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(ggVennDiagram)
```

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

```
library(stringr)
library(abind)
```

```
## Warning: package 'abind' was built under R version 4.0.3
```

```
library(patchwork)
```

```
## Warning: package 'patchwork' was built under R version 4.0.3
```

```
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:ggVennDiagram':
##
##     circle
```

```
## 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:tidyr':
##
##     smiths
```

Visualization on both CIFAR 10 and 100. To better understand the differences between train_training and val_training LDA training methodologies, we focus on pairwise predictions. This allows us to observe the outputs of LDA models without interference from the coupling methods.

CIFAR 10 - validation set of size 500

```
base_dir <- "../data/data_train_val_c10"
repls <- 0:29
folds <- 0:0
classes <- 10

net_pw_results <- read.csv(file.path(base_dir, "net_pw_accuracies.csv"))
ens_pw_results <- read.csv(file.path(base_dir, "ensemble_pw_accuracies.csv"))
net_pw_results[, c("class1", "class2")] <- lapply(net_pw_results[, c("class1", "class2")], as.factor)
ens_pw_results[, c("class1", "class2")] <- lapply(ens_pw_results[, c("class1", "class2")], as.factor)
```

```
for (ri in repls)
{
  net_plot <- net_pw_results %>% filter(repli == ri) %>%
    ggplot(mapping=aes(x=class2, y=class1, fill=accuracy)) + geom_raster() + facet_wrap(~network) +
    xlab("Class") +
    ylab("Class") +
    scale_y_discrete(limits=rev) +
    scale_fill_binned(type="viridis", limits=c(0.92, 1),  name="accuracy") +
    coord_fixed() +
    ggtitle("Pairwise accuracies networks") +
    theme(plot.title = element_text(hjust = 0.5),
      axis.ticks = element_blank(),
      panel.grid.major = element_blank(),
      panel.grid.minor = element_blank())

  ens_plot <- ens_pw_results %>% filter(repli == ri & fold == 1) %>%
    ggplot(mapping=aes(x=class2, y=class1, fill=accuracy)) + geom_raster() + facet_wrap(~train_set) +
    xlab("Class") +
    ylab("Class") +
    scale_y_discrete(limits=rev) +
    coord_fixed() +
    ggtitle("Pairwise accuracies ensembles") +
    scale_fill_binned(type="viridis", limits=c(0.92, 1), name="accuracy") +
    theme(plot.title = element_text(hjust = 0.5),
      axis.ticks = element_blank(),
      panel.grid.major = element_blank(),
      panel.grid.minor = element_blank())

