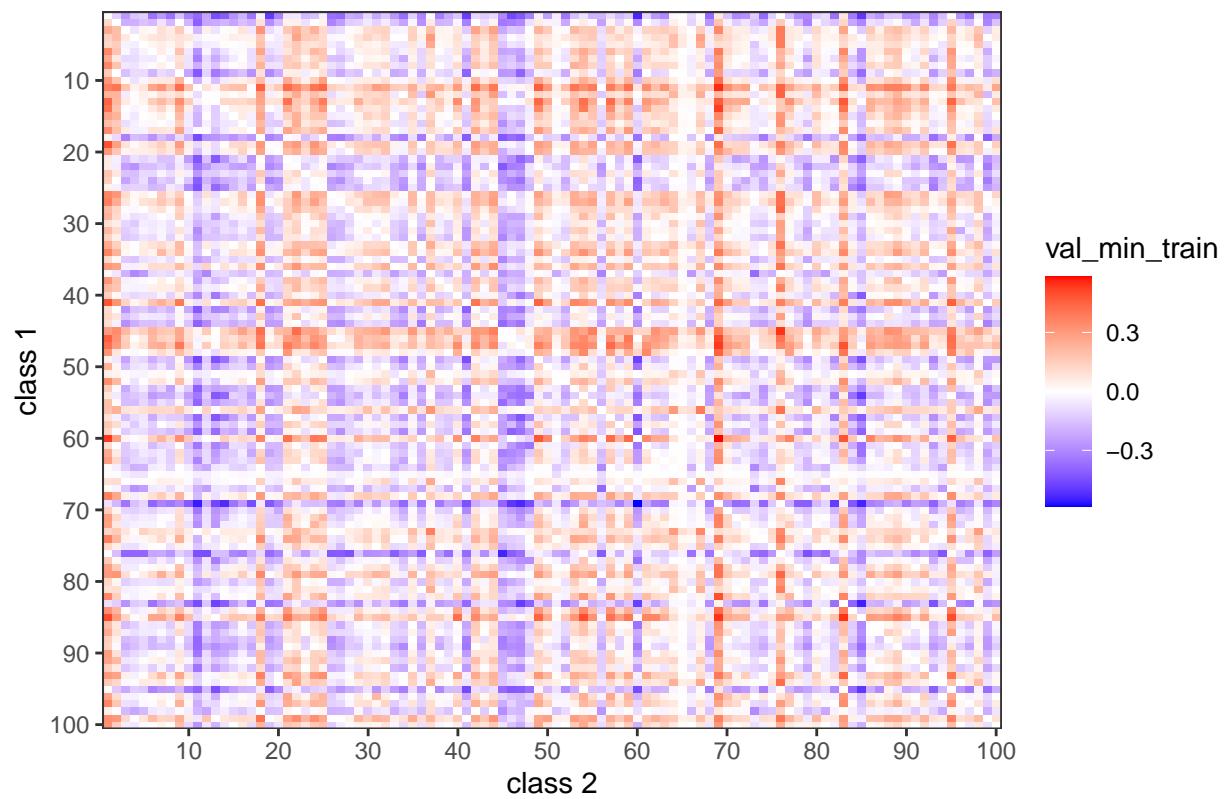
Pairwise probabilities differences – class 63



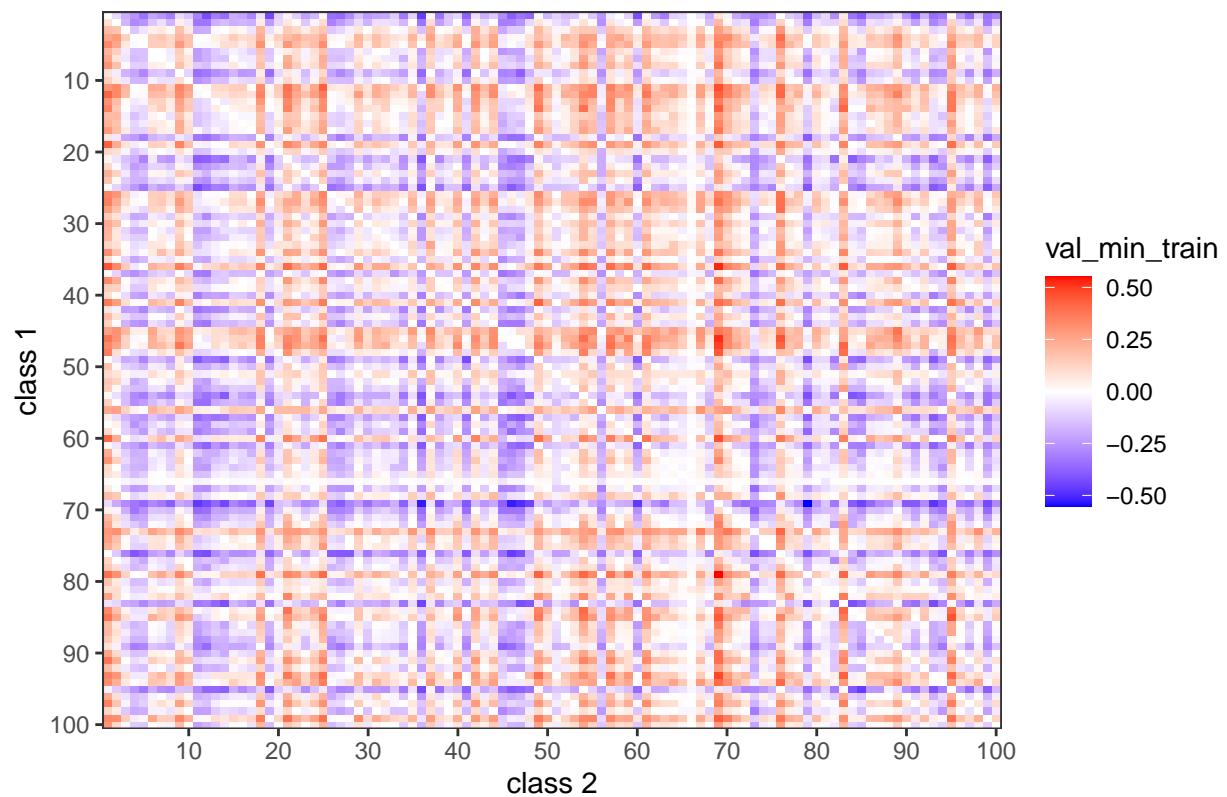
Pairwise probabilities differences – class 64



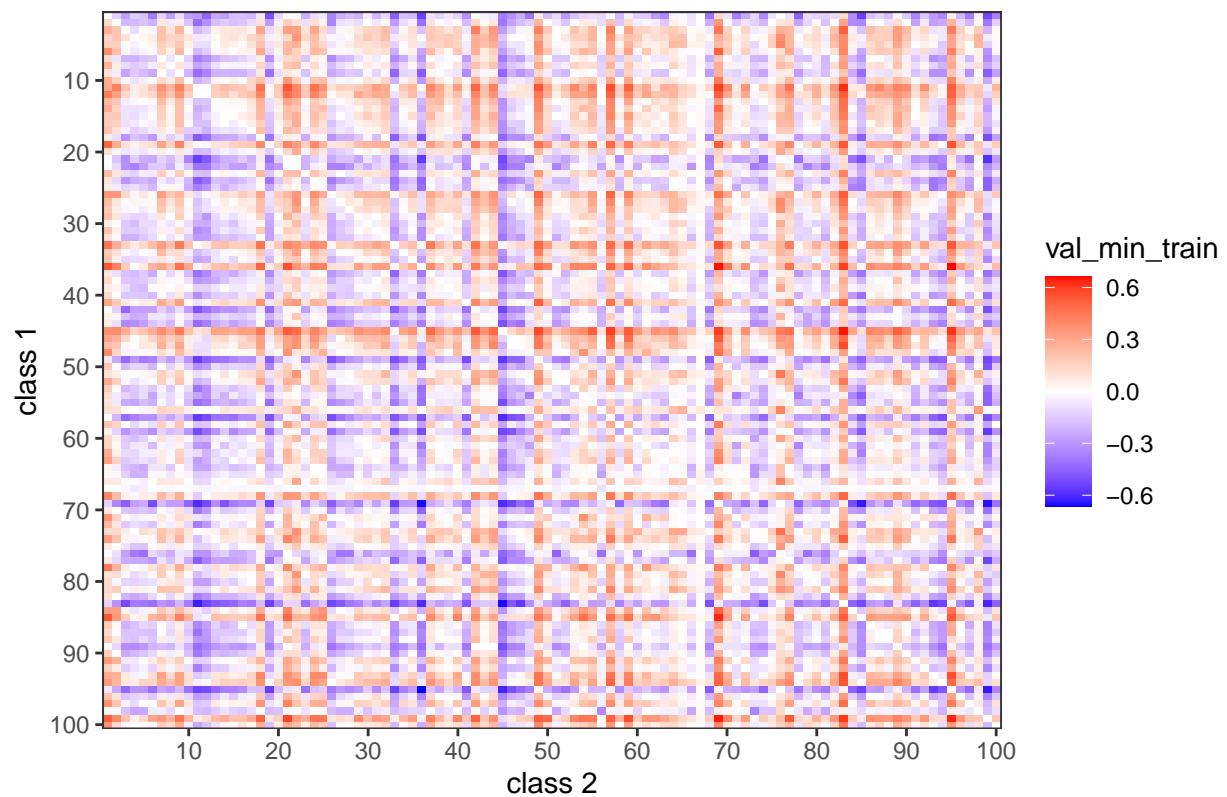
Pairwise probabilities differences – class 65



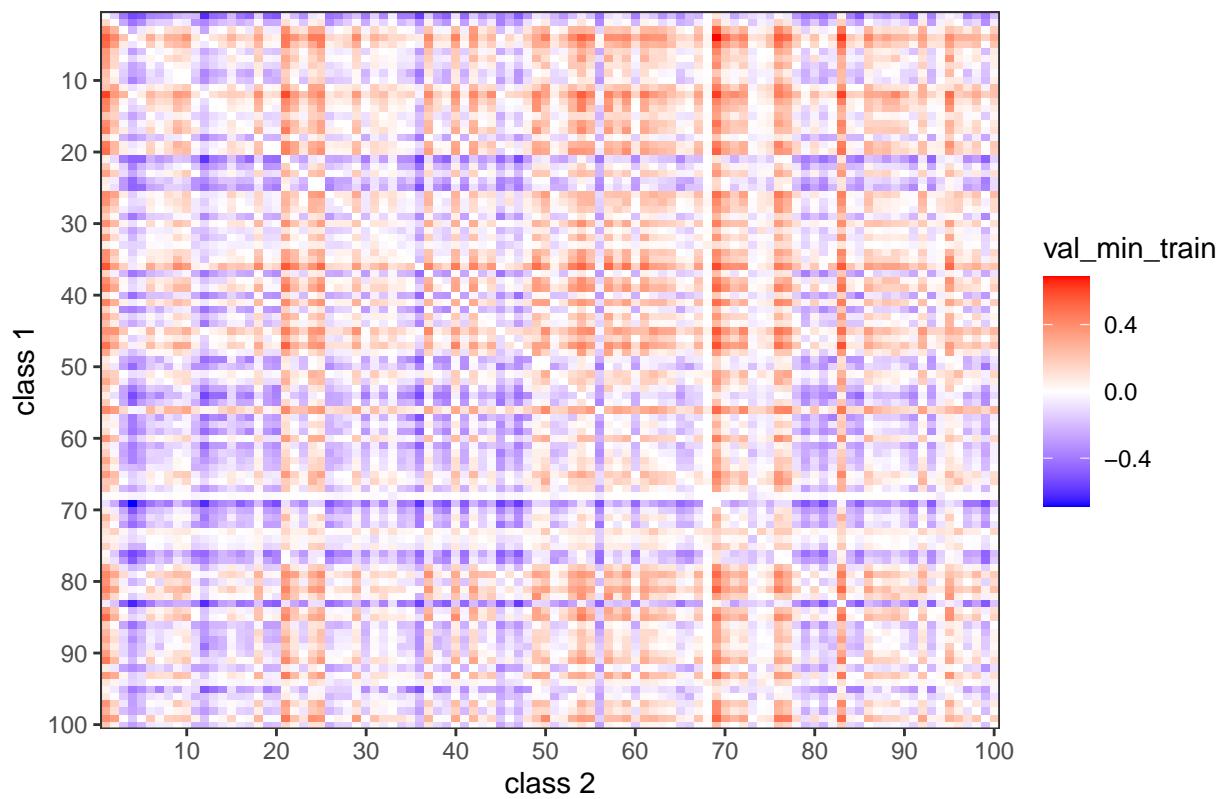
Pairwise probabilities differences – class 66



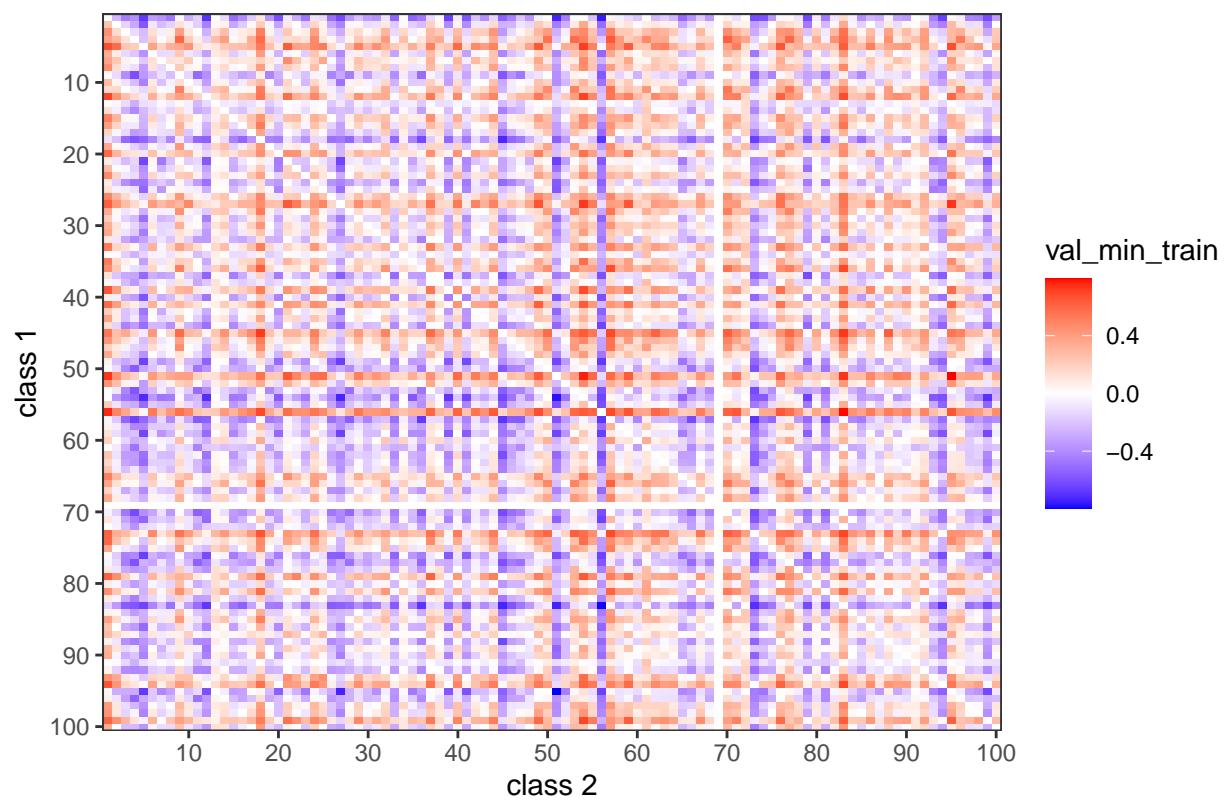
Pairwise probabilities differences – class 67



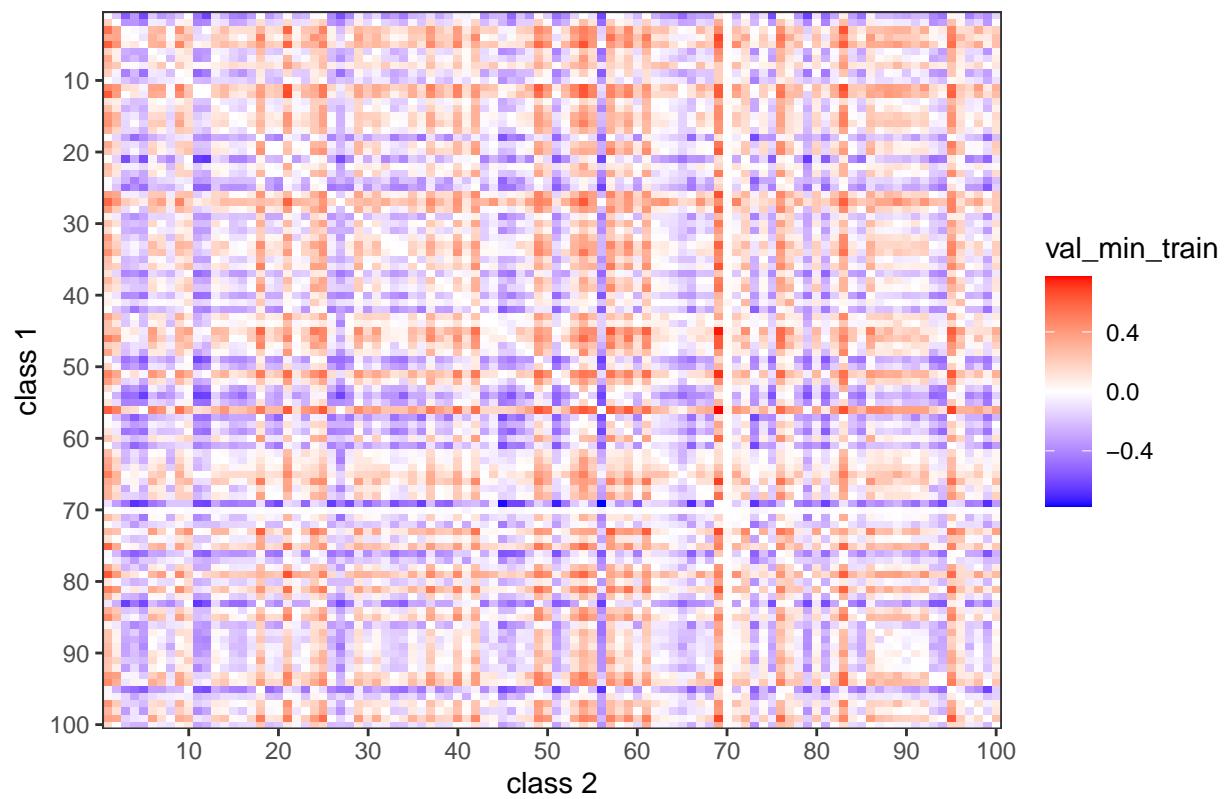
Pairwise probabilities differences – class 68



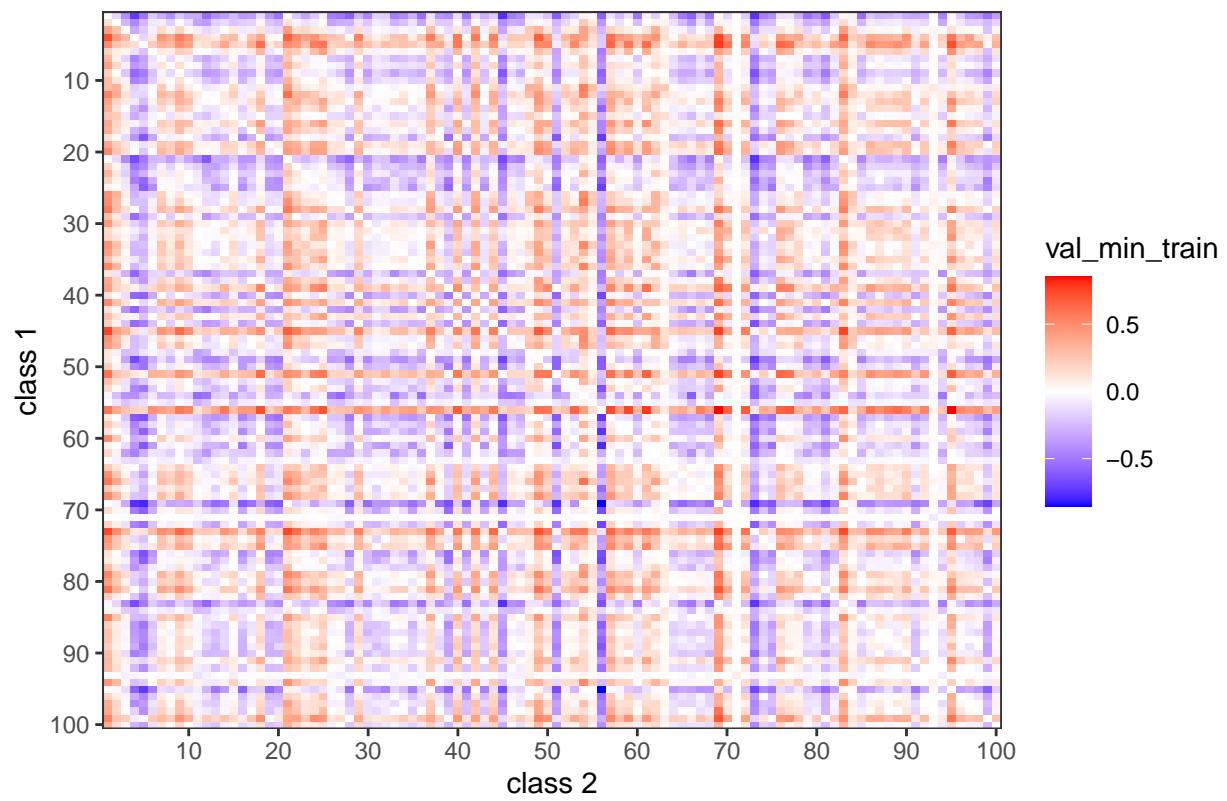
Pairwise probabilities differences – class 69



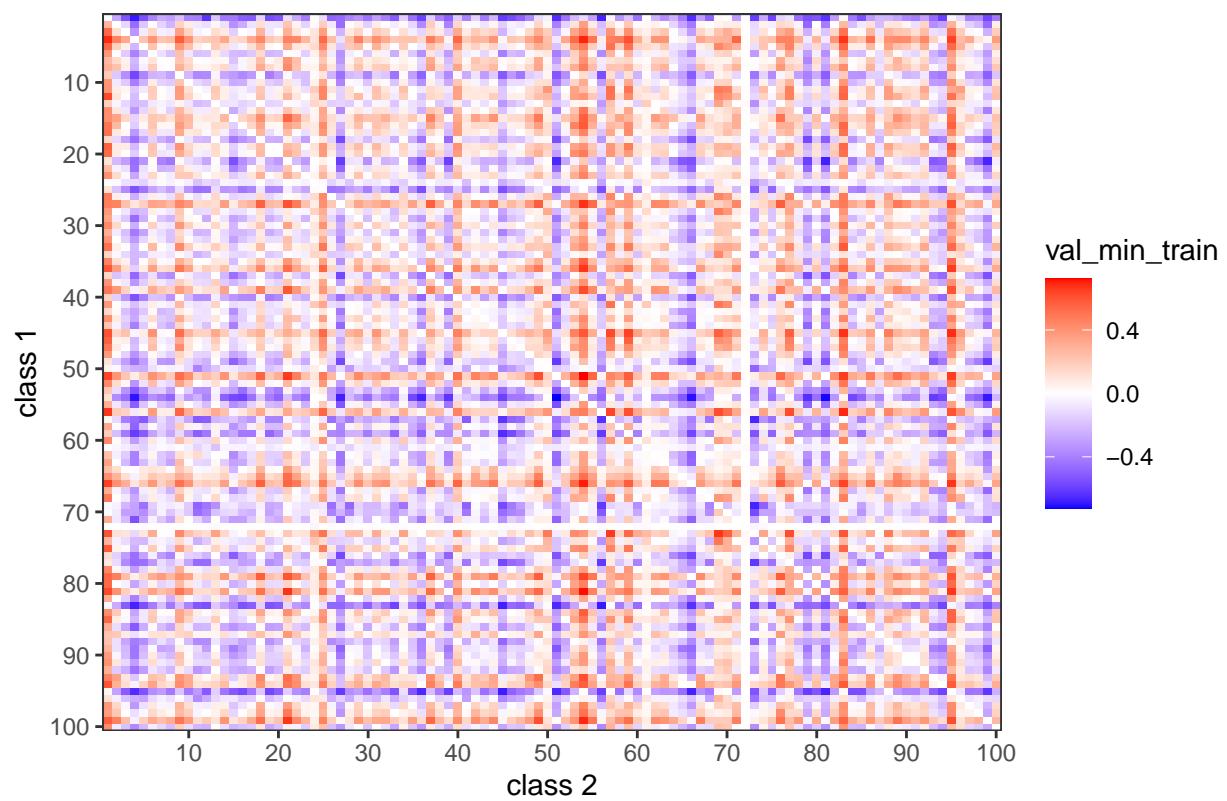
Pairwise probabilities differences – class 70



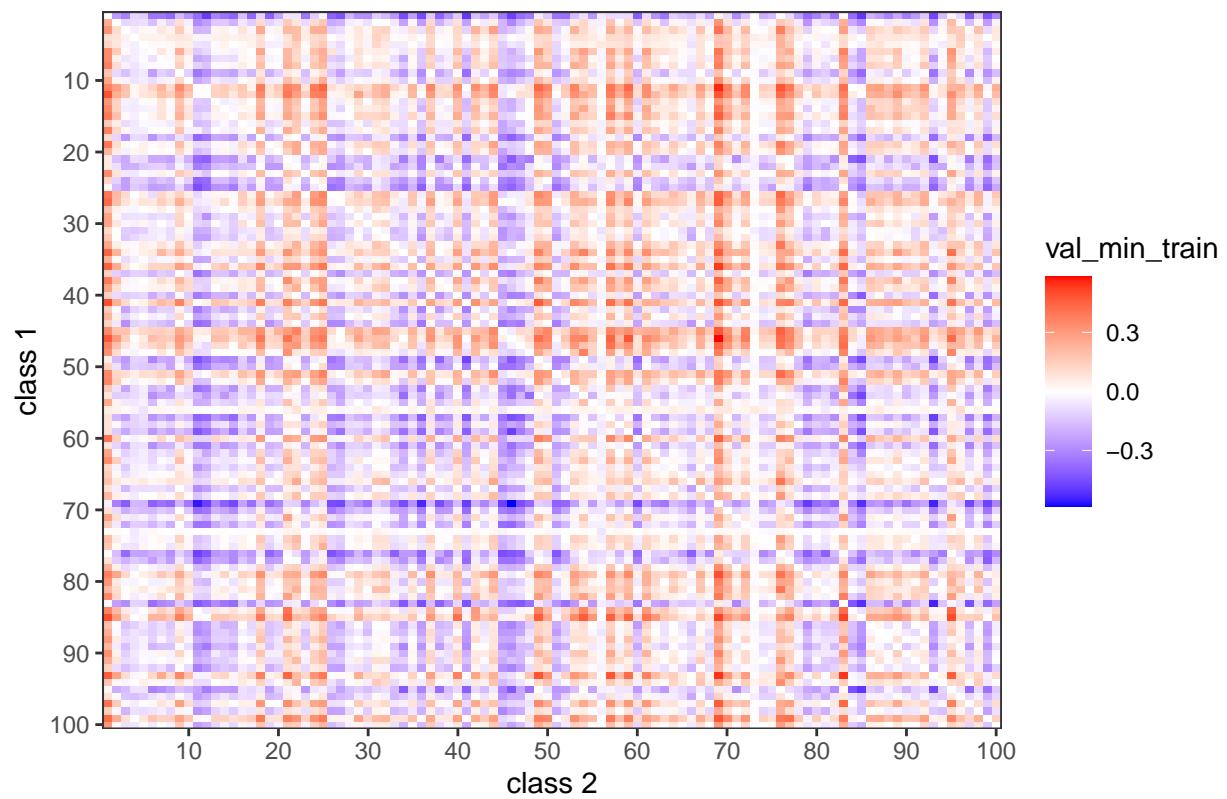
Pairwise probabilities differences – class 71



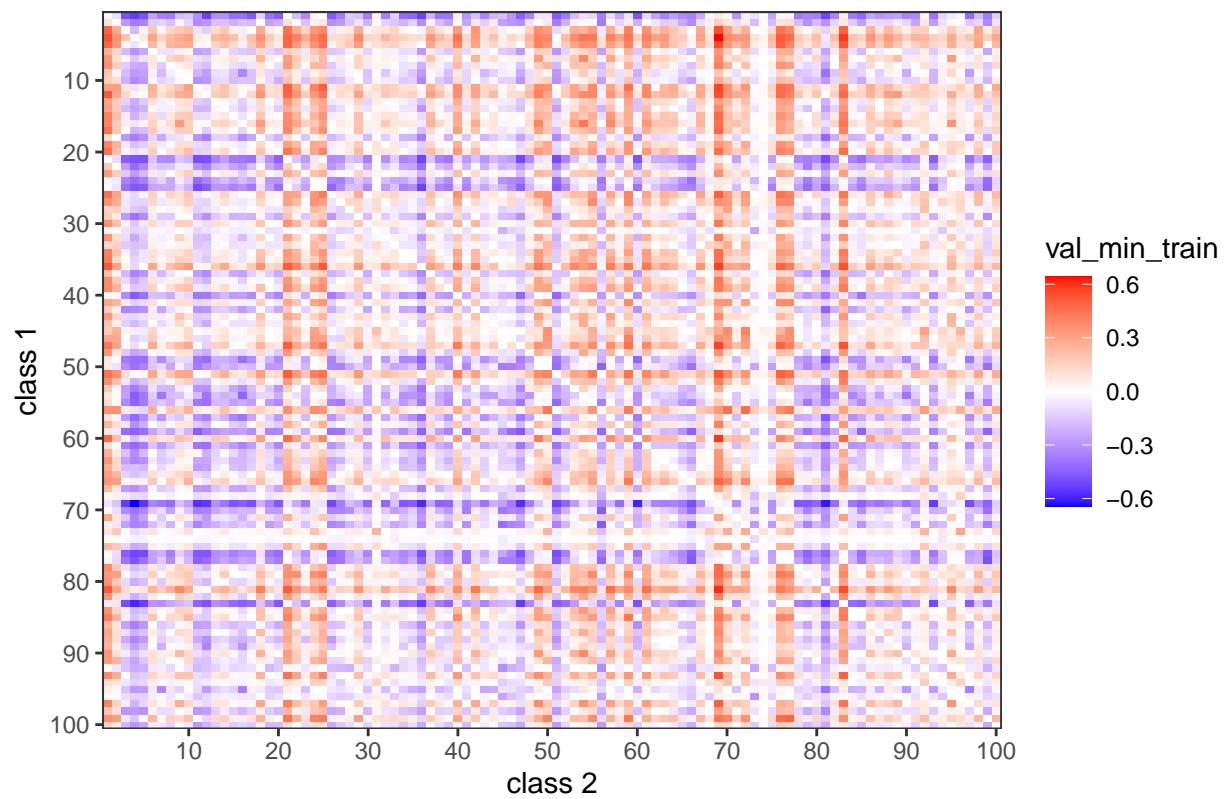
Pairwise probabilities differences – class 72



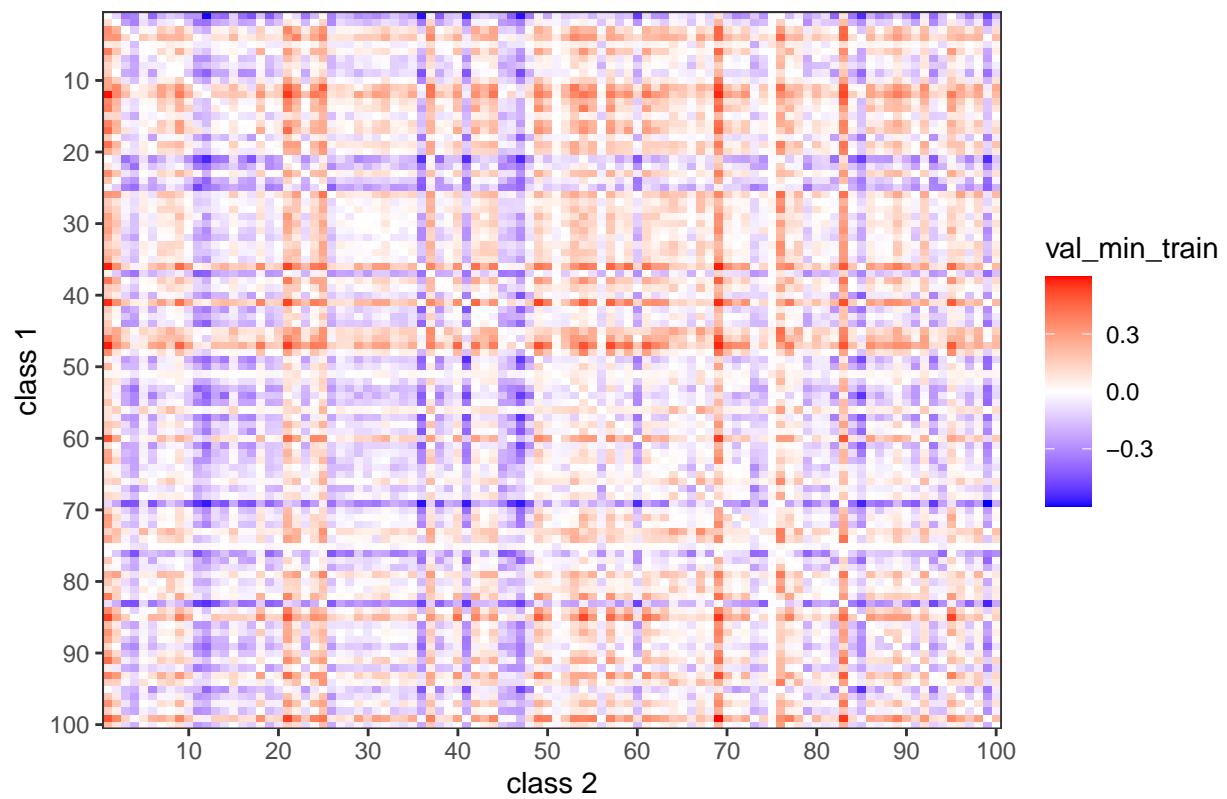
Pairwise probabilities differences – class 73



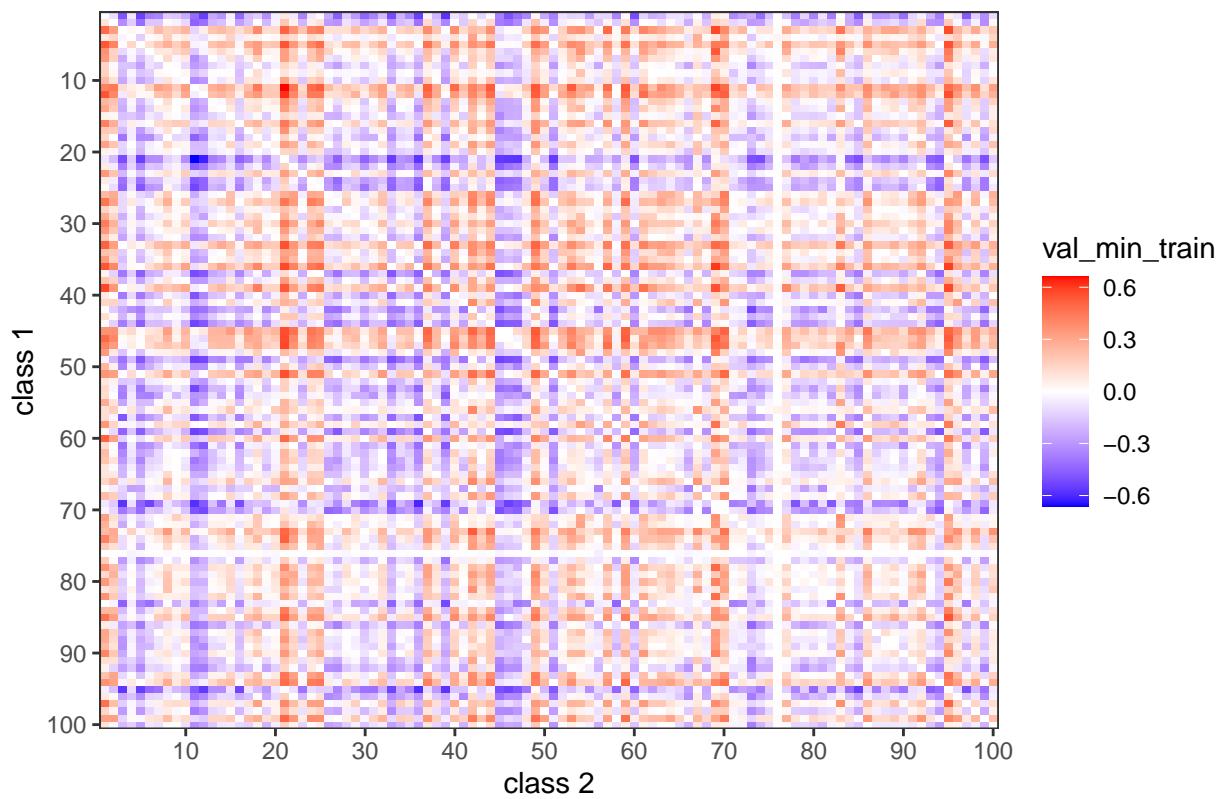
Pairwise probabilities differences – class 74



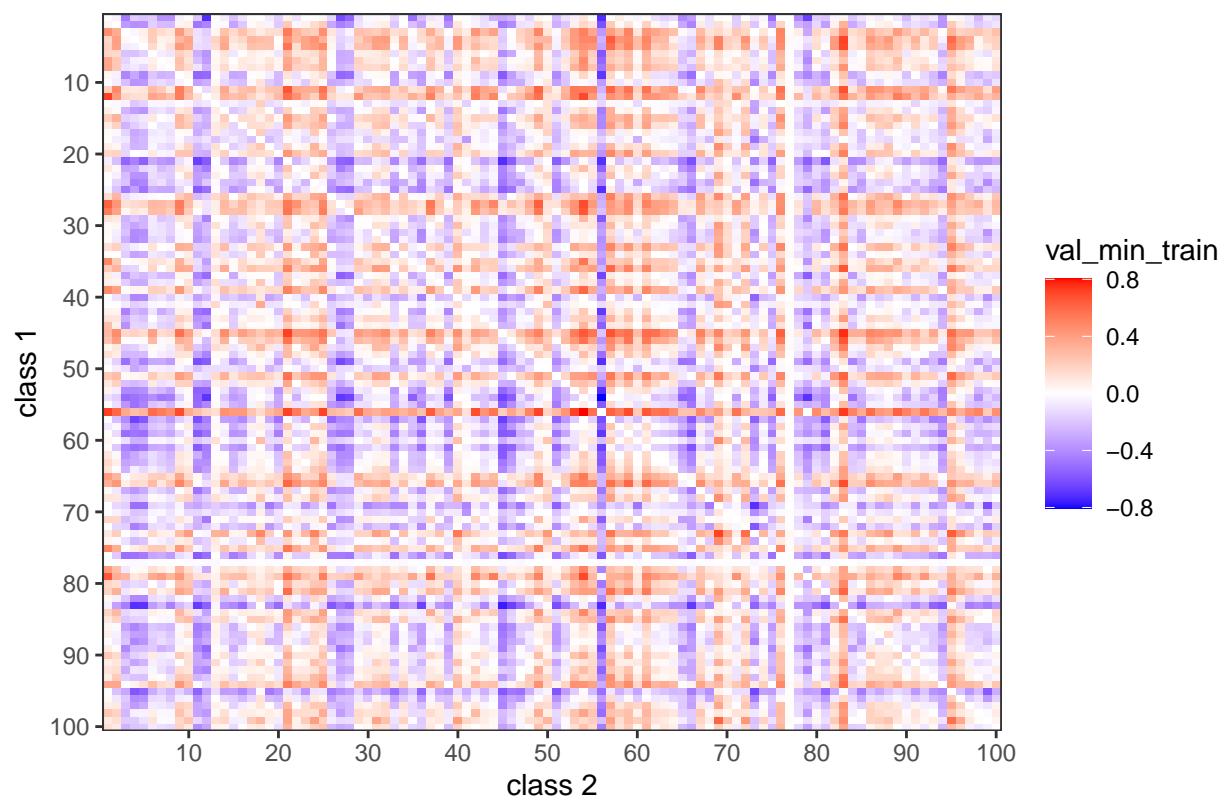
Pairwise probabilities differences – class 75



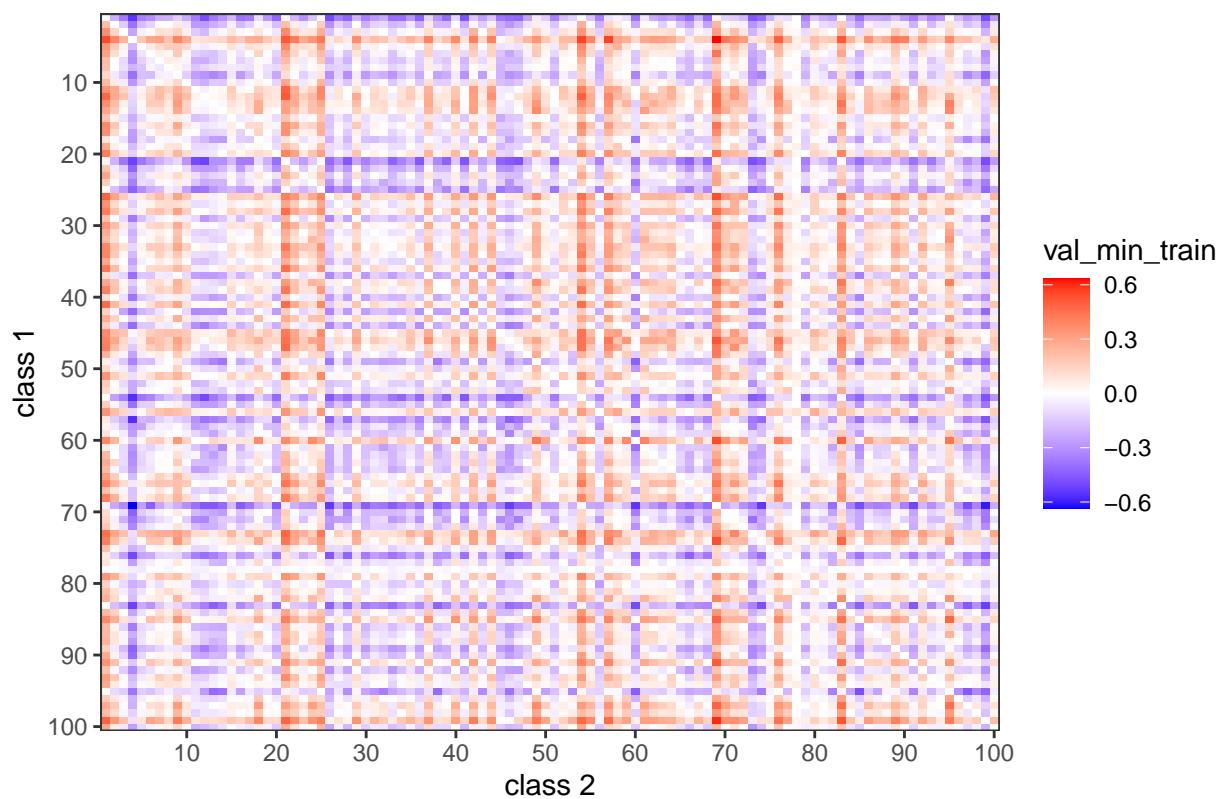
Pairwise probabilities differences – class 76



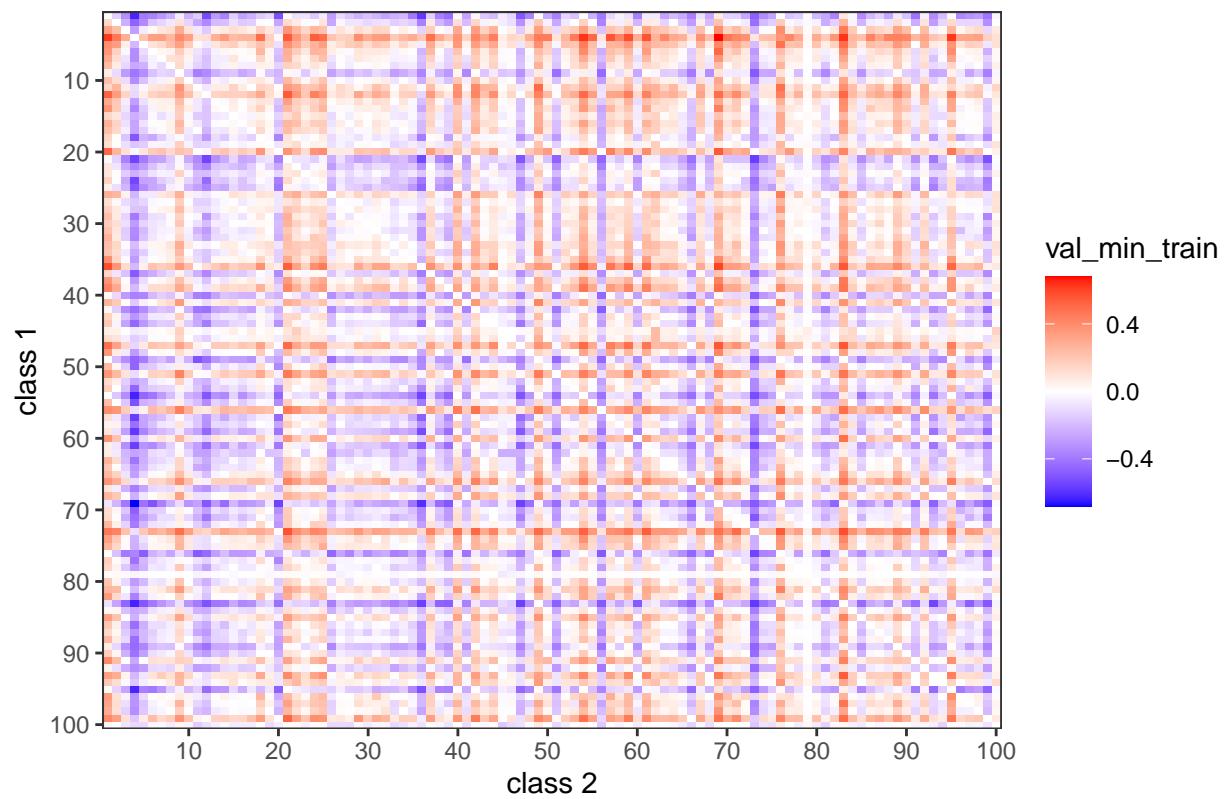
Pairwise probabilities differences – class 77



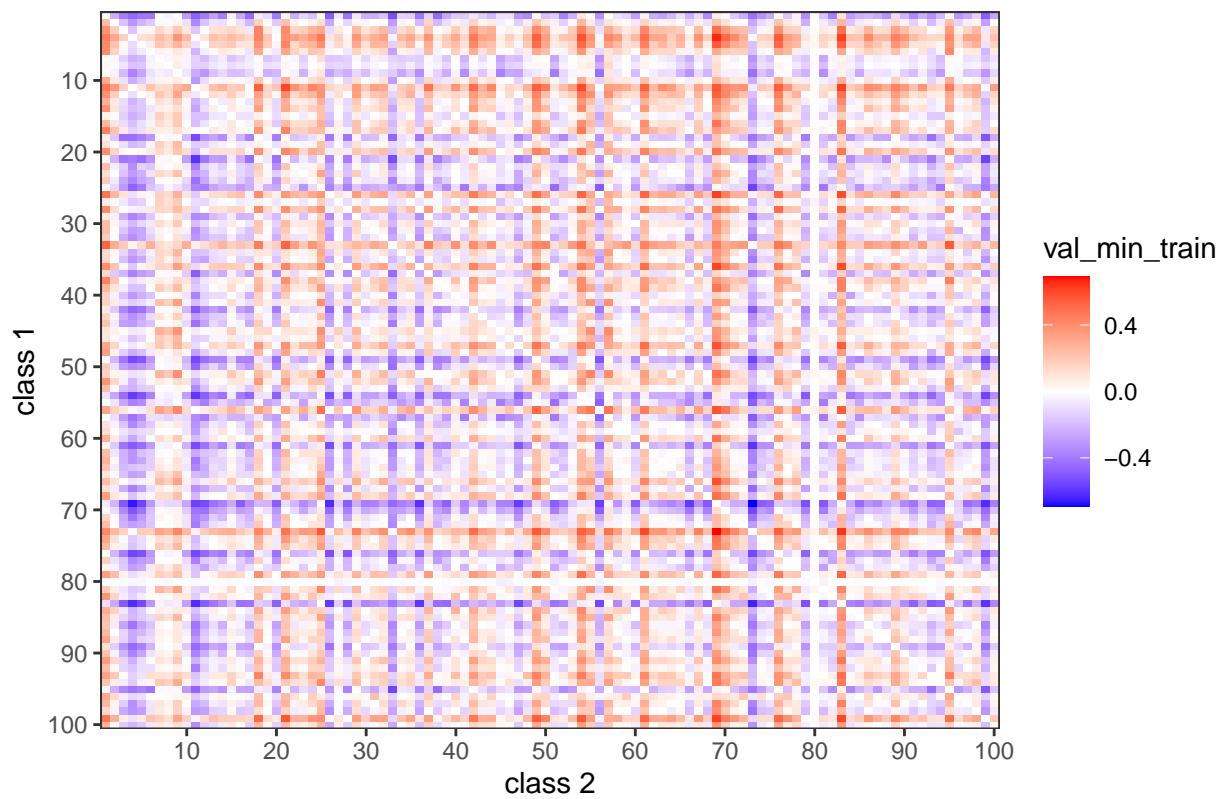
Pairwise probabilities differences – class 78



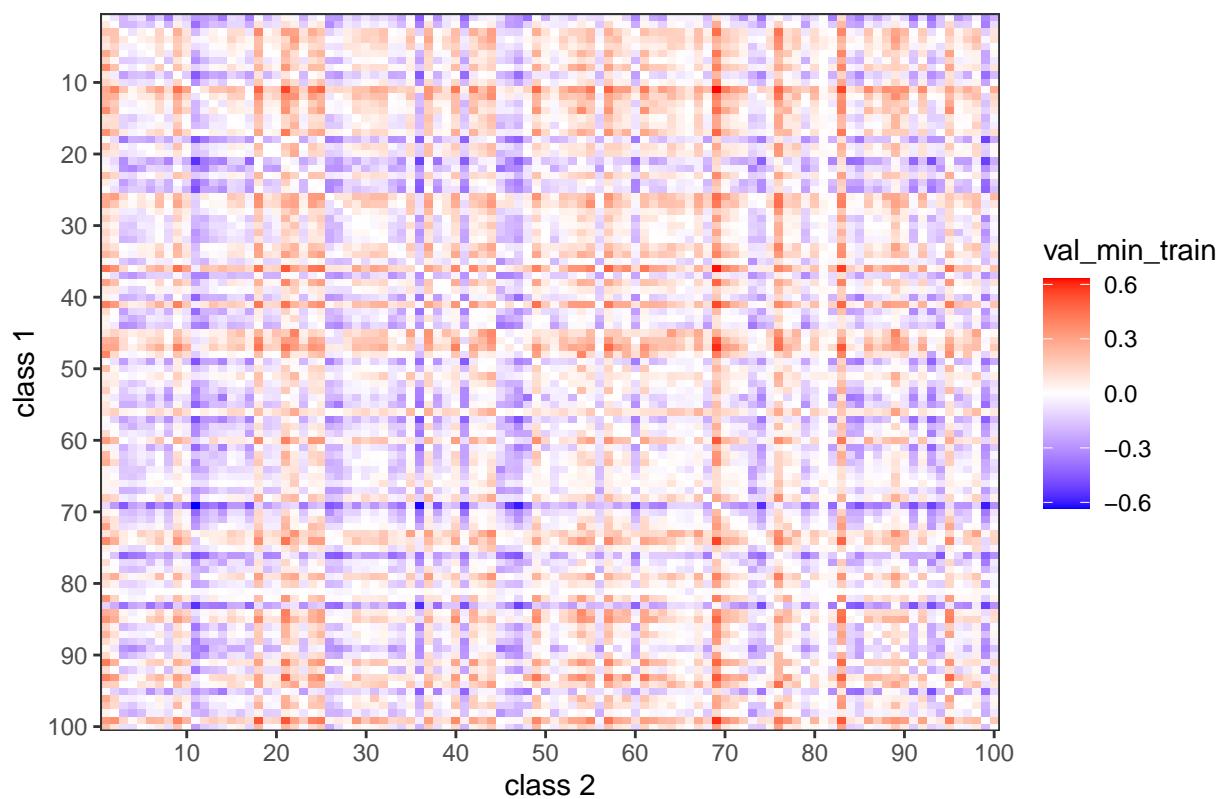
Pairwise probabilities differences – class 79



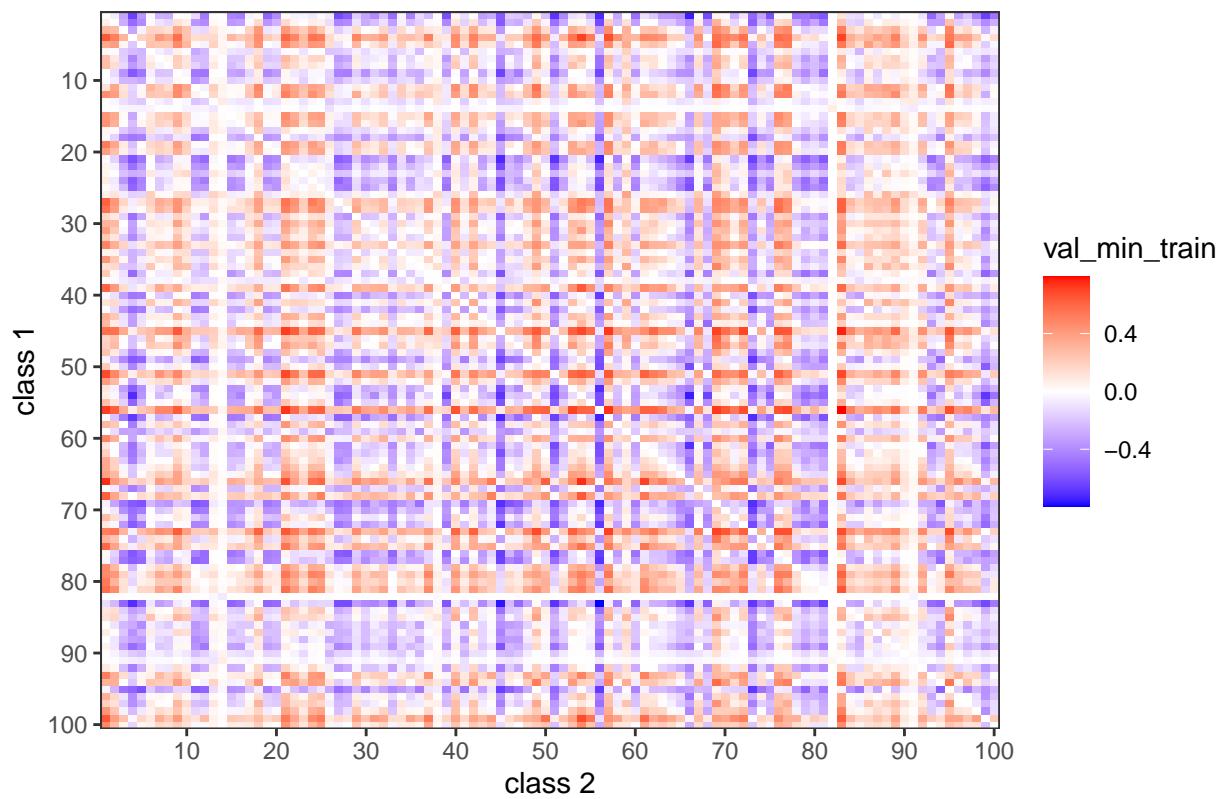
Pairwise probabilities differences – class 80



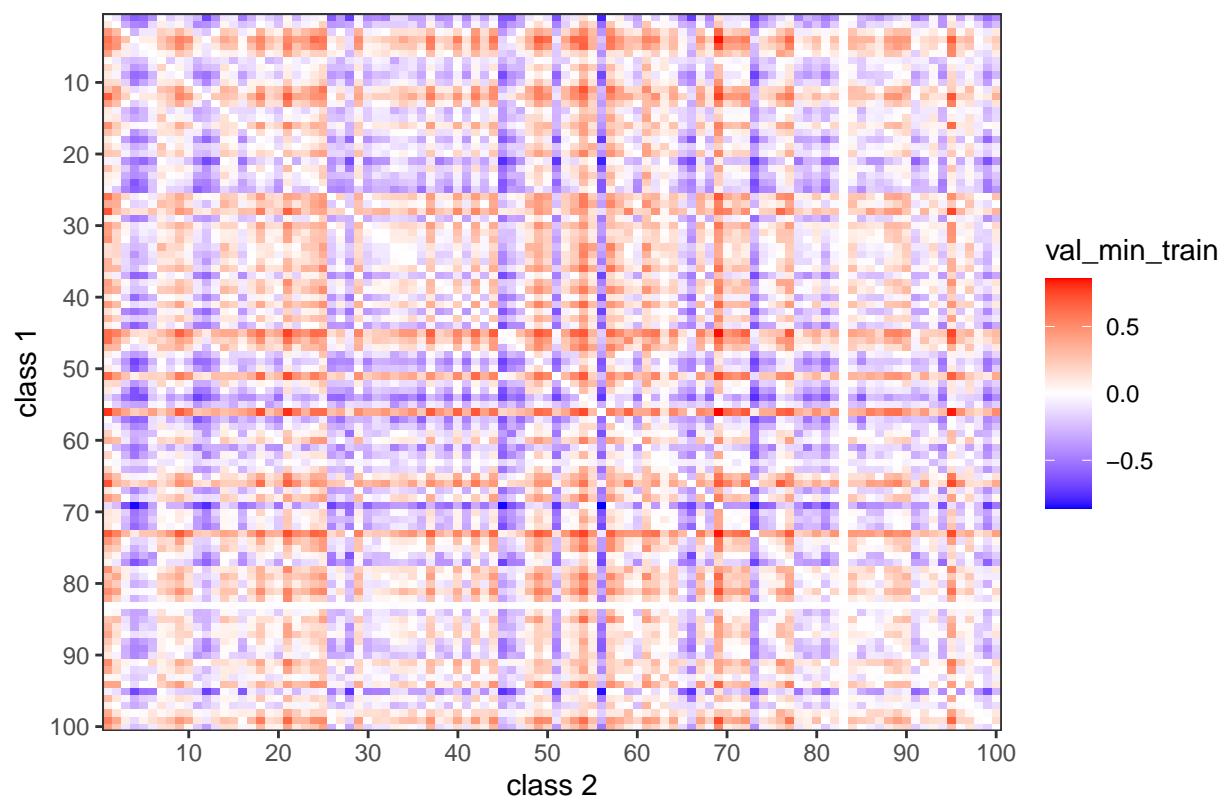
Pairwise probabilities differences – class 81



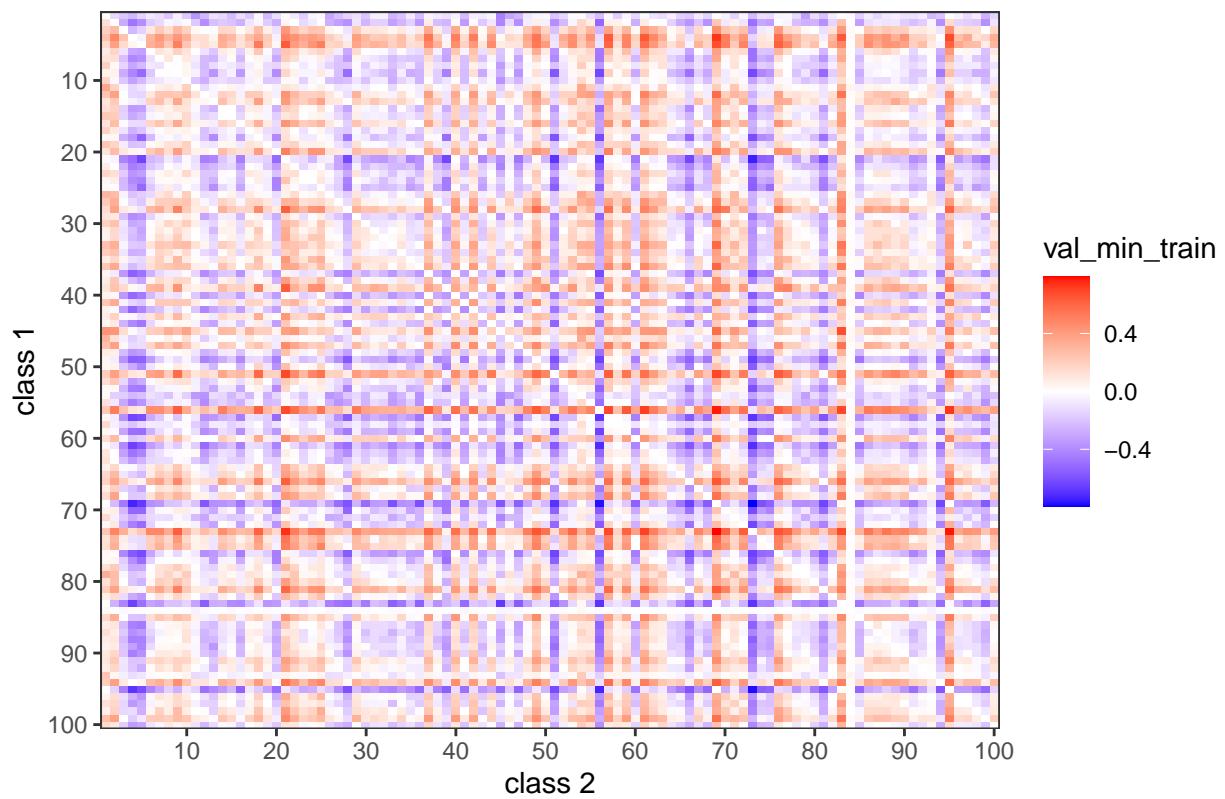
Pairwise probabilities differences – class 82



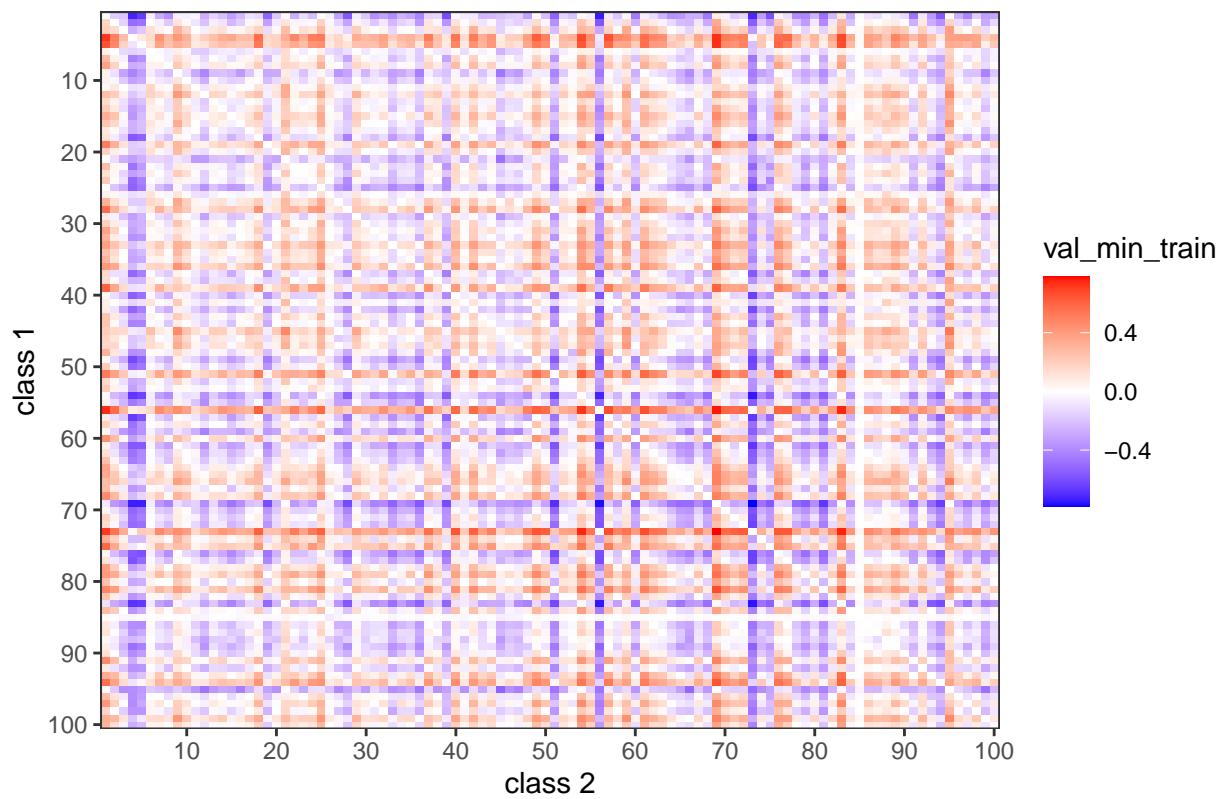
Pairwise probabilities differences – class 83



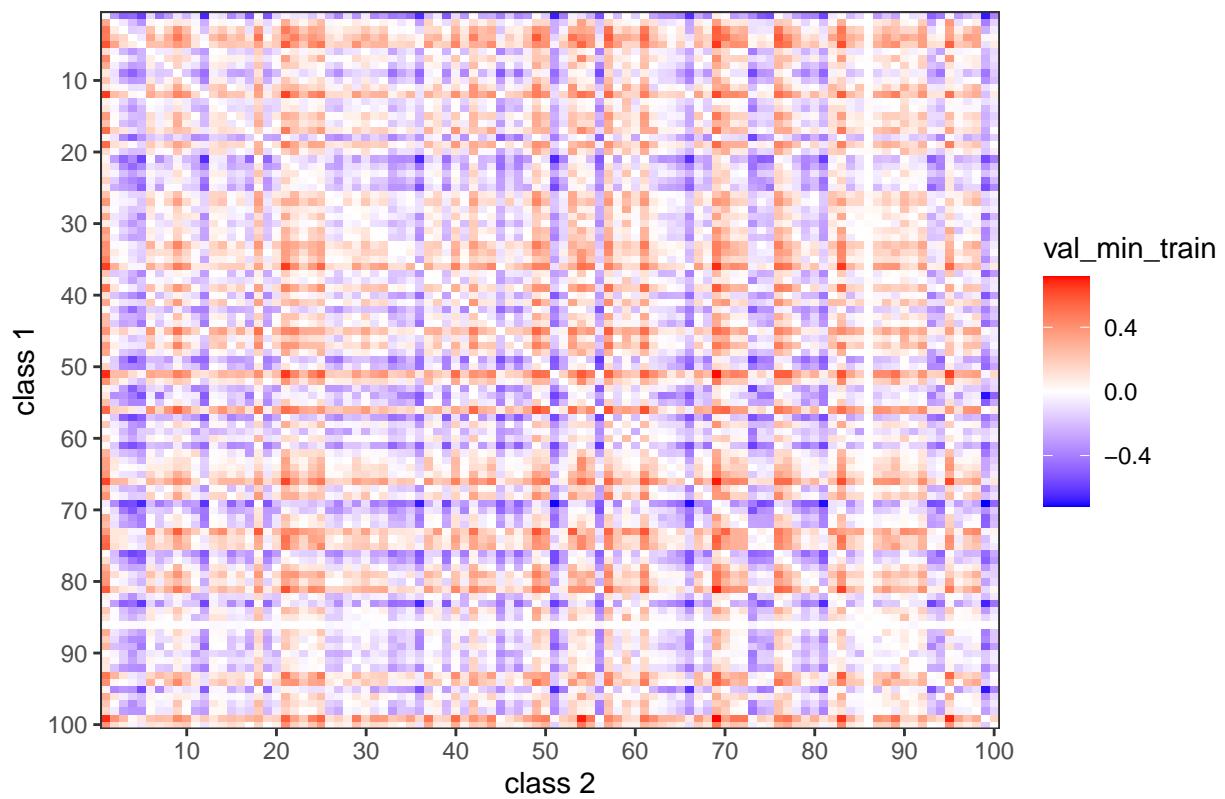
Pairwise probabilities differences – class 84



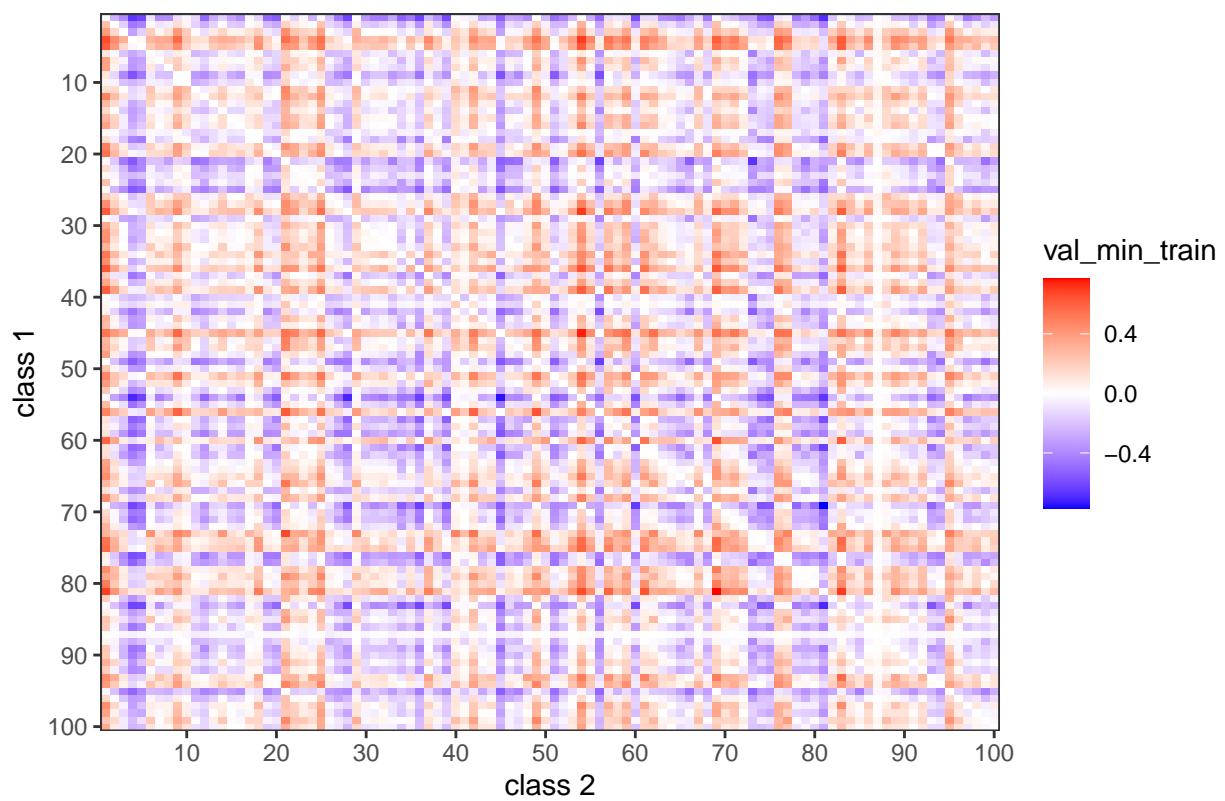
Pairwise probabilities differences – class 85



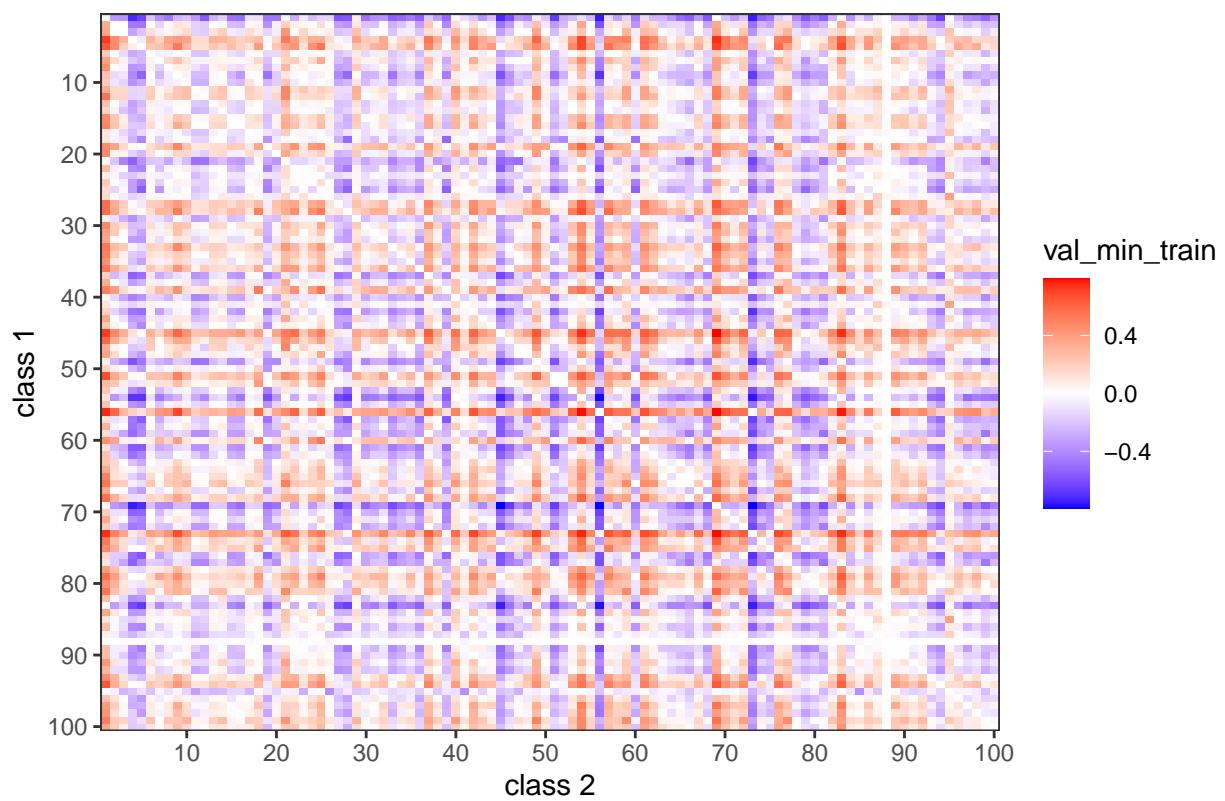
Pairwise probabilities differences – class 86



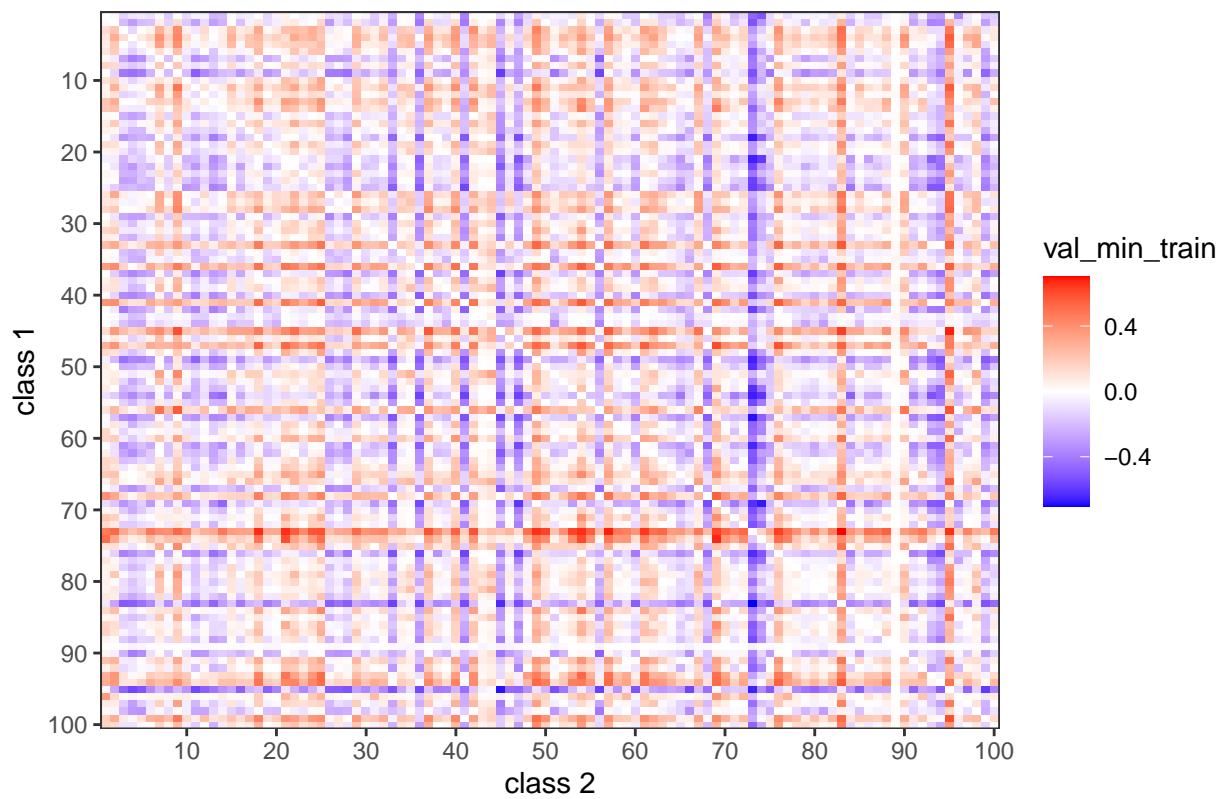
Pairwise probabilities differences – class 87



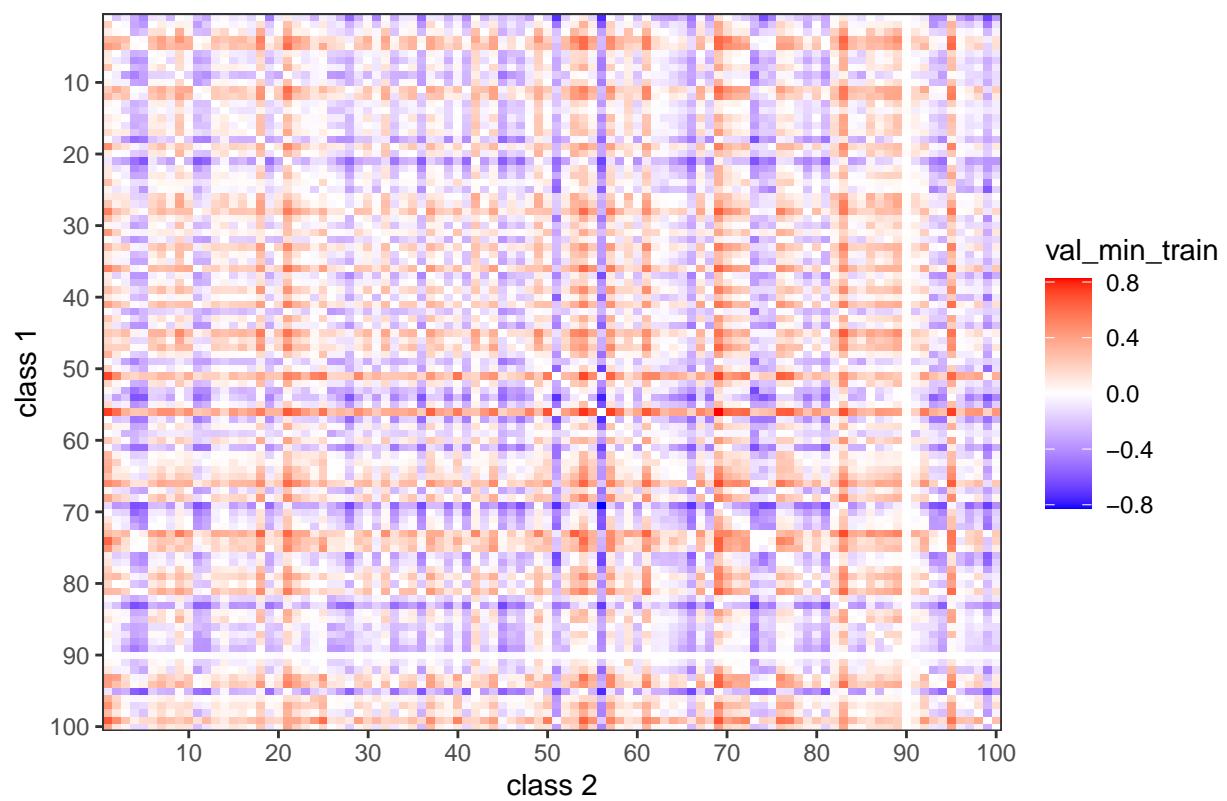
Pairwise probabilities differences – class 88



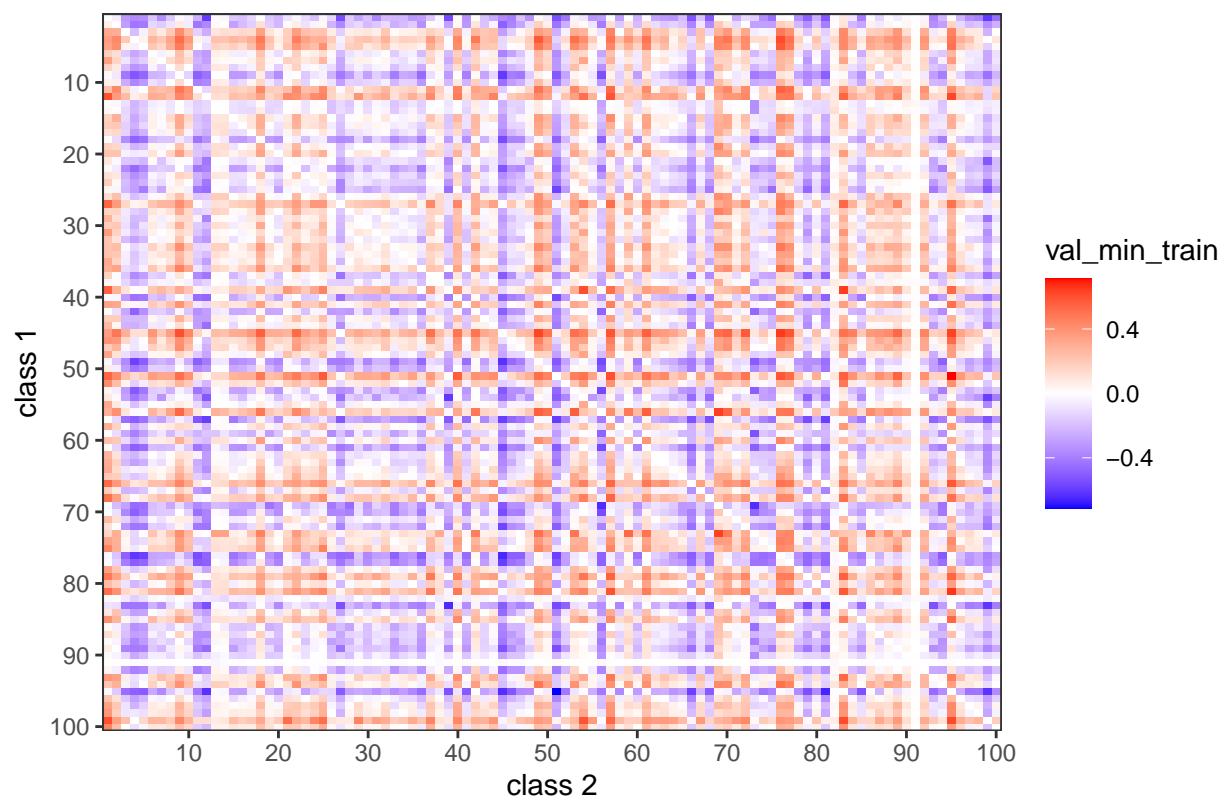
Pairwise probabilities differences – class 89



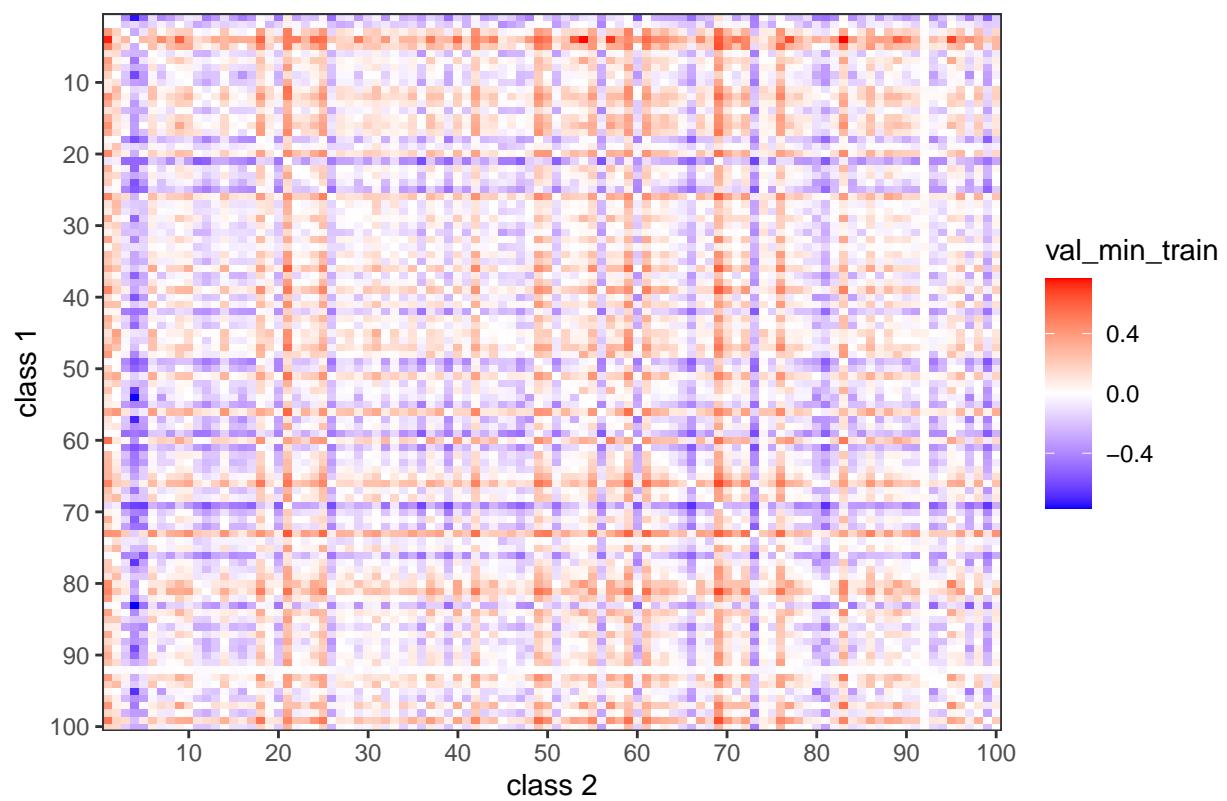
Pairwise probabilities differences – class 90



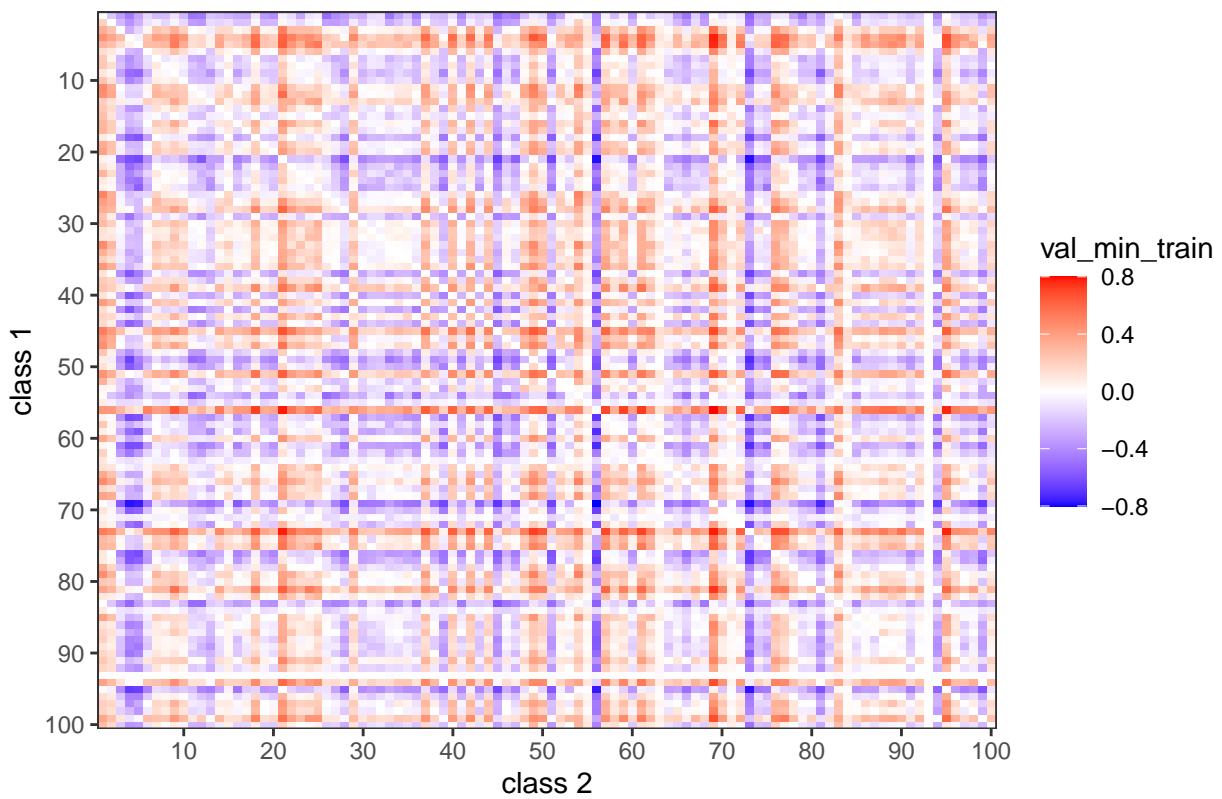
Pairwise probabilities differences – class 91