    print((net_plot/ens_plot) + plot_annotation(title=paste("Replication ", ri)))
}
```

Replication 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 1
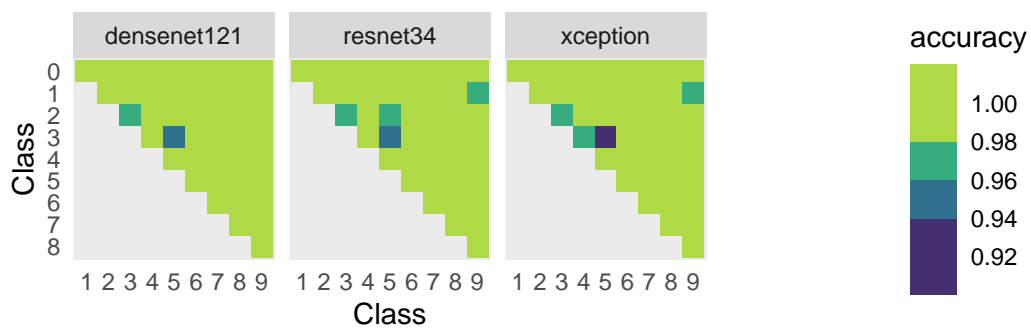
Pairwise accuracies networks
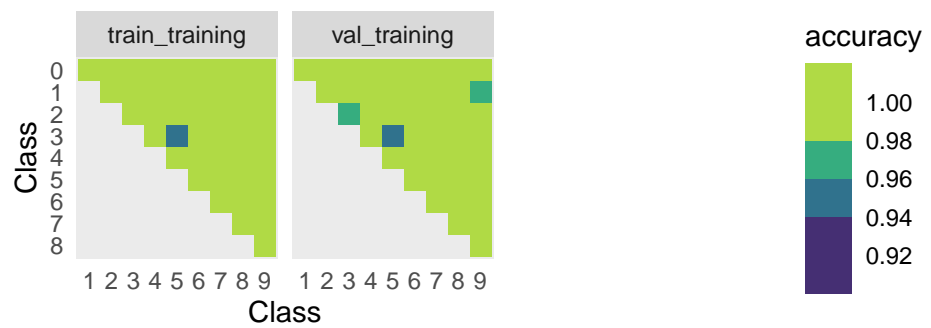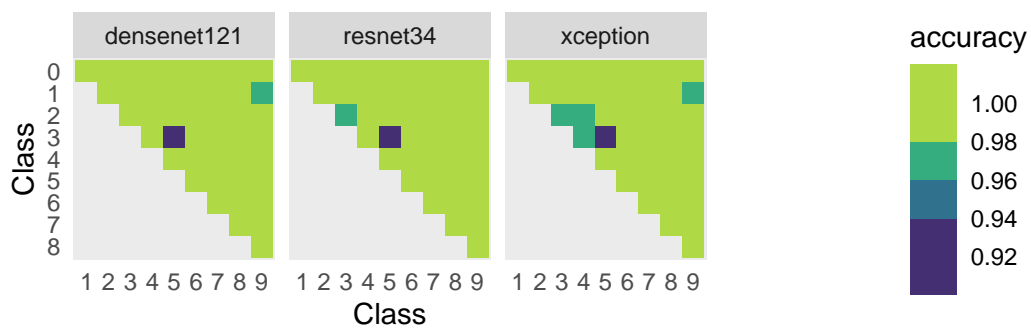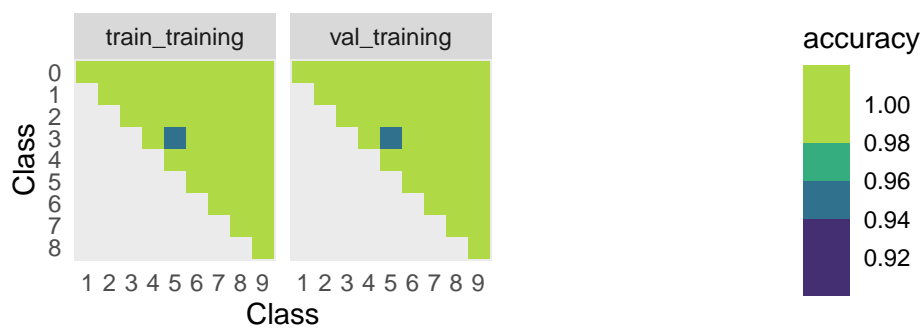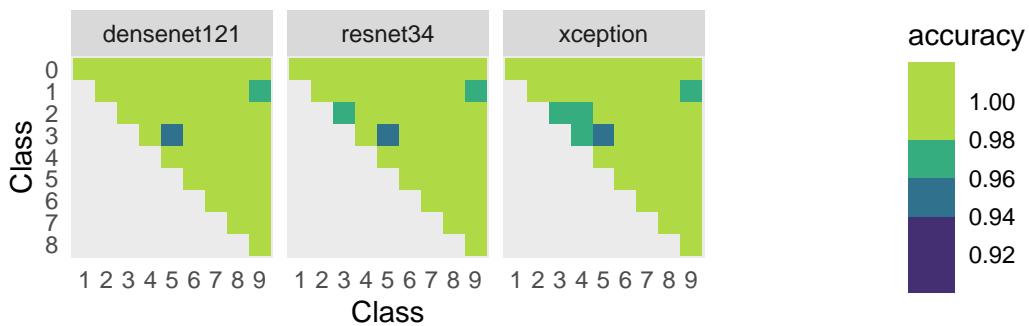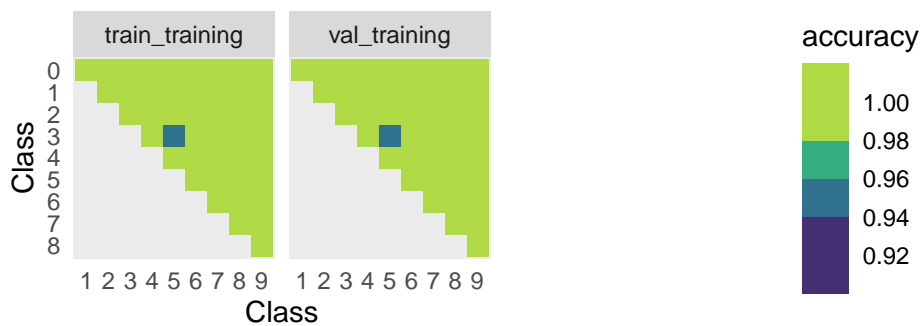

Pairwise accuracies ensembles
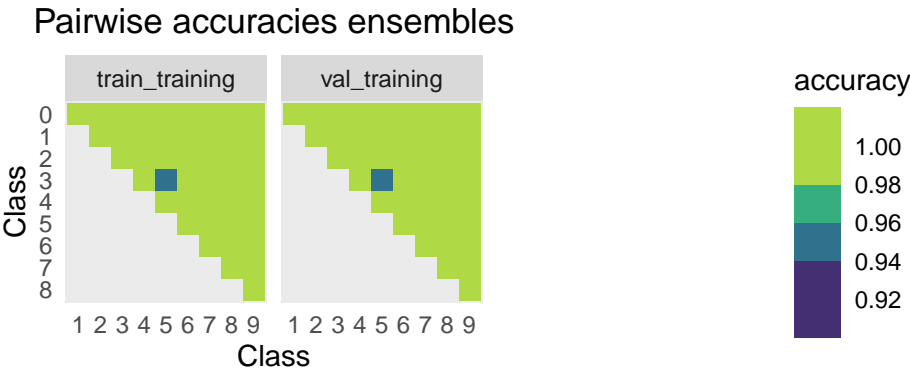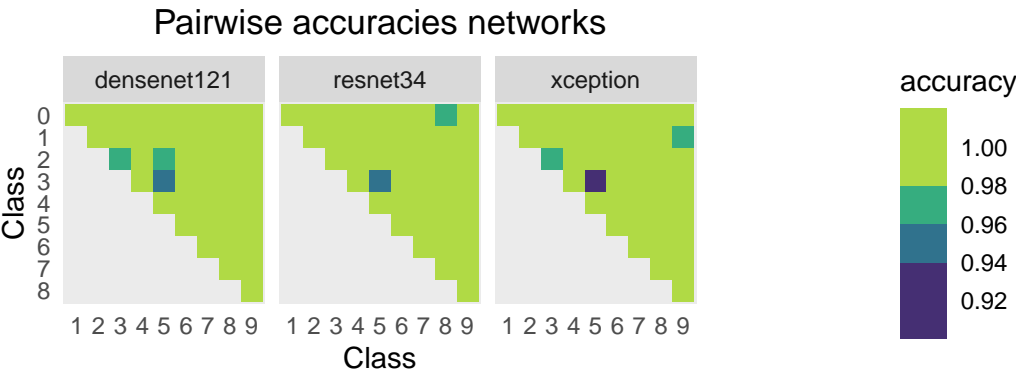
Replication 2

Pairwise accuracies networks
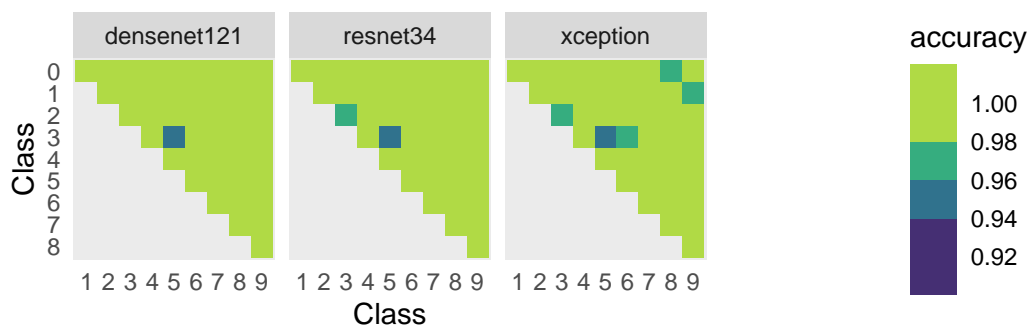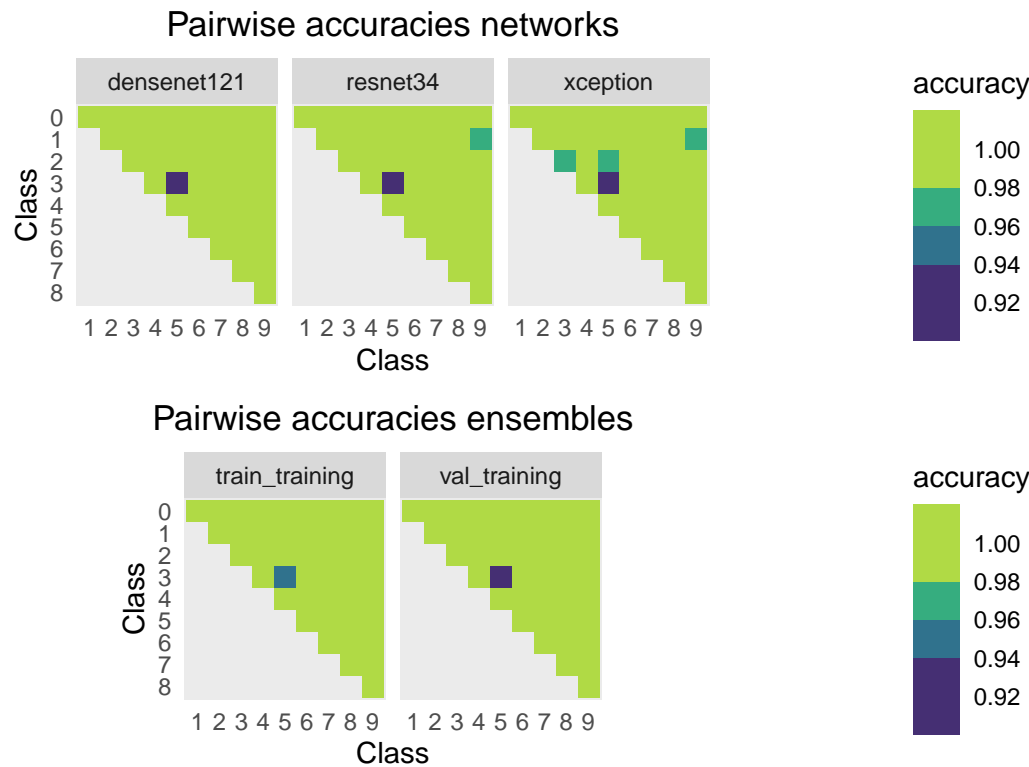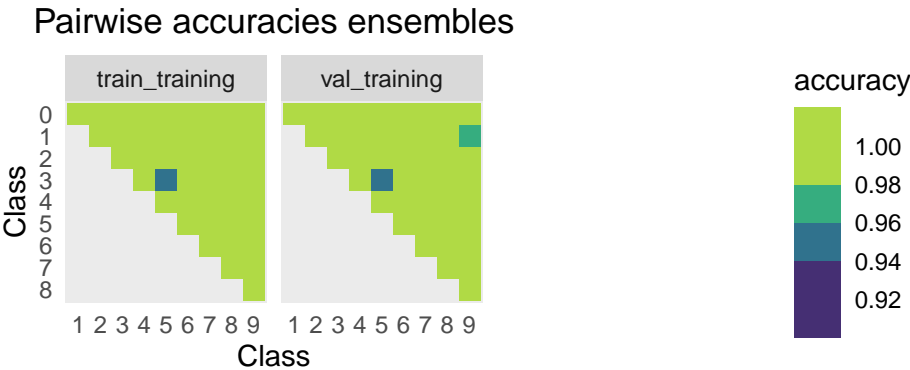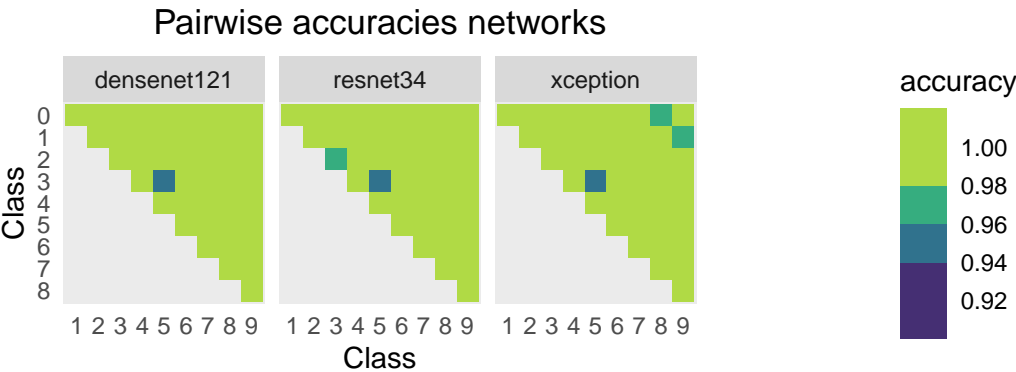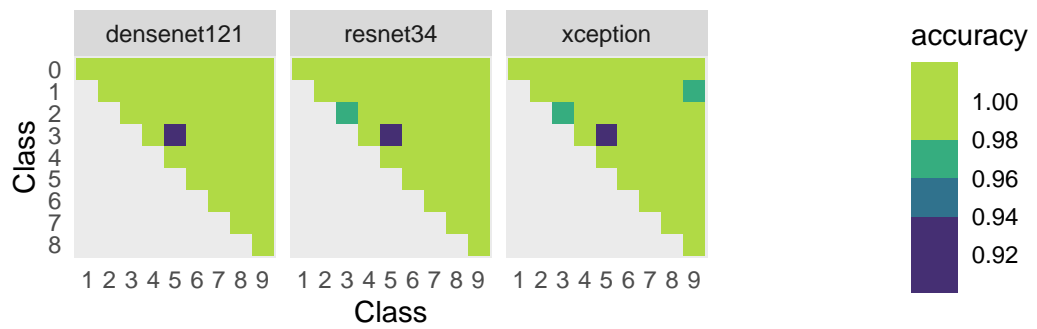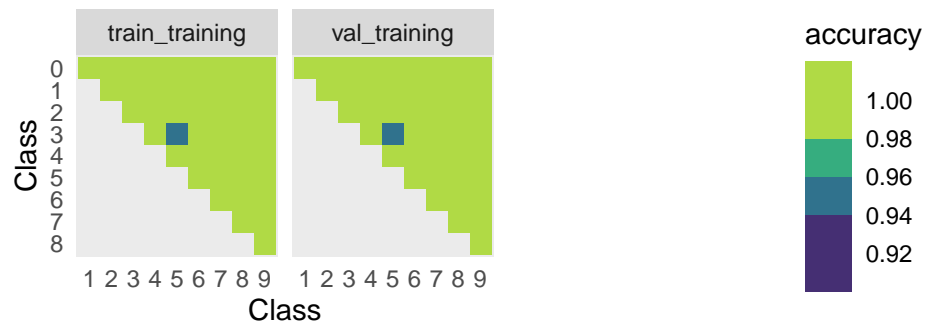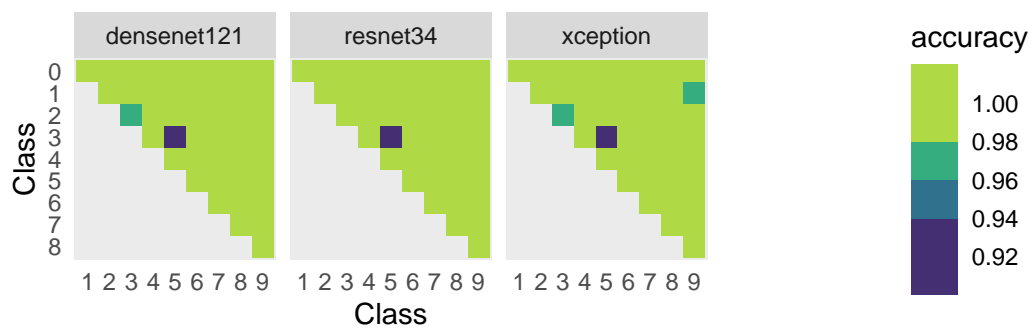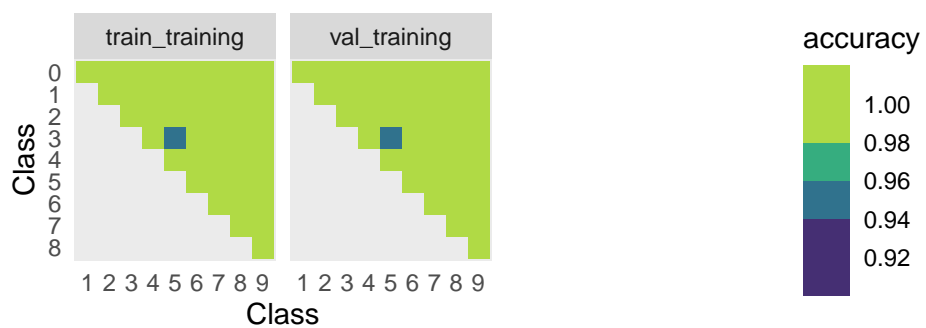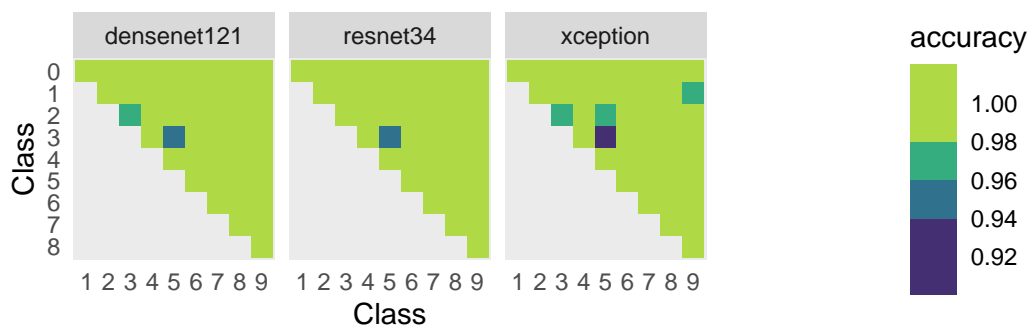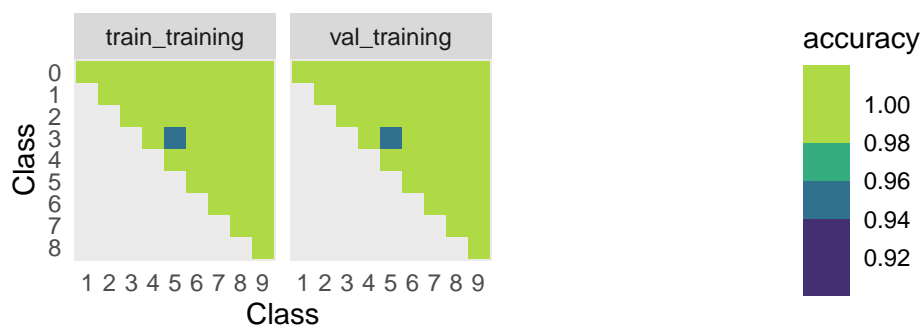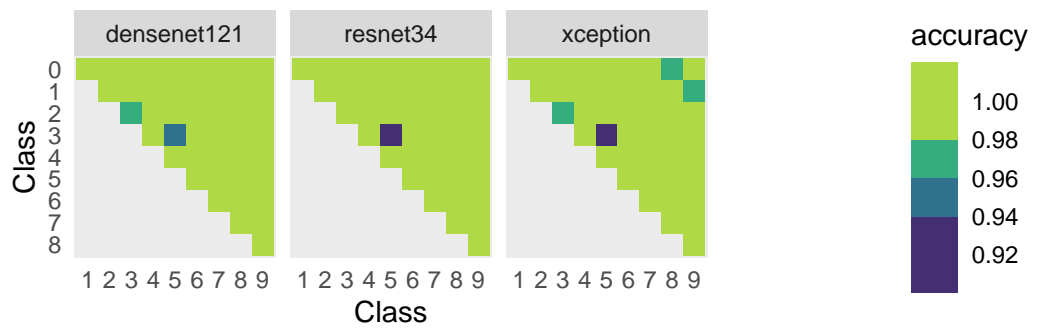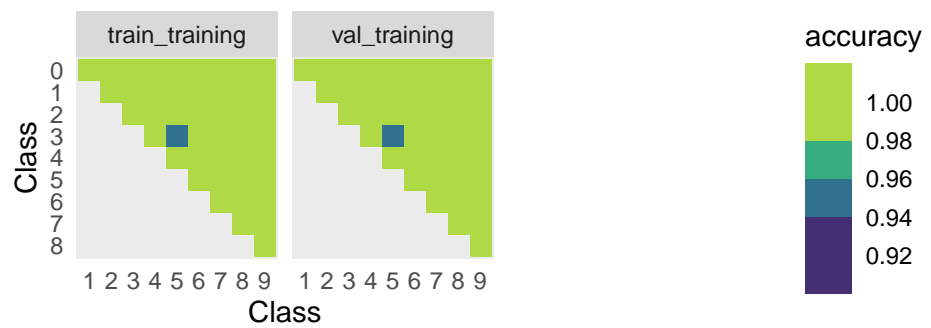

Pairwise accuracies ensembles

Replication 3

Pairwise accuracies networks
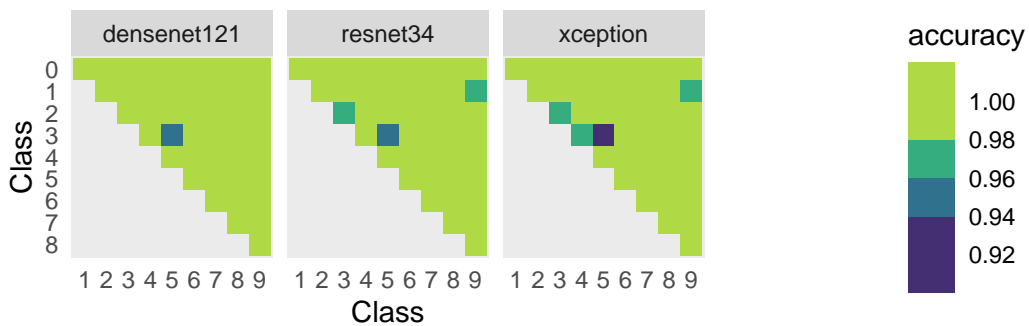
Pairwise accuracies ensembles
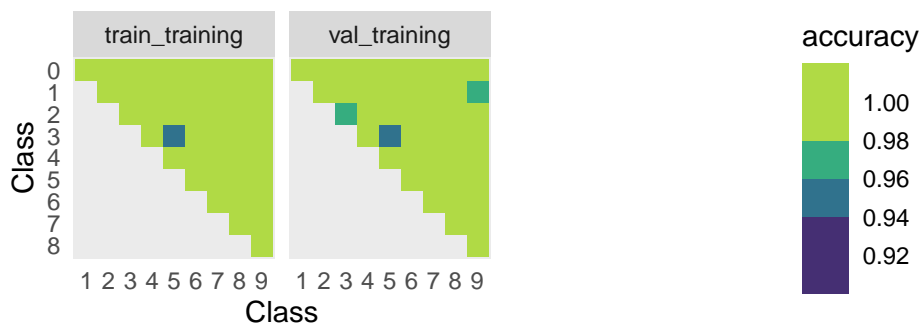
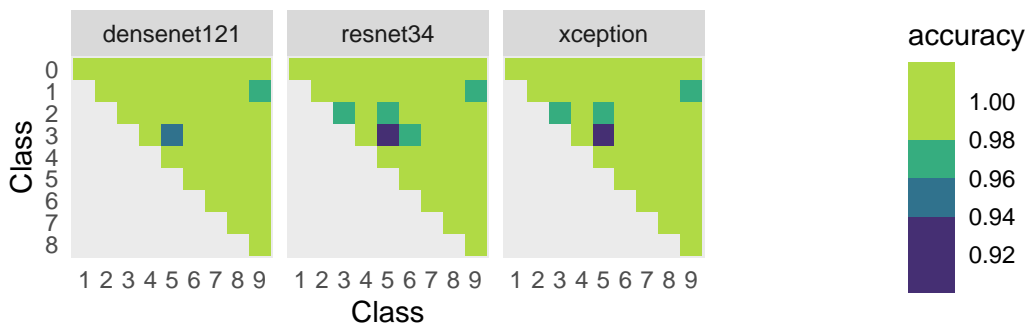Replication 4

Pairwise accuracies networks
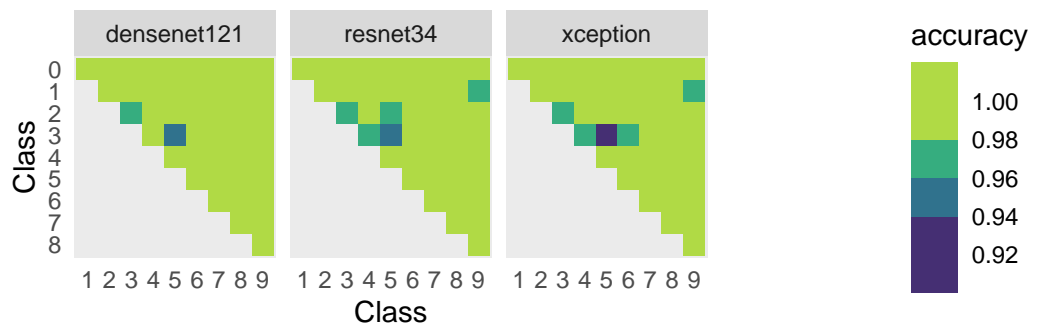
Pairwise accuracies ensembles
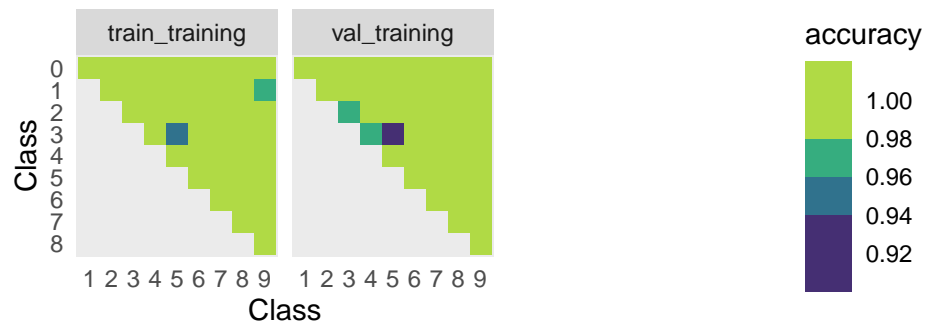
Replication 5

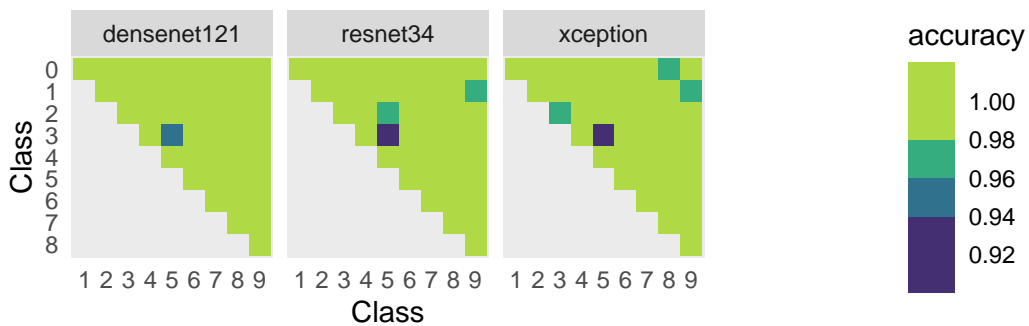## Pairwise accuracies networks
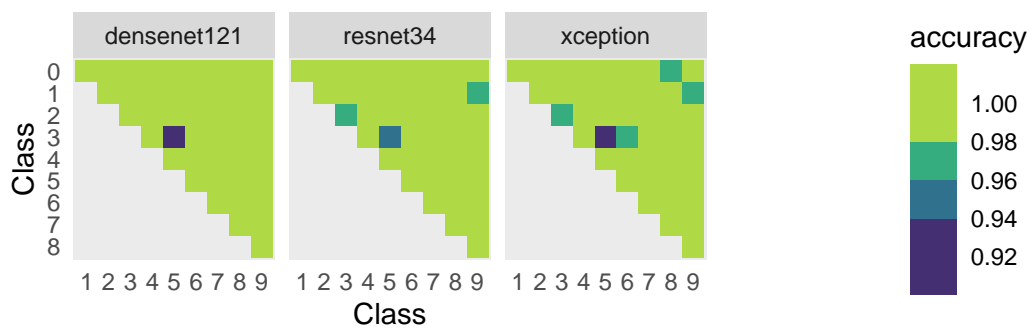
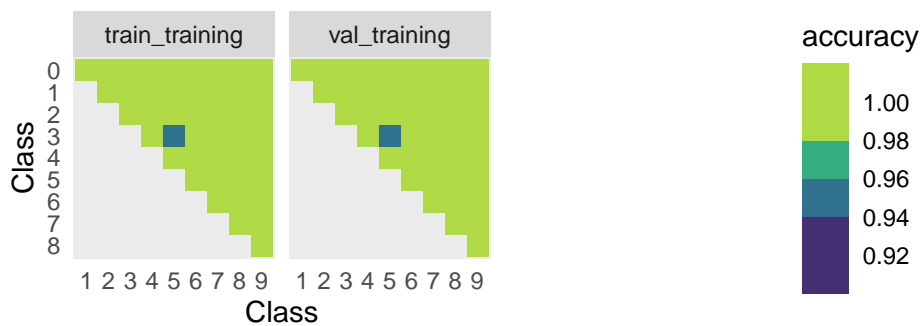## Pairwise accuracies ensembles

Replication 6

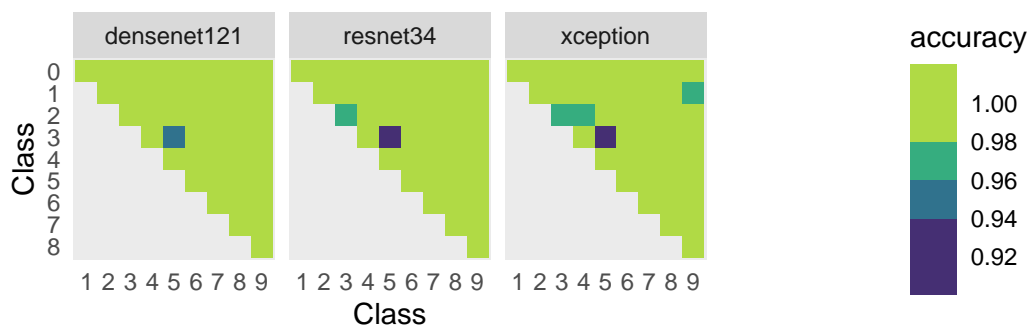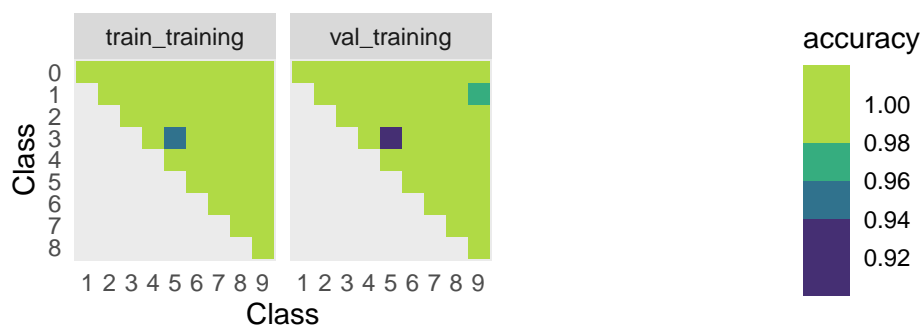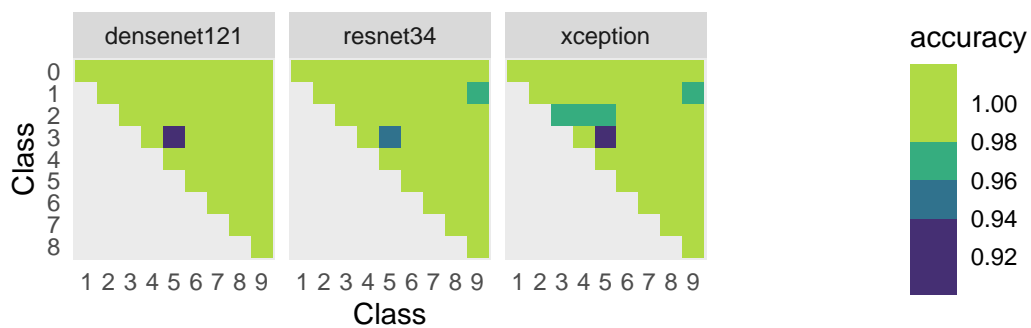## Pairwise accuracies networks
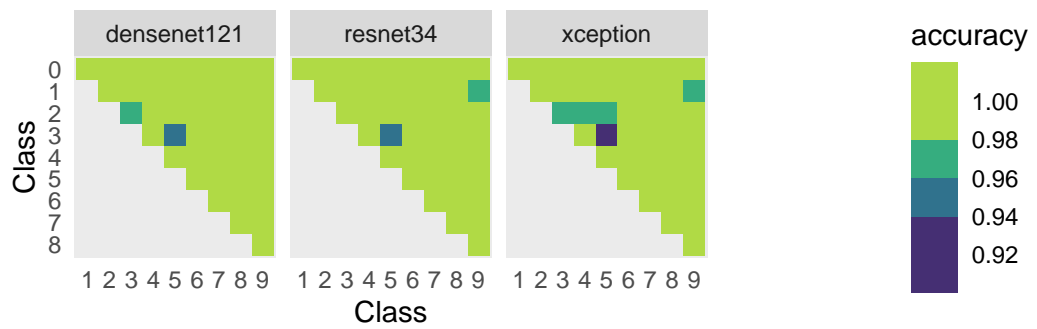
Pairwise accuracies ensembles

Replication 7

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 8

Pairwise accuracies networks
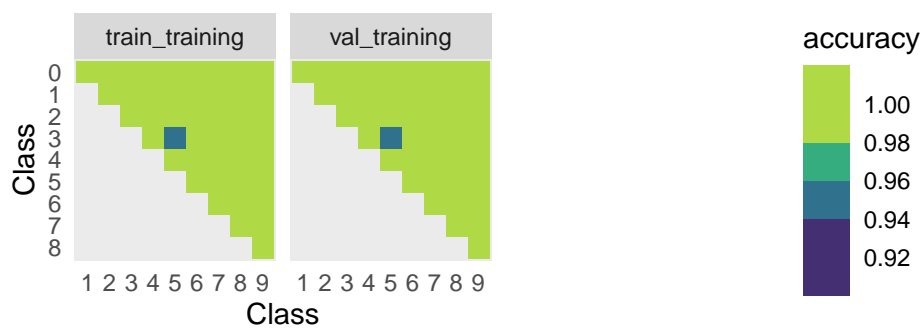

Pairwise accuracies ensembles

Replication 9

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 10

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 11

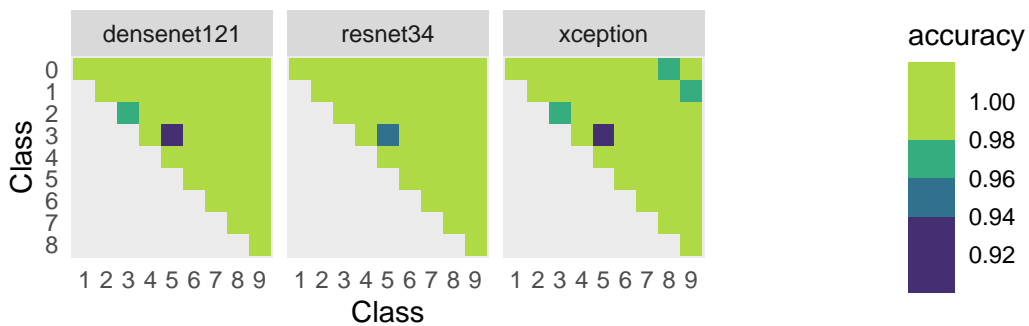## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 12

Pairwise accuracies networks

Pairwise accuracies ensembles

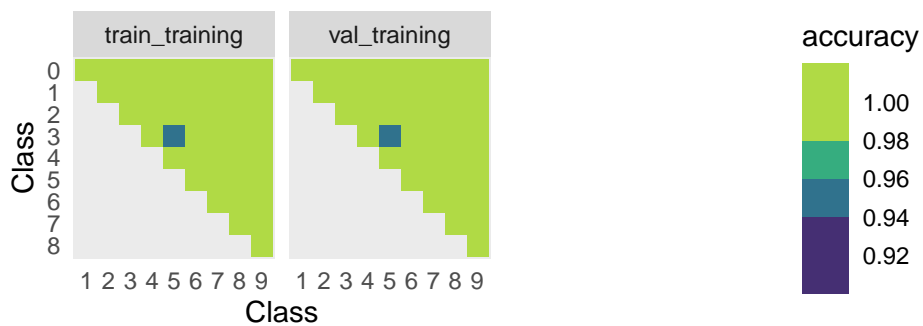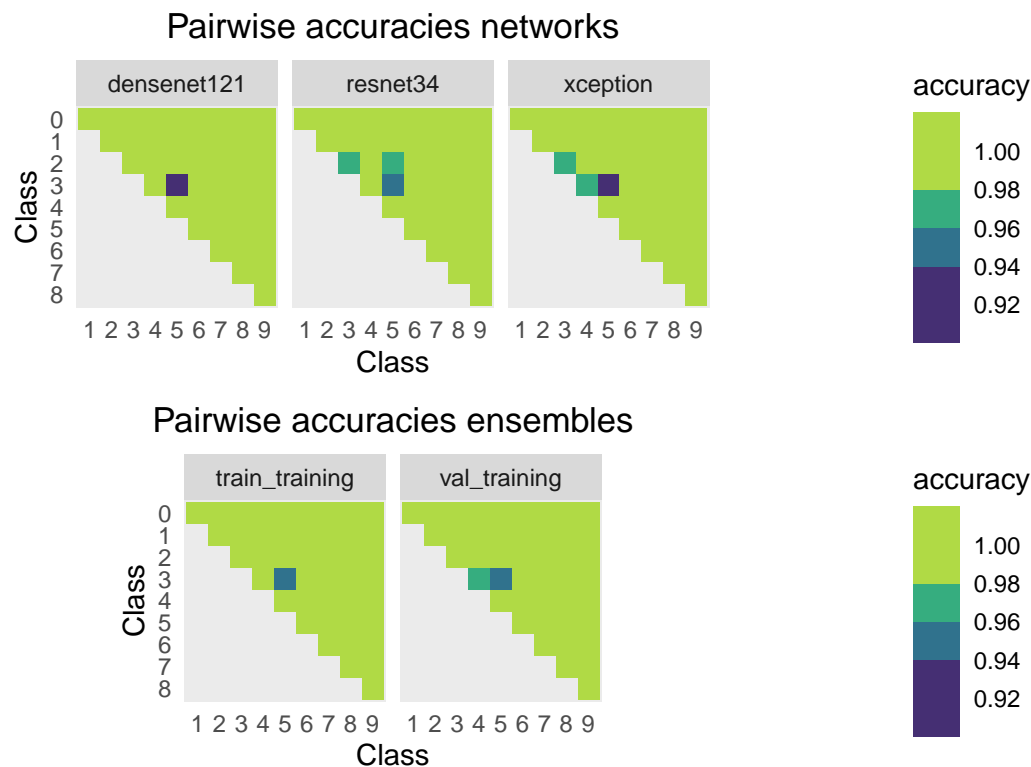Replication 13

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 14

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 15

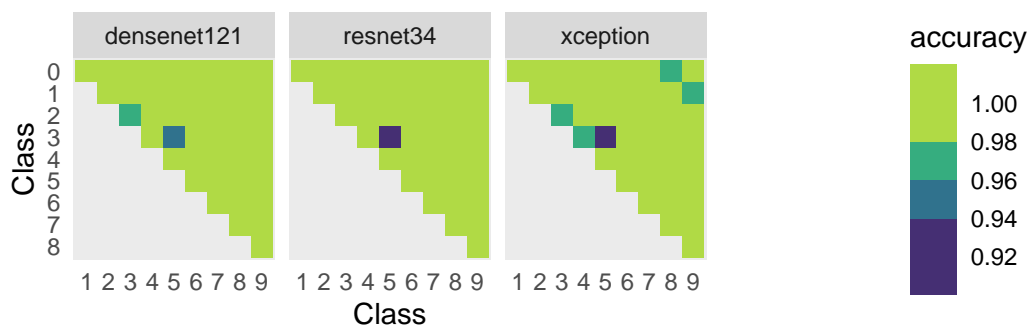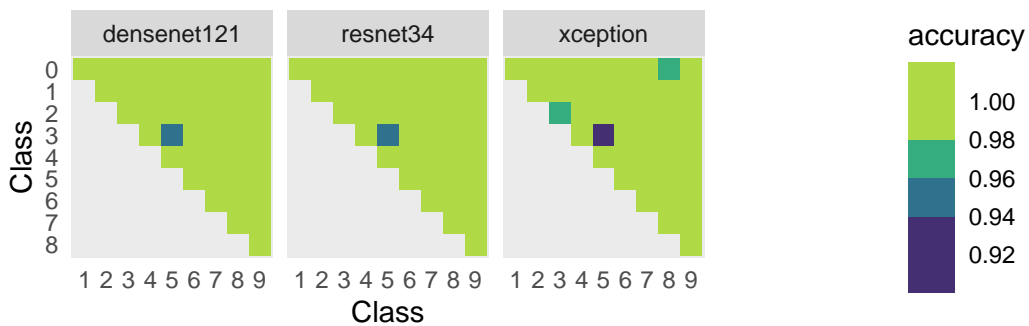## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 16

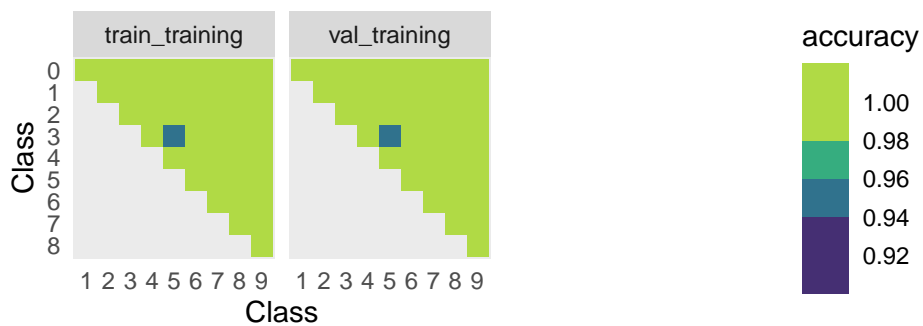## Pairwise accuracies networks

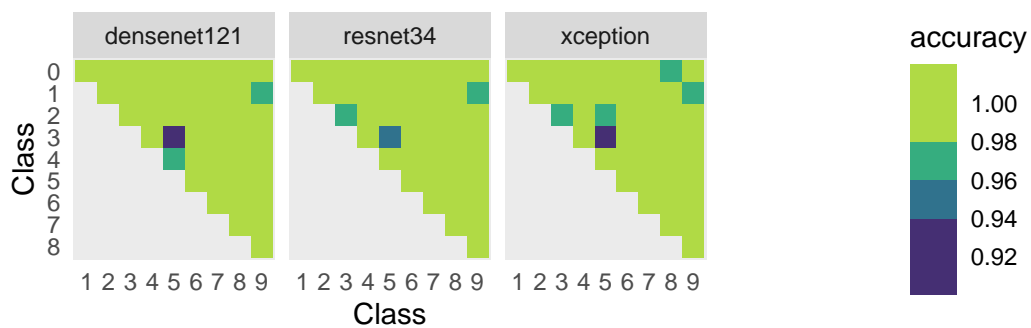

Pairwise accuracies ensembles

Replication 17

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 18

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 19

Pairwise accuracies networks

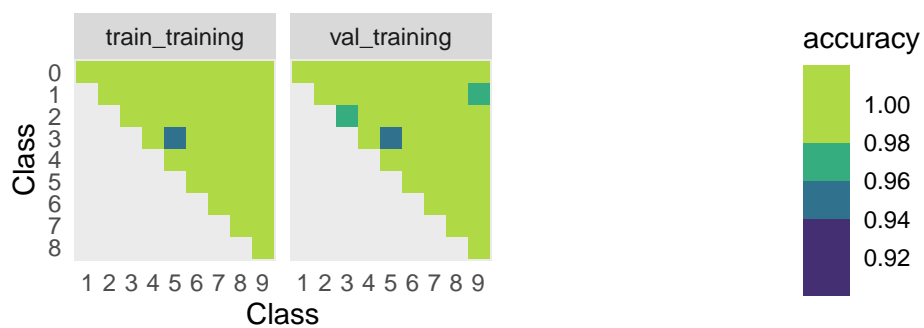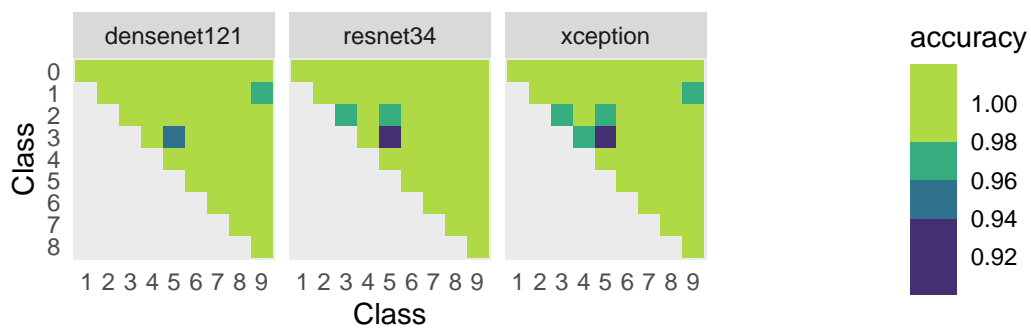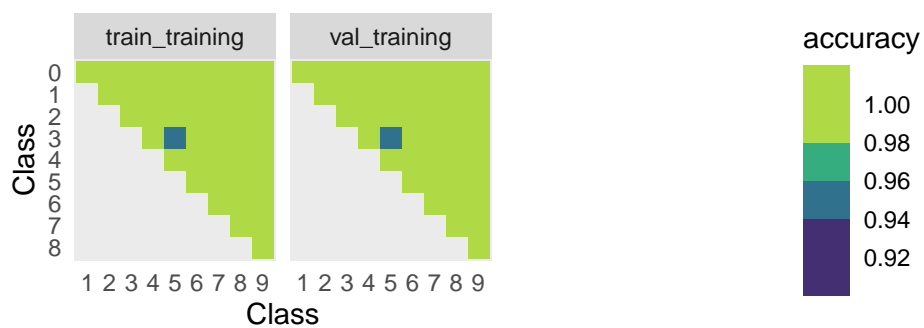## Pairwise accuracies ensembles

Replication 20

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 21

Pairwise accuracies networks

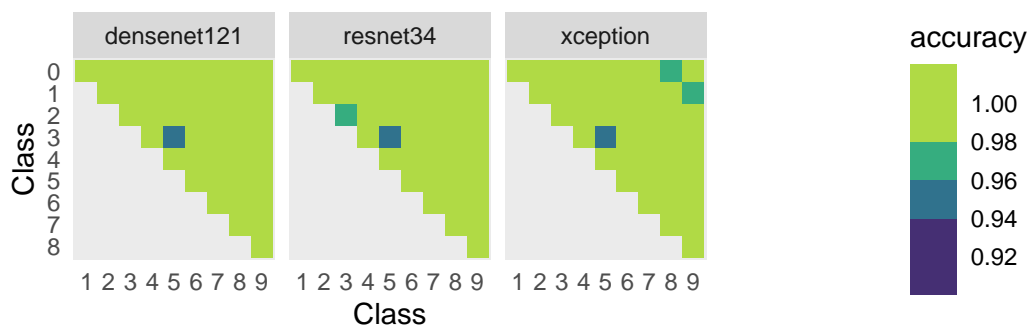## Pairwise accuracies ensembles
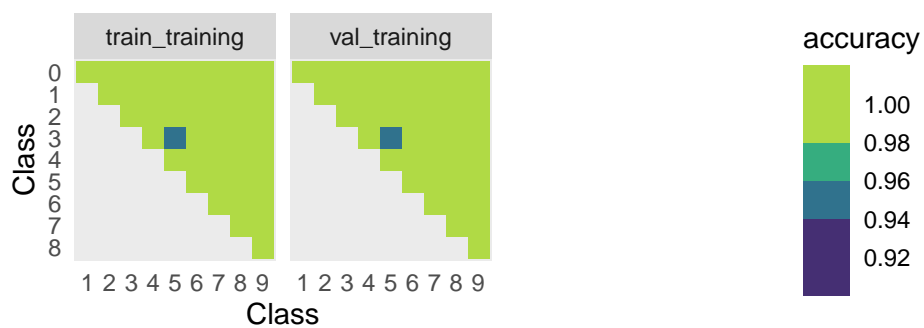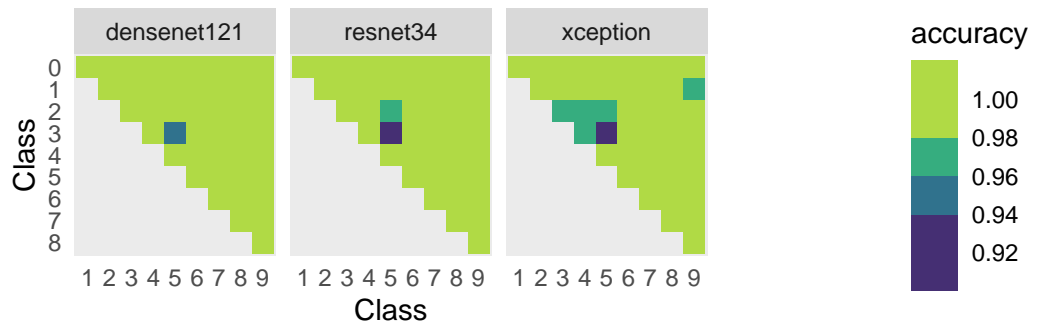
Replication 22

Pairwise accuracies networks
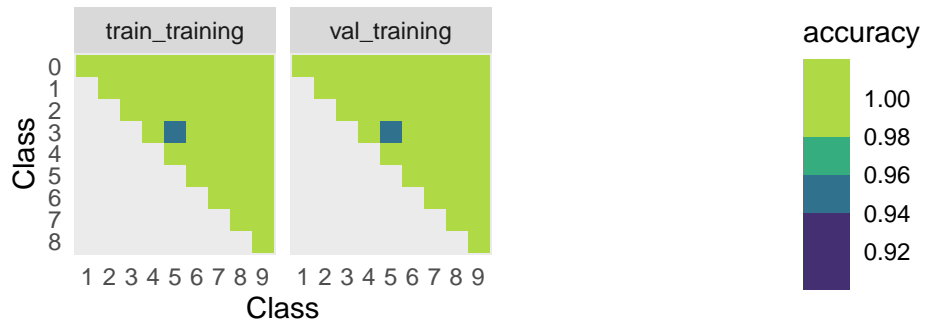

Pairwise accuracies ensembles

Replication 23

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 24

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 25

Pairwise accuracies networks

Pairwise accuracies ensembles

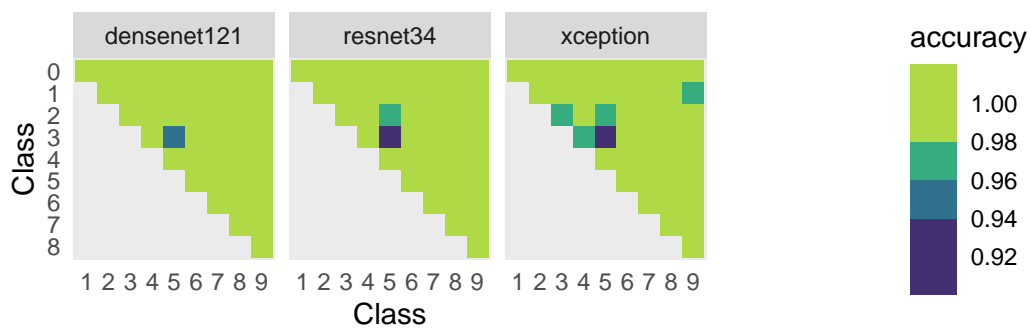Replication 26

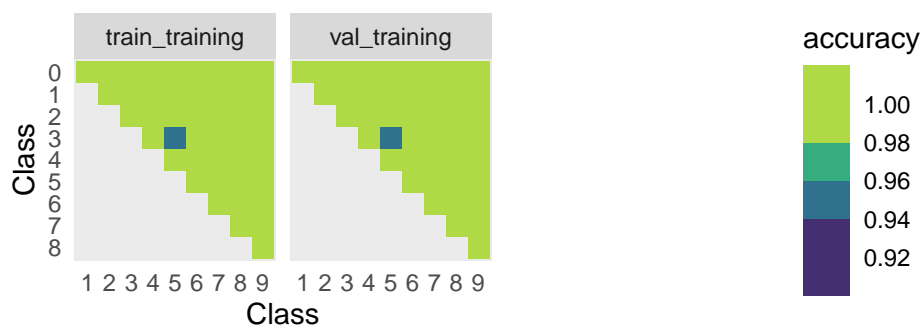## Pairwise accuracies networks

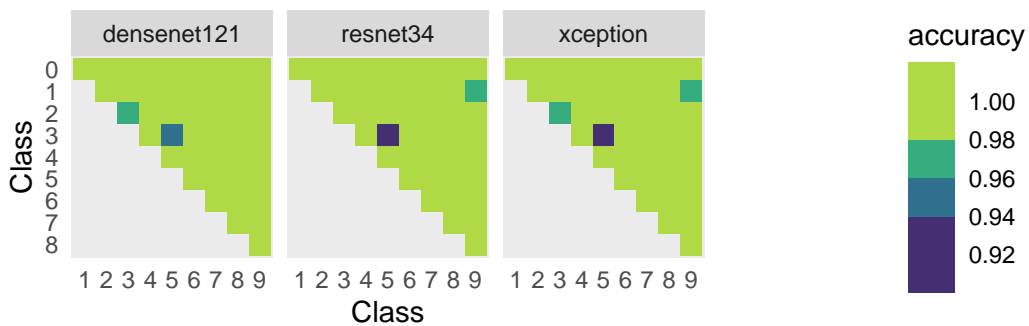## Pairwise accuracies ensembles

Replication 27

Pairwise accuracies networks

Pairwise accuracies ensembles
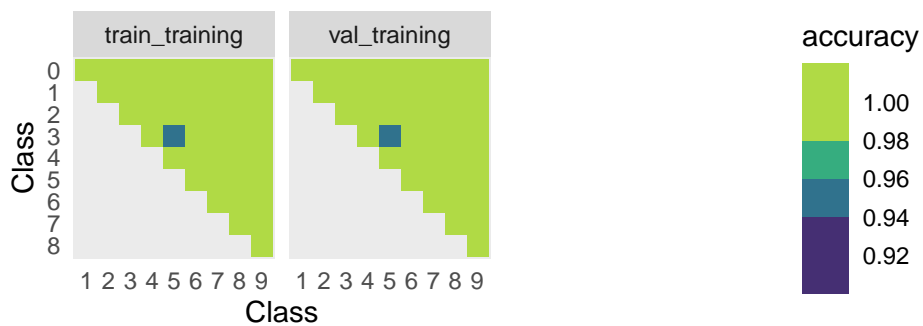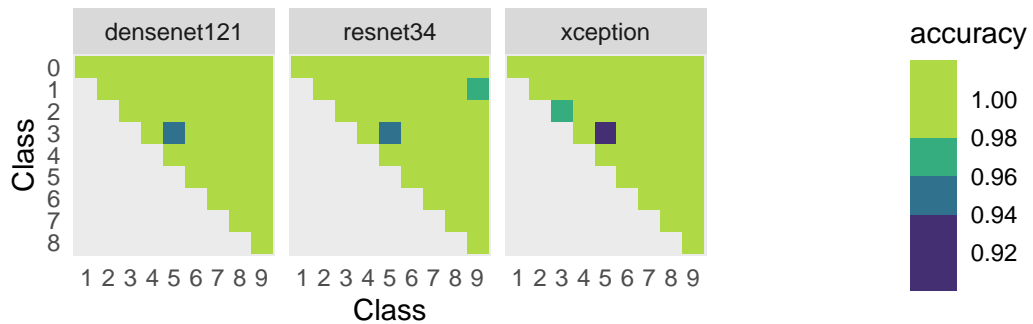
Pairwise accuracies networks
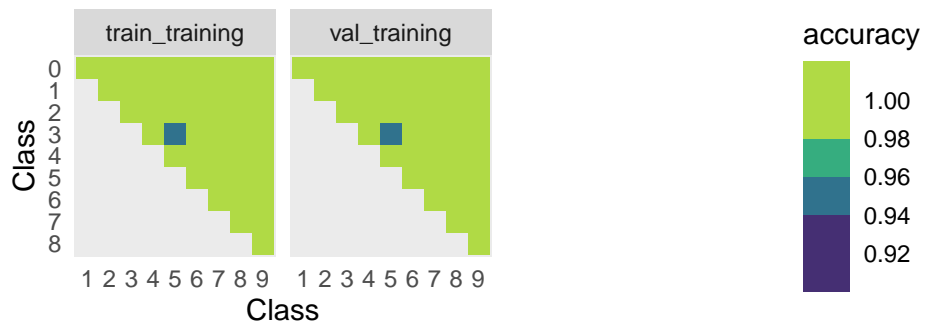

Pairwise accuracies ensembles

Replication 29

Pairwise accuracies networks

Pairwise accuracies ensembles

LDA combination is able to improve pairwise probabilities in almost all examples. tt seems to be a little bit more successful than vt. Especially problematic seem classes 3 and 5 - cat and dog.

CIFAR 10 - validation set of size 25000

```r
base_dir <- "../data/data_train_val_half_c10"
repls <- 0:0
folds <- 0:49
classes <- 10


net_pw_results <- read.csv(file.path(base_dir, "net_pw_accuracies.csv"))
ens_pw_results <- read.csv(file.path(base_dir, "ensemble_pw_accuracies.csv"))
net_pw_results[, c("class1", "class2")] <- lapply(net_pw_results[, c("class1", "class2")], as.factor)
ens_pw_results[, c("class1", "class2")] <- lapply(ens_pw_results[, c("class1", "class2")], as.factor)
```

```r
for (ri in repls)
{
  net_plot <- net_pw_results %>% filter(repli == ri) %>%
    ggplot(mapping=aes(x=class2, y=class1, fill=accuracy)) + geom_raster() + facet_wrap(~network) +
    xlab("Class") +
    ylab("Class") +
    scale_y_discrete(limits=rev) +
    scale_fill_binned(type="viridis", limits=c(0.92, 1),  name="accuracy") +
    coord_fixed() +
```

```r
      ggtitle("Pairwise accuracies networks") +
      theme(plot.title = element_text(hjust = 0.5),
        axis.ticks = element_blank(),
        panel.grid.major = element_blank(),
        panel.grid.minor = element_blank())



  for (fi in folds)
  {
    ens_plot <- ens_pw_results %>% filter(repli == ri & fold == fi) %>%
      ggplot(mapping=aes(x=class2, y=class1, fill=accuracy)) + geom_raster() + facet_wrap(~train_set) +
      xlab("Class") +
      ylab("Class") +
      scale_y_discrete(limits=rev) +
      coord_fixed() +
      ggtitle("Pairwise accuracies ensembles") +
      scale_fill_binned(type="viridis", limits=c(0.92, 1), name="accuracy") +
      theme(plot.title = element_text(hjust = 0.5),
        axis.ticks = element_blank(),
        panel.grid.major = element_blank(),
        panel.grid.minor = element_blank())