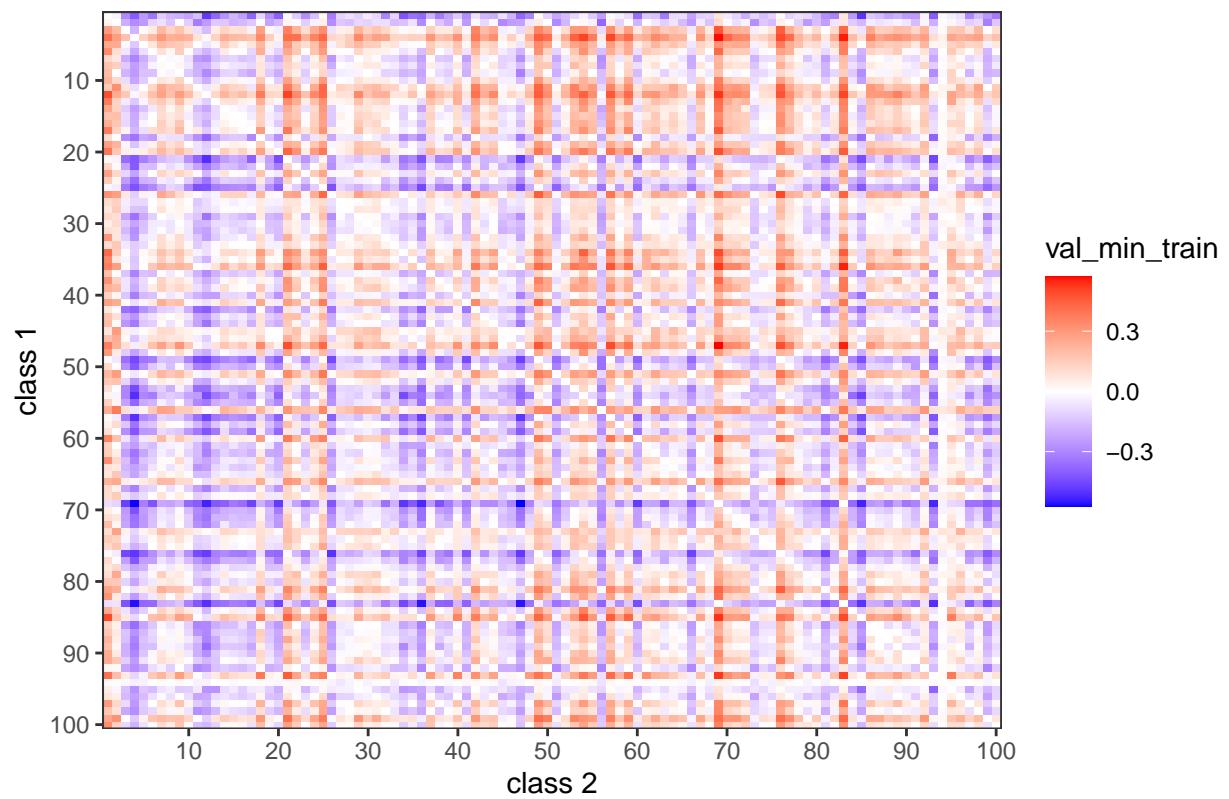
Pairwise probabilities differences – class 92



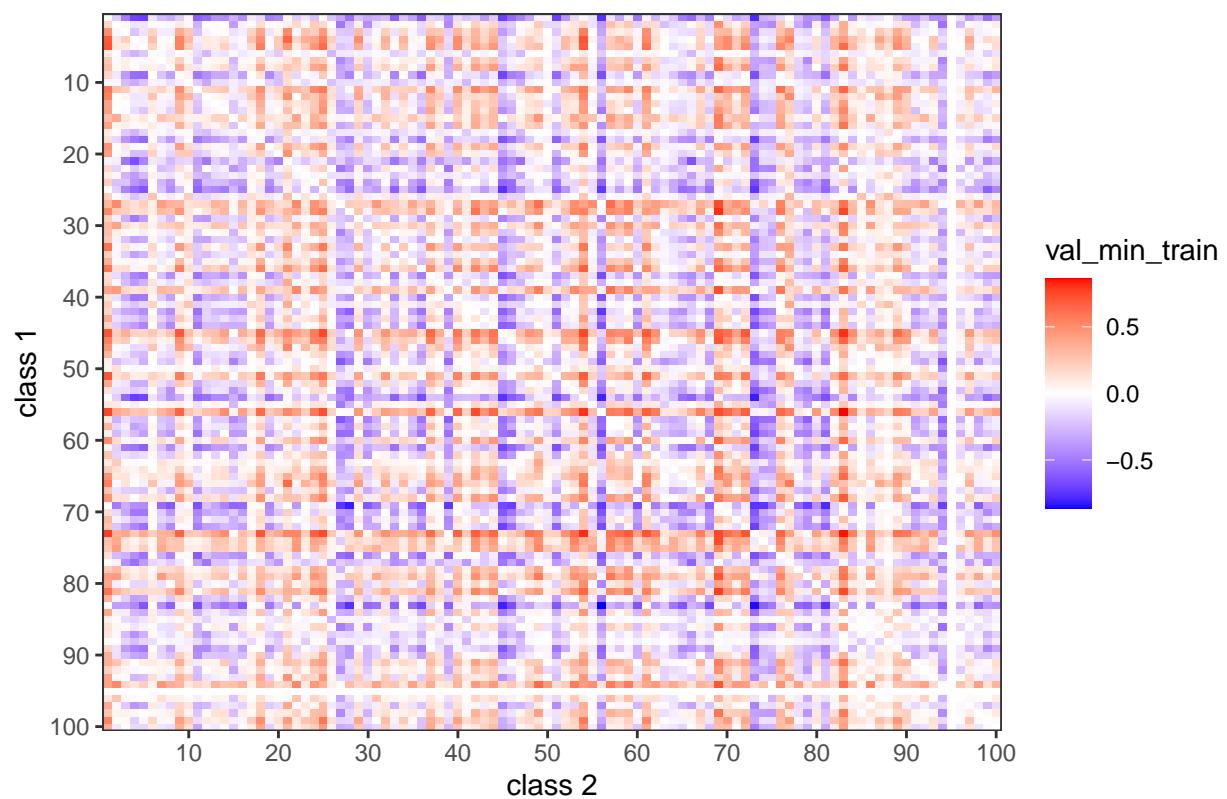
Pairwise probabilities differences – class 93



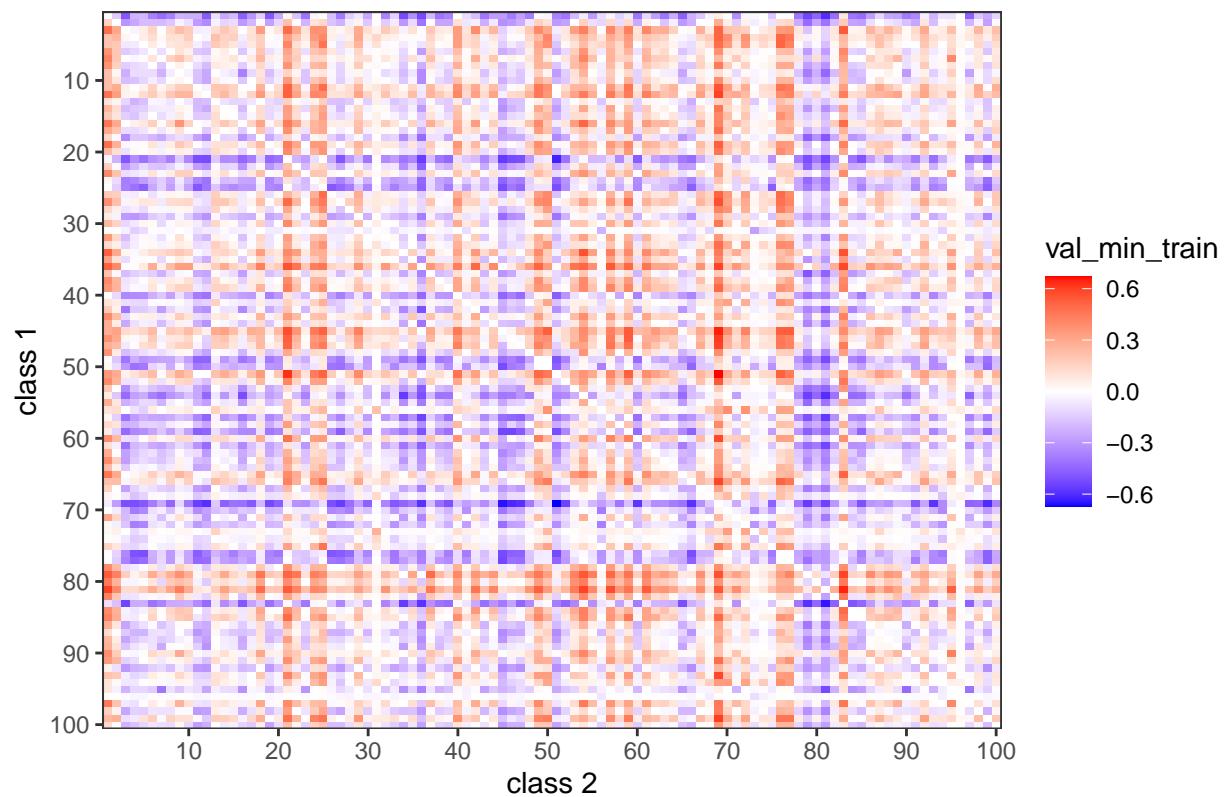
Pairwise probabilities differences – class 94



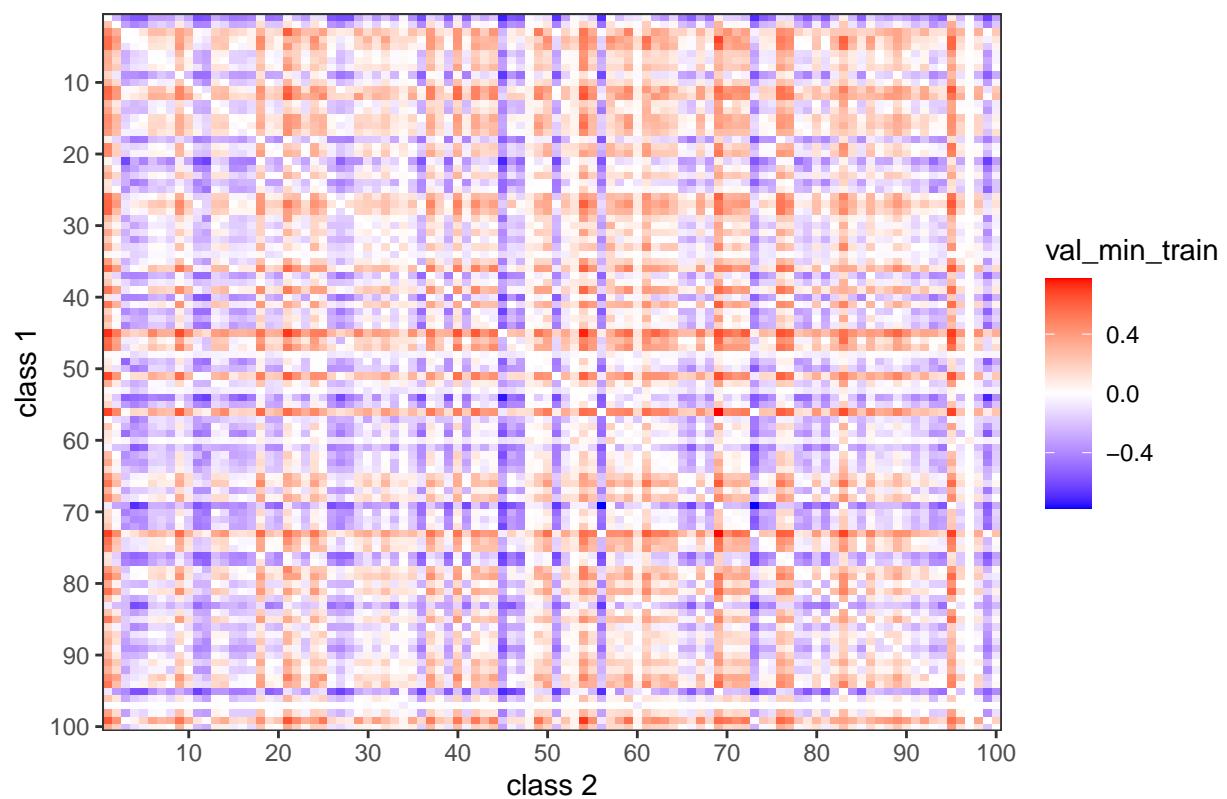
Pairwise probabilities differences – class 95



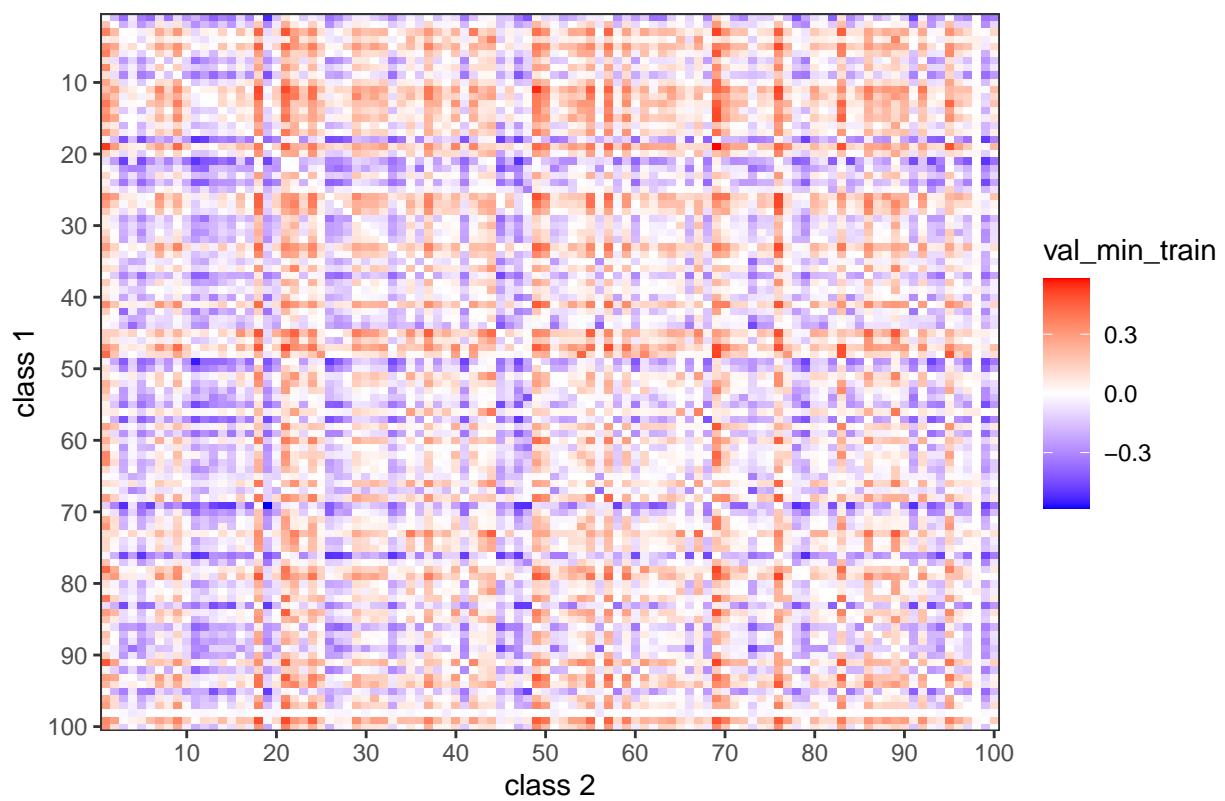
Pairwise probabilities differences – class 96



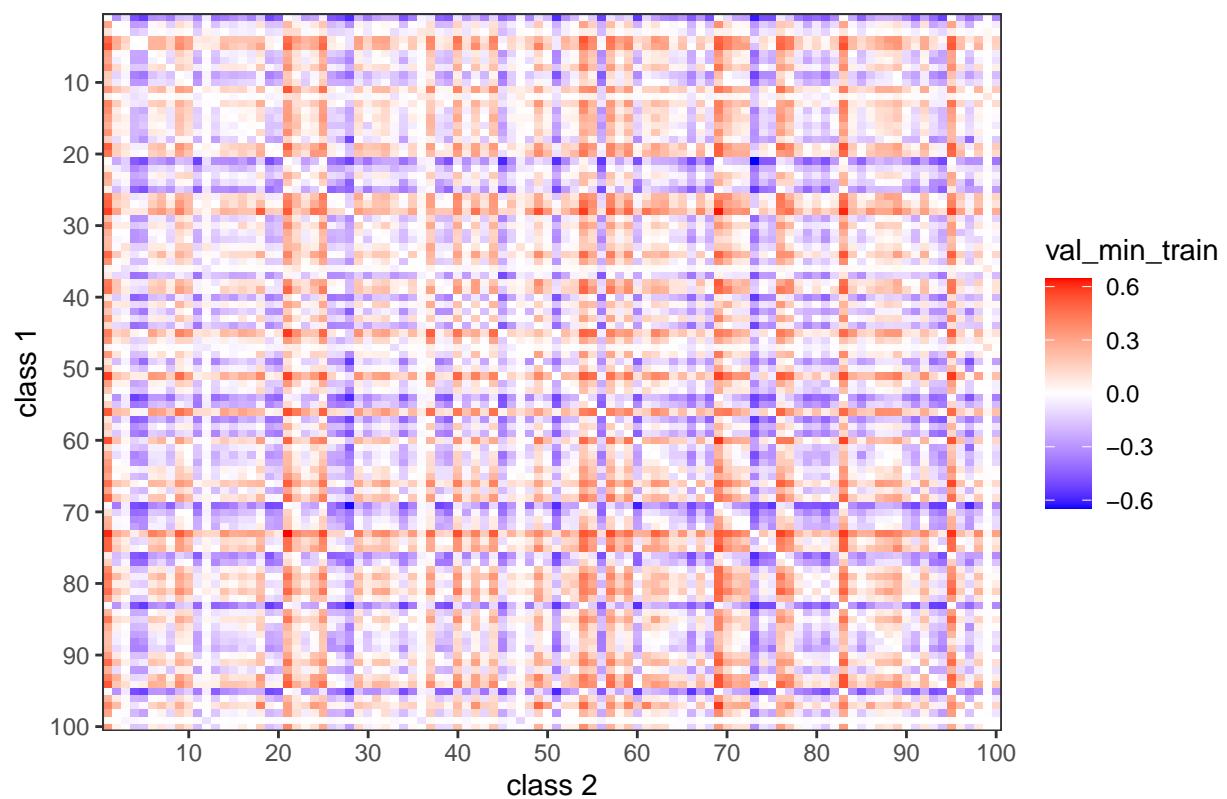
Pairwise probabilities differences – class 97



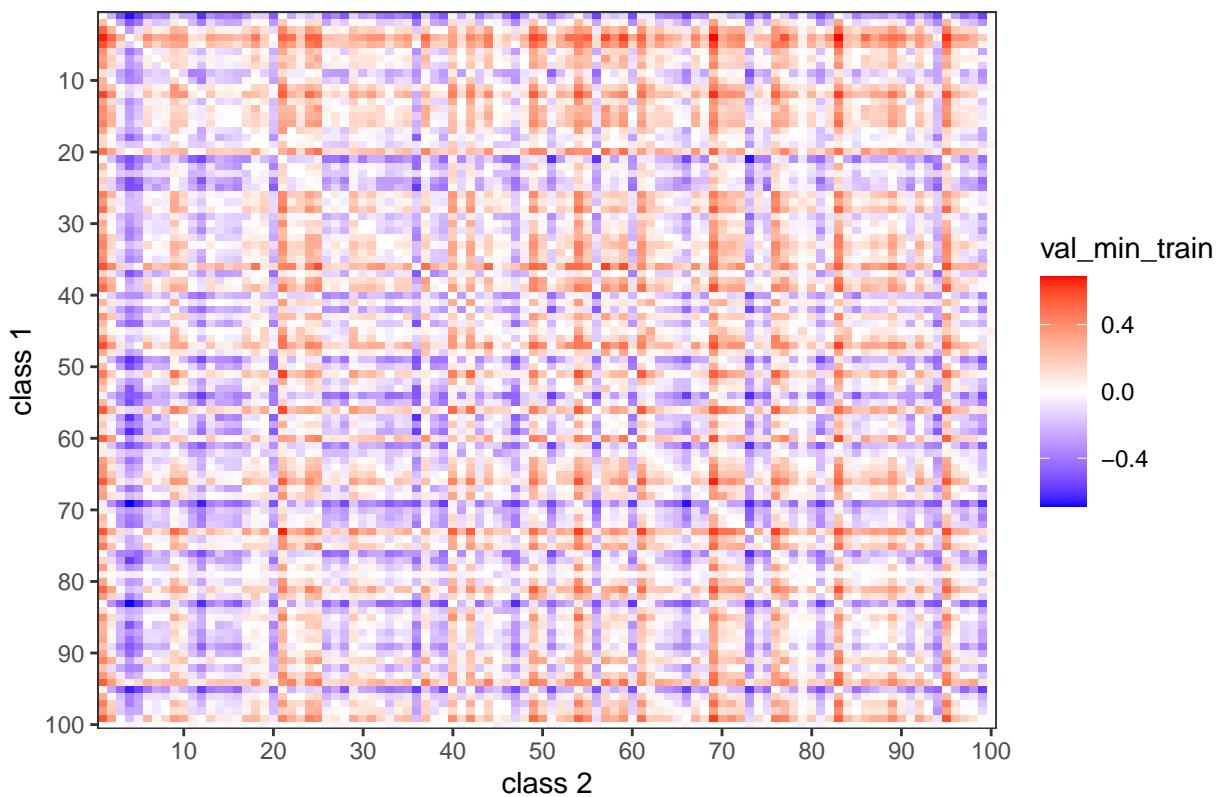
Pairwise probabilities differences – class 98



Pairwise probabilities differences – class 99



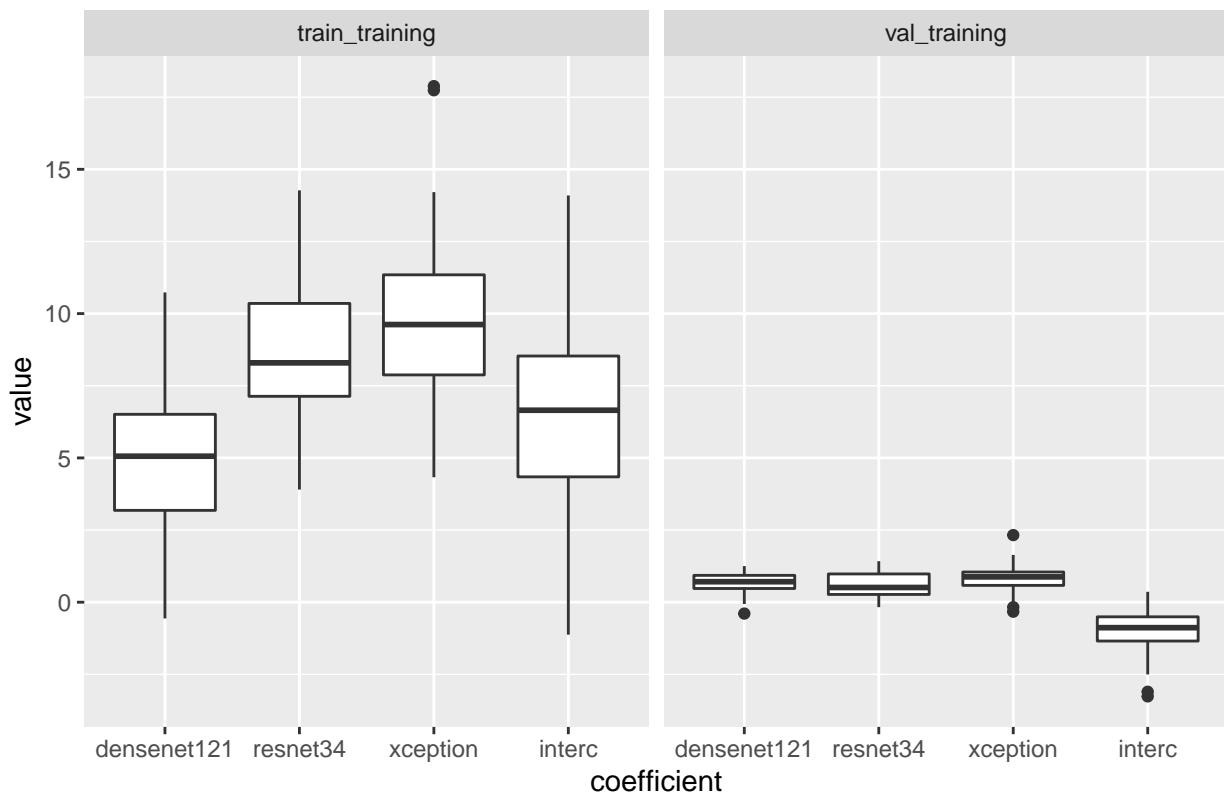
Pairwise probabilities differences – class 100



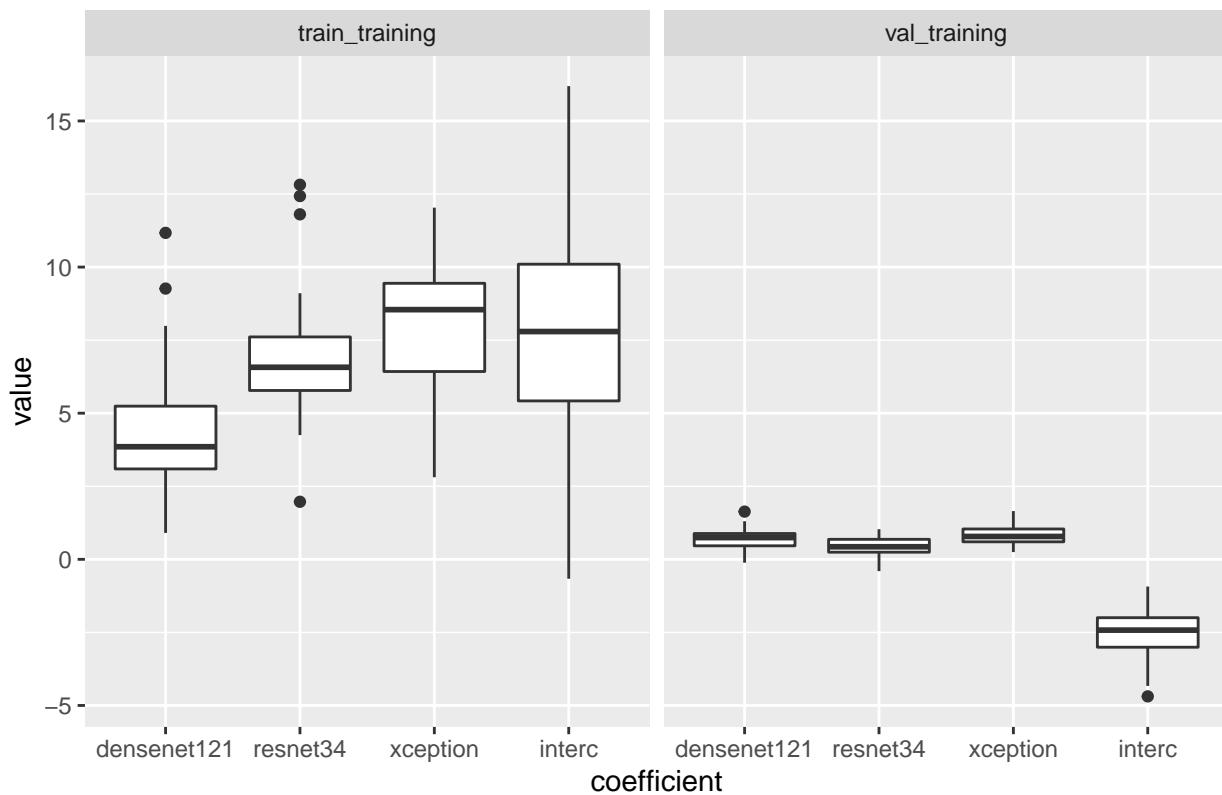
```
lda_coefs <- load_lda_coefs(base_dir, repls, folds)
```

```
for (cl1 in 1:19)
{
  for (cl2 in (cl1 + 1):20)
  {
    cur_plt <- lda_coefs %>% filter(class1 == cl1 & class2 == cl2) %>% ggplot() + geom_boxplot(aes(x=co
  }
}
```