    print((net_plot/ens_plot) + plot_annotation(title=paste("Replication ", ri, ", fold ", fi)))
  }
}
```
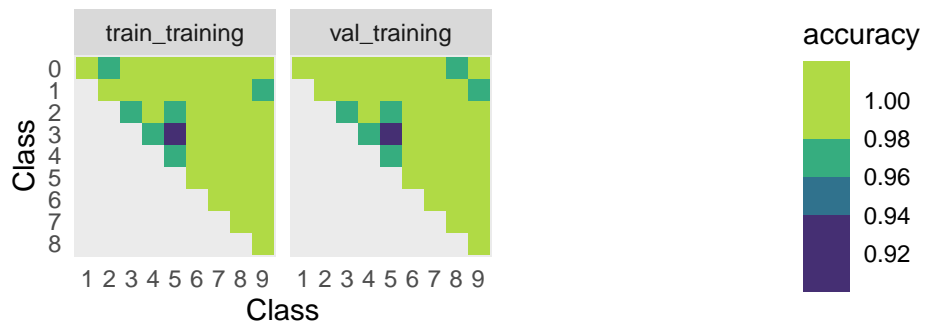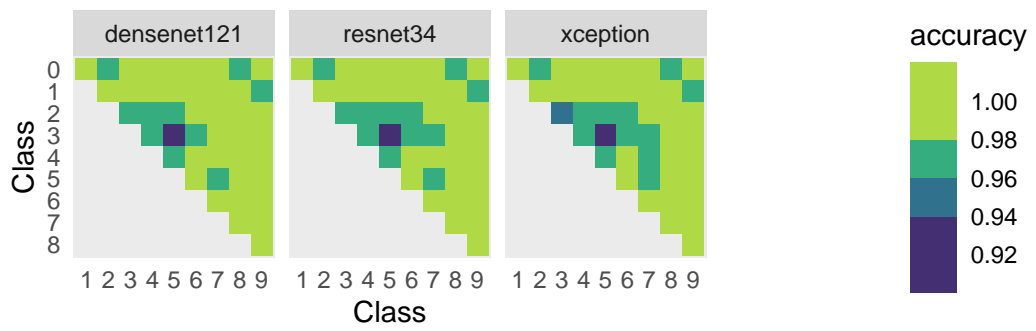
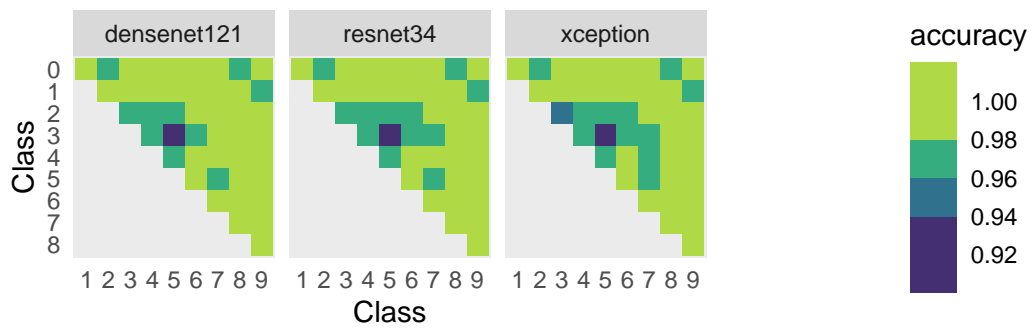Replication 0 , fold 0

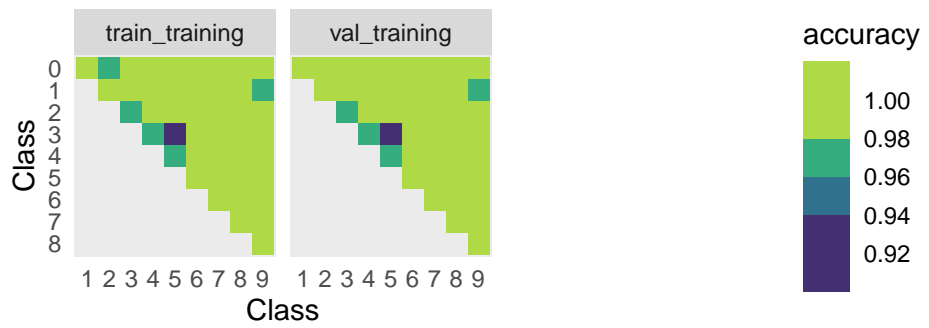## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles
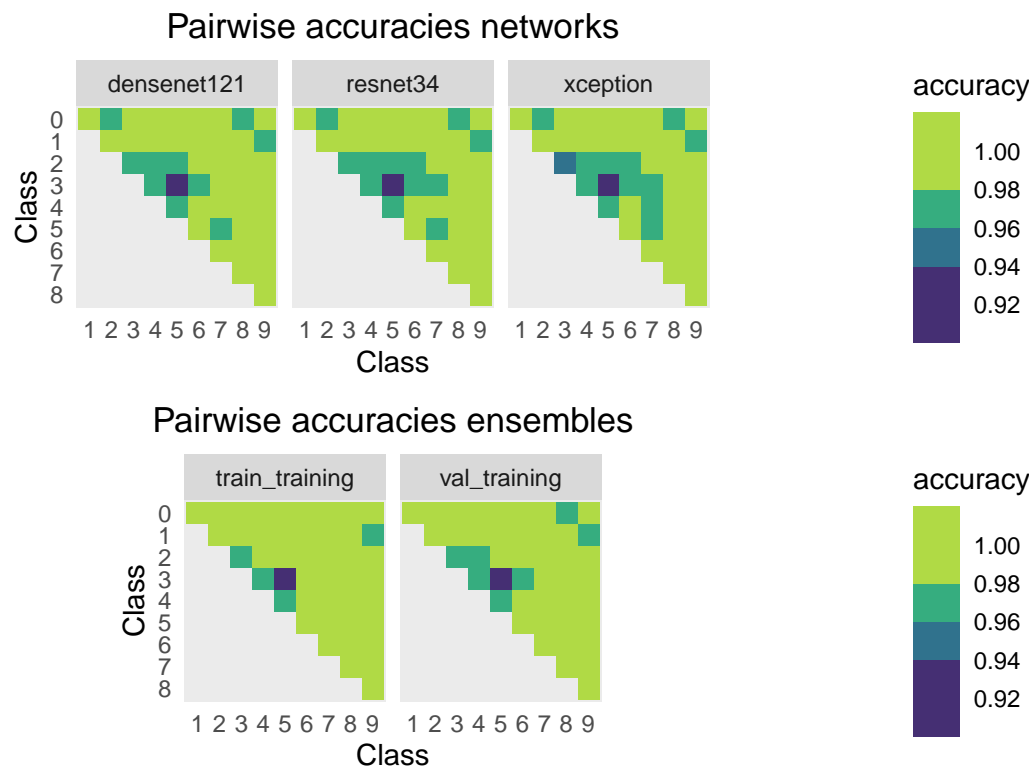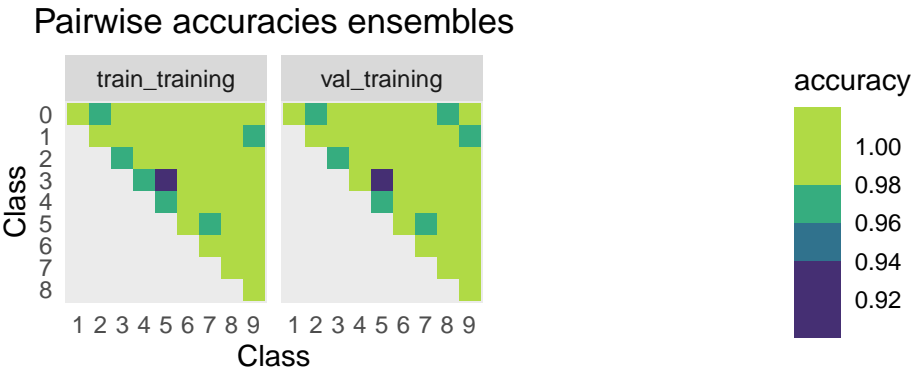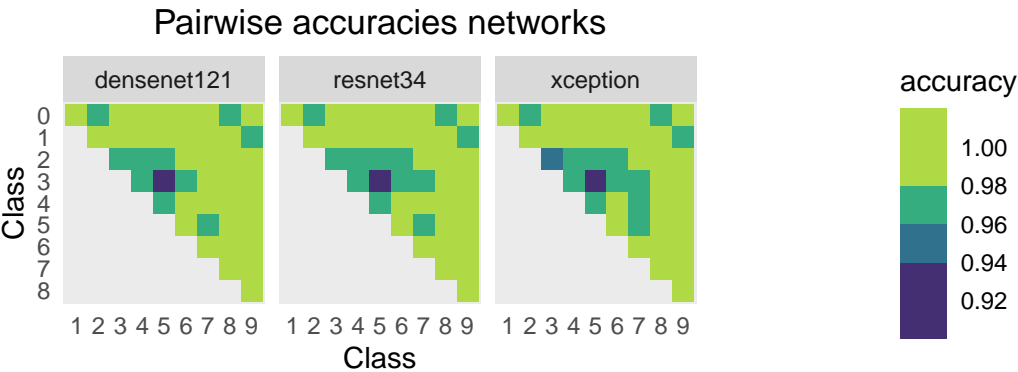
Replication 0 , fold 2

Pairwise accuracies networks
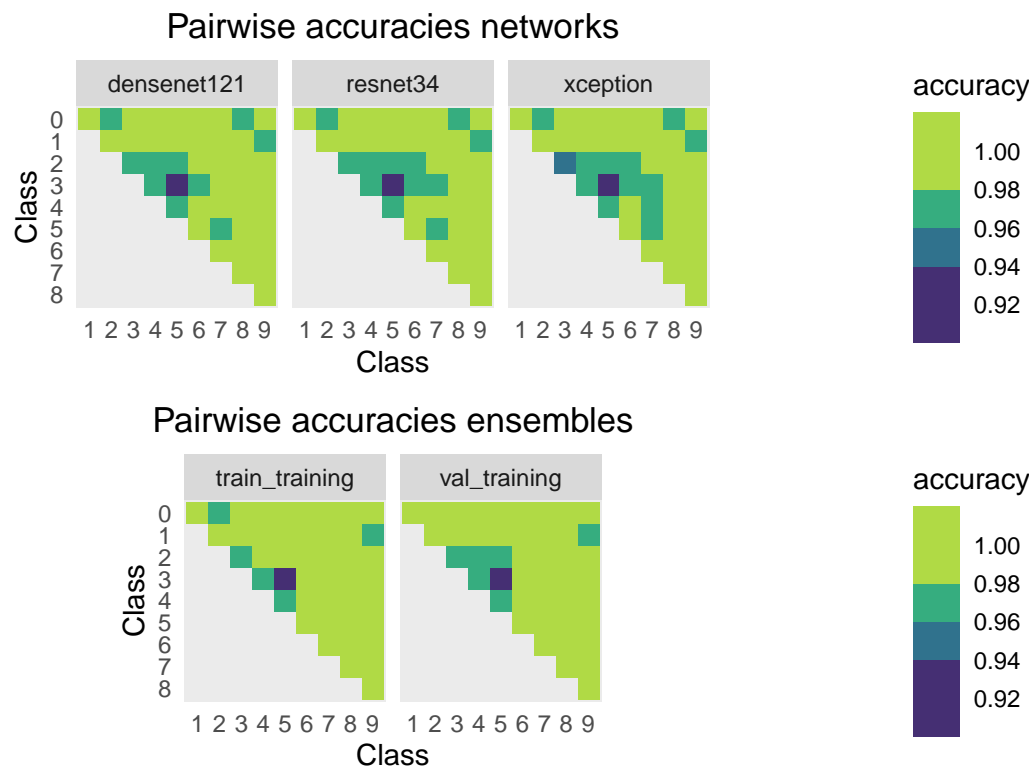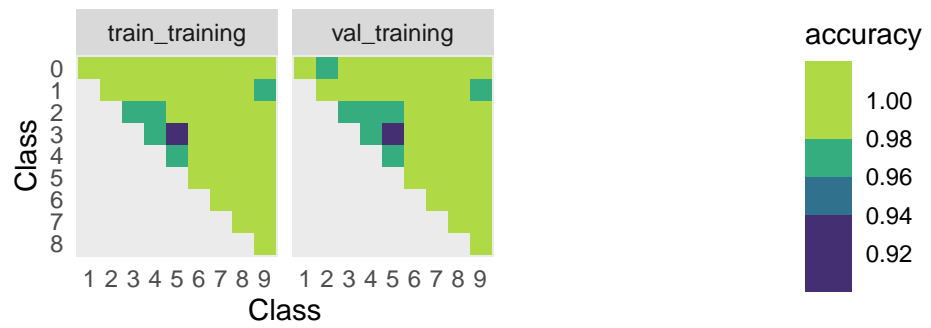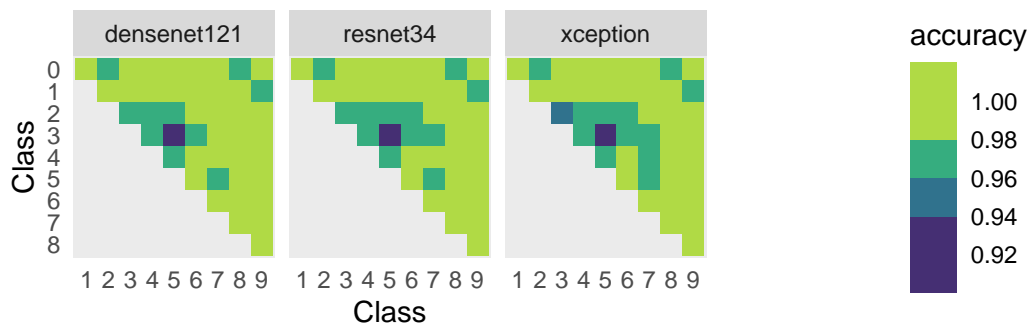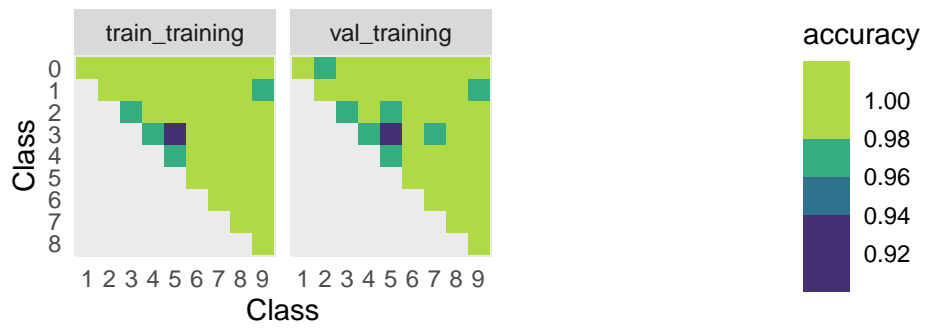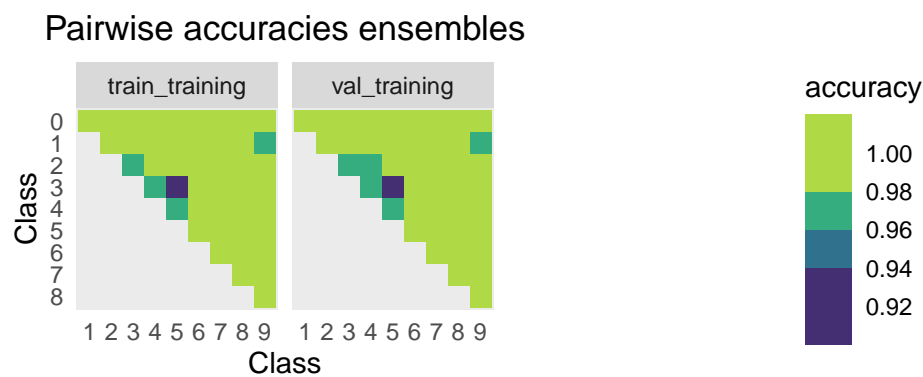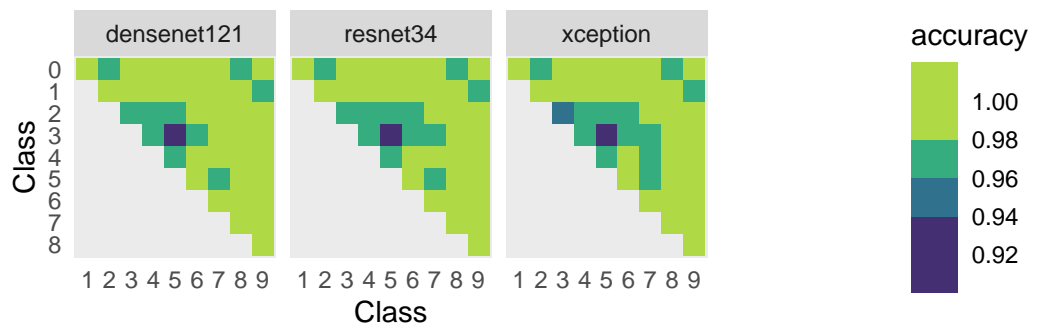

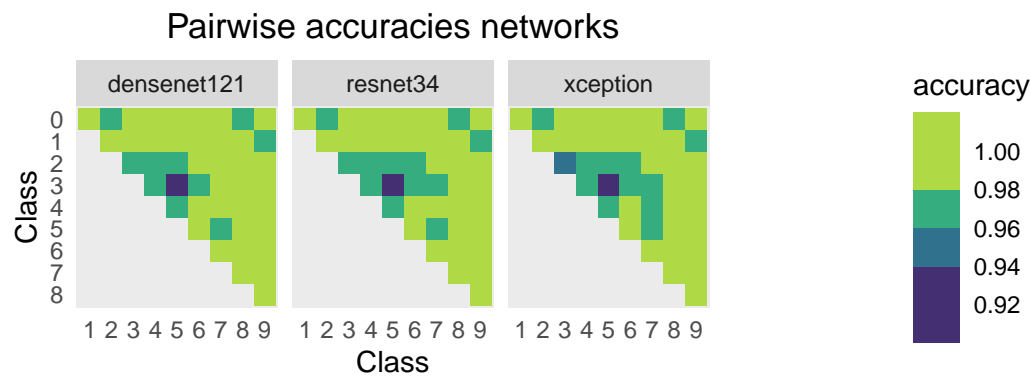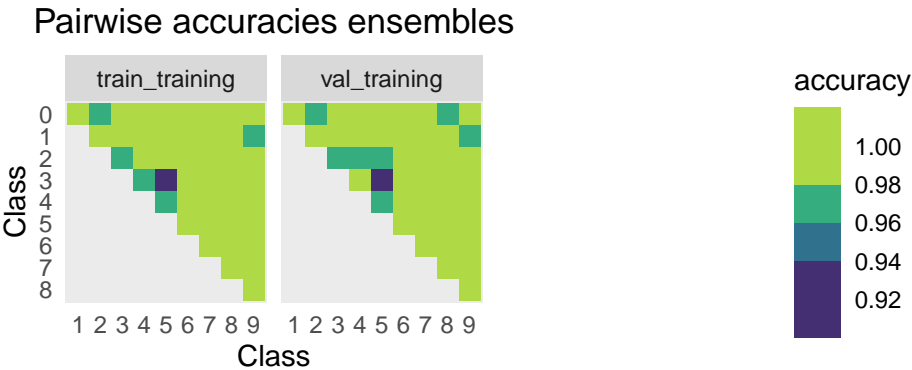# Pairwise accuracies ensembles

Replication 0 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 5

Pairwise accuracies networks

Pairwise accuracies ensembles
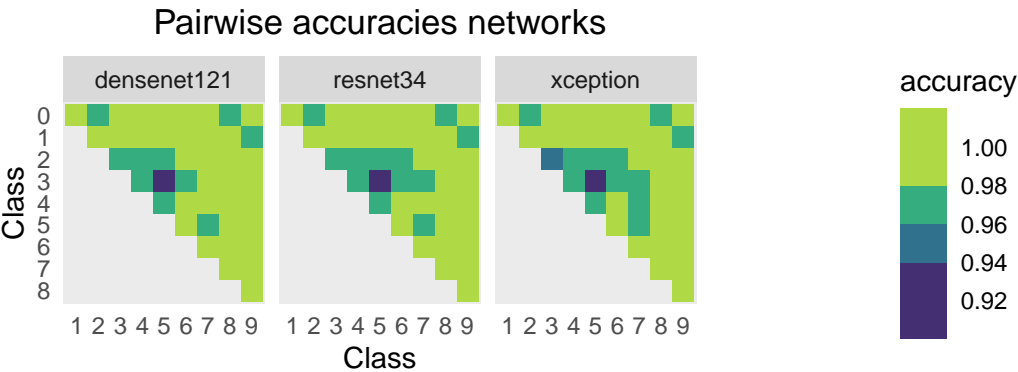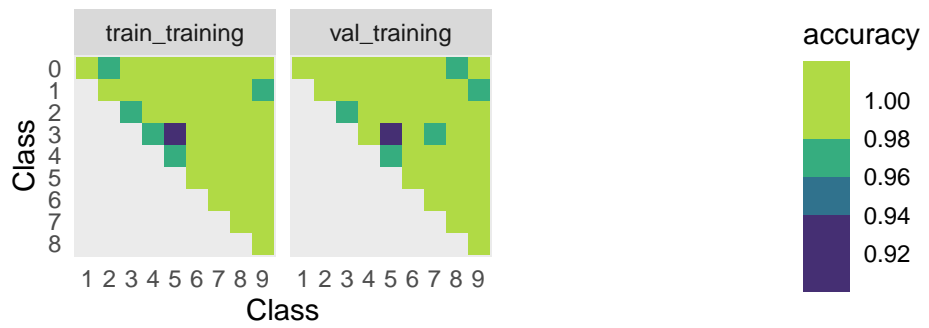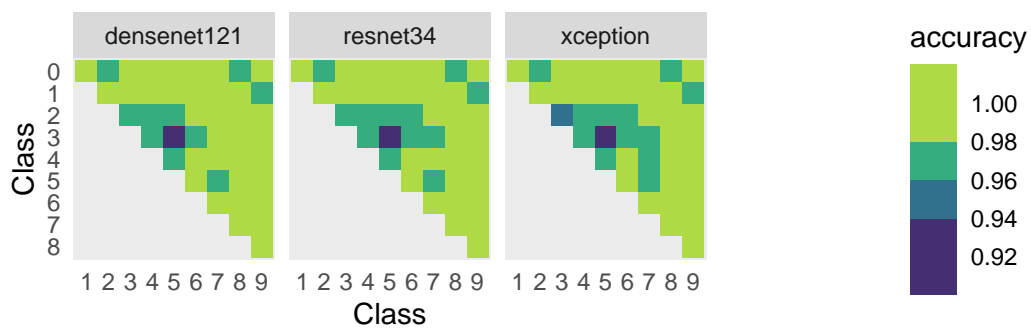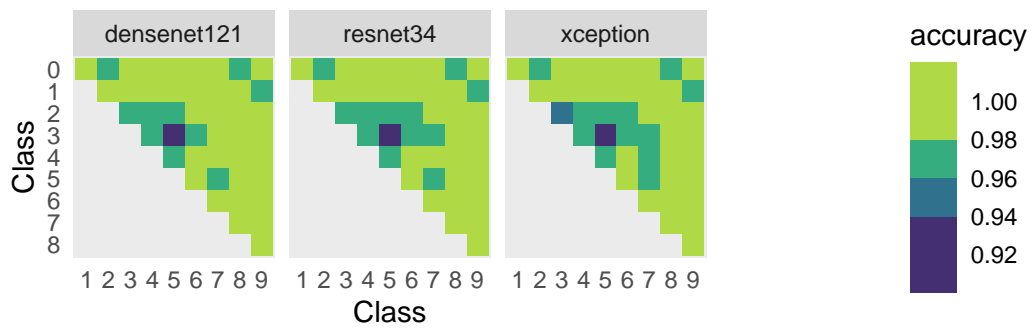
Replication 0 , fold 6

Pairwise accuracies networks
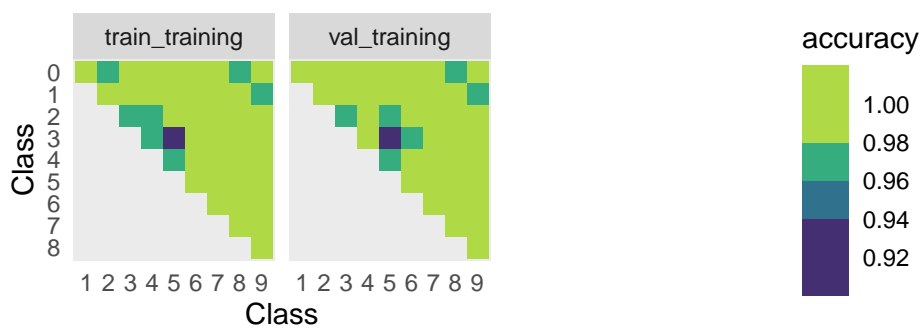

Pairwise accuracies ensembles
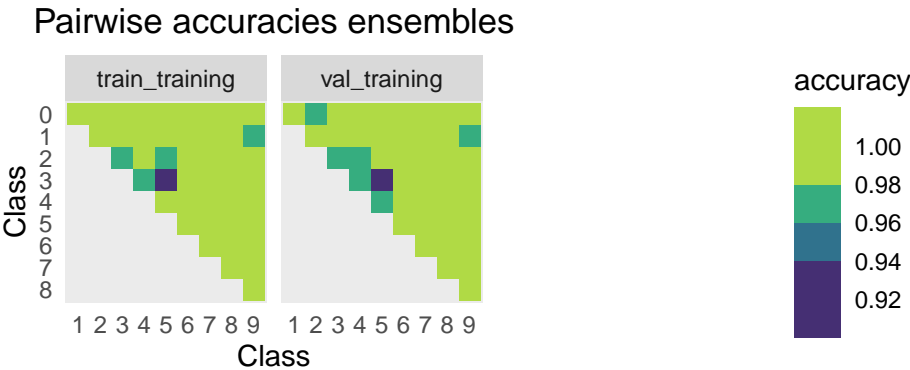
Replication 0 , fold 7
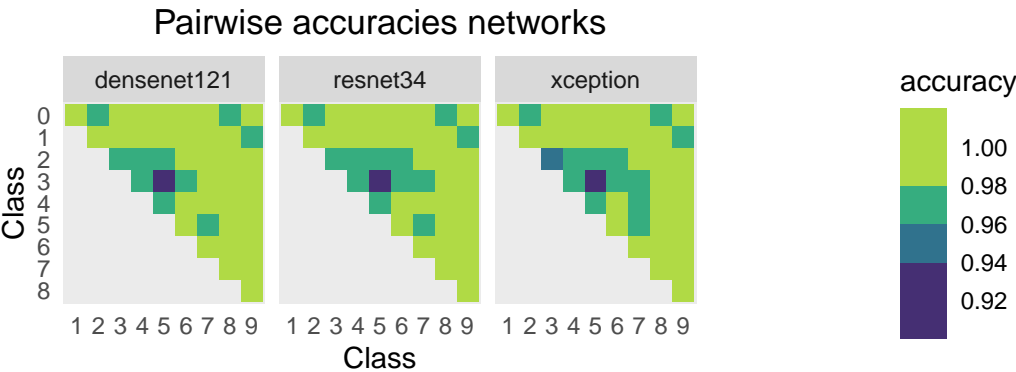
Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 8

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 9

Pairwise accuracies networks

Pairwise accuracies ensembles

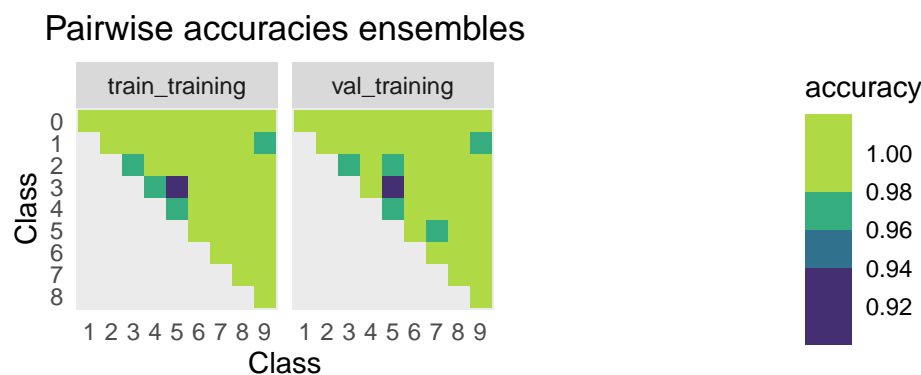Replication 0 , fold 10
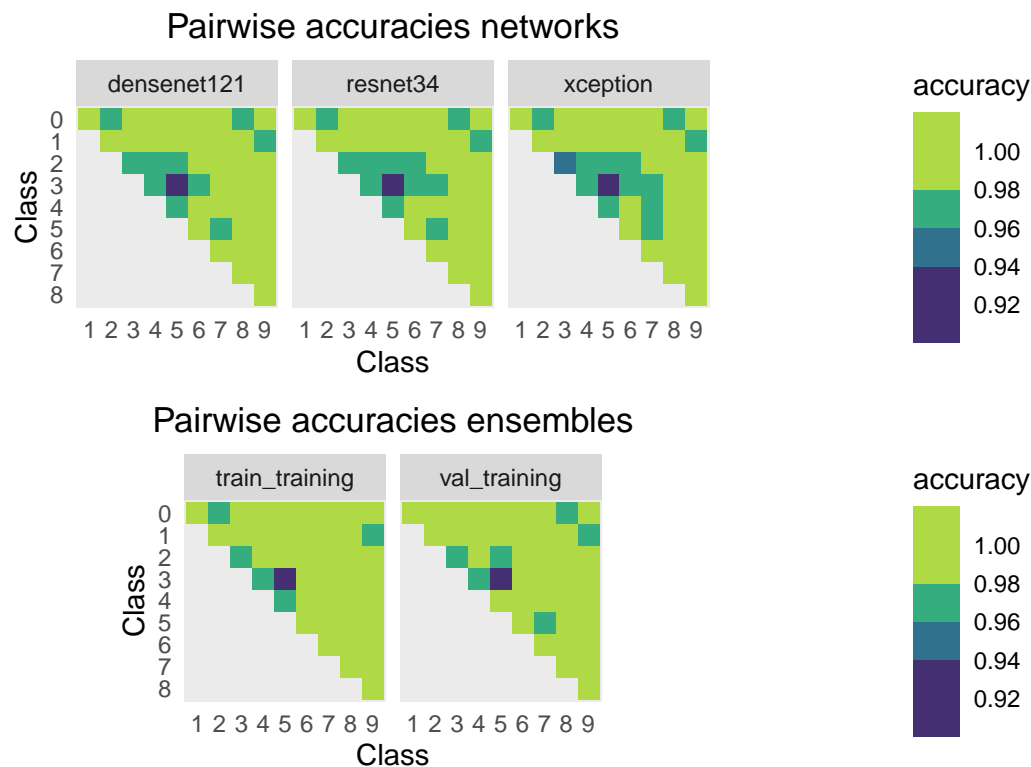
Pairwise accuracies networks

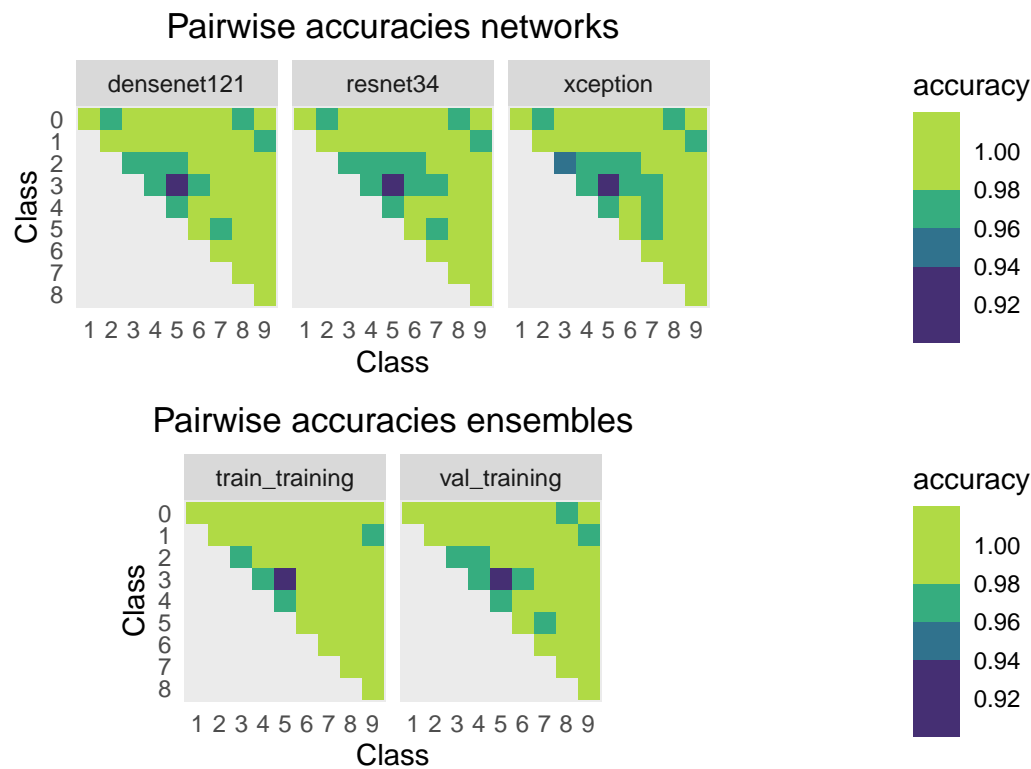# Pairwise accuracies ensembles

Replication 0 , fold 11

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 12

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 13

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 14

Pairwise accuracies networks

Pairwise accuracies ensembles
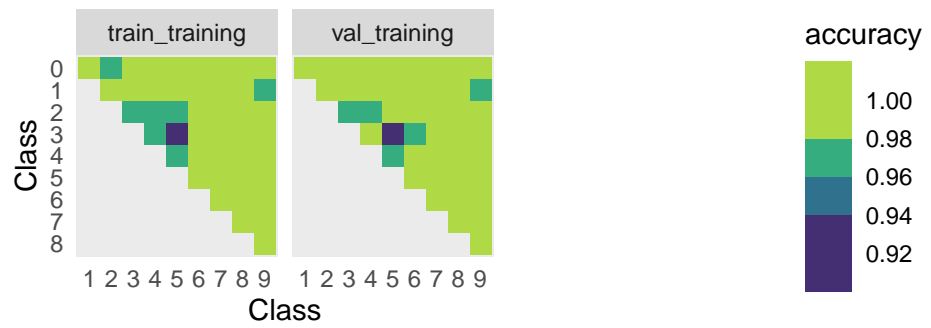
Replication 0 , fold 15
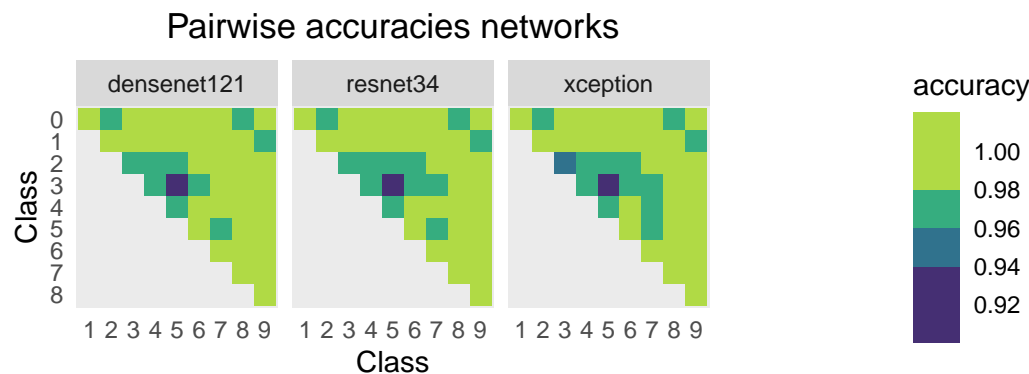
Pairwise accuracies networks

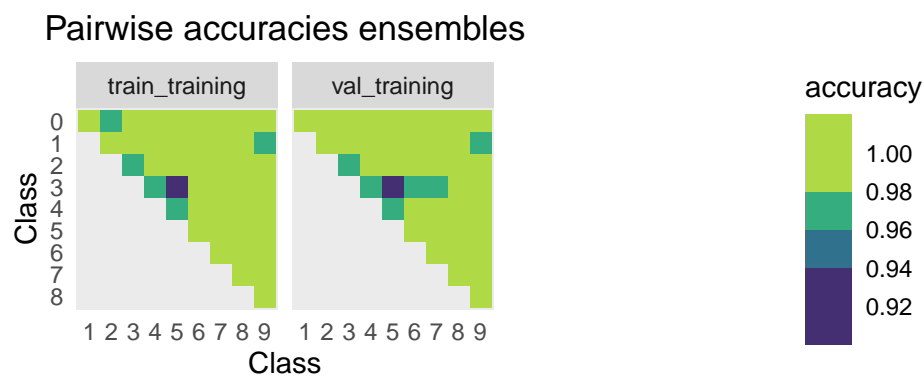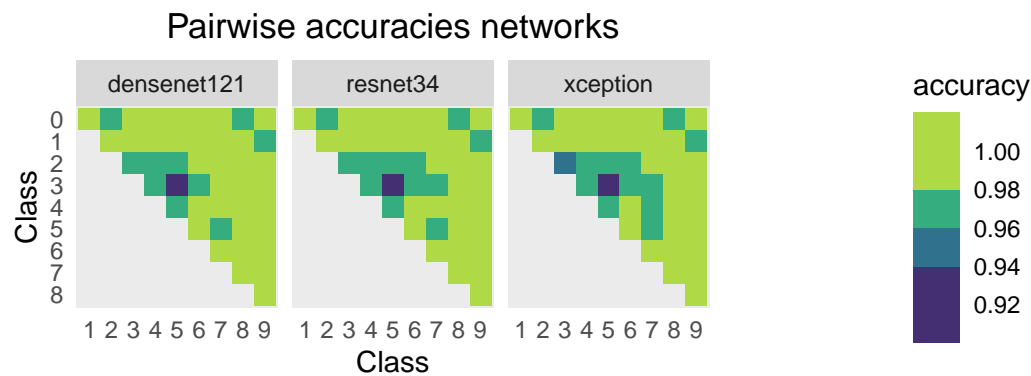## Pairwise accuracies ensembles
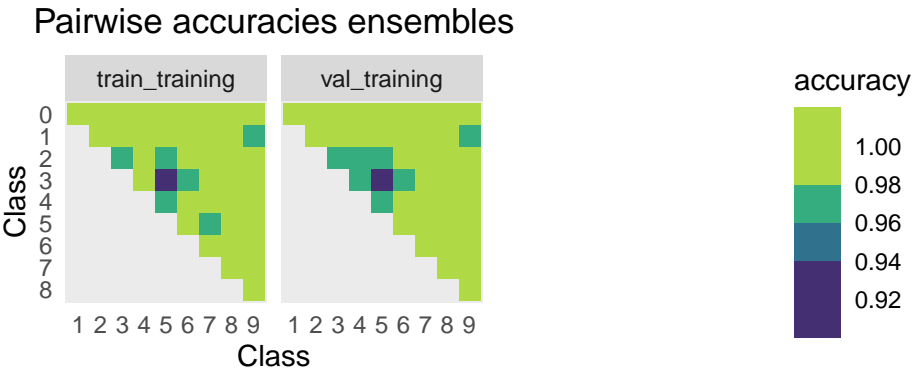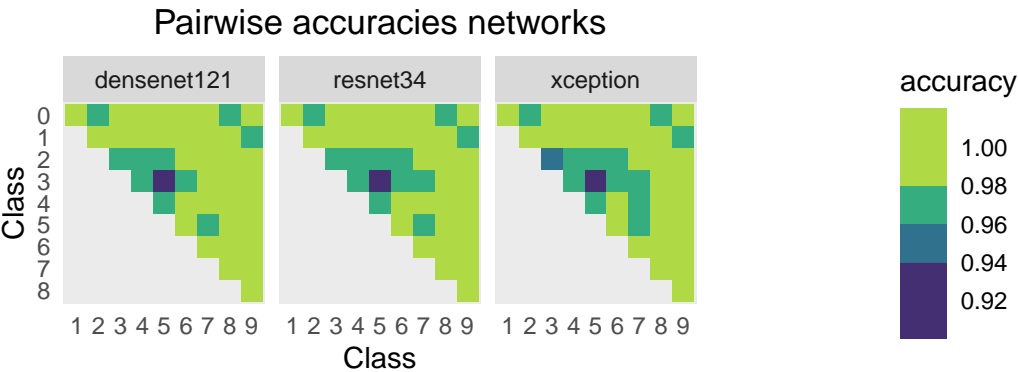
Replication 0 , fold 16

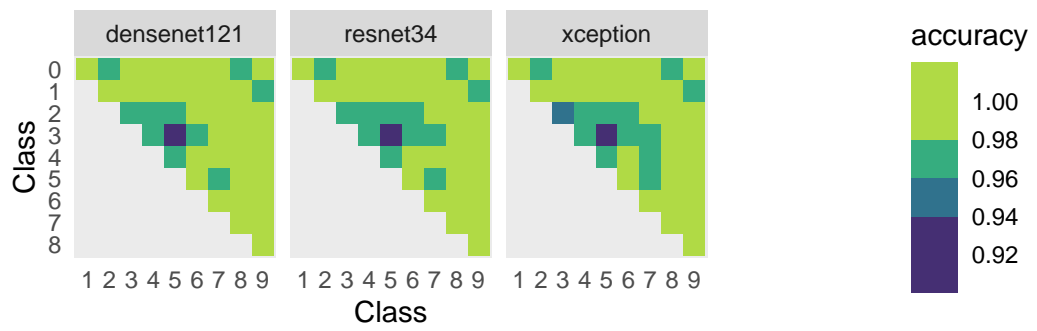## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 17
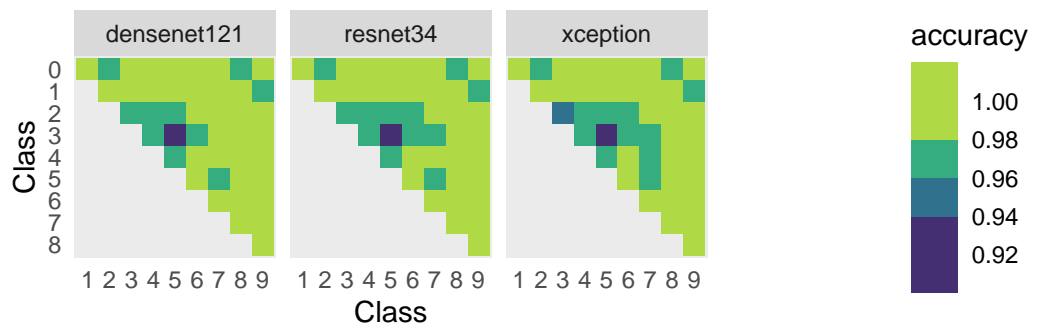
Pairwise accuracies networks
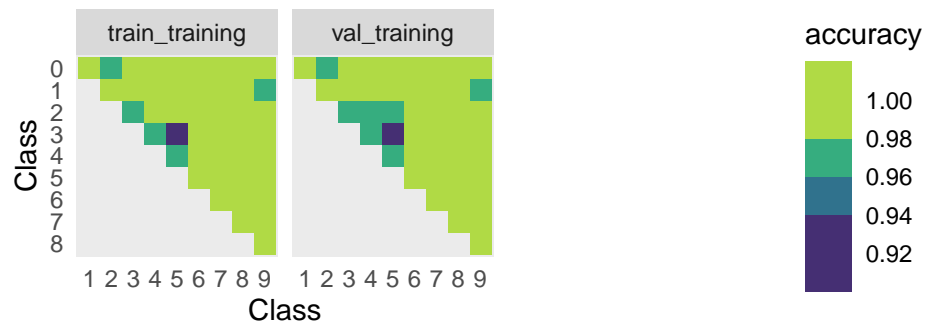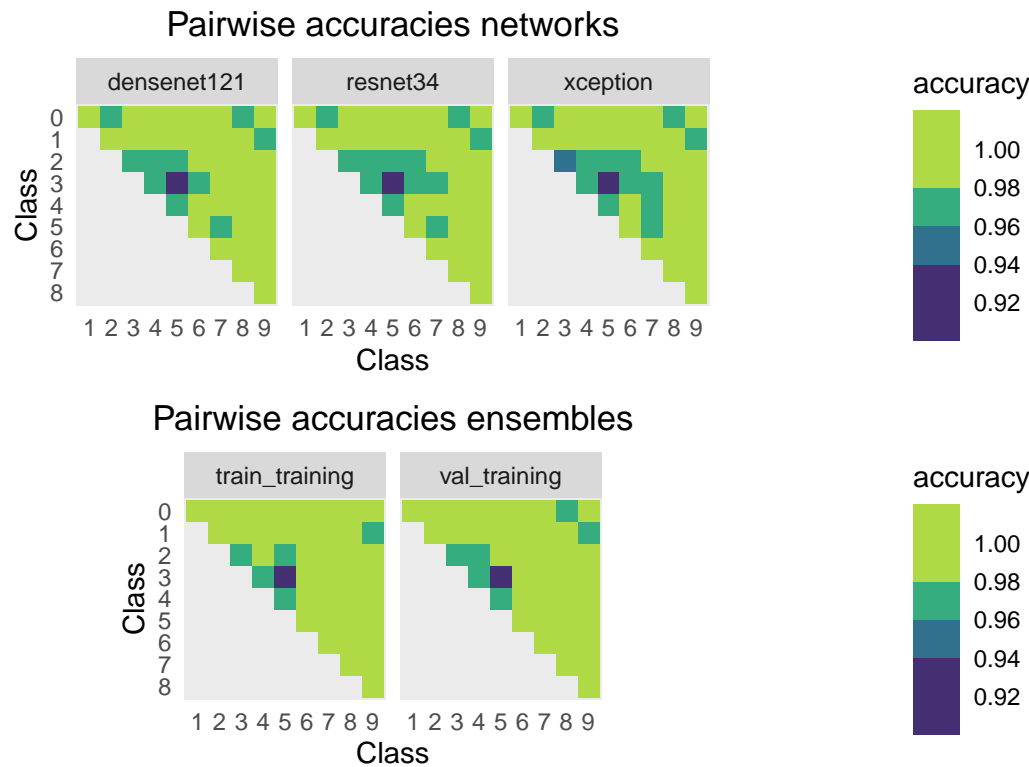

Pairwise accuracies ensembles

Replication 0 , fold 18

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 19

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 20

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 21
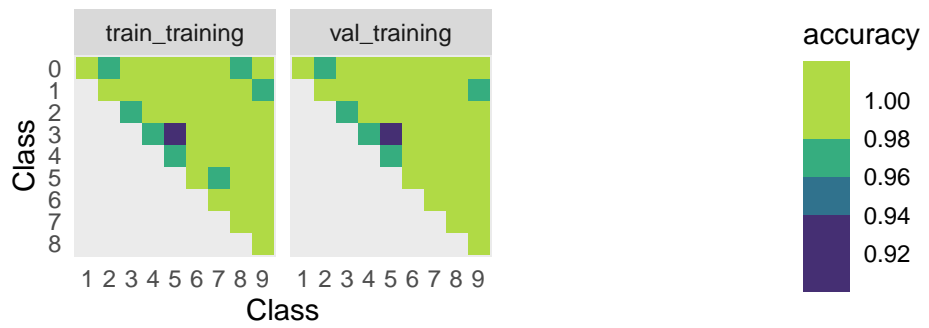
Pairwise accuracies networks

Pairwise accuracies ensembles
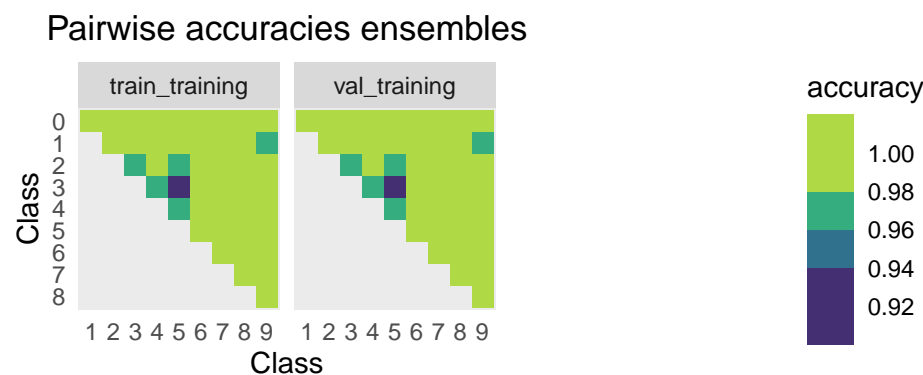
Replication 0 , fold 22

Pairwise accuracies networks
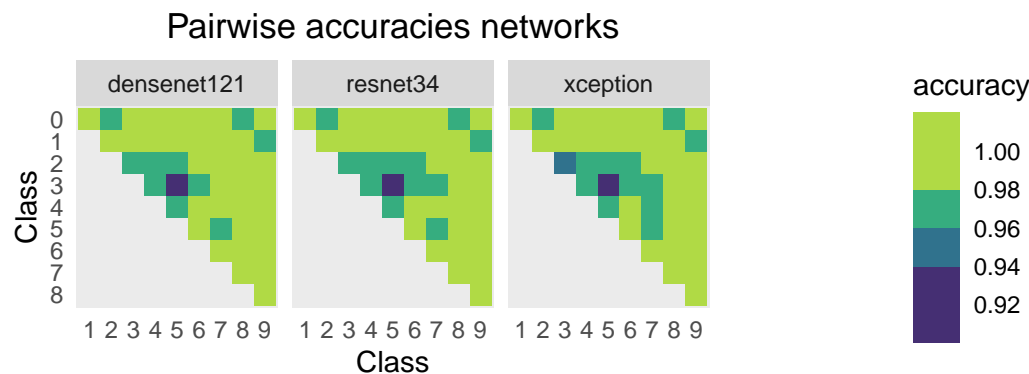
Pairwise accuracies ensembles
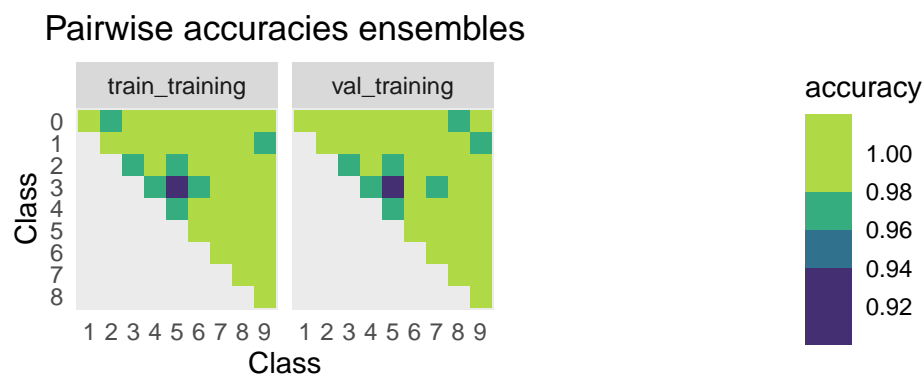
Replication 0 , fold 23

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 24

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 25

Pairwise accuracies networks

Pairwise accuracies ensembles
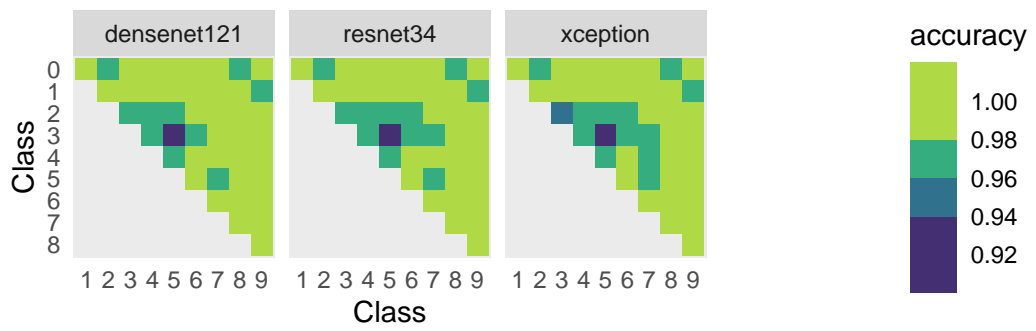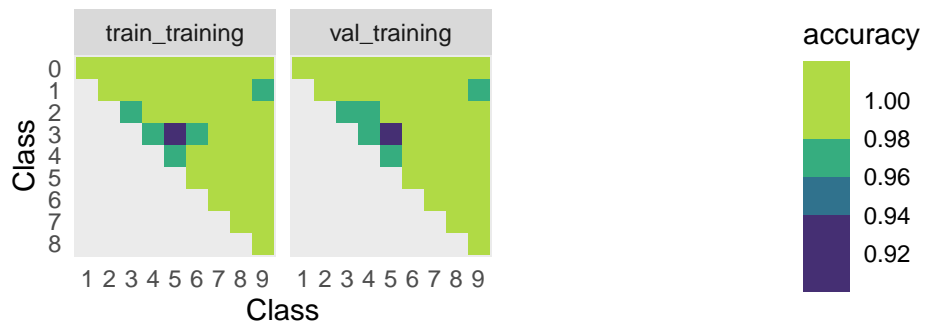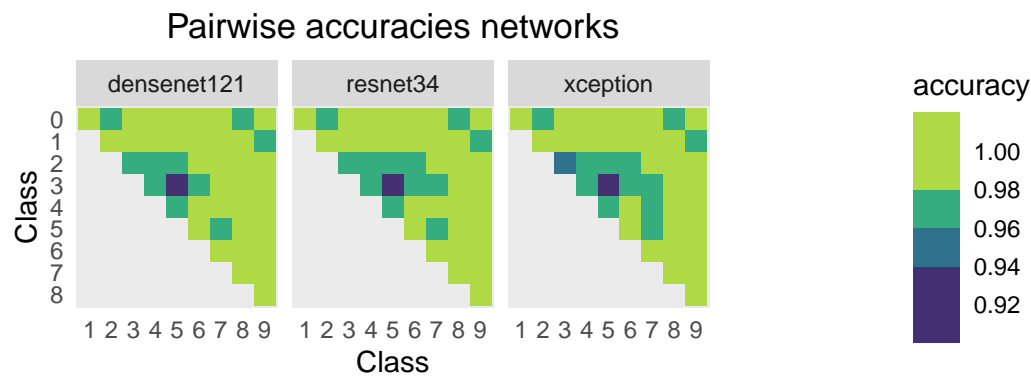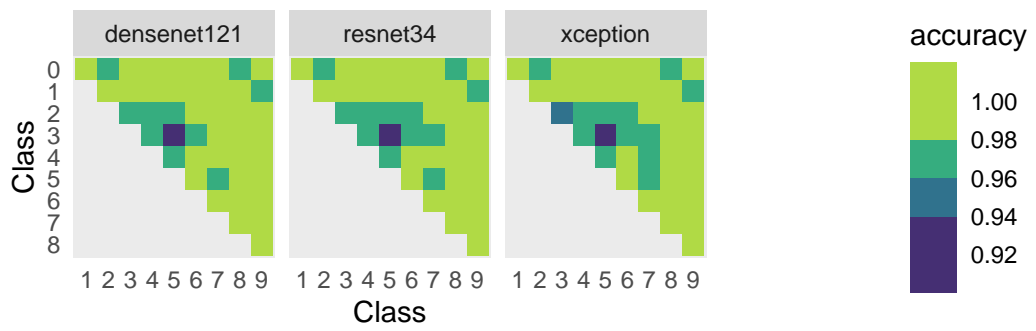
Replication 0 , fold 26

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 27

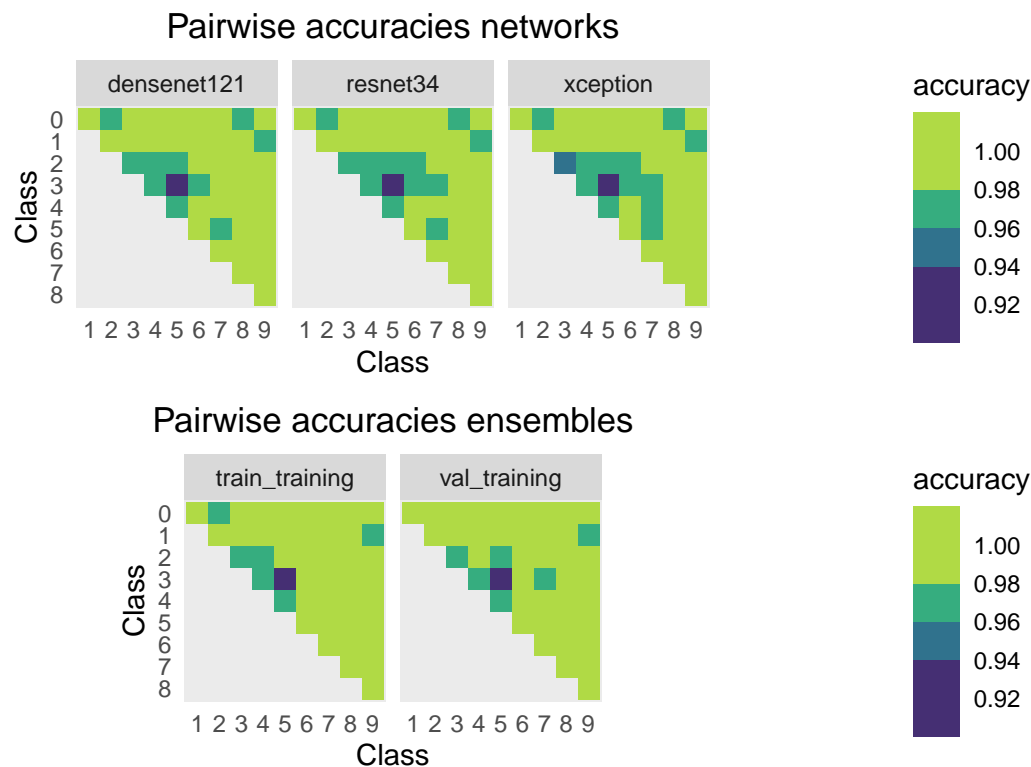## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 28

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 29

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 30

Pairwise accuracies networks

Pairwise accuracies ensembles
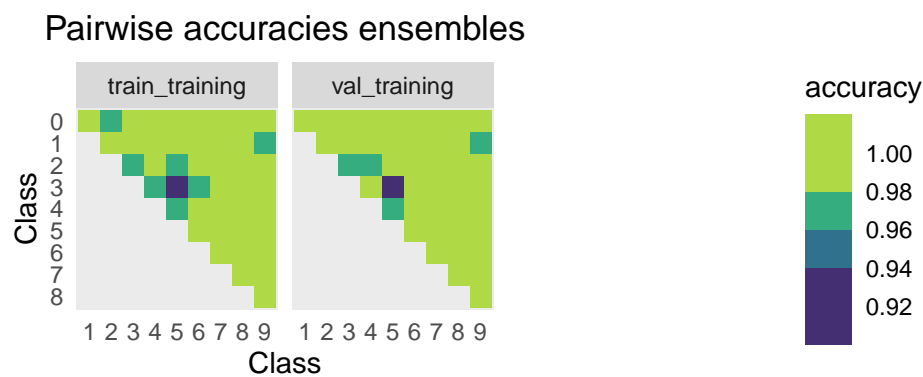
Replication 0 , fold 31

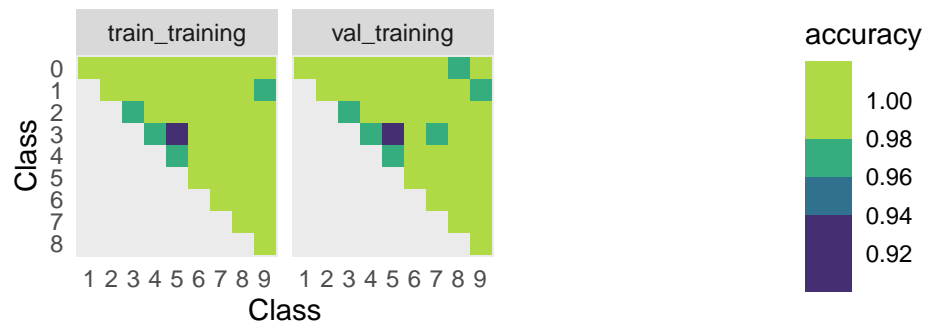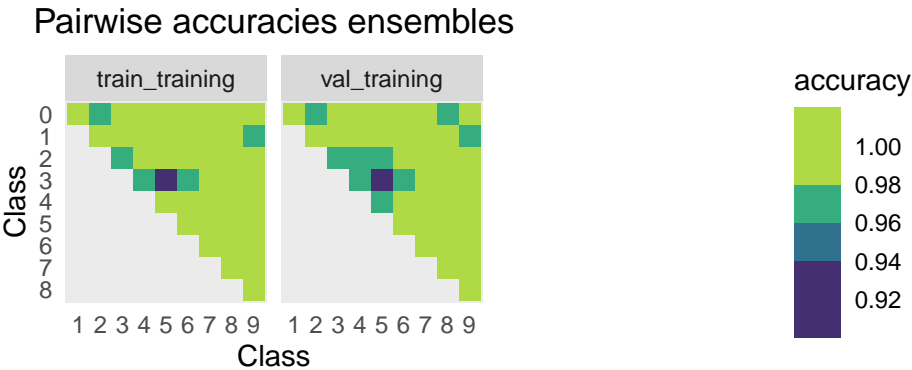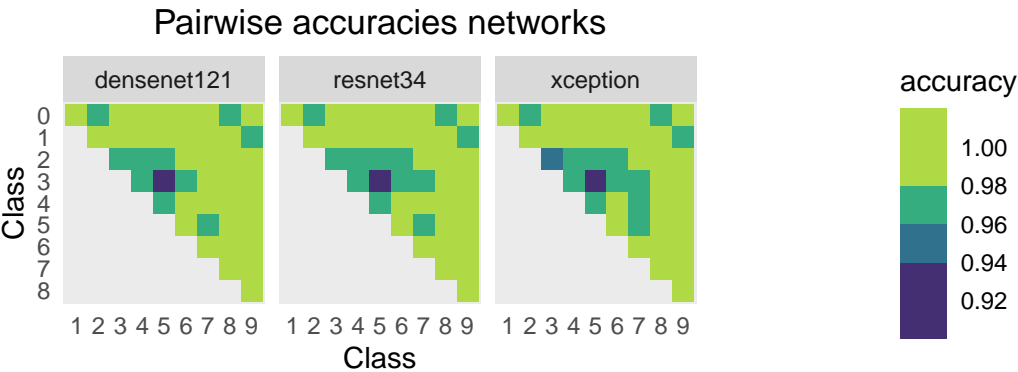## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 32

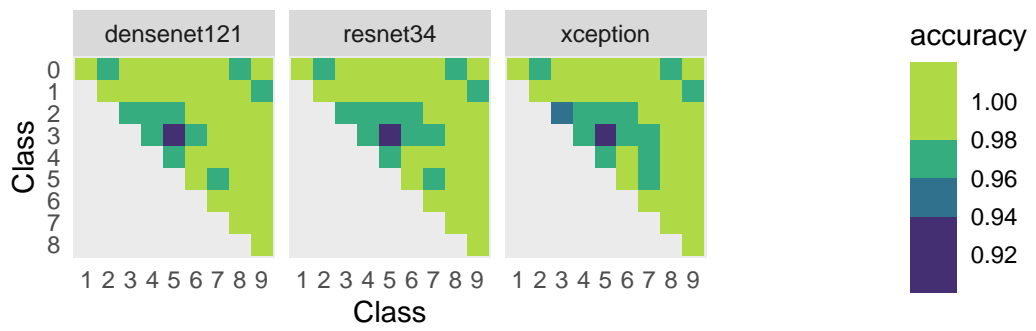## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 33
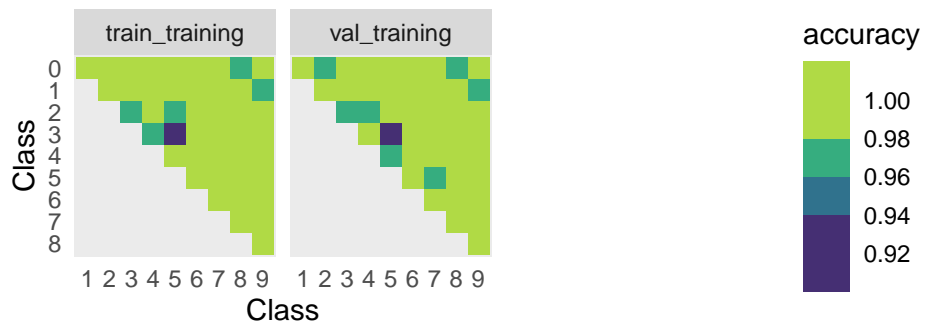
Pairwise accuracies networks

Pairwise accuracies ensembles
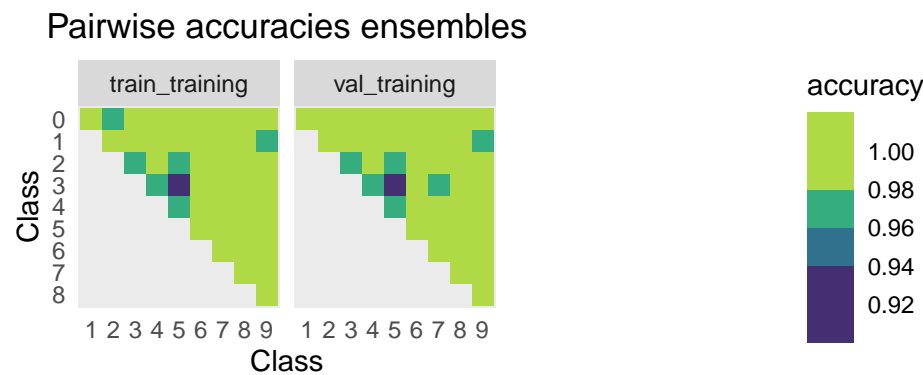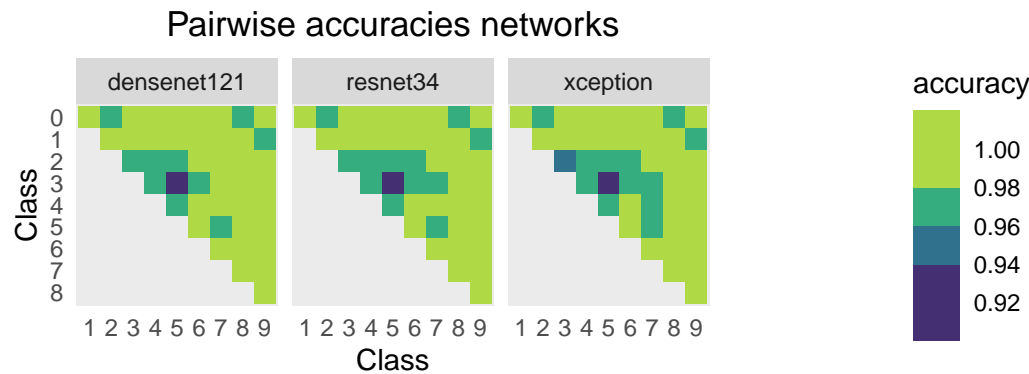
Replication 0 , fold 34