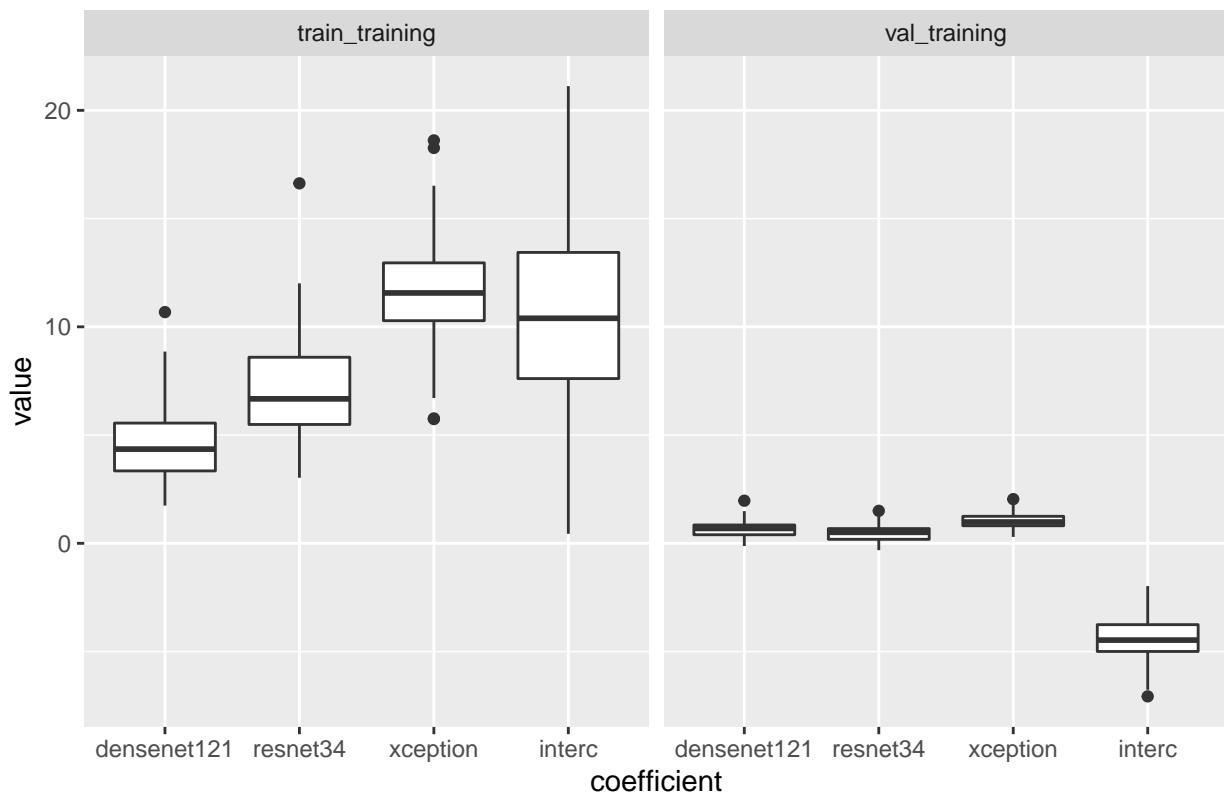
Coefficients for class 1 vs 2



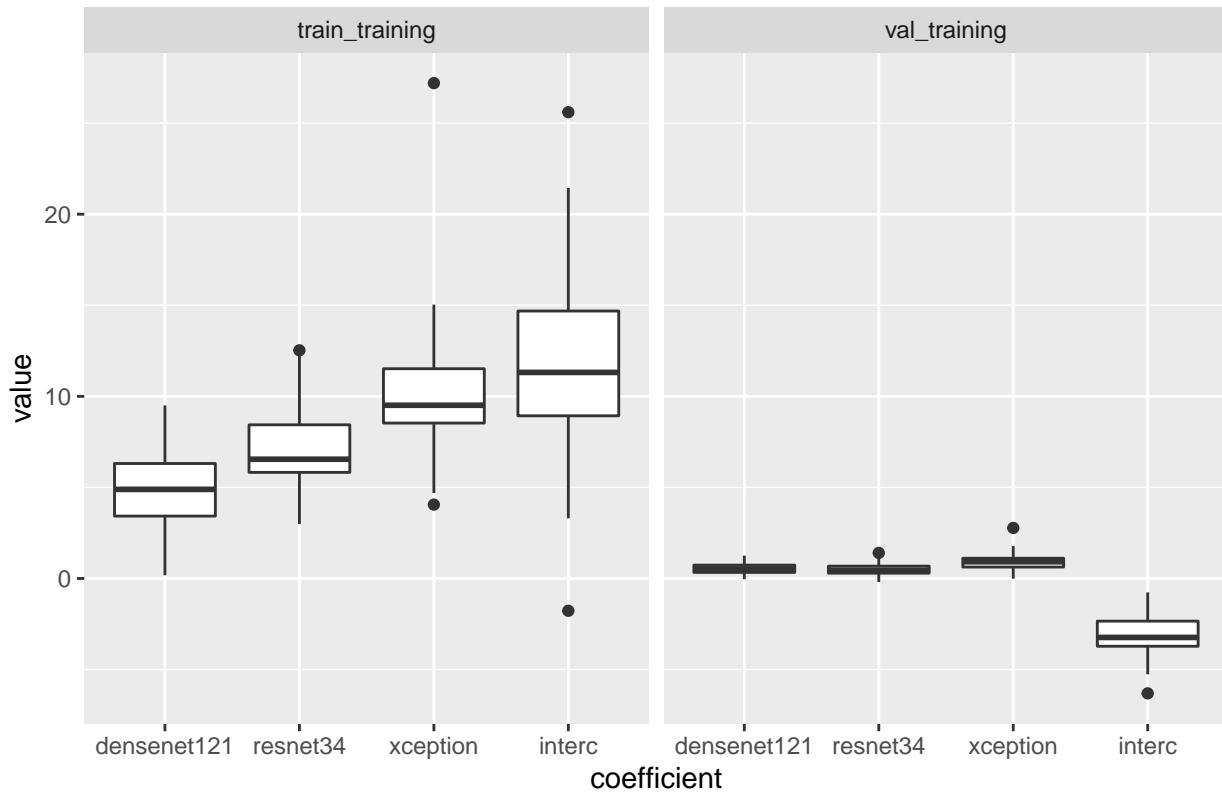
Coefficients for class 1 vs 3



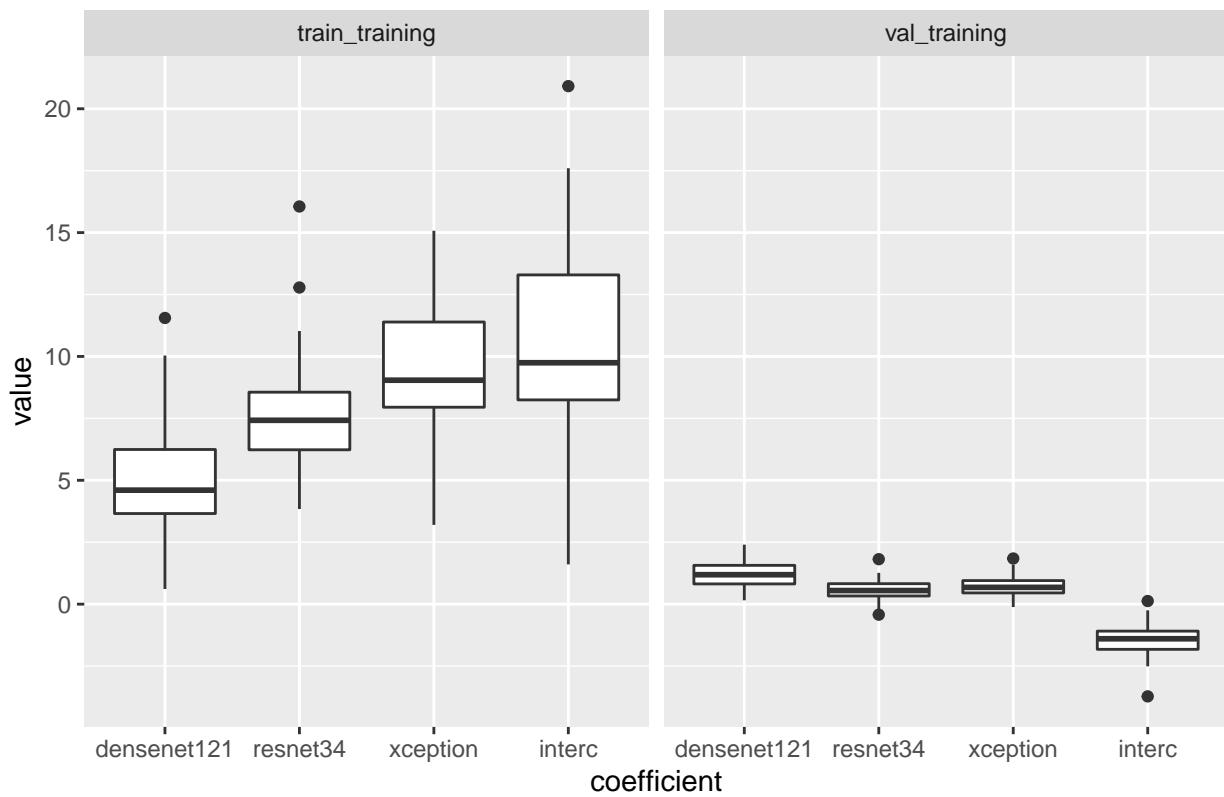
Coefficients for class 1 vs 4



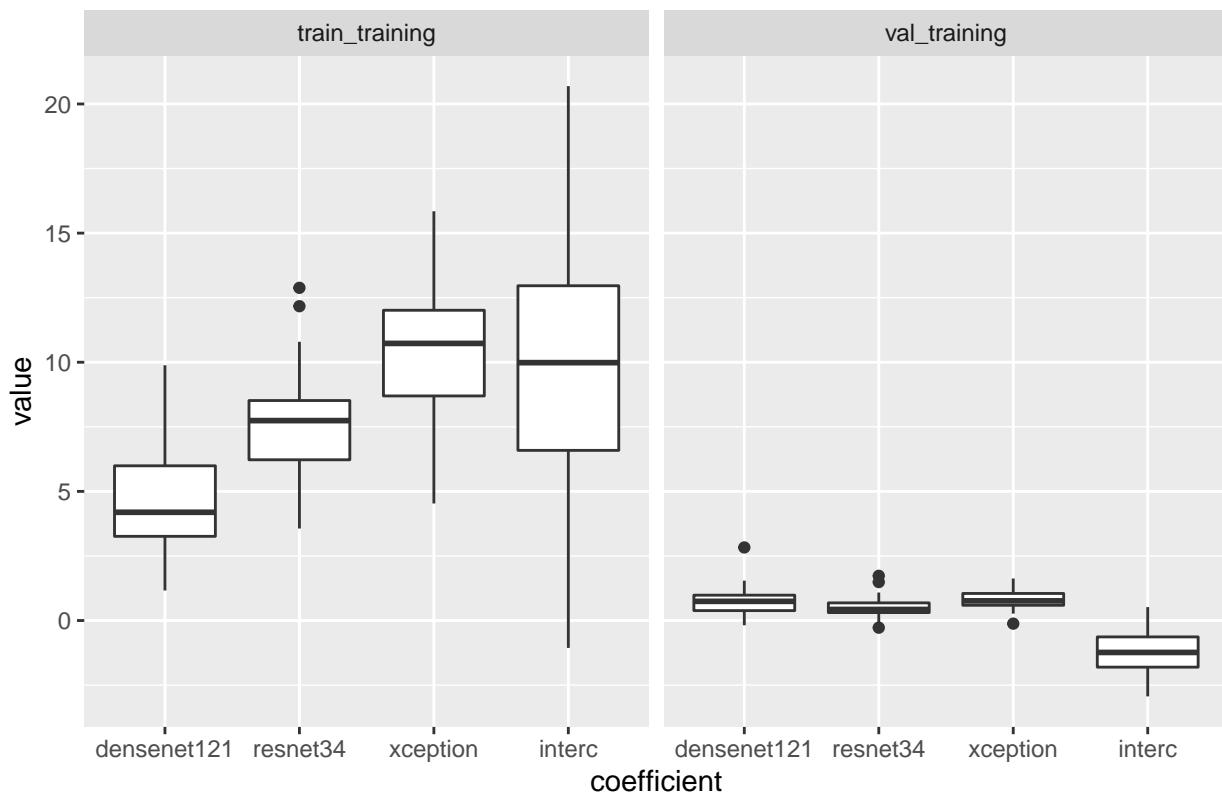
Coefficients for class 1 vs 5



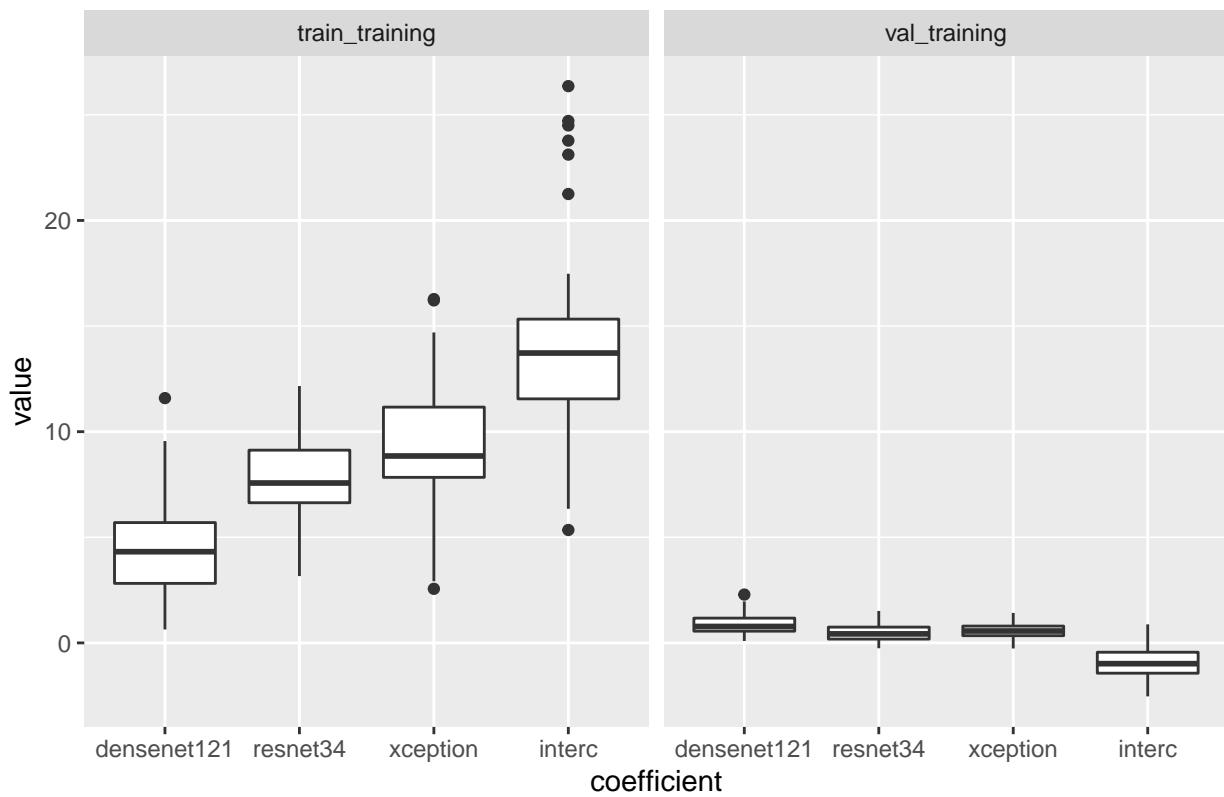
Coefficients for class 1 vs 6



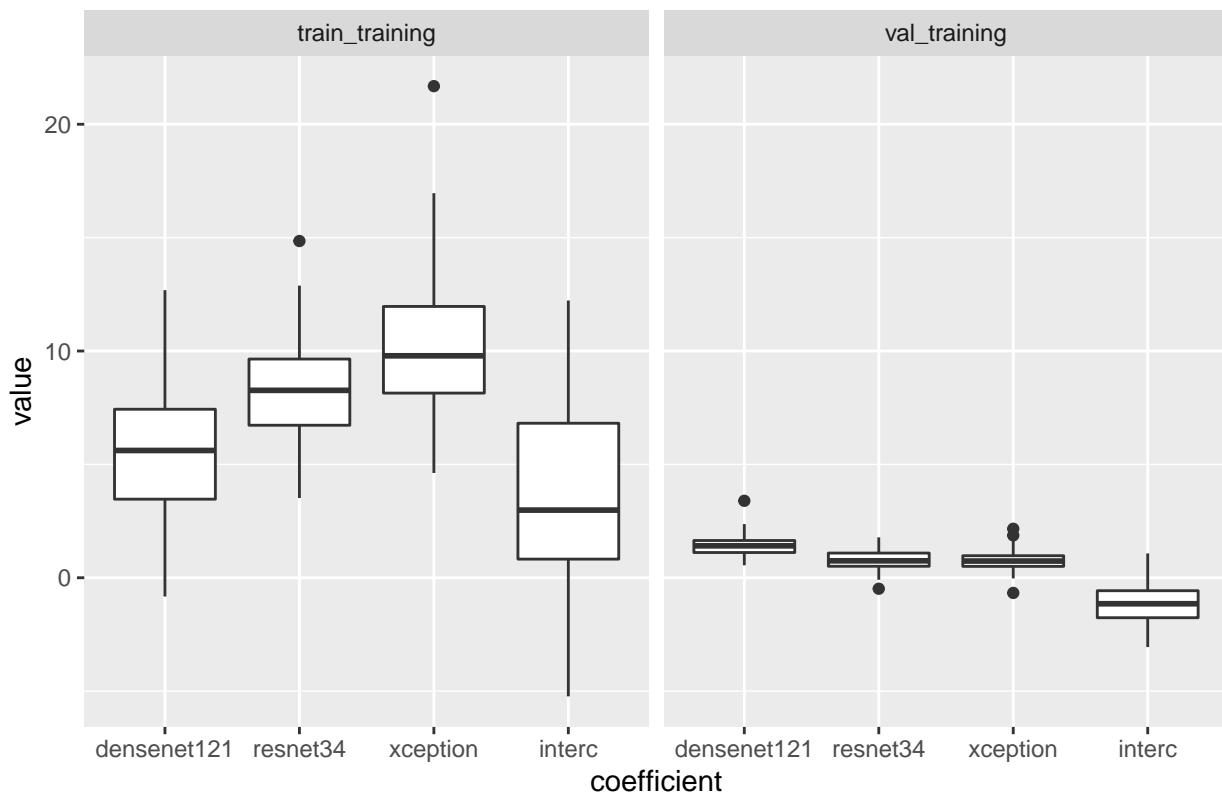
Coefficients for class 1 vs 7



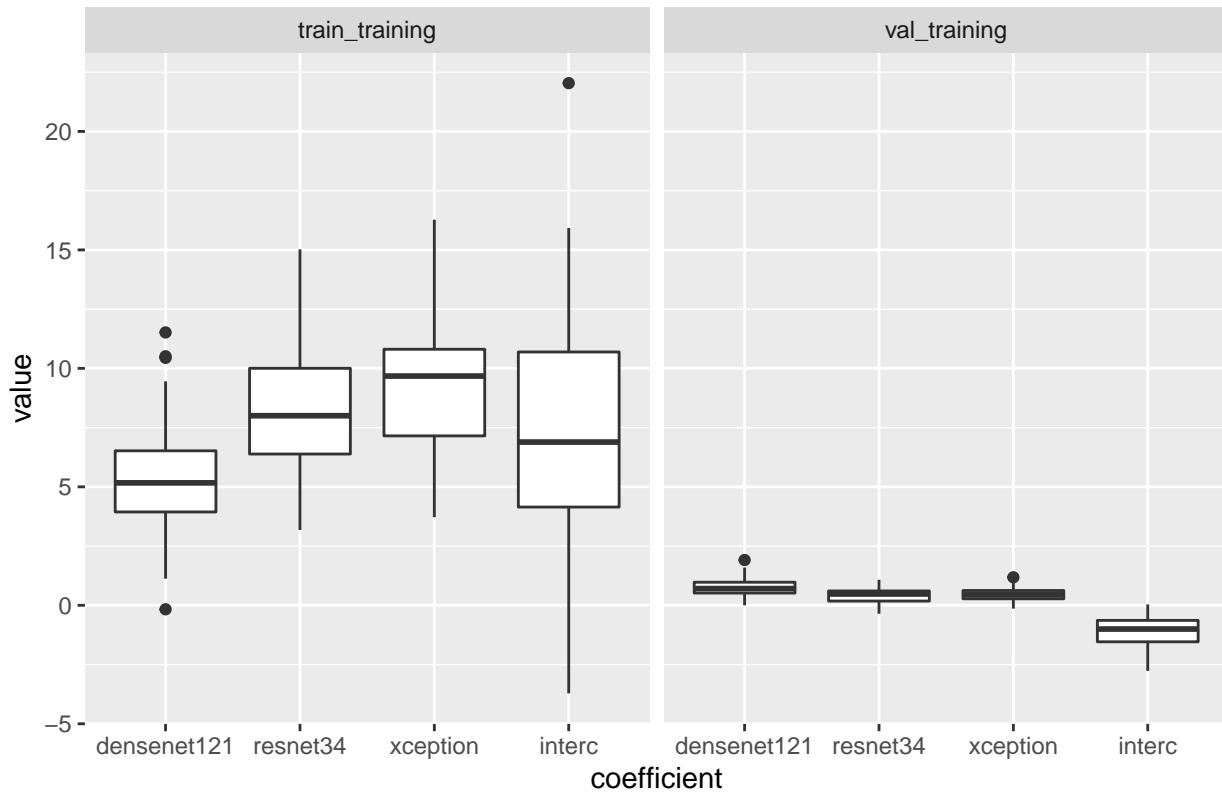
Coefficients for class 1 vs 8



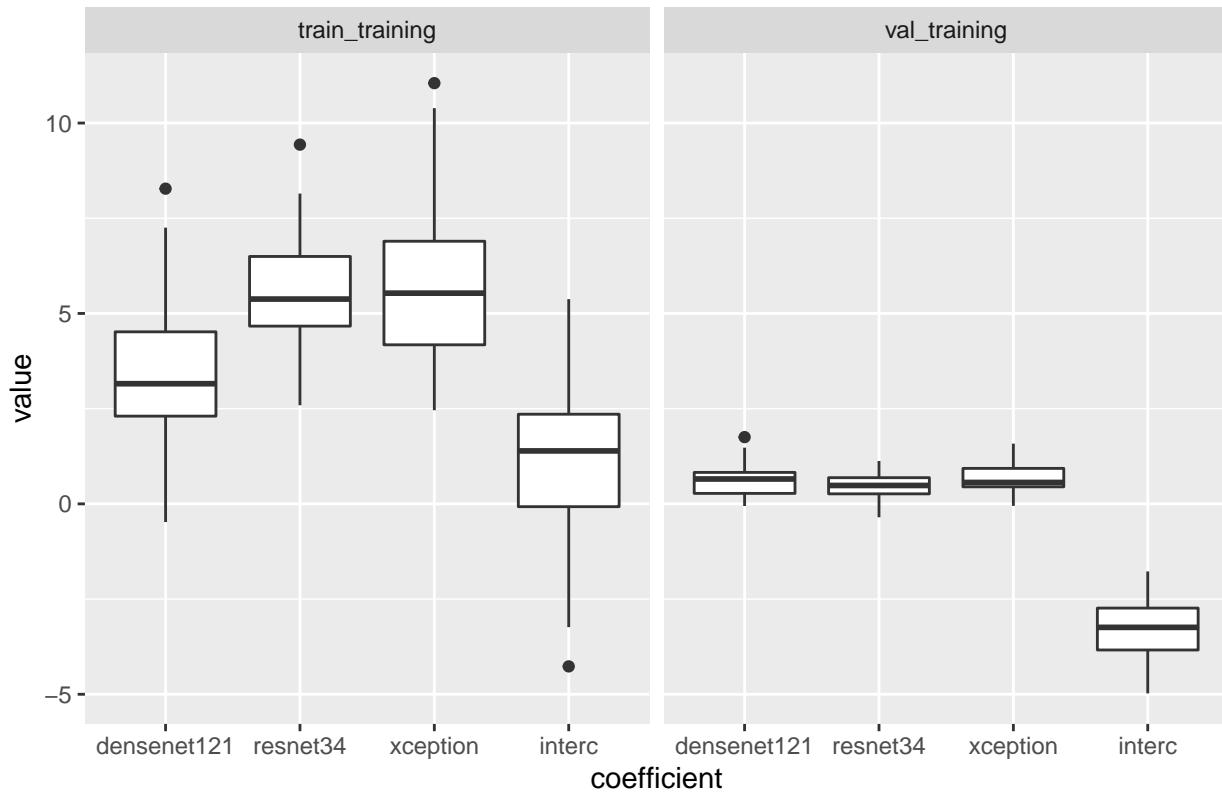
Coefficients for class 1 vs 9



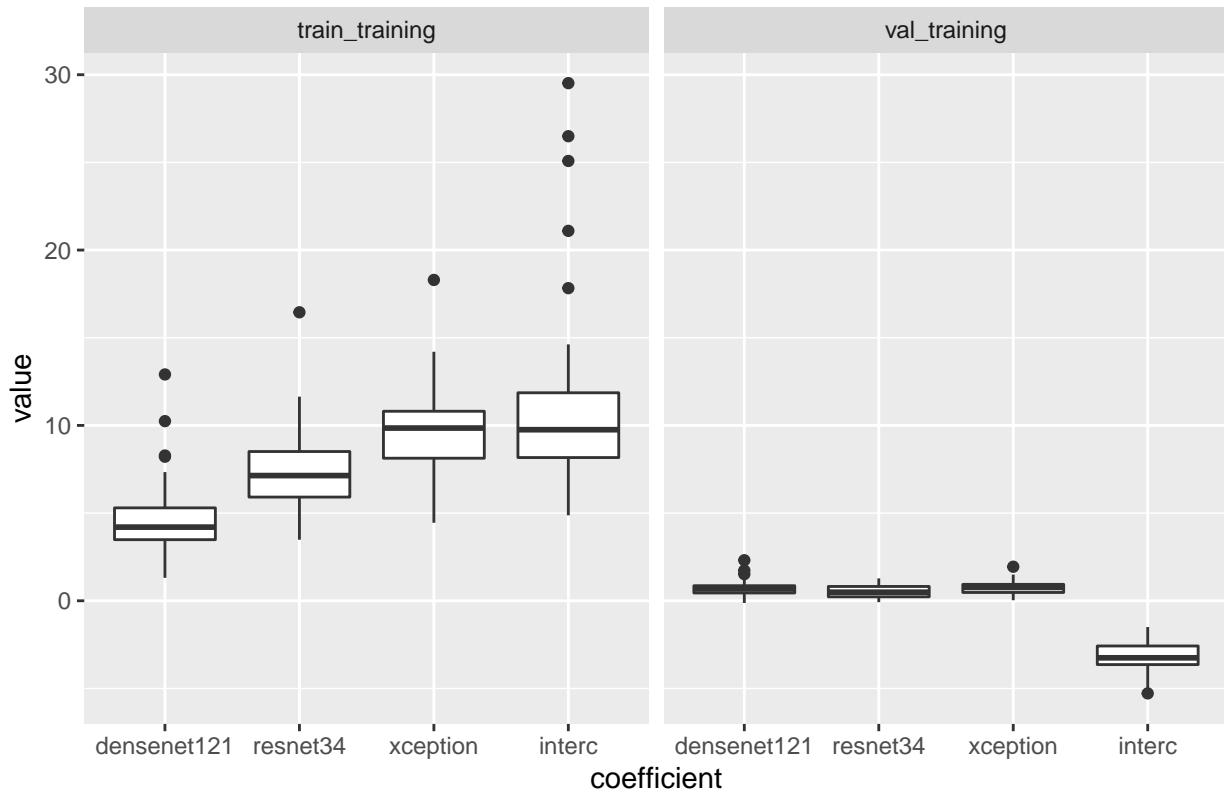
Coefficients for class 1 vs 10



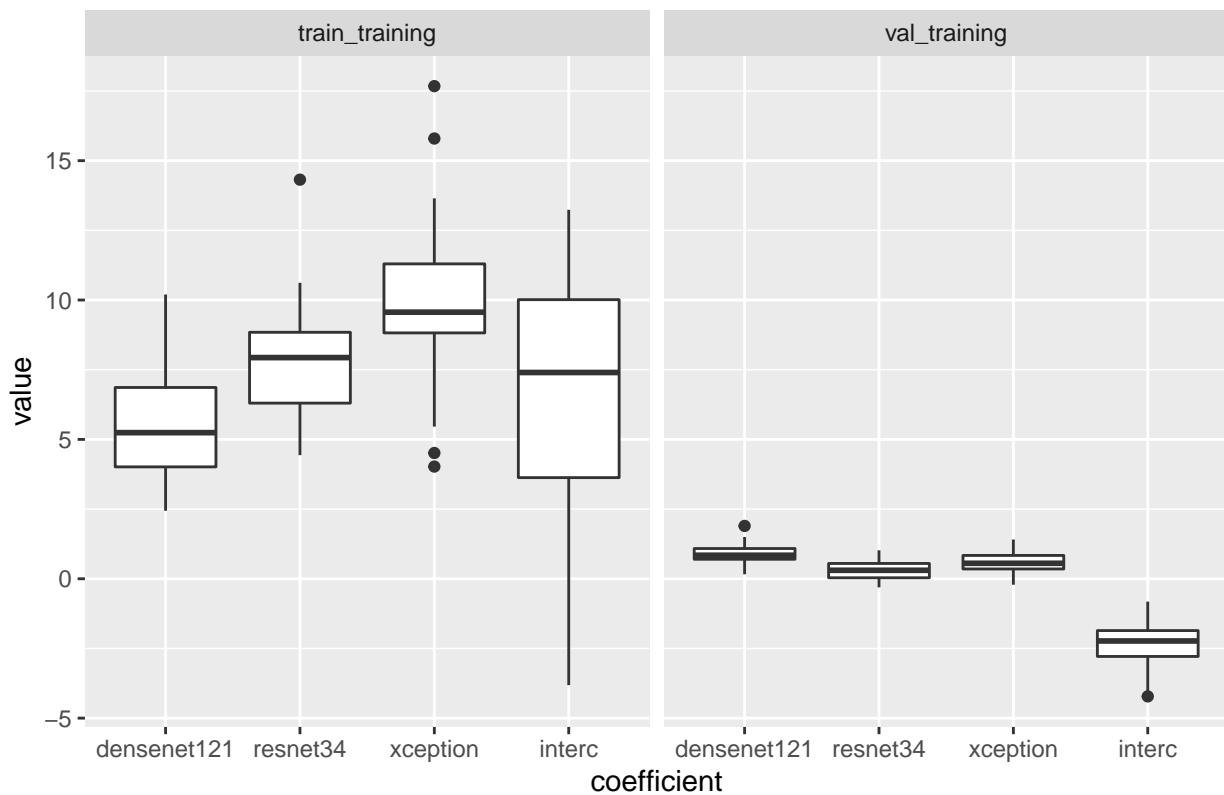
Coefficients for class 1 vs 11



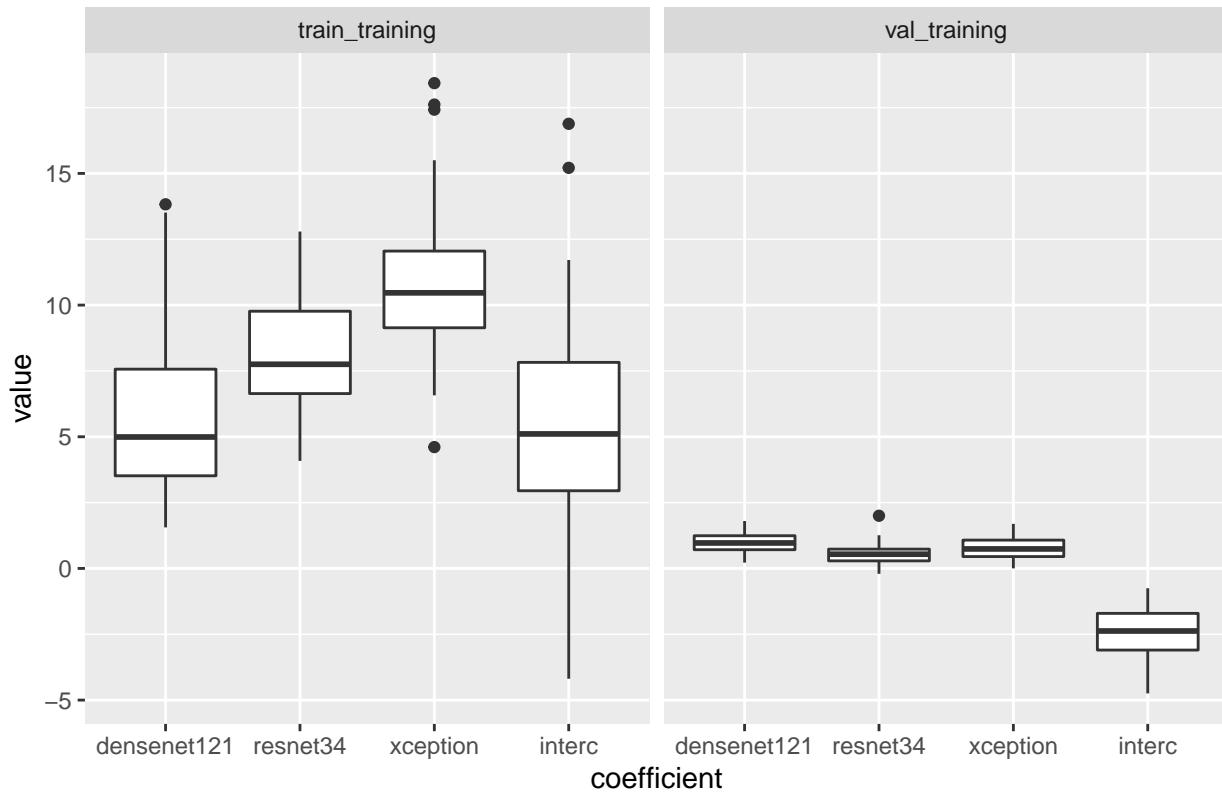
Coefficients for class 1 vs 12



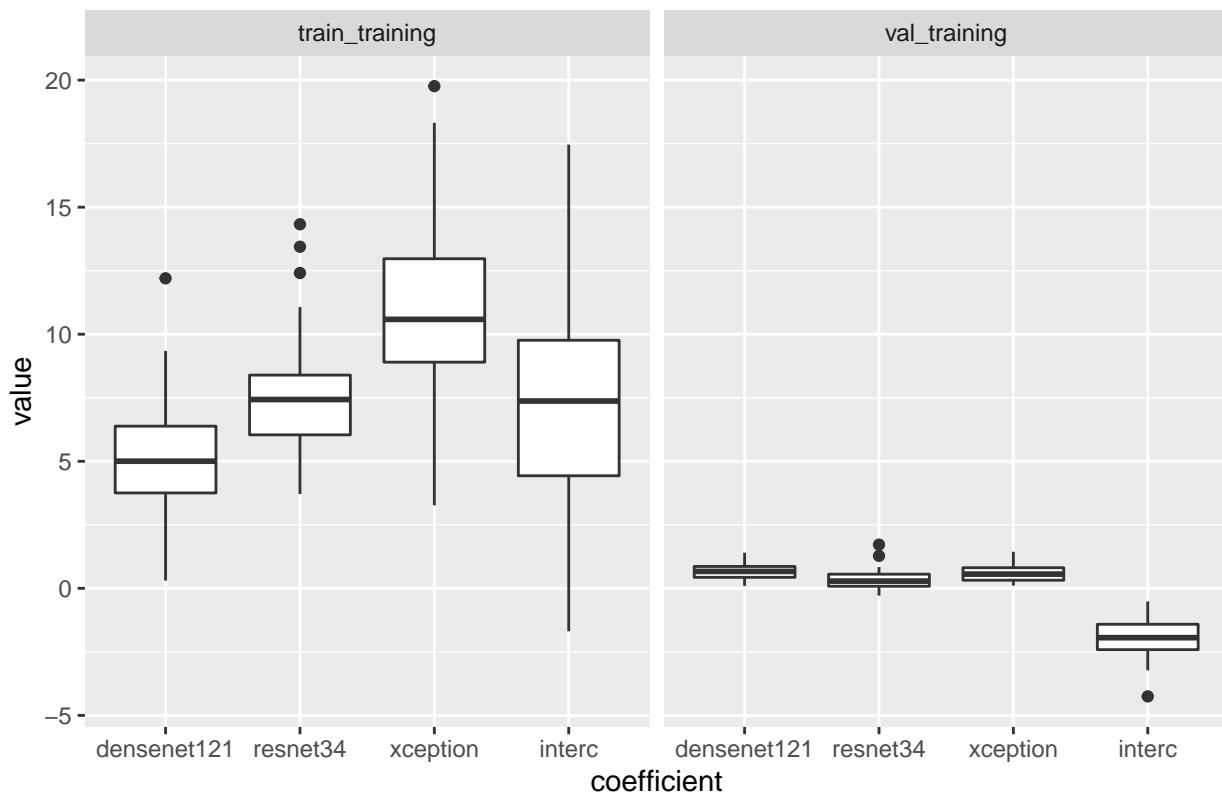
Coefficients for class 1 vs 13



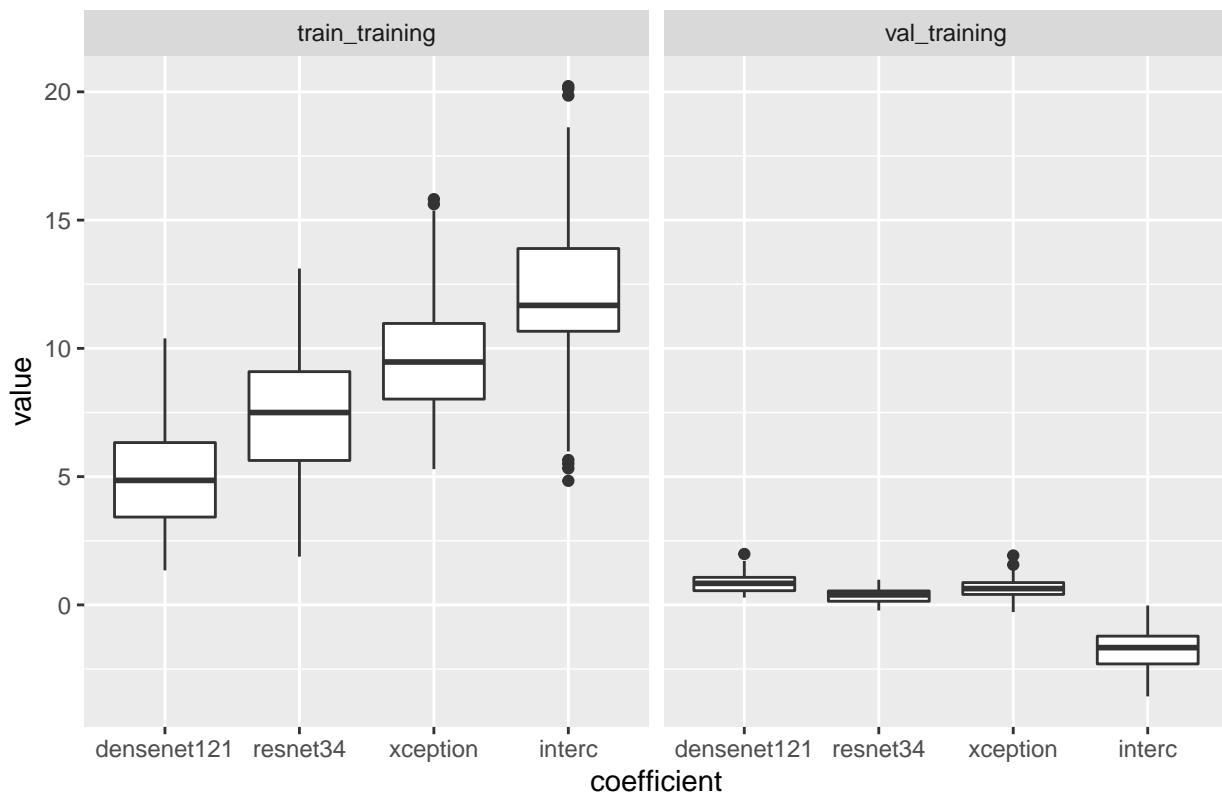
Coefficients for class 1 vs 14



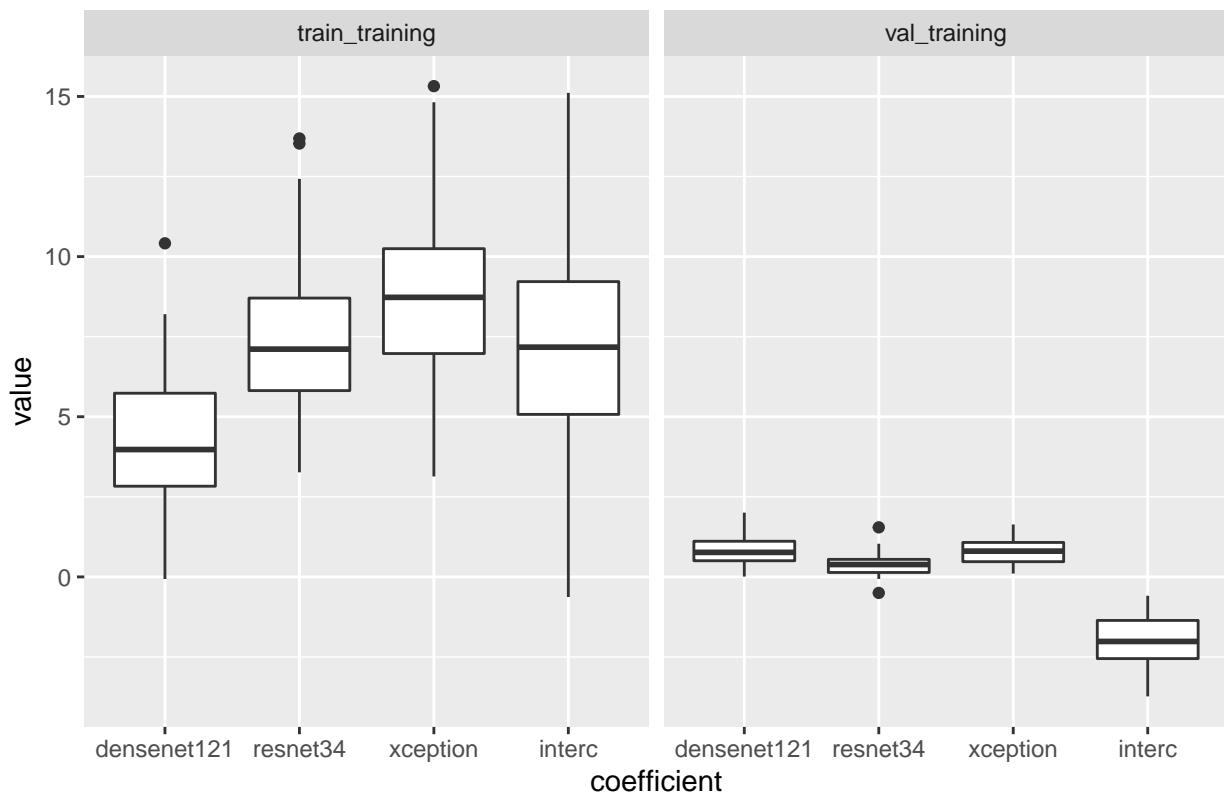
Coefficients for class 1 vs 15



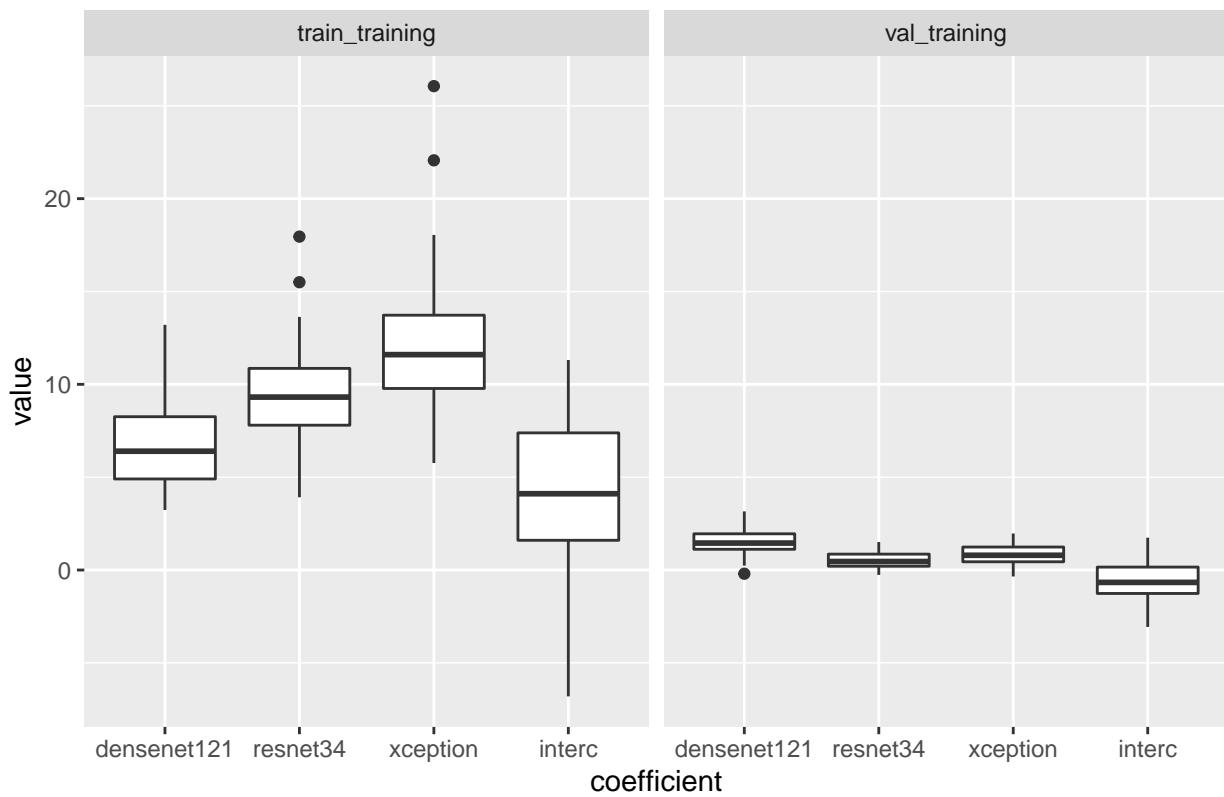
Coefficients for class 1 vs 16



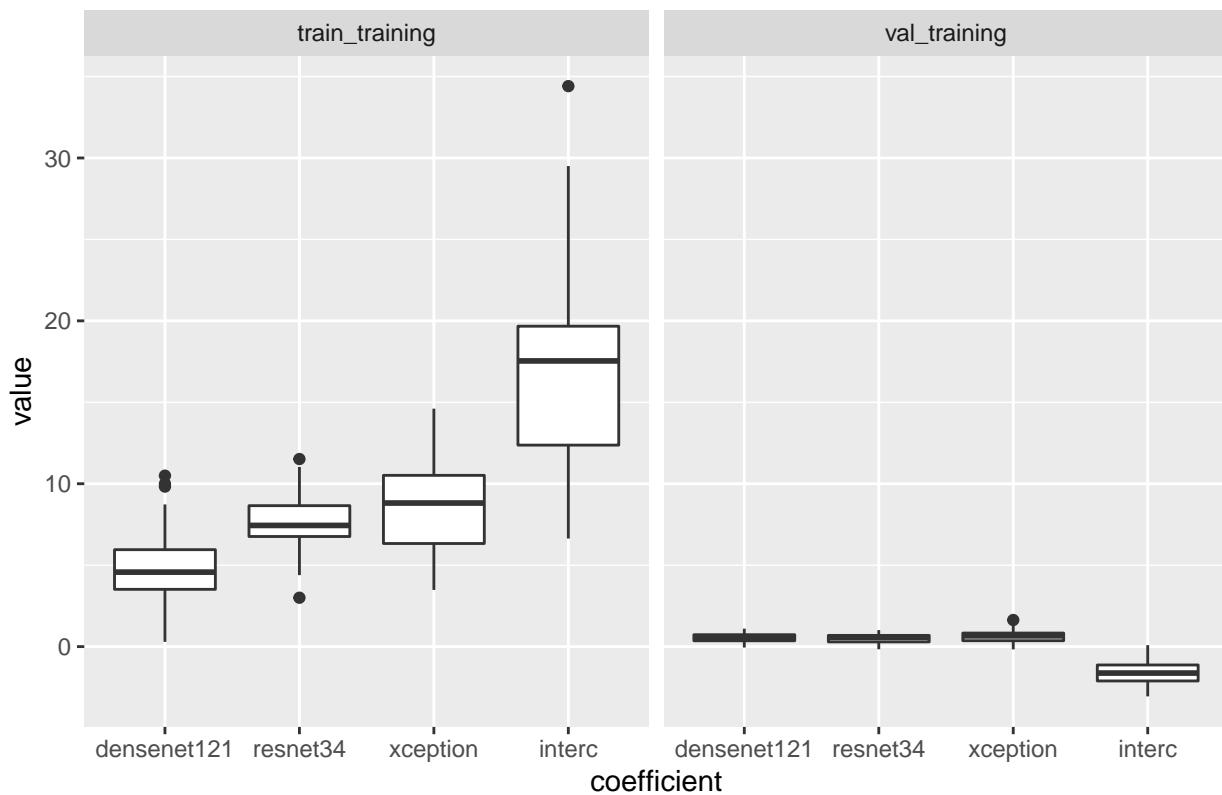
Coefficients for class 1 vs 17



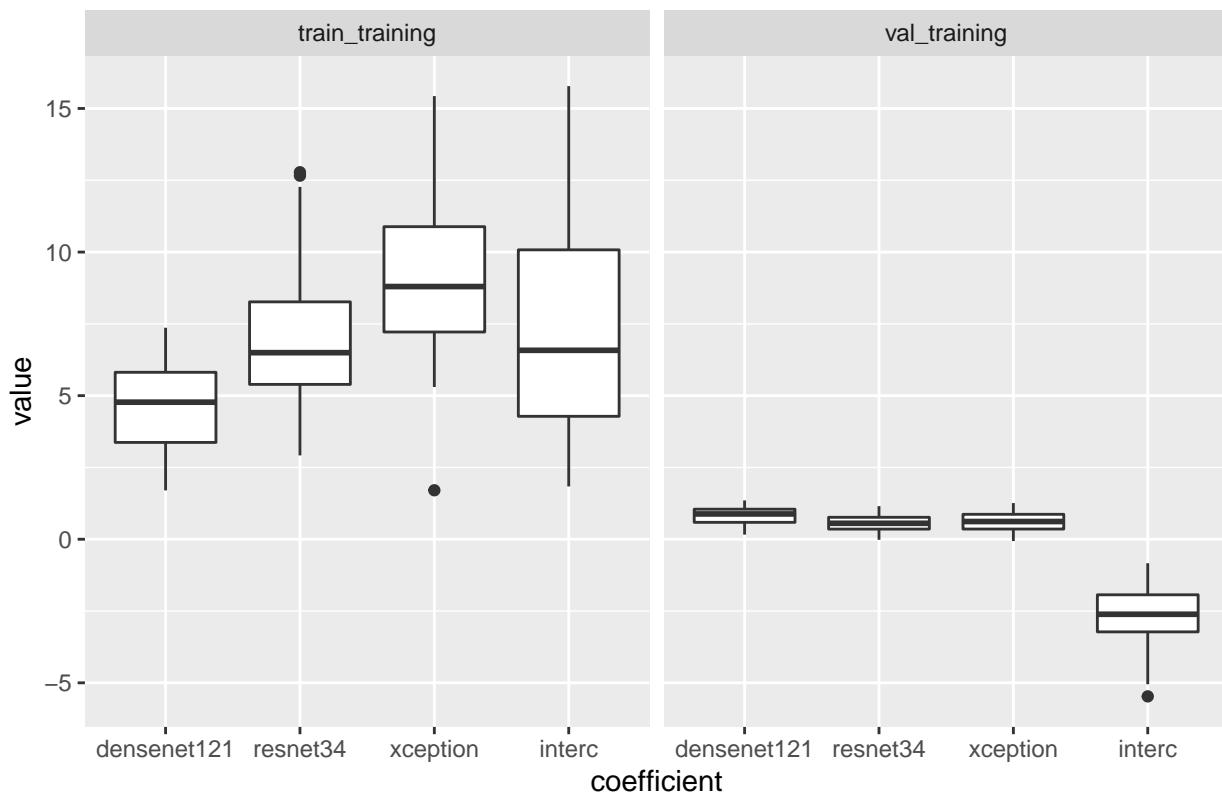
Coefficients for class 1 vs 18



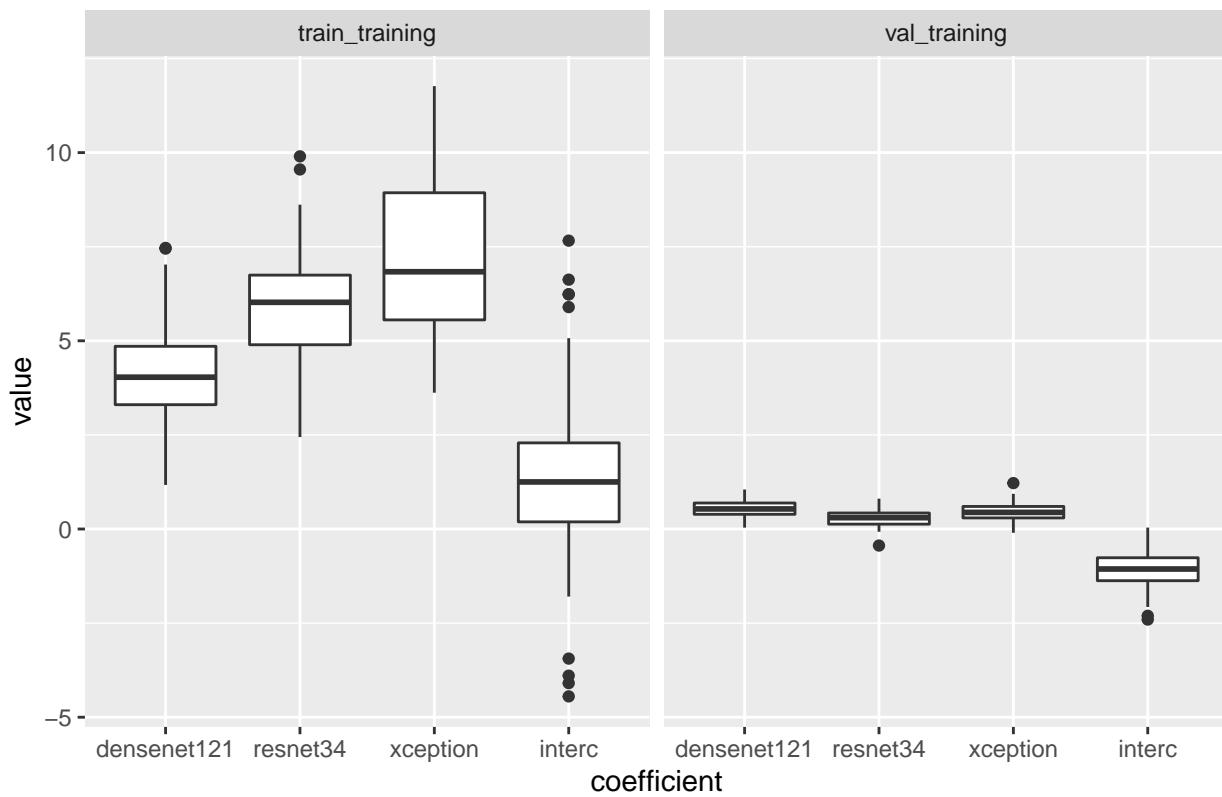
Coefficients for class 1 vs 19



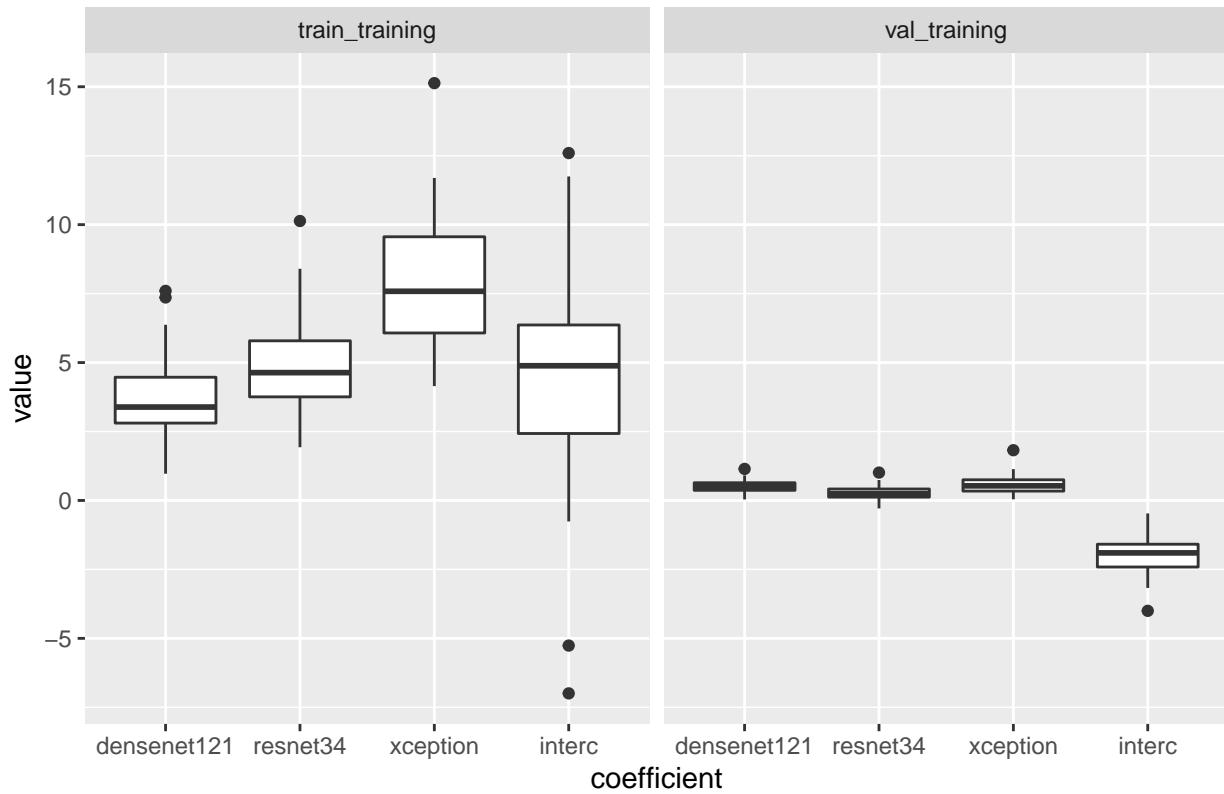
Coefficients for class 1 vs 20



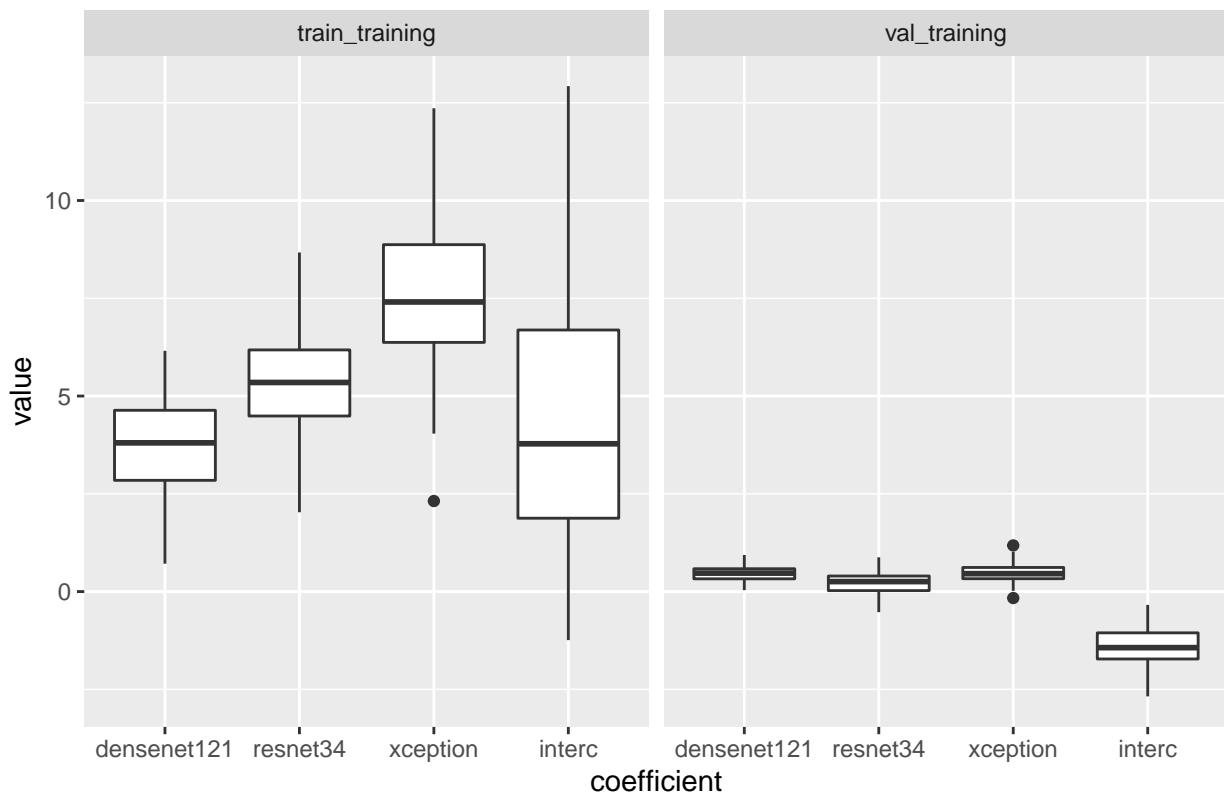
Coefficients for class 2 vs 3



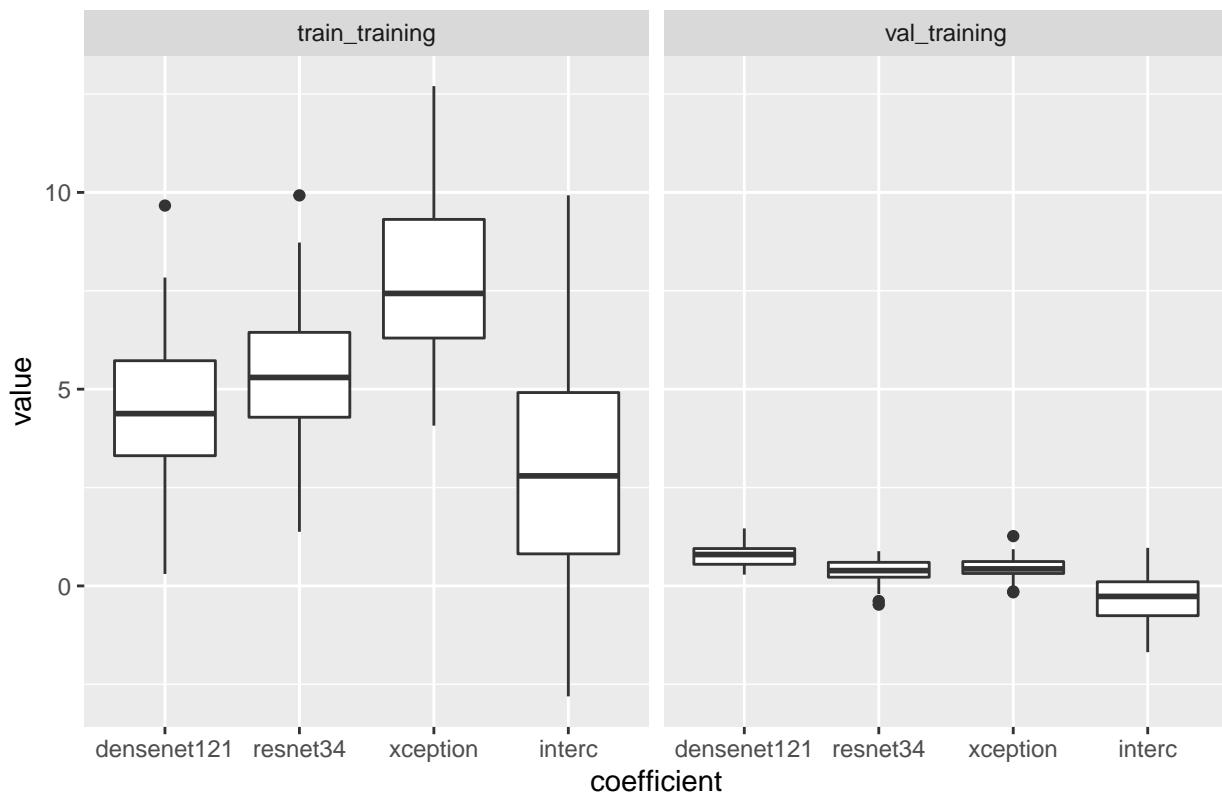
Coefficients for class 2 vs 4



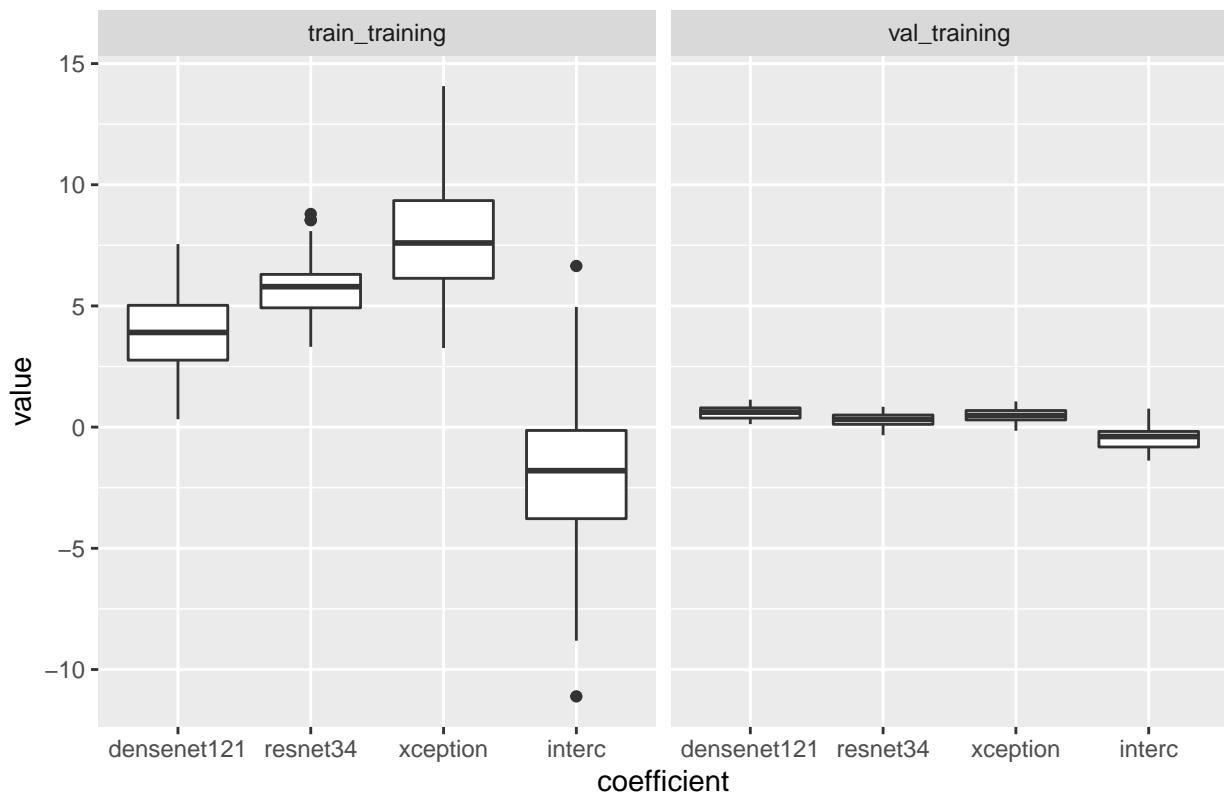
Coefficients for class 2 vs 5



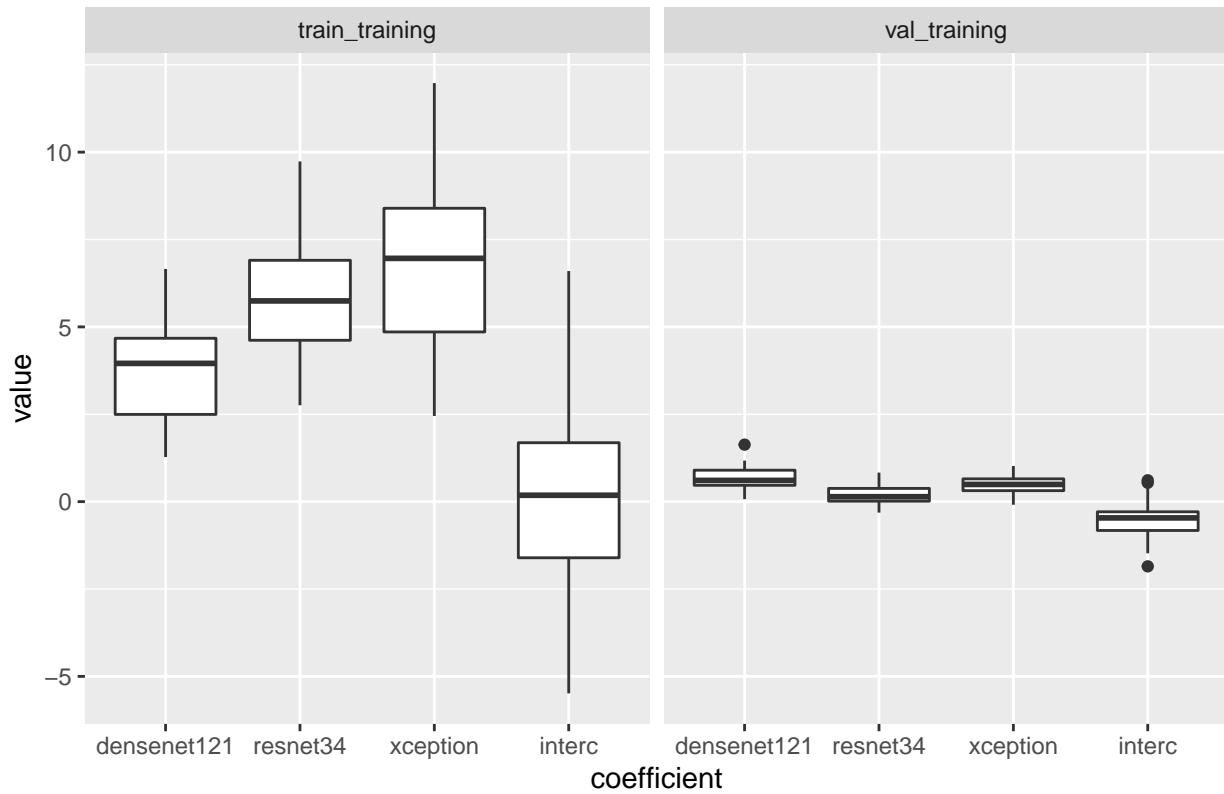
Coefficients for class 2 vs 6



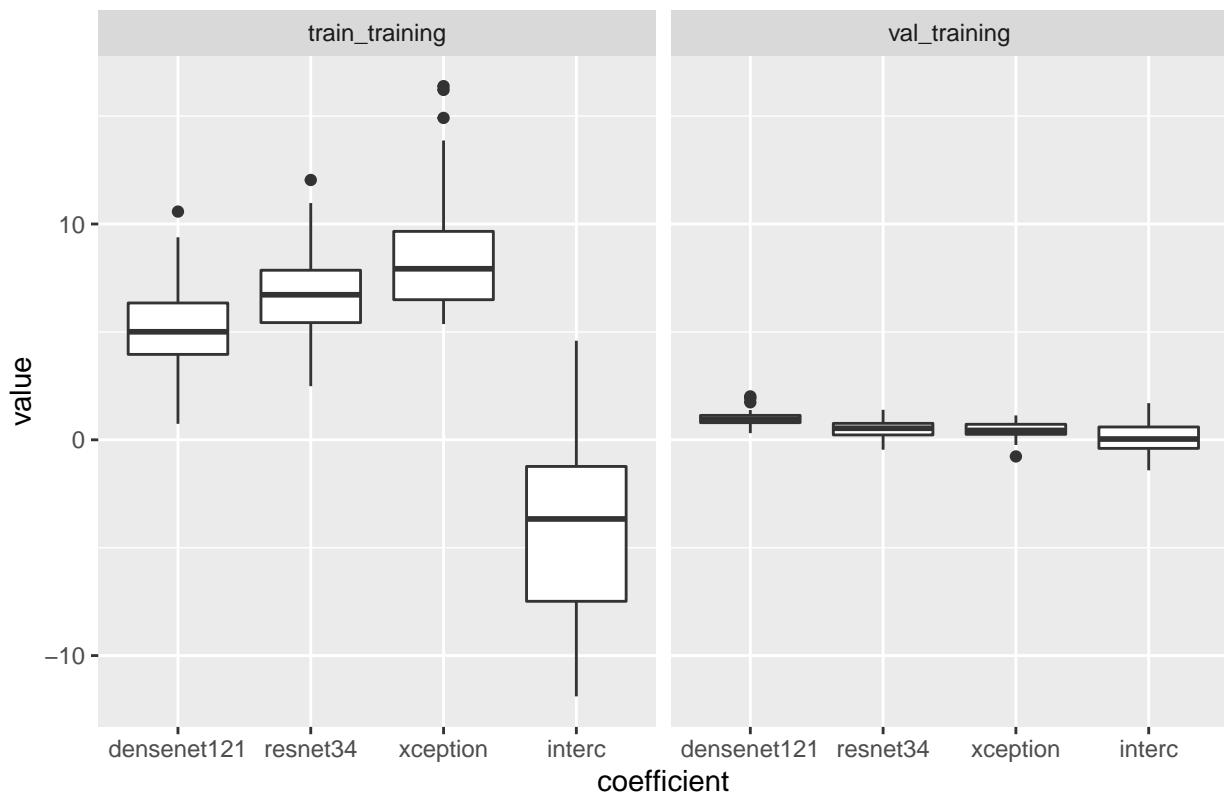
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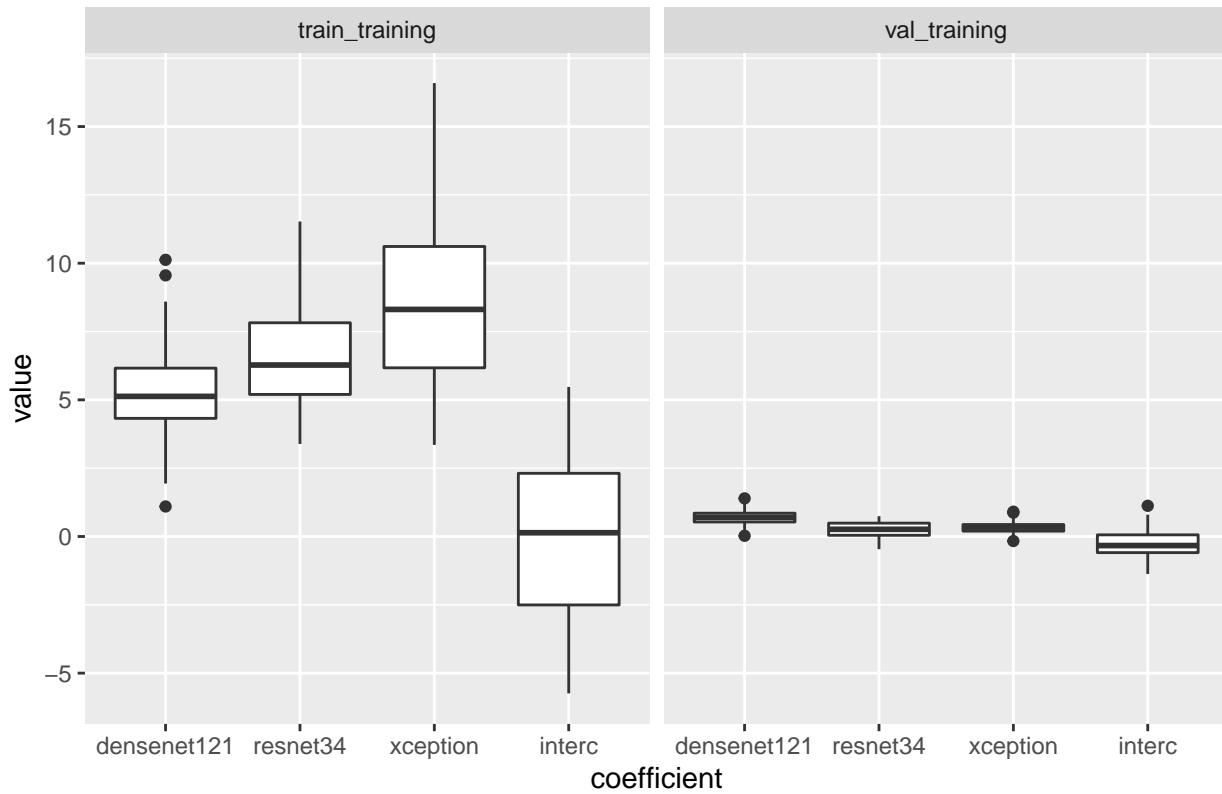
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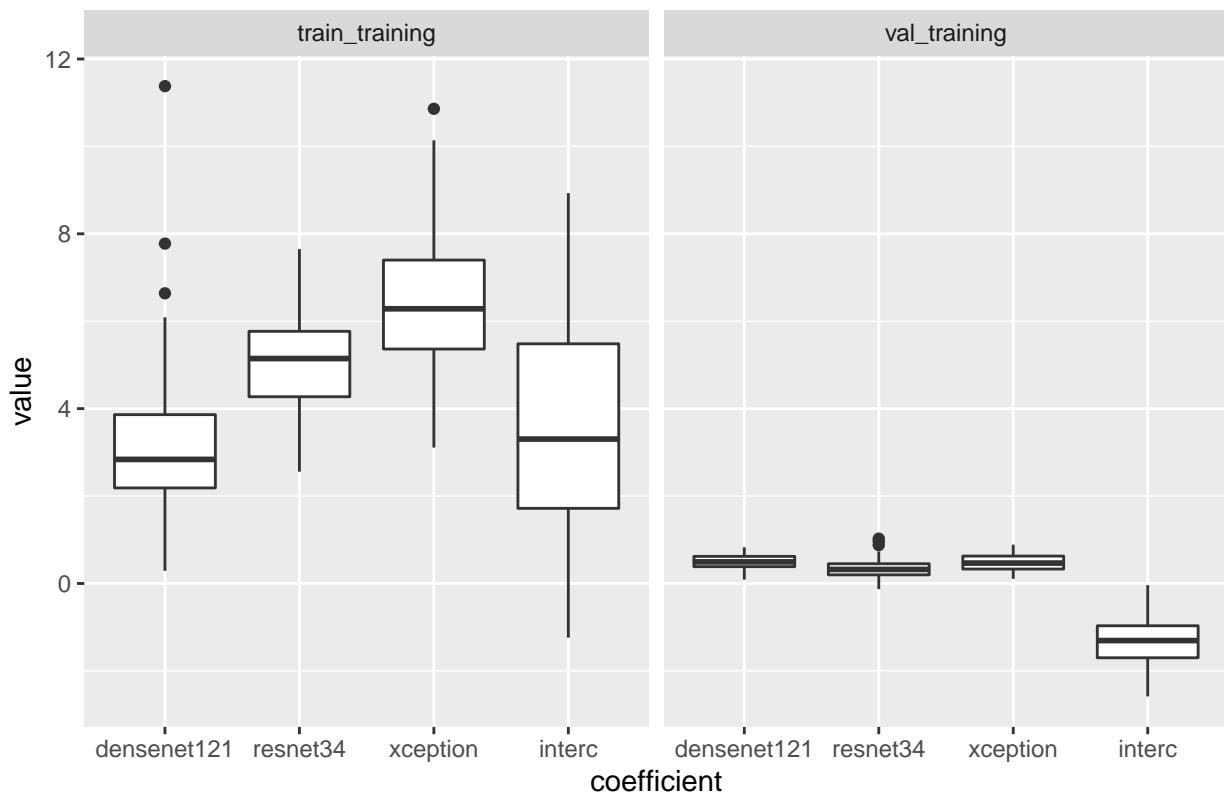
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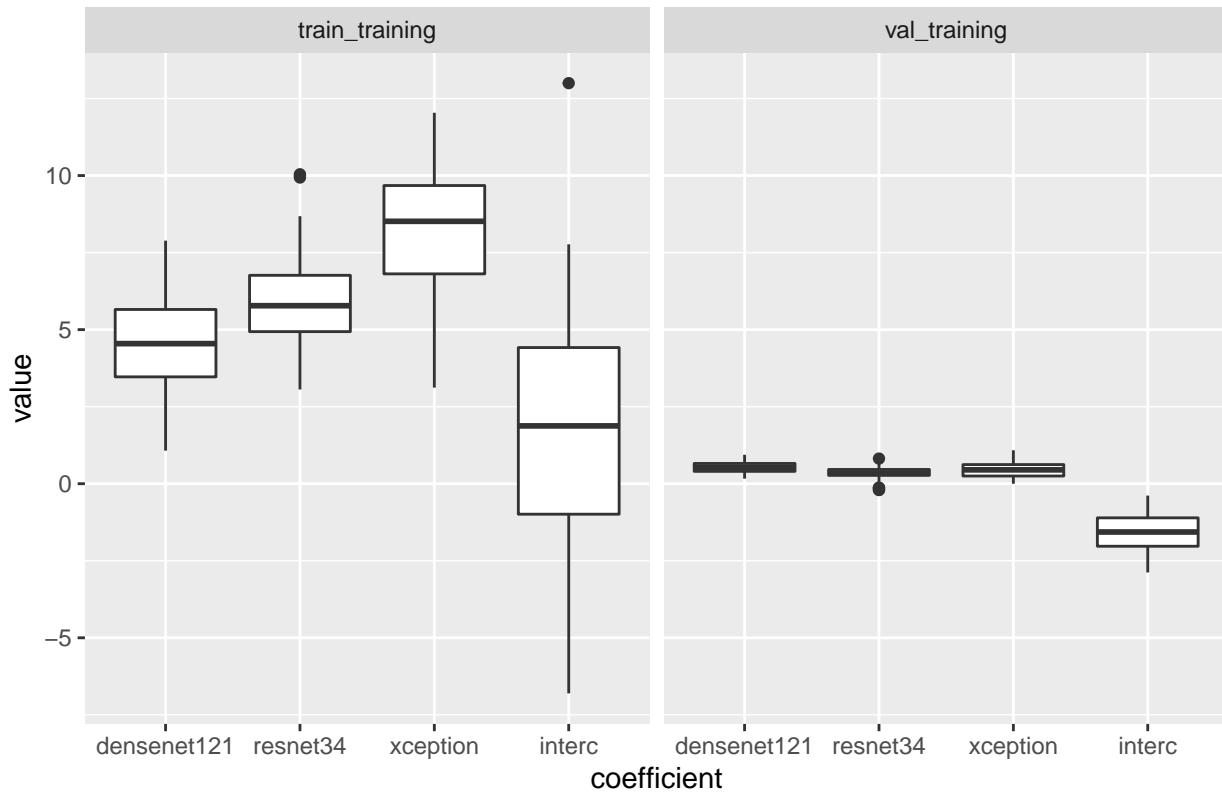
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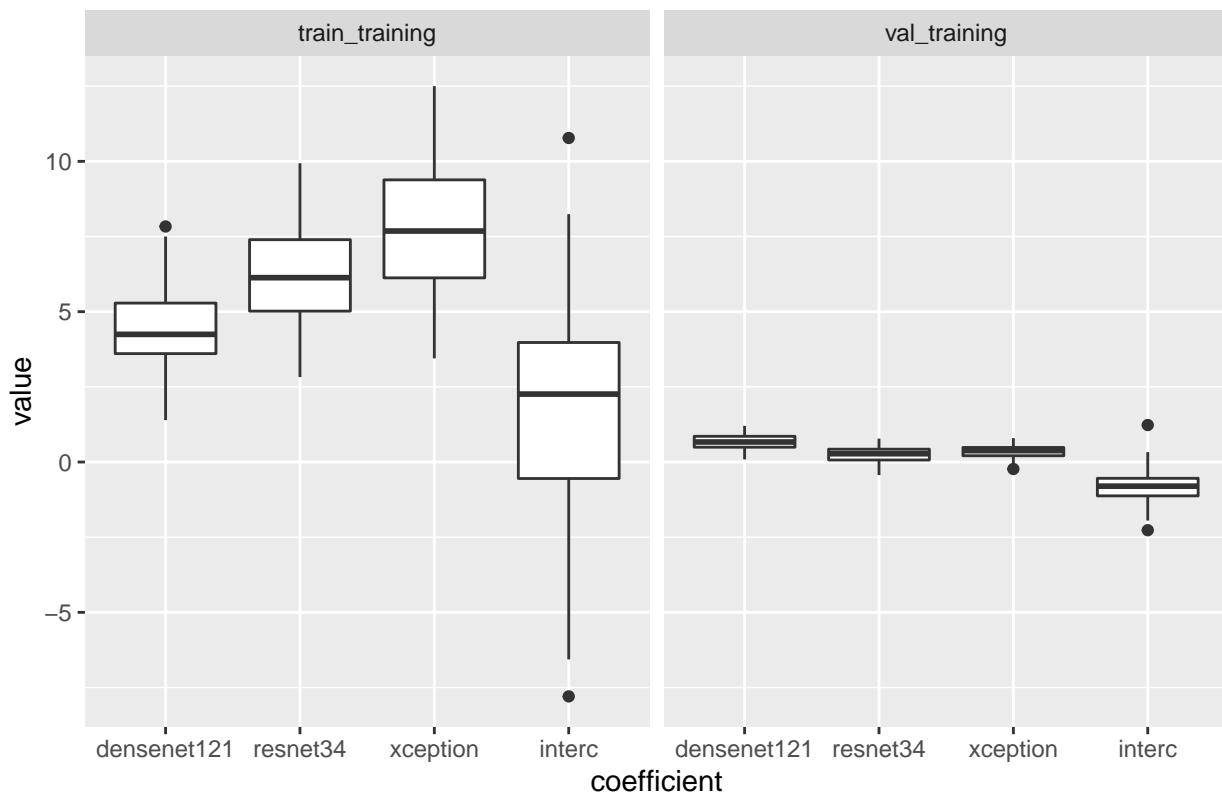
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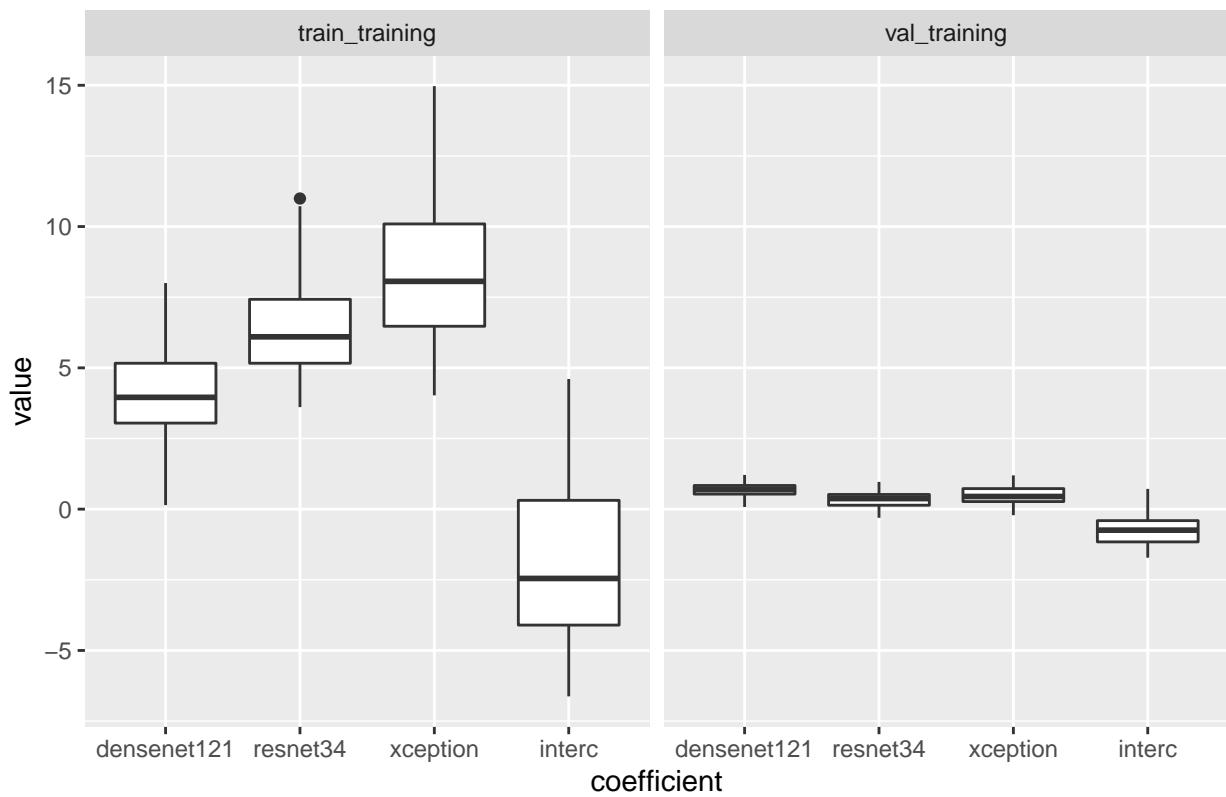
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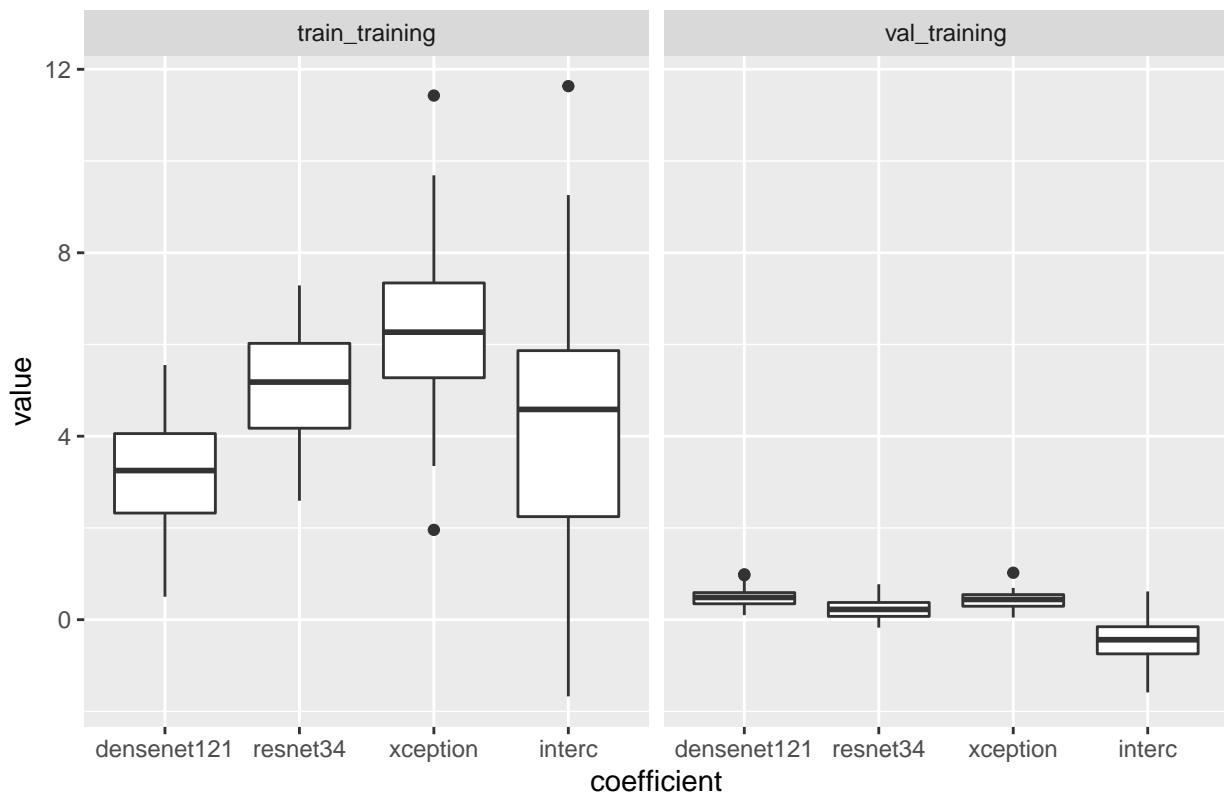
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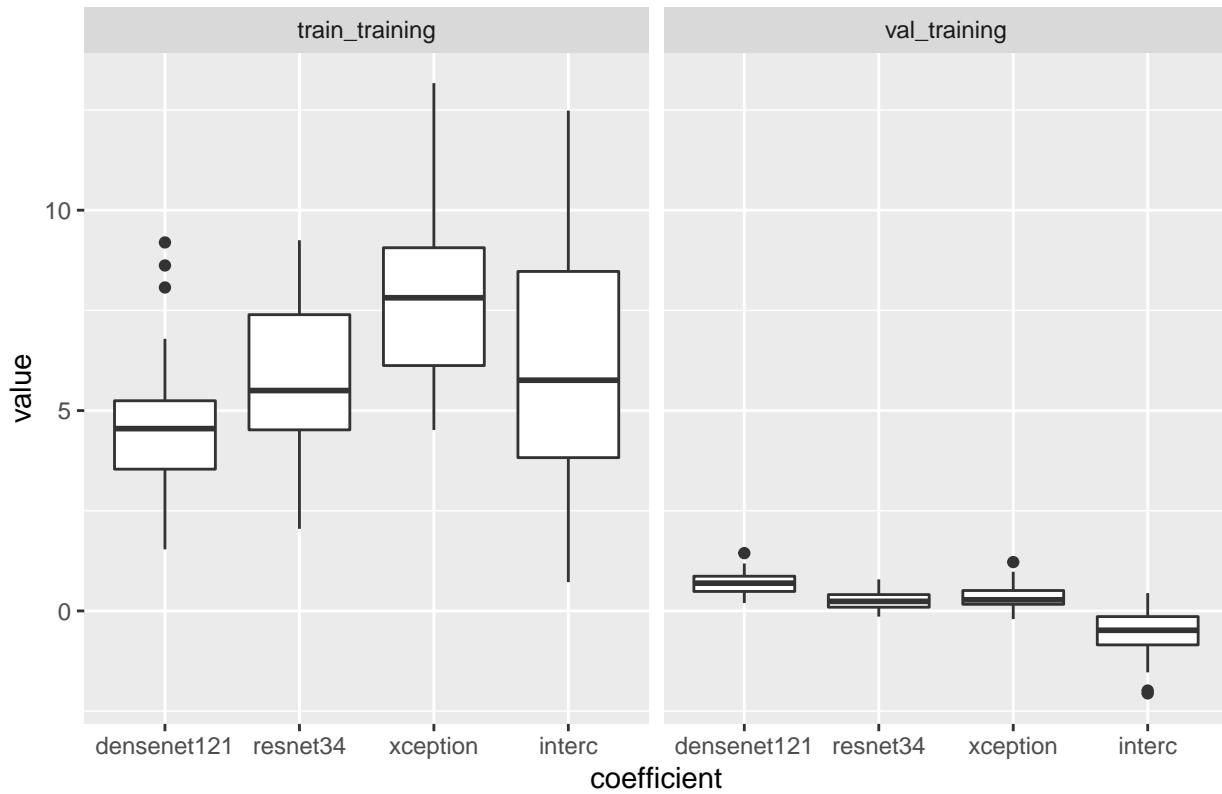
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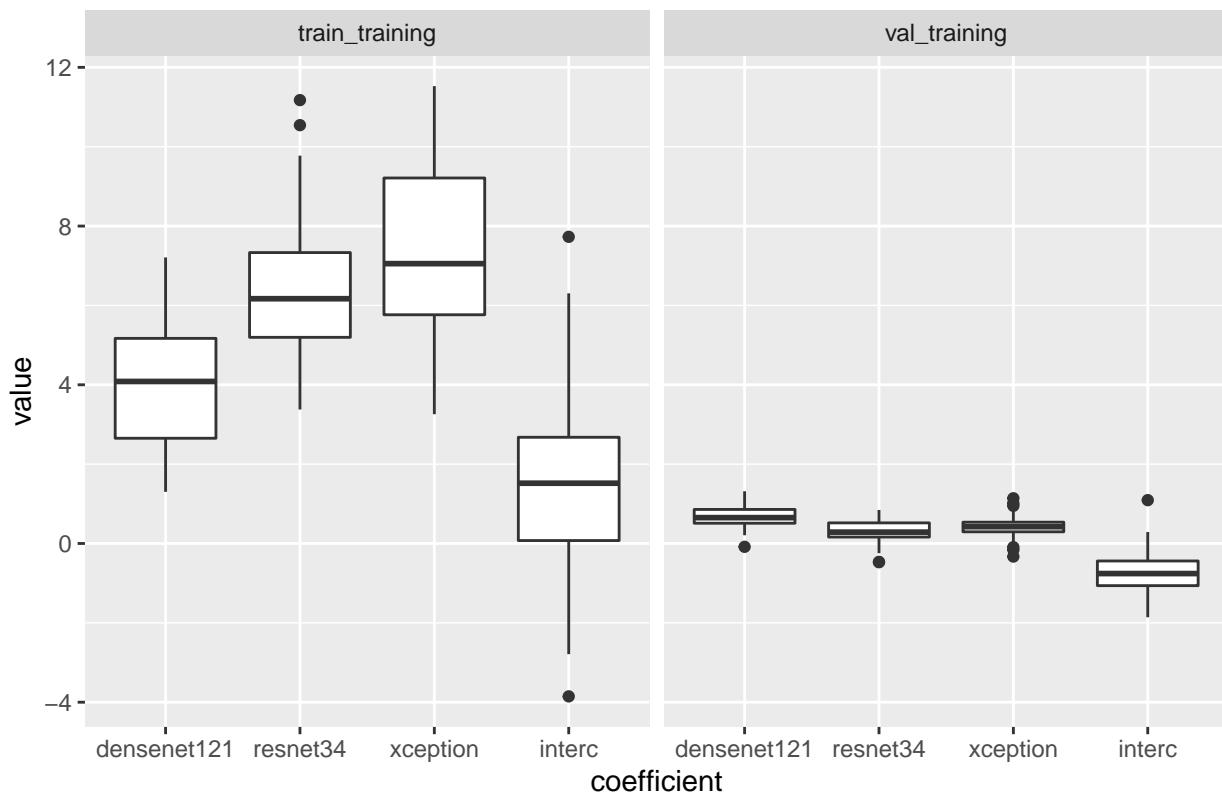
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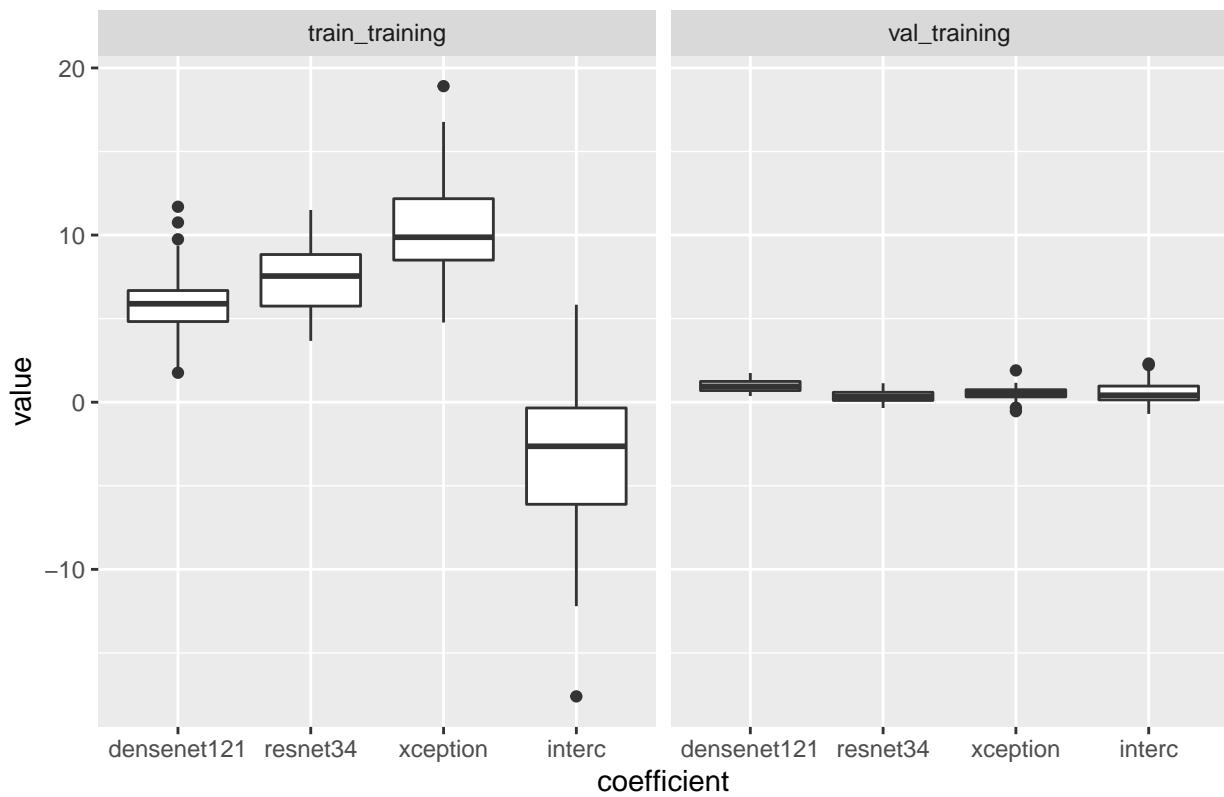
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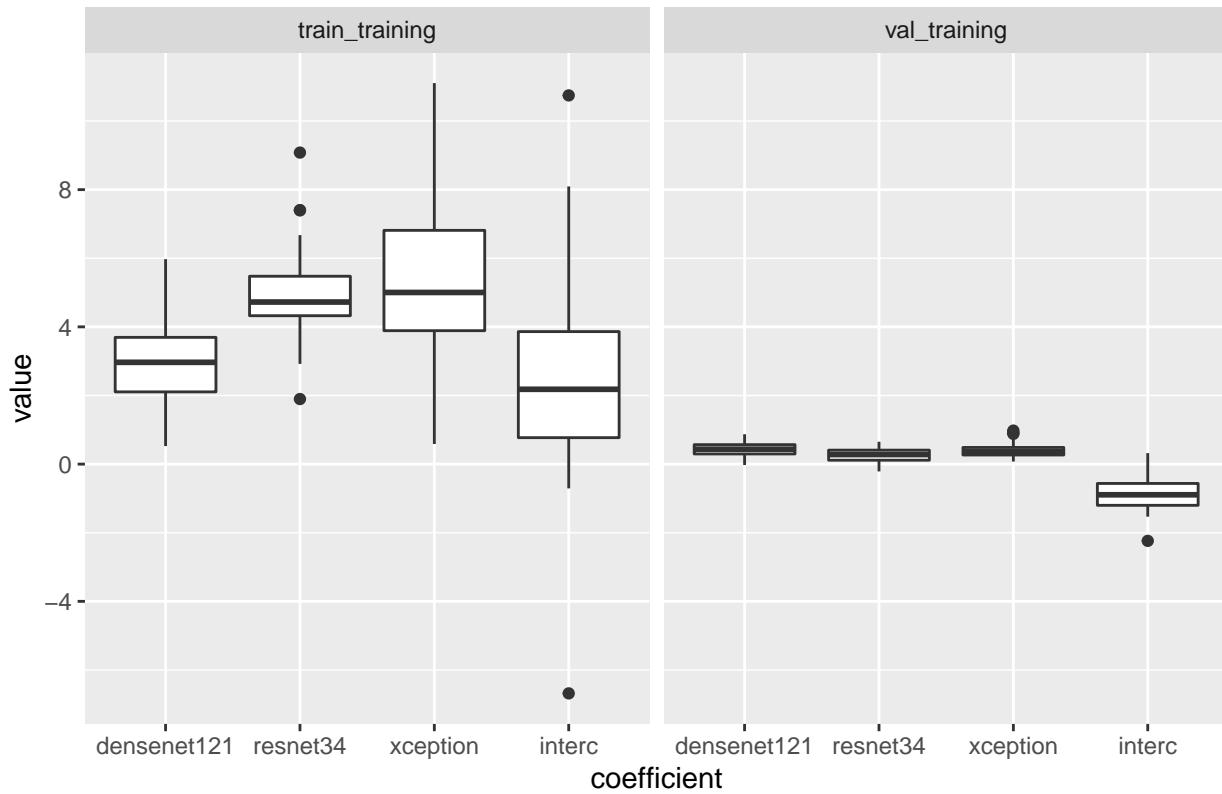
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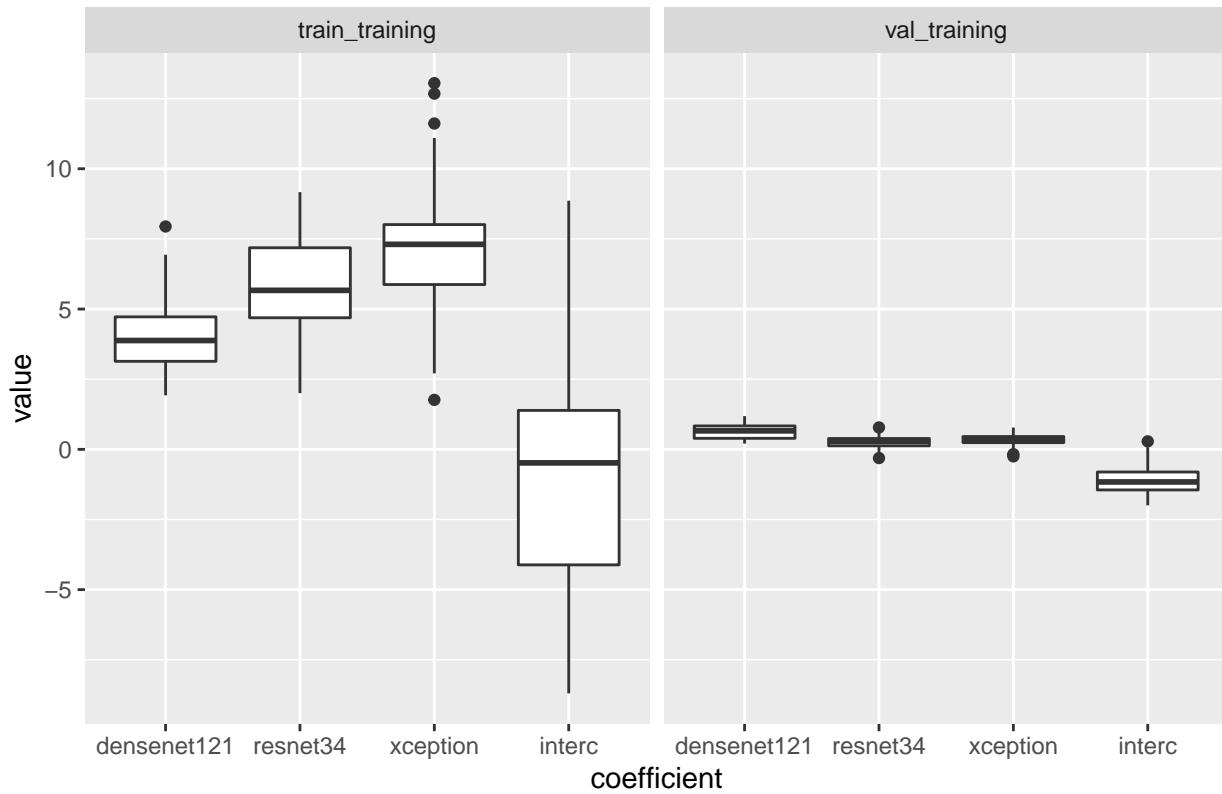
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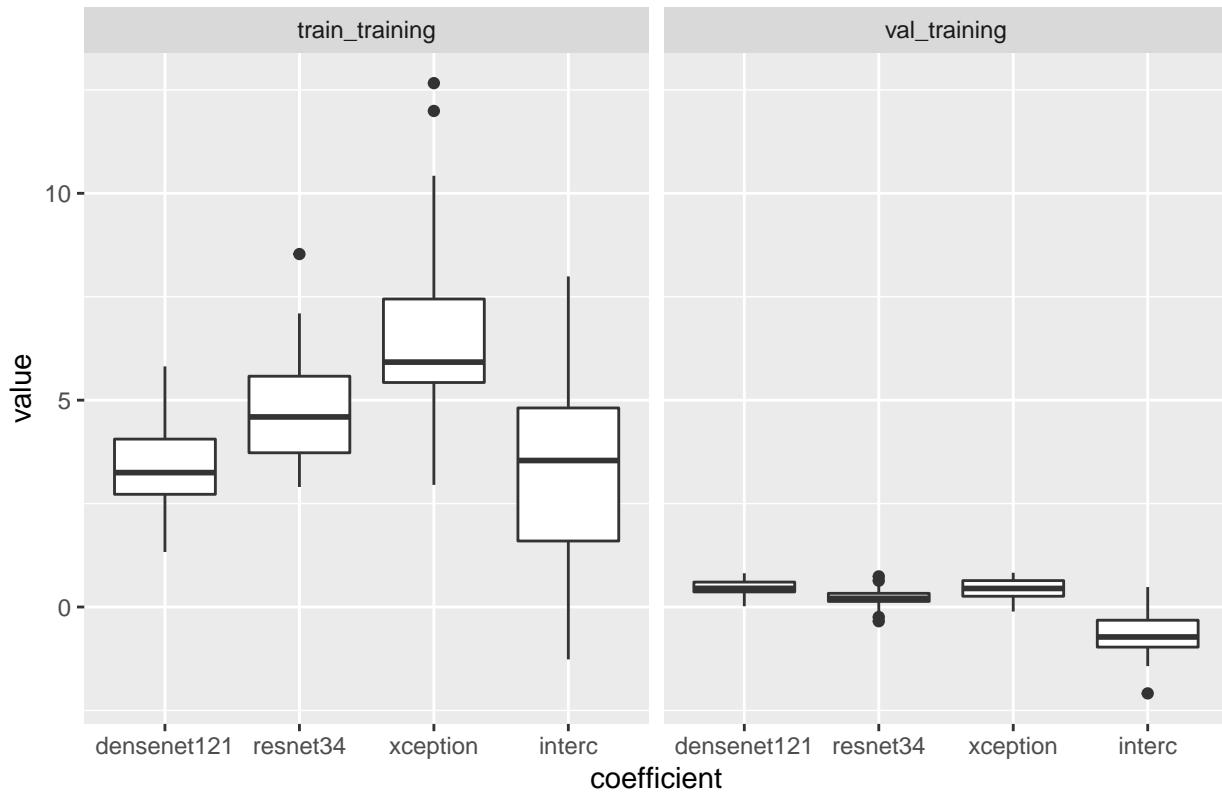
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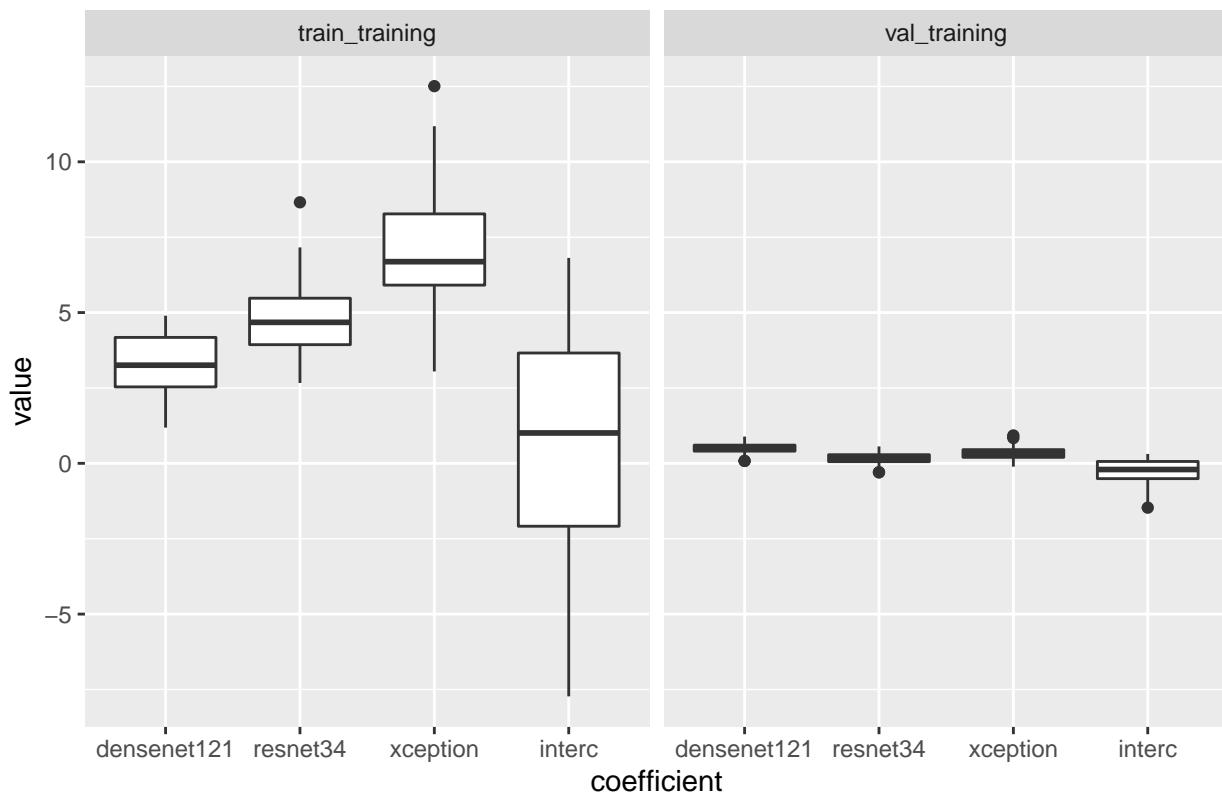
Coefficients for class 2 vs 20



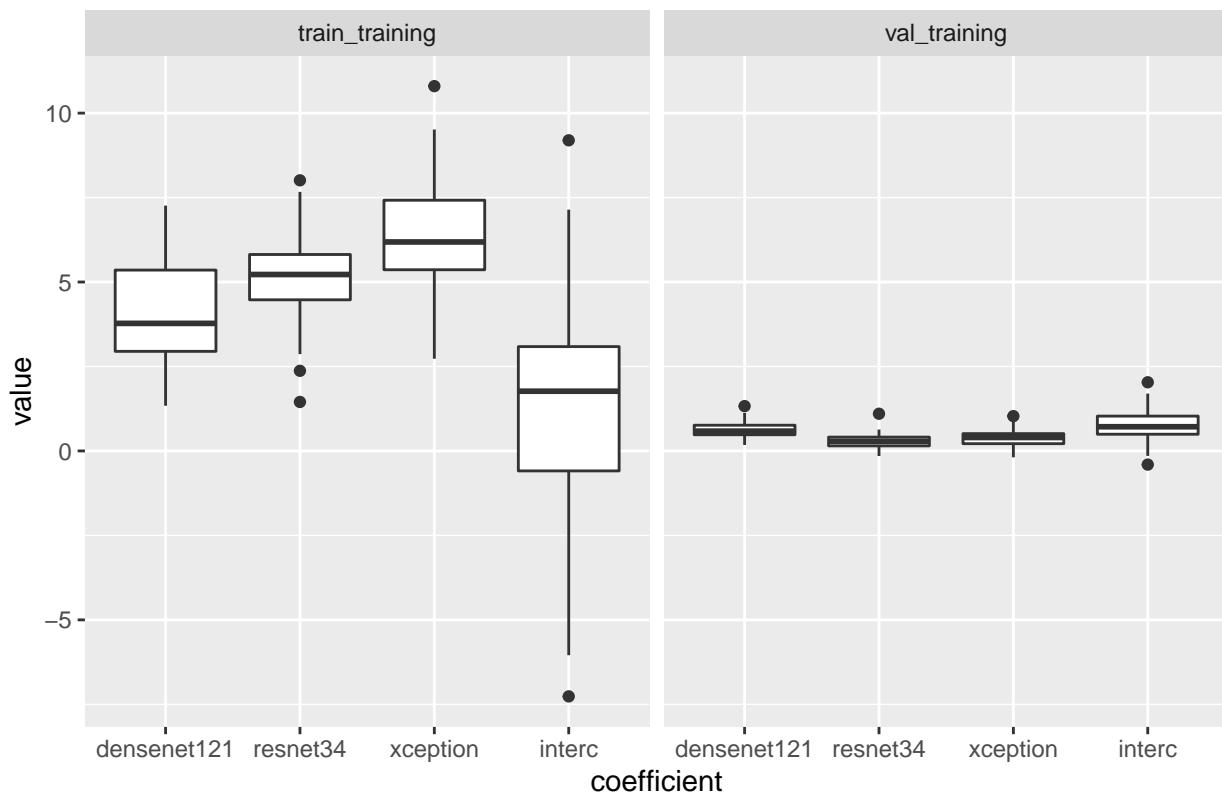
Coefficients for class 3 vs 4



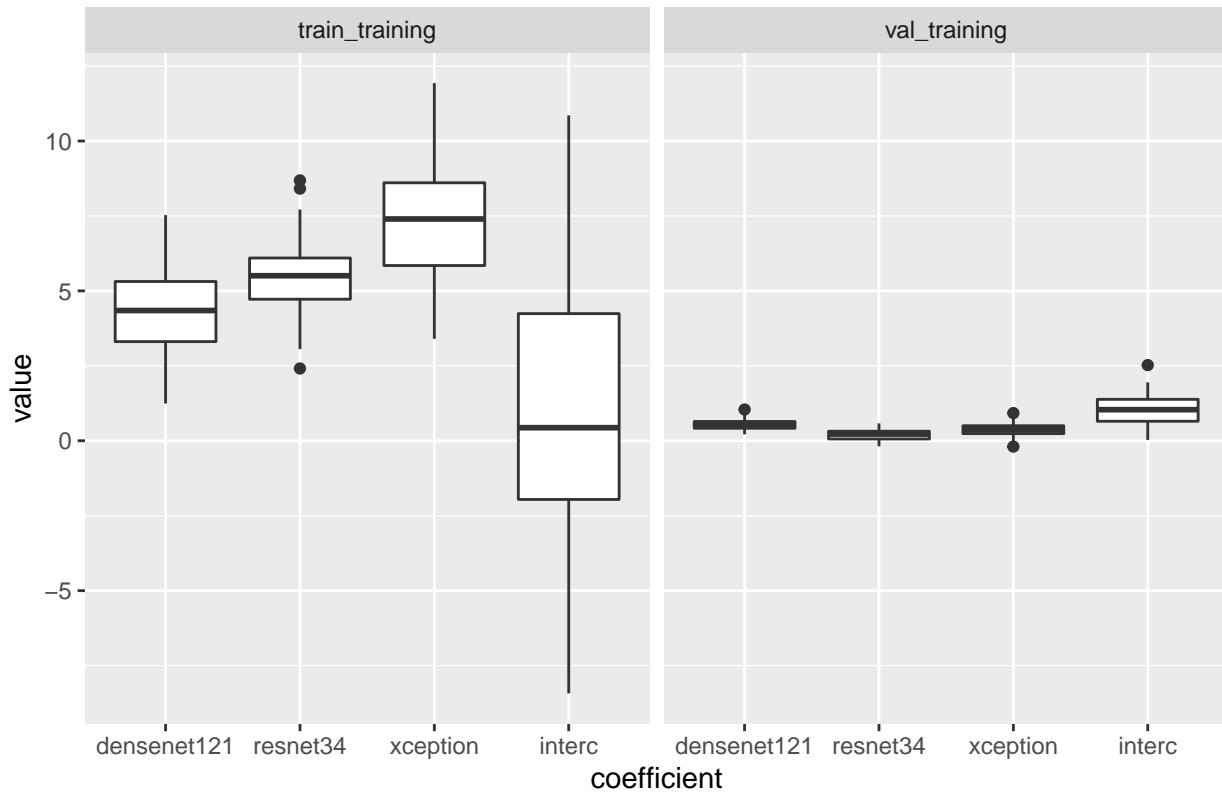
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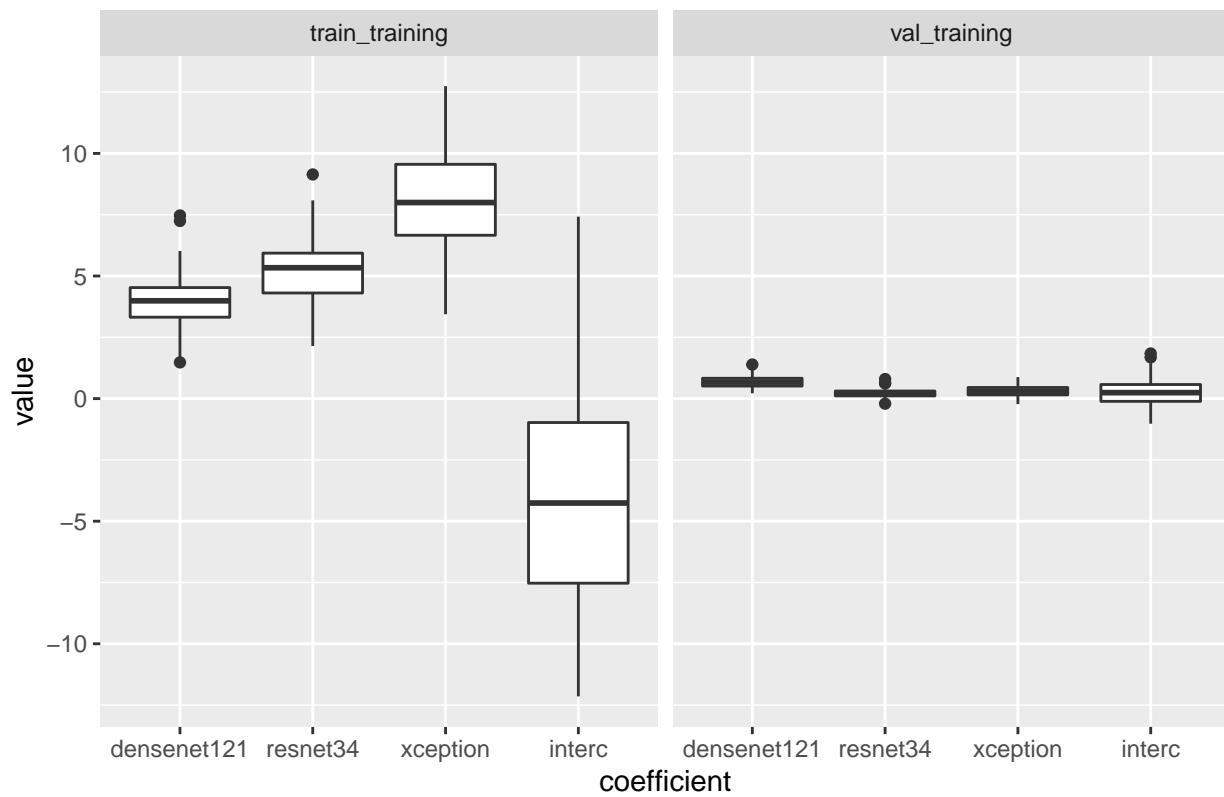
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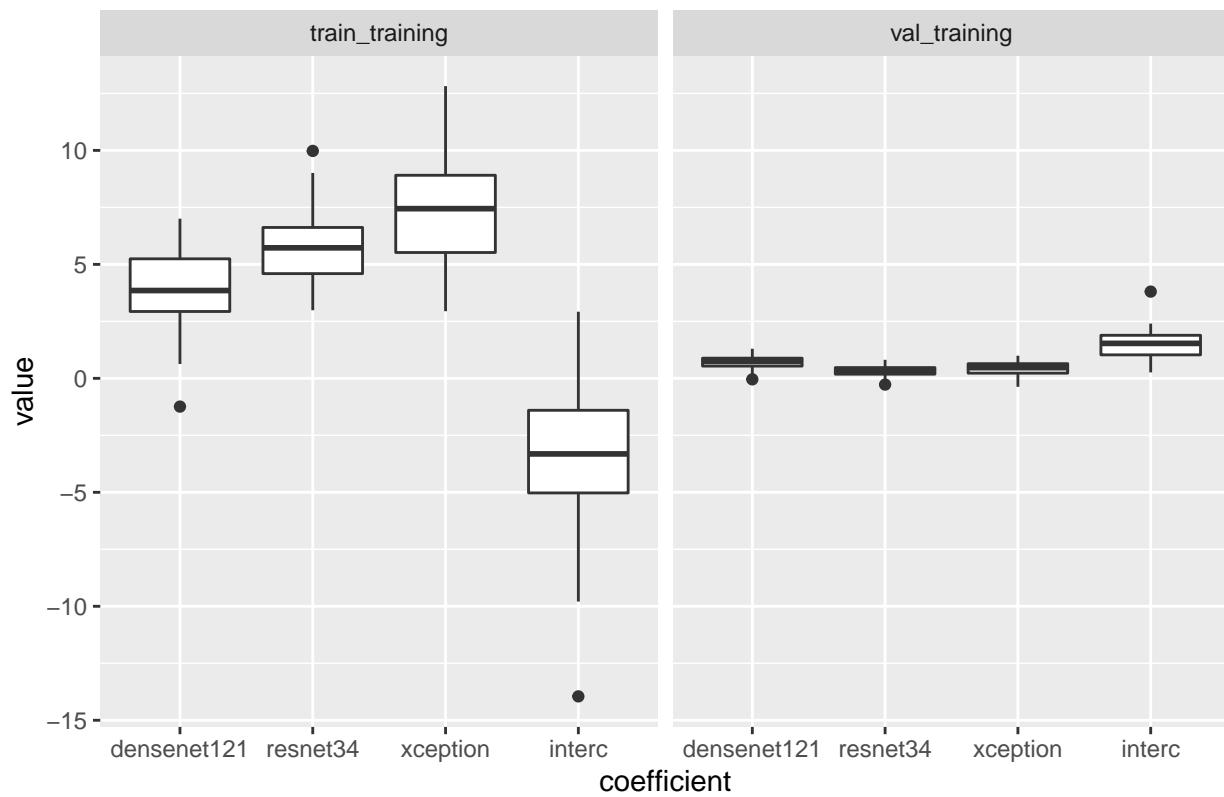
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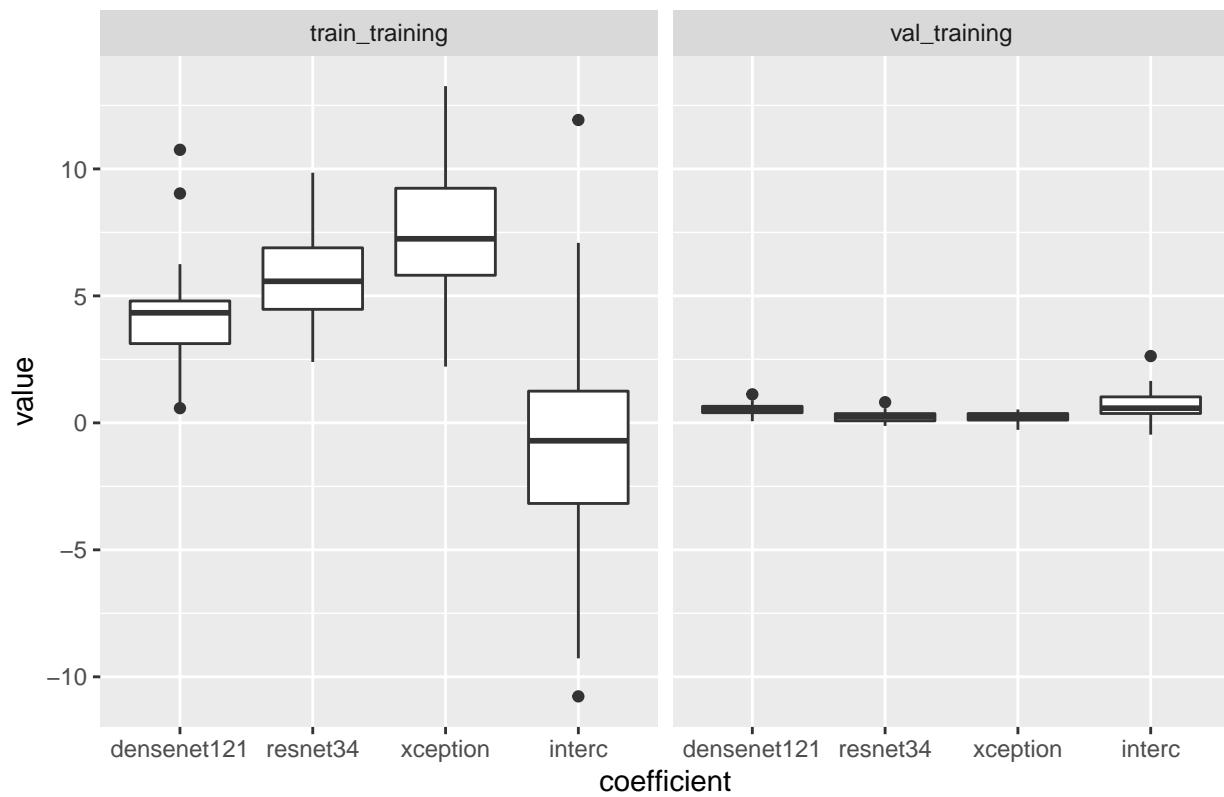
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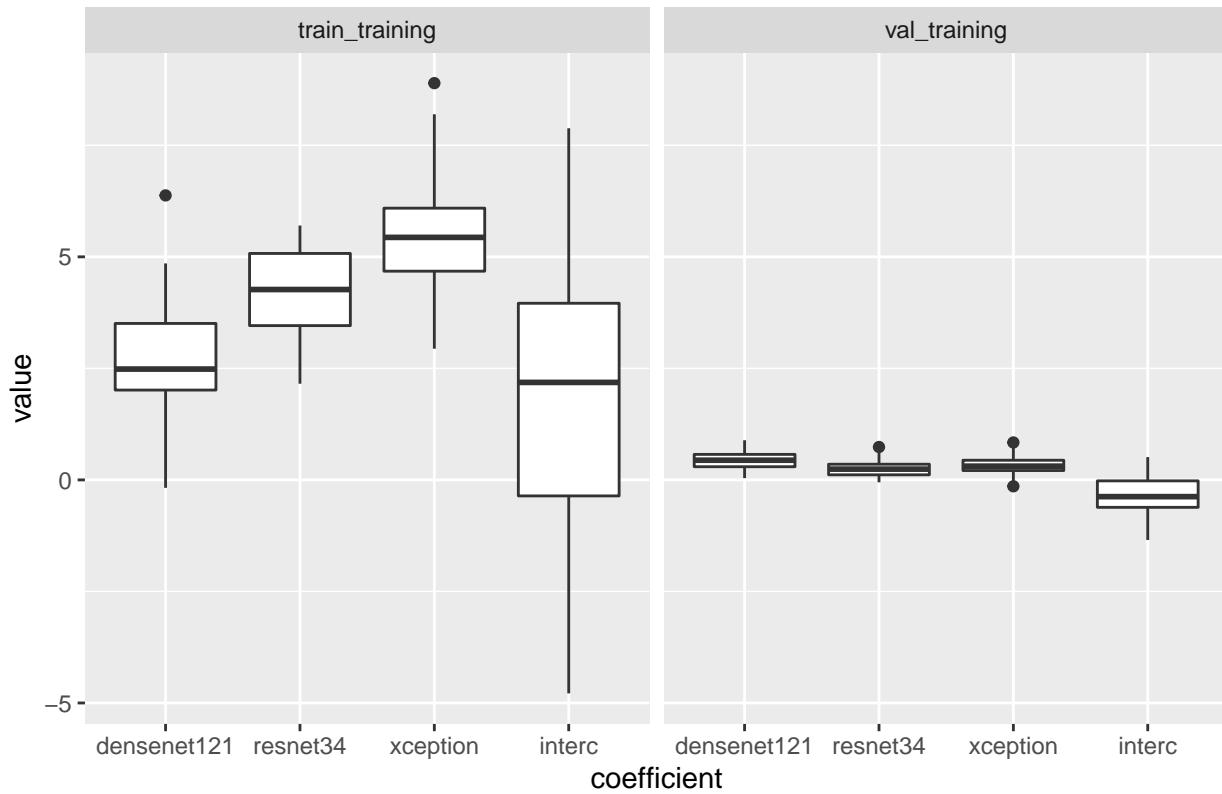
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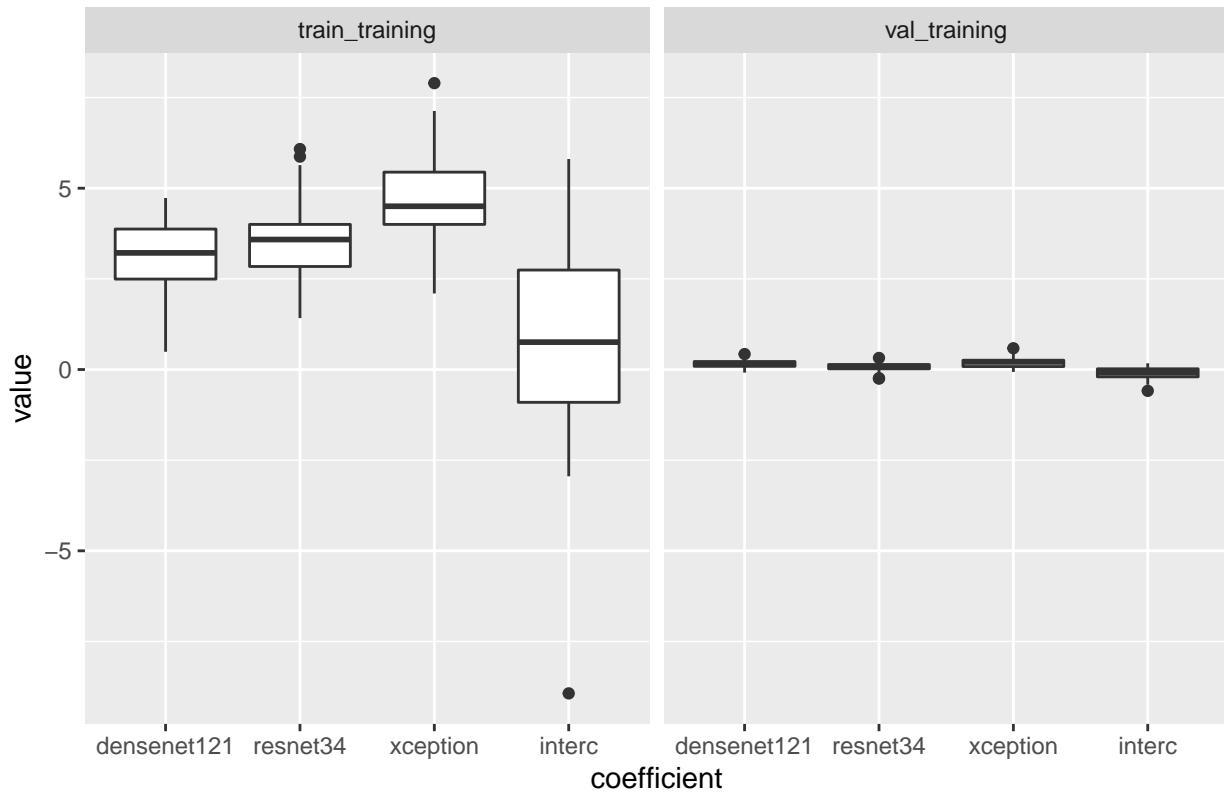
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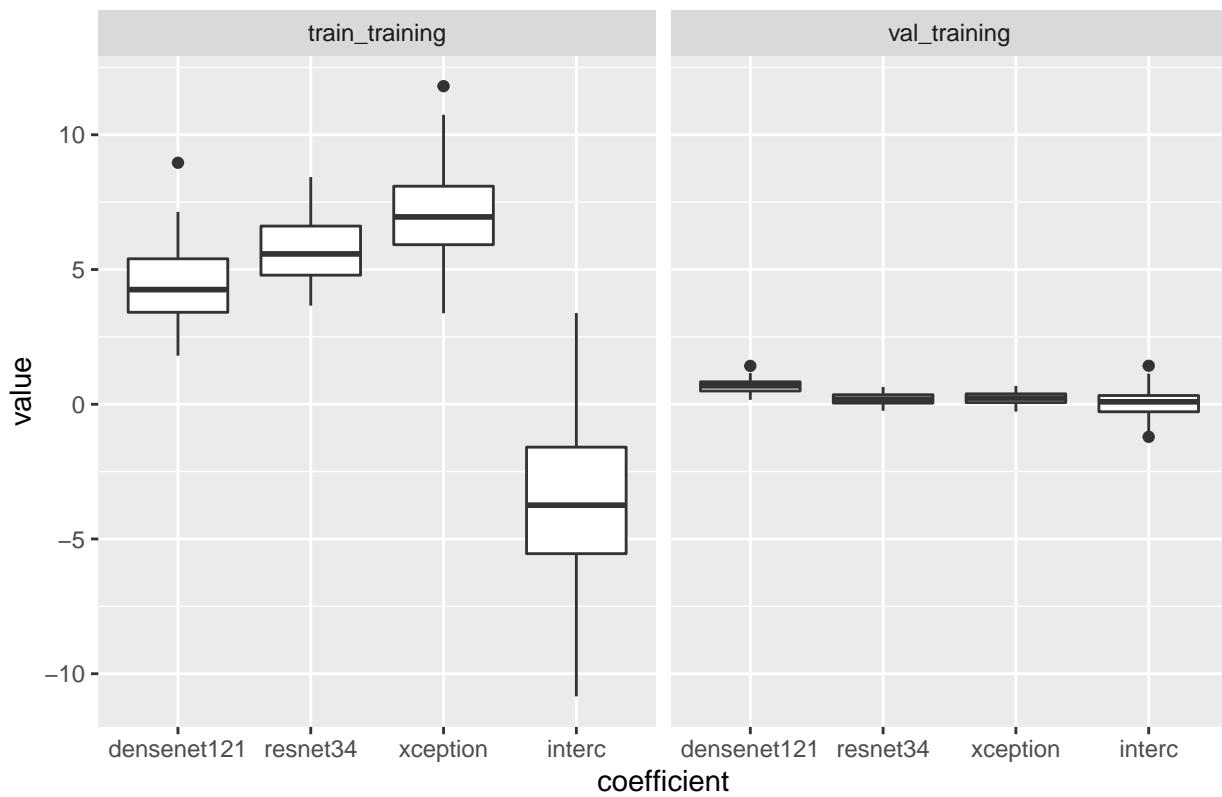
Coefficients for class 3 vs 11