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 35

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 36

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 37

Pairwise accuracies networks

Pairwise accuracies ensembles
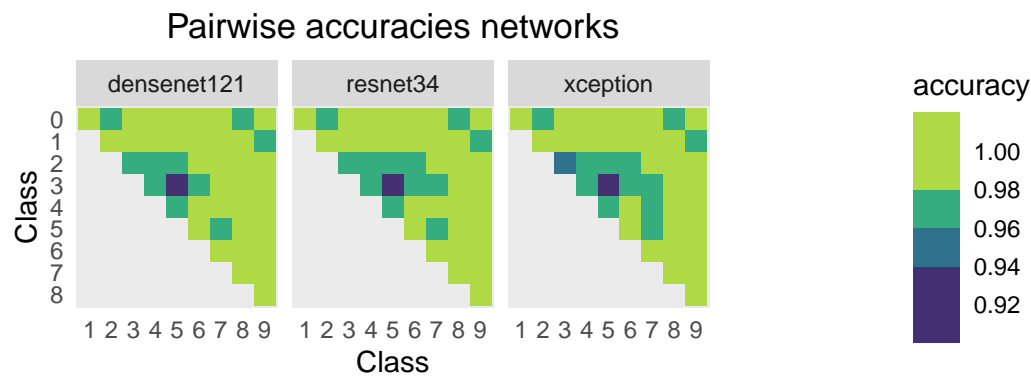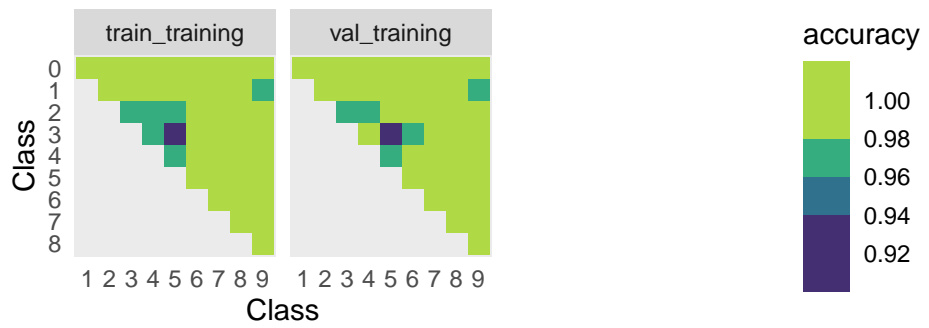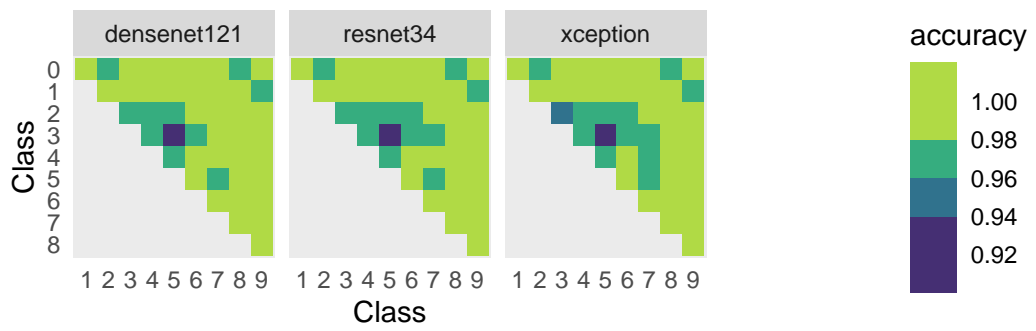
Replication 0 , fold 38

Pairwise accuracies networks

Pairwise accuracies ensembles
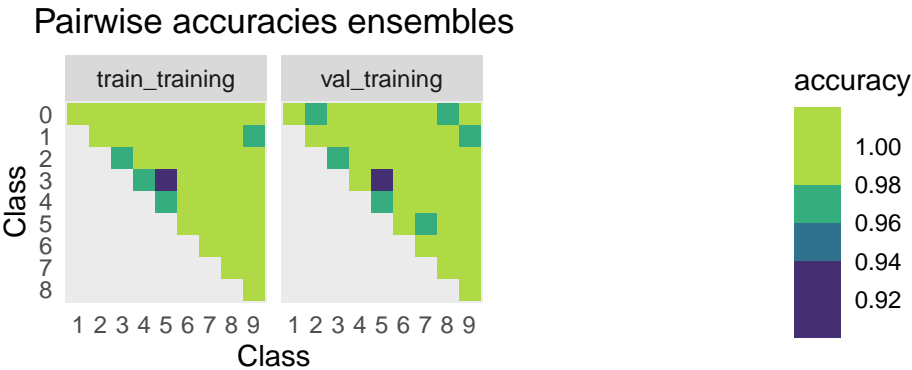
Replication 0 , fold 39

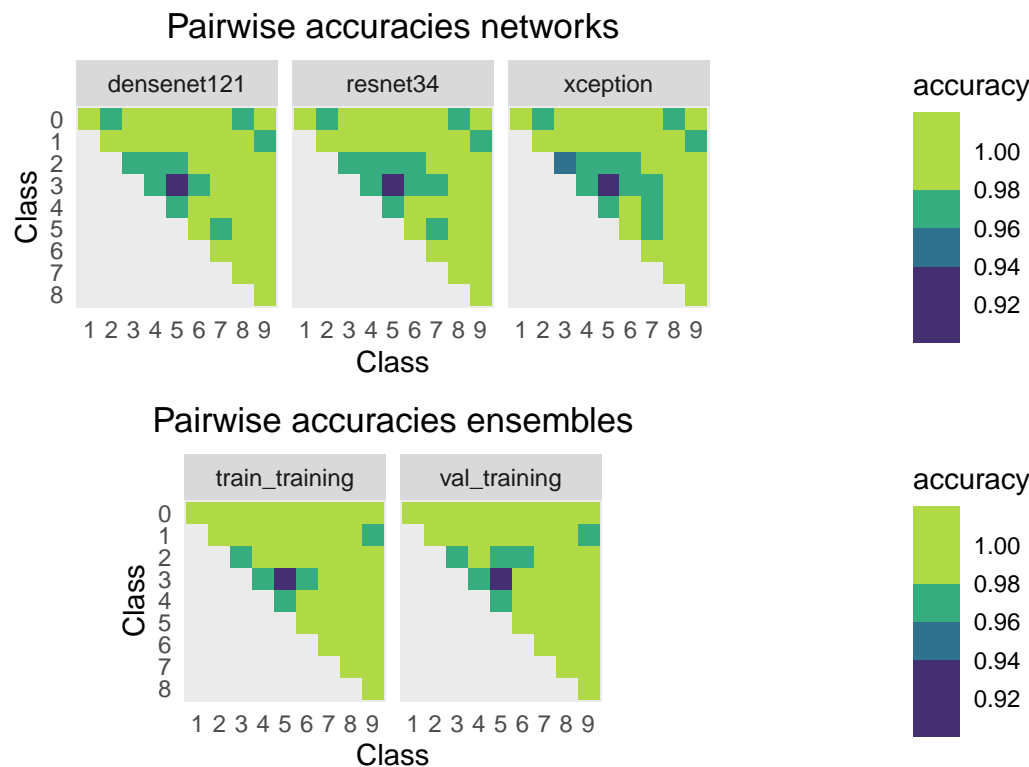## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 40

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 41

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 42
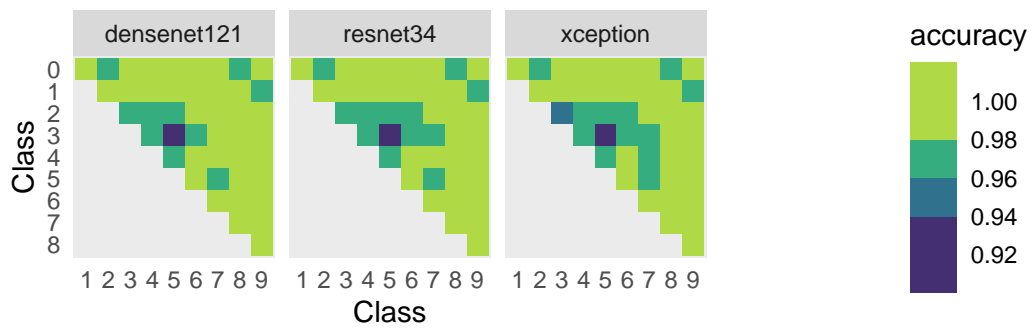
Pairwise accuracies networks
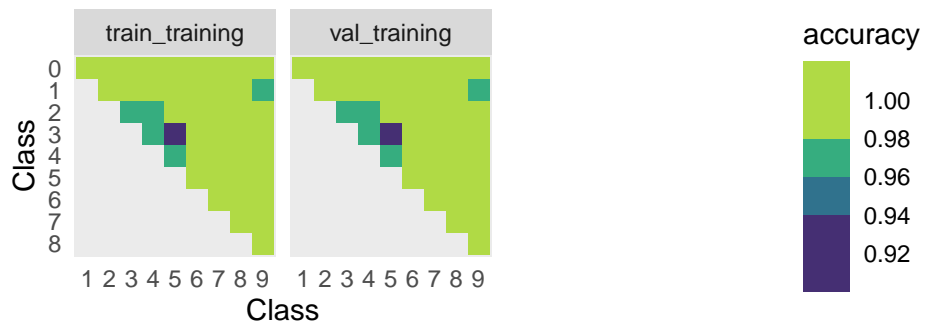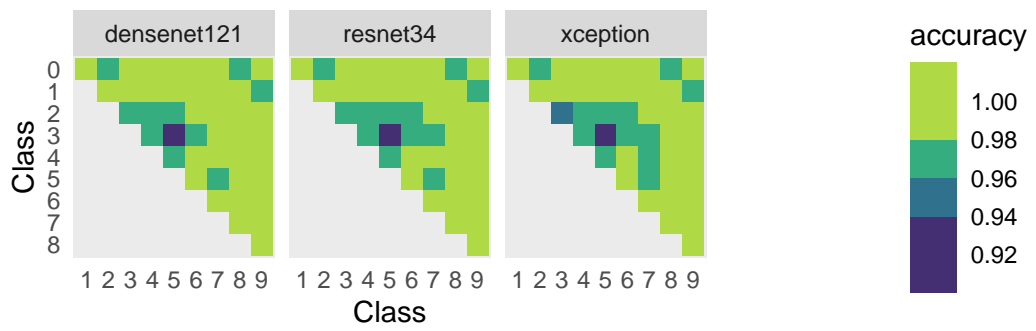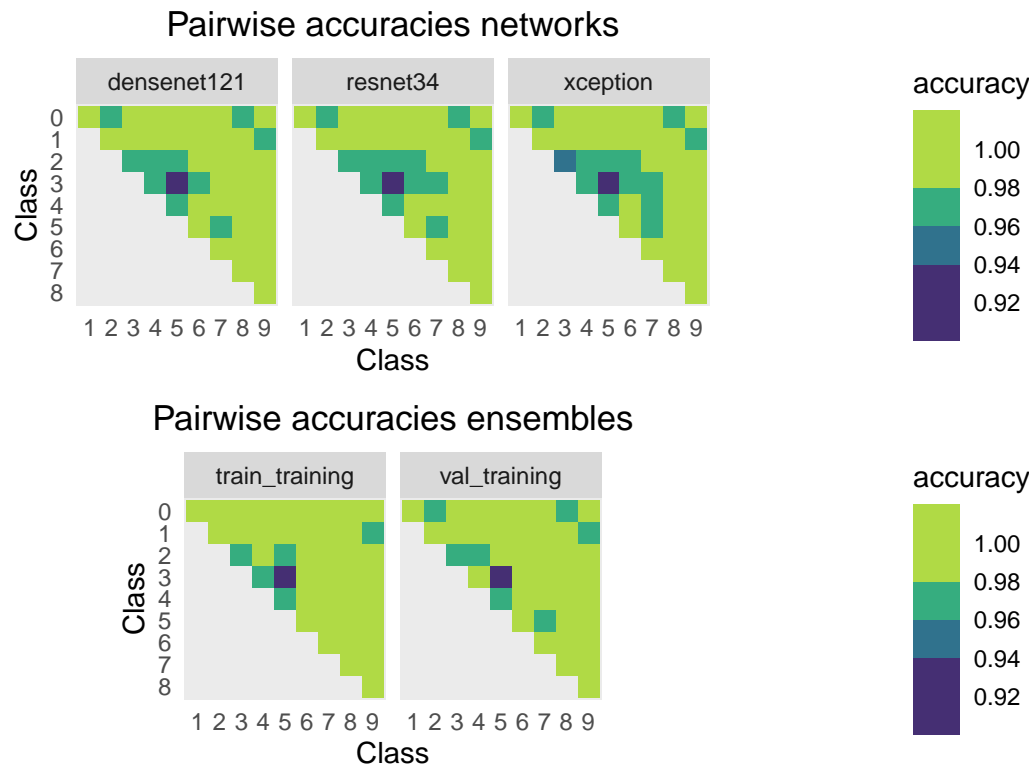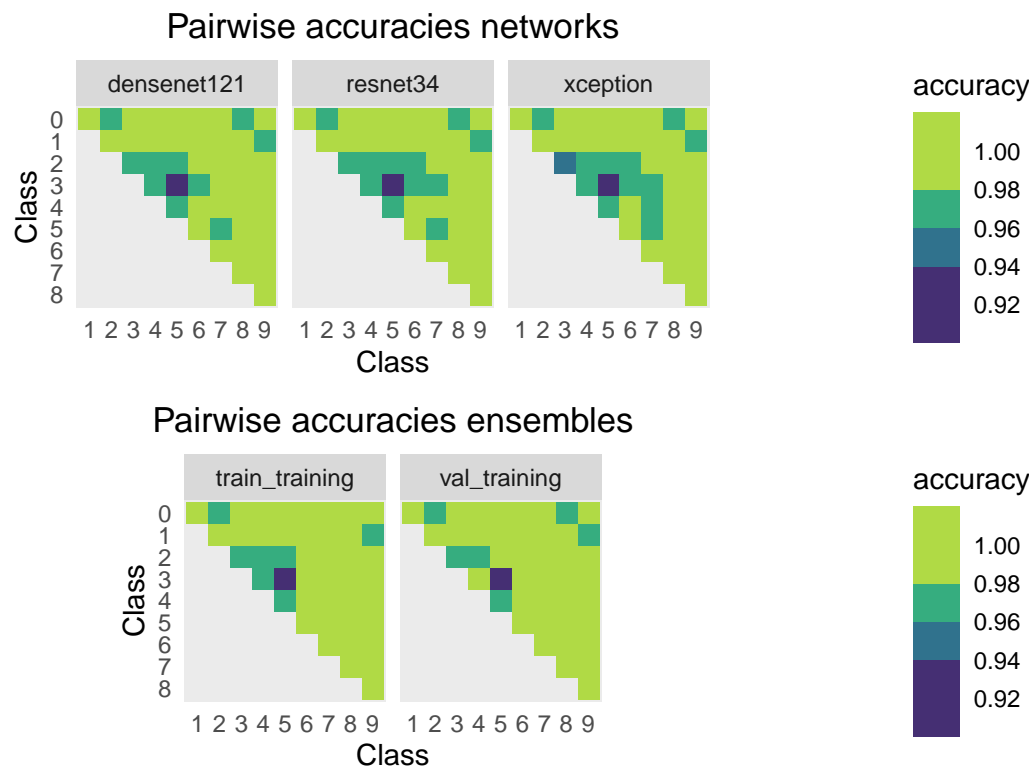

Pairwise accuracies ensembles

Replication 0 , fold 43

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 44

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 45

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 46

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 47

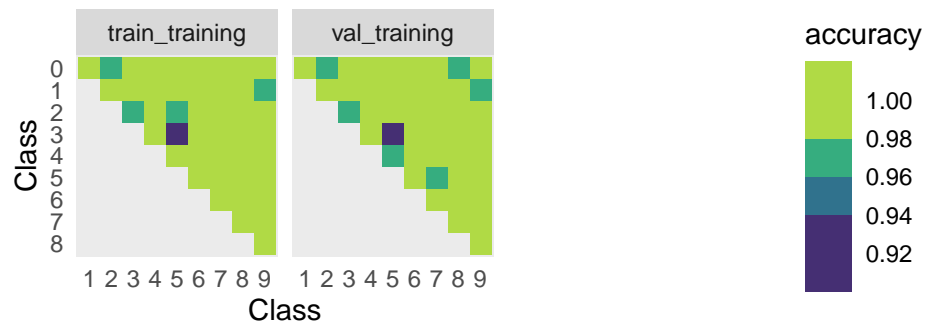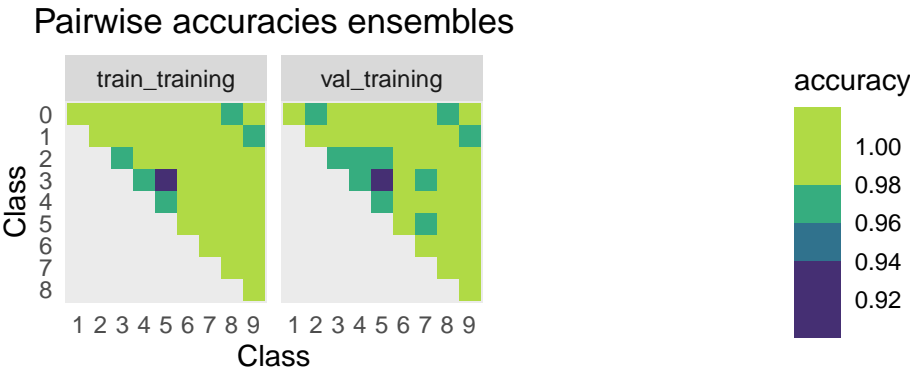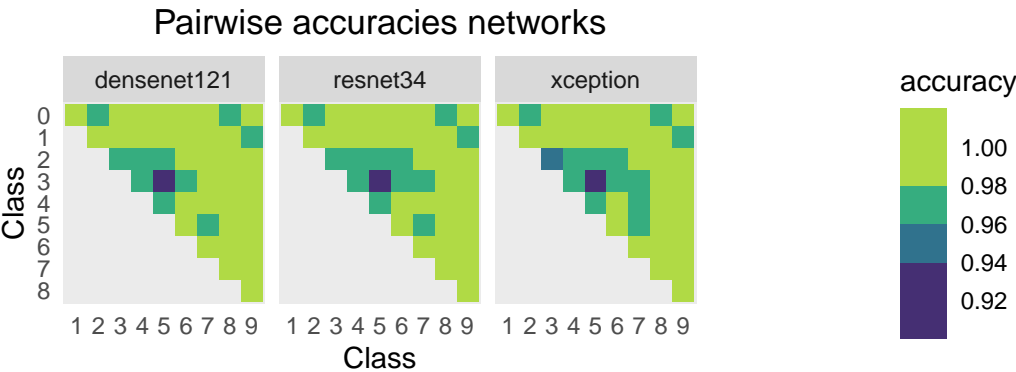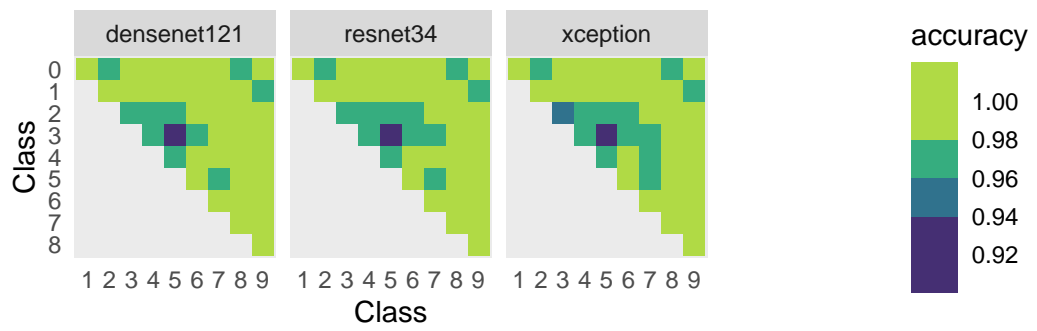Pairwise accuracies networks

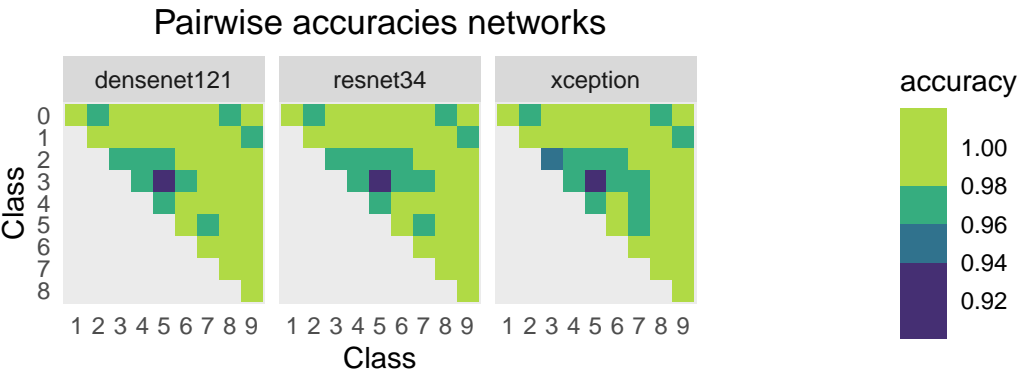Pairwise accuracies ensembles

Replication 0 , fold 48

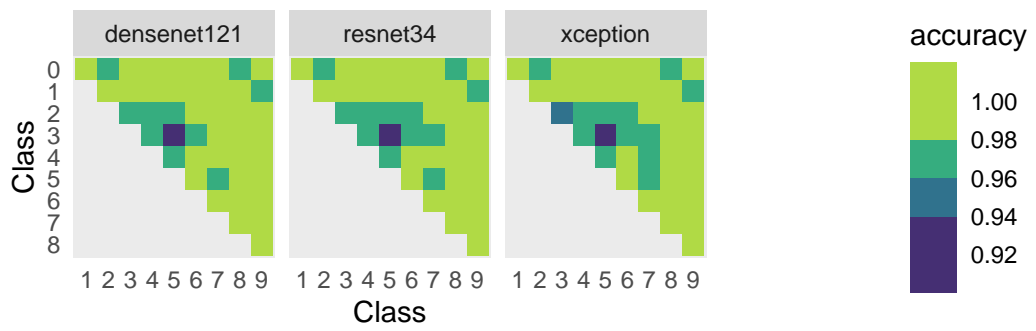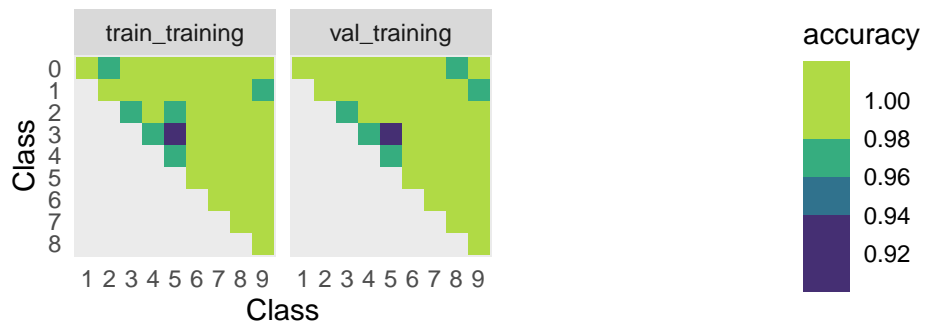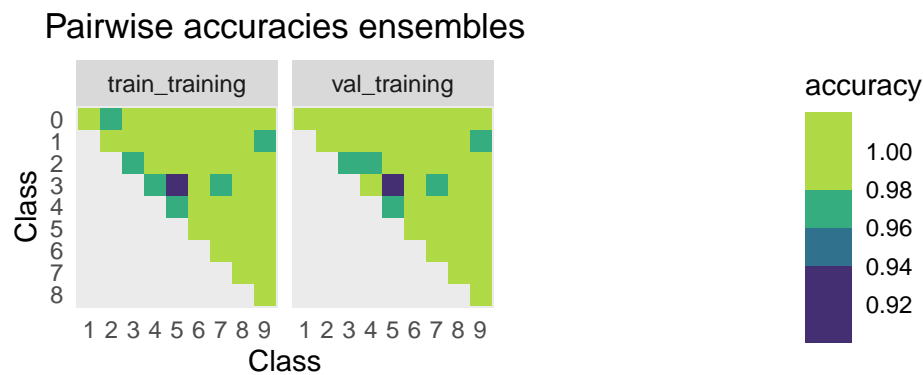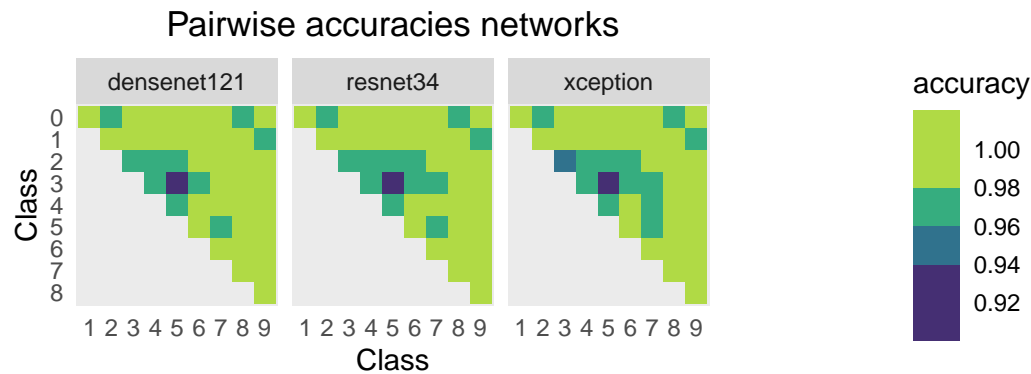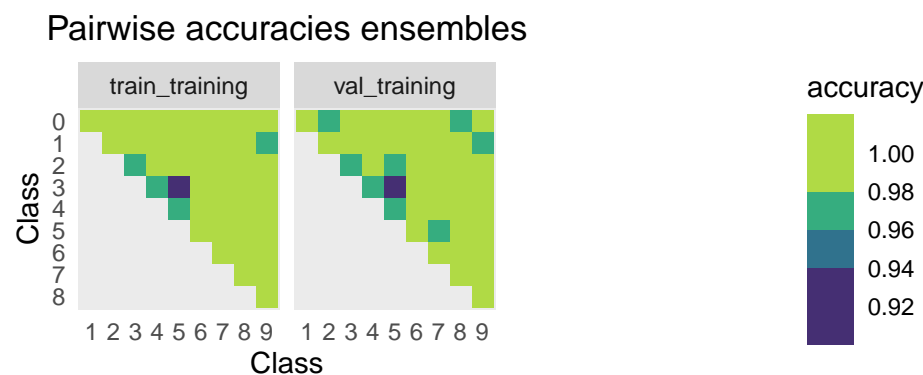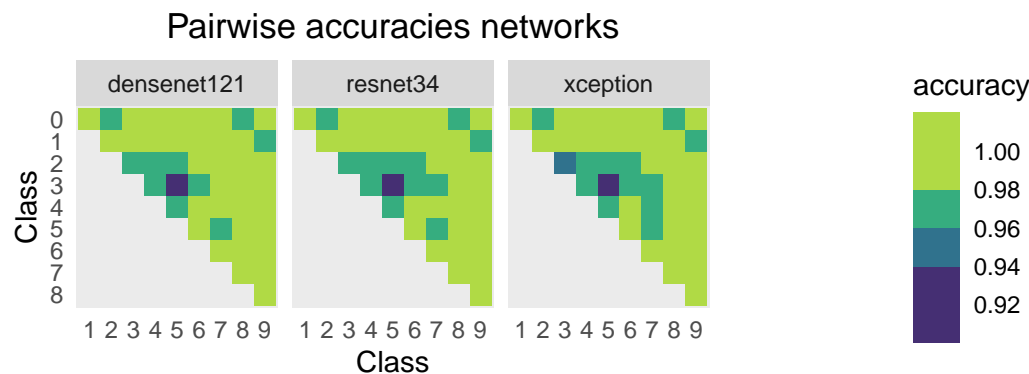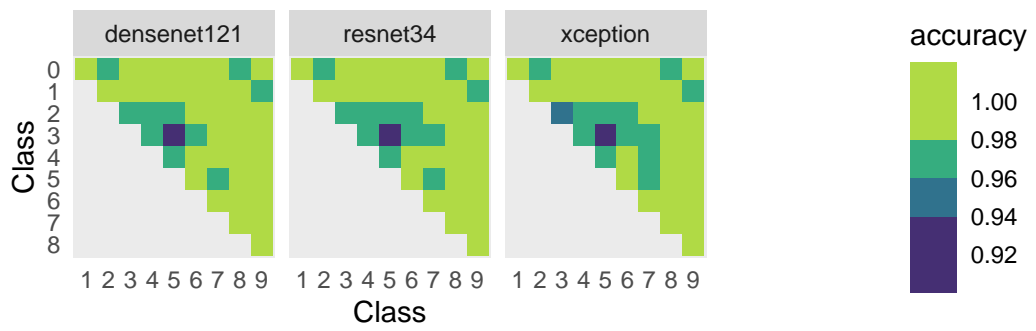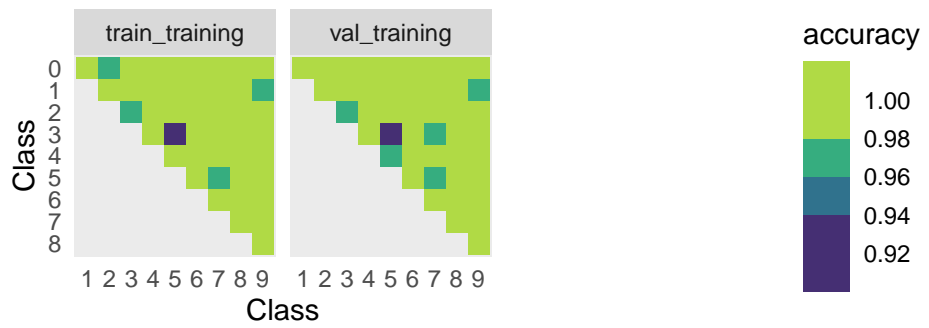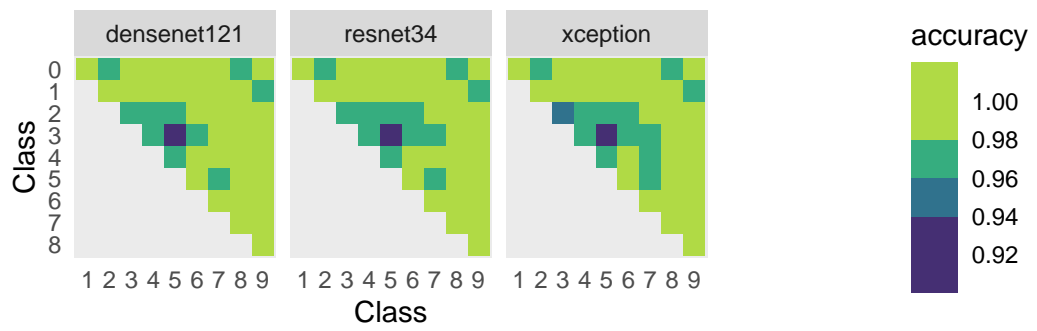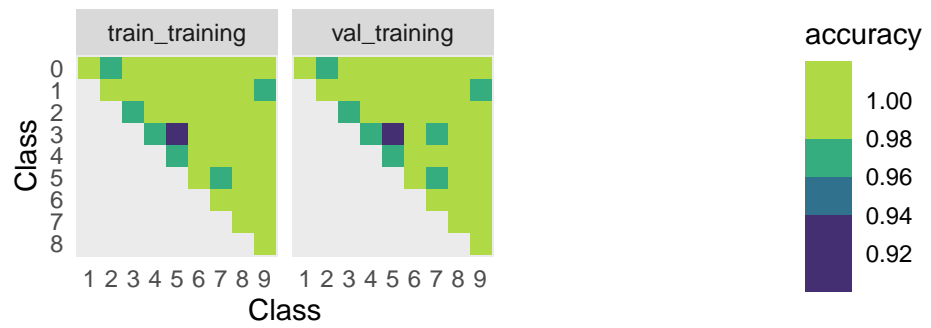## Pairwise accuracies networks
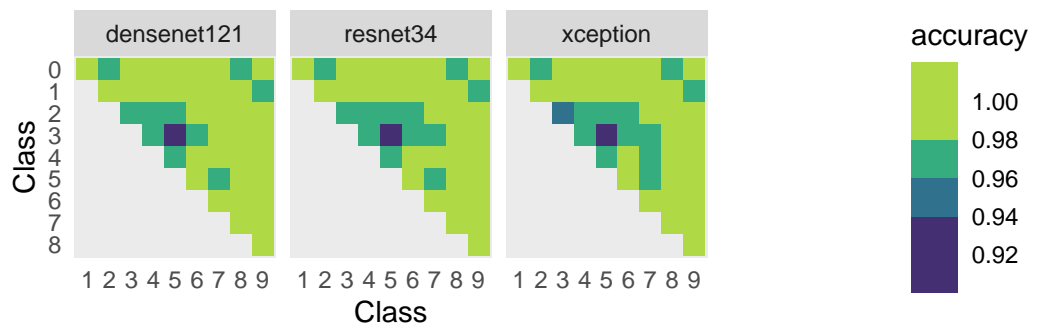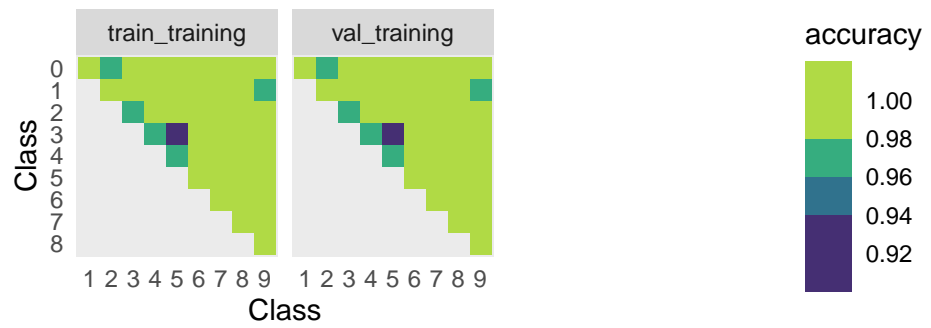

Pairwise accuracies ensembles

Replication 0 , fold 49

Pairwise accuracies networks

Pairwise accuracies ensembles
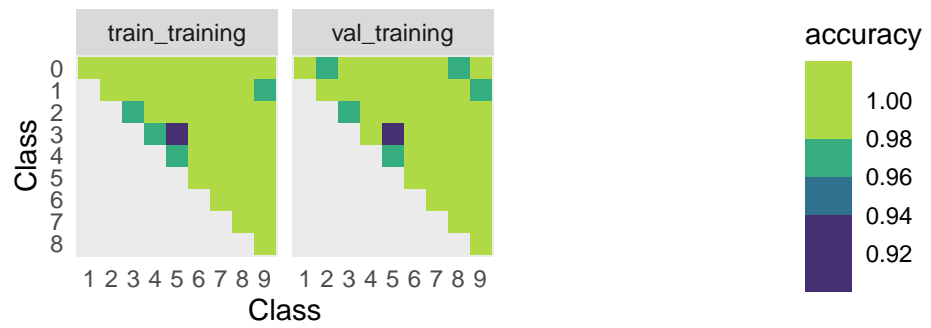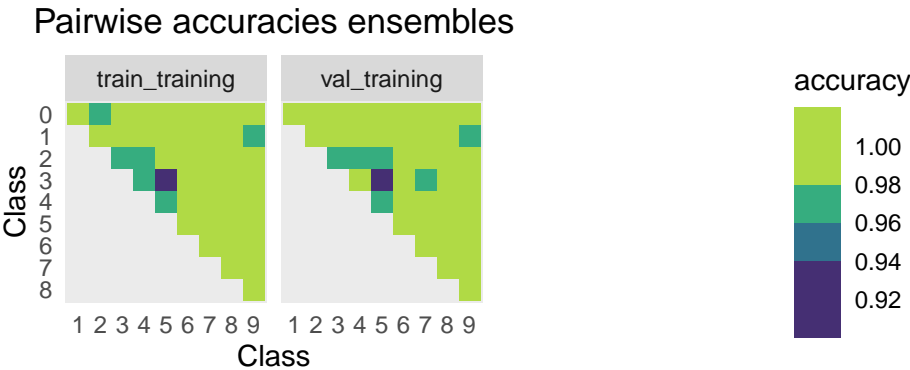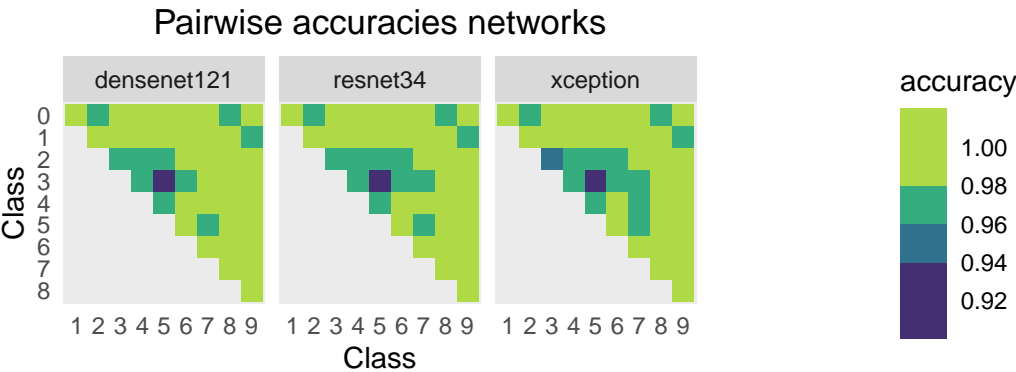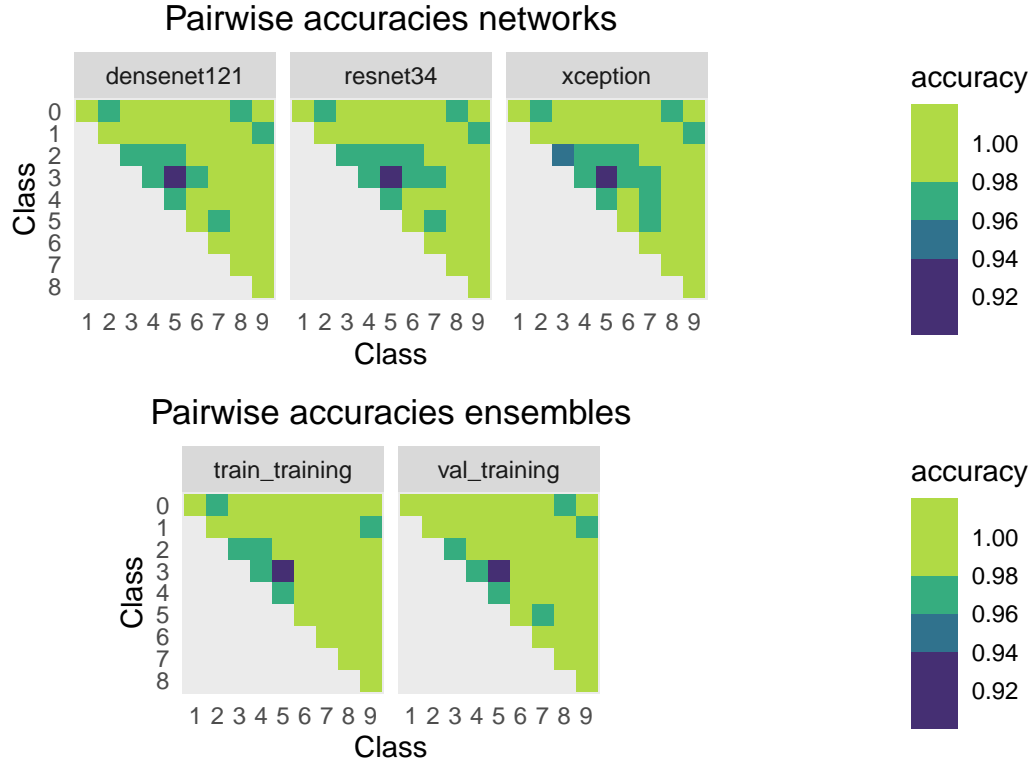
Networks are same across all the folds. vt and tt for a given fold have no special relationship, they are displayed together just for convenience. tt again seems to be more successfull at improving the parwise probabilities.

CIFAR 10 - validation set of size 25000

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


net_pw_results <- read.csv(file.path(base_dir, "net_pw_accuracies.csv"))
ens_pw_results <- read.csv(file.path(base_dir, "ensemble_pw_accuracies.csv"))
net_pw_results[, c("class1", "class2")] <- lapply(net_pw_results[, c("class1", "class2")], as.factor)
ens_pw_results[, c("class1", "class2")] <- lapply(ens_pw_results[, c("class1", "class2")], as.factor)


for (ri in repls)
{
  net_plot <- net_pw_results %>% filter(repli == ri) %>%
    ggplot(mapping=aes(x=class2, y=class1, fill=accuracy)) + geom_raster() + facet_wrap(~network) +
    xlab("Class") +
    ylab("Class") +
    scale_y_discrete(limits=rev, breaks=seq(0, classes, 20)) +
    scale_x_discrete(breaks=seq(0, classes, 20)) +
```

```r
    scale_fill_binned(type="viridis",  name="accuracy", limits=c(0.7, 1)) +
    coord_fixed() +
    ggtitle("Pairwise accuracies networks") +
    theme(plot.title = element_text(hjust = 0.5),
      axis.ticks = element_blank(),
      panel.grid.major = element_blank(),
      panel.grid.minor = element_blank())



  for (fi in folds)
  {
    ens_plot <- ens_pw_results %>% filter(repli == ri & fold == fi) %>%
      ggplot(mapping=aes(x=class2, y=class1, fill=accuracy)) + geom_raster() + facet_wrap(~train_set) +
      xlab("Class") +
      ylab("Class") +
      scale_y_discrete(limits=rev, breaks=seq(0, classes, 20)) +
      scale_x_discrete(breaks=seq(0, classes, 20)) +
      coord_fixed() +
      ggtitle("Pairwise accuracies ensembles") +
      scale_fill_binned(type="viridis", name="accuracy", limits=c(0.7, 1)) +
      theme(plot.title = element_text(hjust = 0.5),
        axis.ticks = element_blank(),
        panel.grid.major = element_blank(),
        panel.grid.minor = element_blank())

    print((net_plot/ens_plot) + plot_annotation(title=paste("Replication ", ri, ", fold ", fi)))
  }
}
```
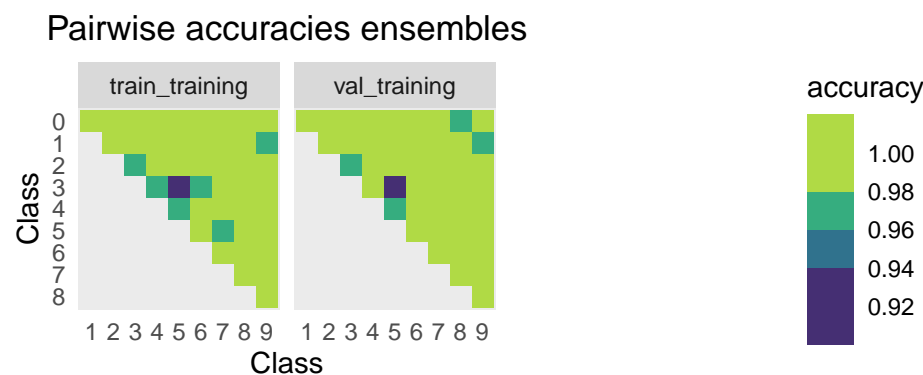
Replication 0 , fold 0