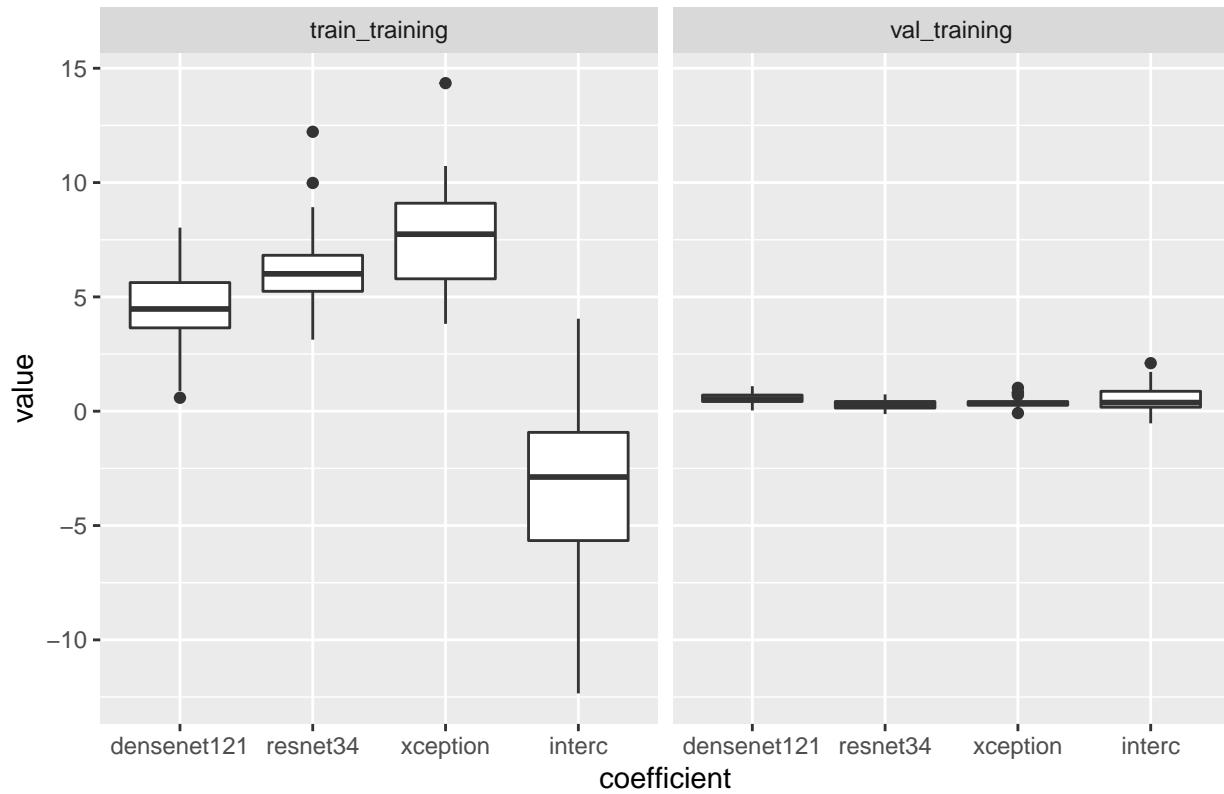
Coefficients for class 3 vs 12



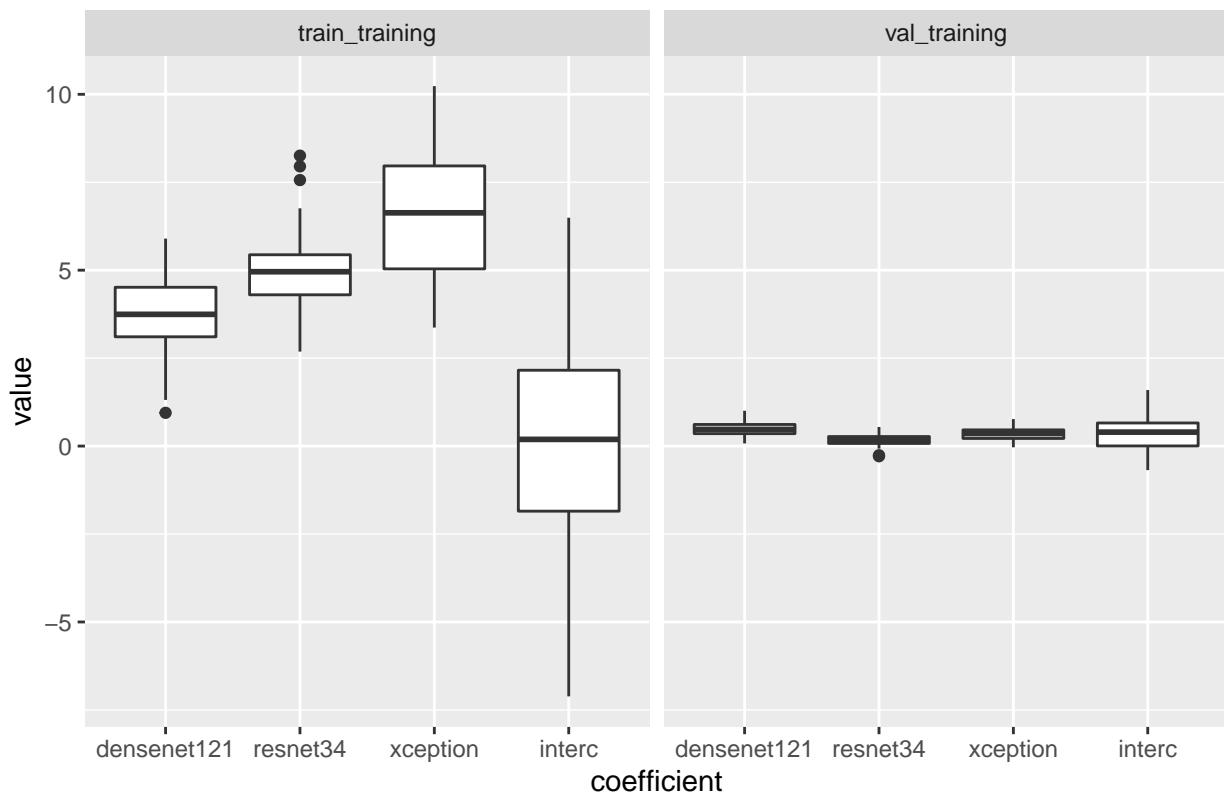
Coefficients for class 3 vs 13



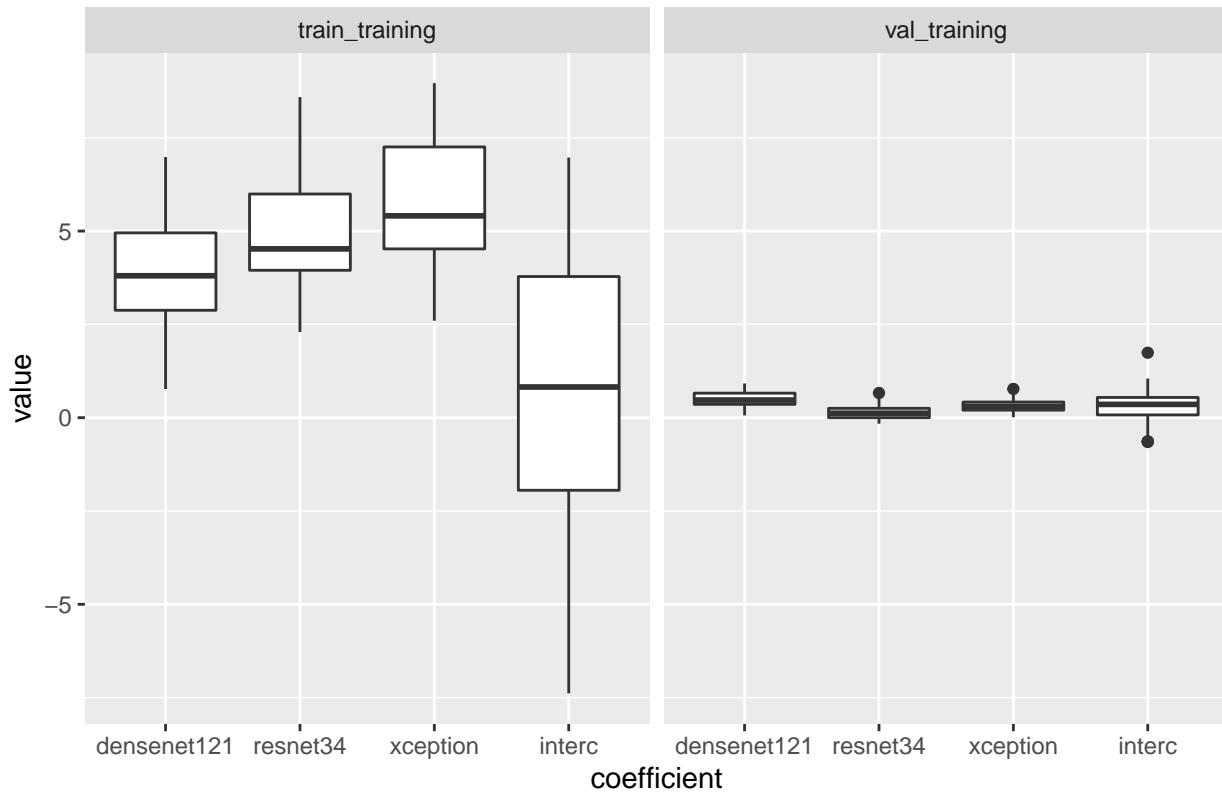
Coefficients for class 3 vs 14



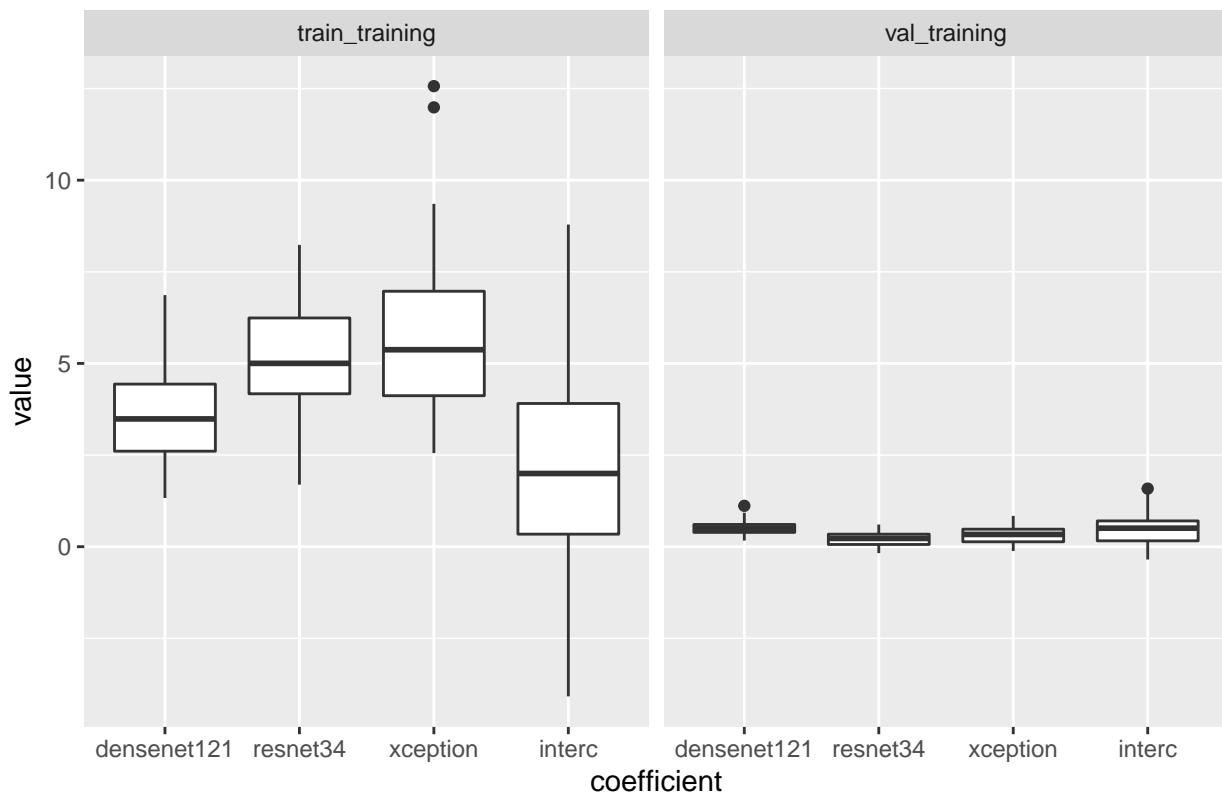
Coefficients for class 3 vs 15



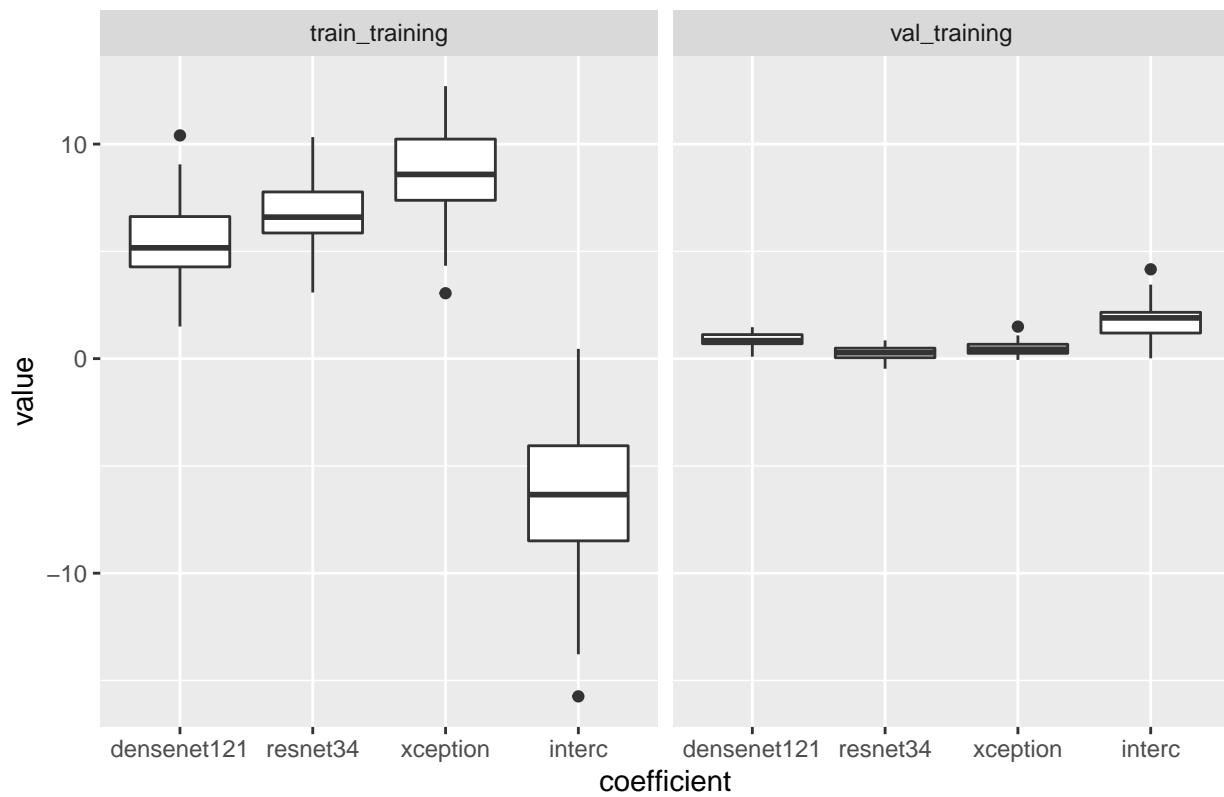
Coefficients for class 3 vs 16



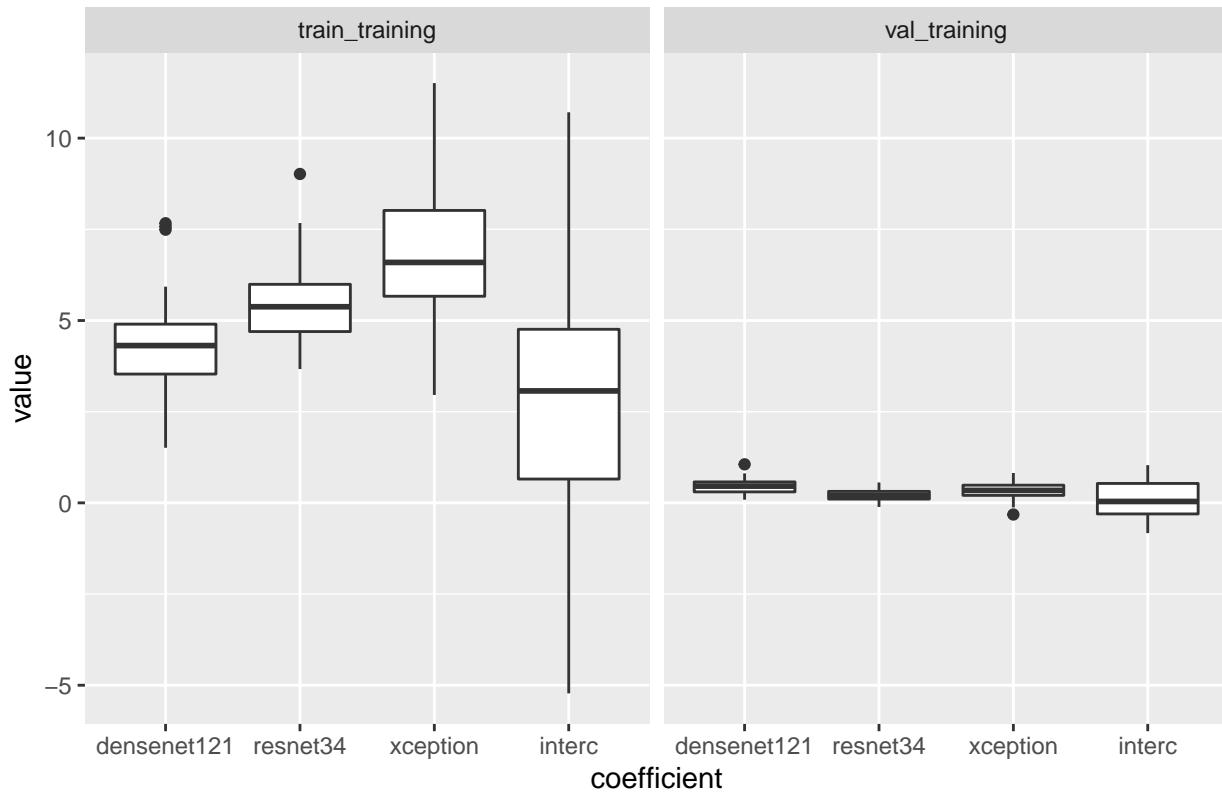
Coefficients for class 3 vs 17



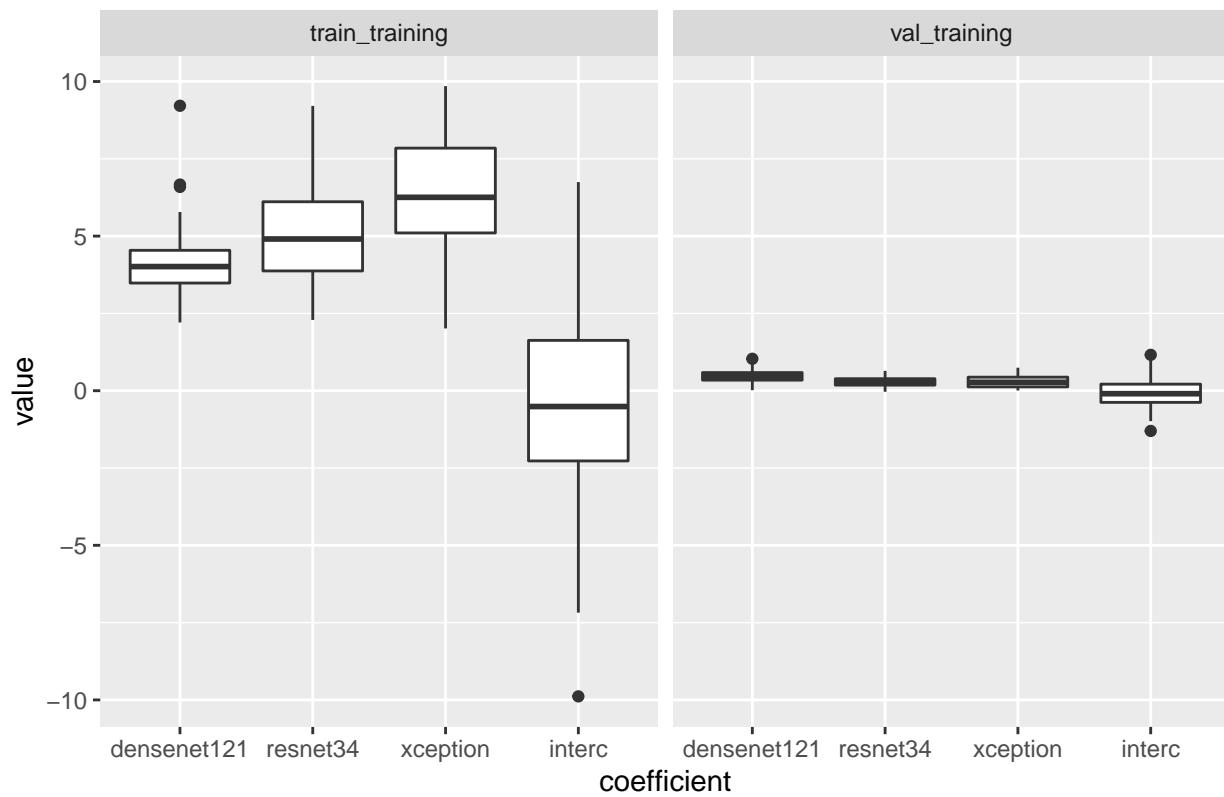
Coefficients for class 3 vs 18



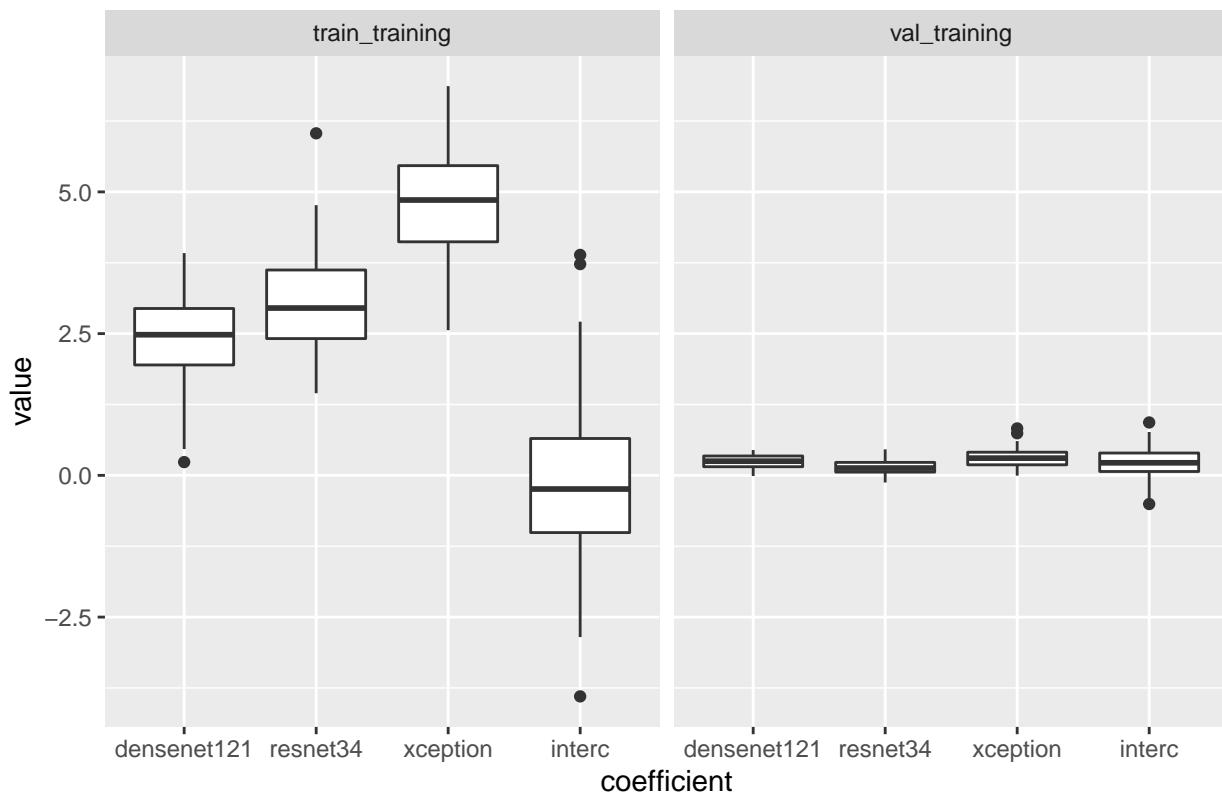
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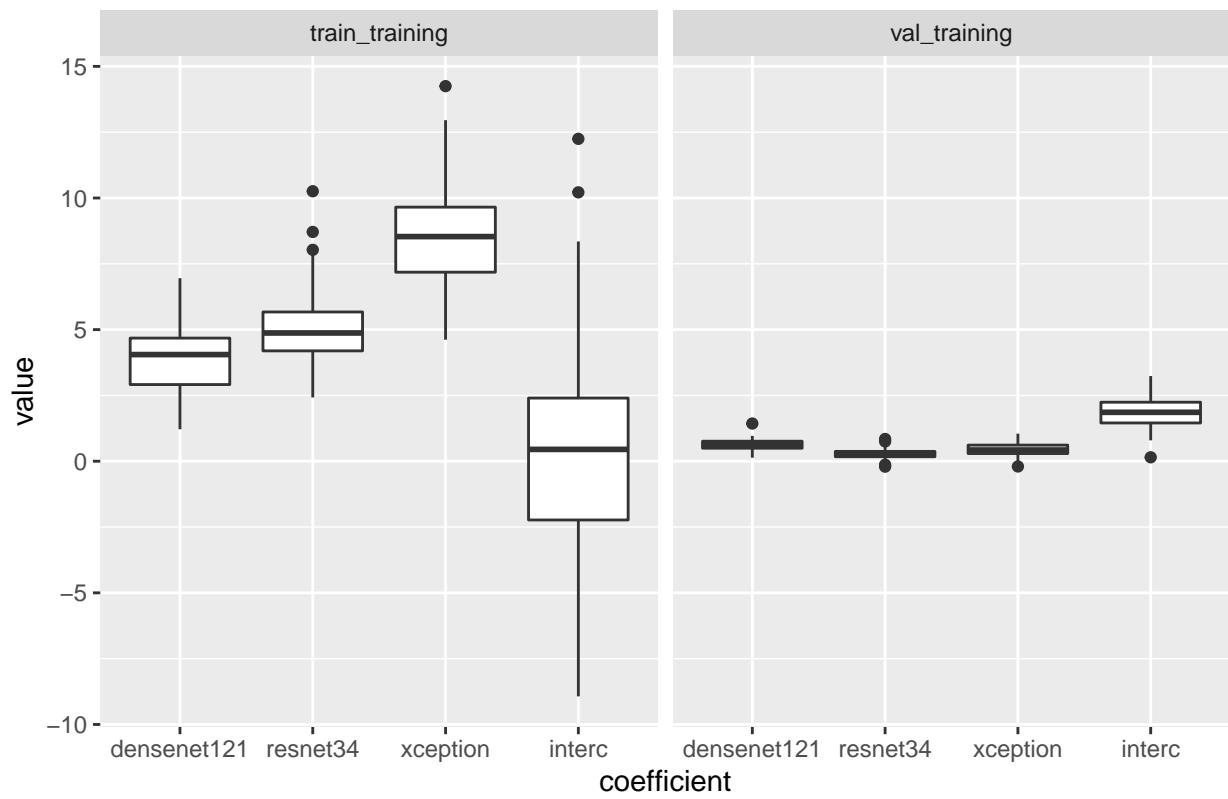
Coefficients for class 3 vs 20



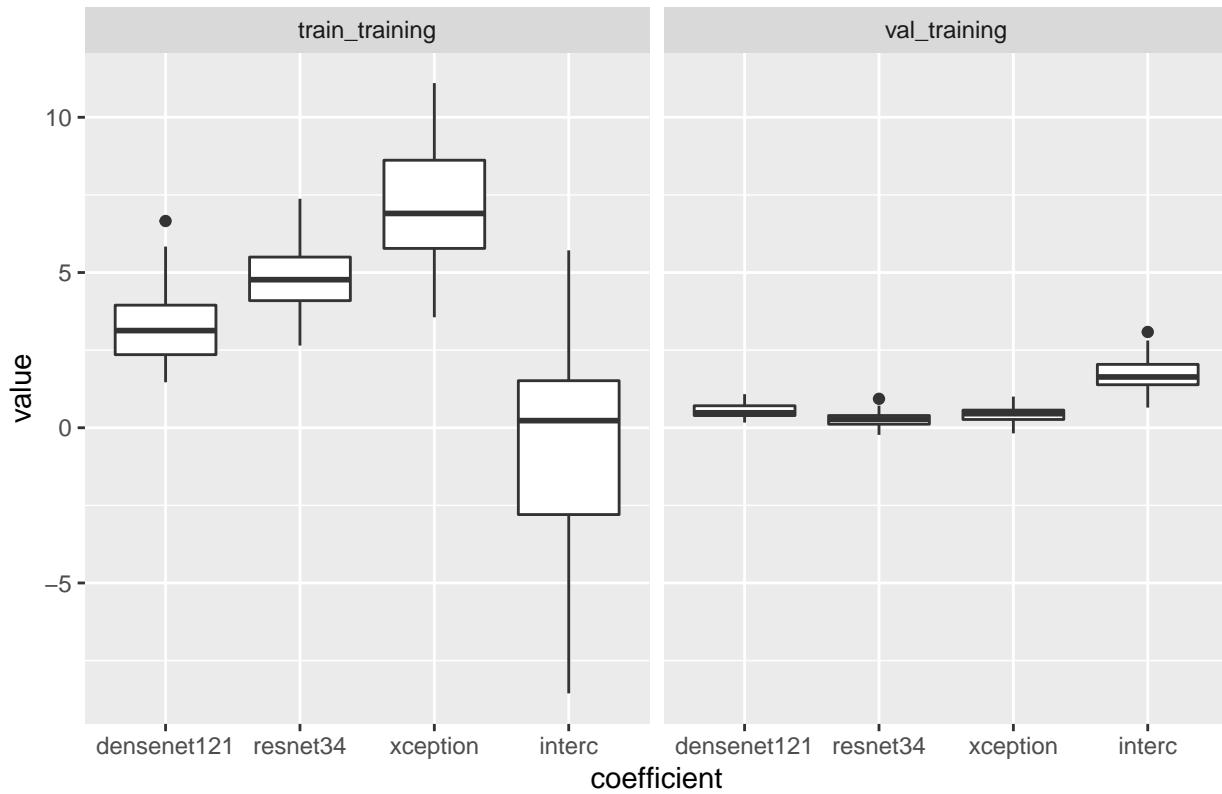
Coefficients for class 4 vs 5



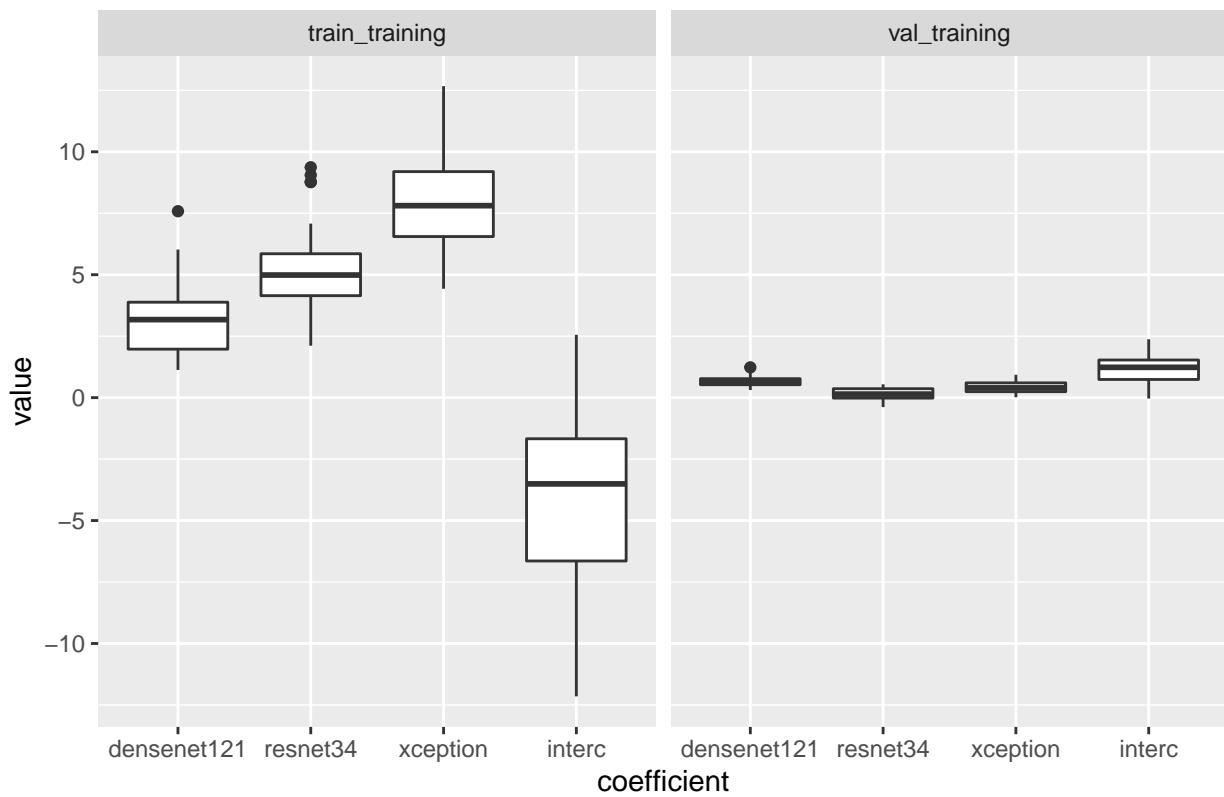
Coefficients for class 4 vs 6



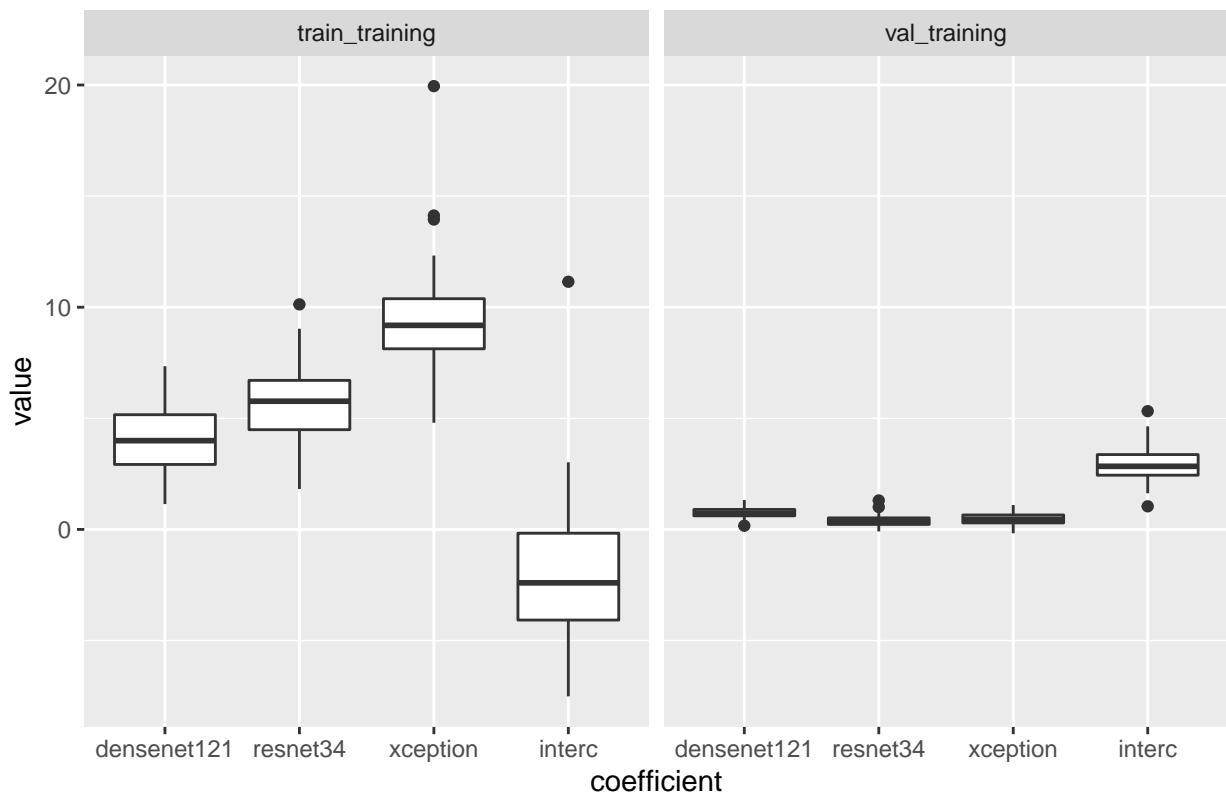
Coefficients for class 4 vs 7



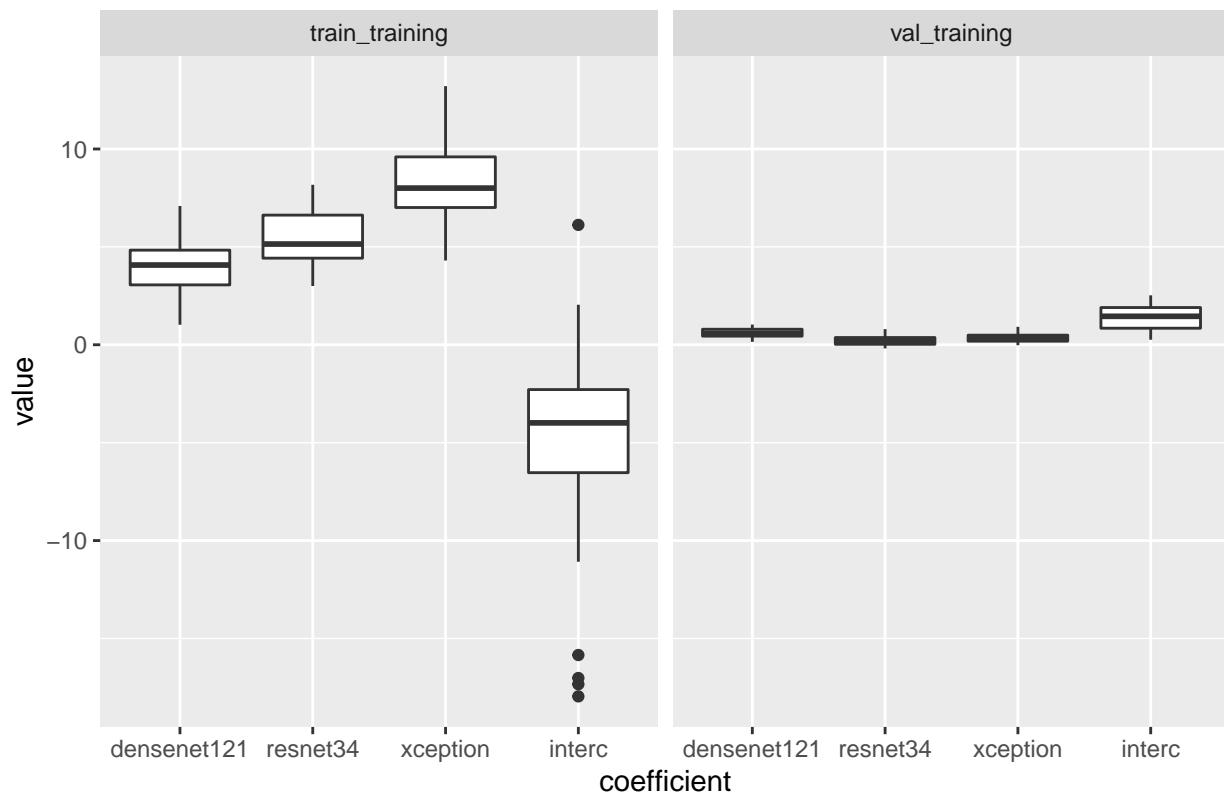
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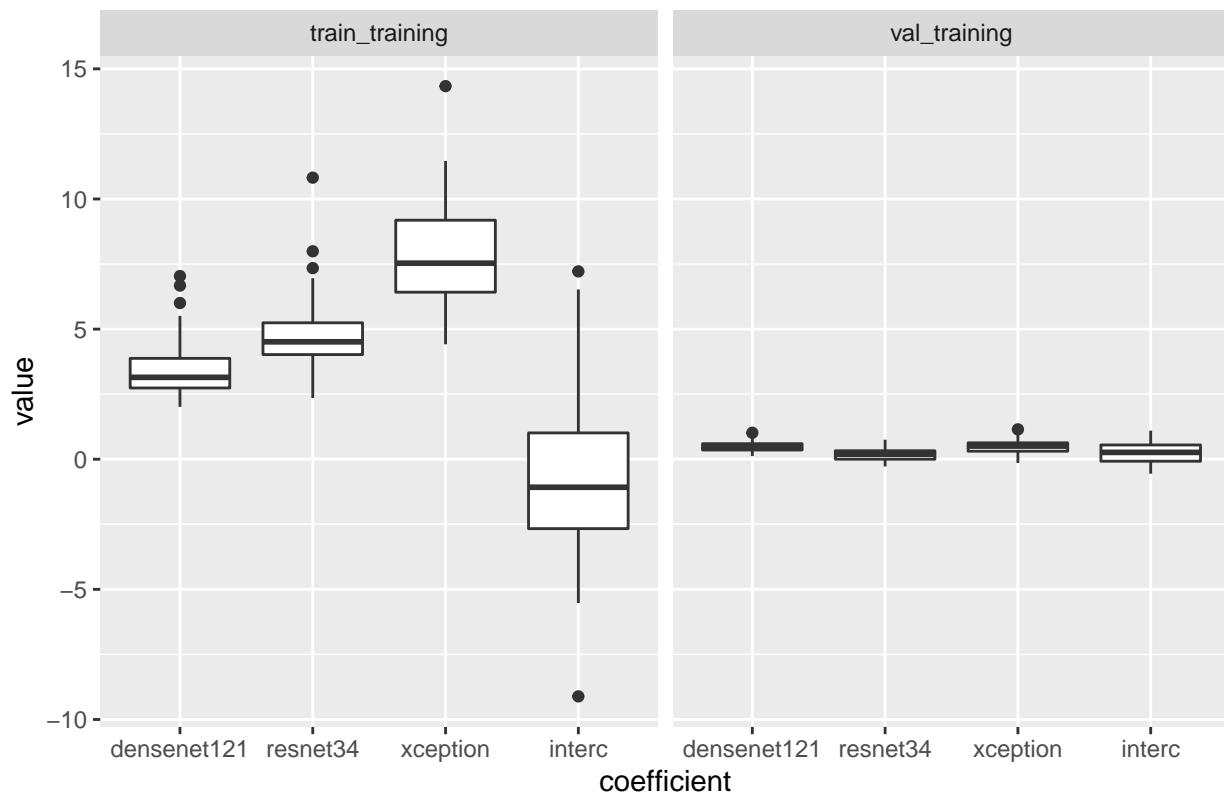
Coefficients for class 4 vs 9



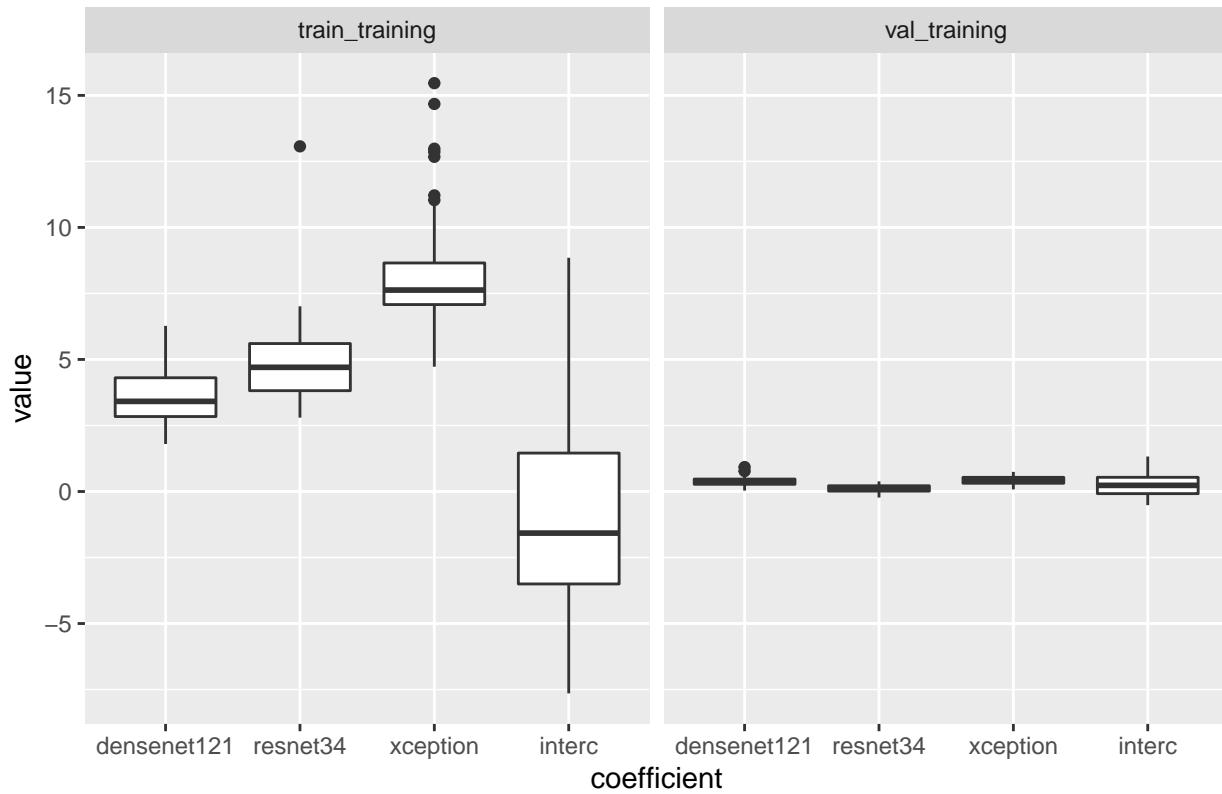
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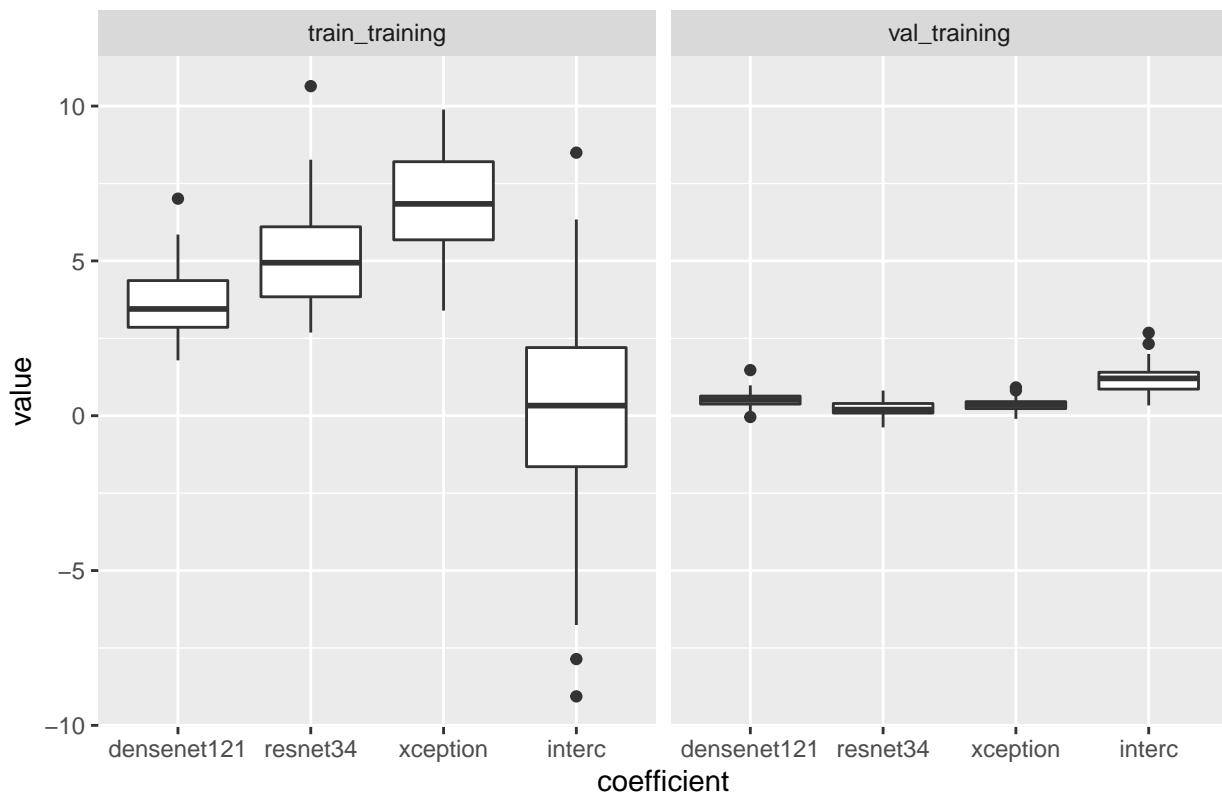
Coefficients for class 4 vs 11



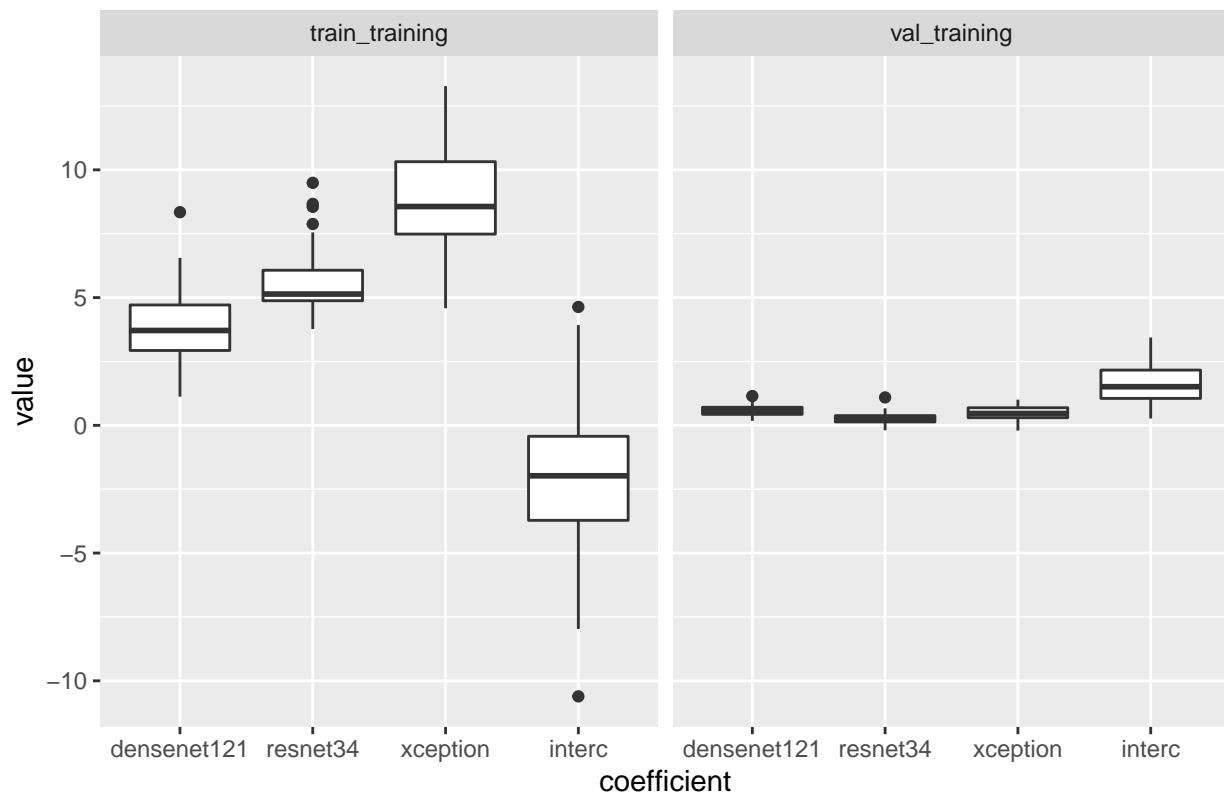
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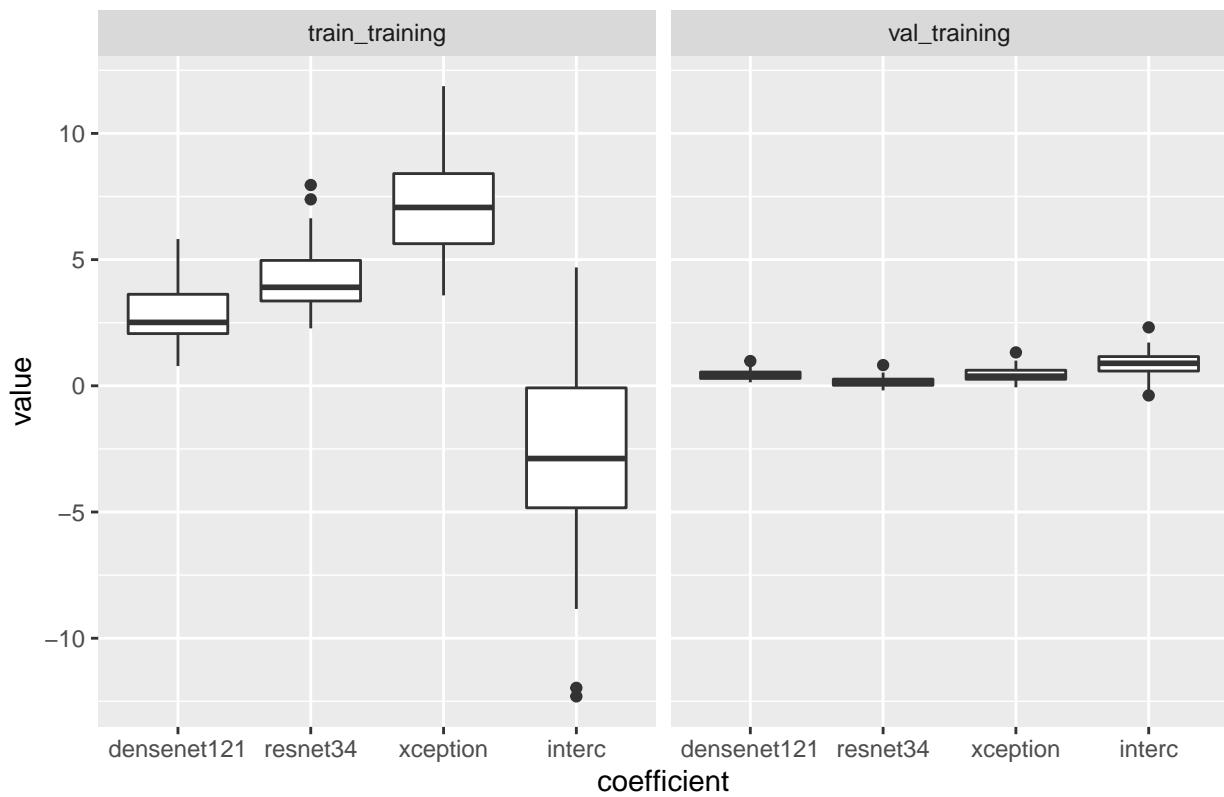
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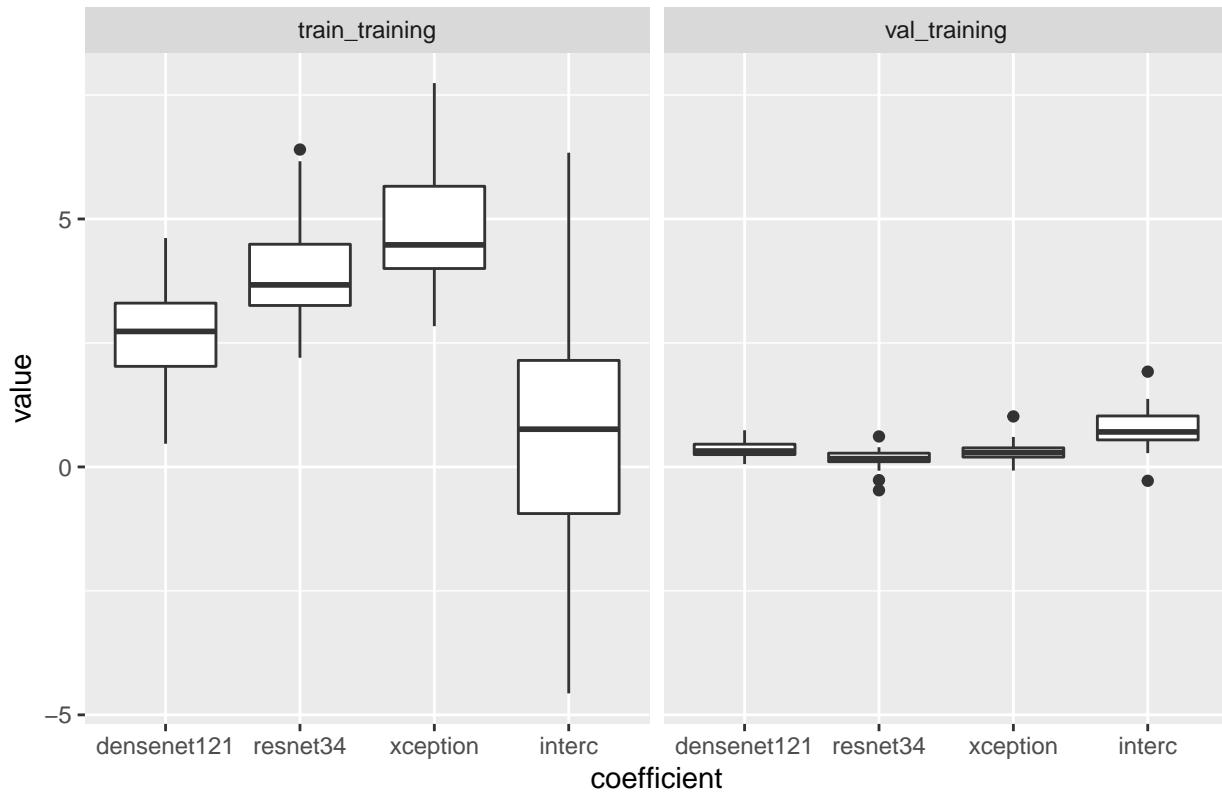
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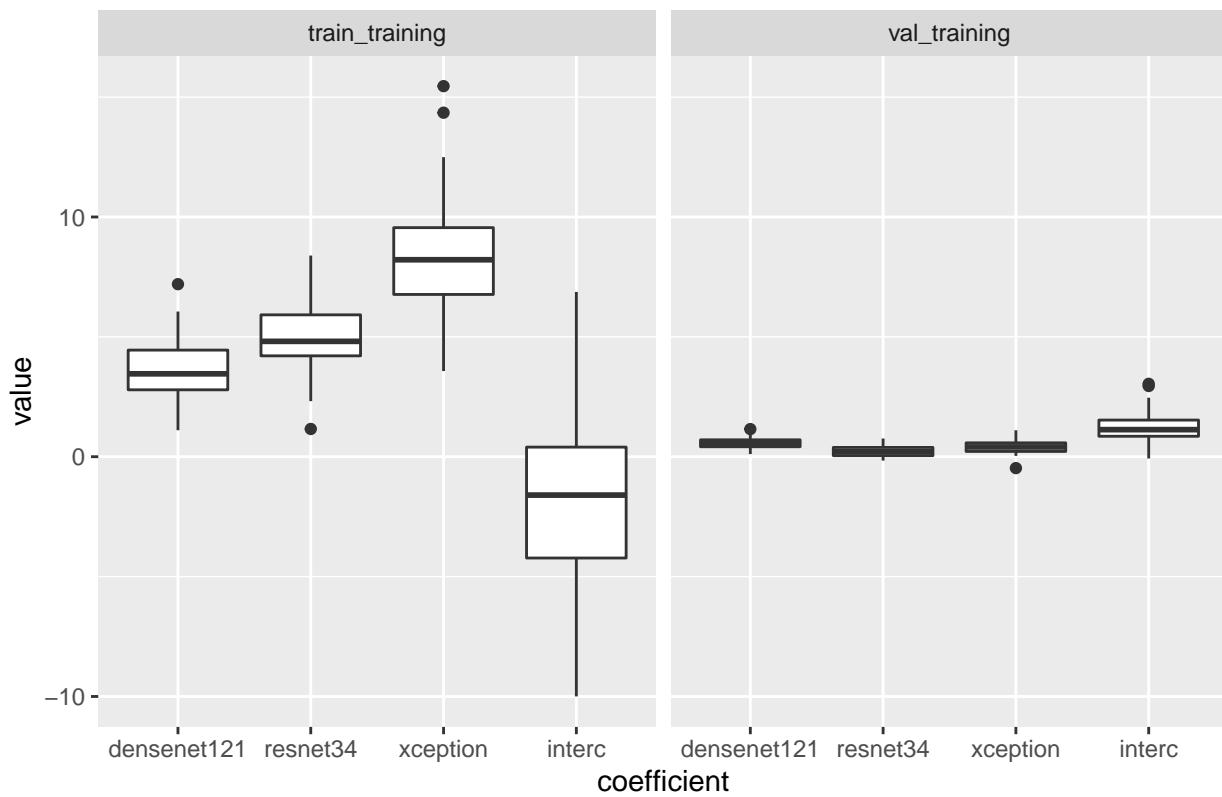
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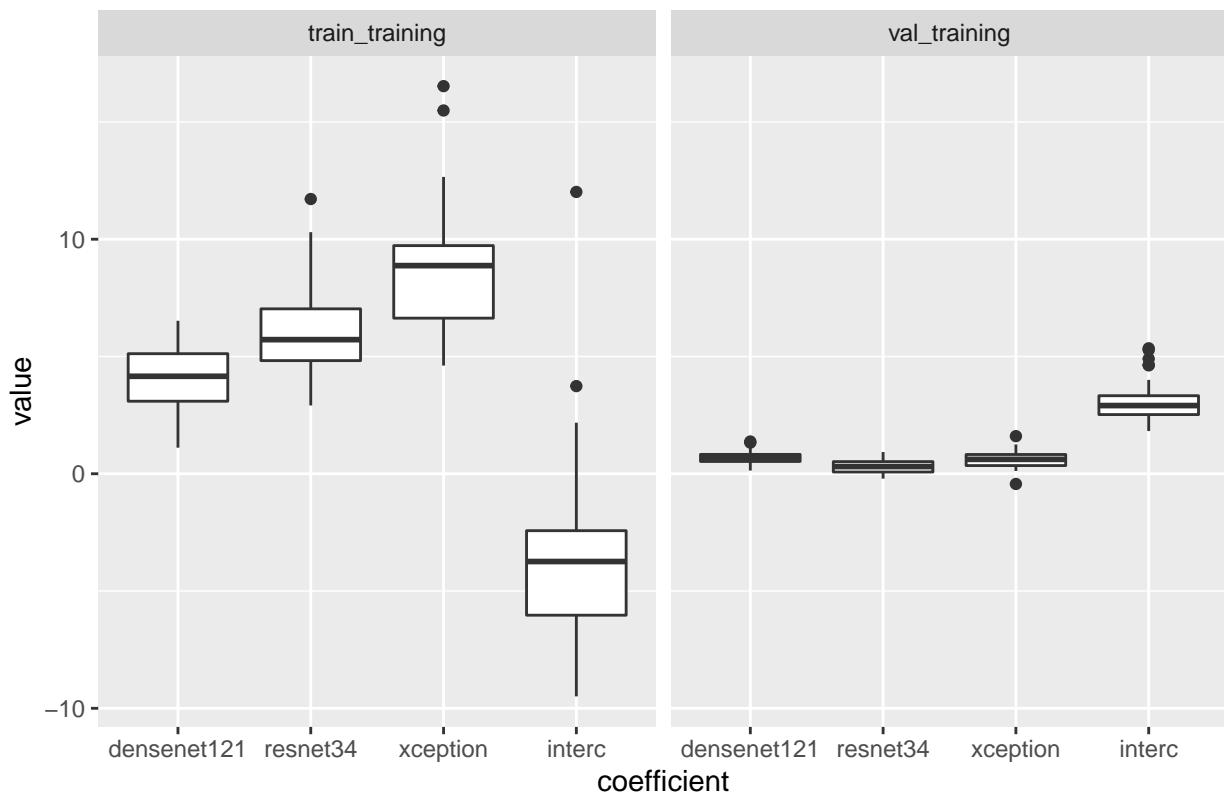
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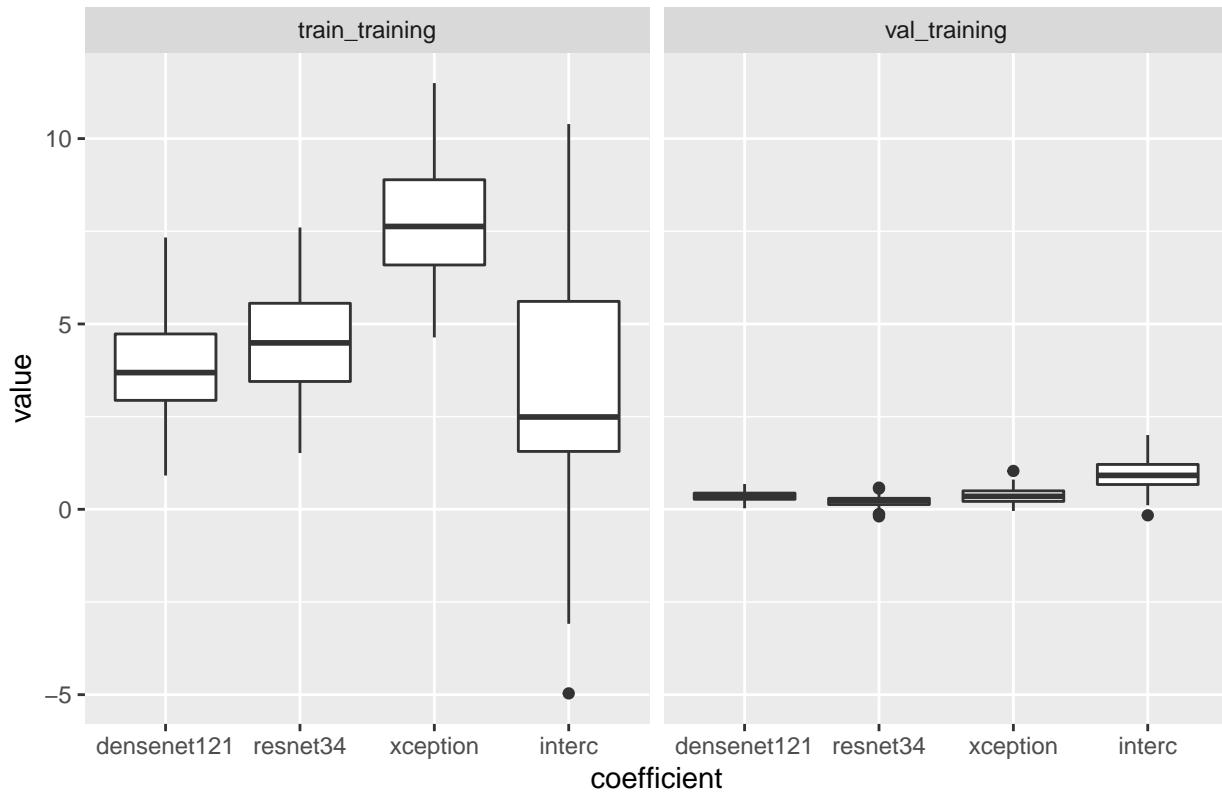
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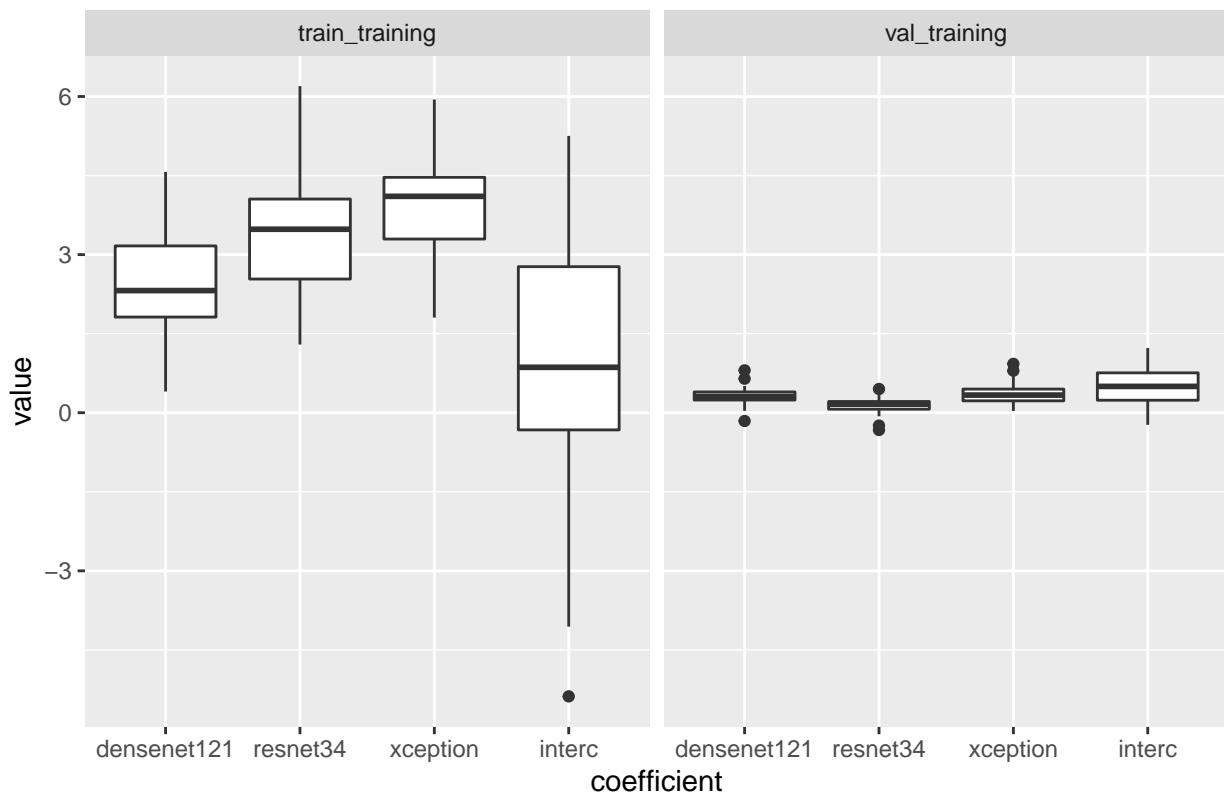
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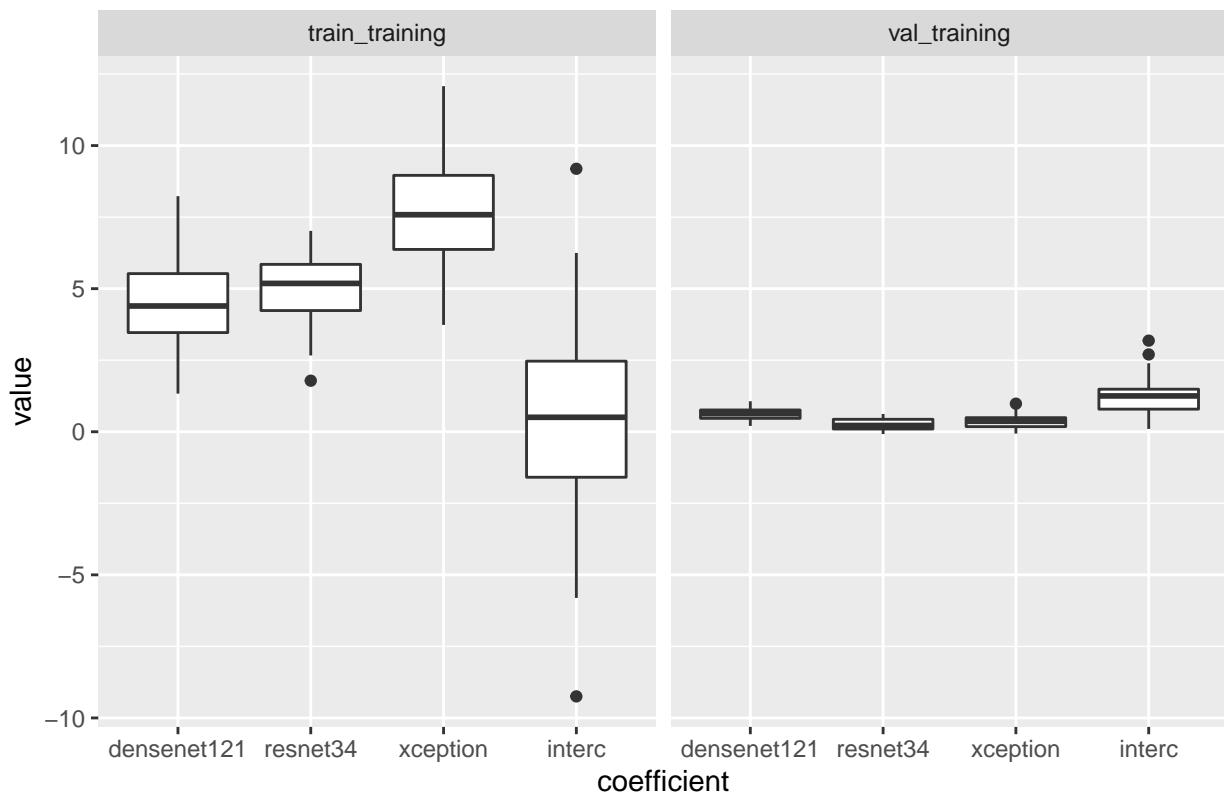
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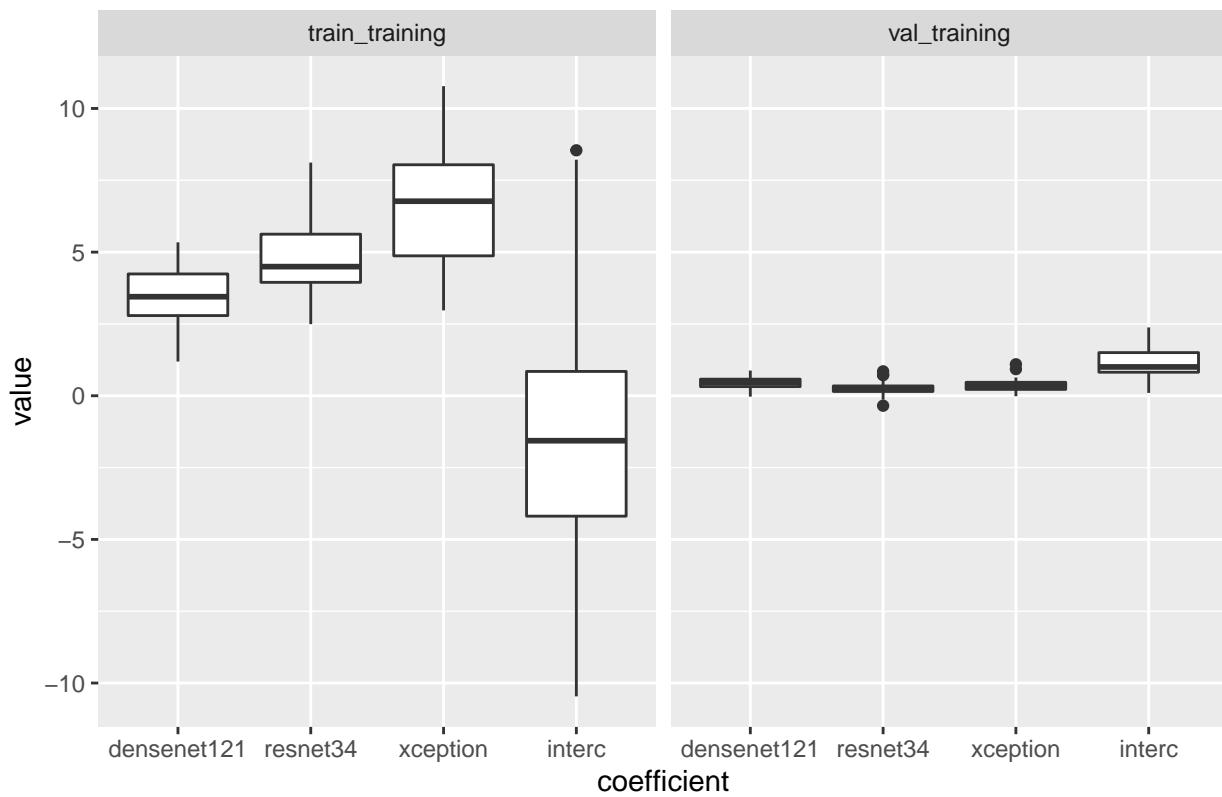
Coefficients for class 4 vs 20



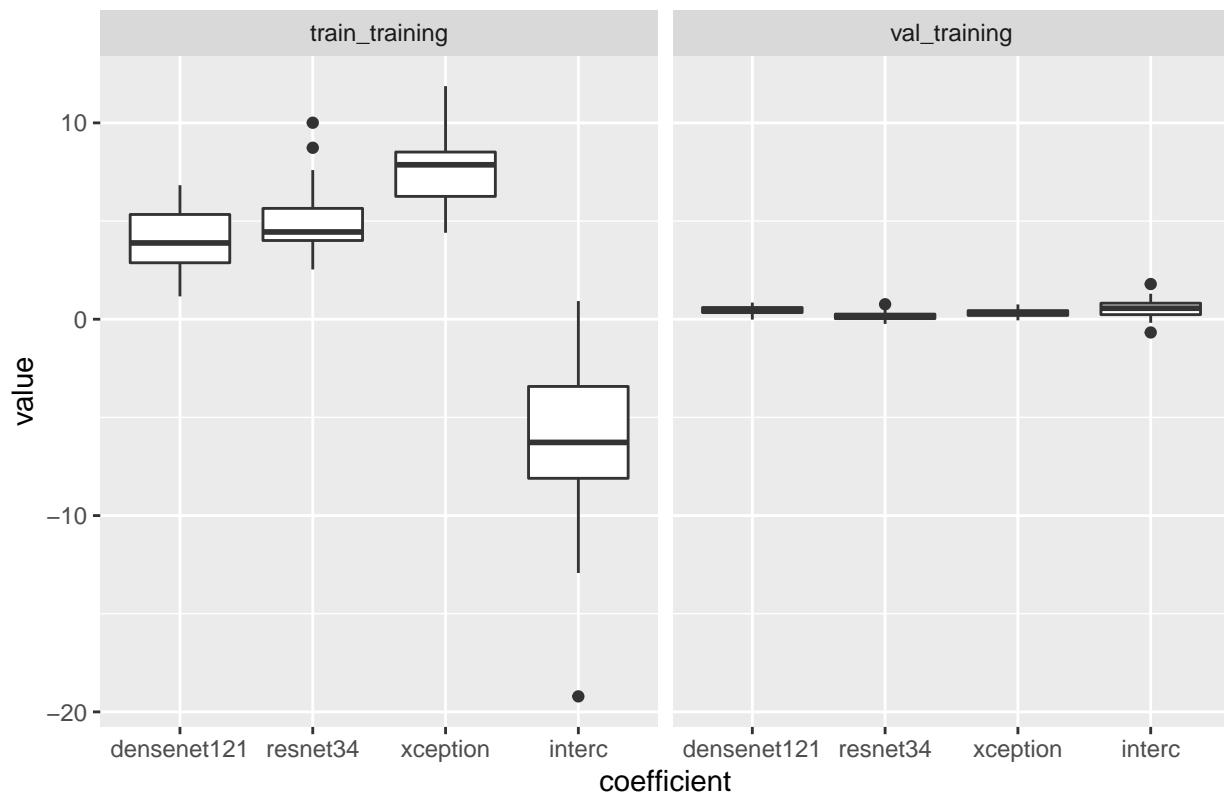
Coefficients for class 5 vs 6



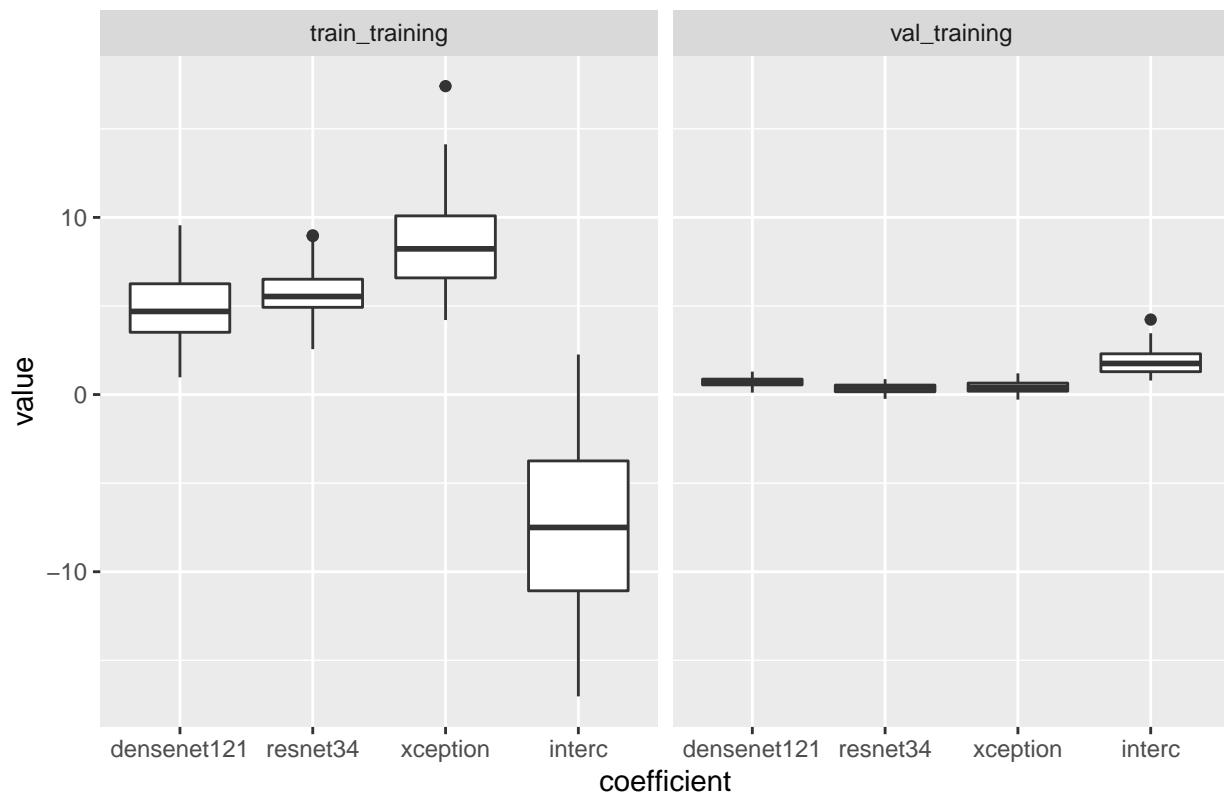
Coefficients for class 5 vs 7



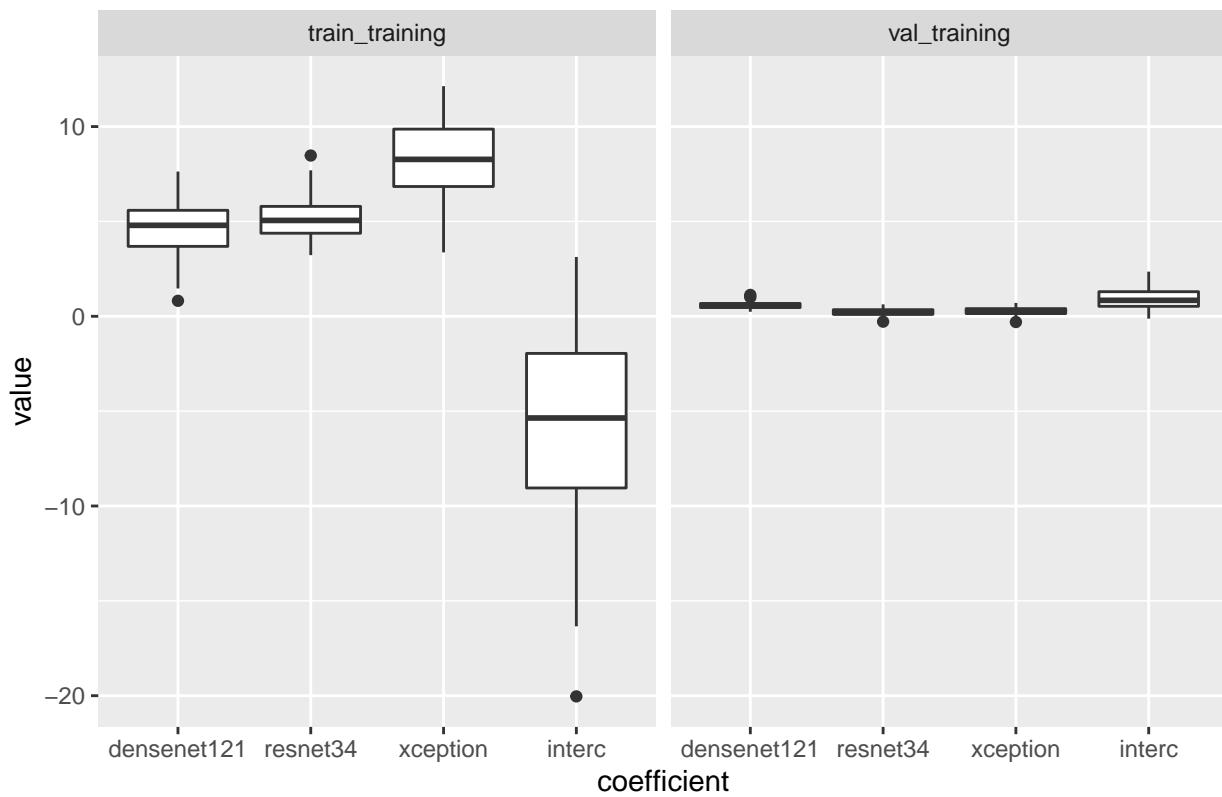
Coefficients for class 5 vs 8



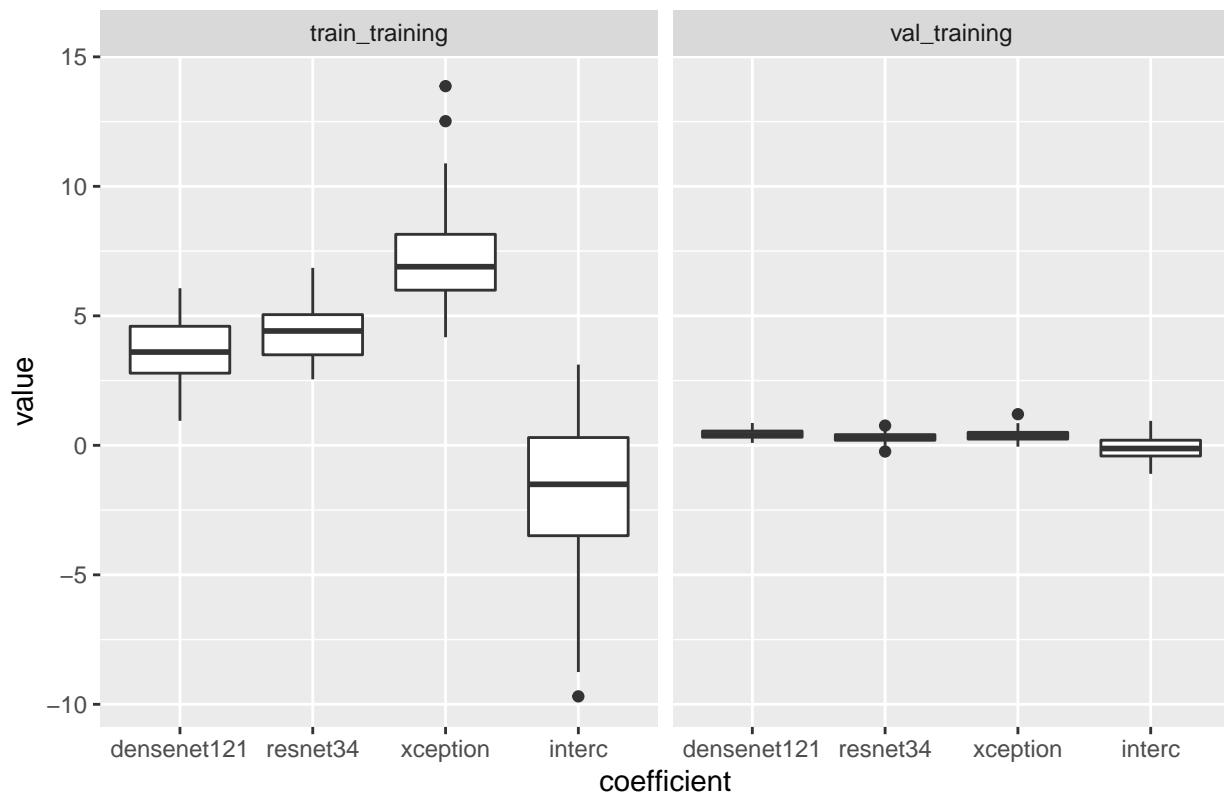
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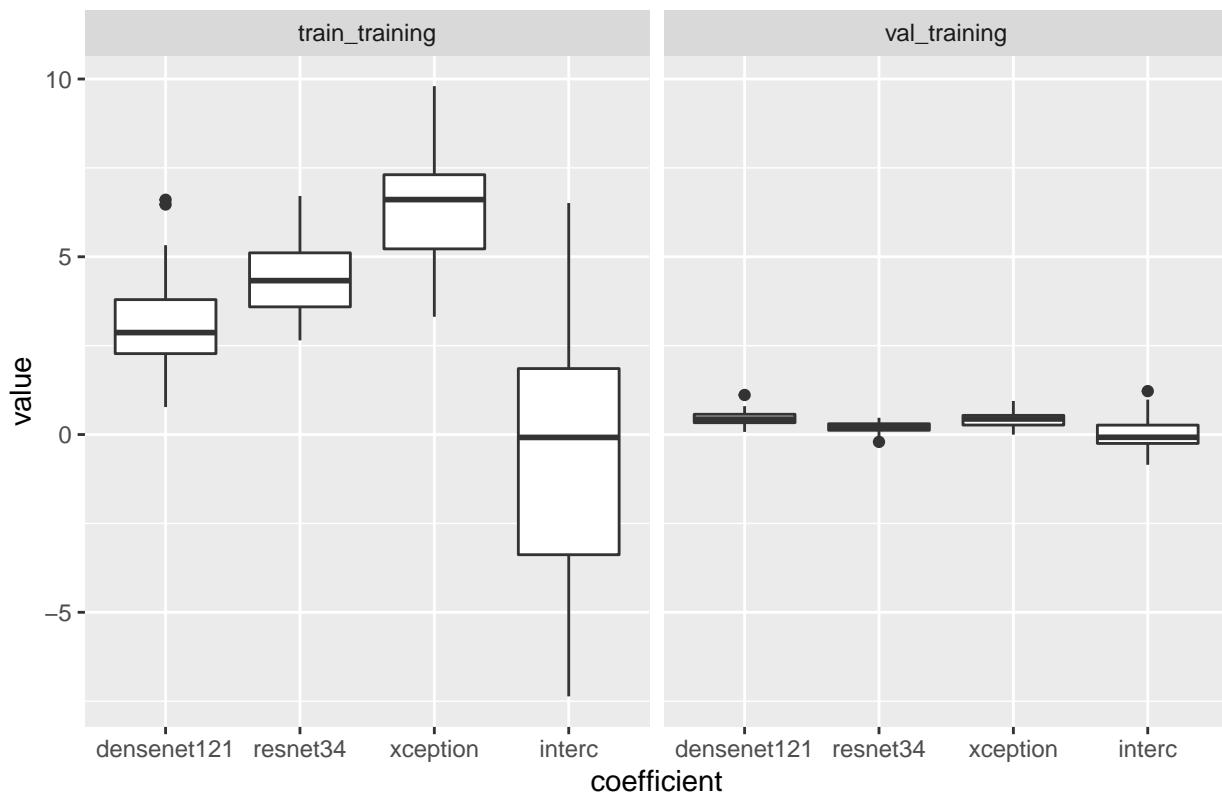
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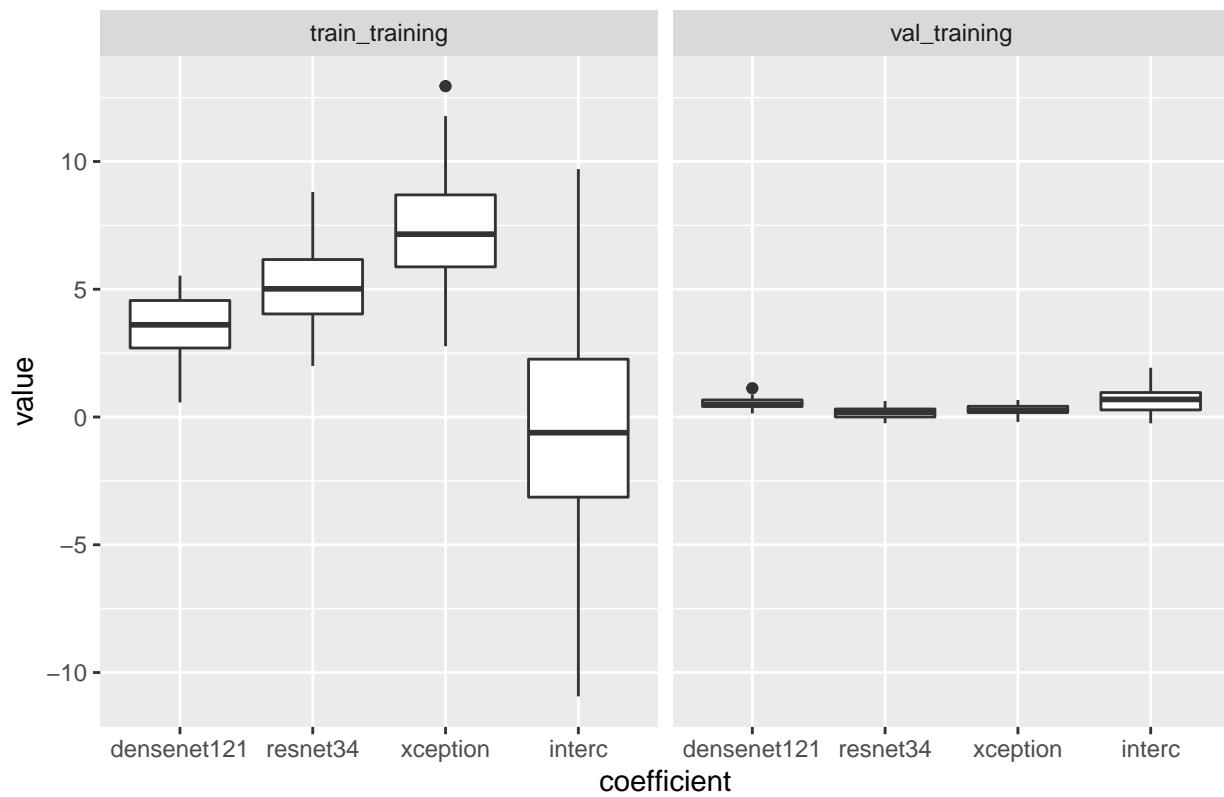
Coefficients for class 5 vs 11



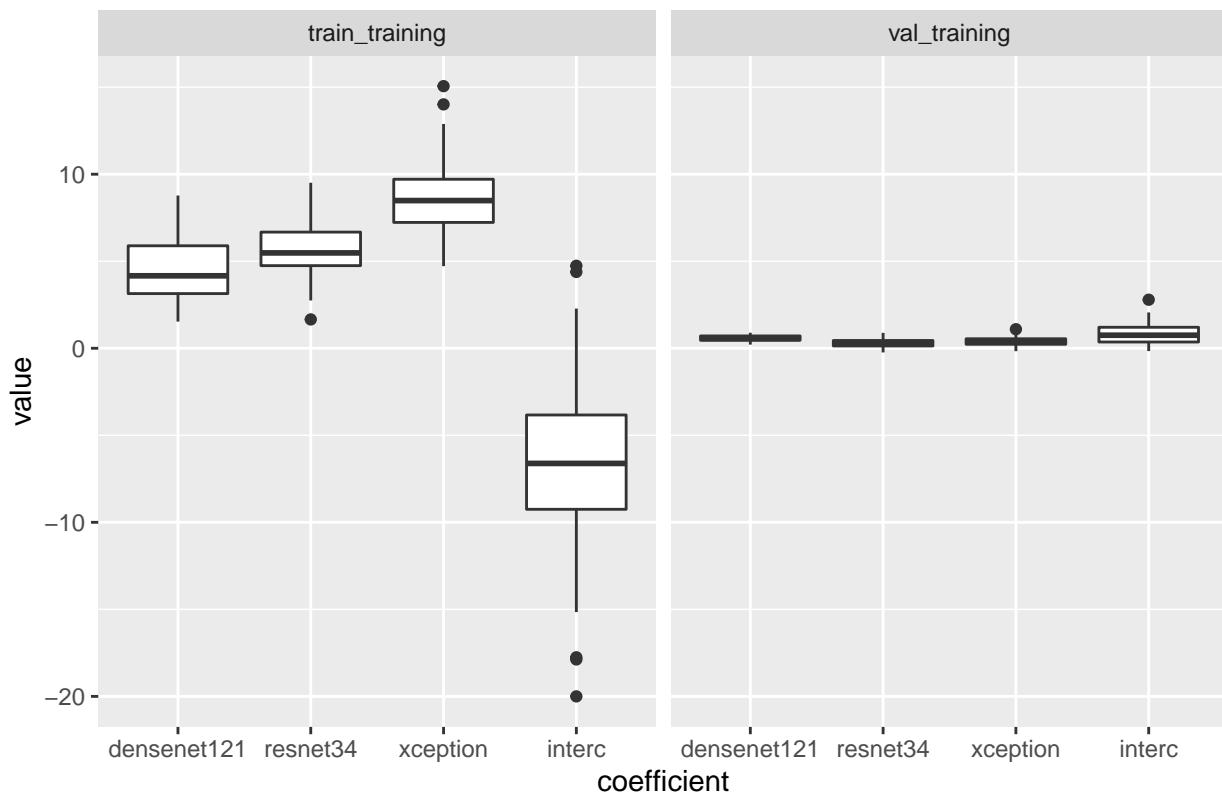
Coefficients for class 5 vs 12



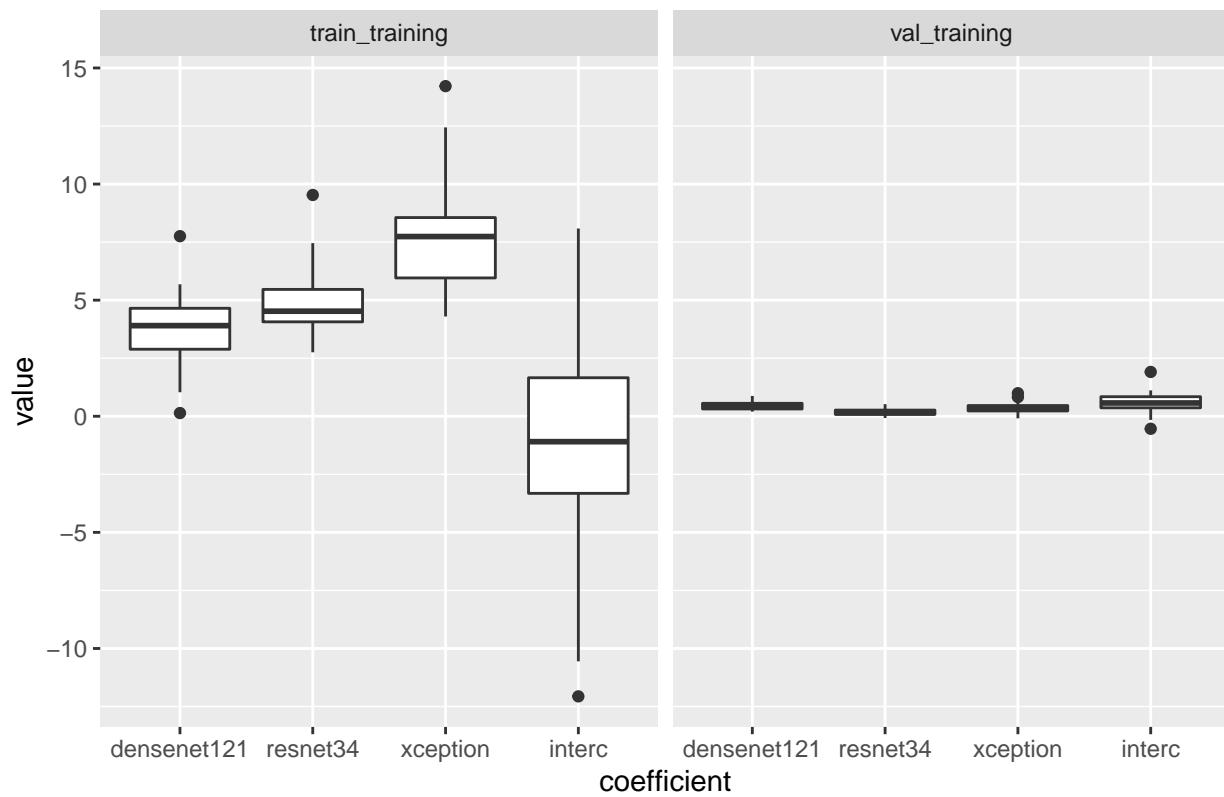
Coefficients for class 5 vs 13



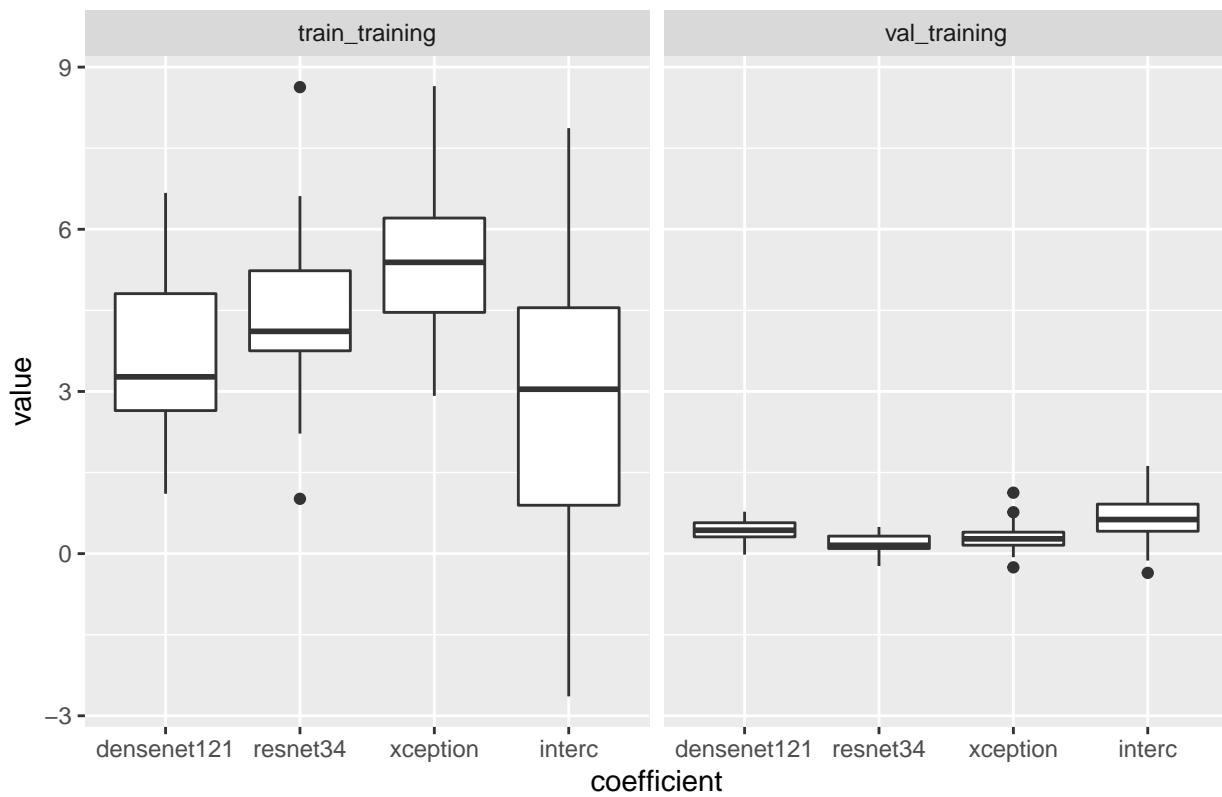
Coefficients for class 5 vs 14



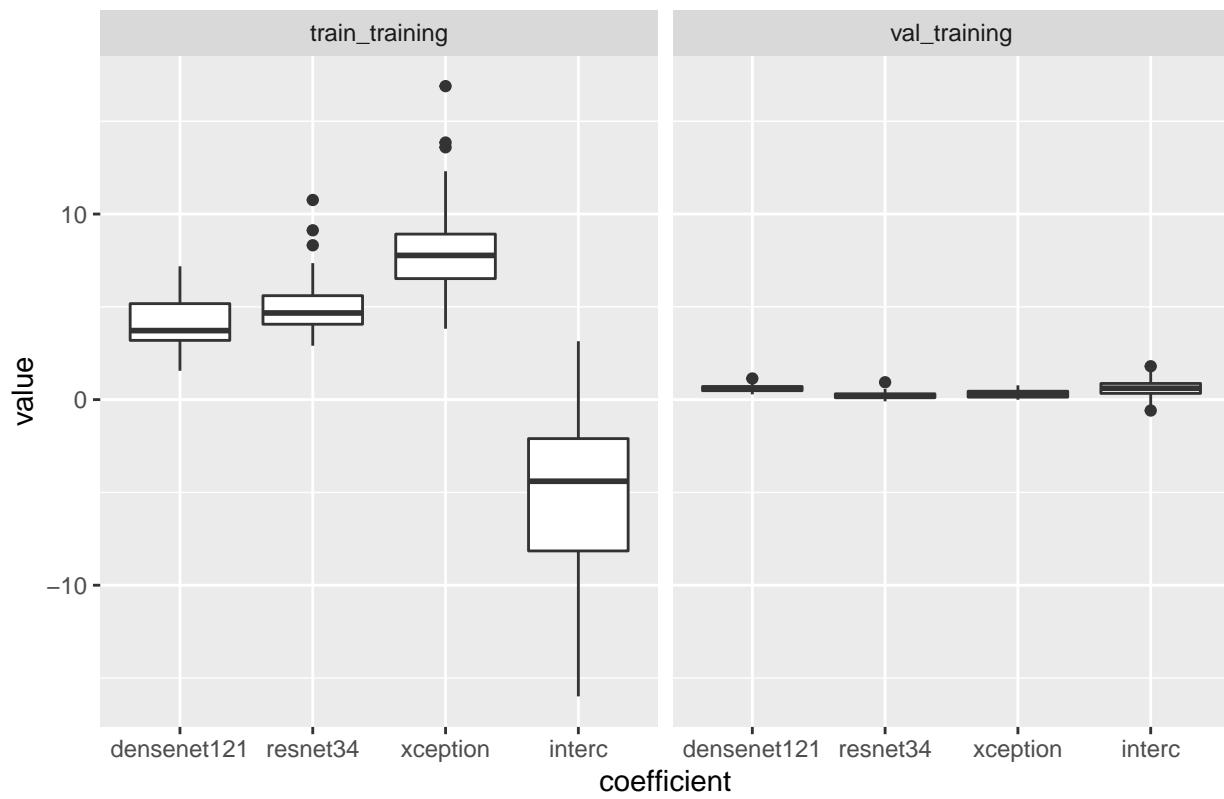
Coefficients for class 5 vs 15



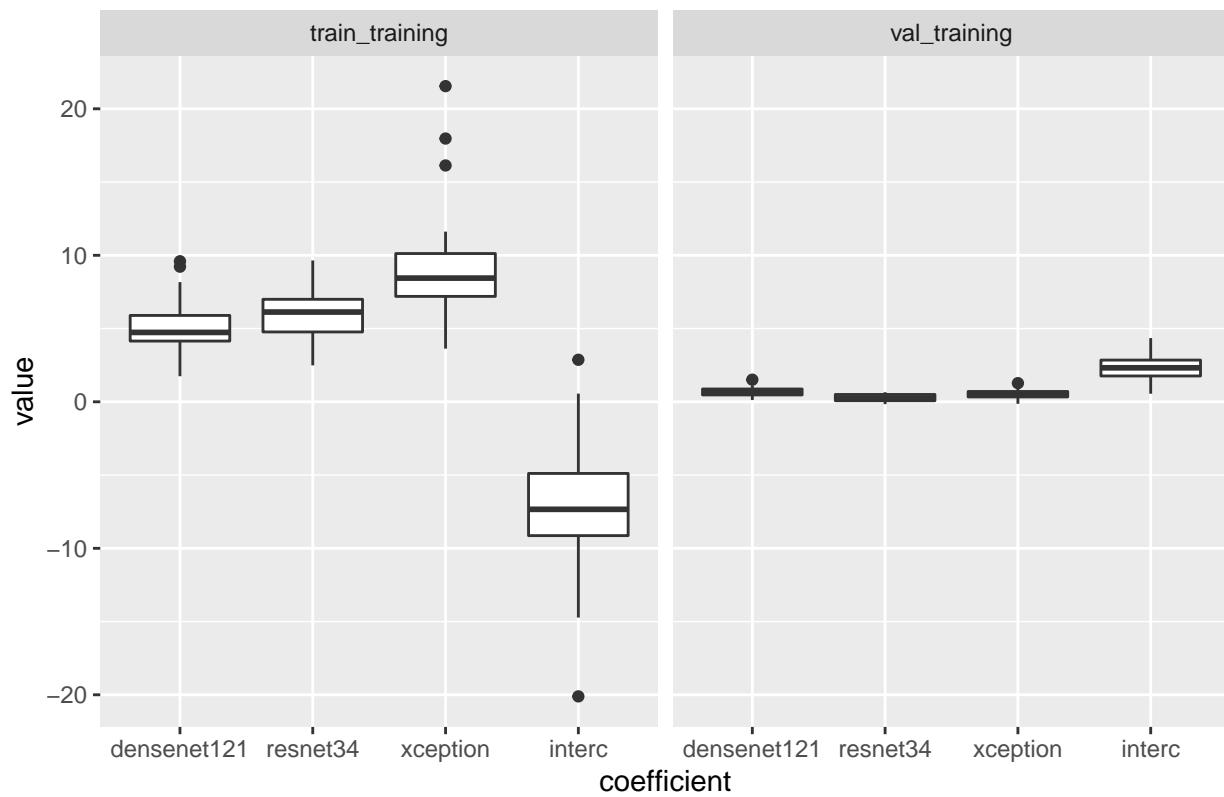
Coefficients for class 5 vs 16



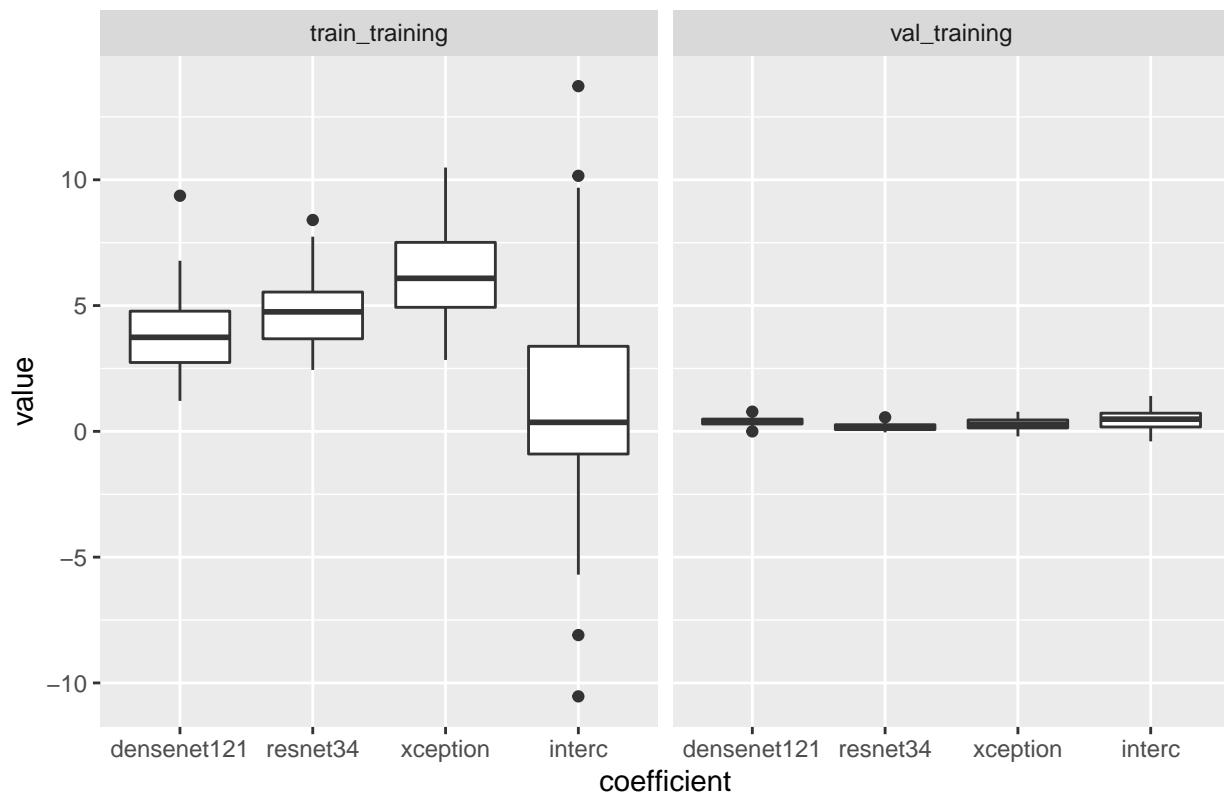
Coefficients for class 5 vs 17



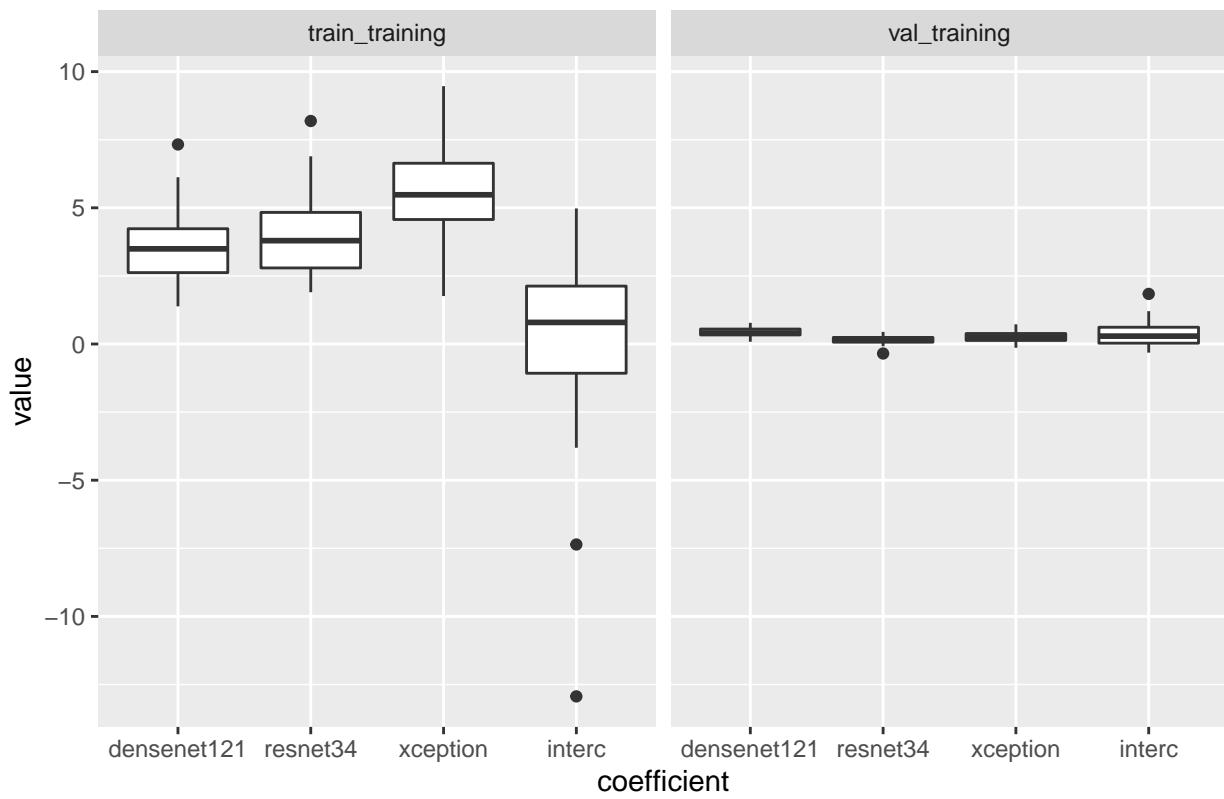
Coefficients for class 5 vs 18



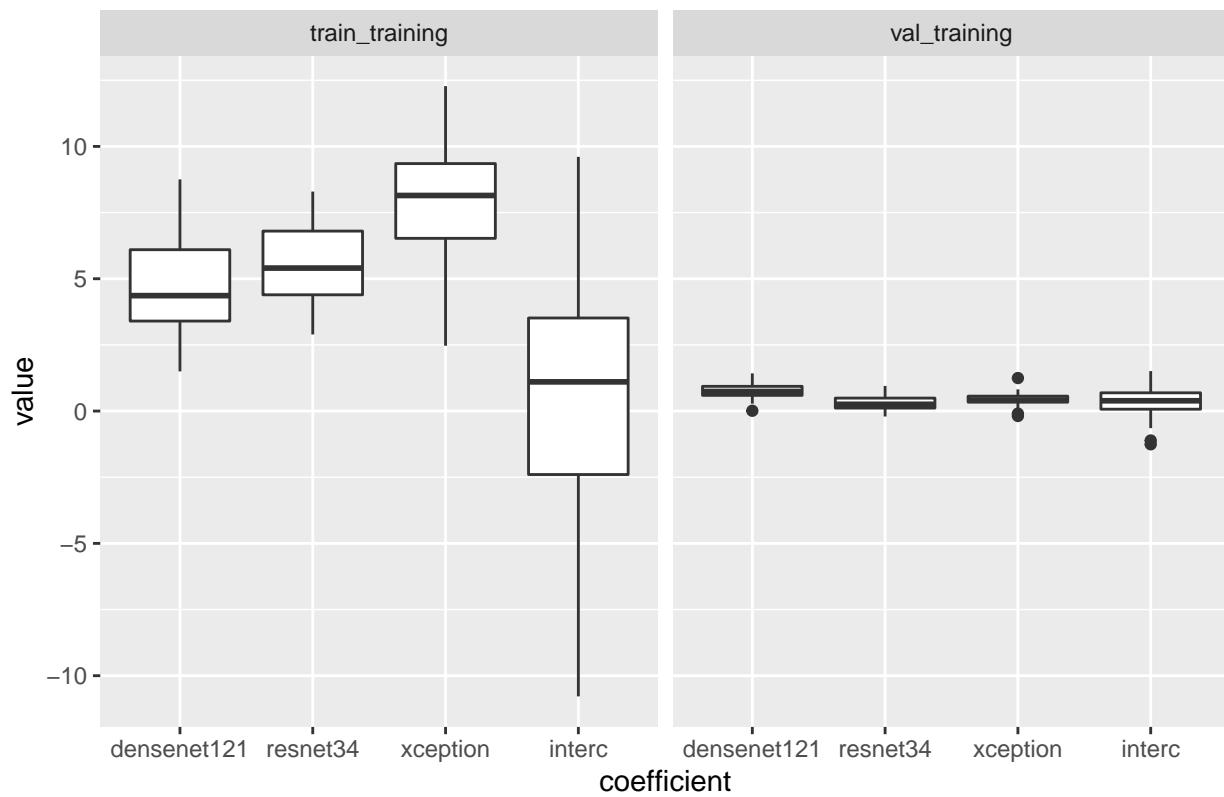
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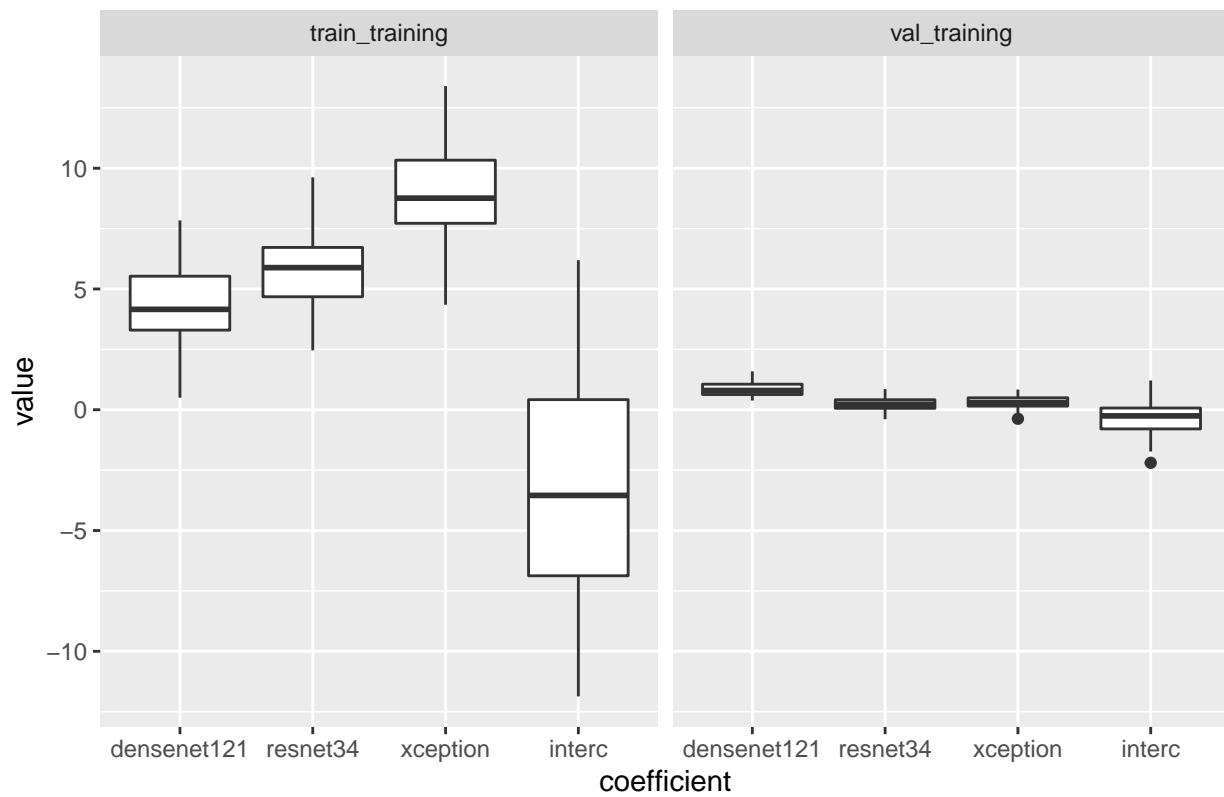
Coefficients for class 5 vs 20



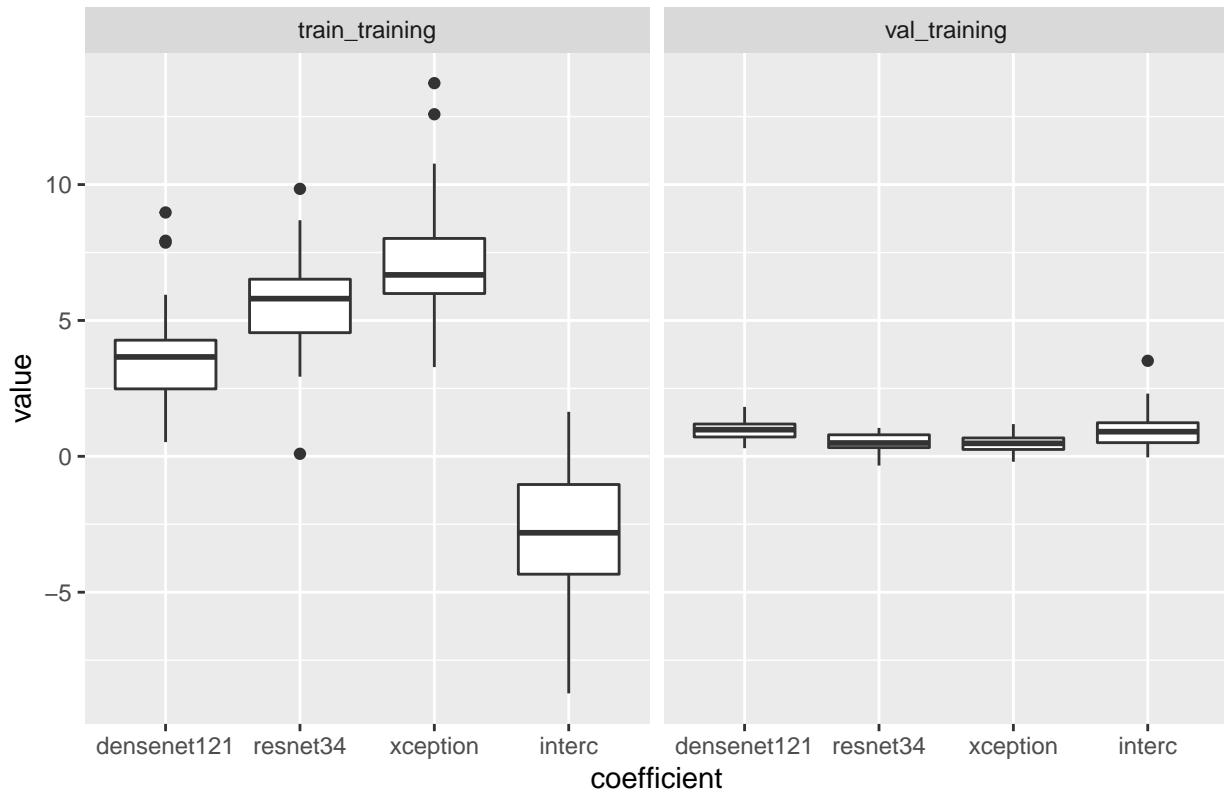
Coefficients for class 6 vs 7



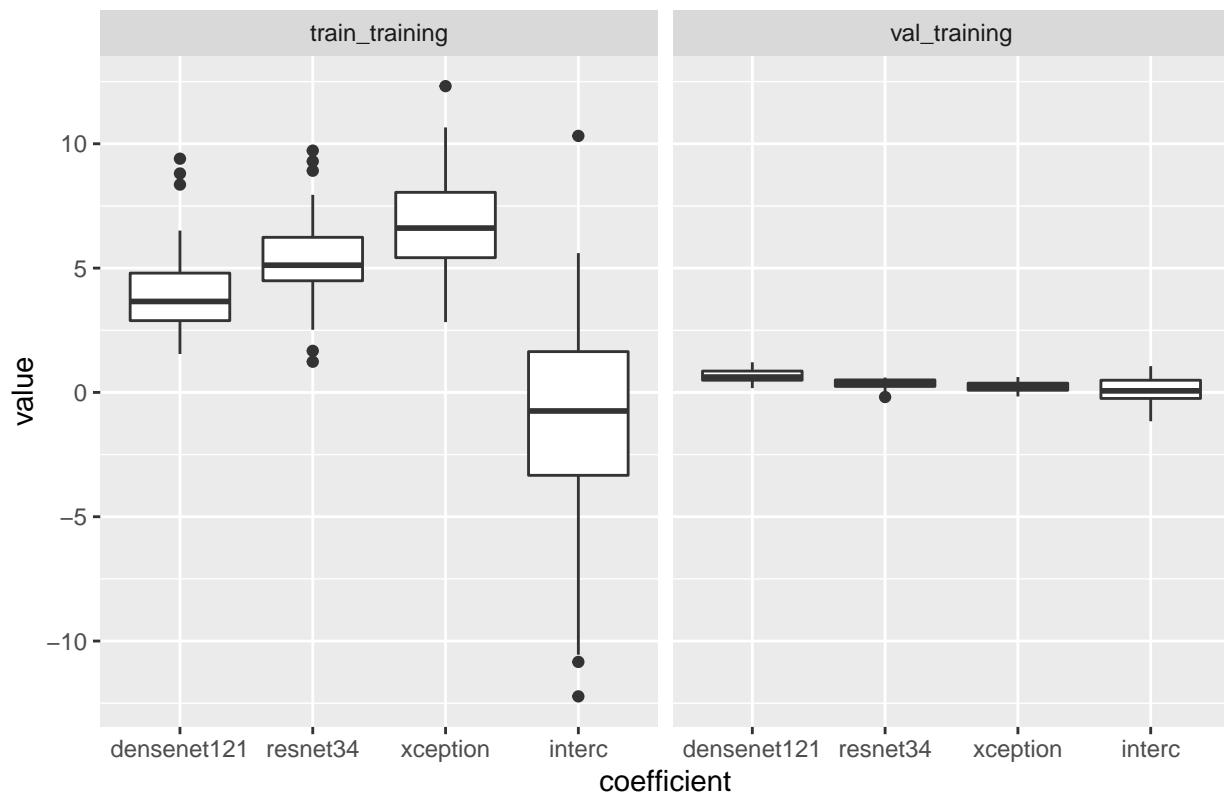
Coefficients for class 6 vs 8



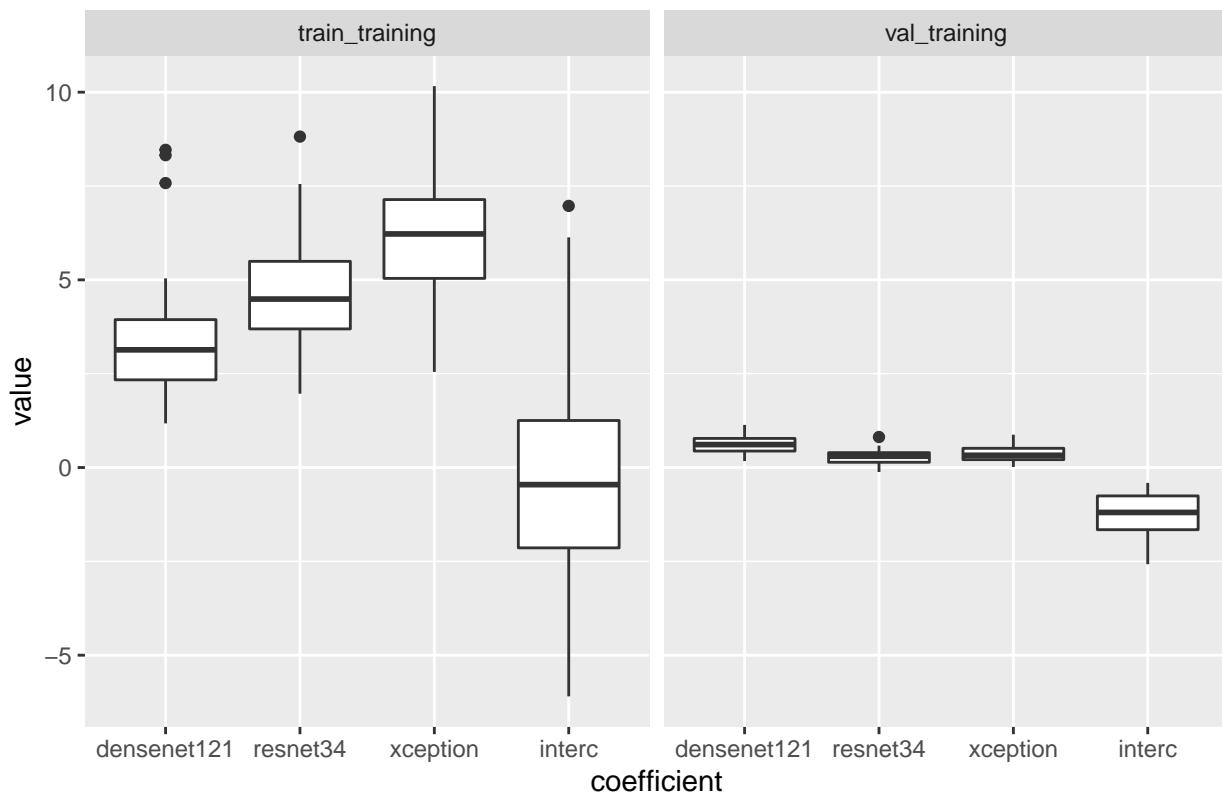
Coefficients for class 6 vs 9



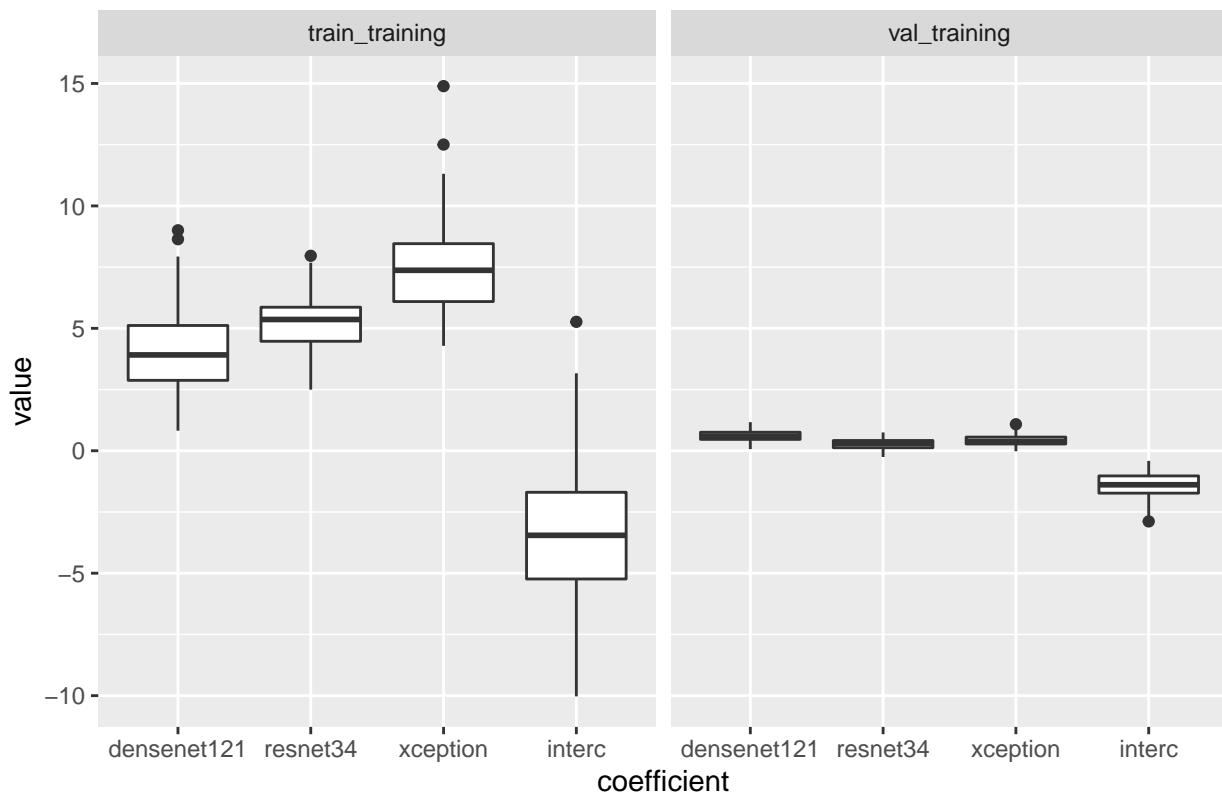
Coefficients for class 6 vs 10



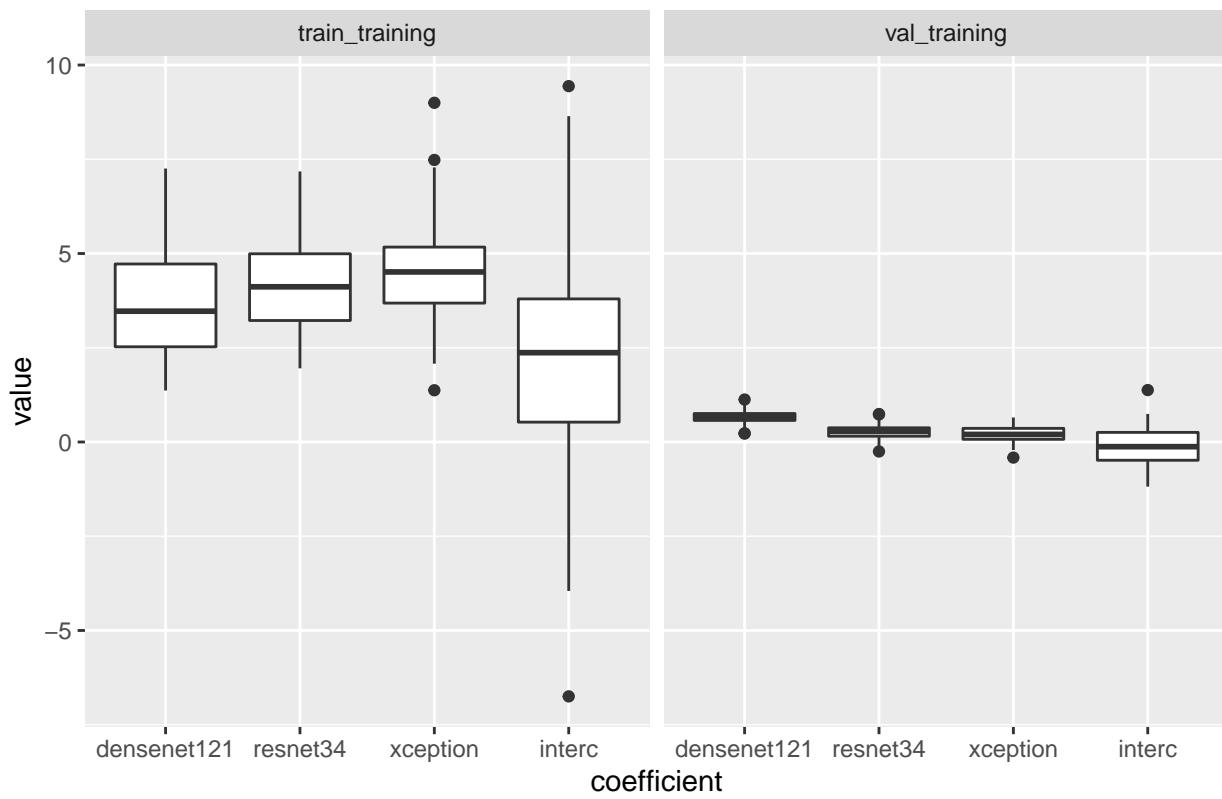
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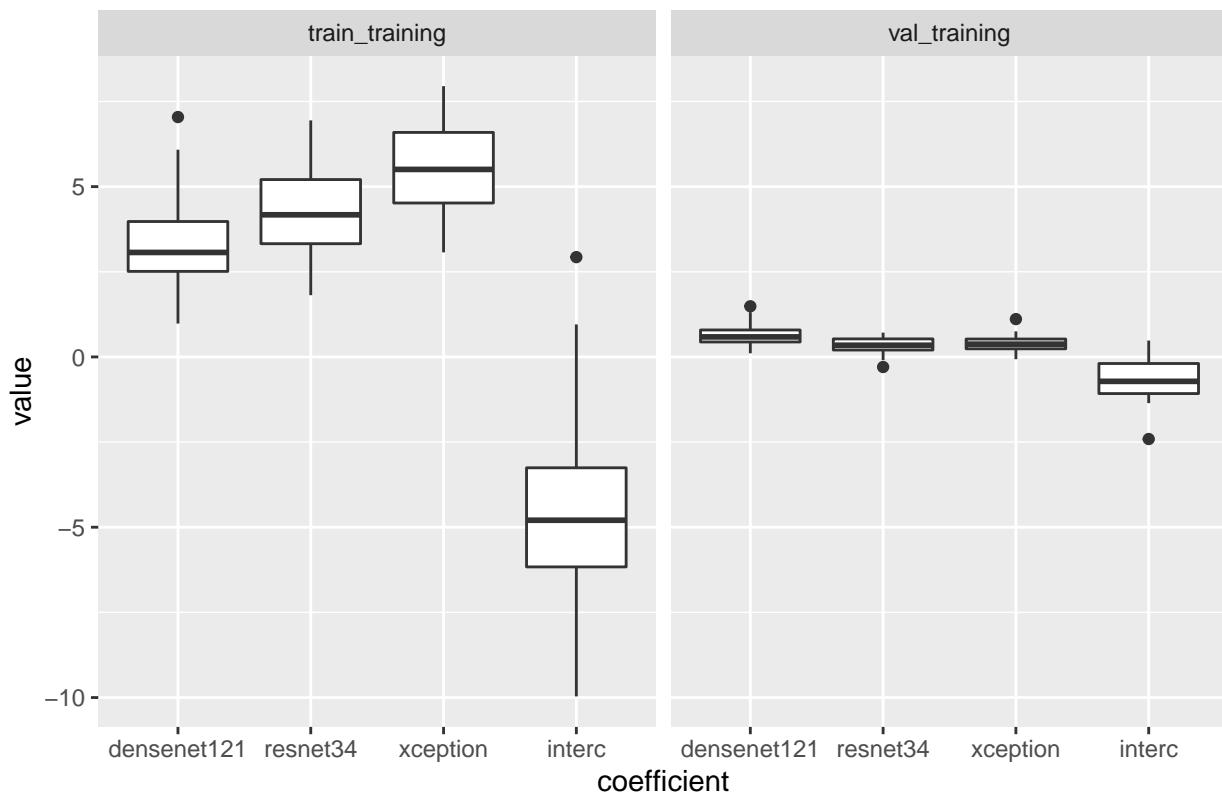
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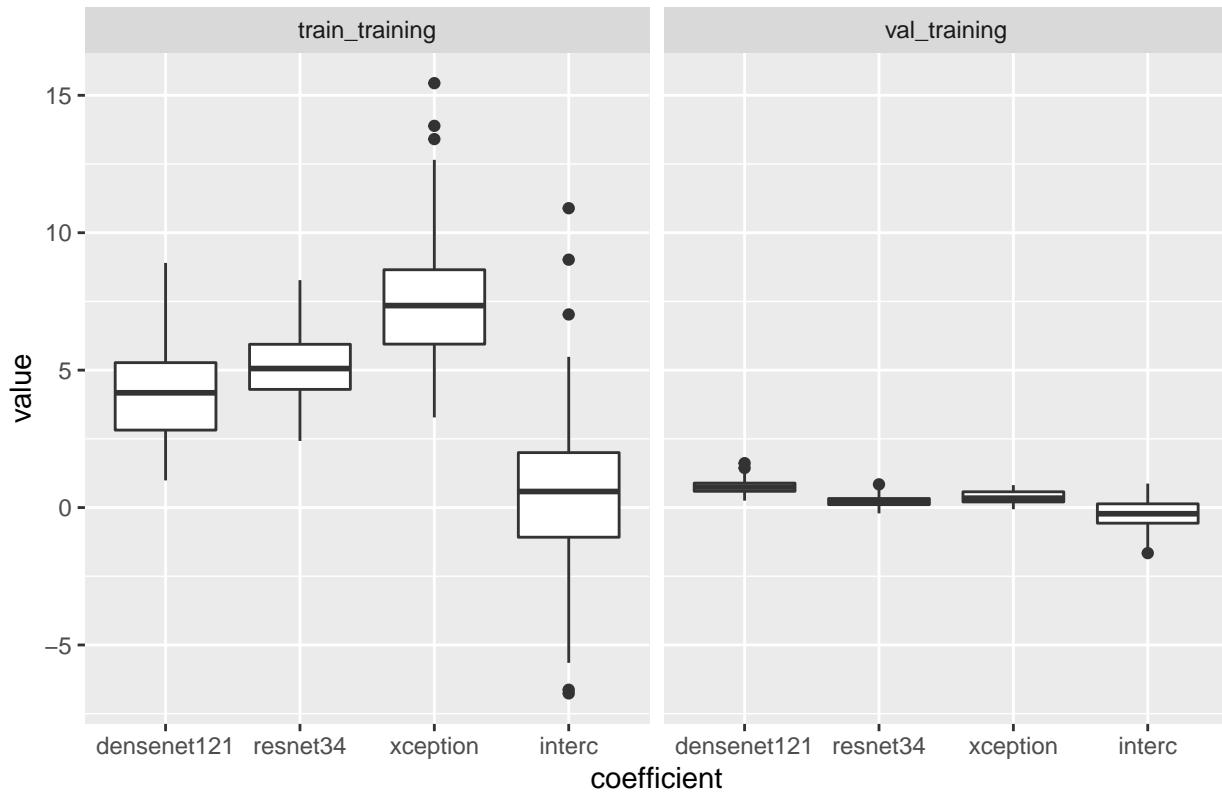
Coefficients for class 6 vs 13



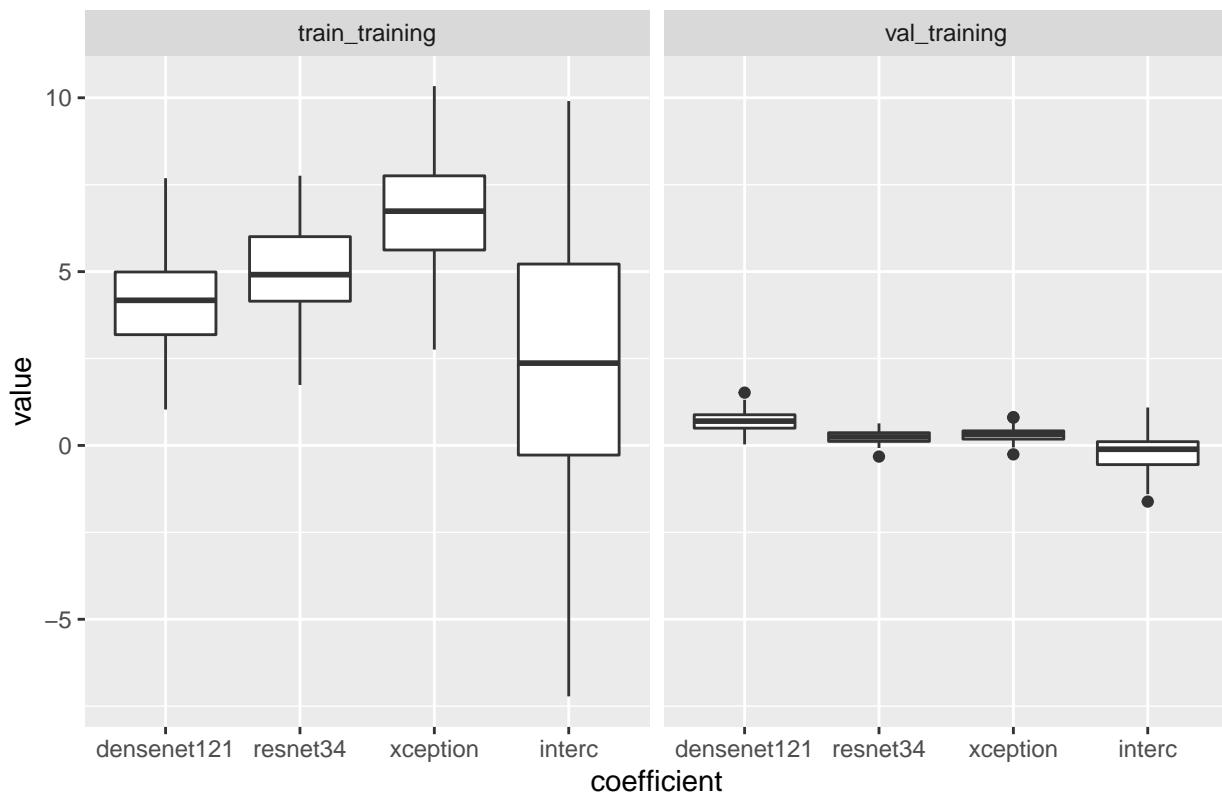
Coefficients for class 6 vs 14



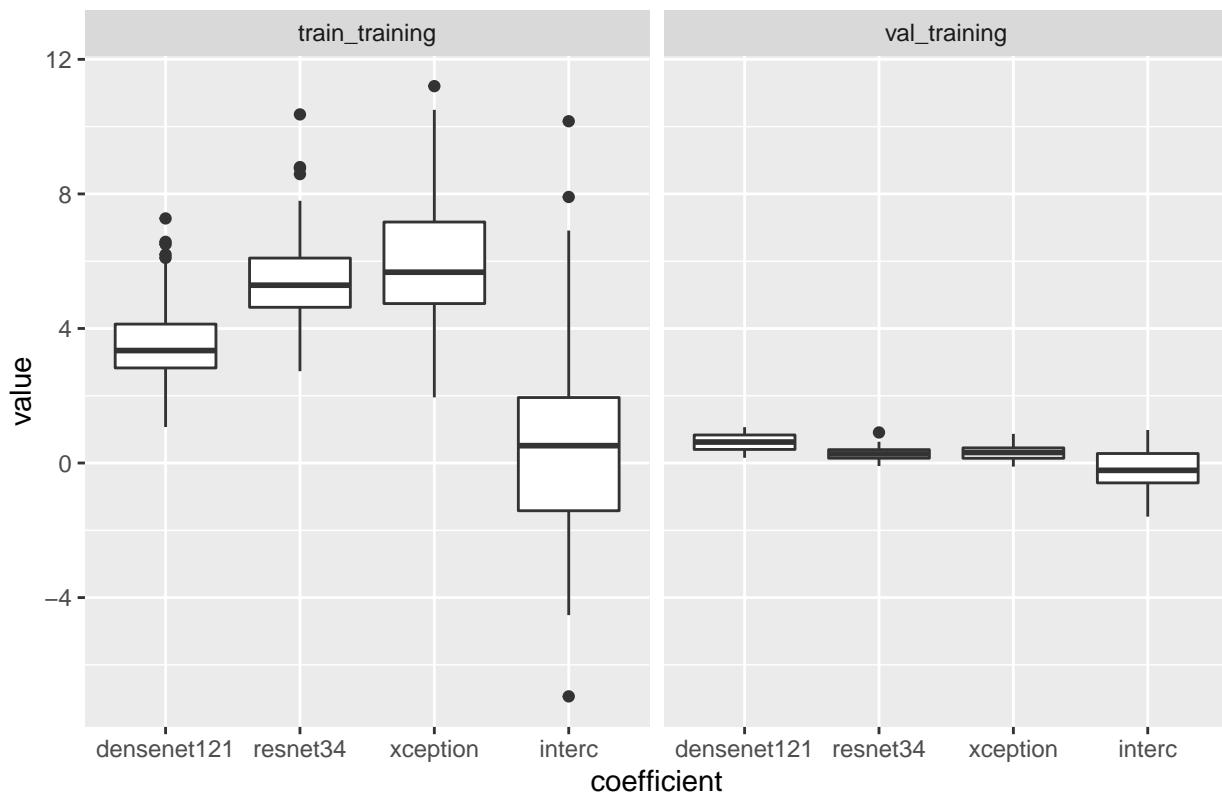
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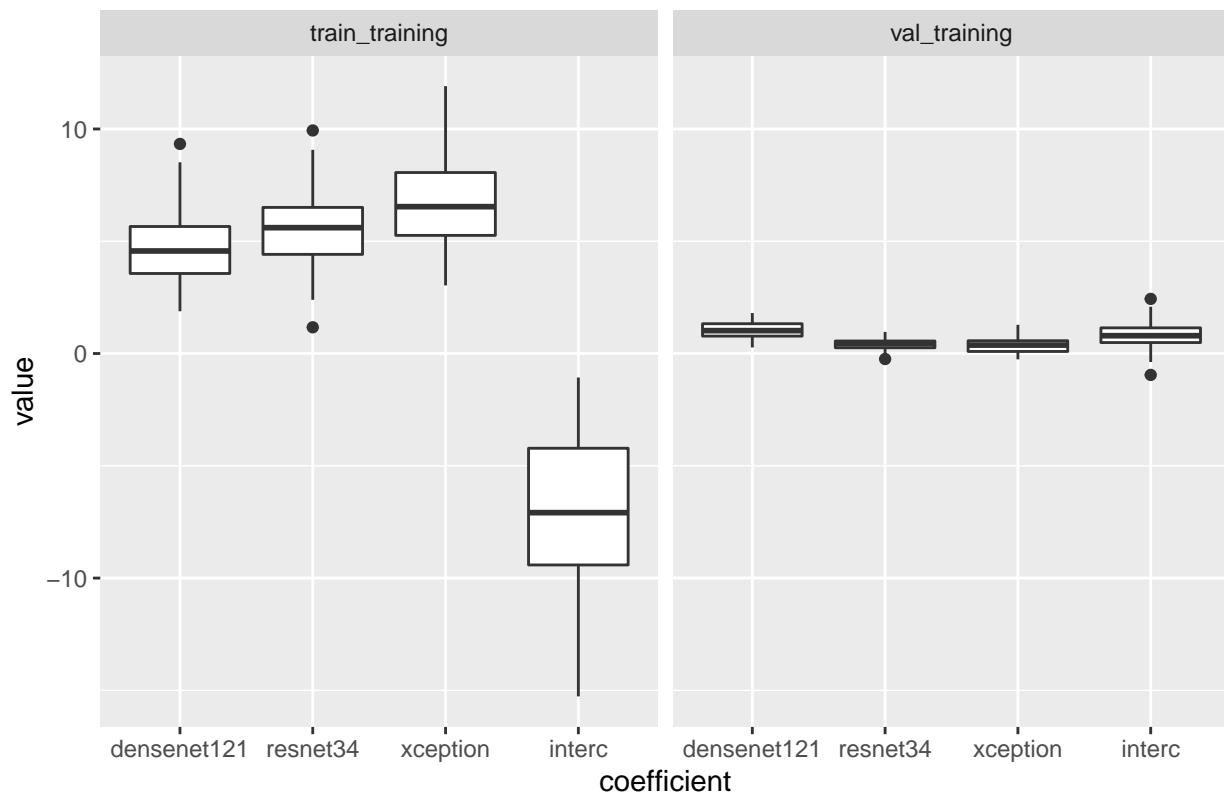
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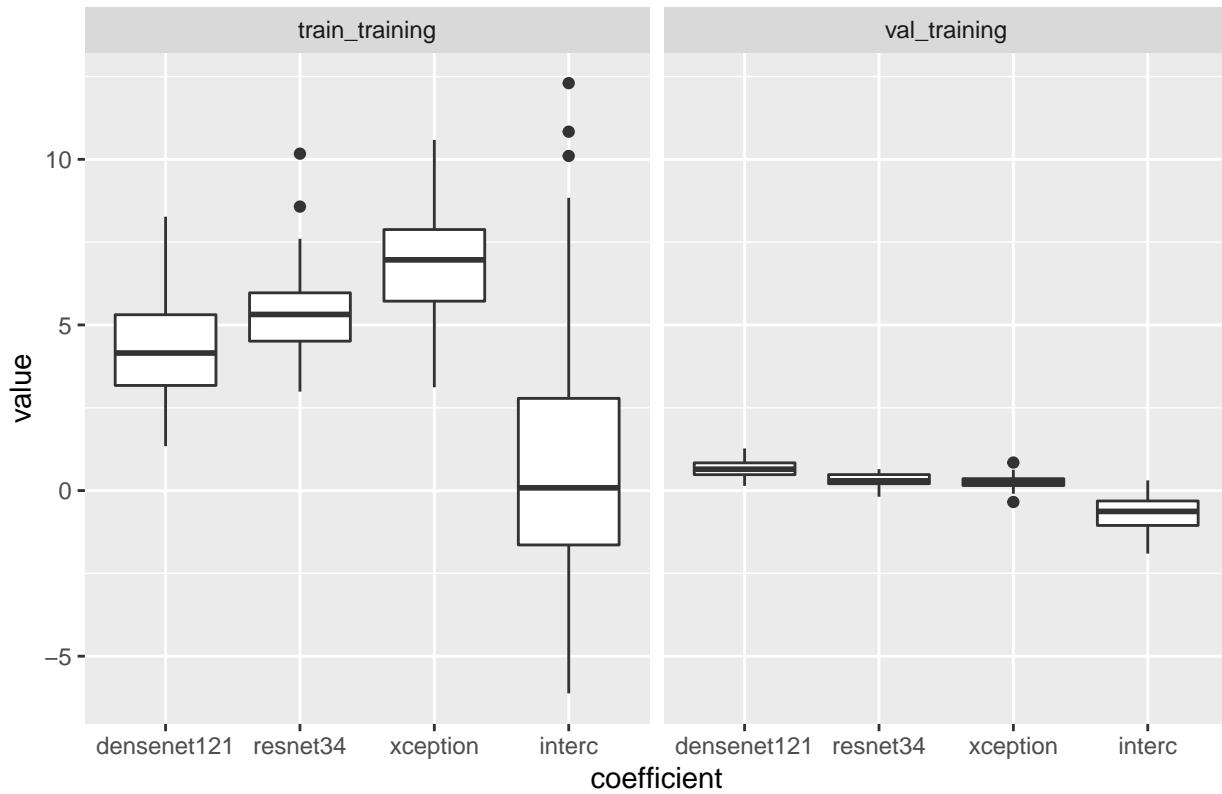
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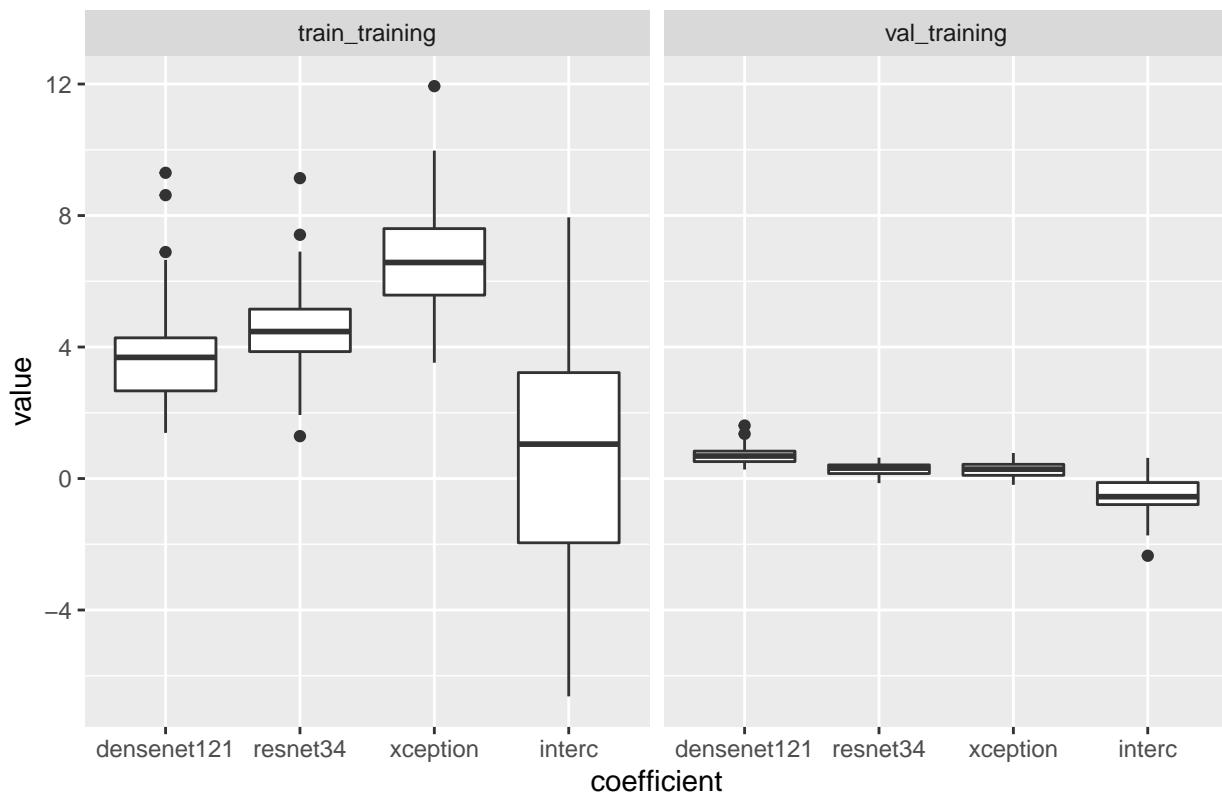
Coefficients for class 6 vs 18



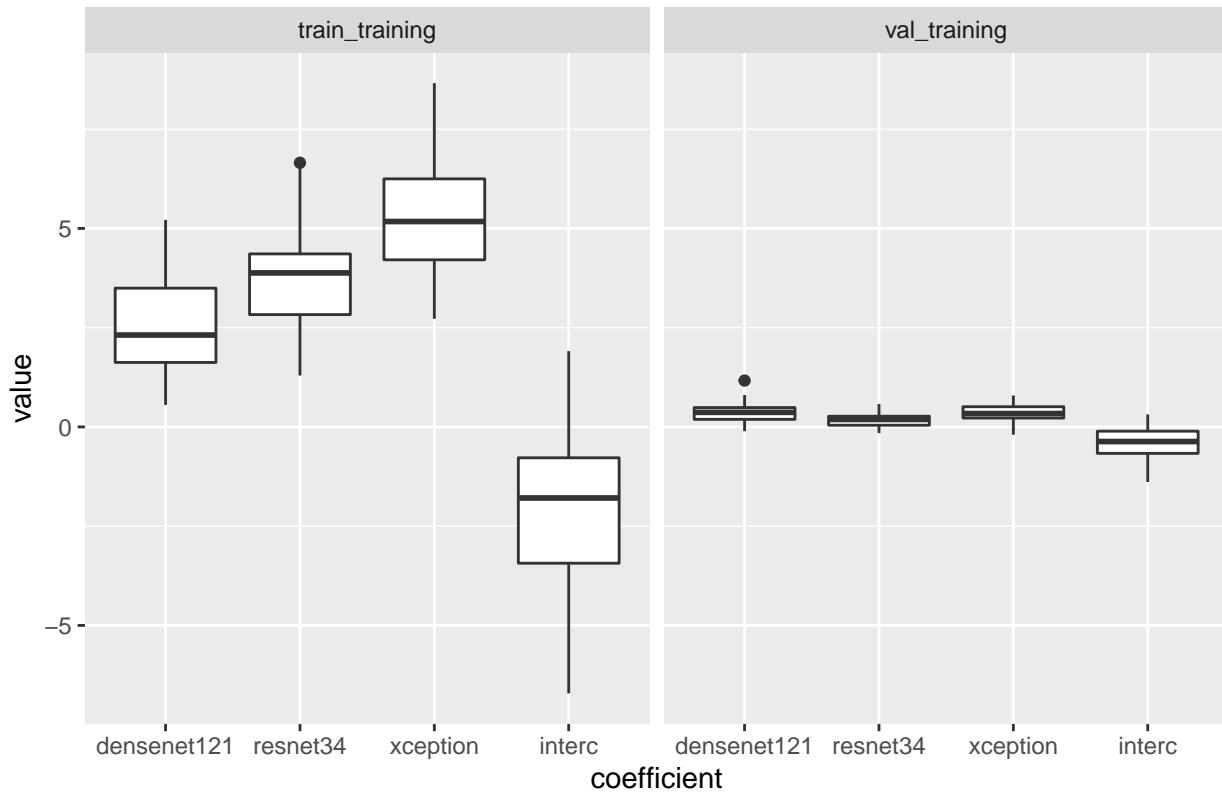
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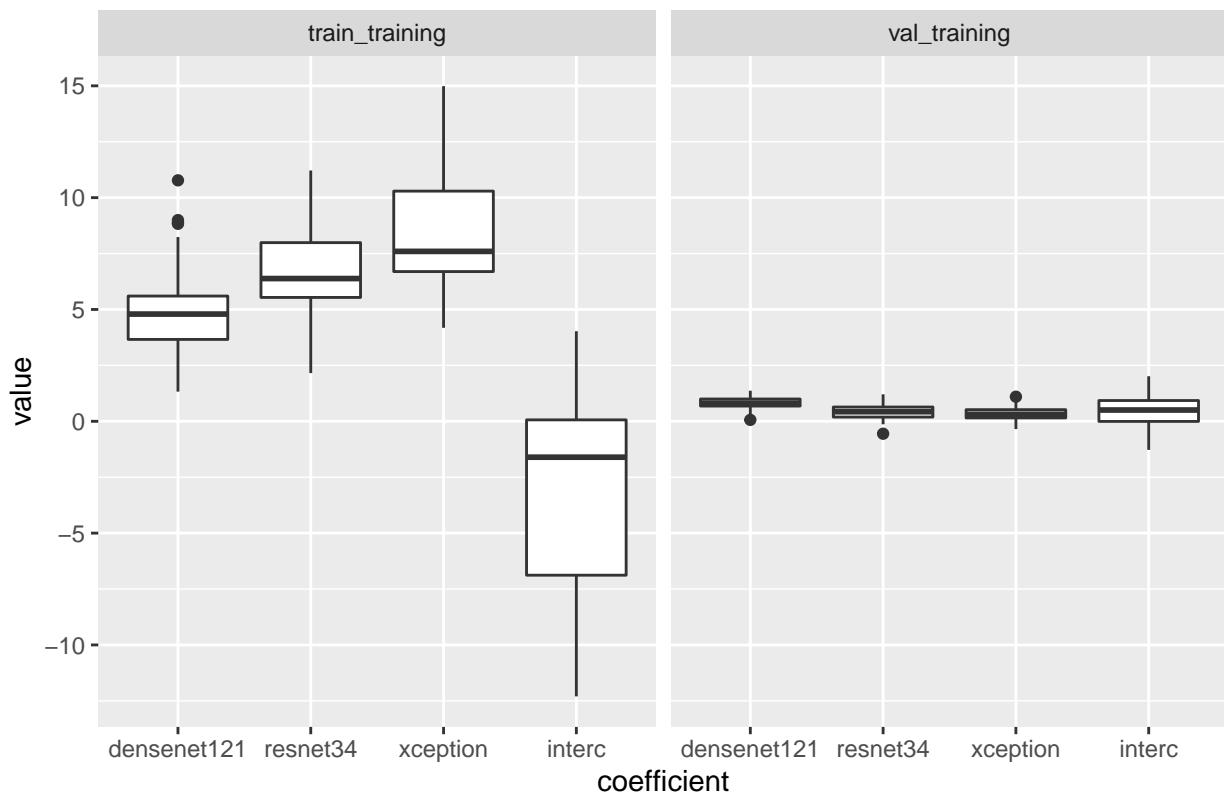
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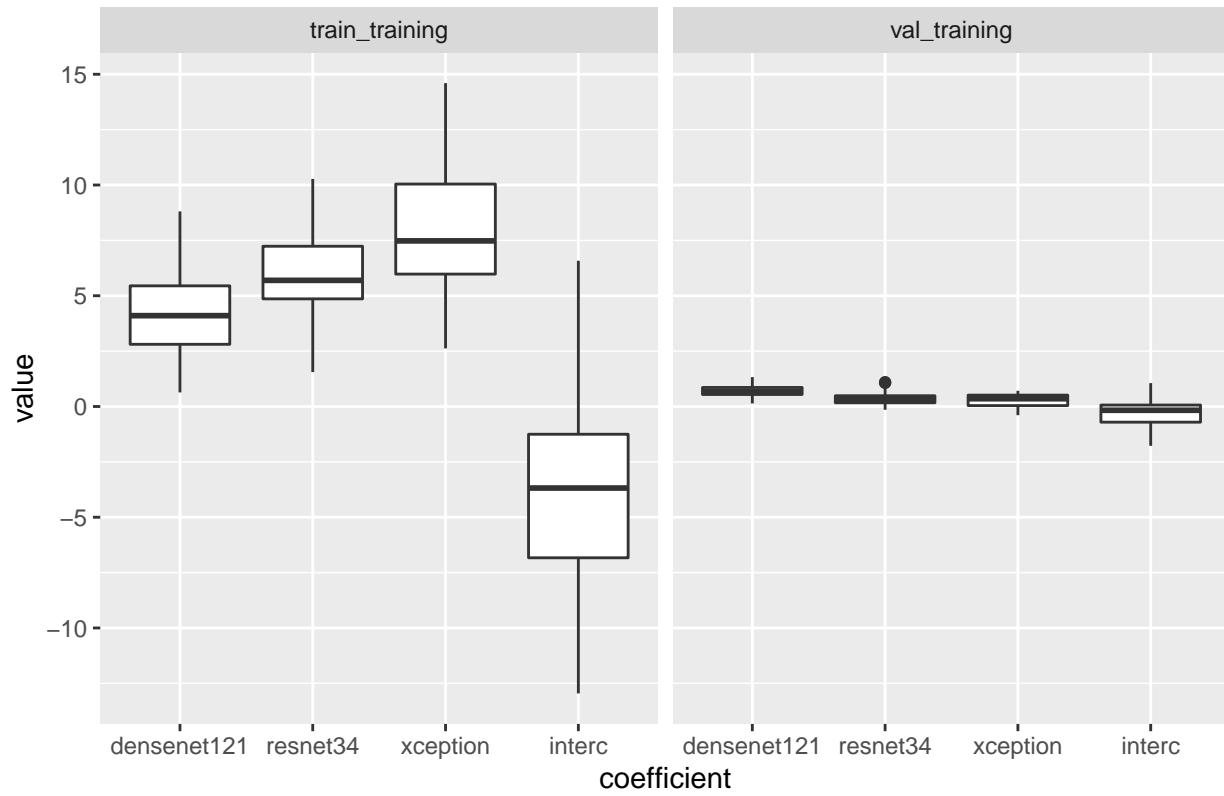
Coefficients for class 7 vs 8



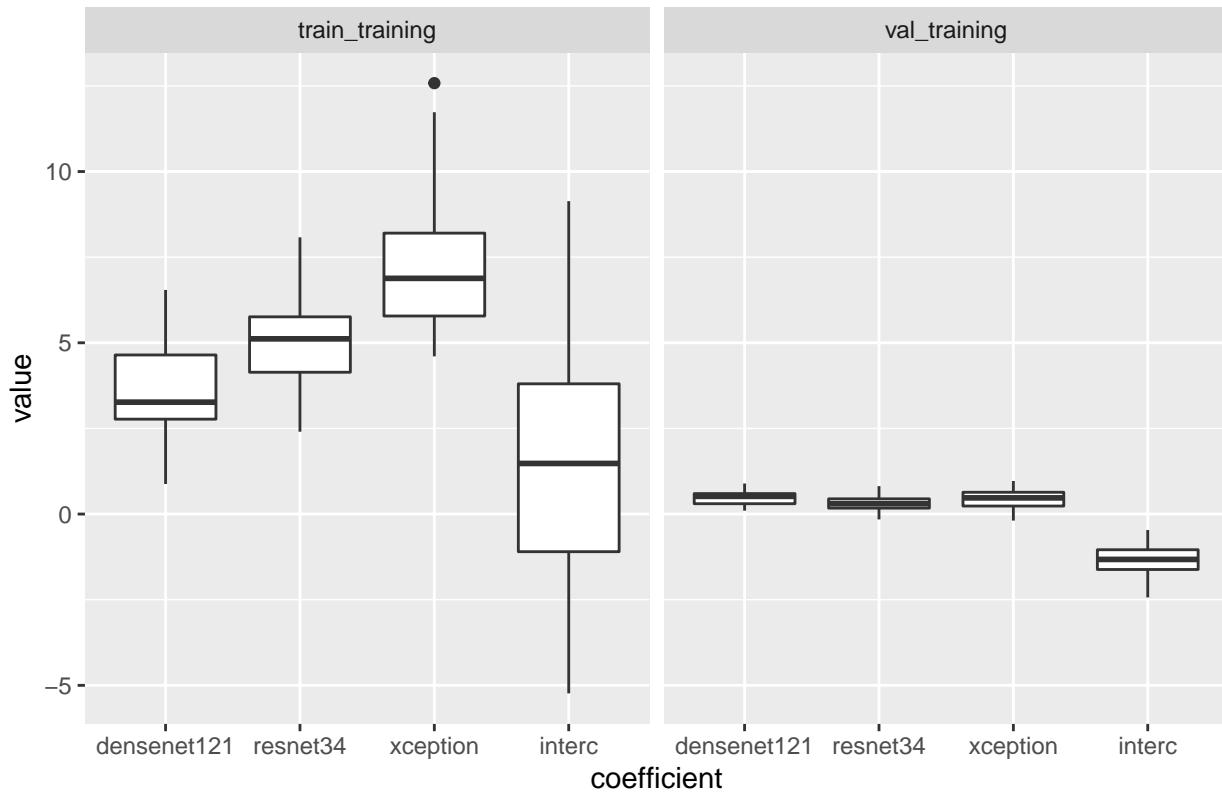
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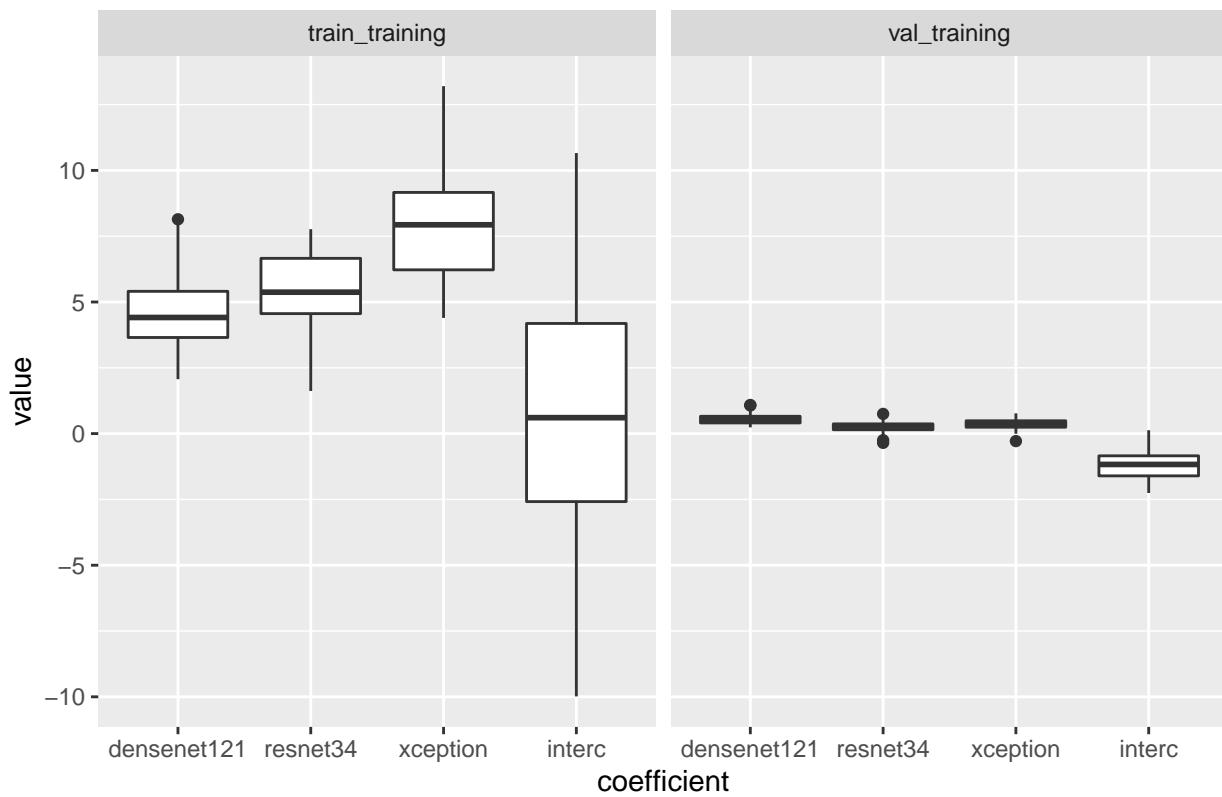
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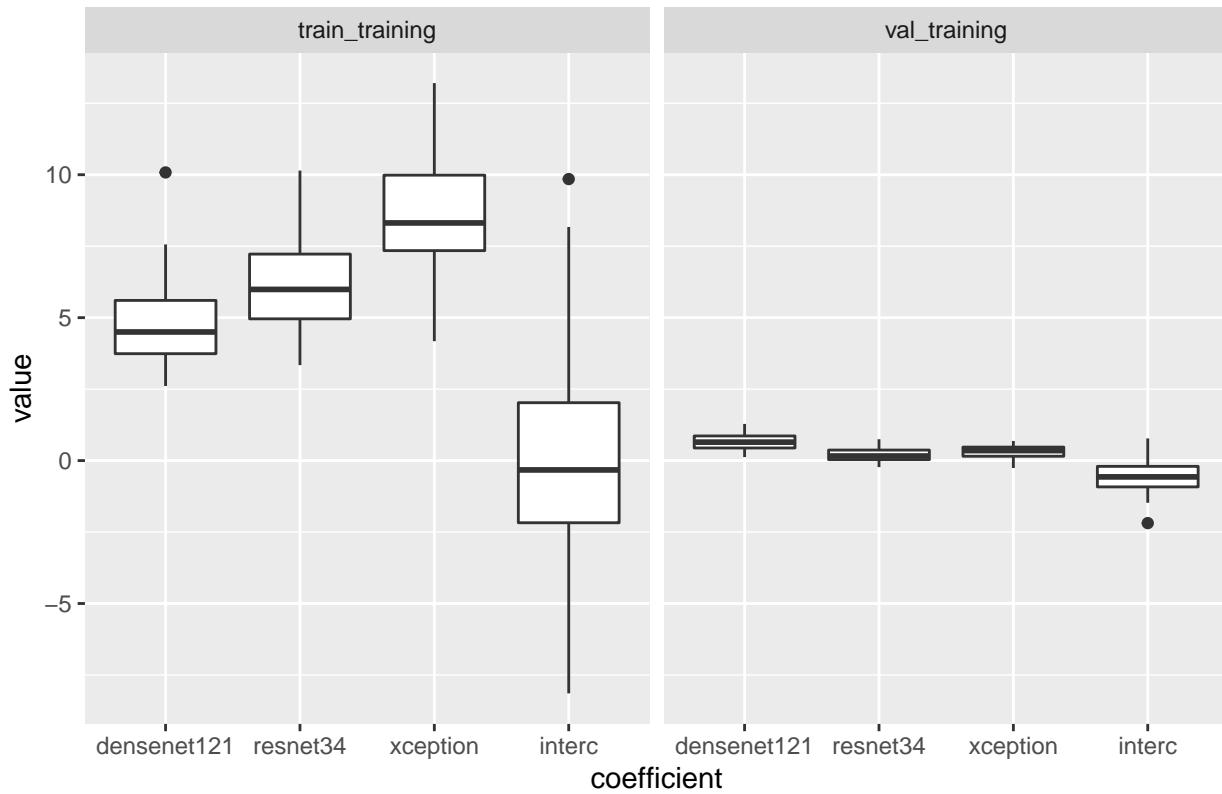
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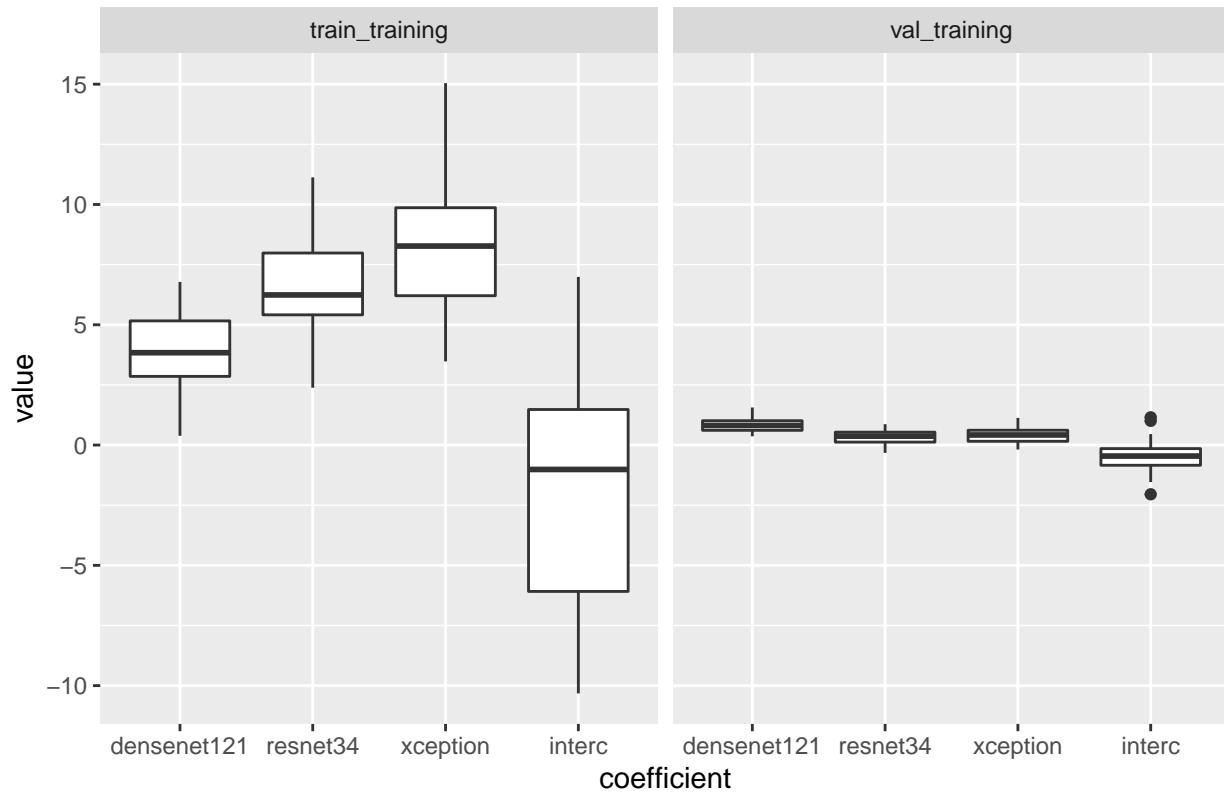
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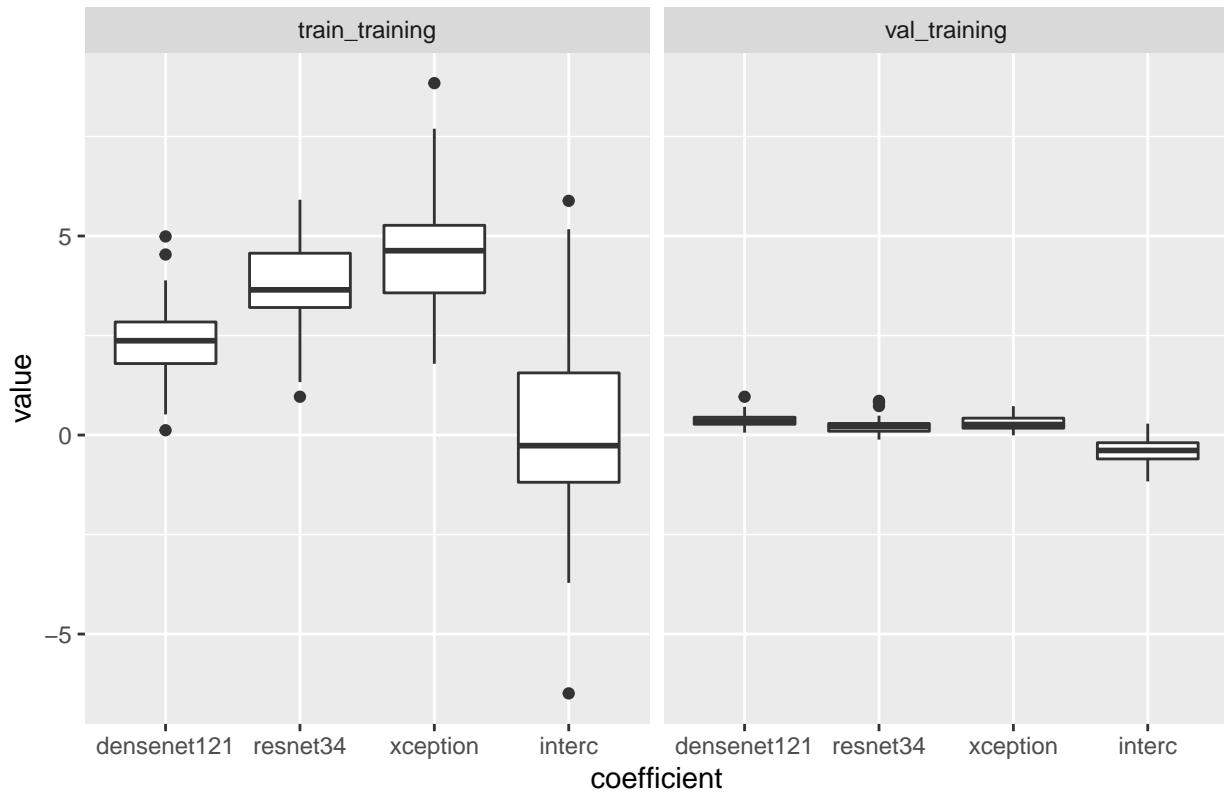
Coefficients for class 7 vs 13



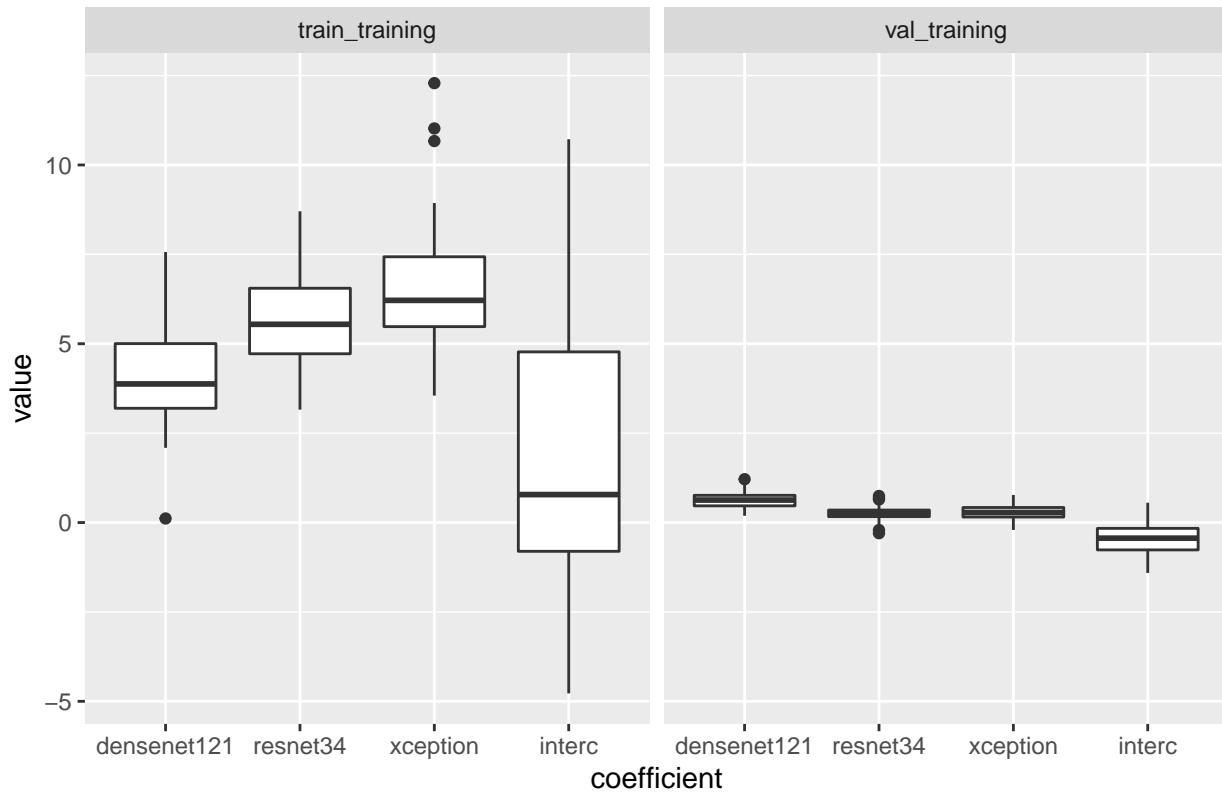
Coefficients for class 7 vs 14



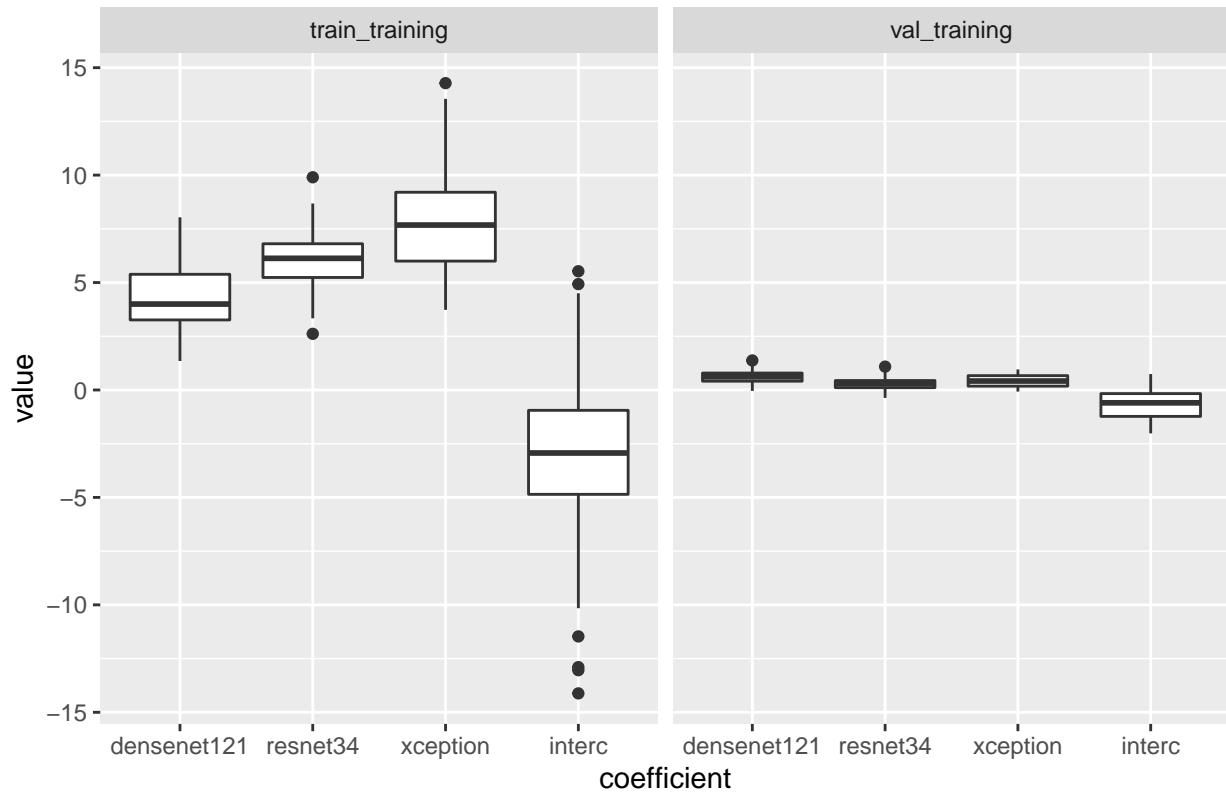
Coefficients for class 7 vs 15



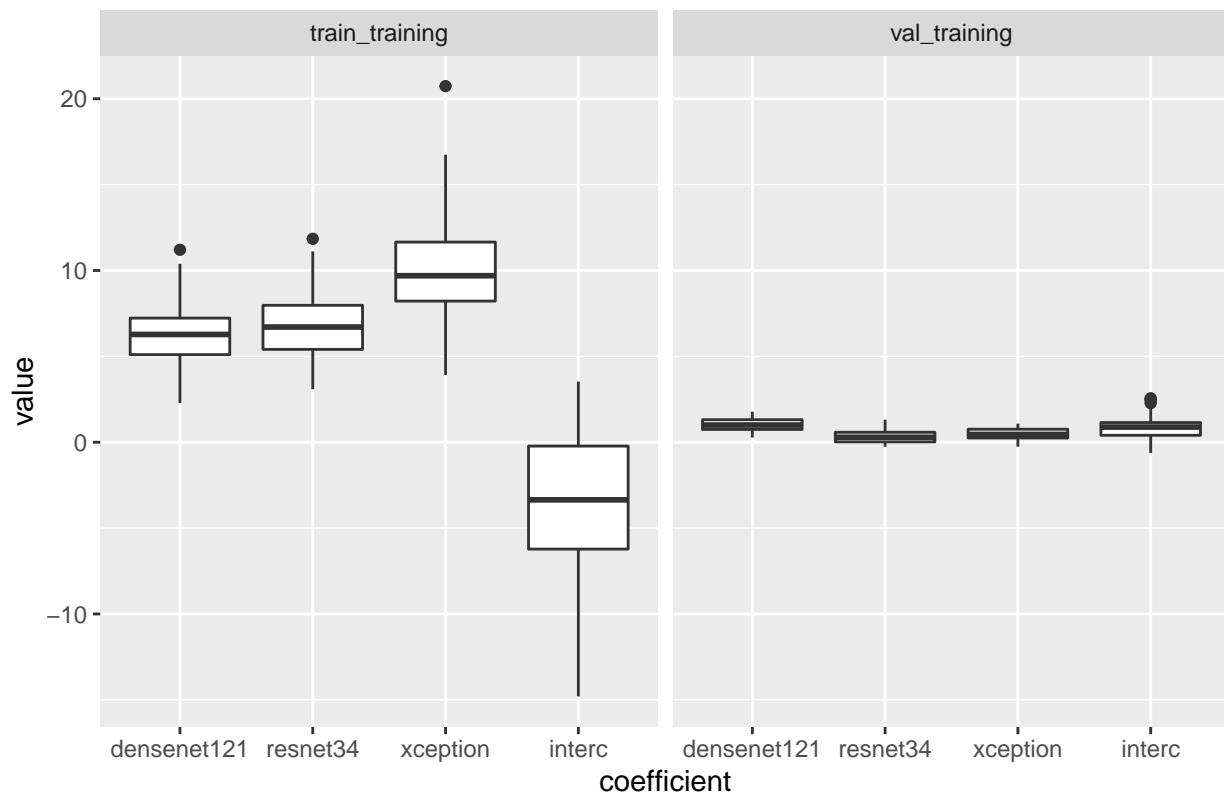
Coefficients for class 7 vs 16



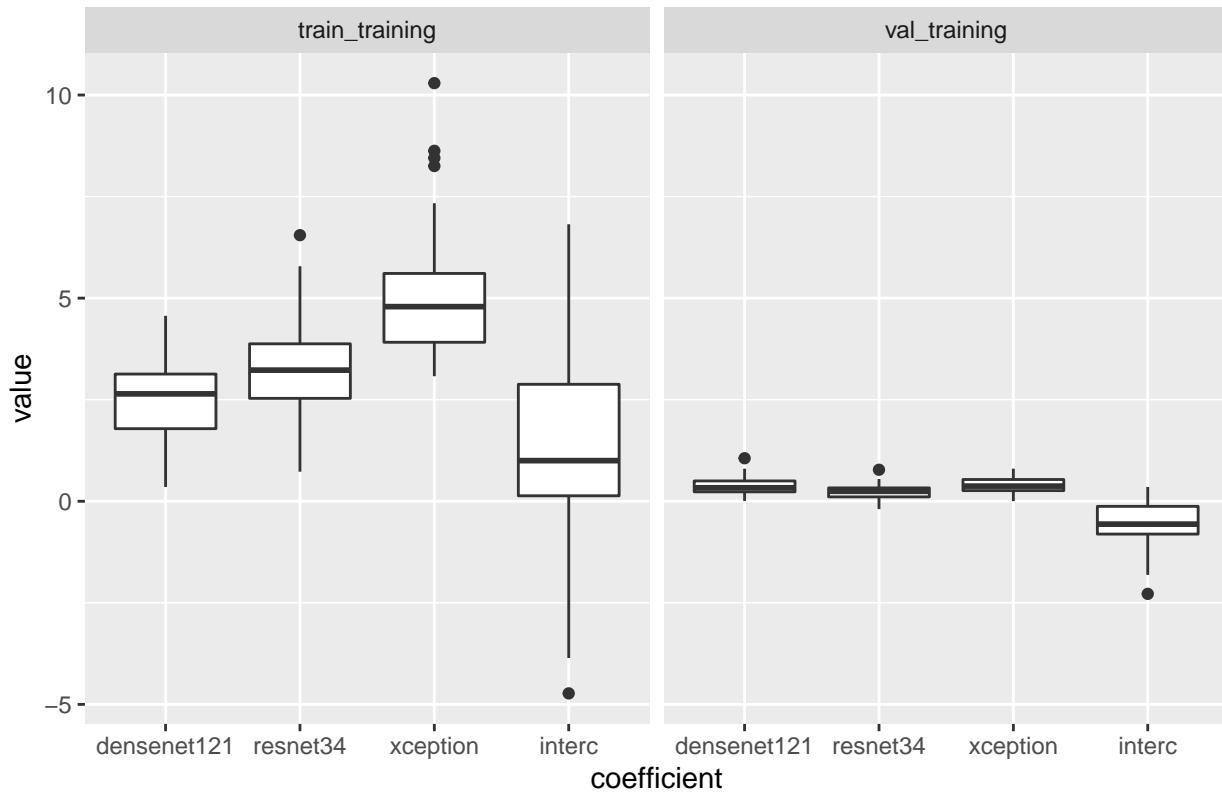
Coefficients for class 7 vs 17



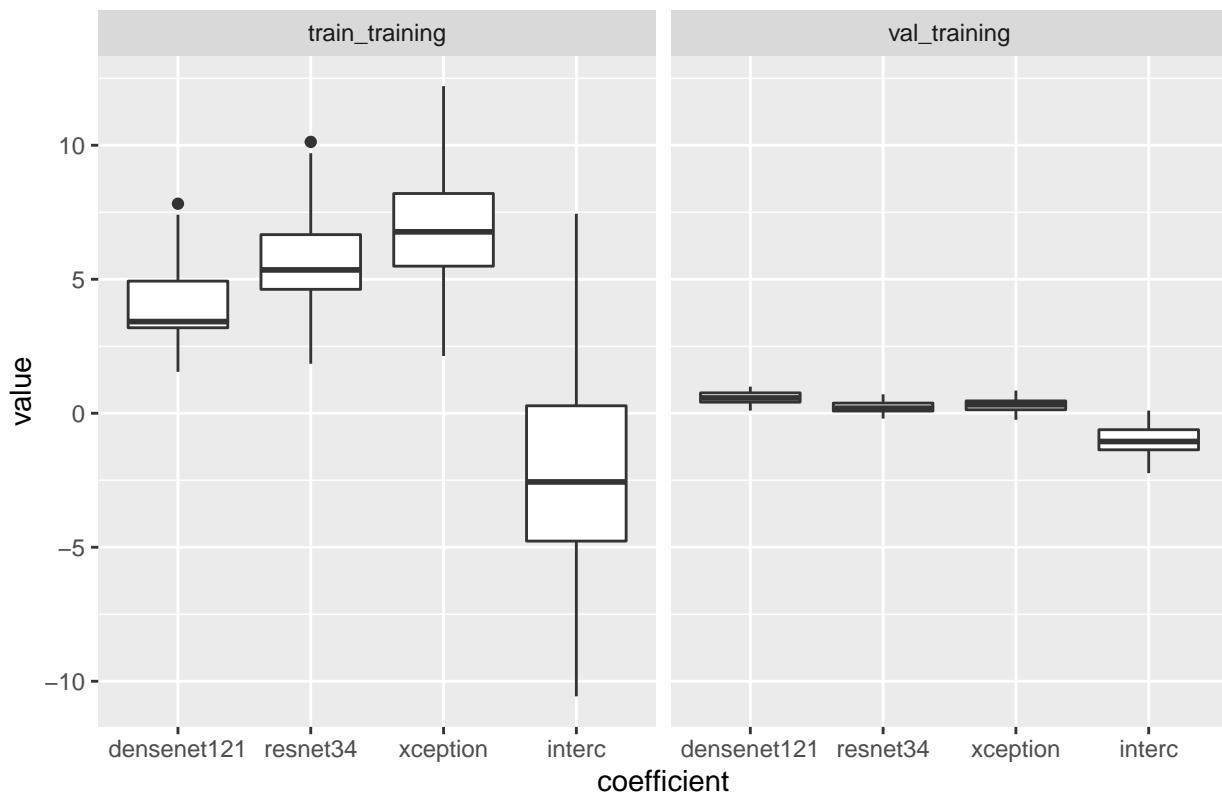
Coefficients for class 7 vs 18



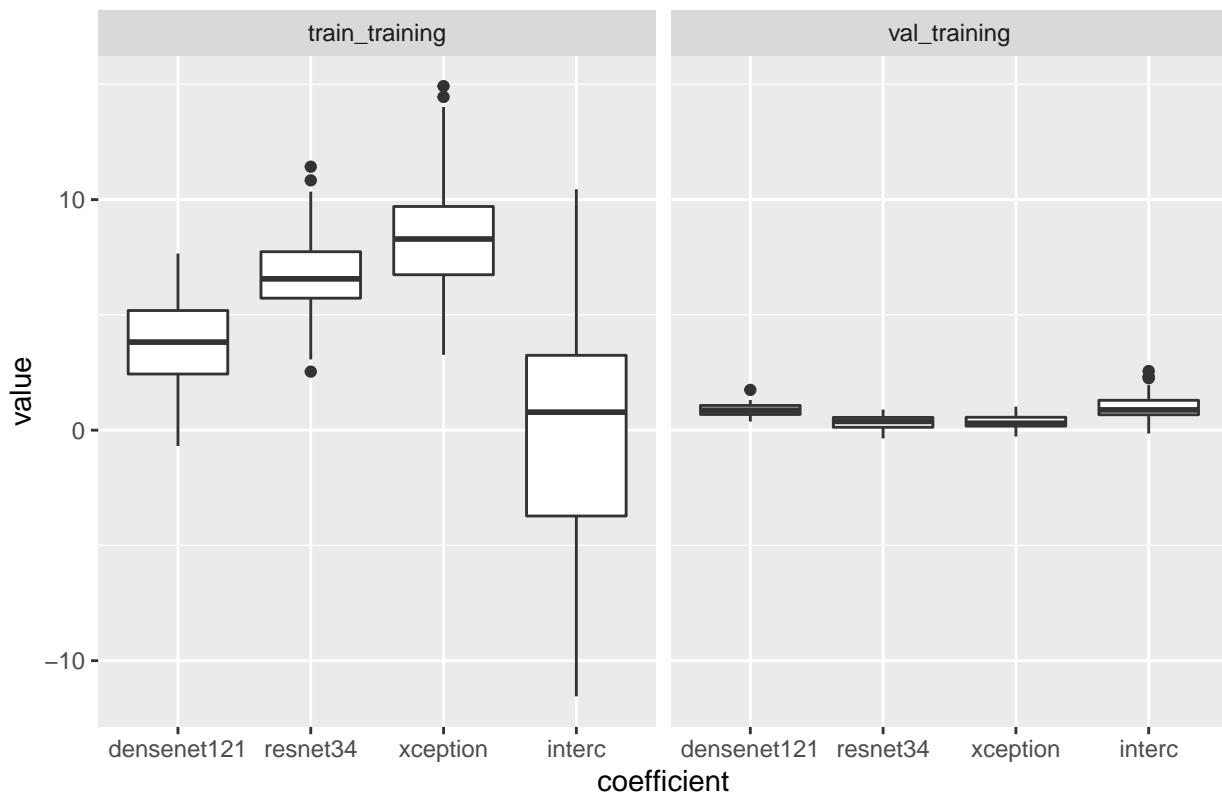
Coefficients for class 7 vs 19



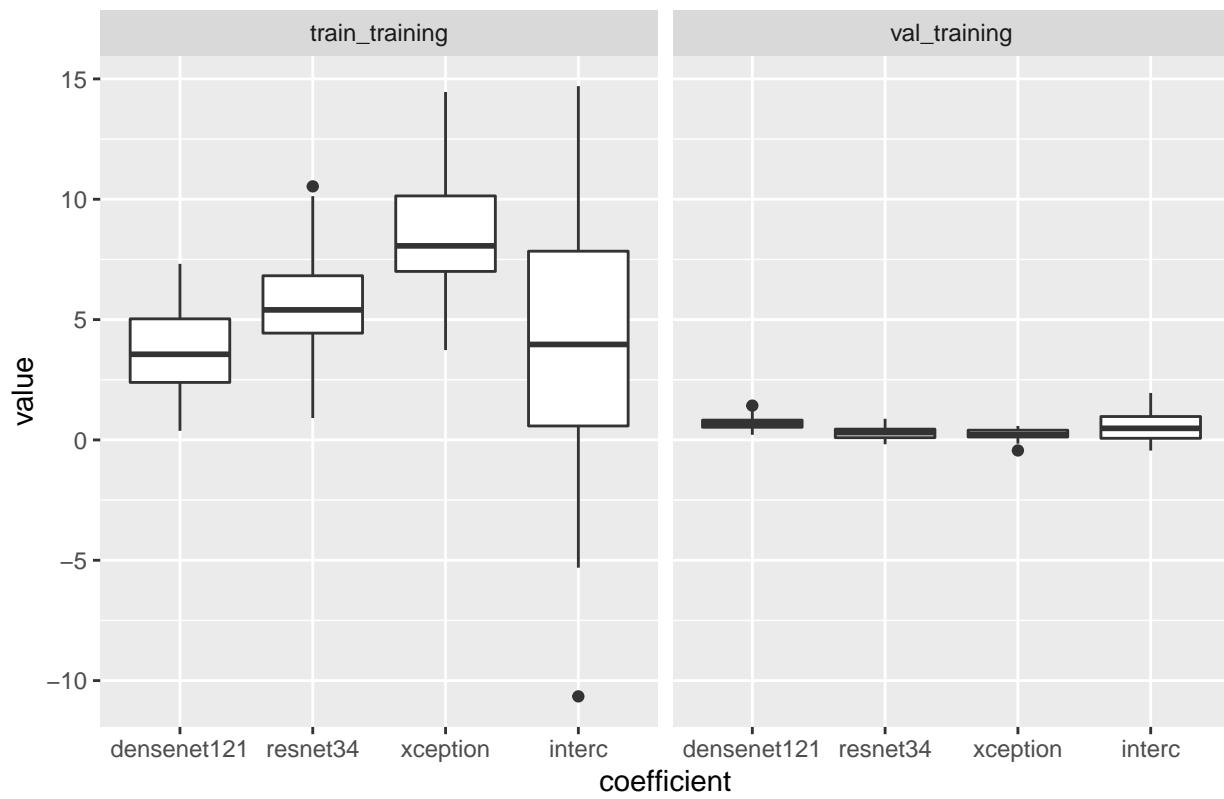
Coefficients for class 7 vs 20



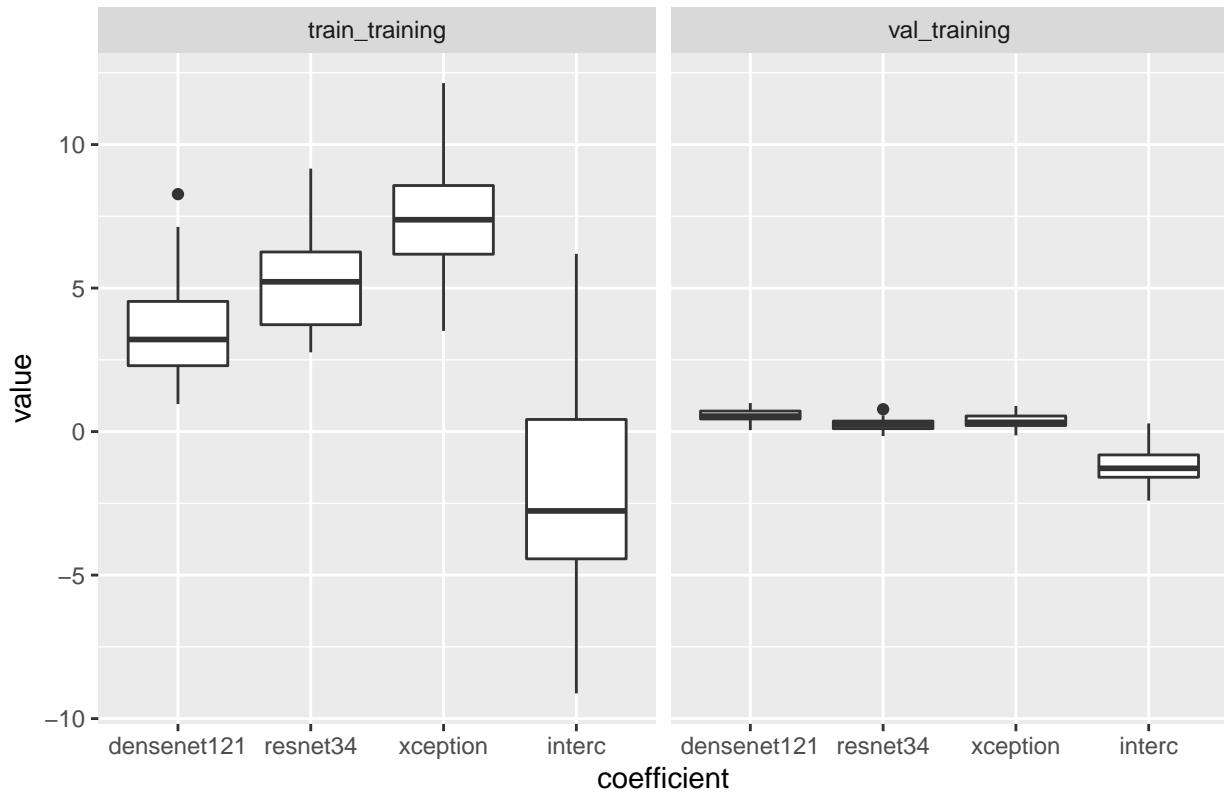
Coefficients for class 8 vs 9



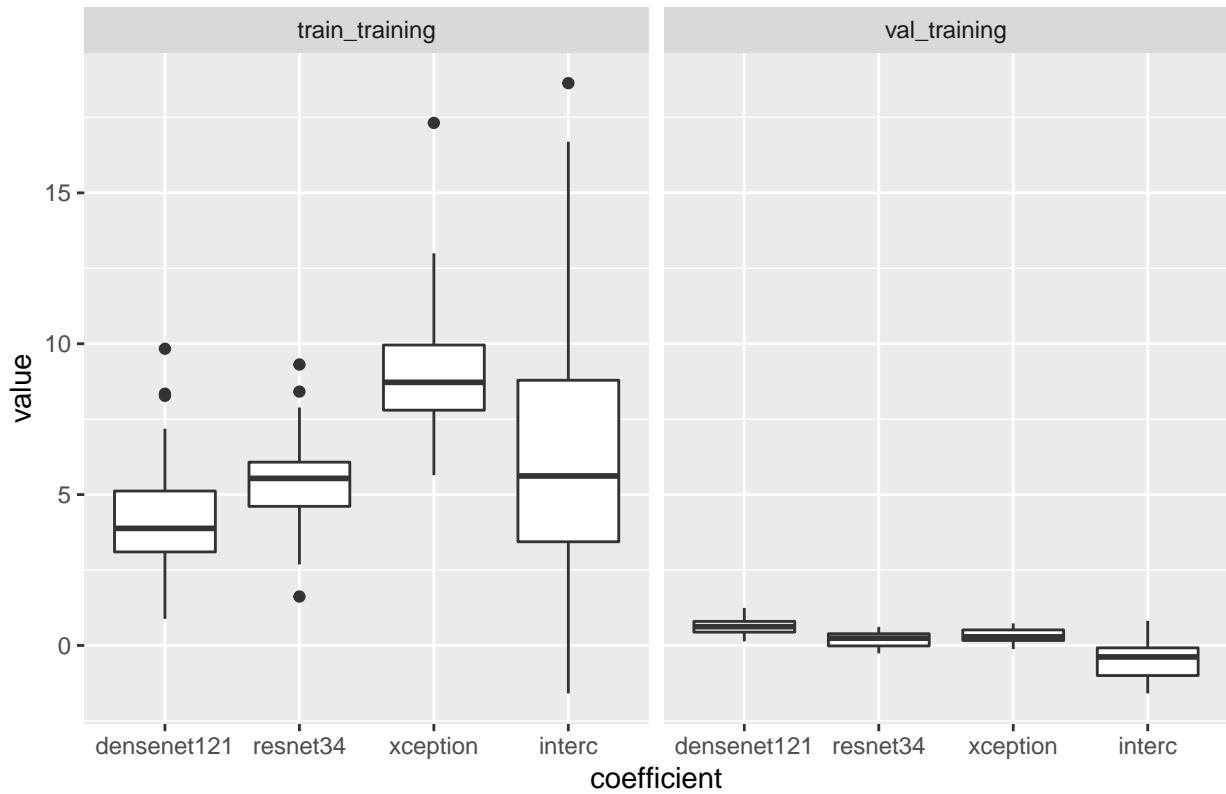
Coefficients for class 8 vs 10



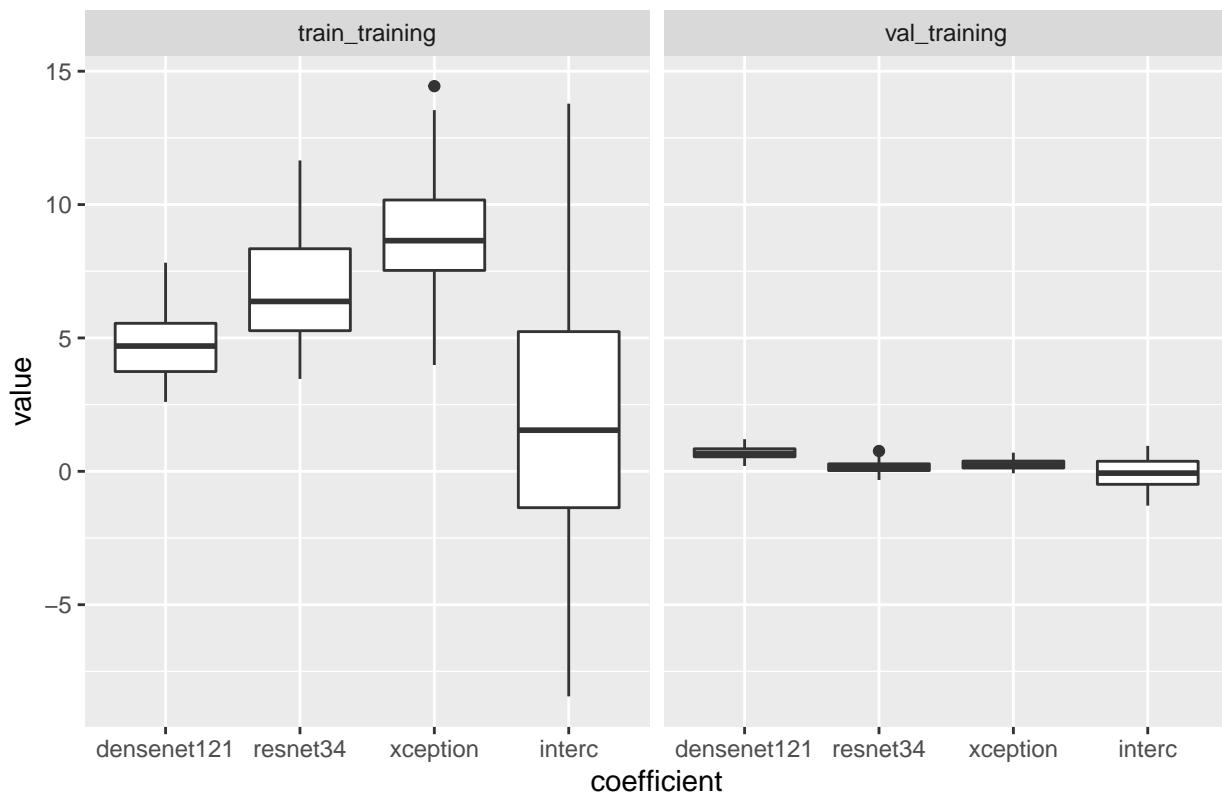
Coefficients for class 8 vs 11



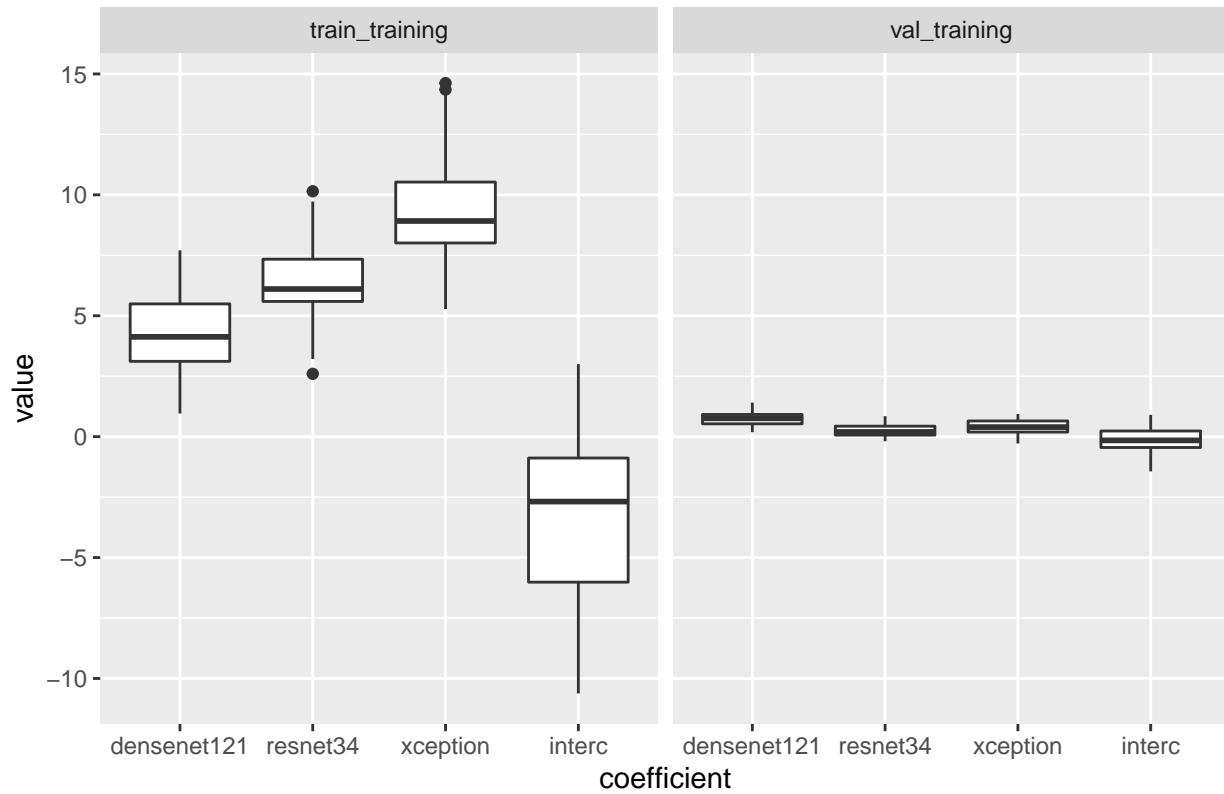
Coefficients for class 8 vs 12



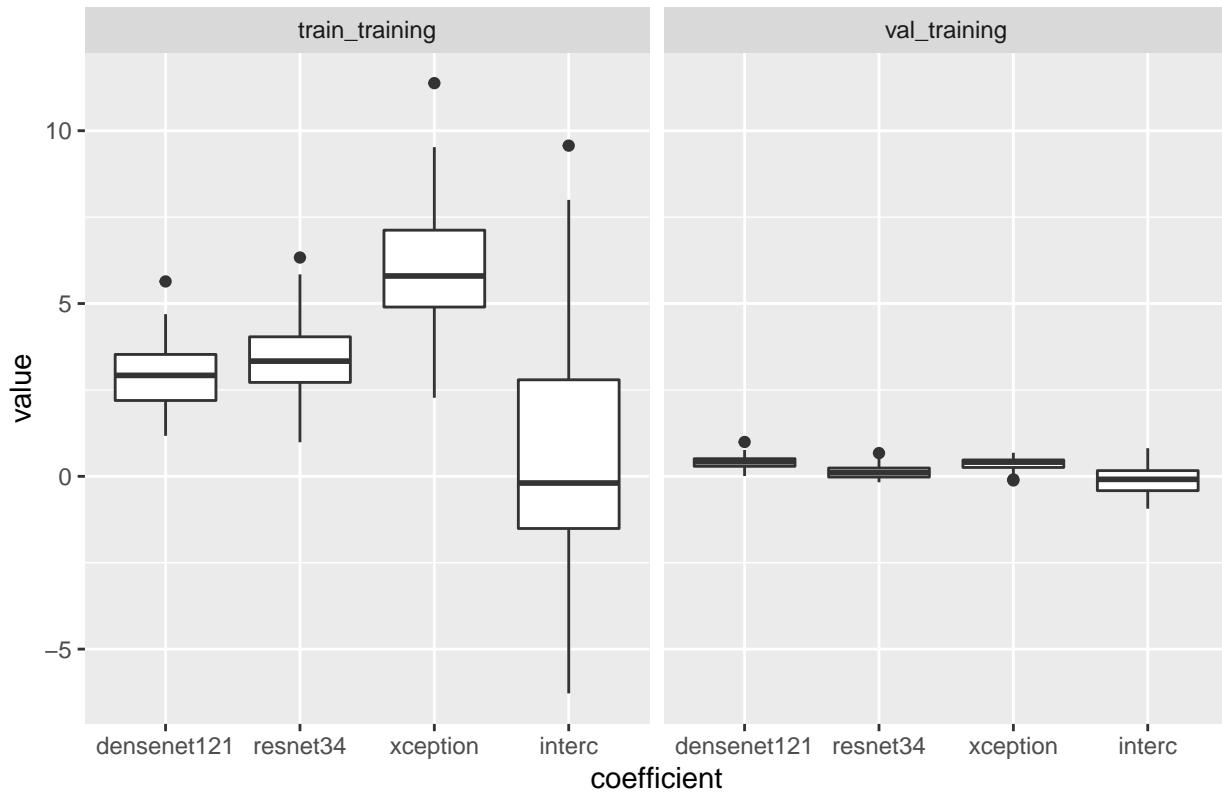
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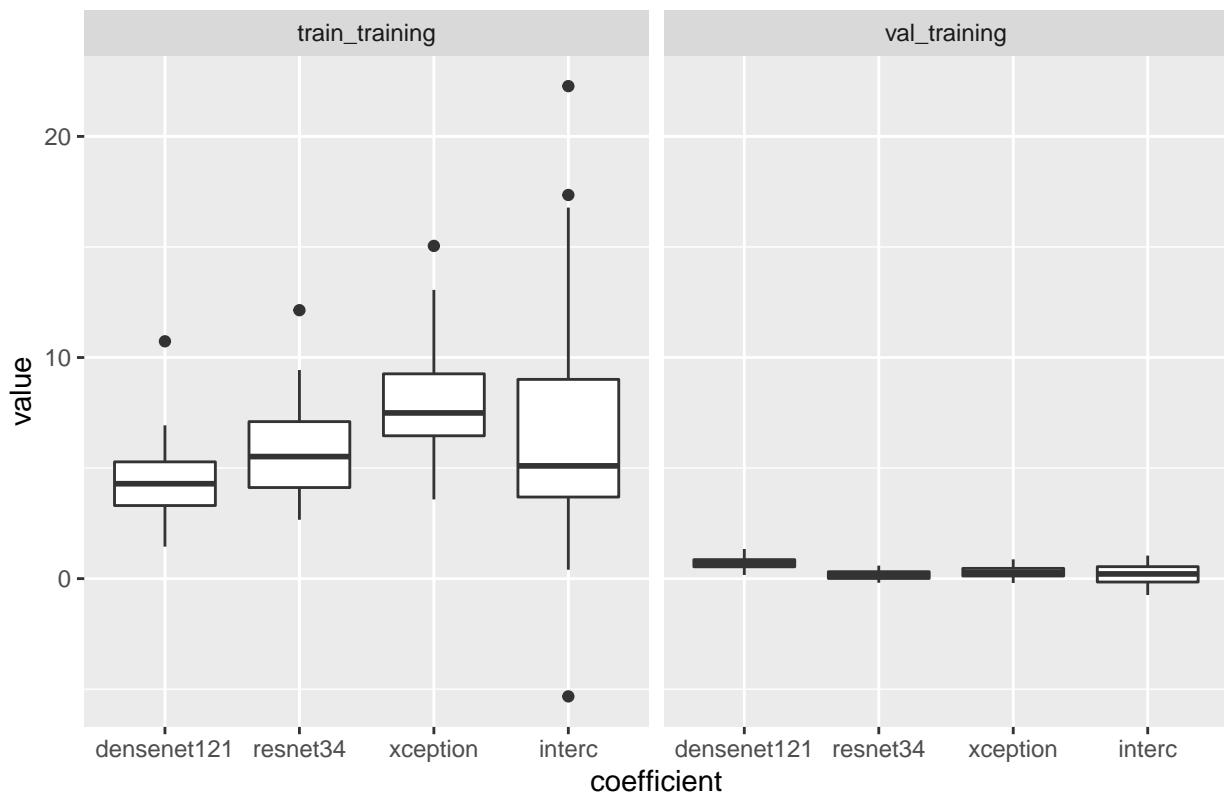
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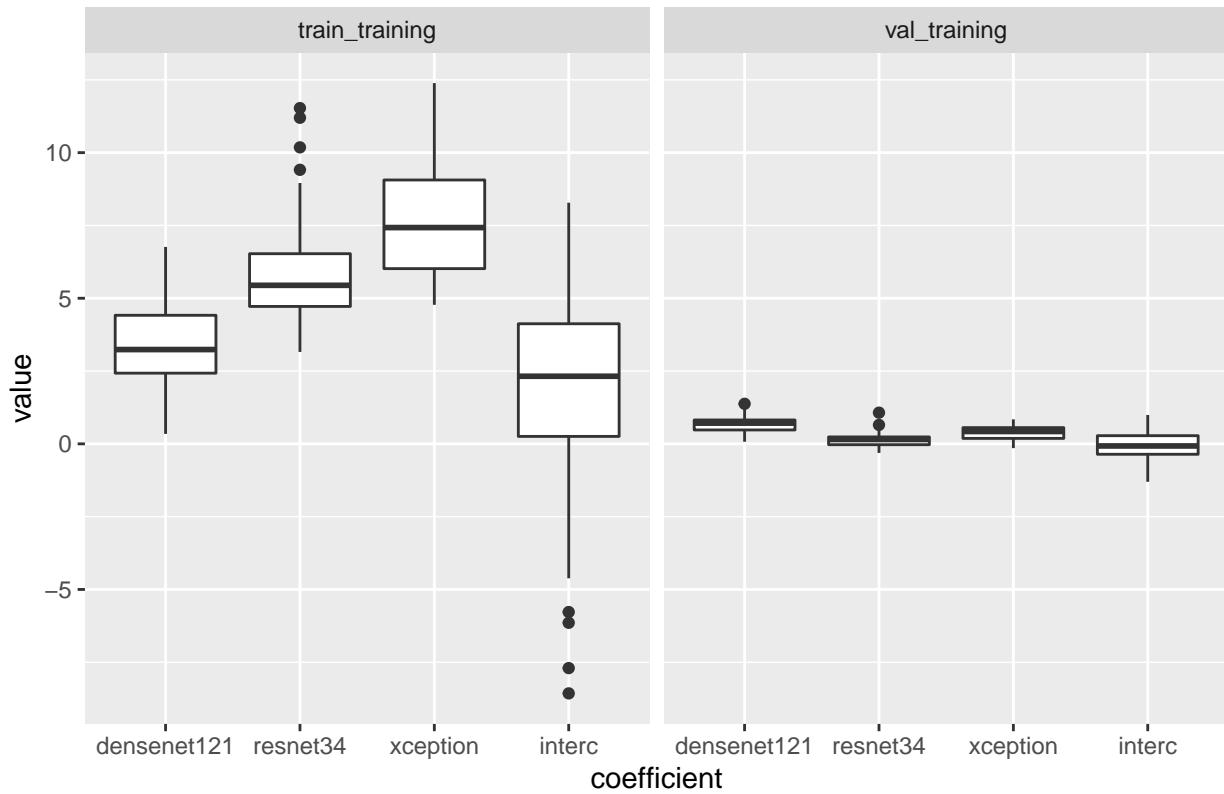
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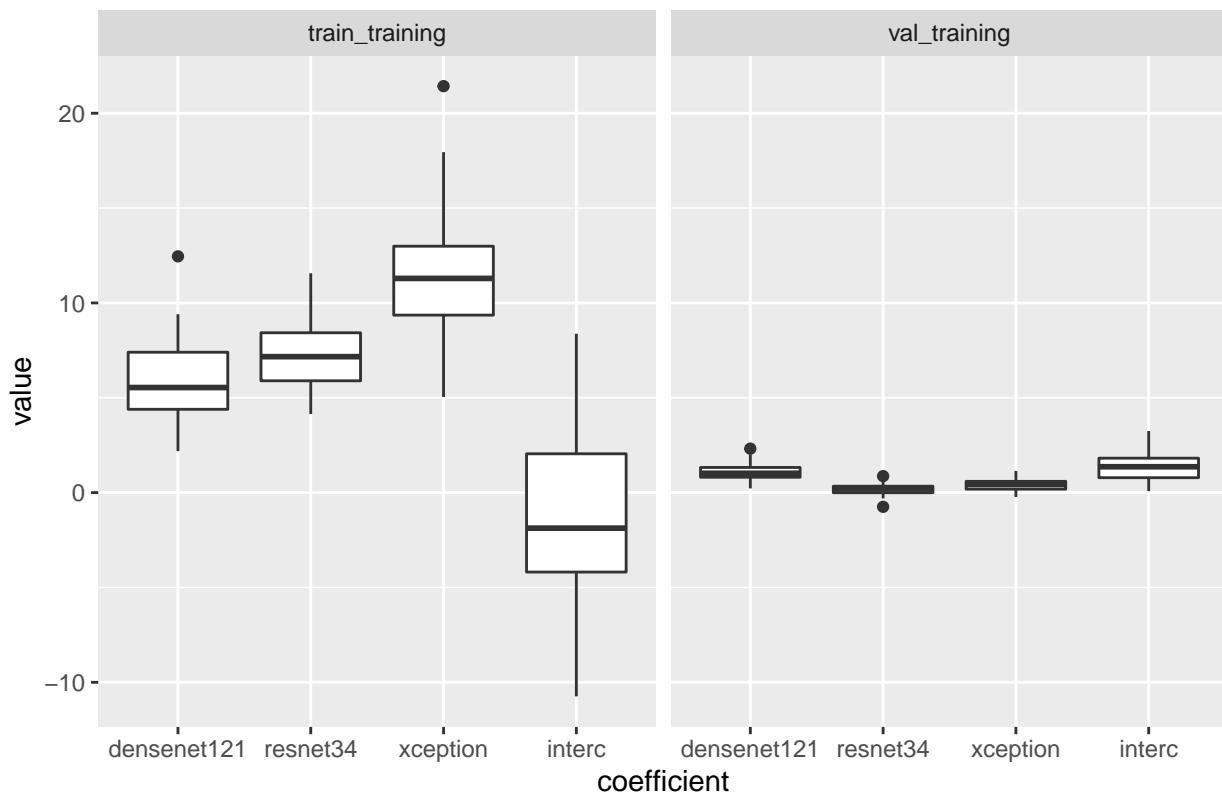
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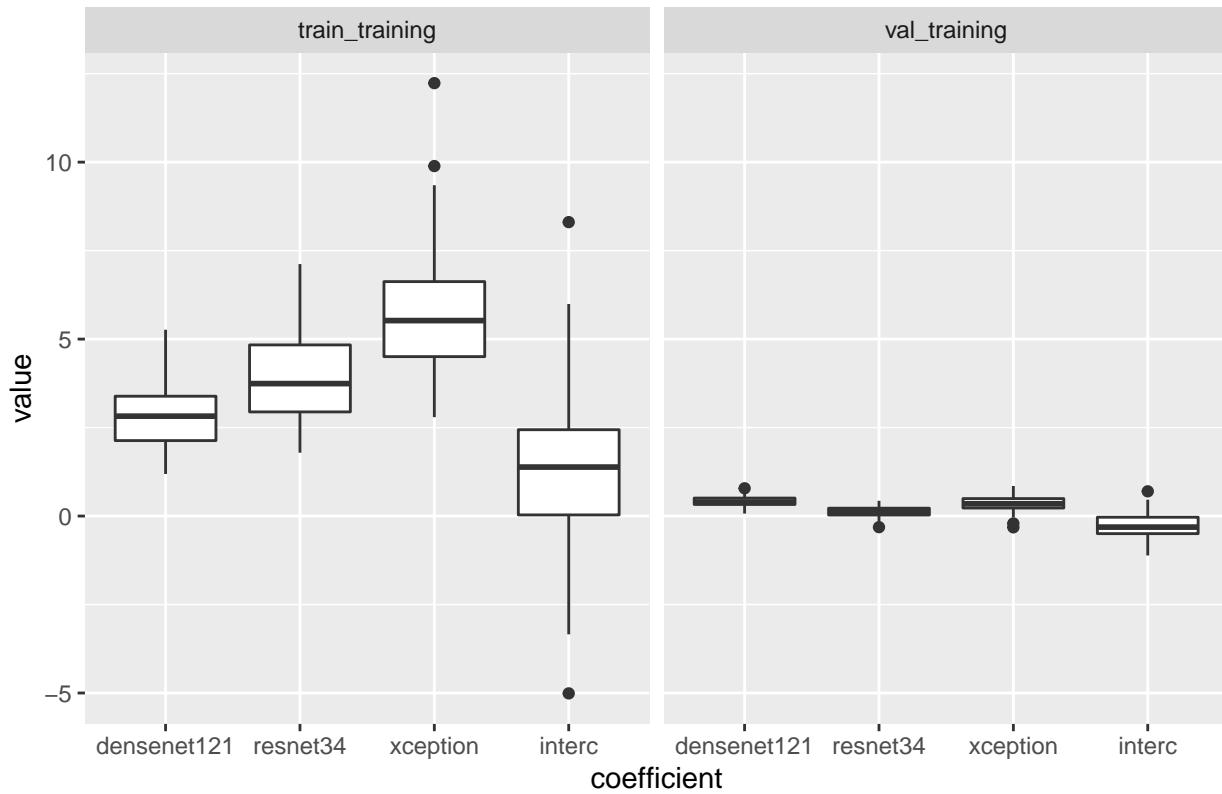
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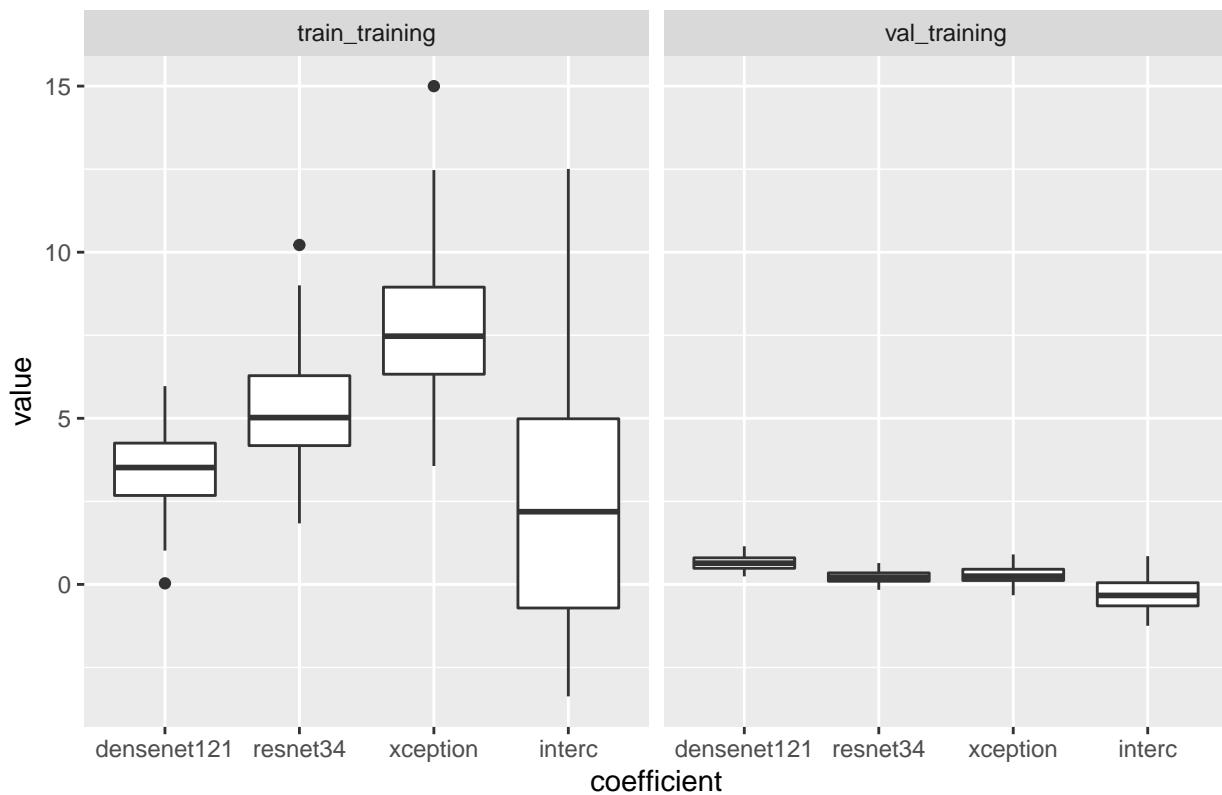
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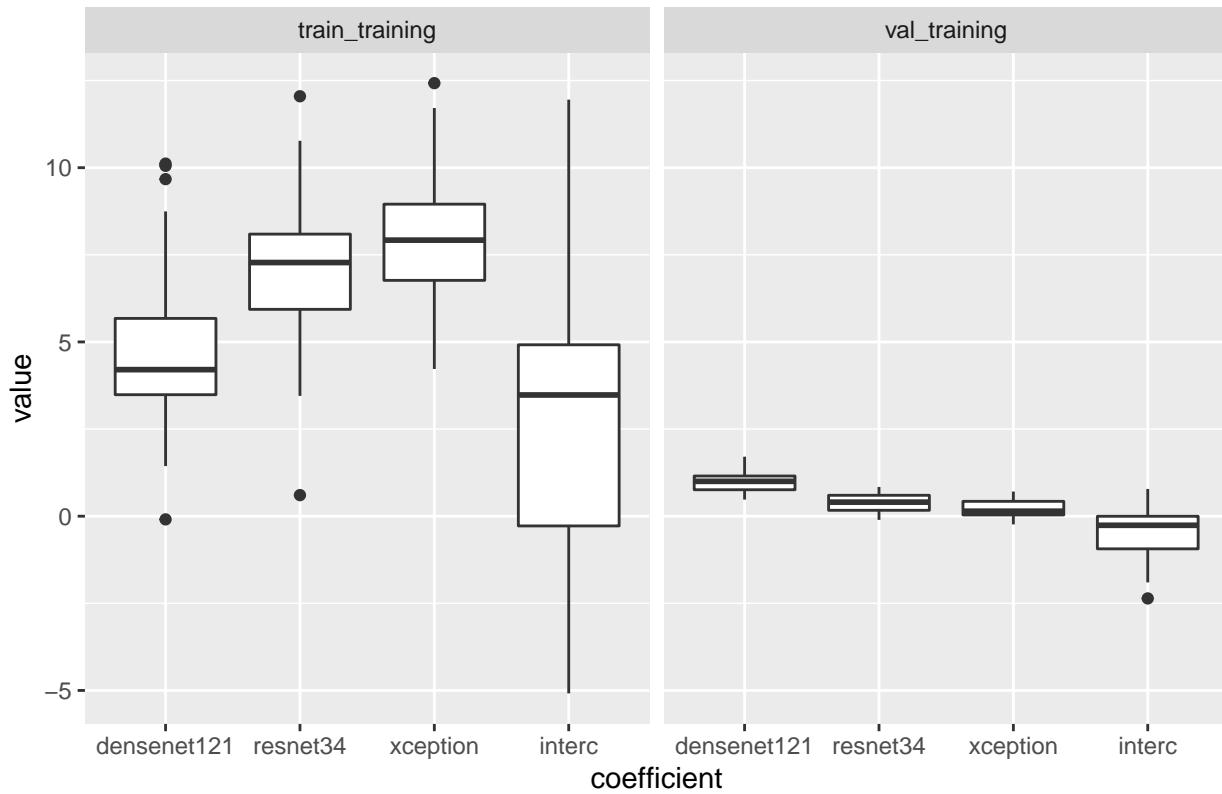
Coefficients for class 8 vs 19



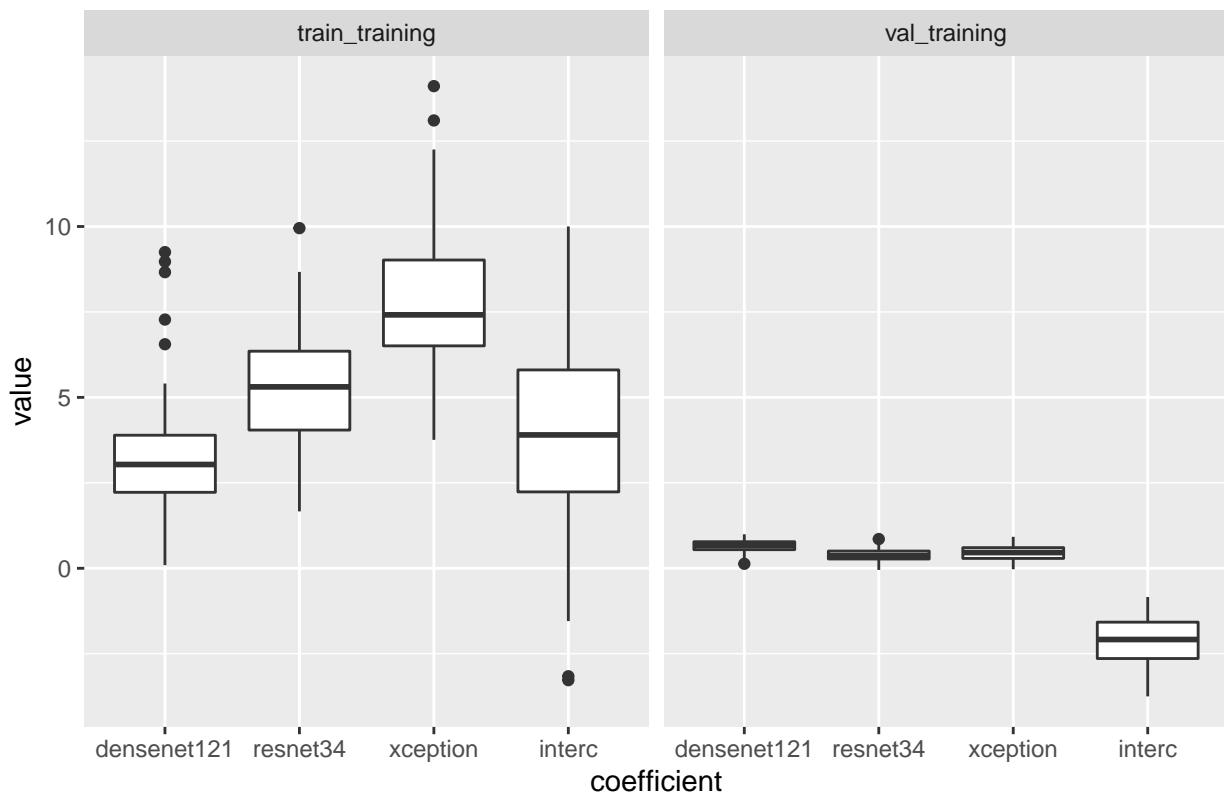
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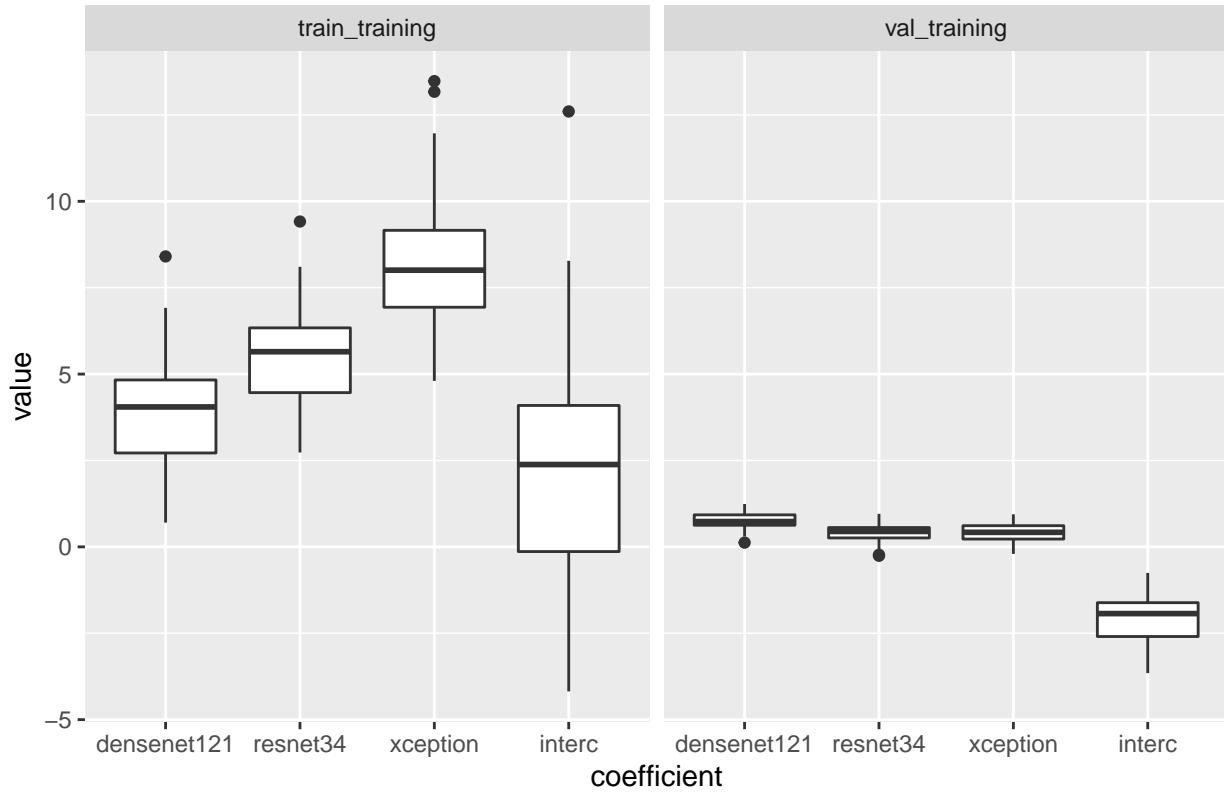
Coefficients for class 9 vs 10



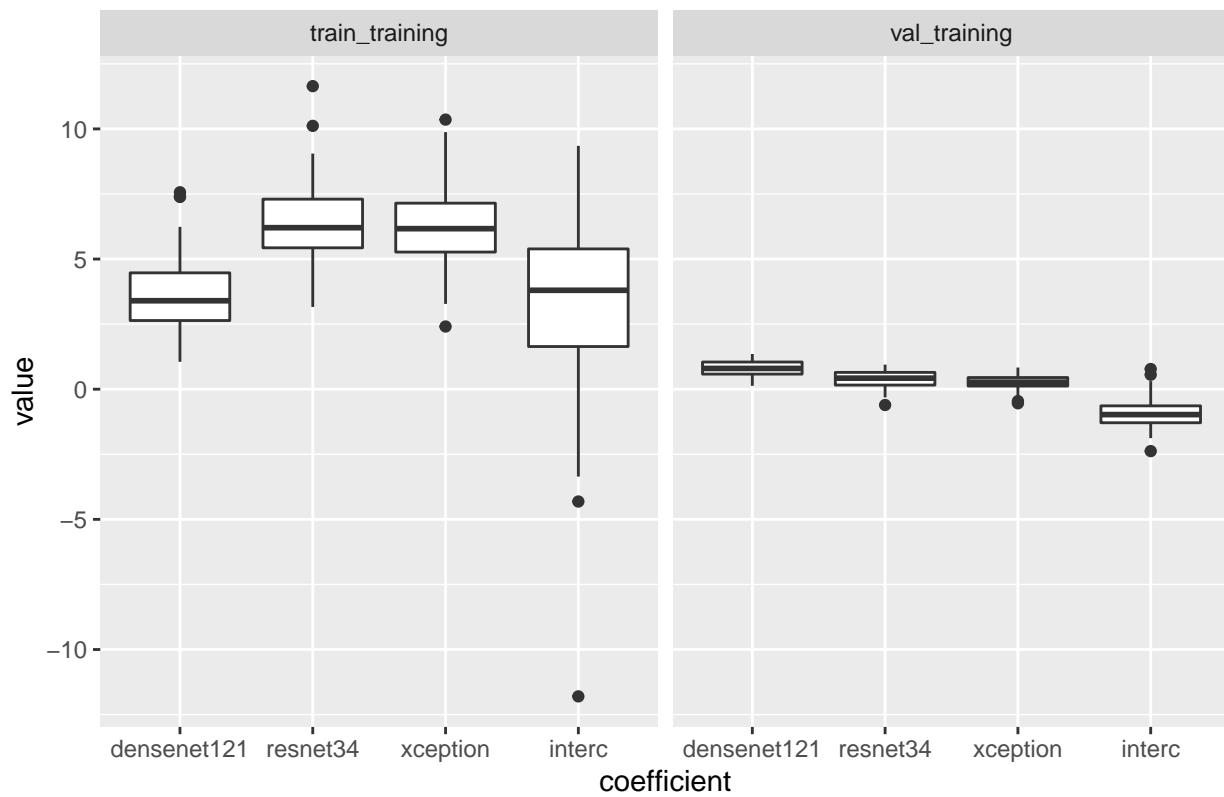
Coefficients for class 9 vs 11



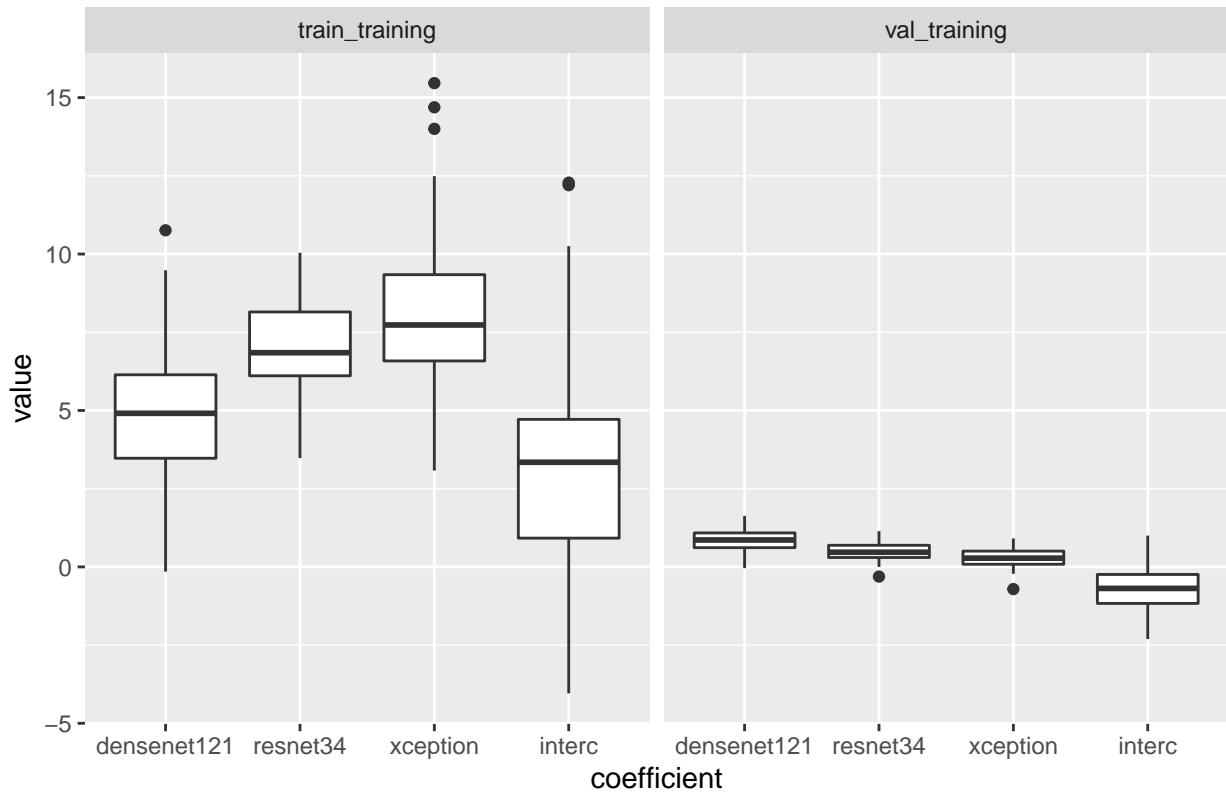
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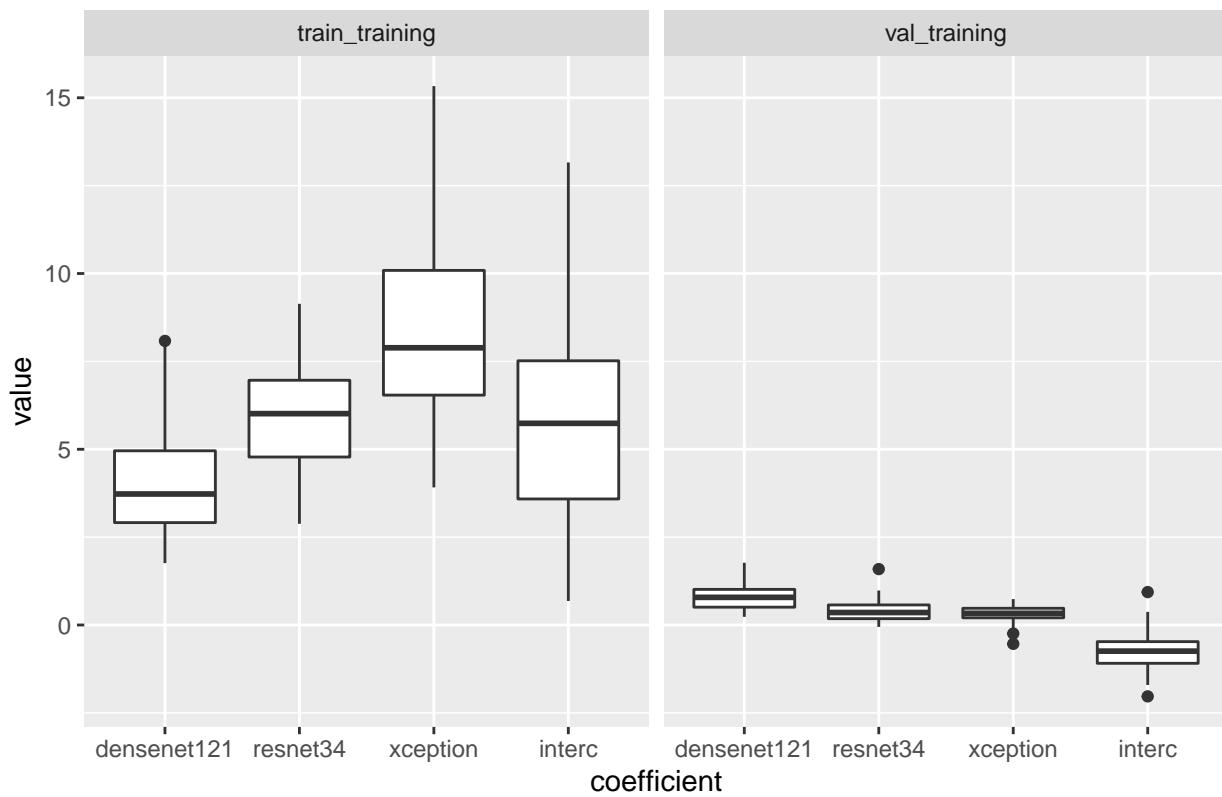
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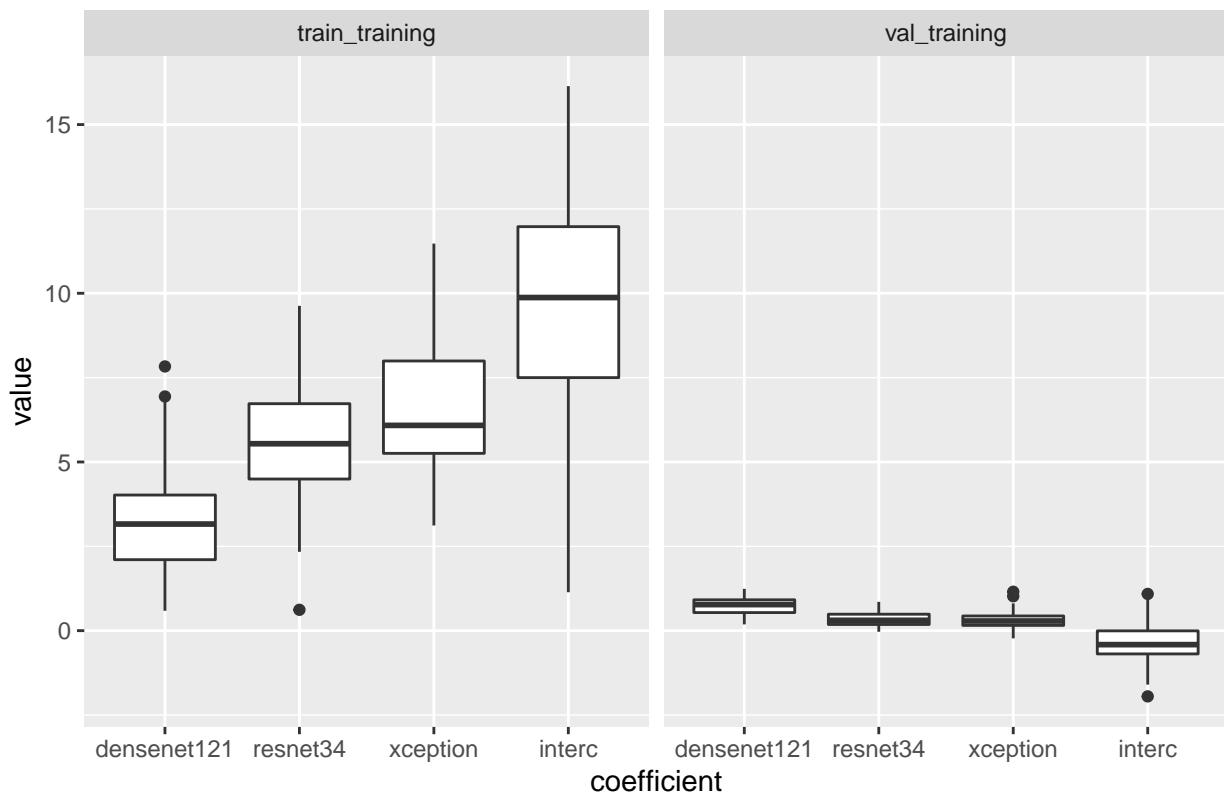
Coefficients for class 9 vs 14



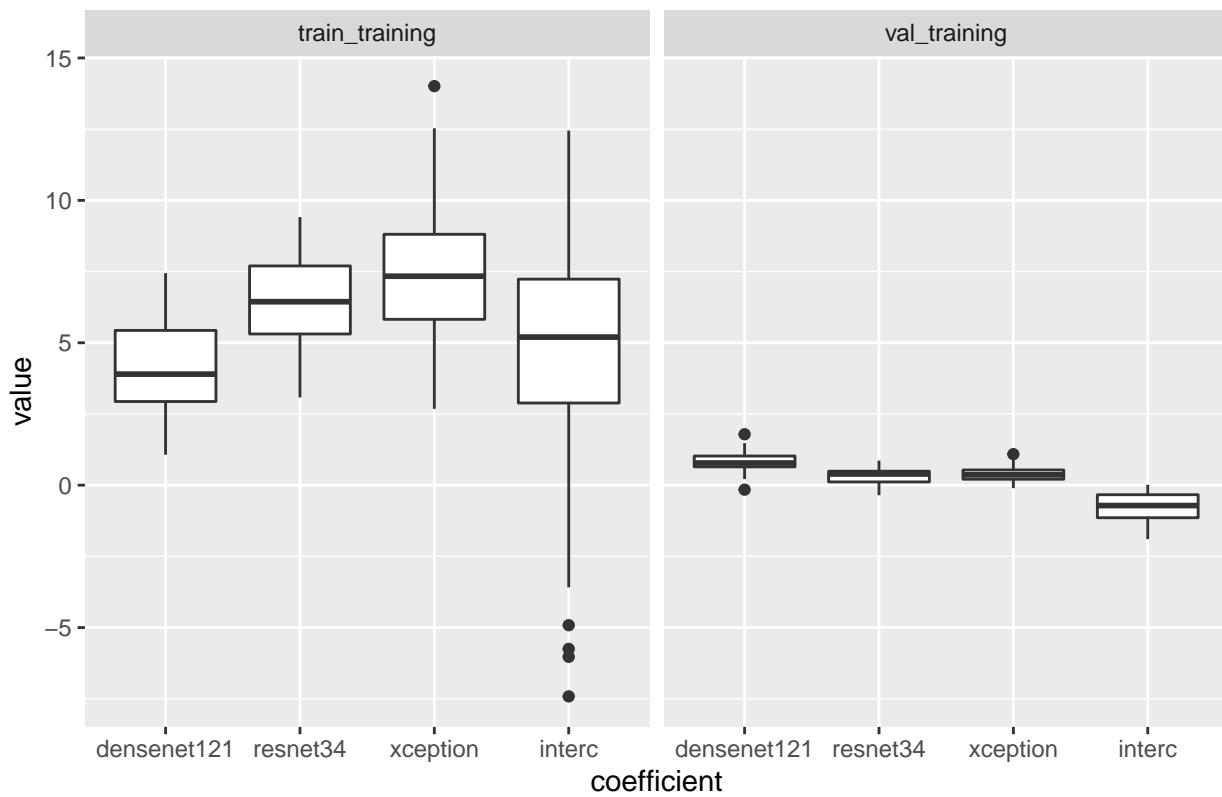
Coefficients for class 9 vs 15



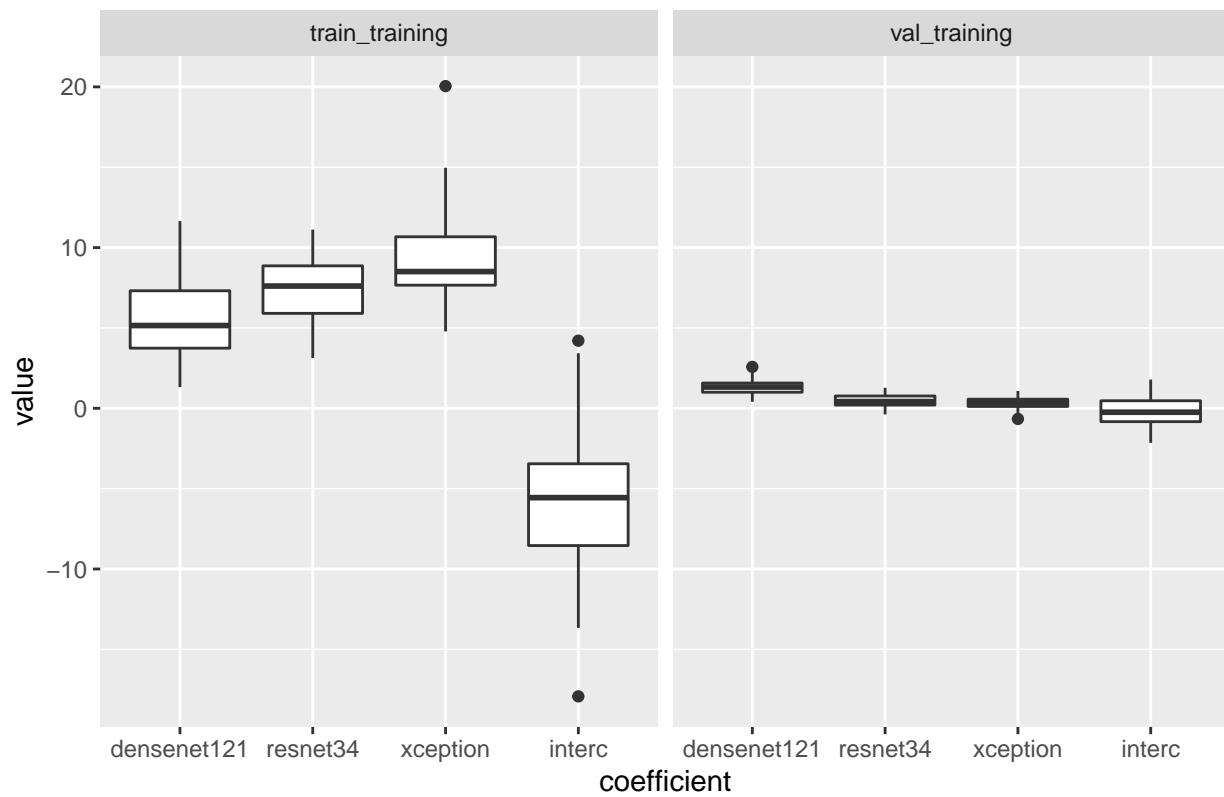
Coefficients for class 9 vs 16



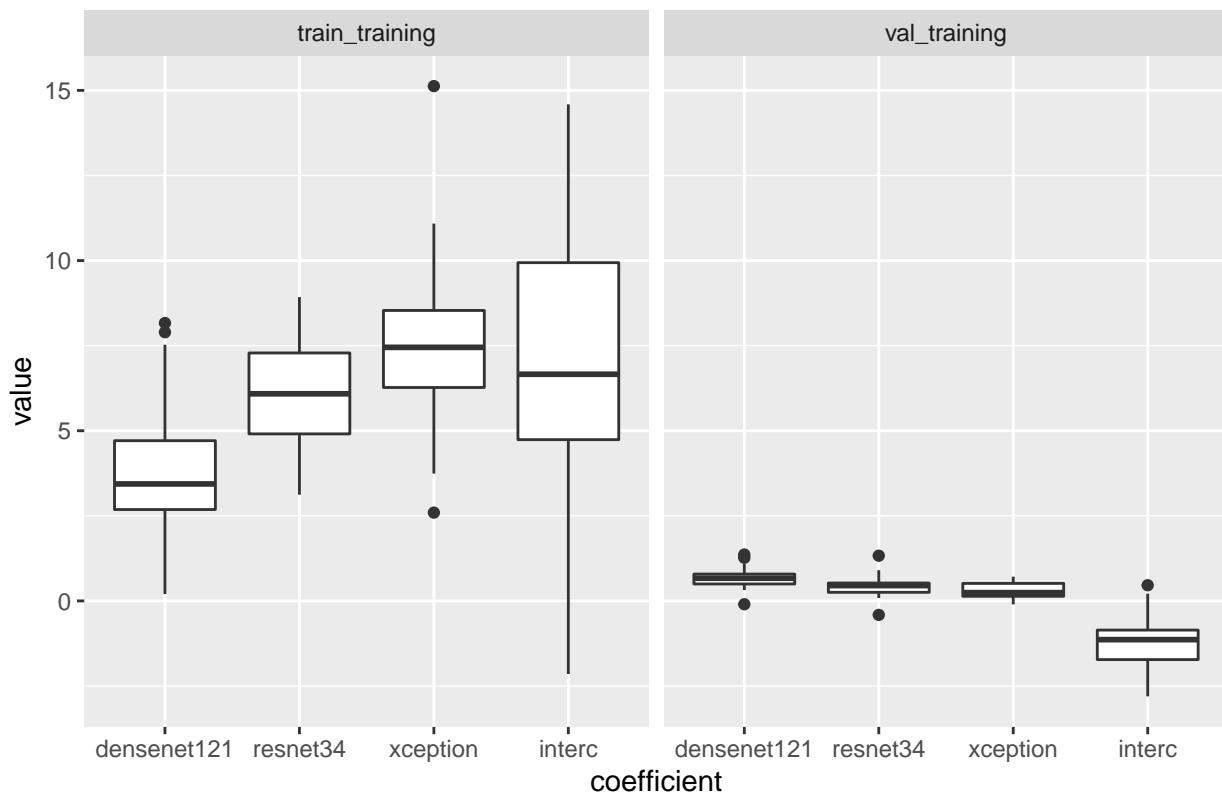
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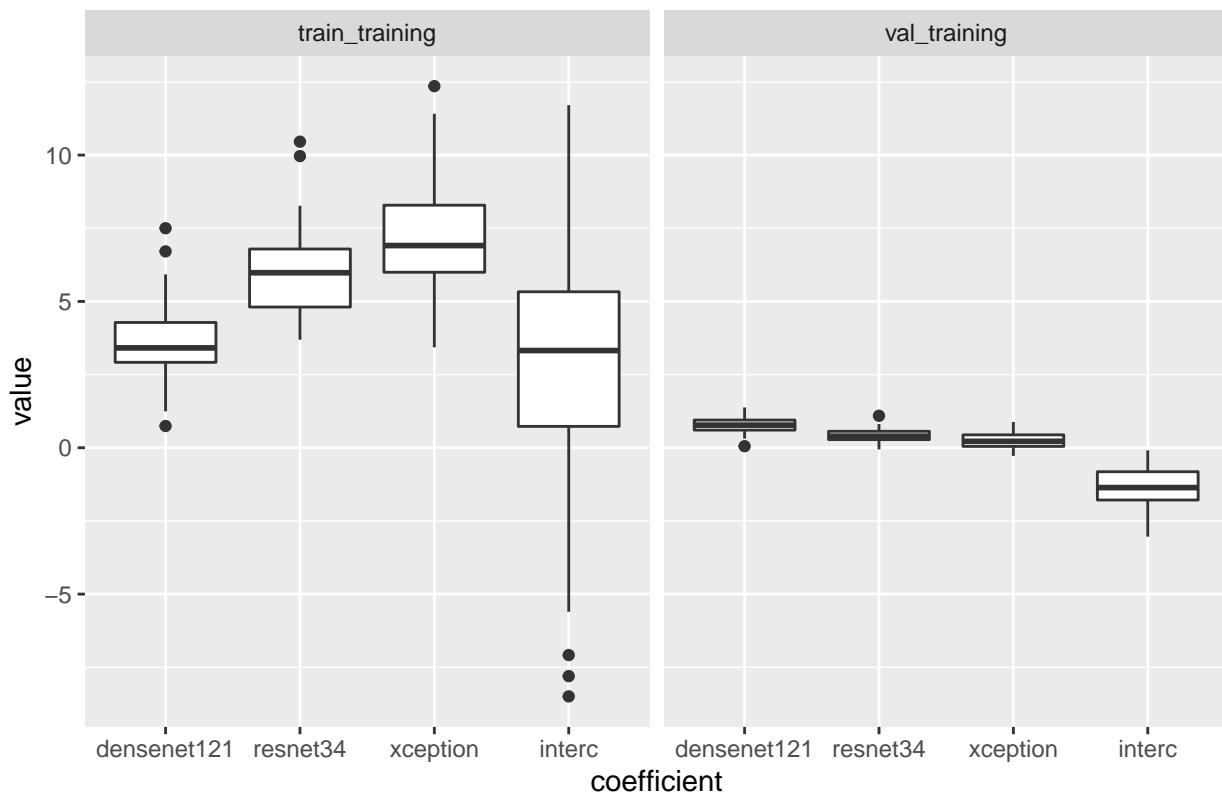
Coefficients for class 9 vs 18



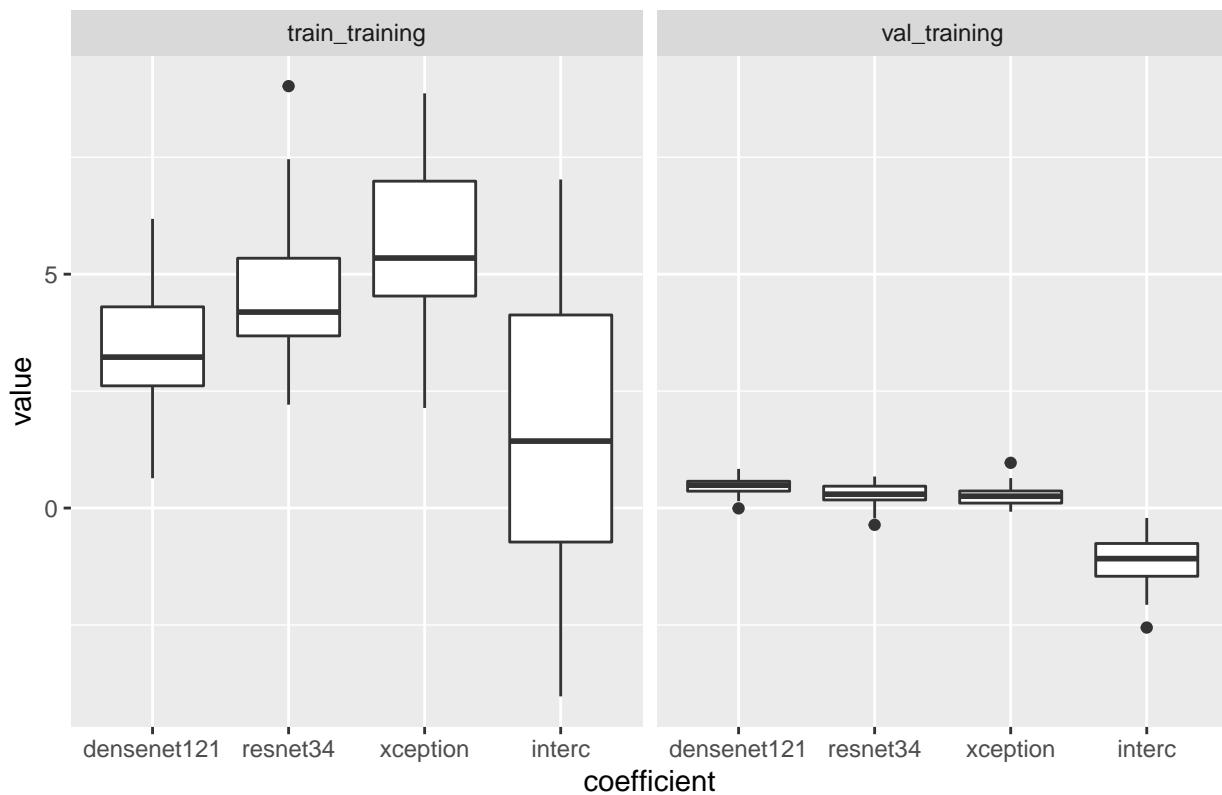
Coefficients for class 9 vs 19



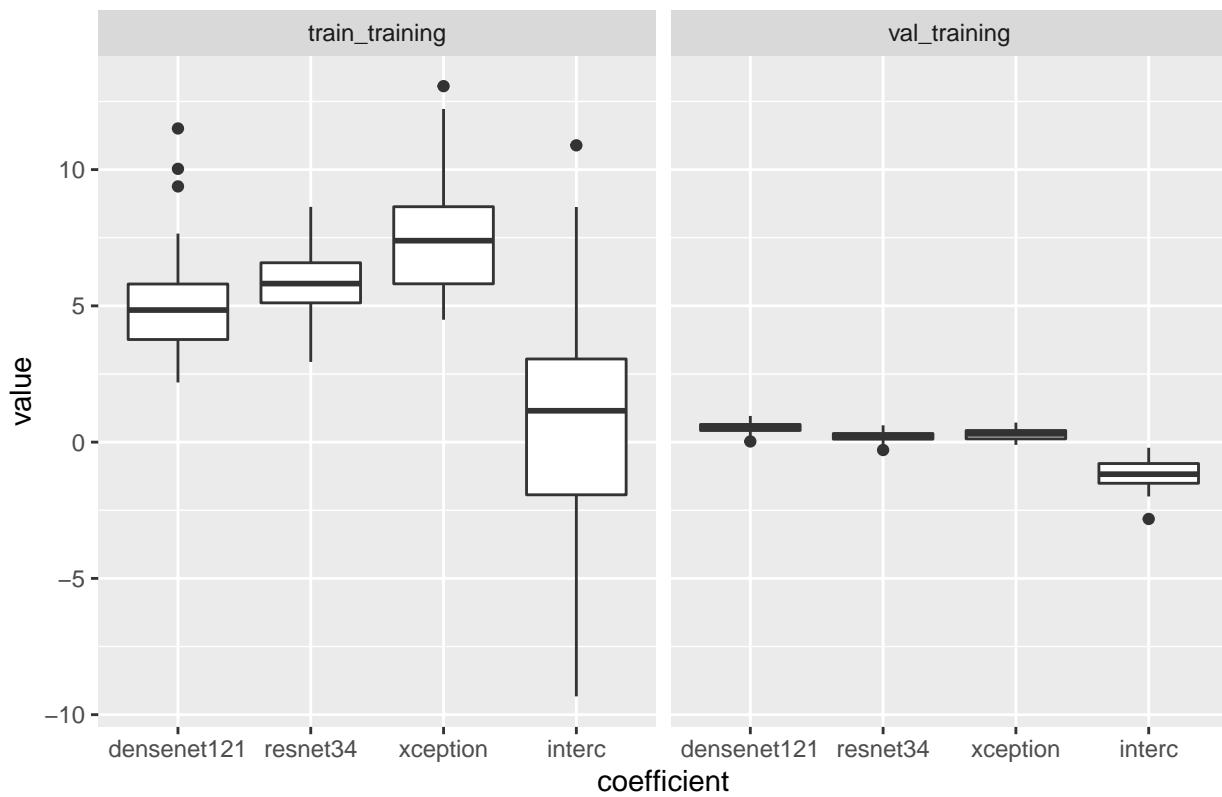
Coefficients for class 9 vs 20



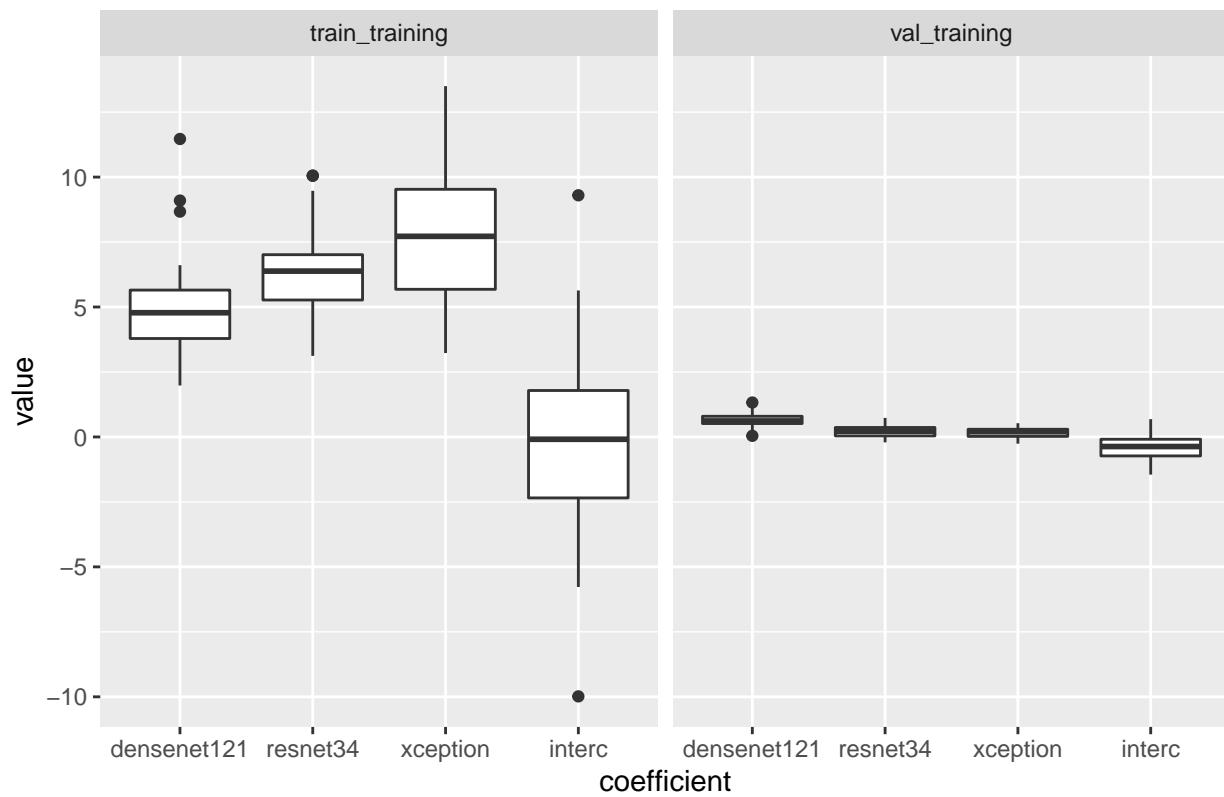
Coefficients for class 10 vs 11



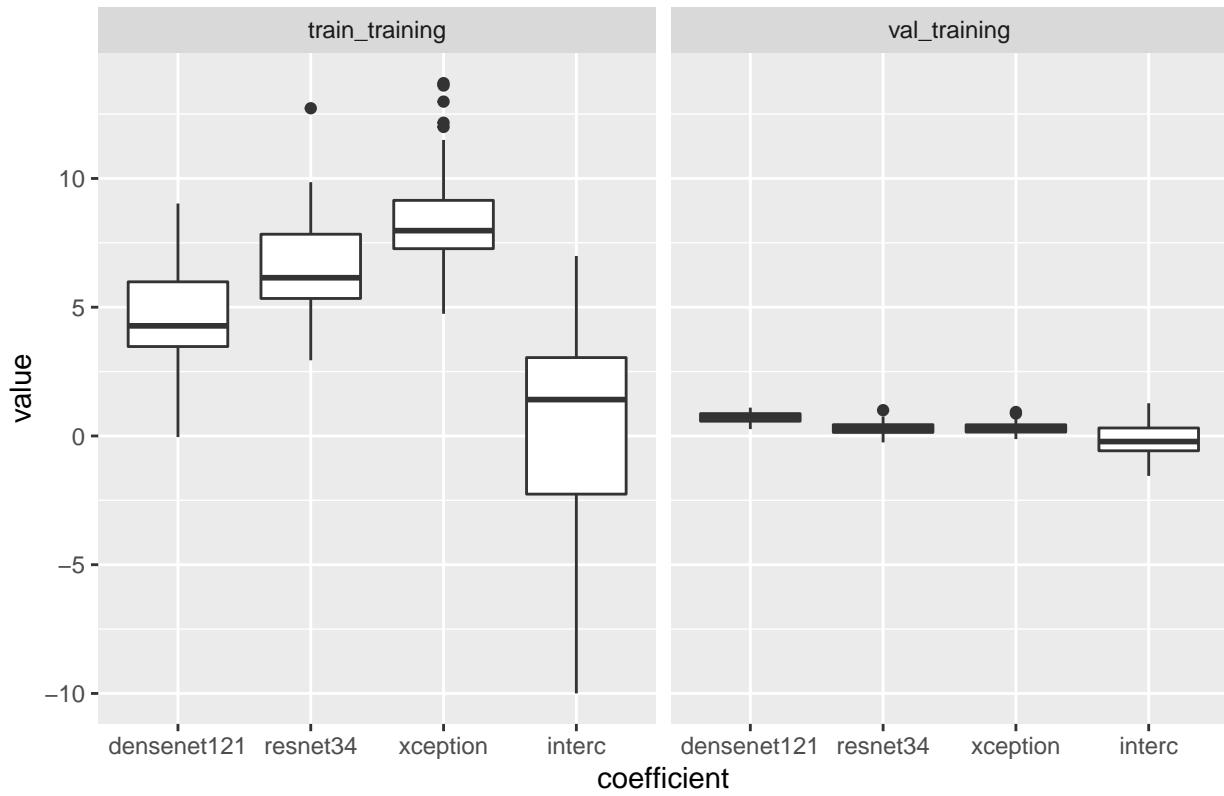
Coefficients for class 10 vs 12



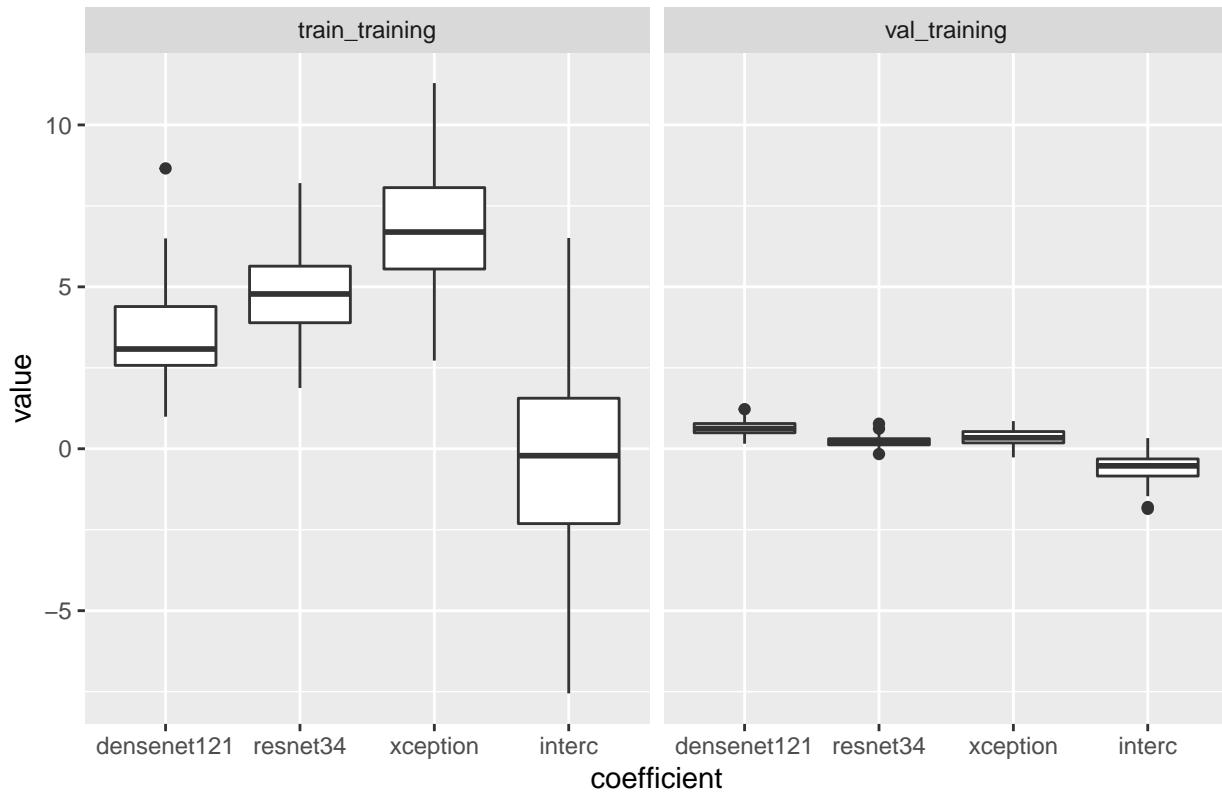
Coefficients for class 10 vs 13



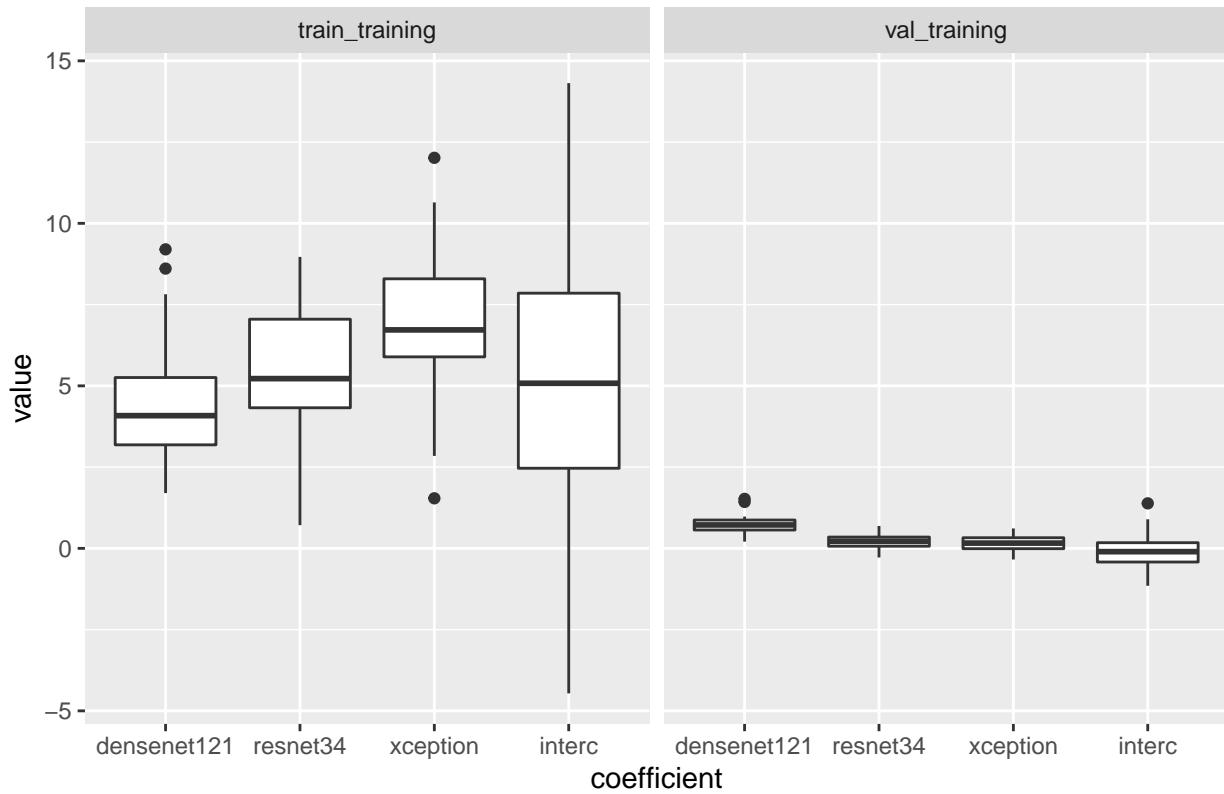
Coefficients for class 10 vs 14



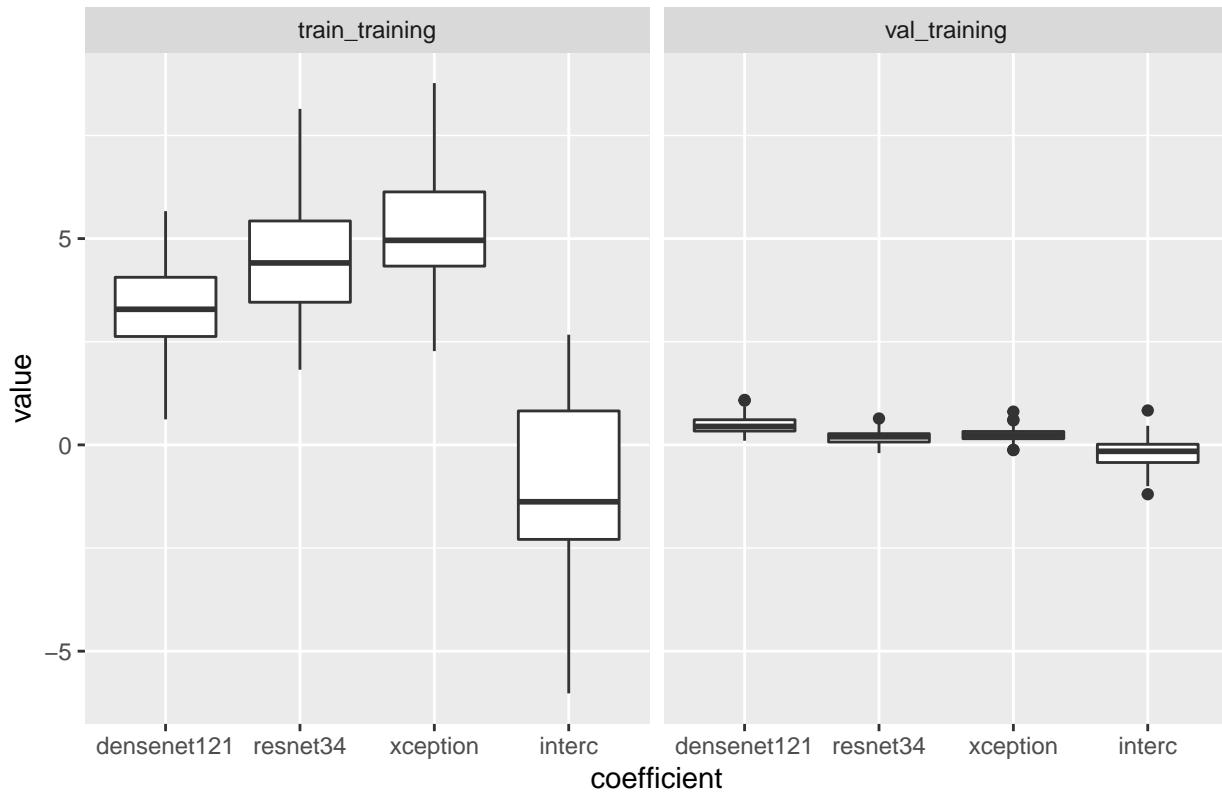
Coefficients for class 10 vs 15



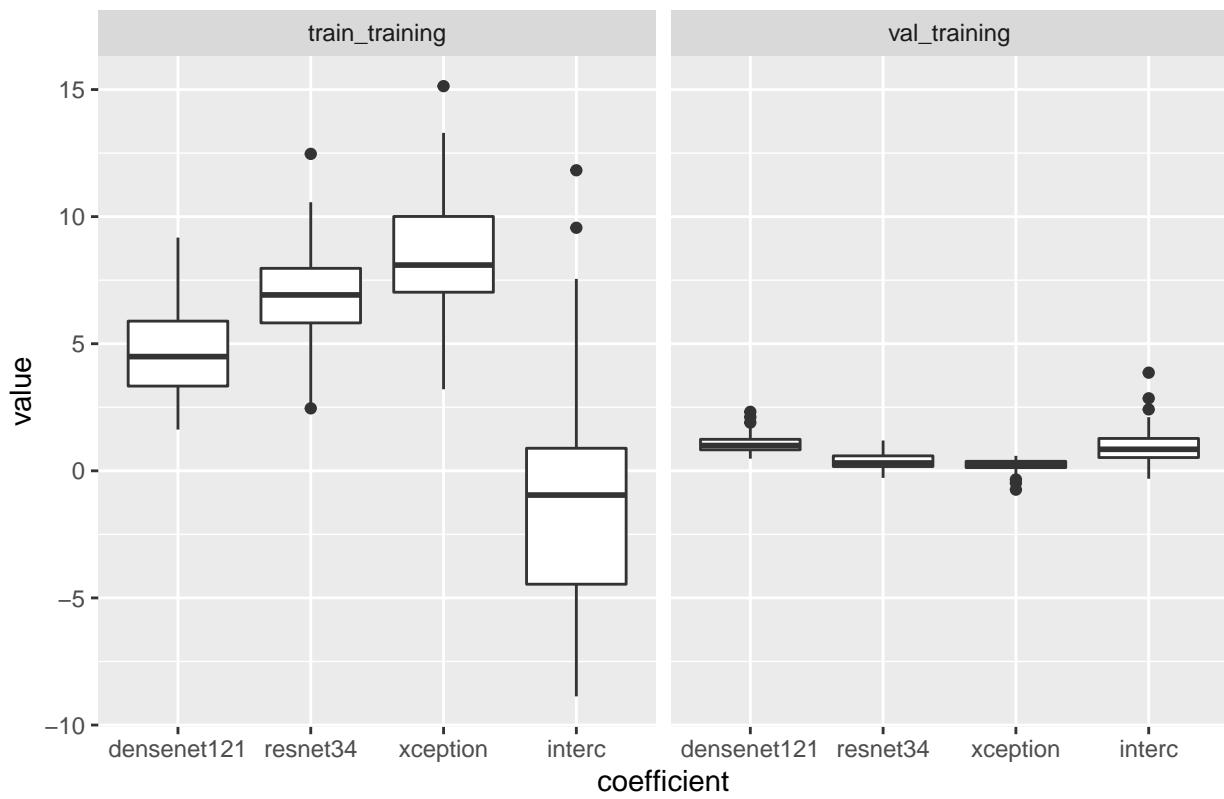
Coefficients for class 10 vs 16



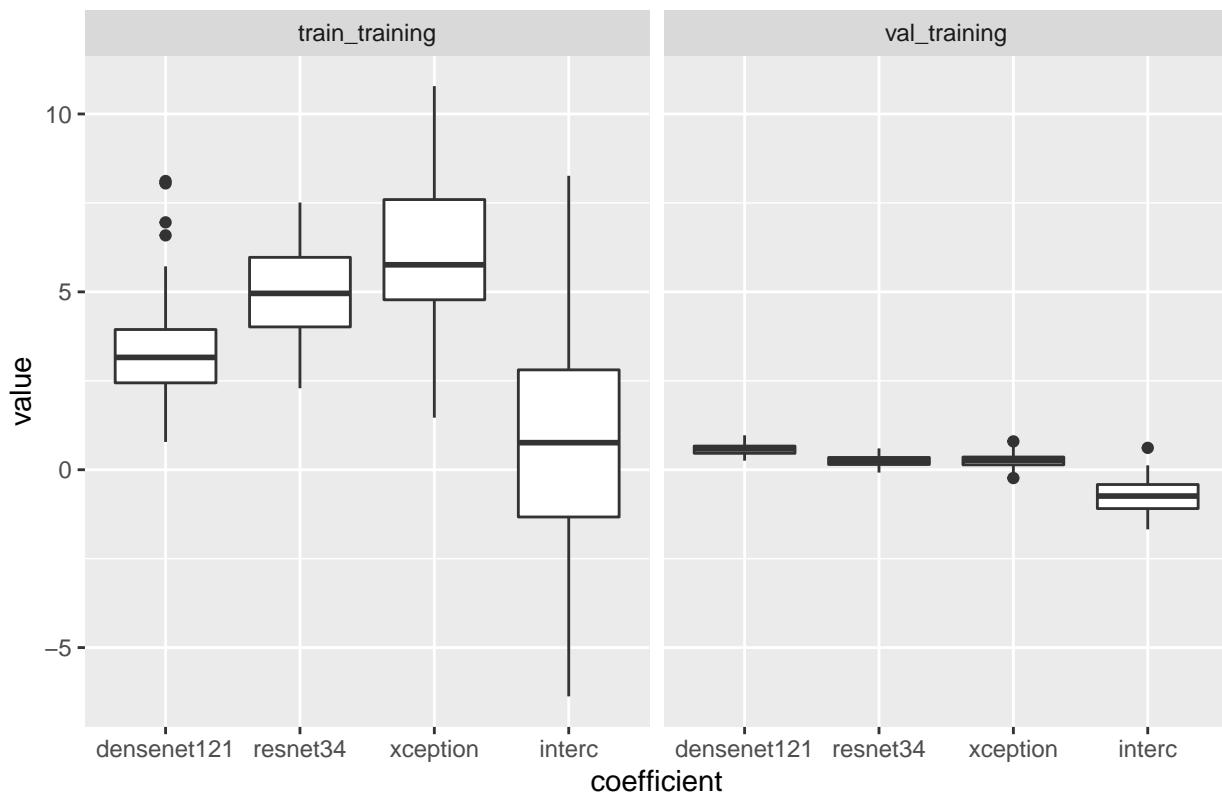
Coefficients for class 10 vs 17



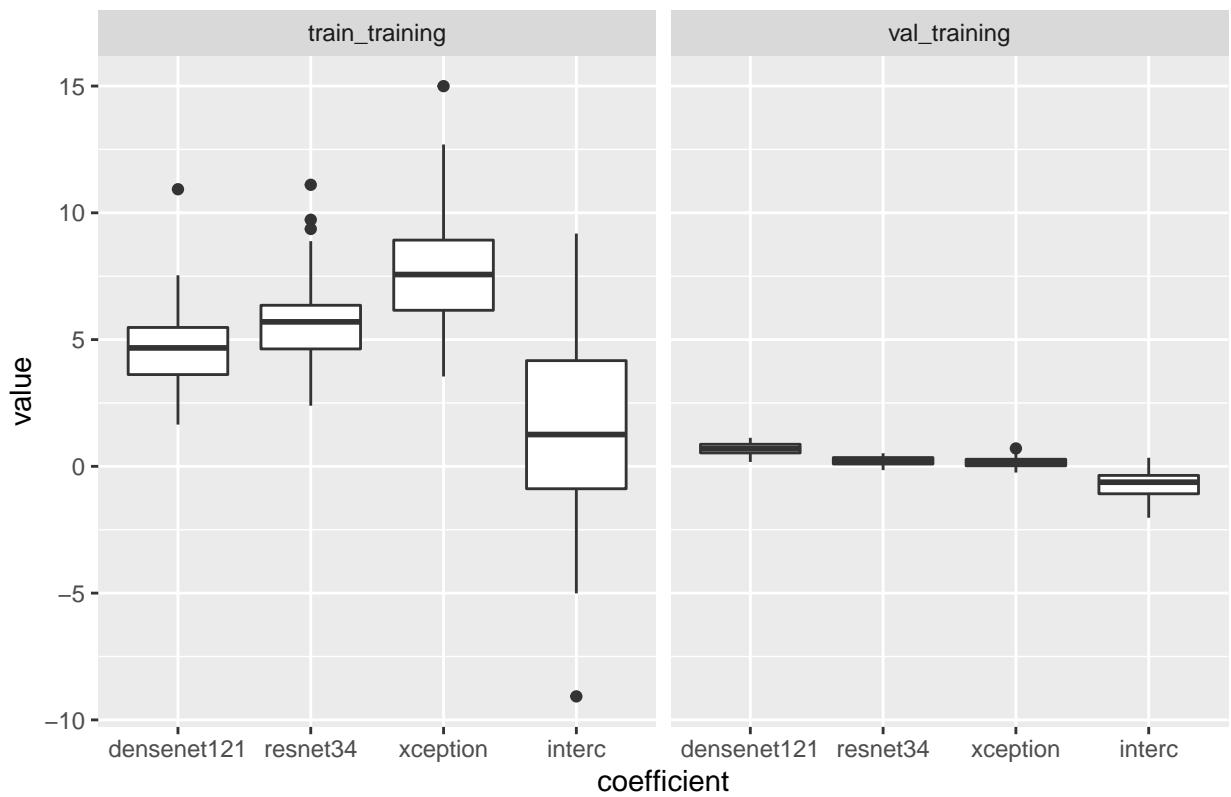
Coefficients for class 10 vs 18



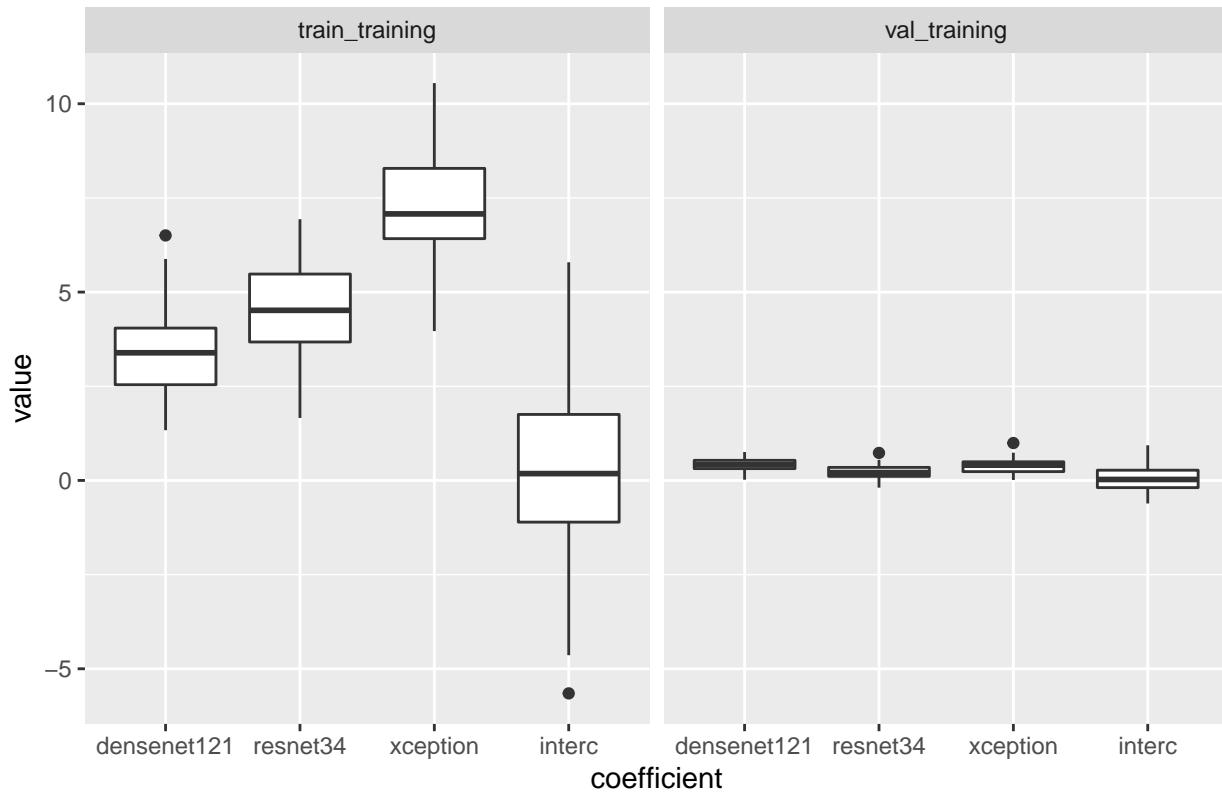
Coefficients for class 10 vs 19



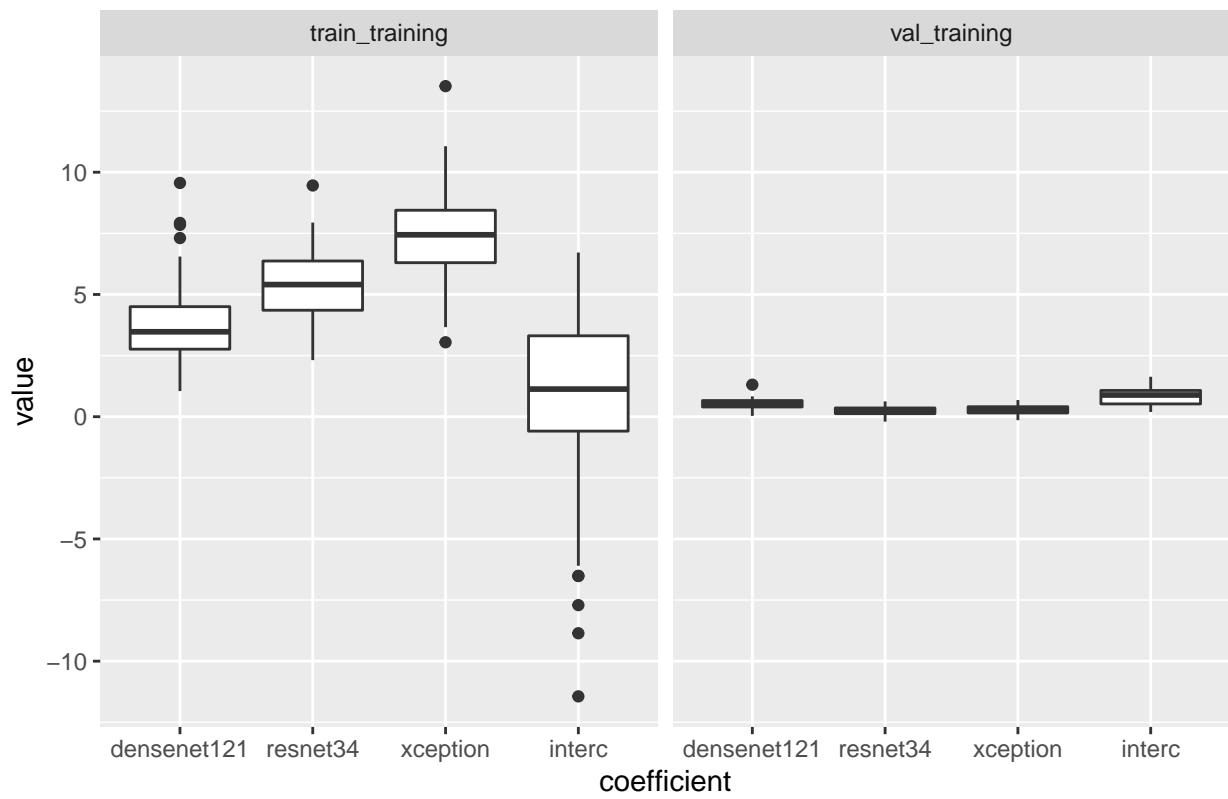
Coefficients for class 10 vs 20



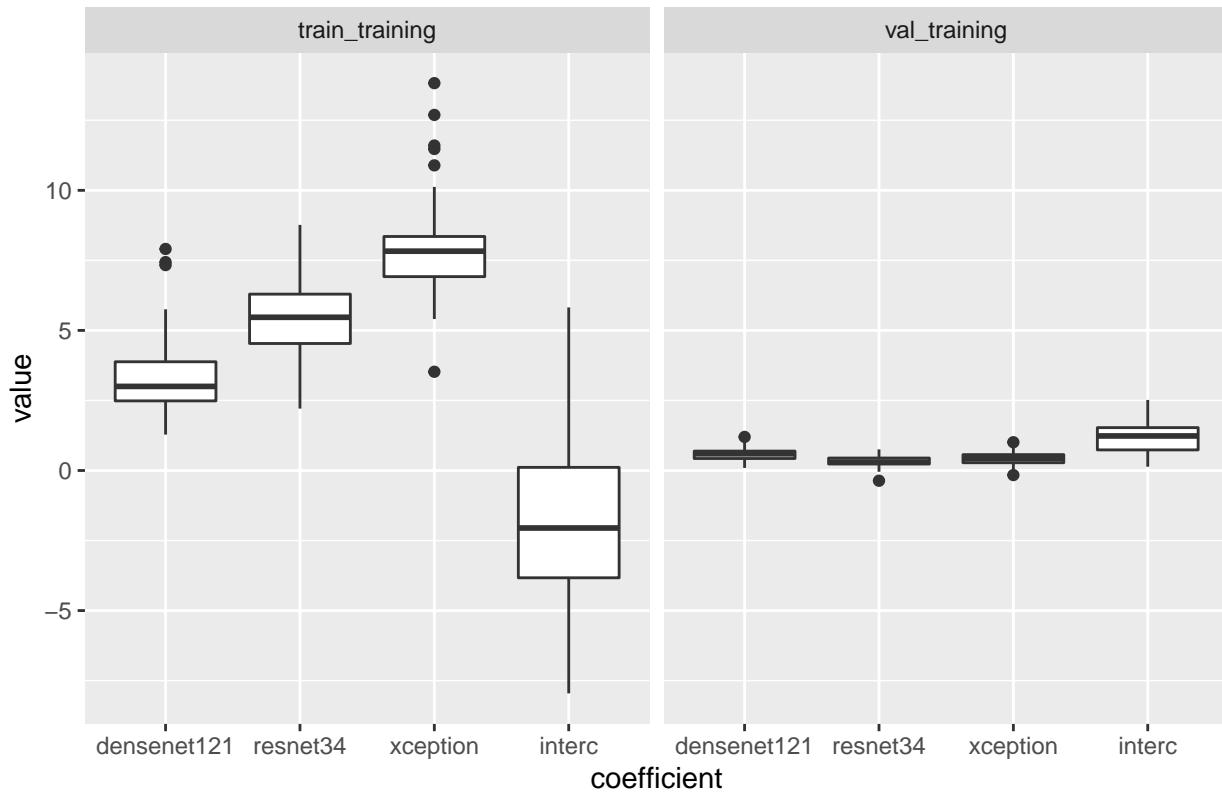
Coefficients for class 11 vs 12



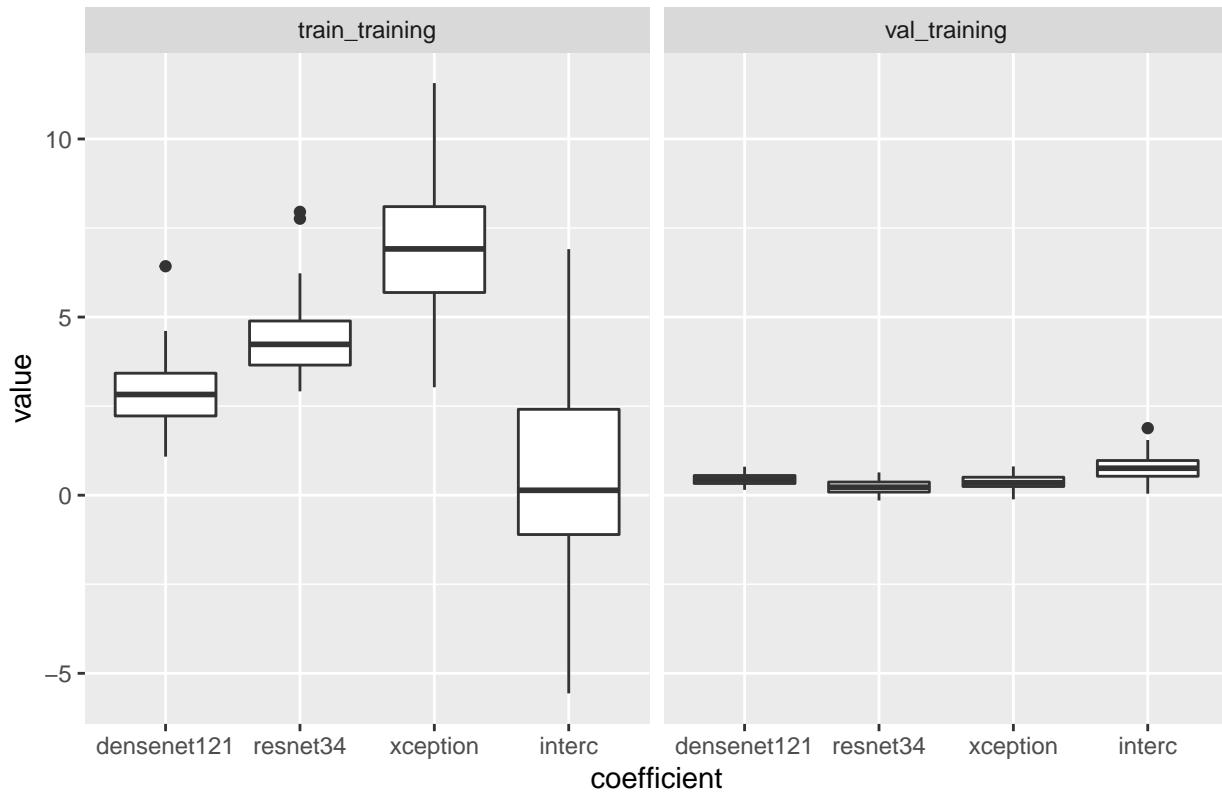
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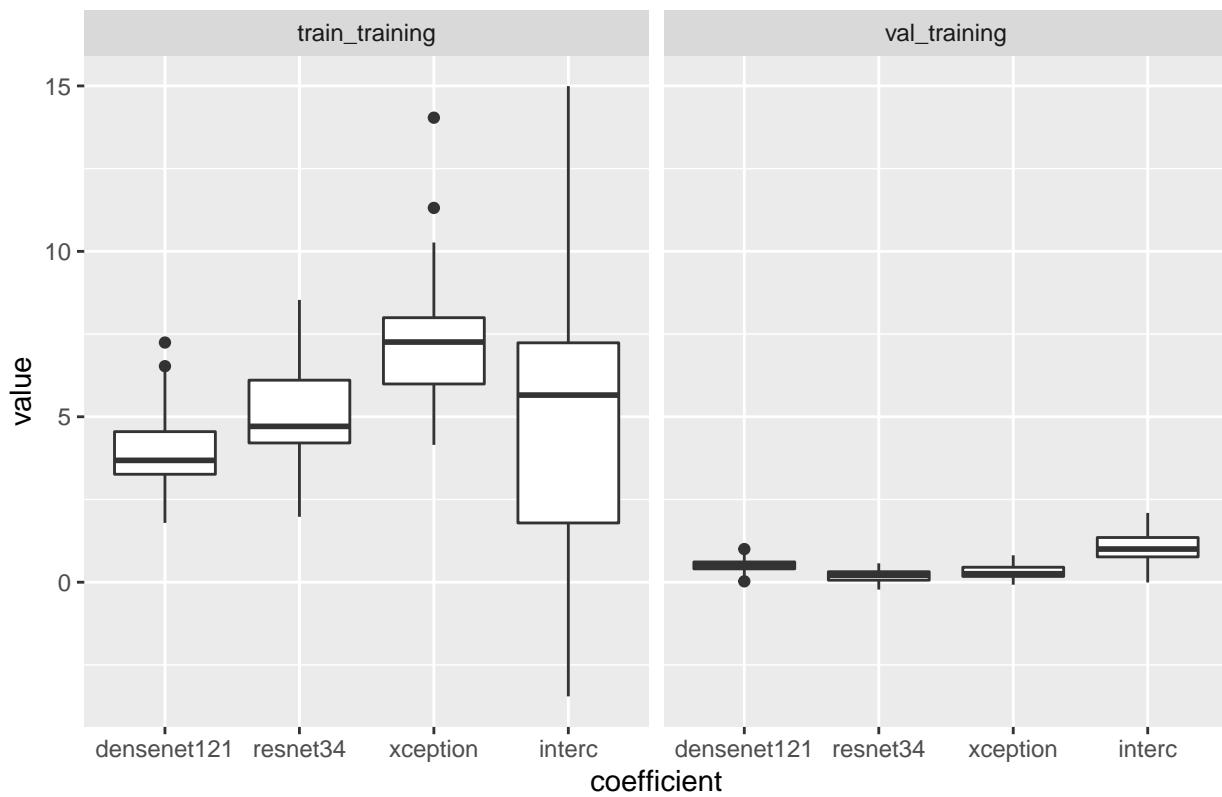
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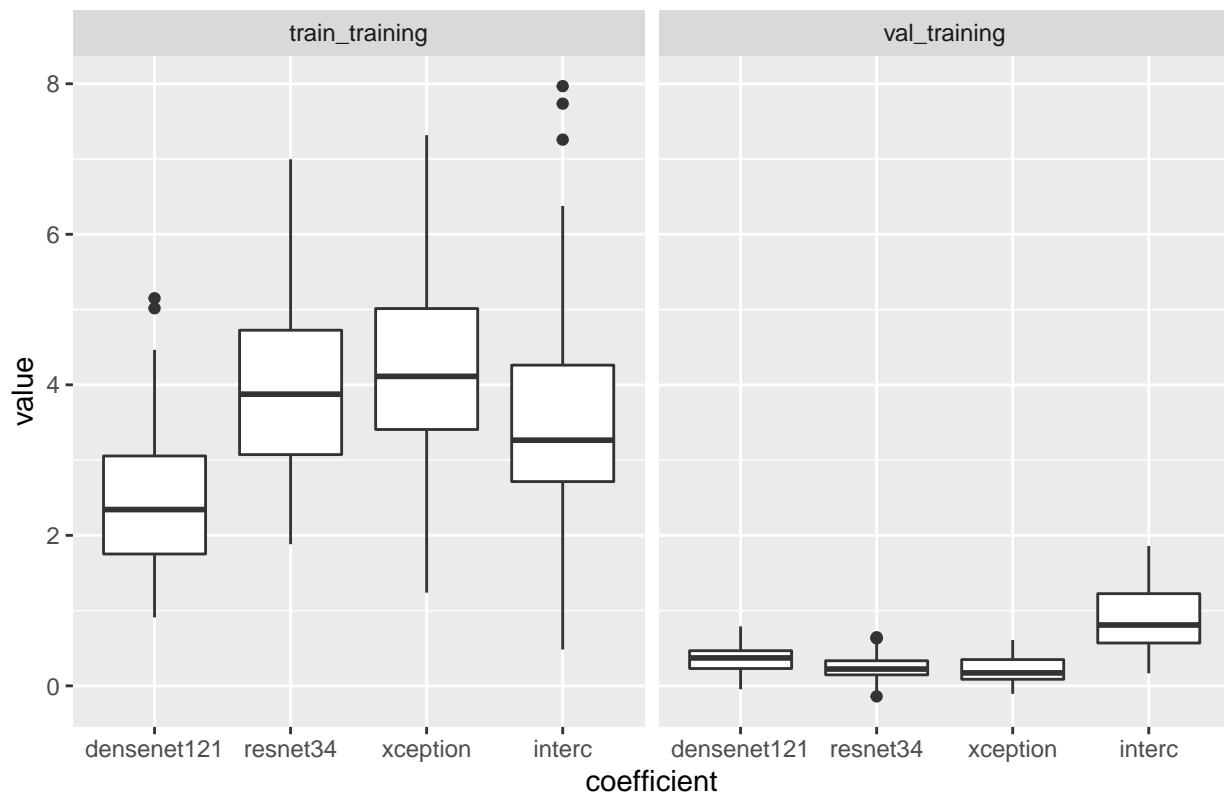
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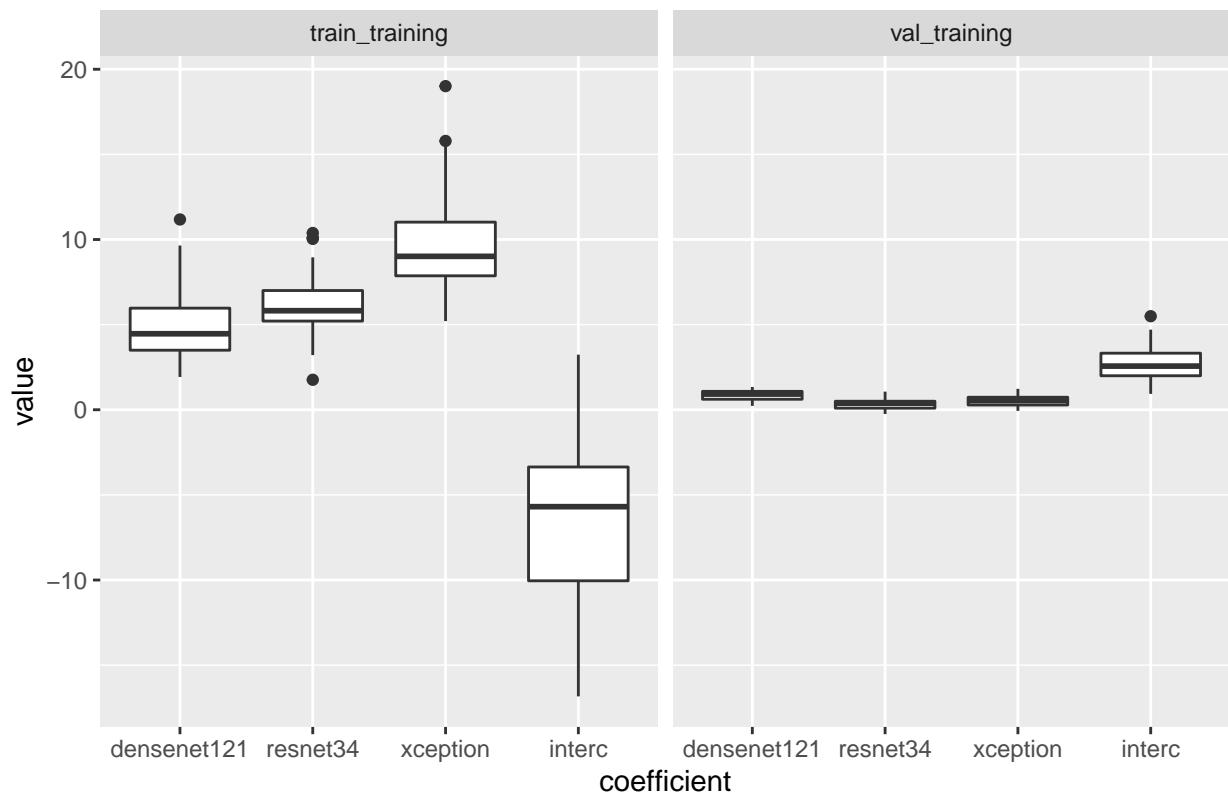
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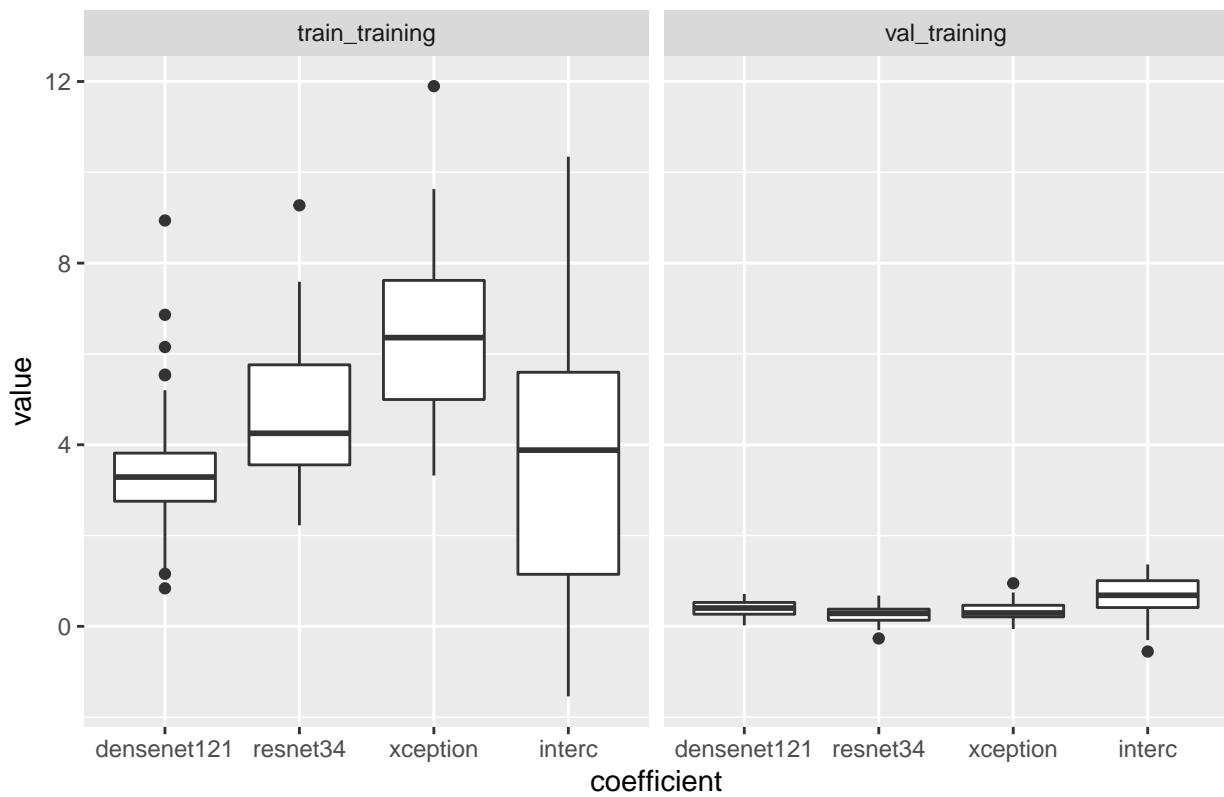
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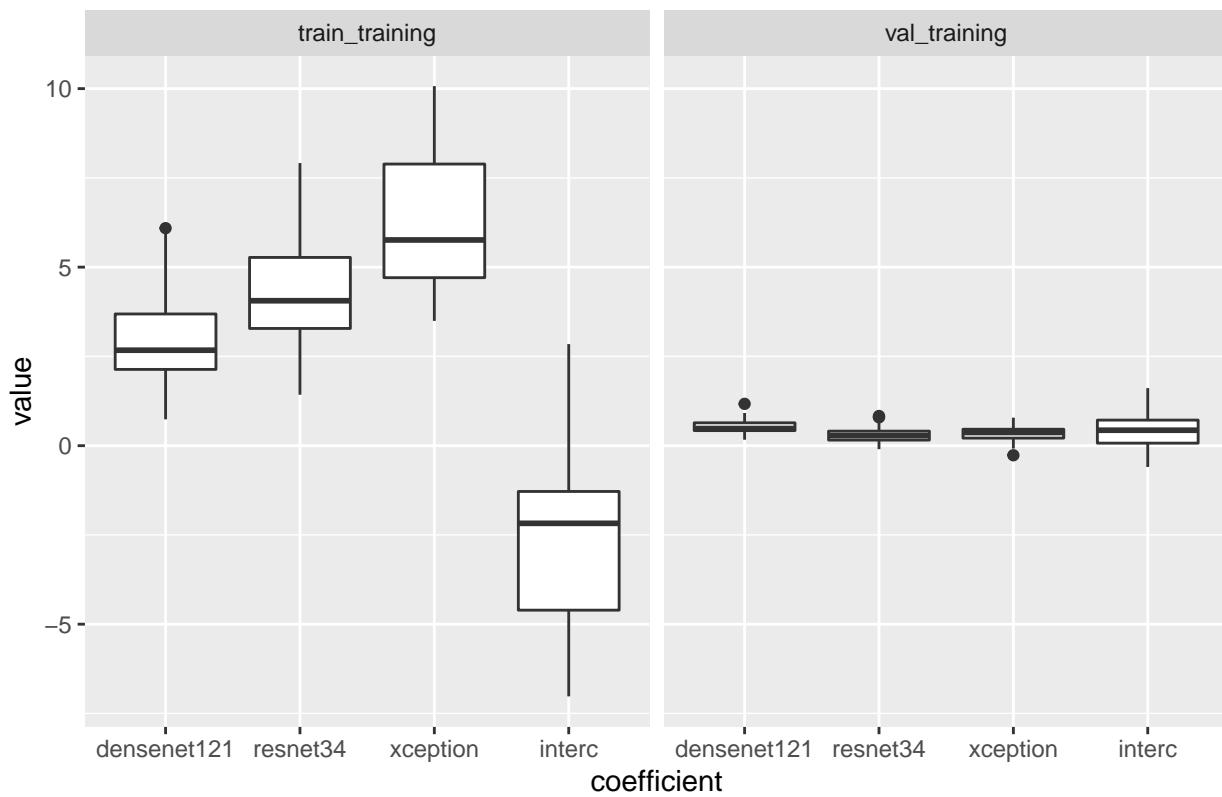
Coefficients for class 11 vs 18



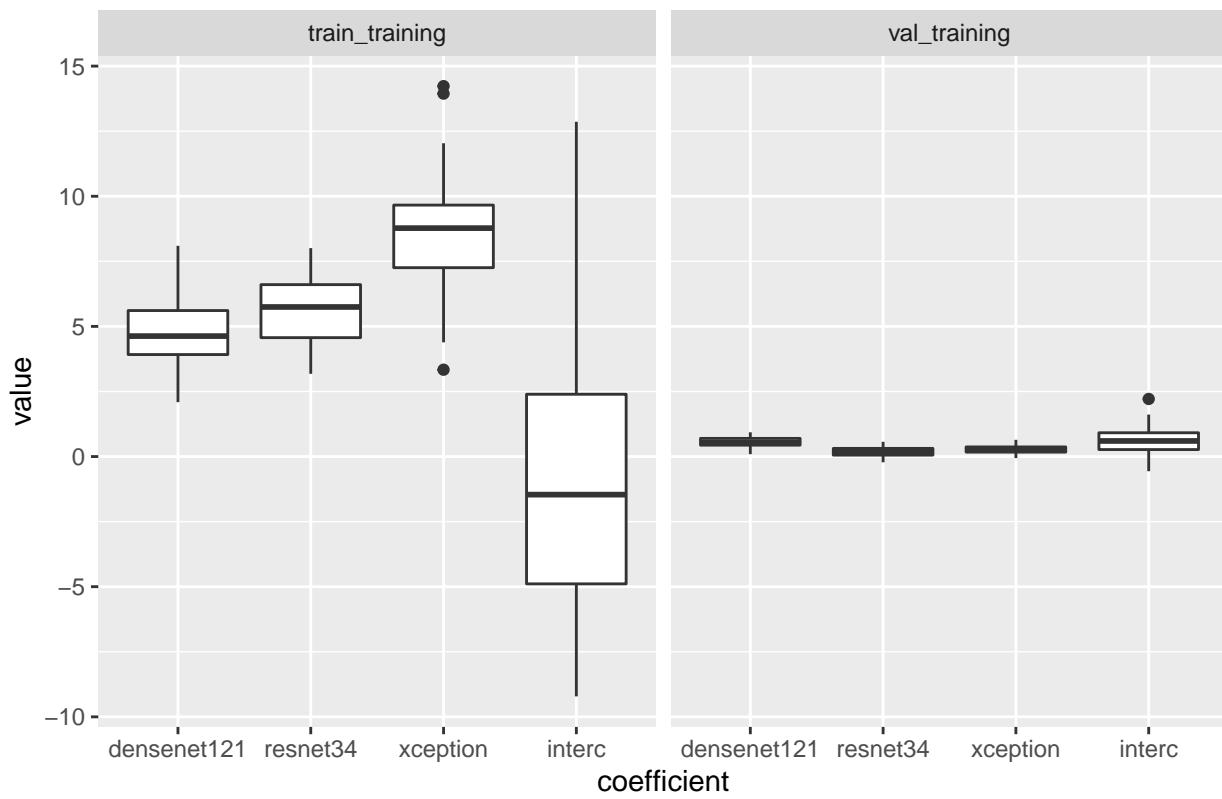
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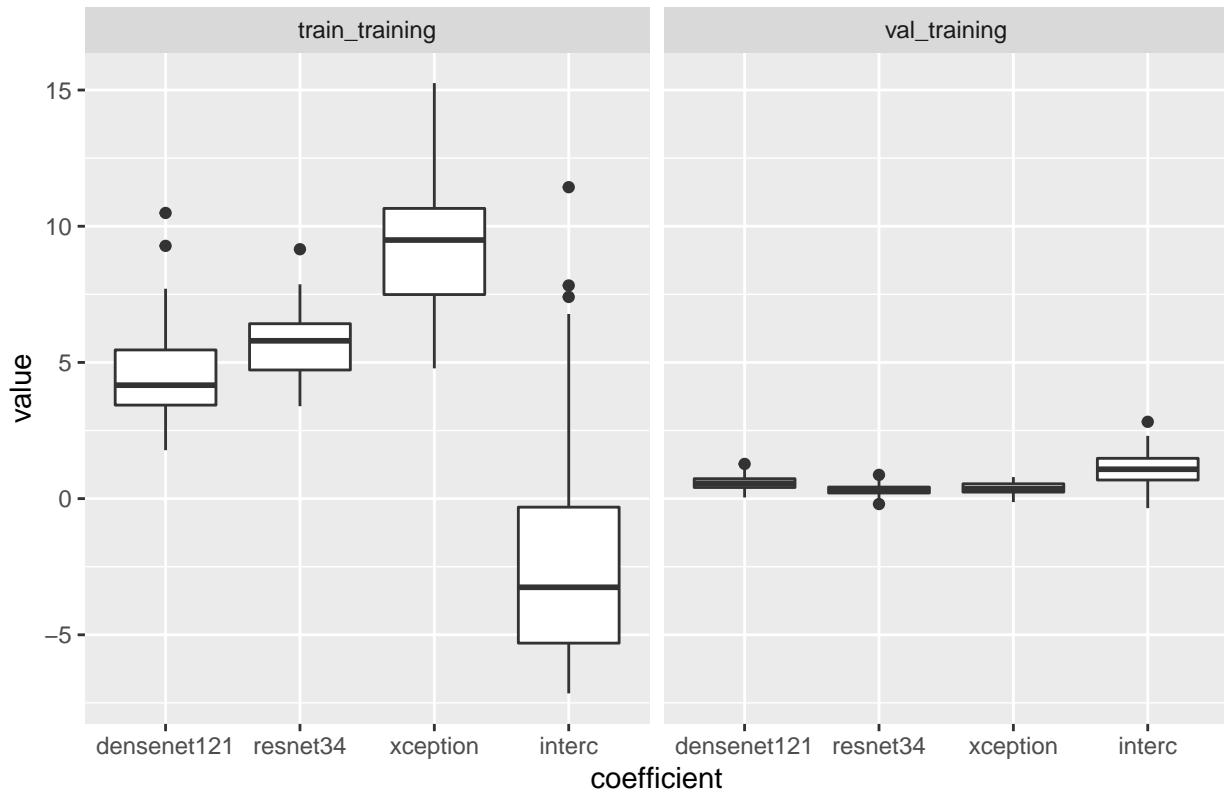
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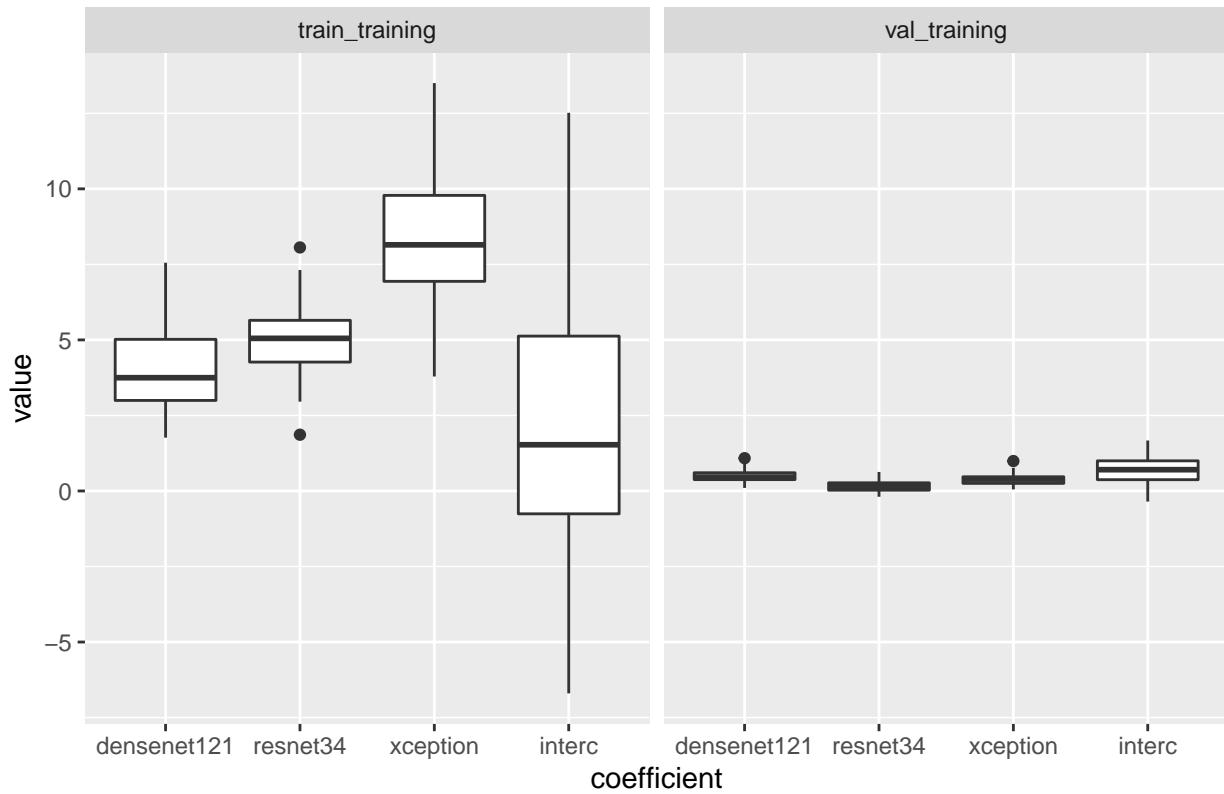
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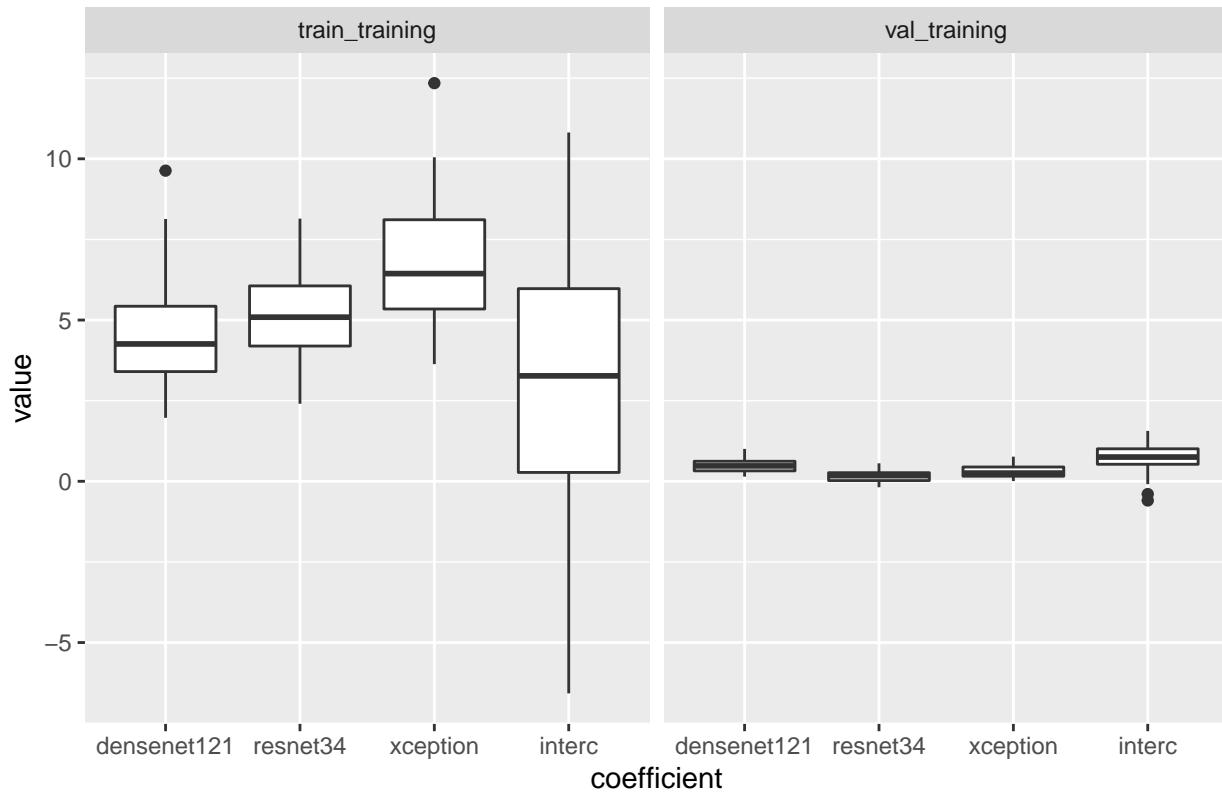
Coefficients for class 12 vs 14



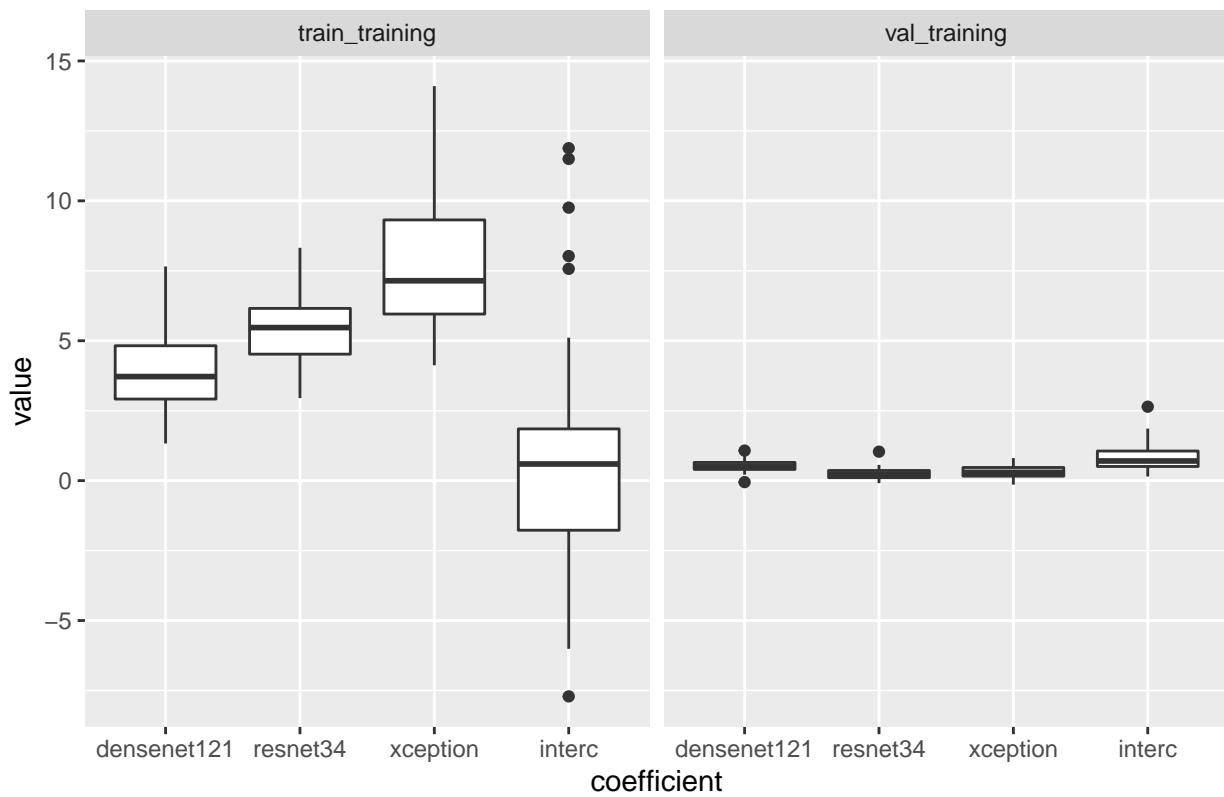
Coefficients for class 12 vs 15



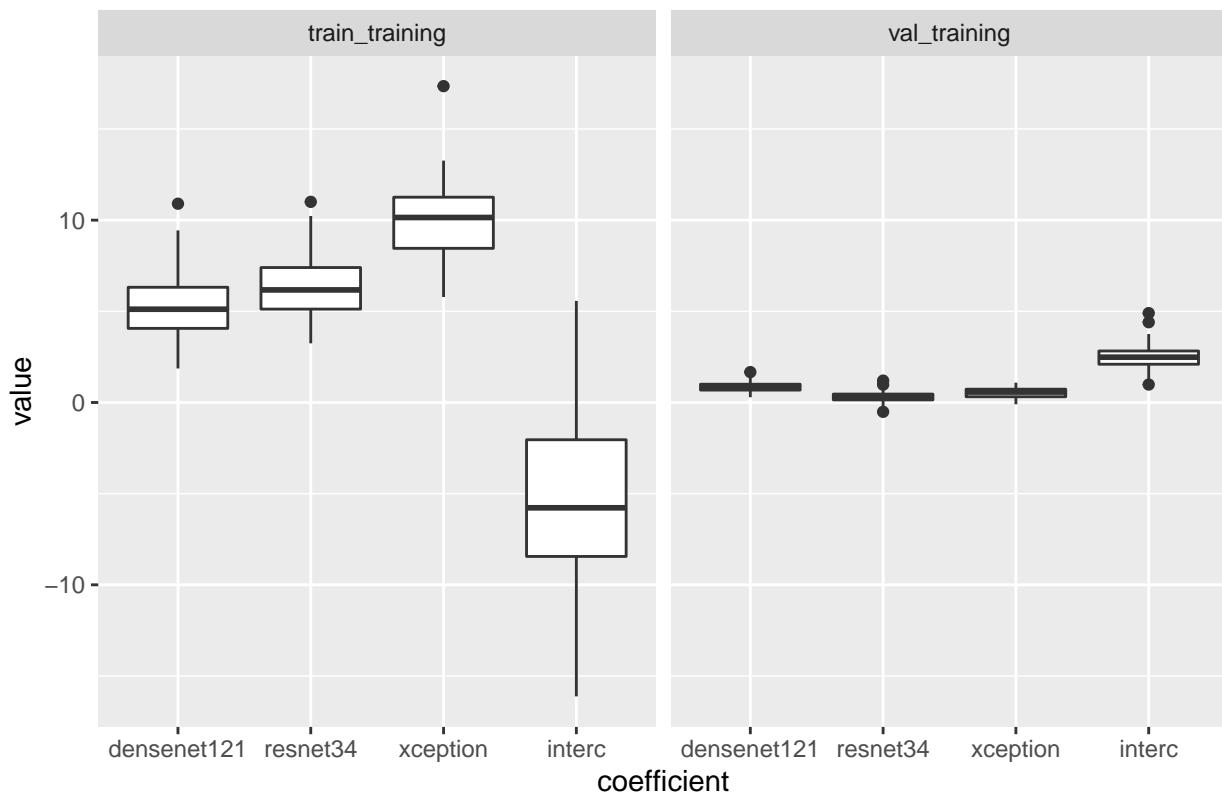
Coefficients for class 12 vs 16



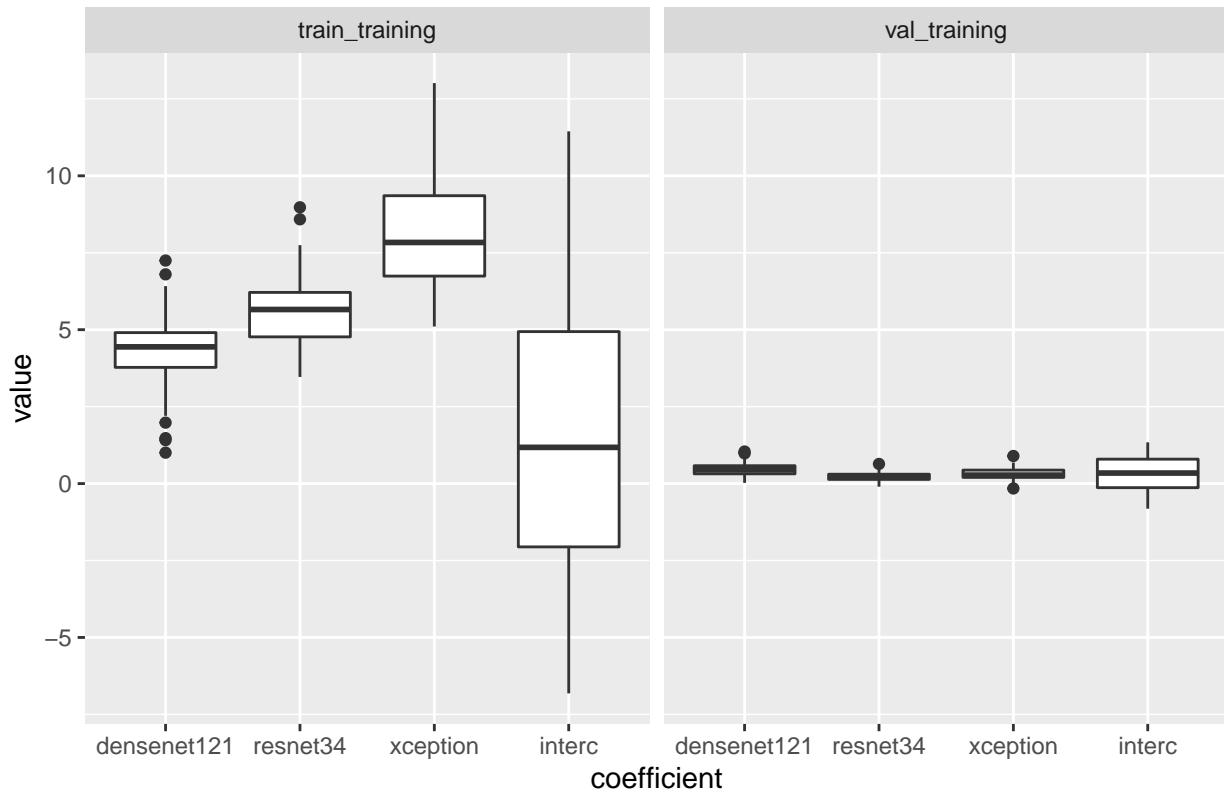
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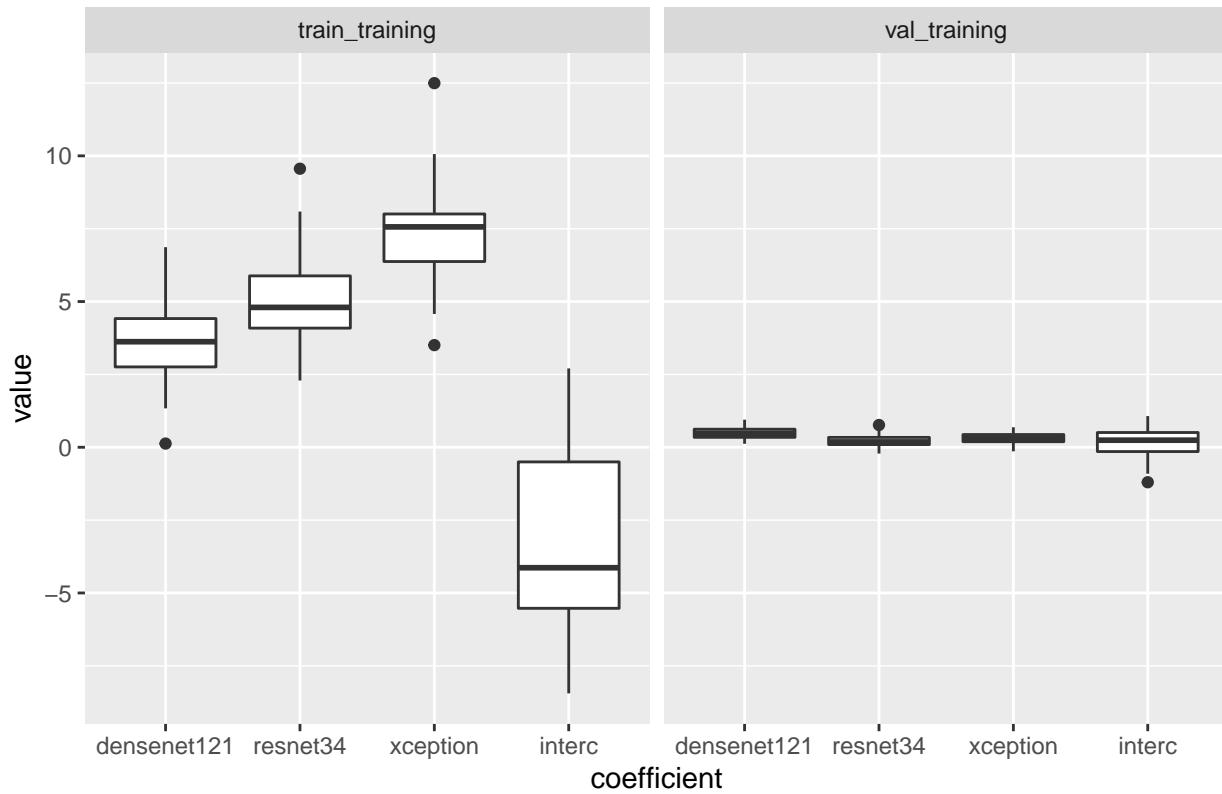
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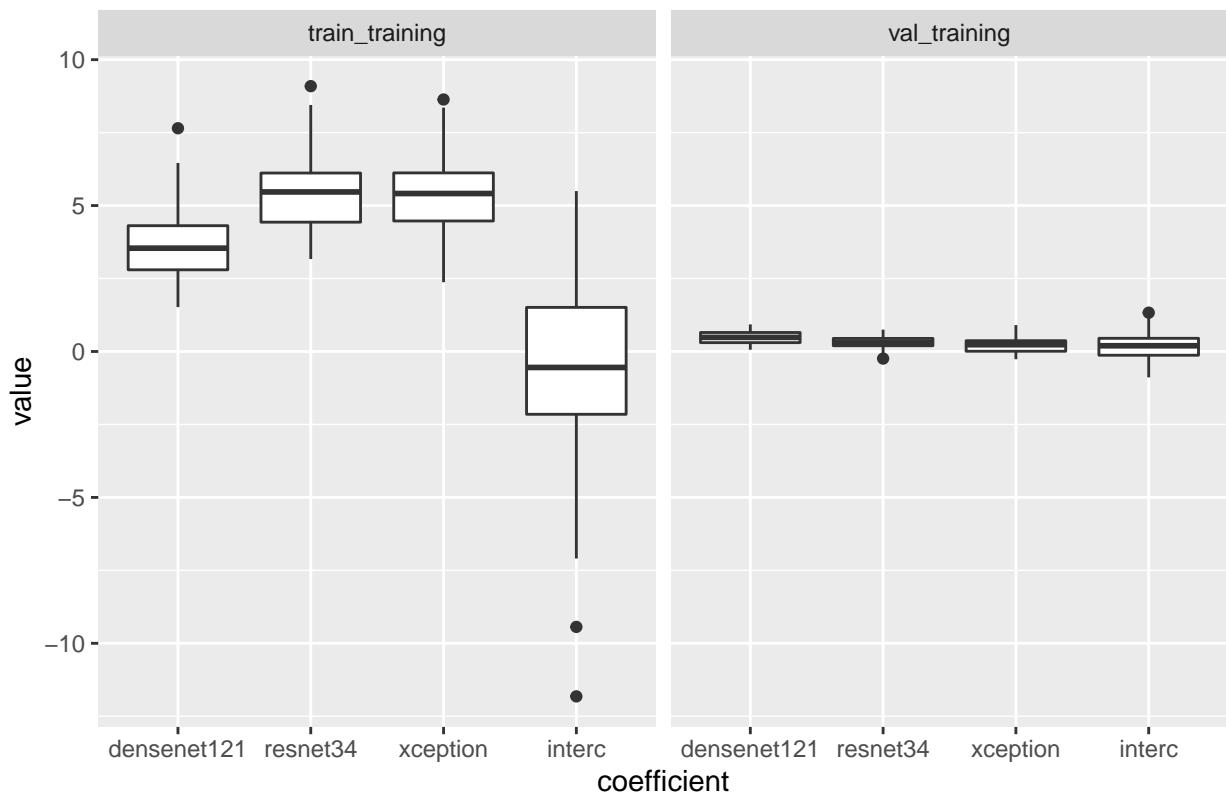
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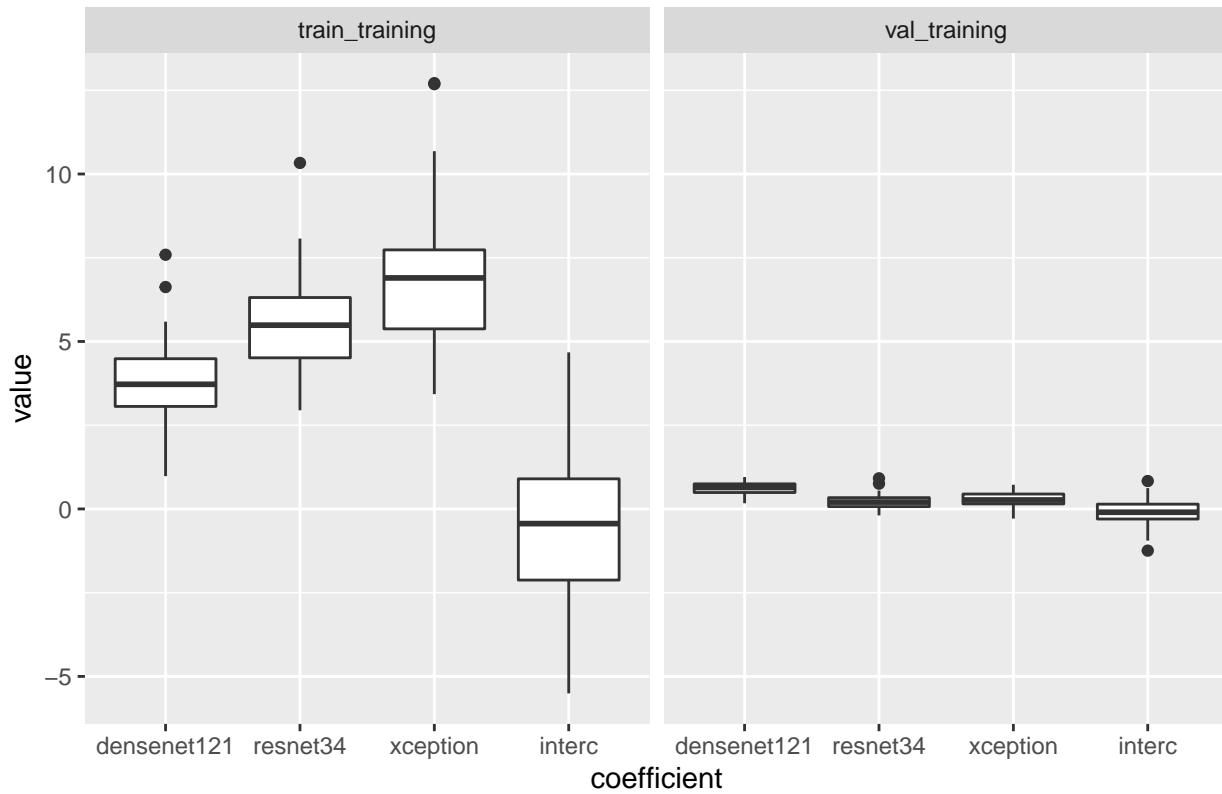
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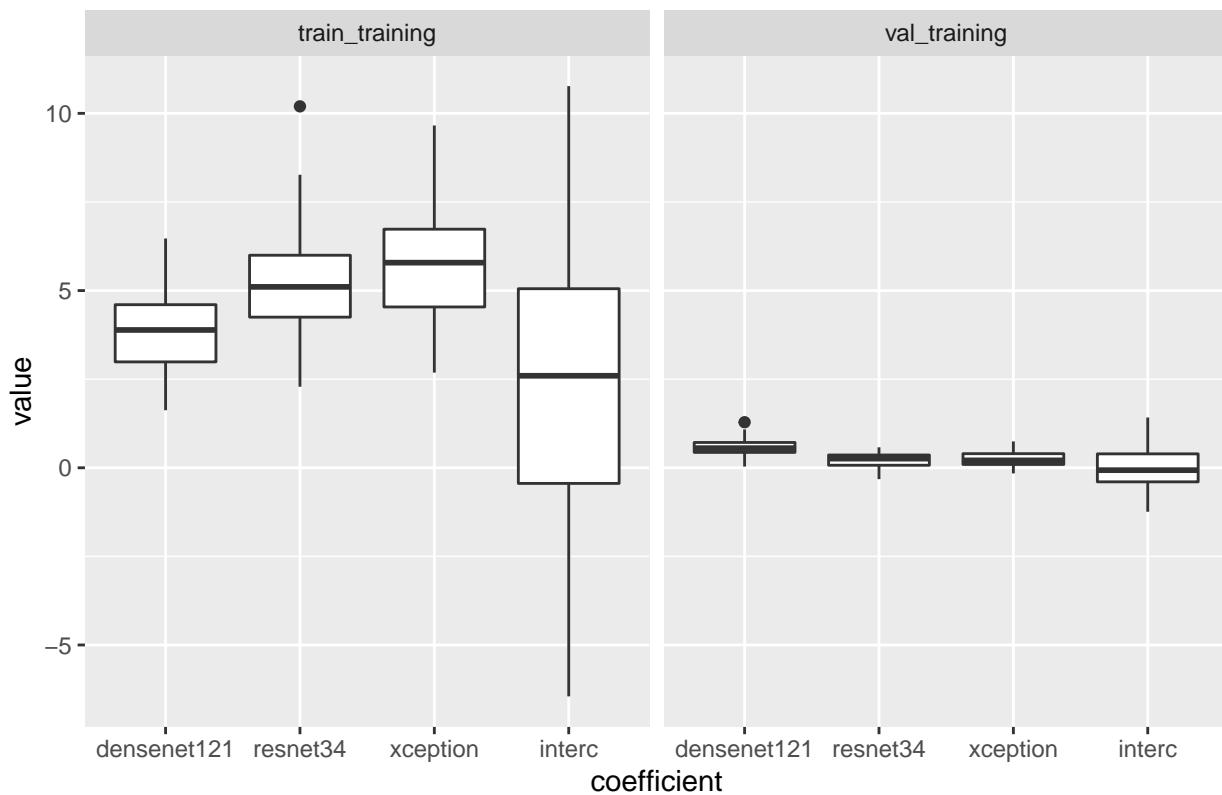
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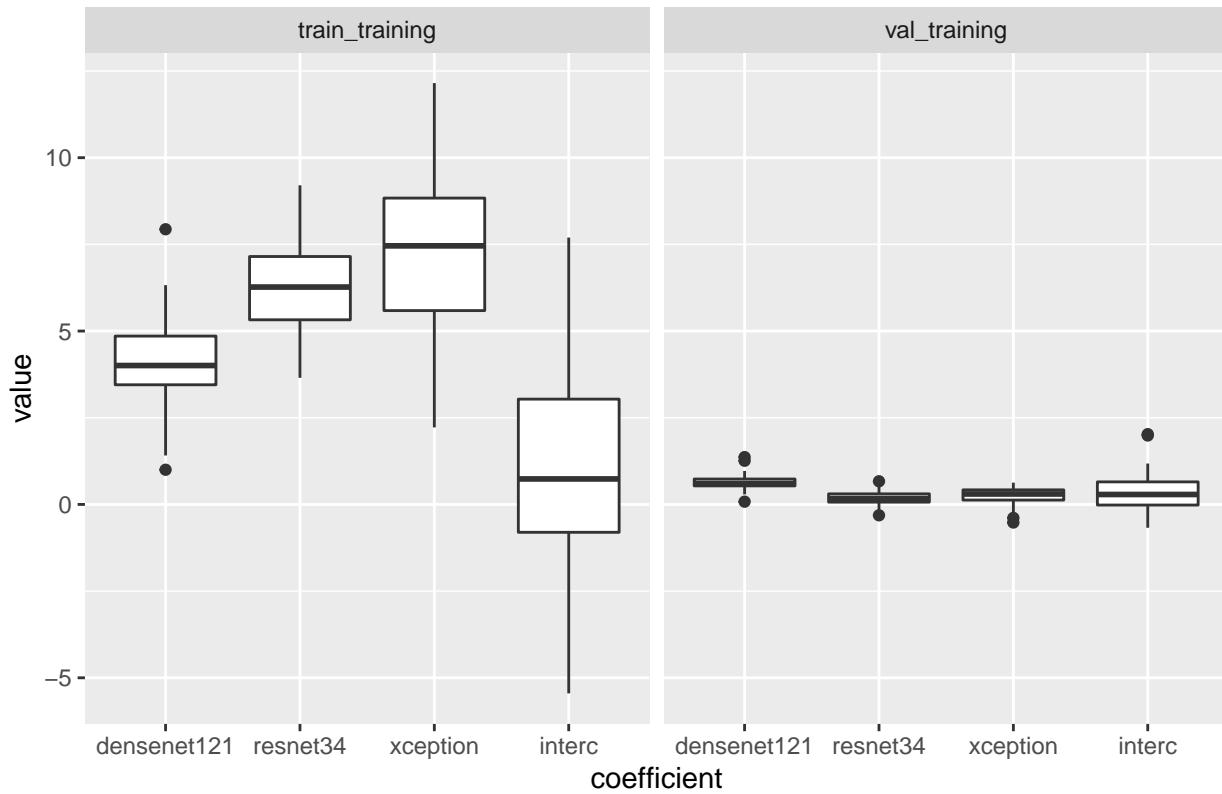
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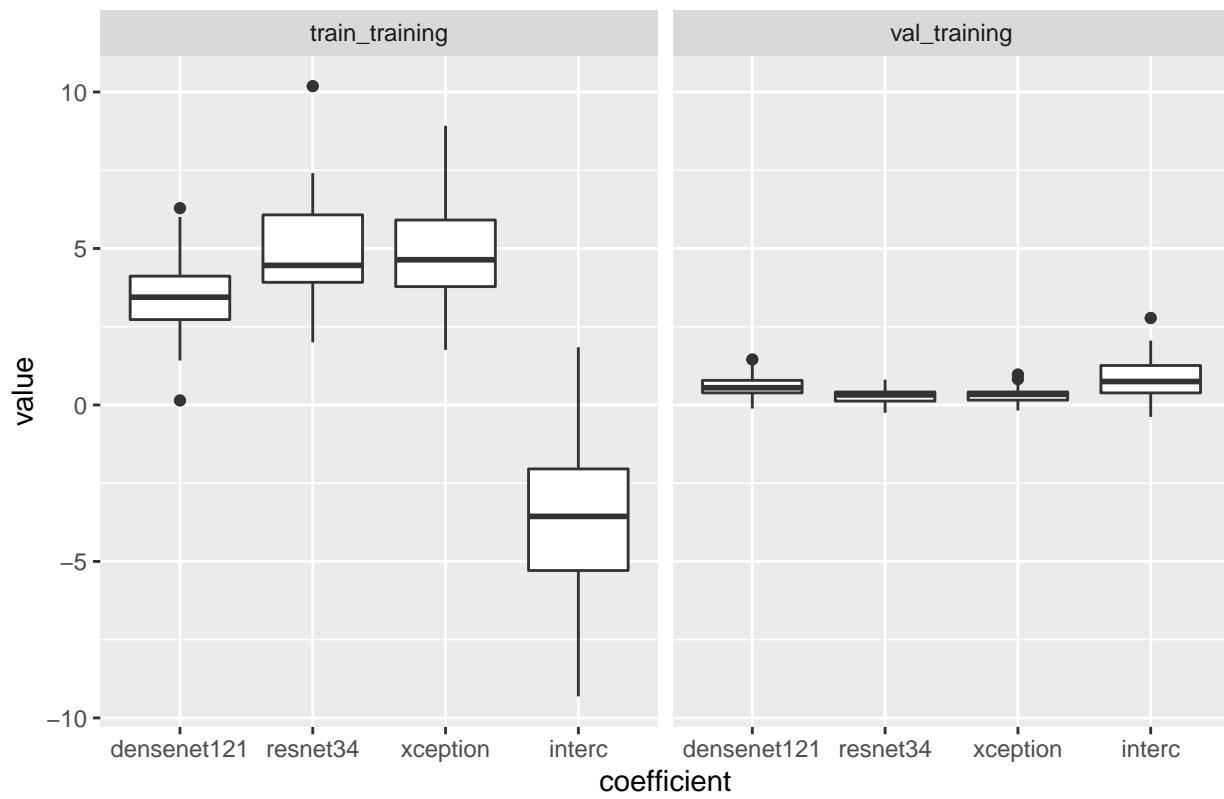
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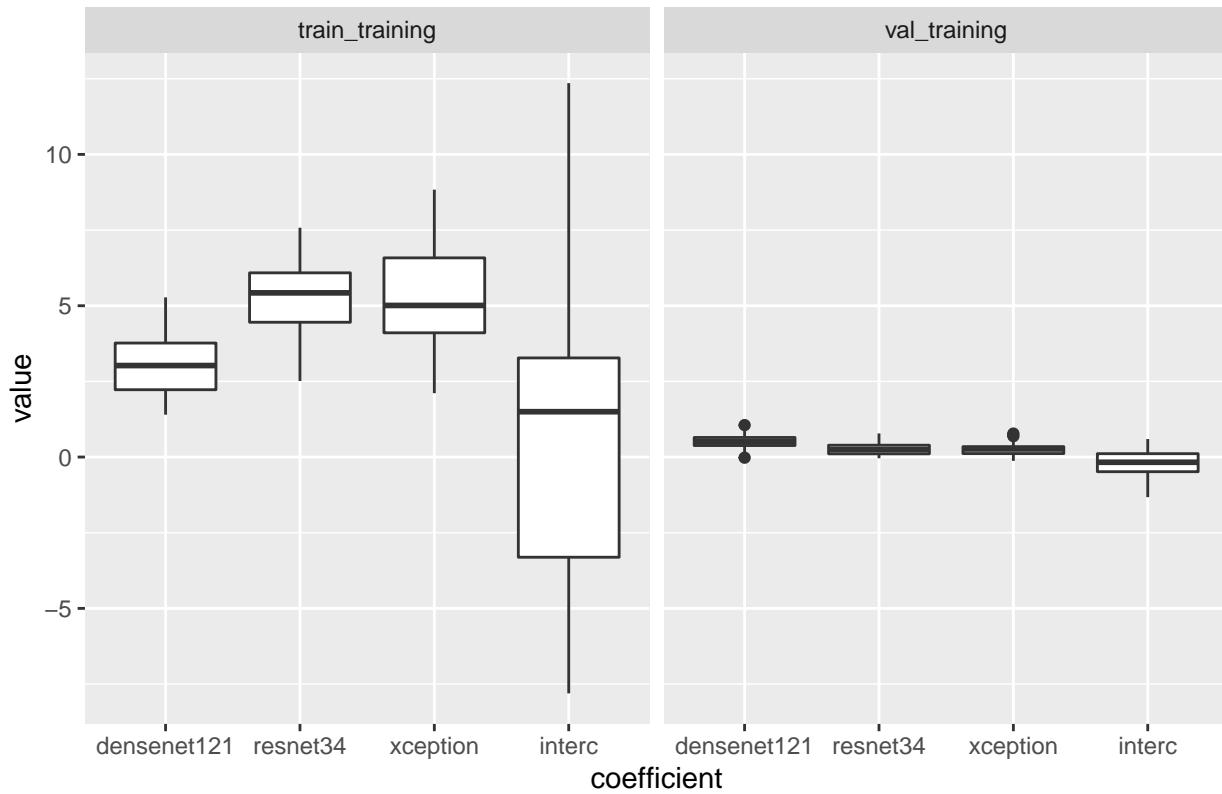
Coefficients for class 13 vs 17



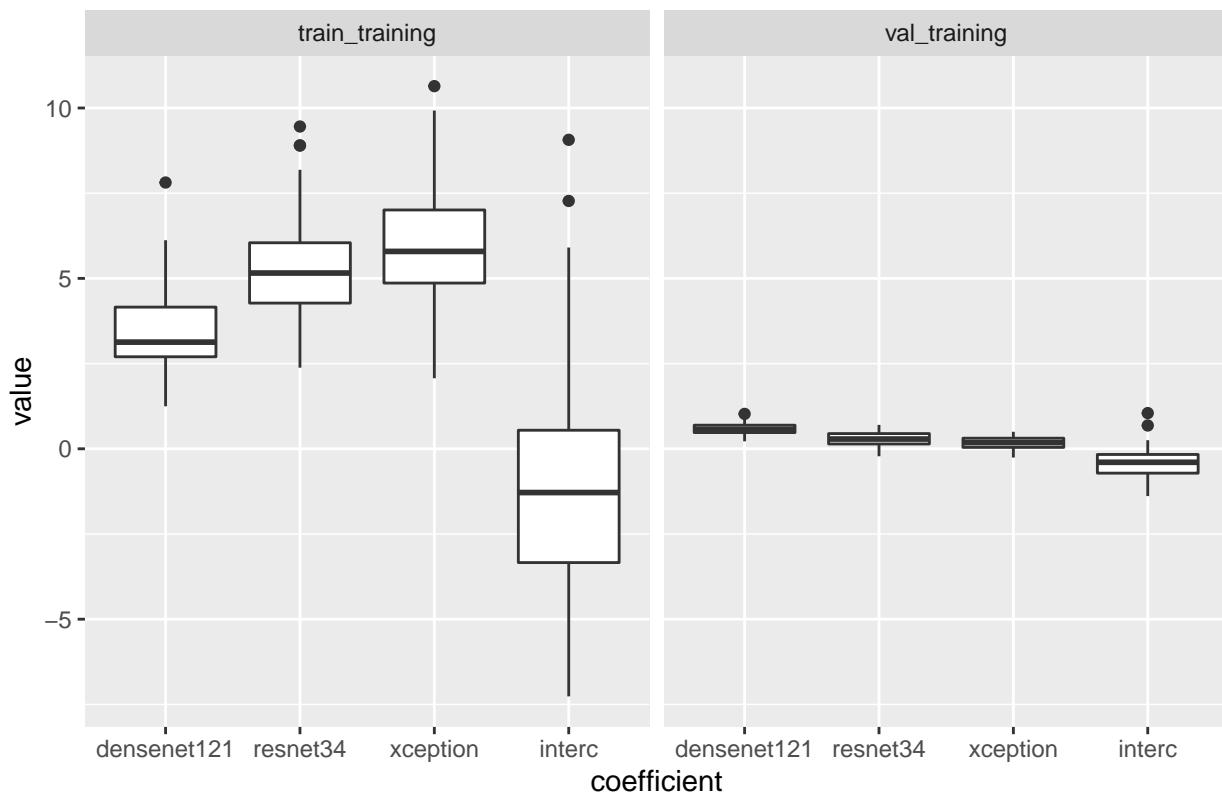
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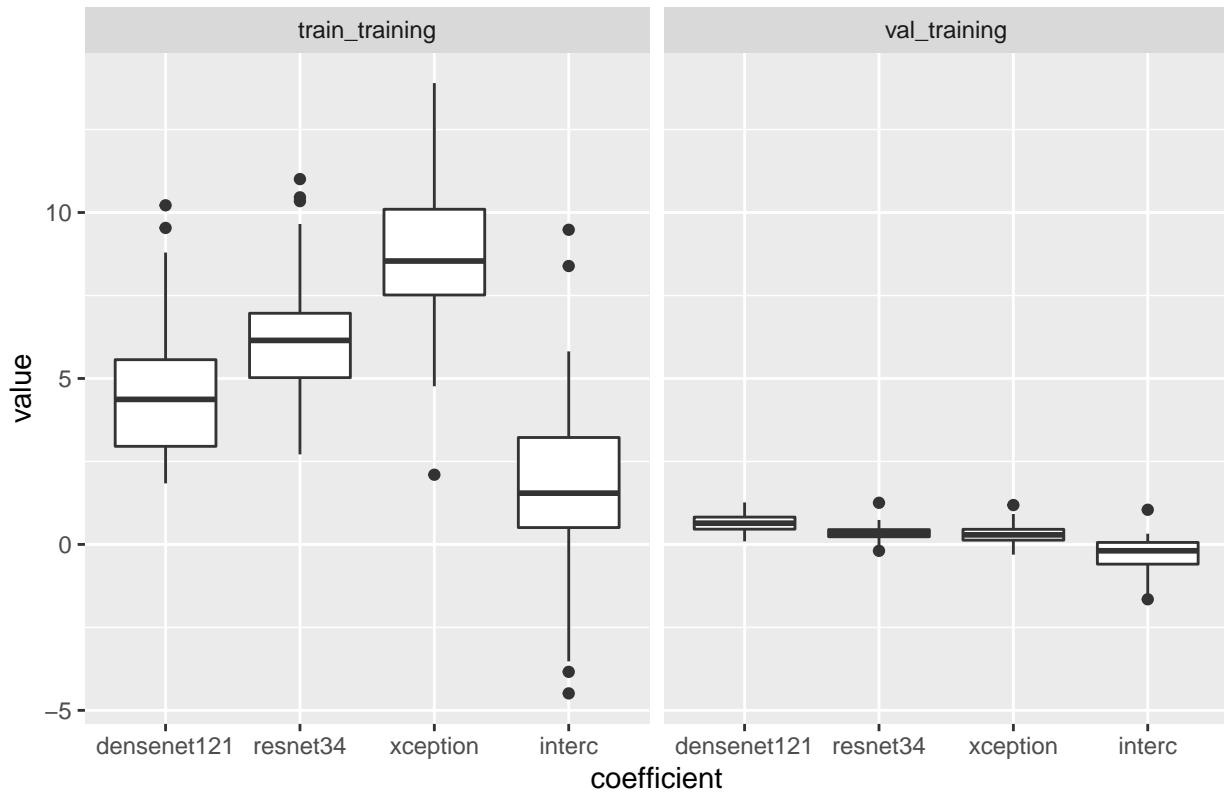
Coefficients for class 13 vs 19



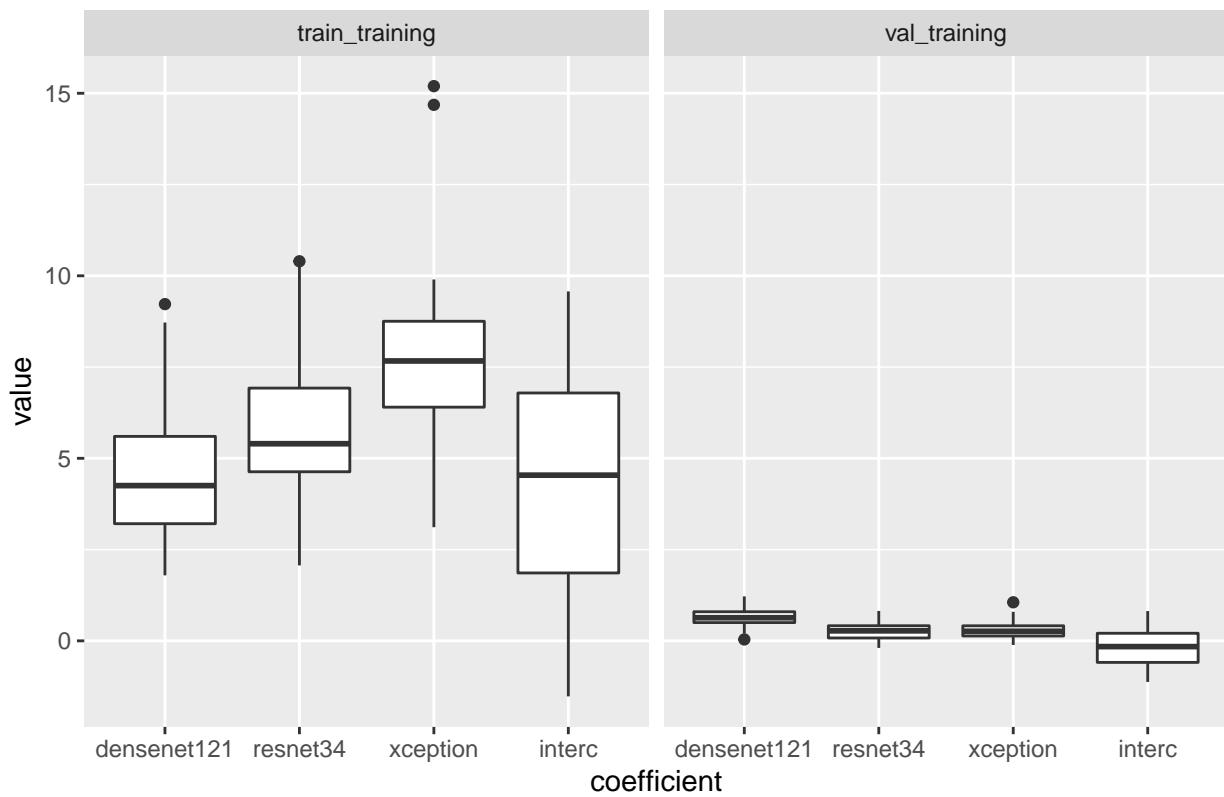
Coefficients for class 13 vs 20



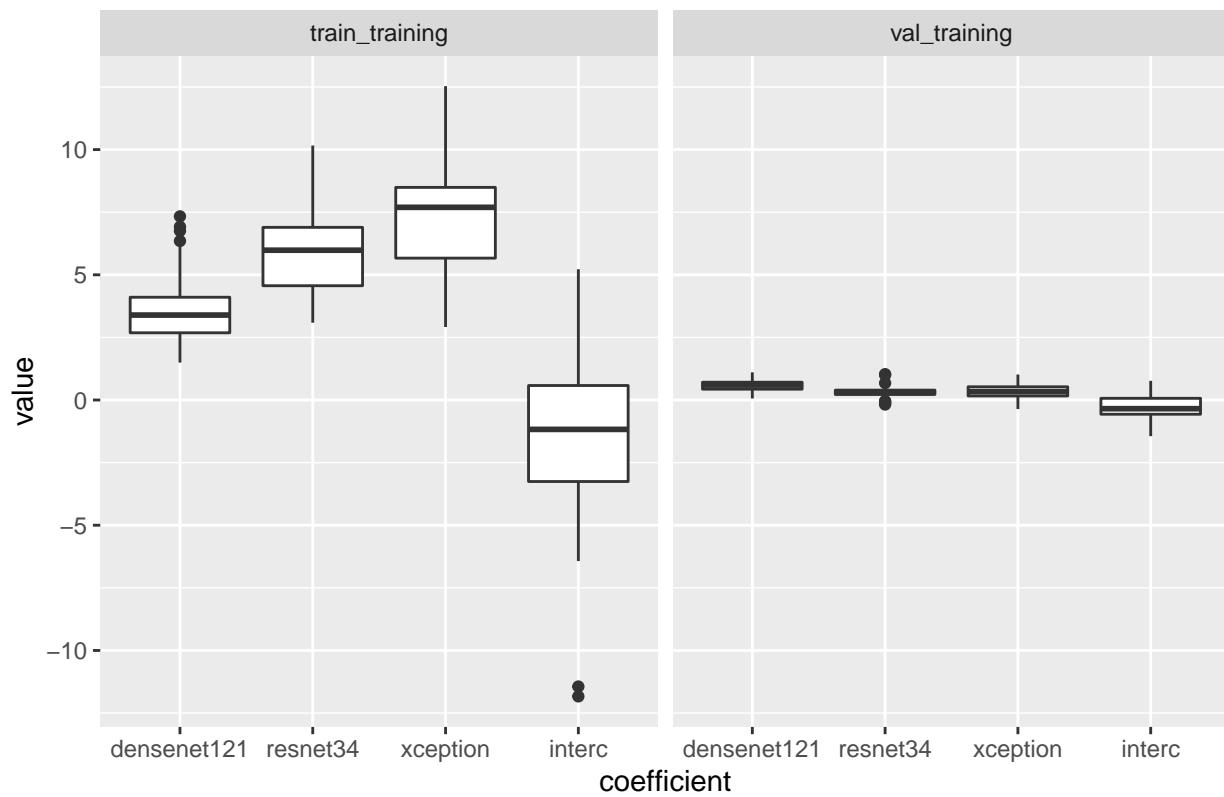
Coefficients for class 14 vs 15



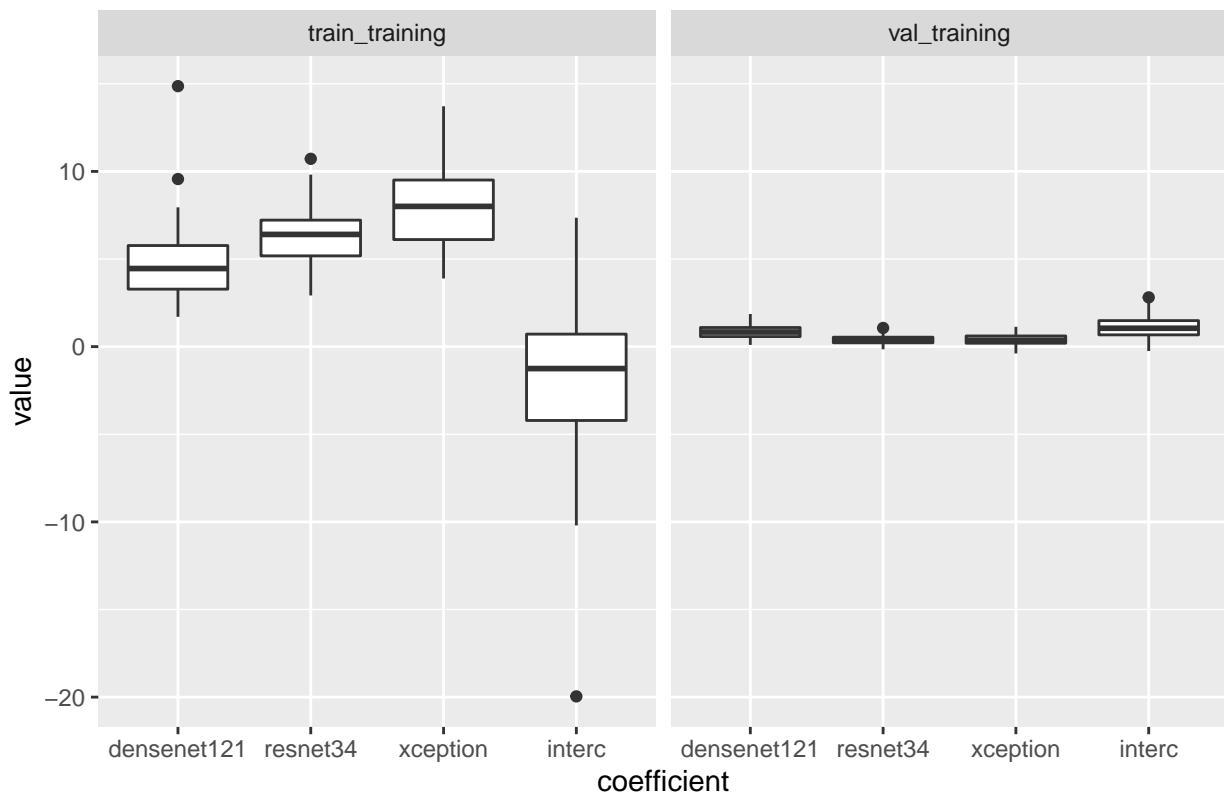
Coefficients for class 14 vs 16



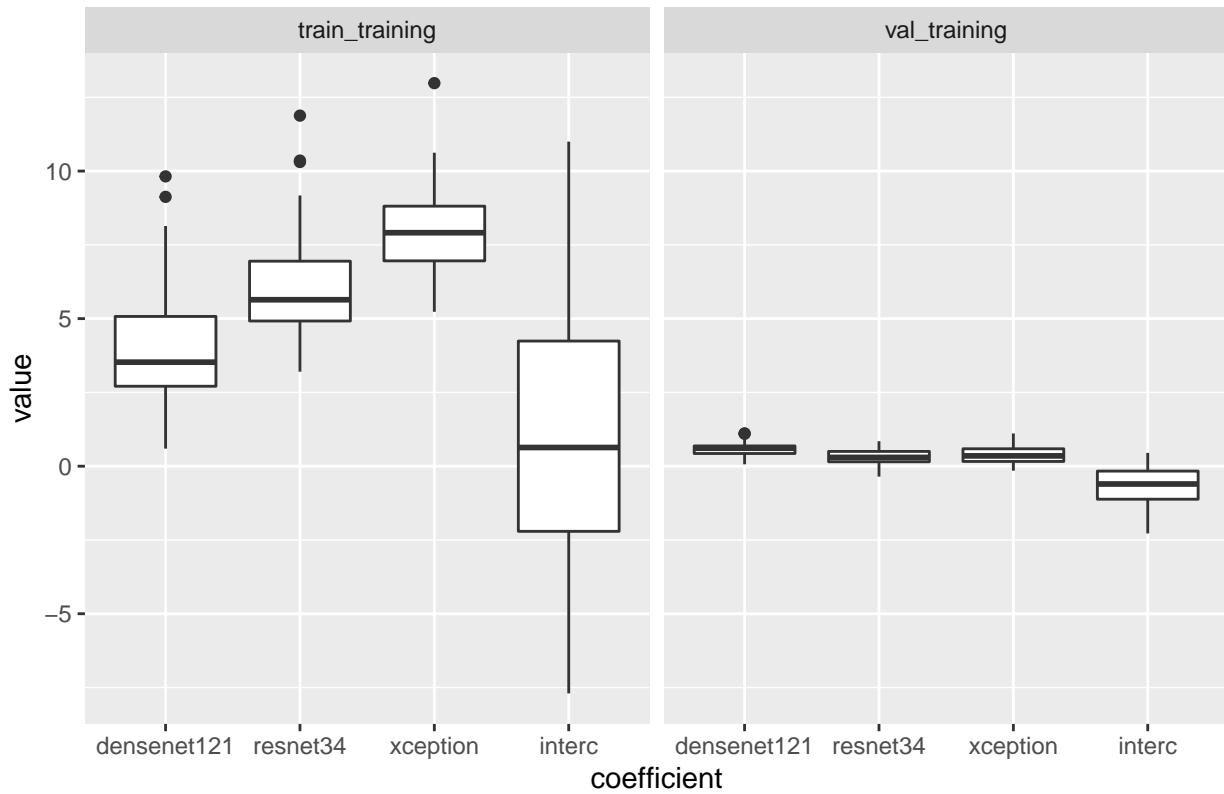
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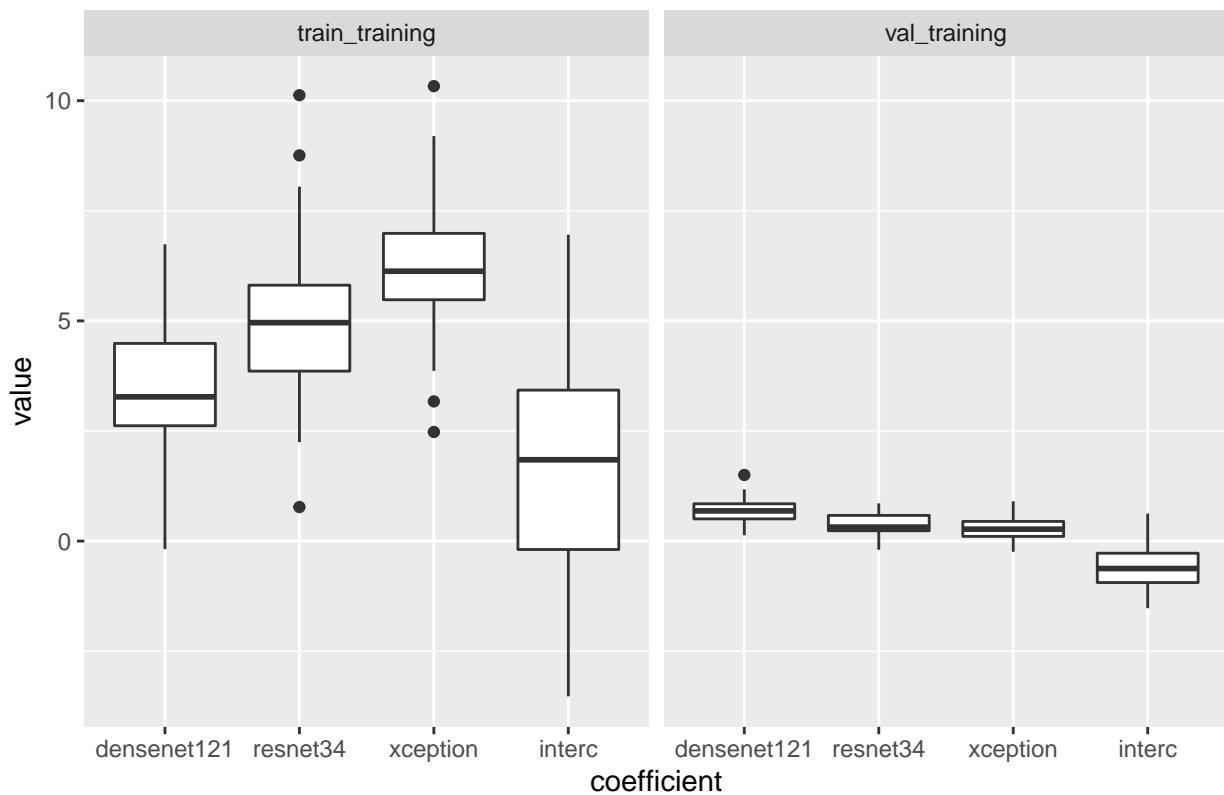
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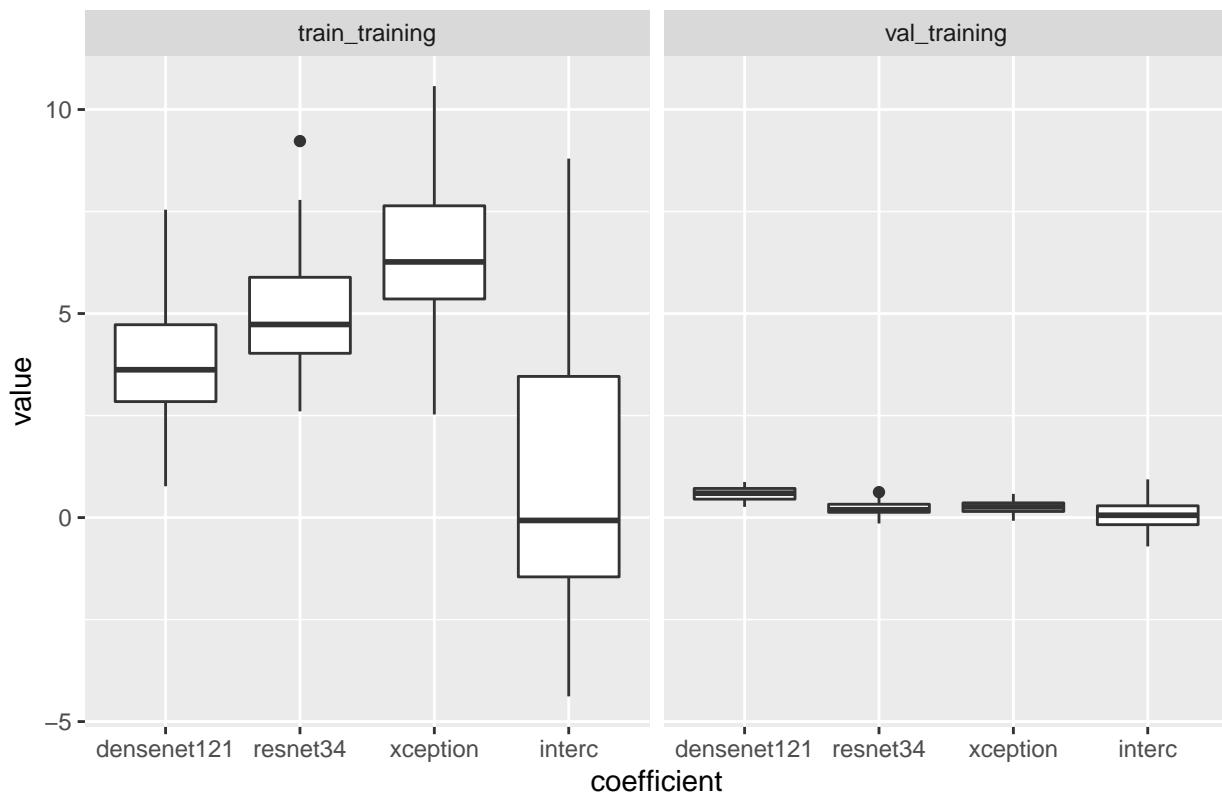
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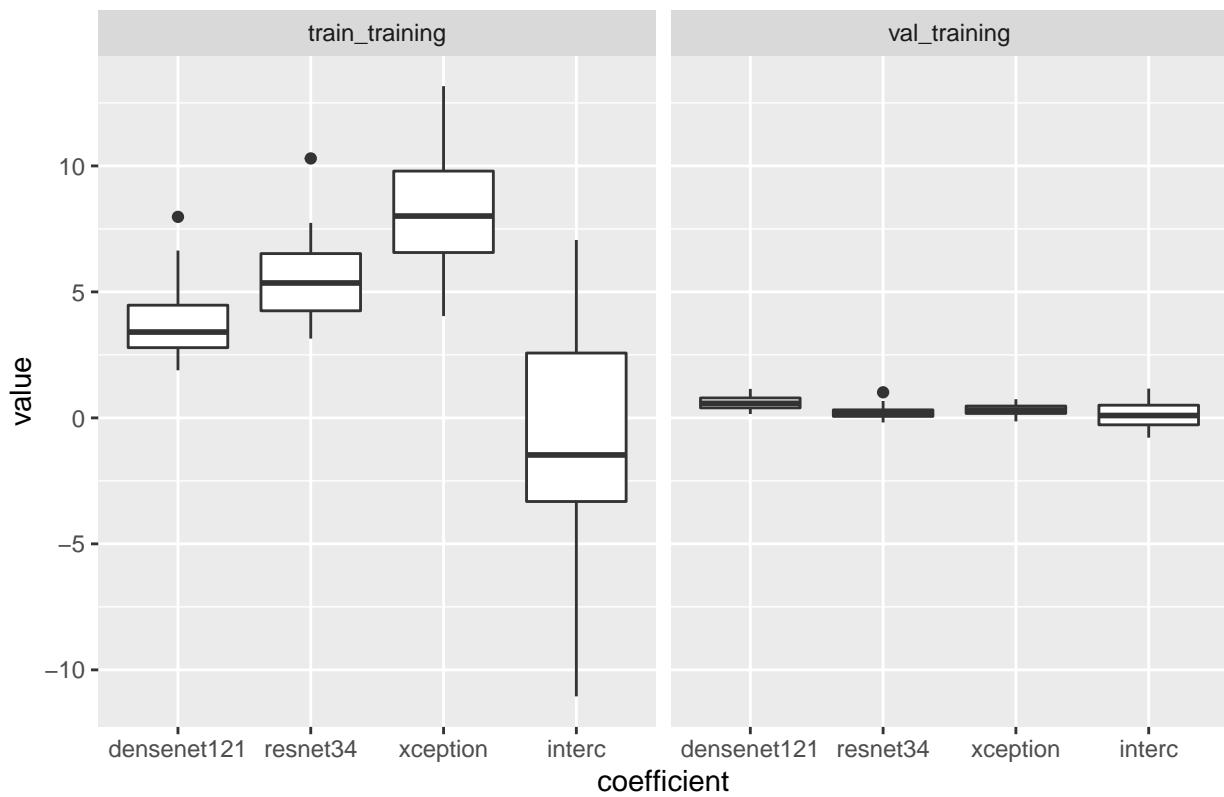
Coefficients for class 14 vs 20



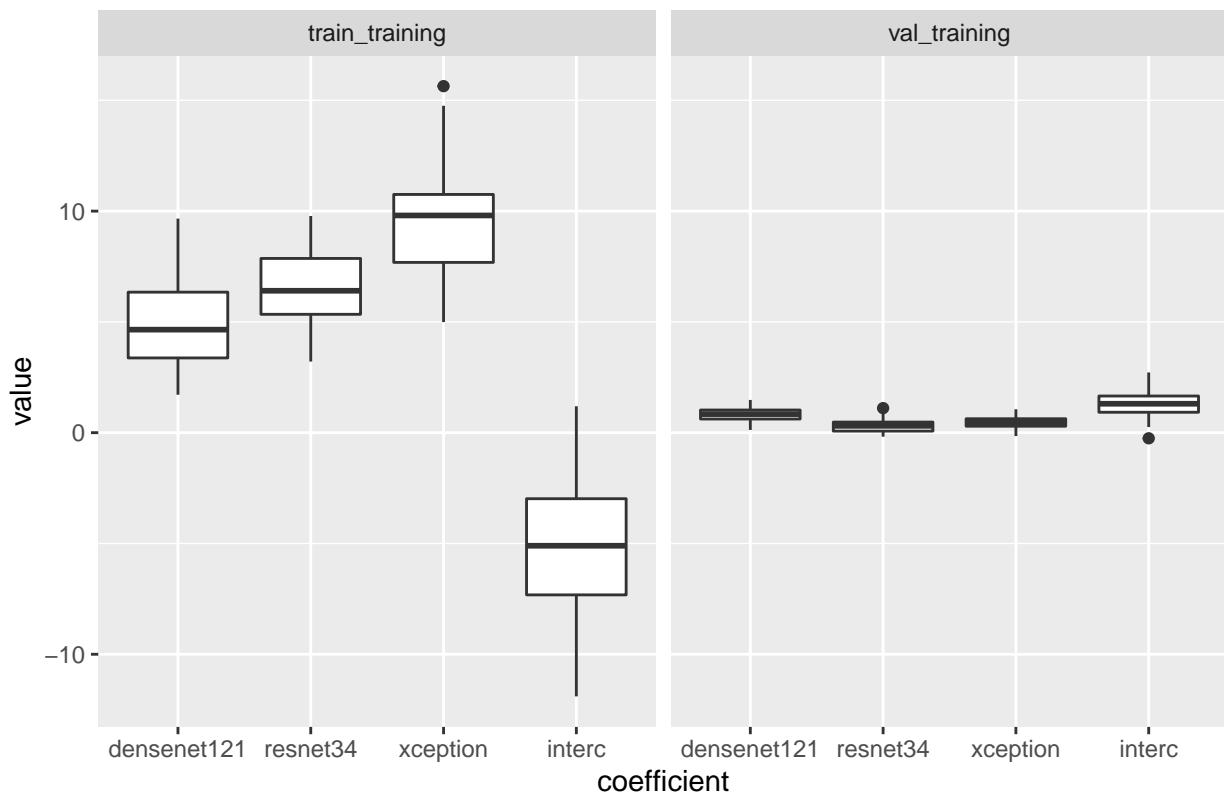
Coefficients for class 15 vs 16



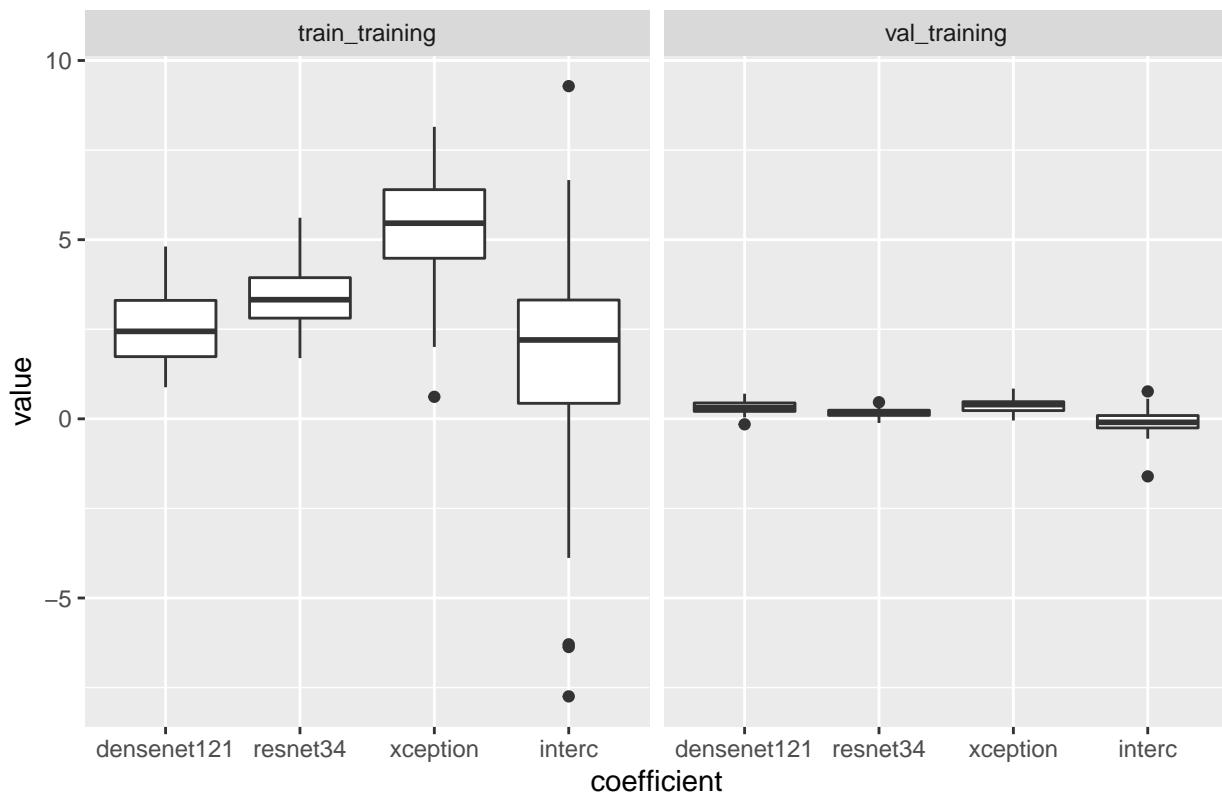
Coefficients for class 15 vs 17



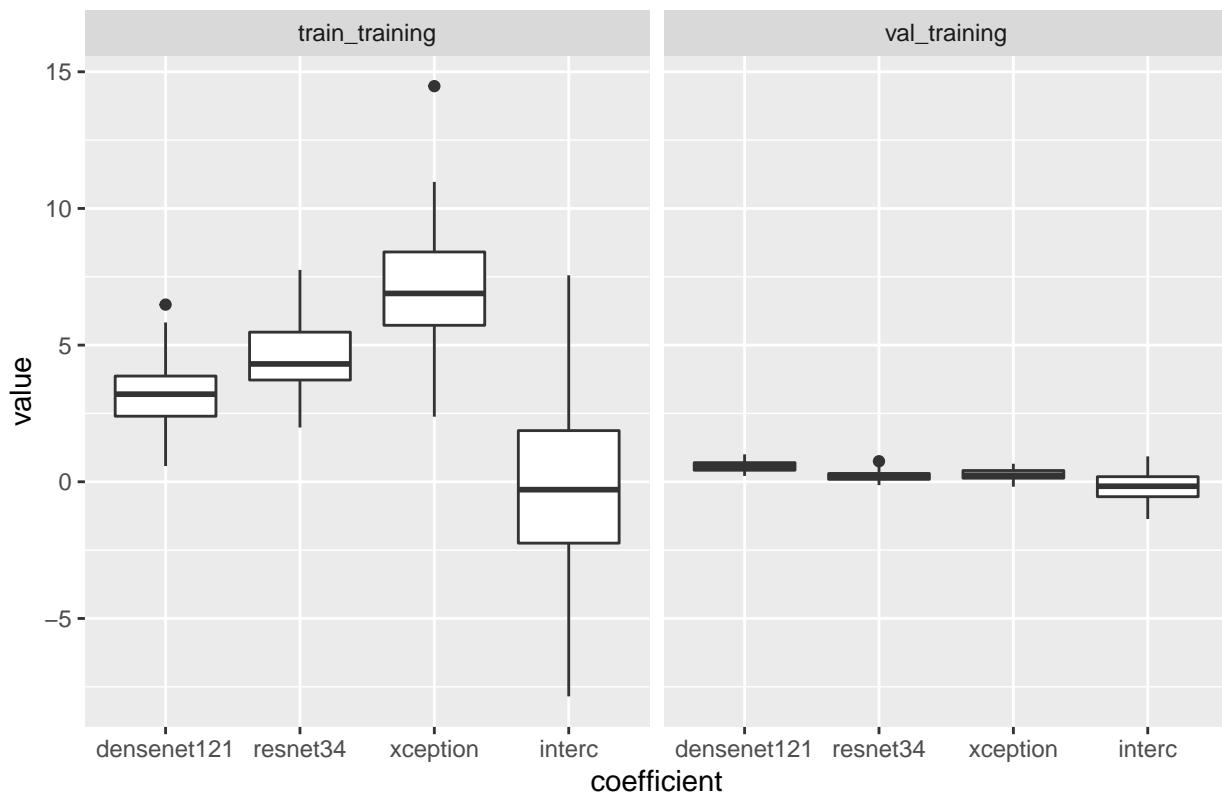
Coefficients for class 15 vs 18



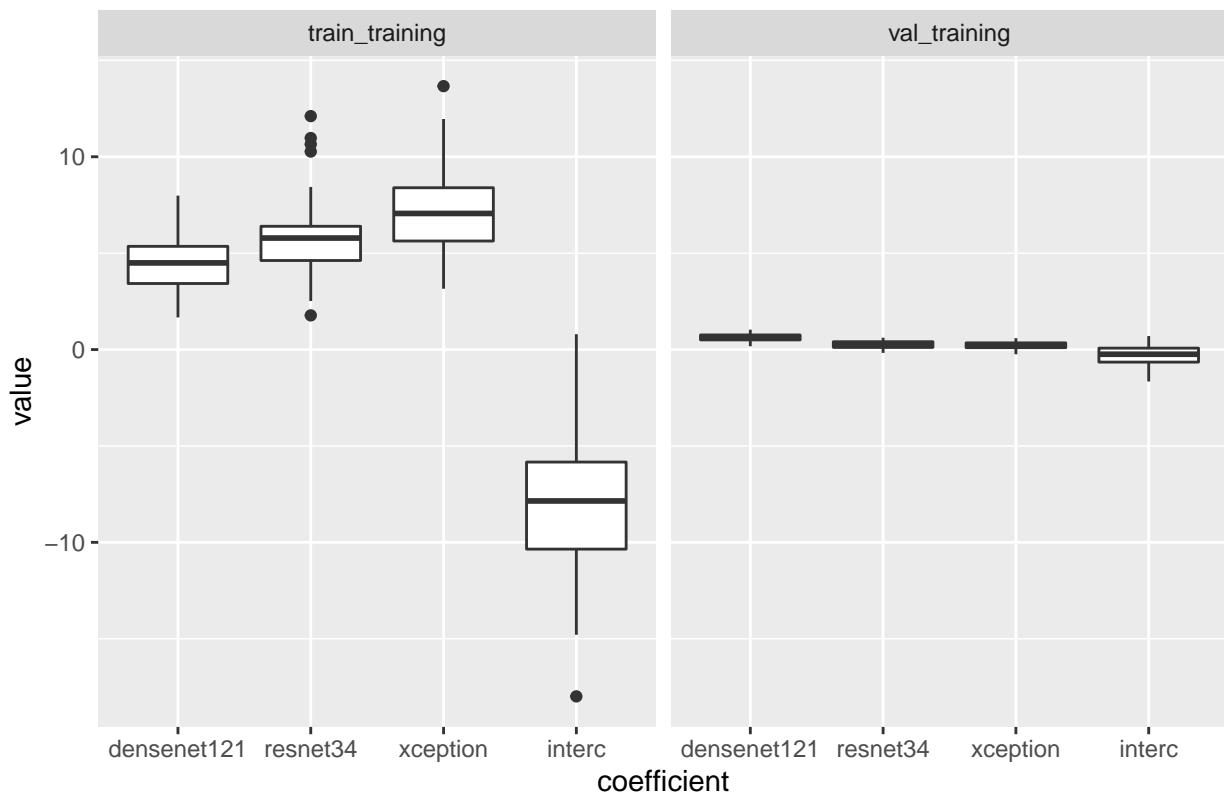
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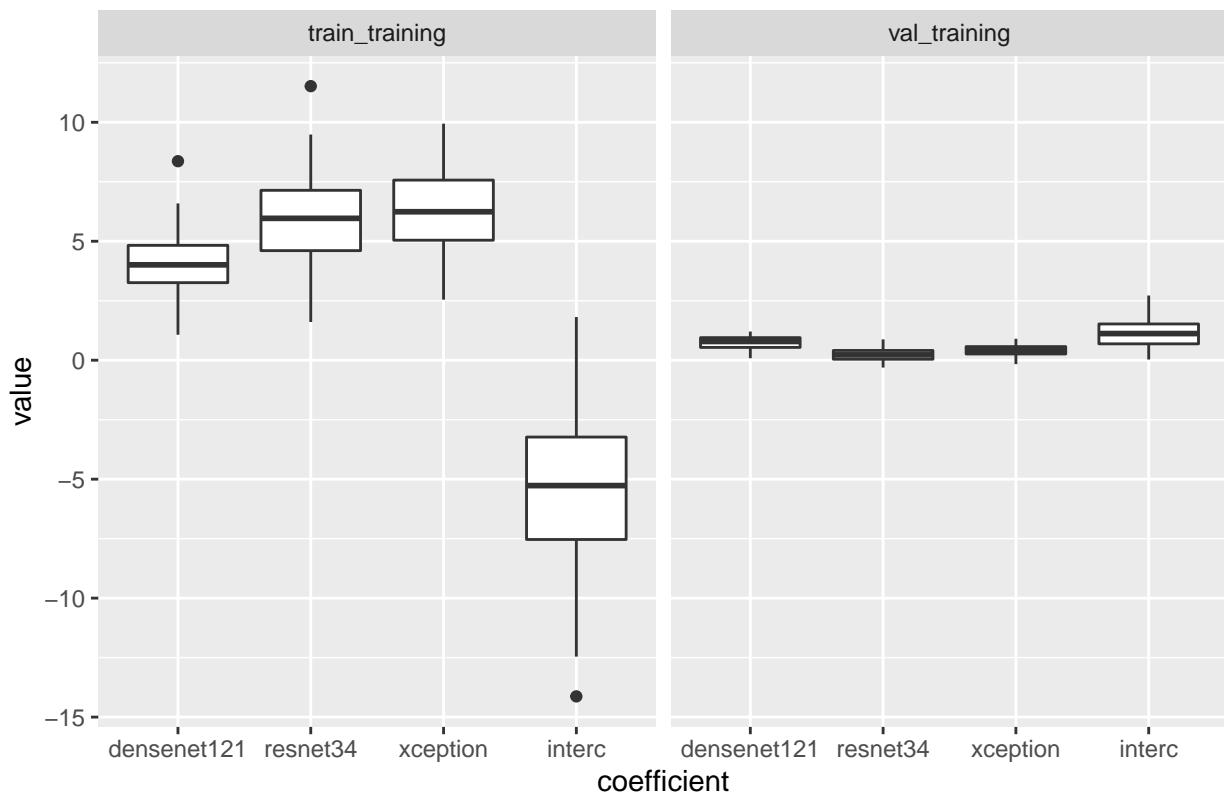
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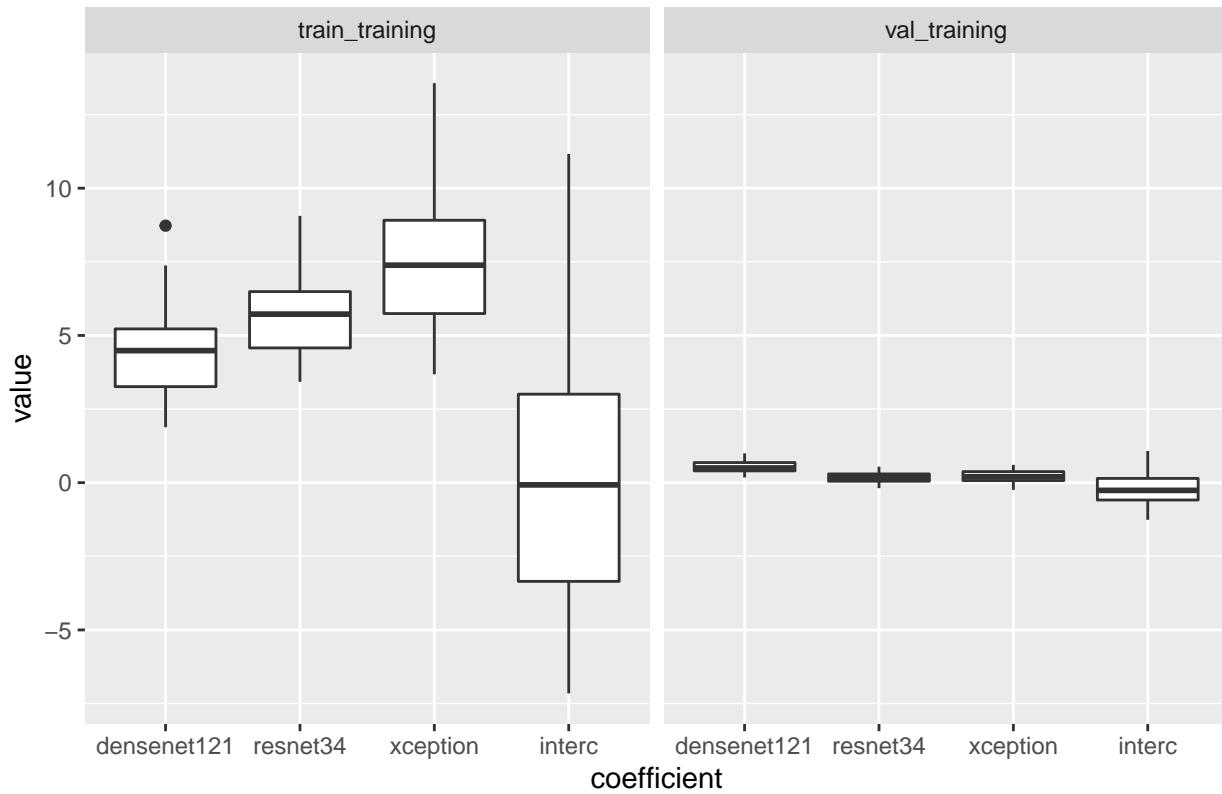
Coefficients for class 16 vs 17



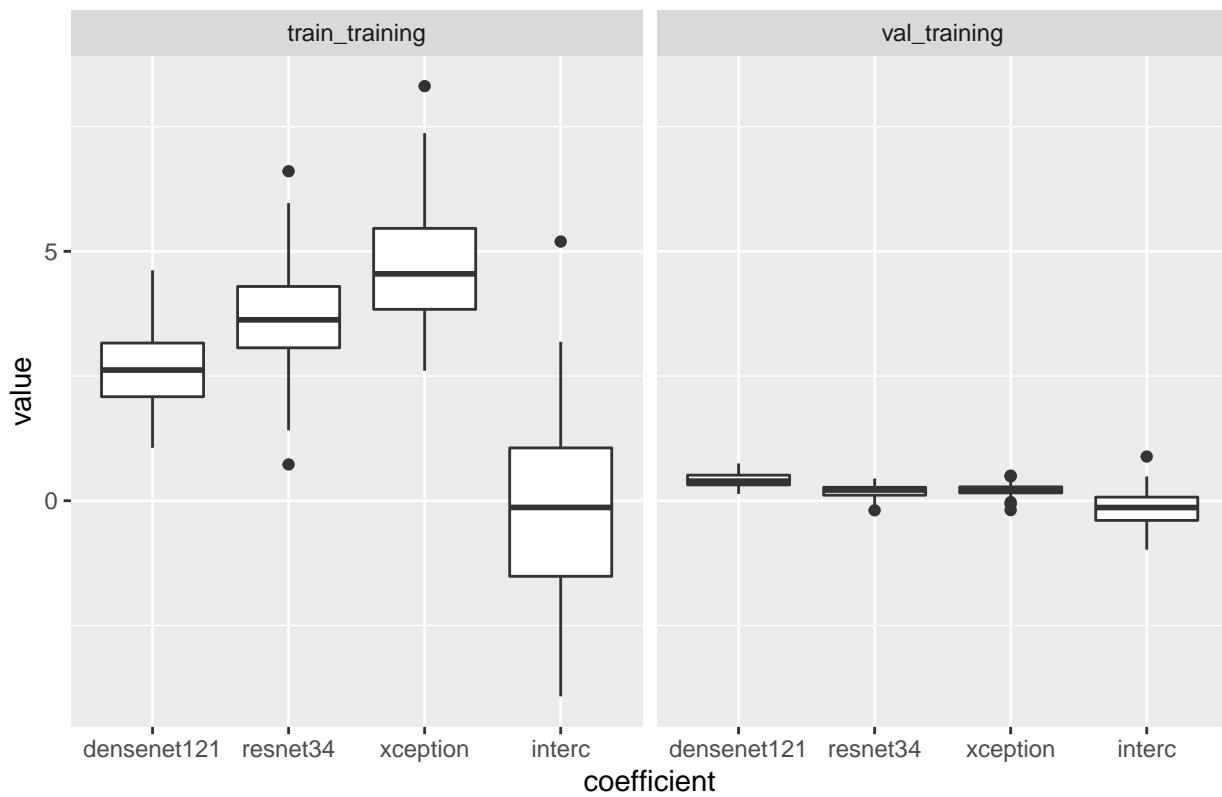
Coefficients for class 16 vs 18



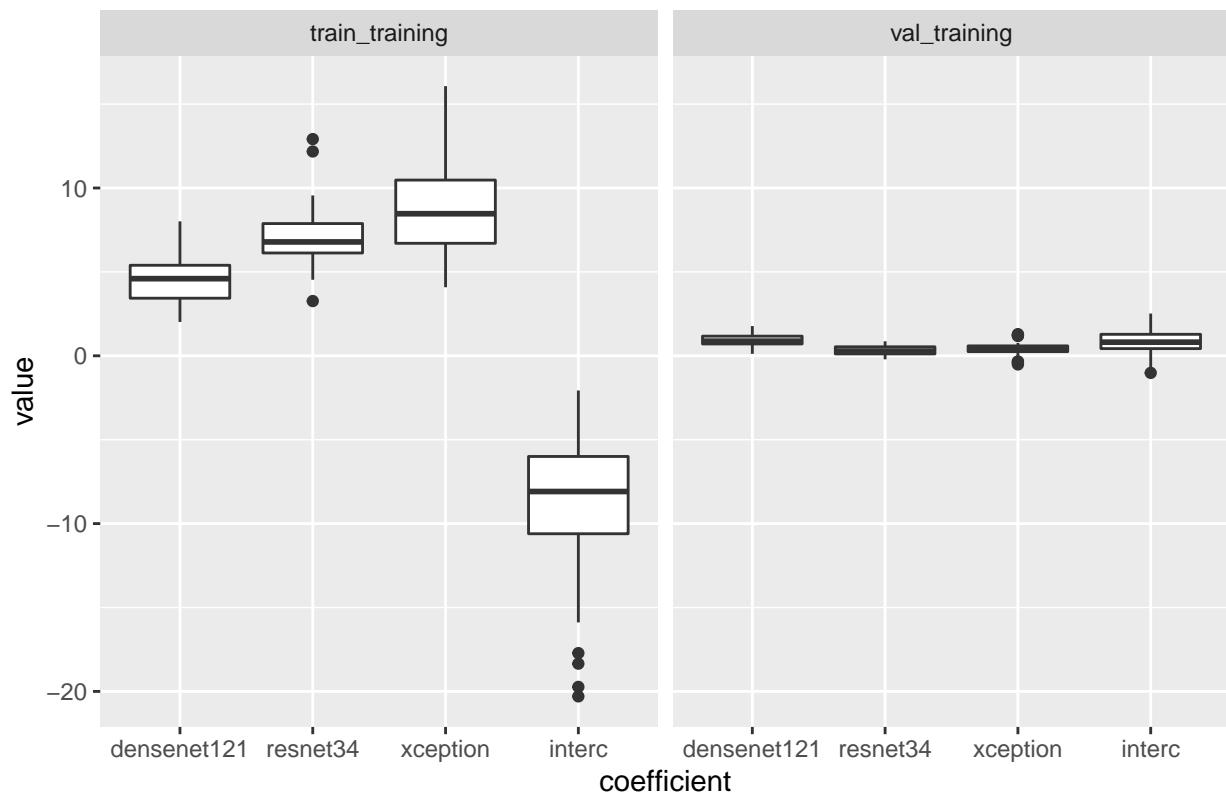
Coefficients for class 16 vs 19



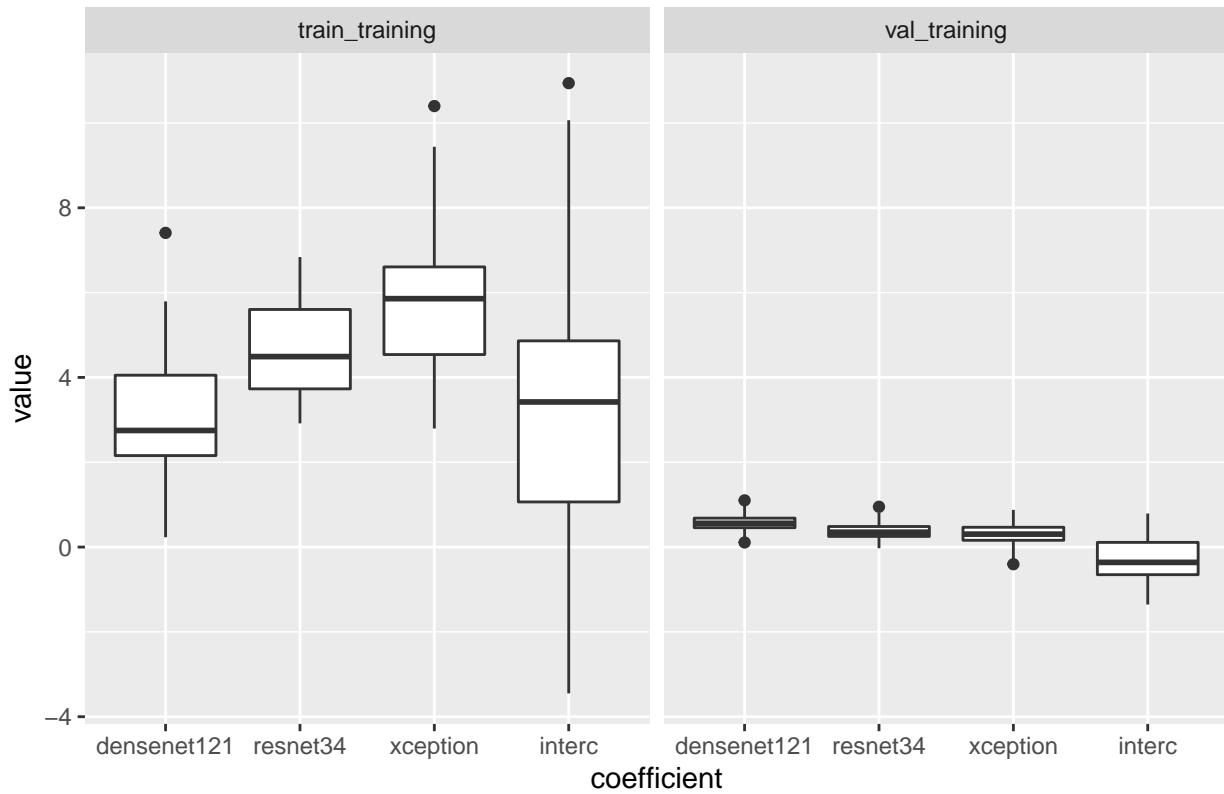
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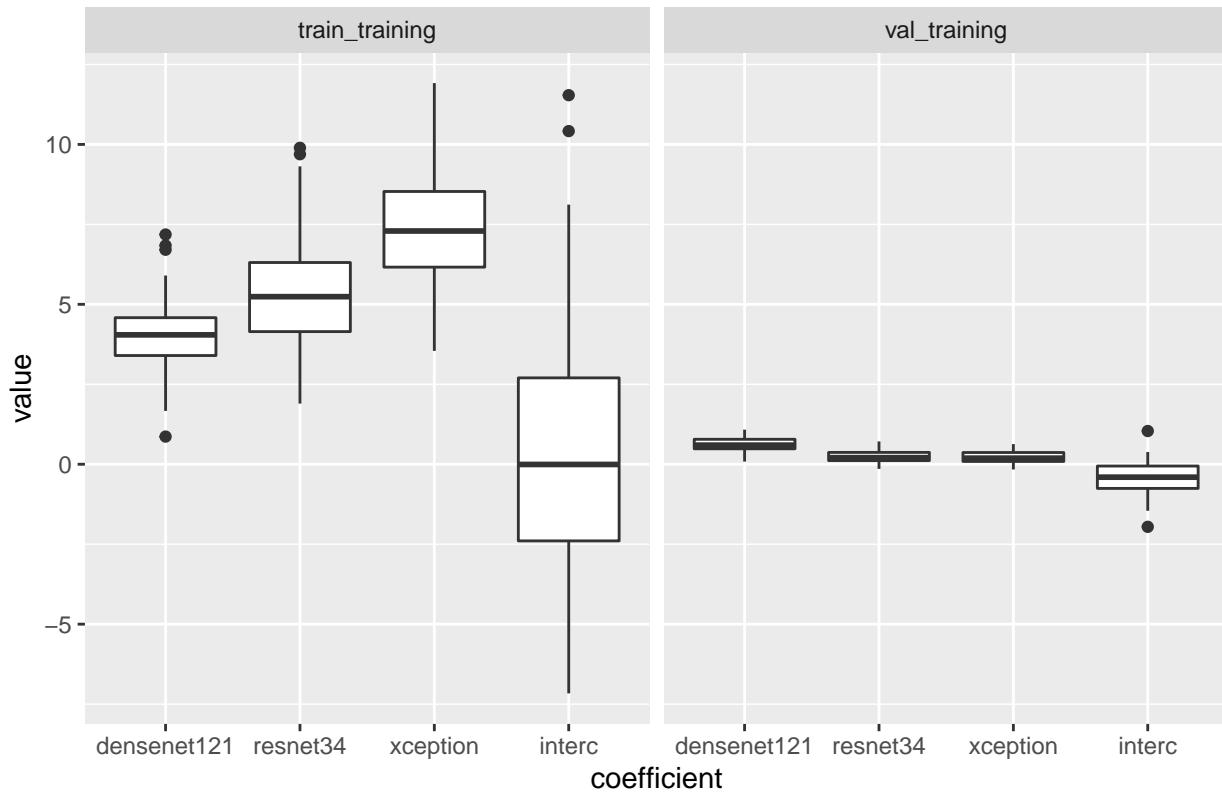
Coefficients for class 17 vs 18



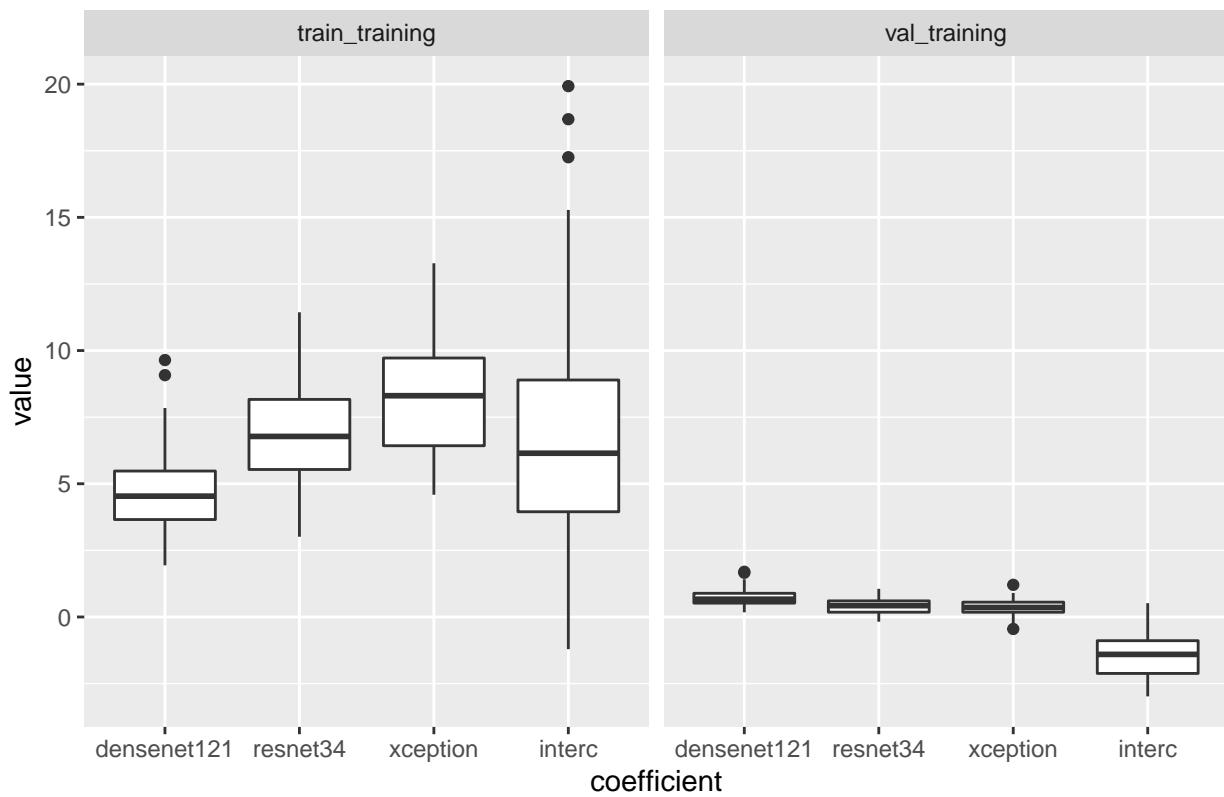
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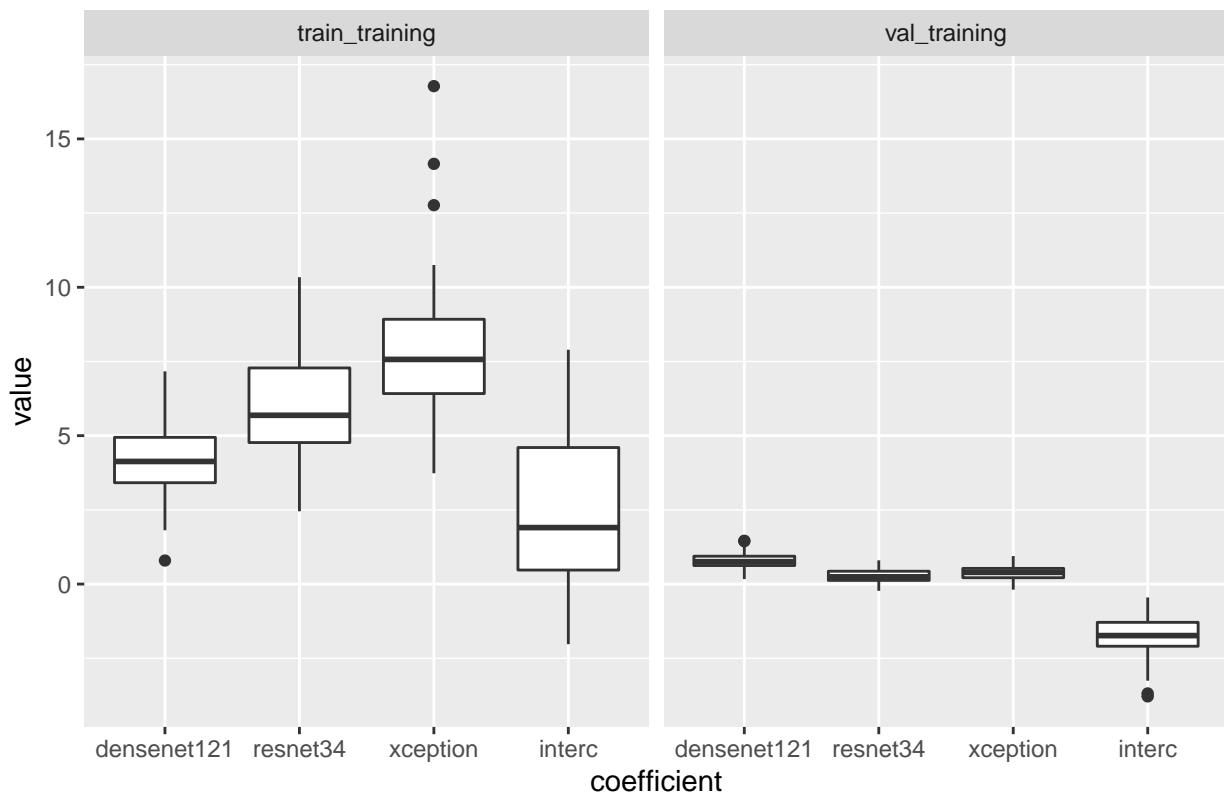
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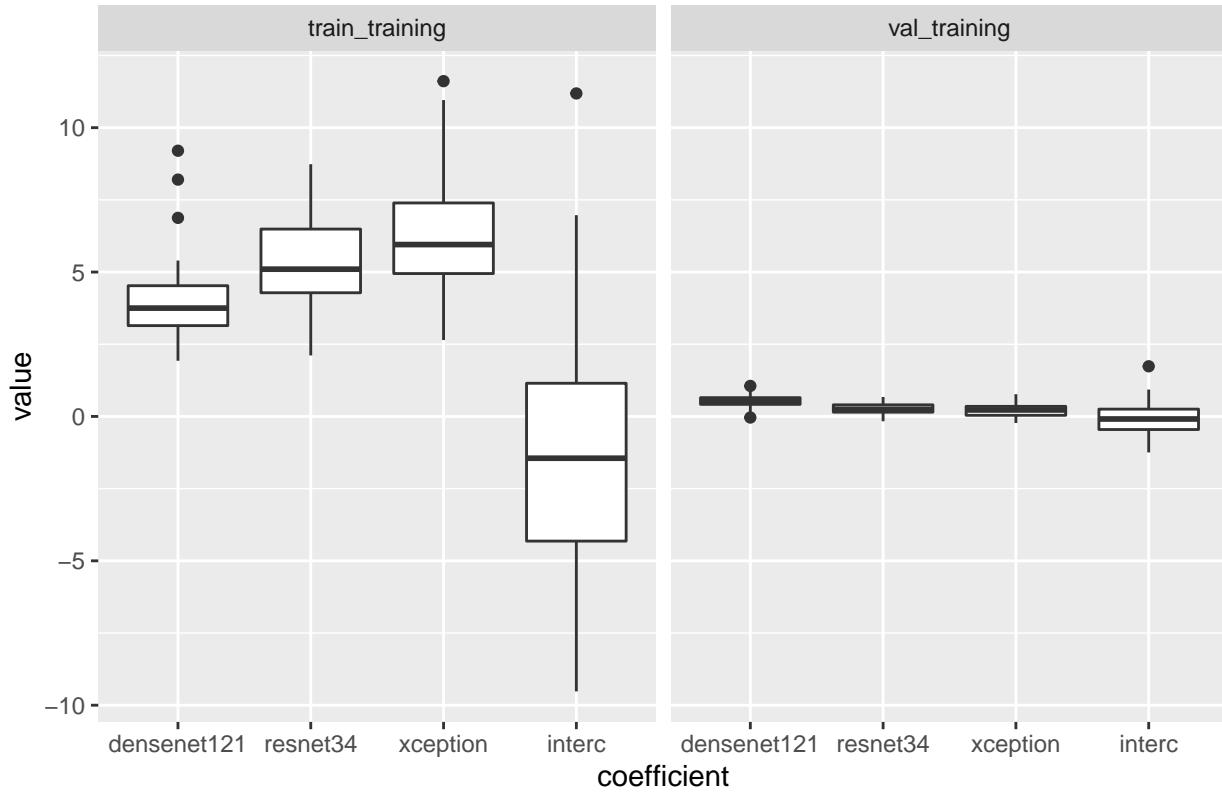
Coefficients for class 18 vs 19



Coefficients for class 18 vs 20



Coefficients for class 19 vs 20



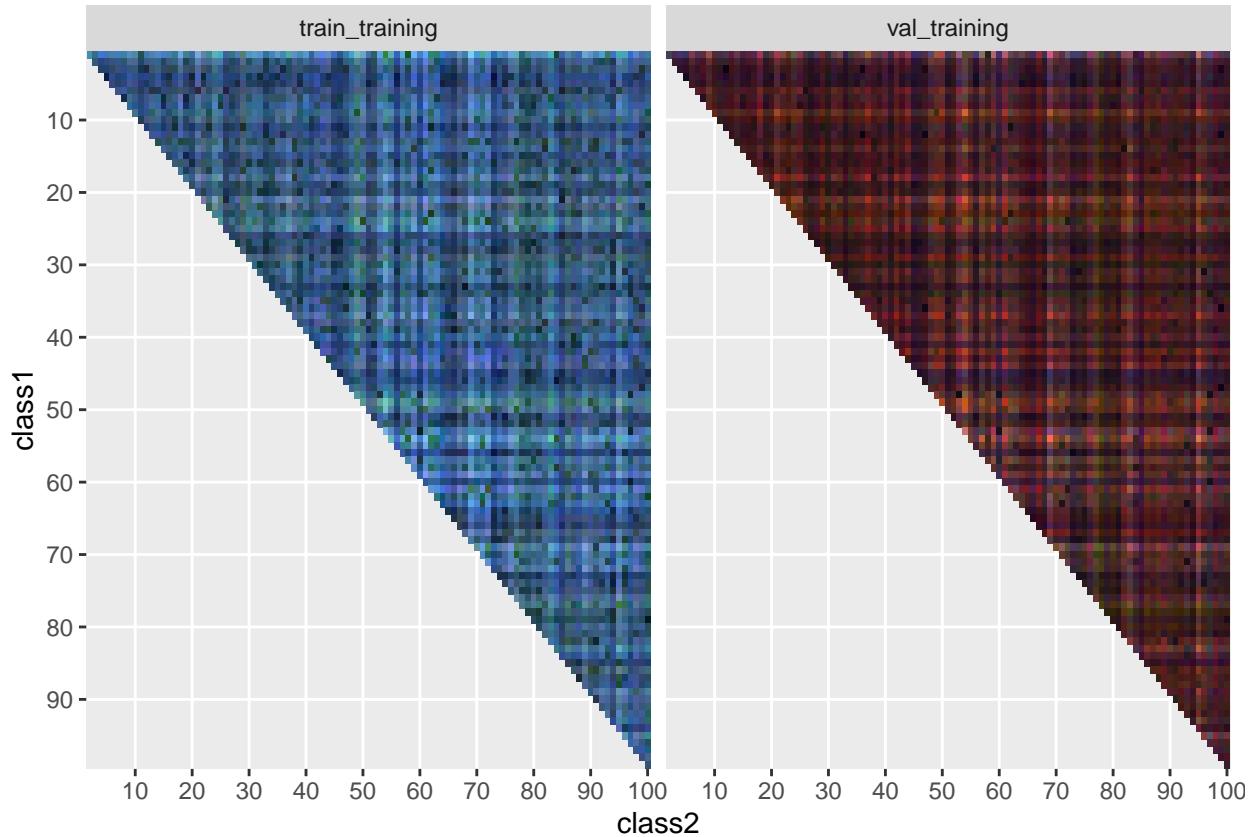
Coefficients of LDA trained on validation set have lower variance and more similar values across the networks.

```
avg_lda_coefs <- lda_coefs %>% filter(coefficient != "interc") %>% group_by(class1, class2, precision, train_type)

## `summarise()` has grouped output by 'class1', 'class2', 'precision', 'train_type'. You can override this by adding .by_group = TRUE to summarise()

avg_lda_coefs_vt <- avg_lda_coefs %>% filter(train_type=="val_training")
avg_lda_coefs_tt <- avg_lda_coefs %>% filter(train_type=="train_training")
avg_lda_coefs_vt$value <- avg_lda_coefs_vt$value - min(avg_lda_coefs_vt$value)
avg_lda_coefs_vt$value <- avg_lda_coefs_vt$value / max(avg_lda_coefs_vt$value)
avg_lda_coefs_tt$value <- avg_lda_coefs_tt$value - min(avg_lda_coefs_tt$value)
avg_lda_coefs_tt$value <- avg_lda_coefs_tt$value / max(avg_lda_coefs_tt$value)
avg_lda_coefs <- rbind(avg_lda_coefs_vt, avg_lda_coefs_tt)
avg_lda_c_w <- pivot_wider(avg_lda_coefs, names_from = coefficient, values_from = value)
avg_lda_c_w[, c("class1", "class2")] <- lapply(avg_lda_c_w[, c("class1", "class2")], as.factor)

raster_plot <- ggplot(avg_lda_c_w) +
  geom_tile(aes(x=class2, y=class1, fill=rgb(densenet121, resnet34, xception))) +
  scale_y_discrete(limits=rev, breaks=seq(0,classes, 10)) + scale_x_discrete(breaks=seq(0,classes, 10))
raster_plot
```



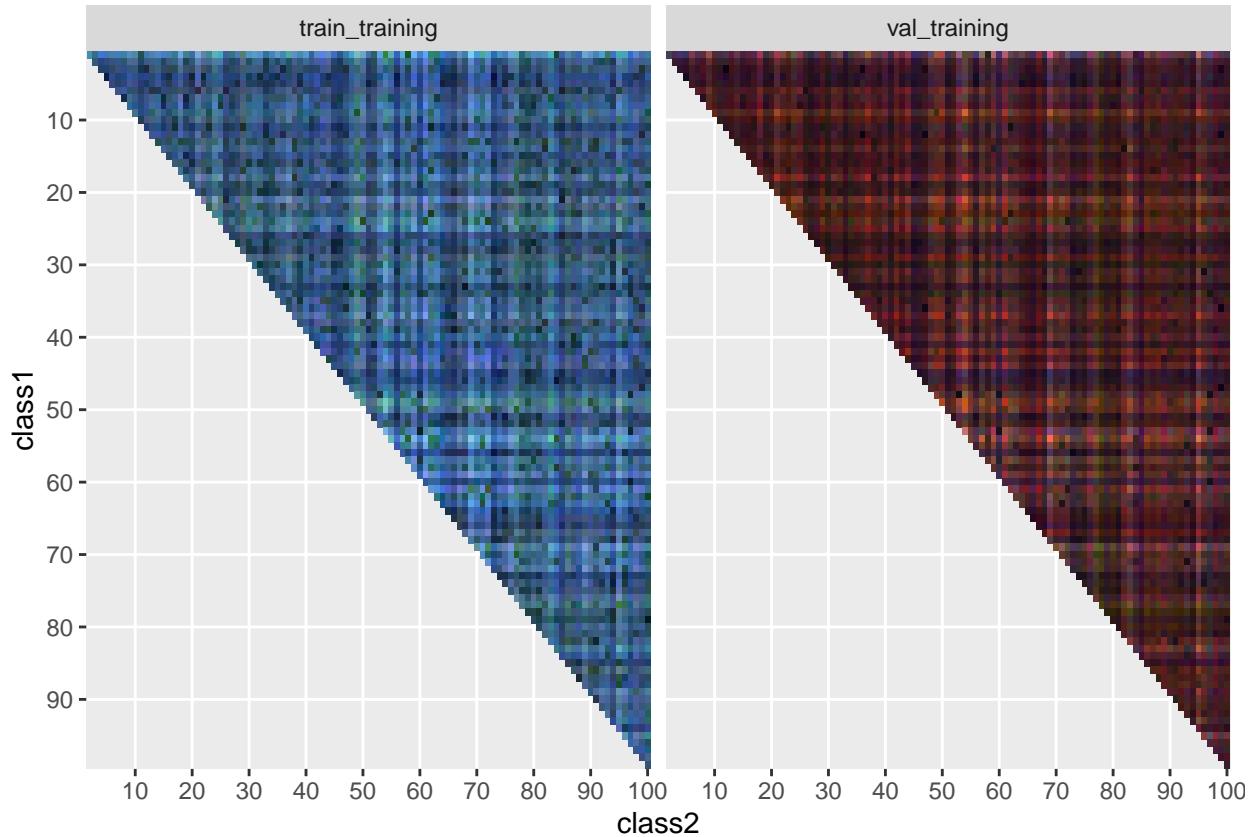
For validation set trained LDAs, red - densenet seems to be dominant. On the other hand for train set trained LDAs blue - xception has higher values.

```
avg_lda_coefs <- lda_coefs %>% filter(coefficient != "interc") %>% group_by(class1, class2, precision, train_type)

## `summarise()` has grouped output by 'class1', 'class2', 'precision', 'train_type'. You can override this by adding .by_group = TRUE to summarise()

avg_lda_coefs_vt <- avg_lda_coefs %>% filter(train_type=="val_training")
avg_lda_coefs_tt <- avg_lda_coefs %>% filter(train_type=="train_training")
avg_lda_coefs_vt$value <- avg_lda_coefs_vt$value - min(avg_lda_coefs_vt$value)
avg_lda_coefs_vt$value <- avg_lda_coefs_vt$value / max(avg_lda_coefs_vt$value)
avg_lda_coefs_tt$value <- avg_lda_coefs_tt$value - min(avg_lda_coefs_tt$value)
avg_lda_coefs_tt$value <- avg_lda_coefs_tt$value / max(avg_lda_coefs_tt$value)
avg_lda_coefs <- rbind(avg_lda_coefs_vt, avg_lda_coefs_tt)
avg_lda_c_w <- pivot_wider(avg_lda_coefs, names_from = coefficient, values_from = value)
avg_lda_c_w[, c("class1", "class2")] <- lapply(avg_lda_c_w[, c("class1", "class2")], as.factor)
avg_lda_c_w$top_net <- factor(c("densenet121", "resnet34", "xception"))[max.col(as.matrix(avg_lda_c_w[, c("class1", "class2")]))]

raster_plot <- ggplot(avg_lda_c_w) +
  geom_tile(aes(x=class2, y=class1, fill=rgb(densenet121, resnet34, xception))) +
  scale_y_discrete(limits=rev, breaks=seq(0,classes, 10)) + scale_x_discrete(breaks=seq(0,classes, 10))
raster_plot
```



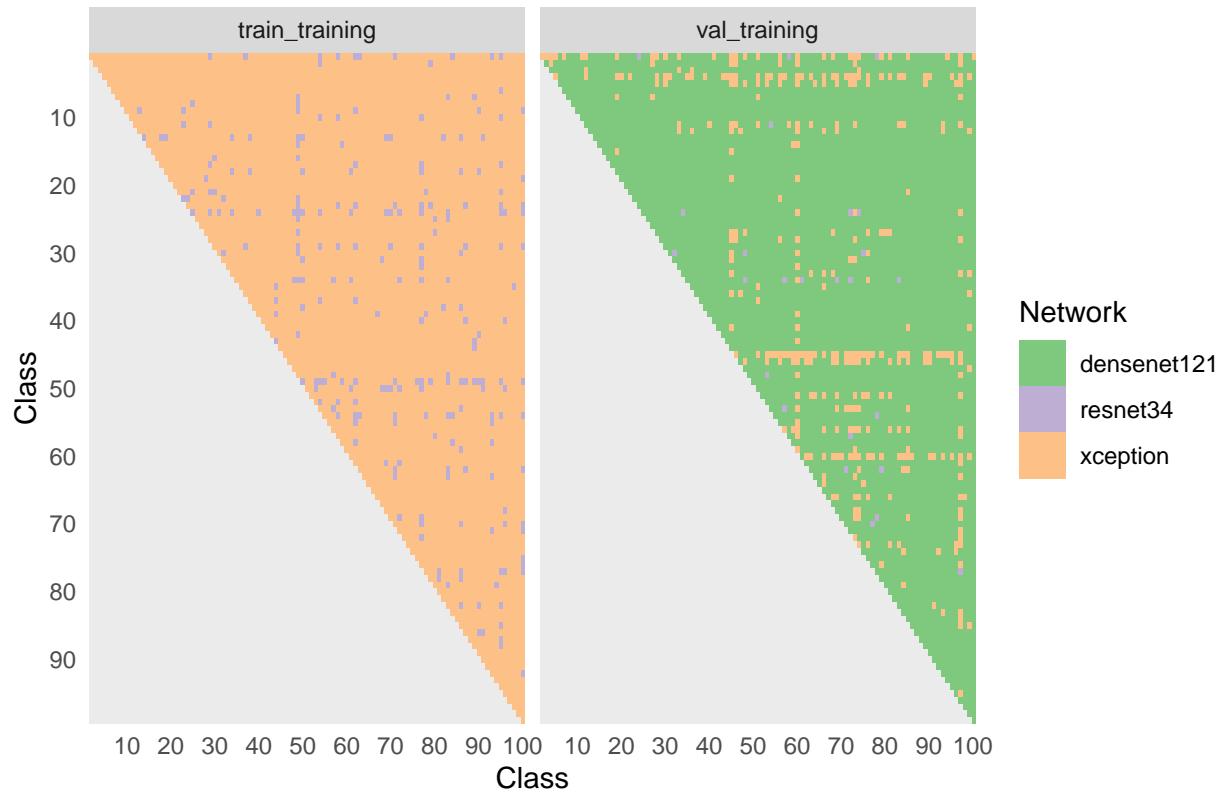
```

coefs_grid <- ggplot(avg_lda_c_w, aes(x=class2, y=class1, fill=top_net)) +
  geom_raster() +
  scale_fill_brewer(type="qual") +
  facet_wrap(~train_type) +
  scale_y_discrete(breaks=seq(0, classes, 10), limits=rev) +
  scale_x_discrete(breaks=seq(0, classes, 10)) +
  guides(fill=guide_legend(title="Network")) +
  xlab("Class") +
  ylab("Class") +
  ggtitle("Network with highest lda weight for class pairs") +
  theme(plot.title = element_text(hjust = 0.5),
        axis.ticks = element_blank(),
        panel.grid.major = element_blank(),
        panel.grid.minor = element_blank())

coefs_grid

```

Network with highest lda weight for class pairs



LDAs trained on nn train set seems to be dominated by xception. LDAs trained on validation set by densenet.