Pairwise accuracies networks

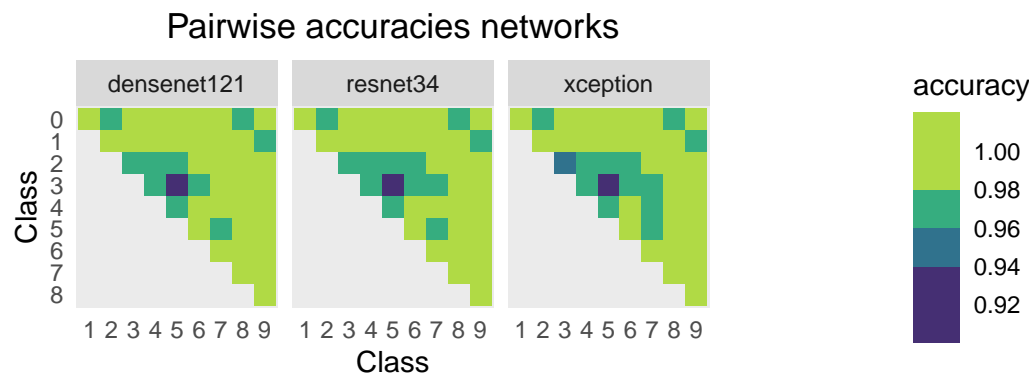## Pairwise accuracies ensembles

Replication 0 , fold 1

Pairwise accuracies networks
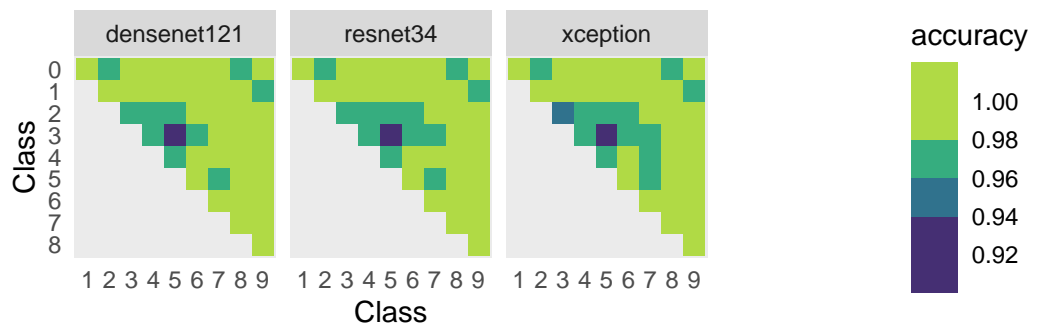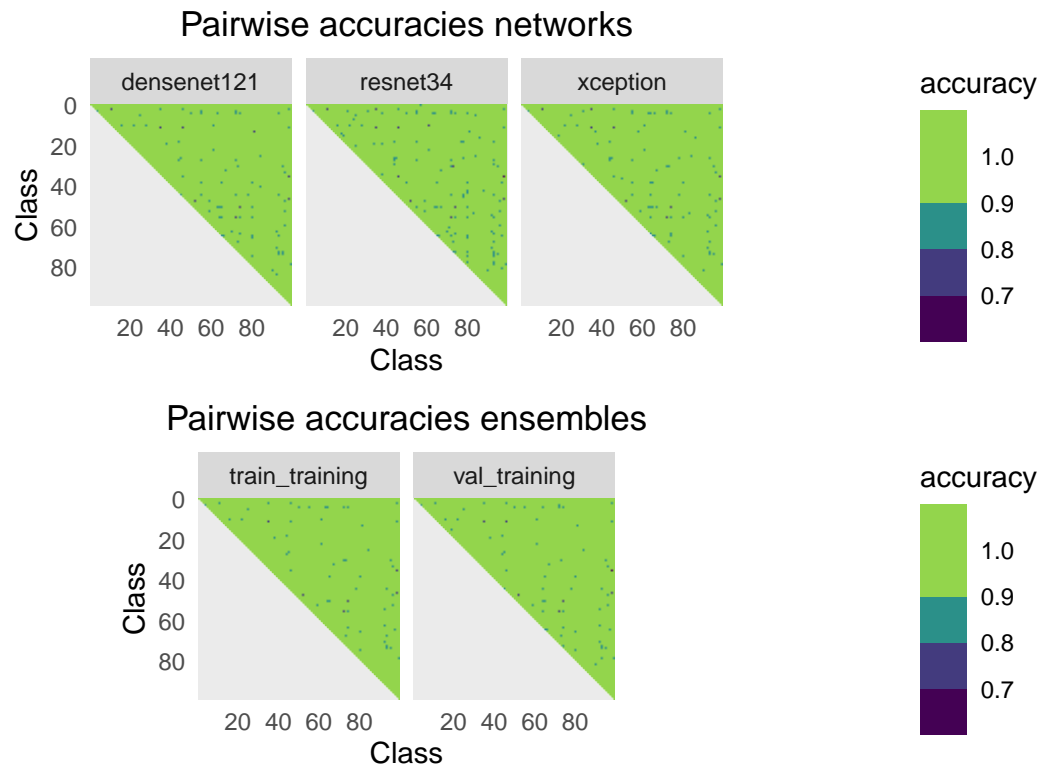

Pairwise accuracies ensembles

Replication 0 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 0 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 1 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 1 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 1 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 1 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 1 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 2 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 2 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 2 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 2 , fold 3

Pairwise accuracies networks
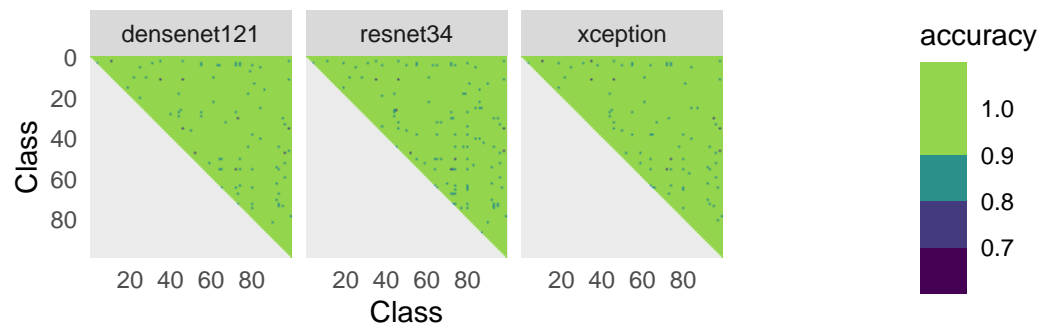
Pairwise accuracies ensembles

Replication 2 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 3 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 3 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 3 , fold 2

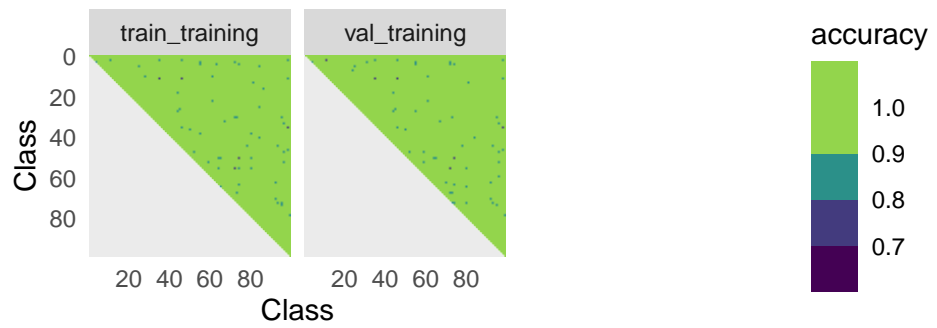## Pairwise accuracies networks

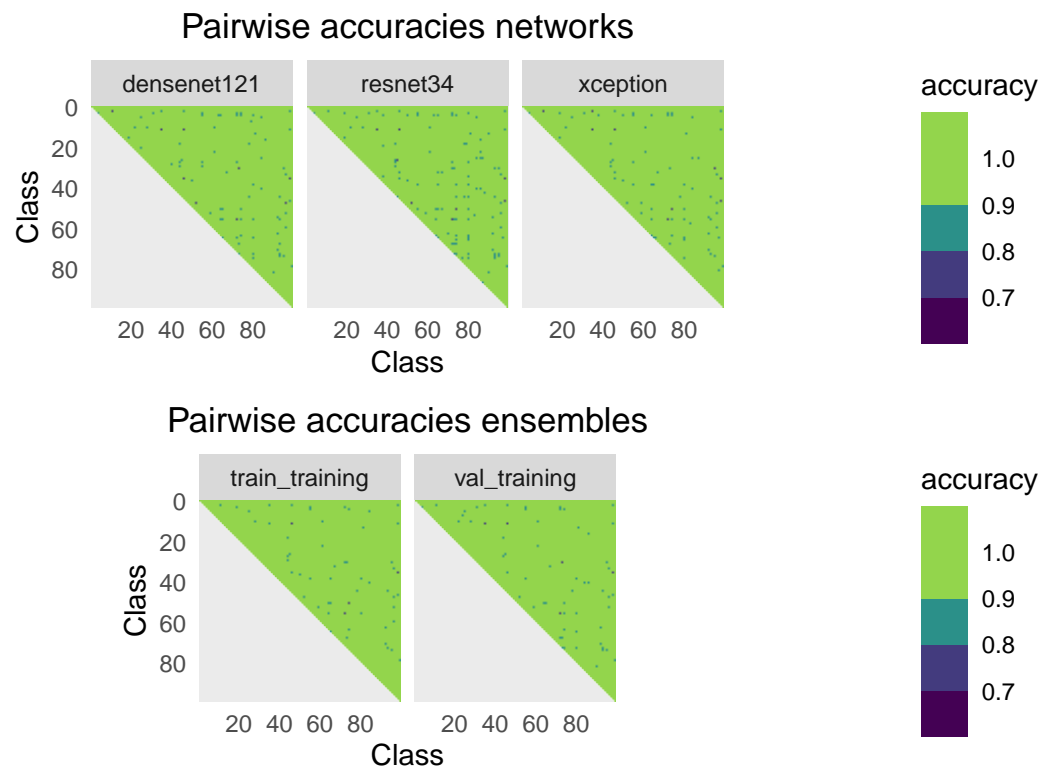## Pairwise accuracies ensembles

Replication 3 , fold 3
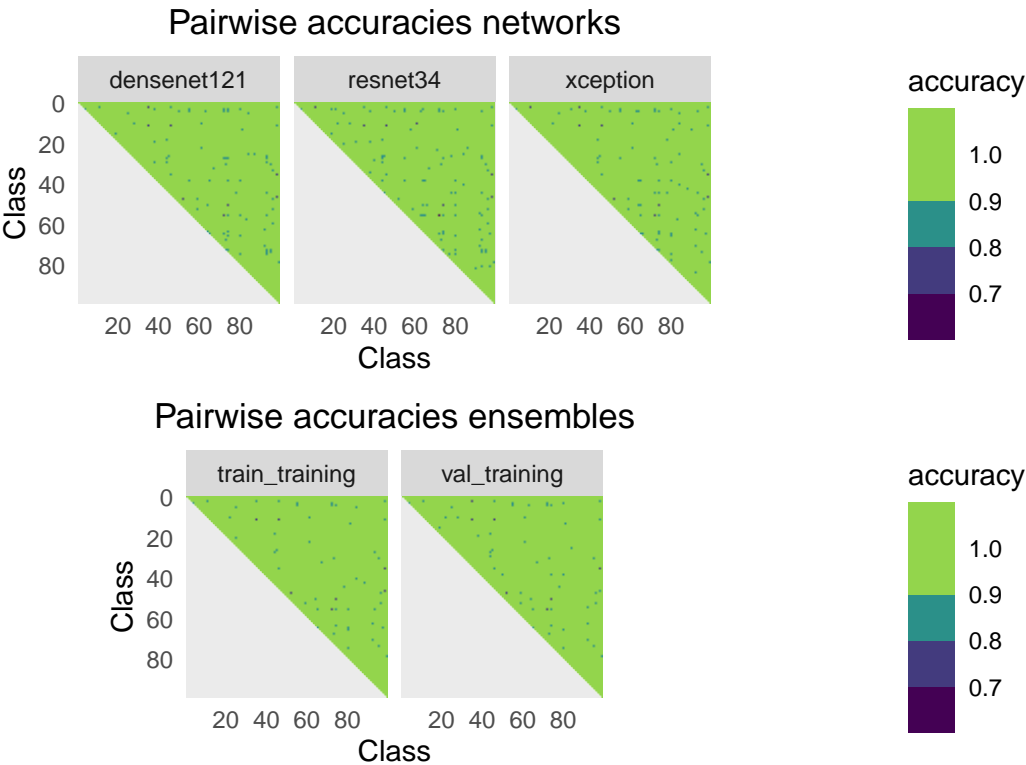
Pairwise accuracies networks

Pairwise accuracies ensembles
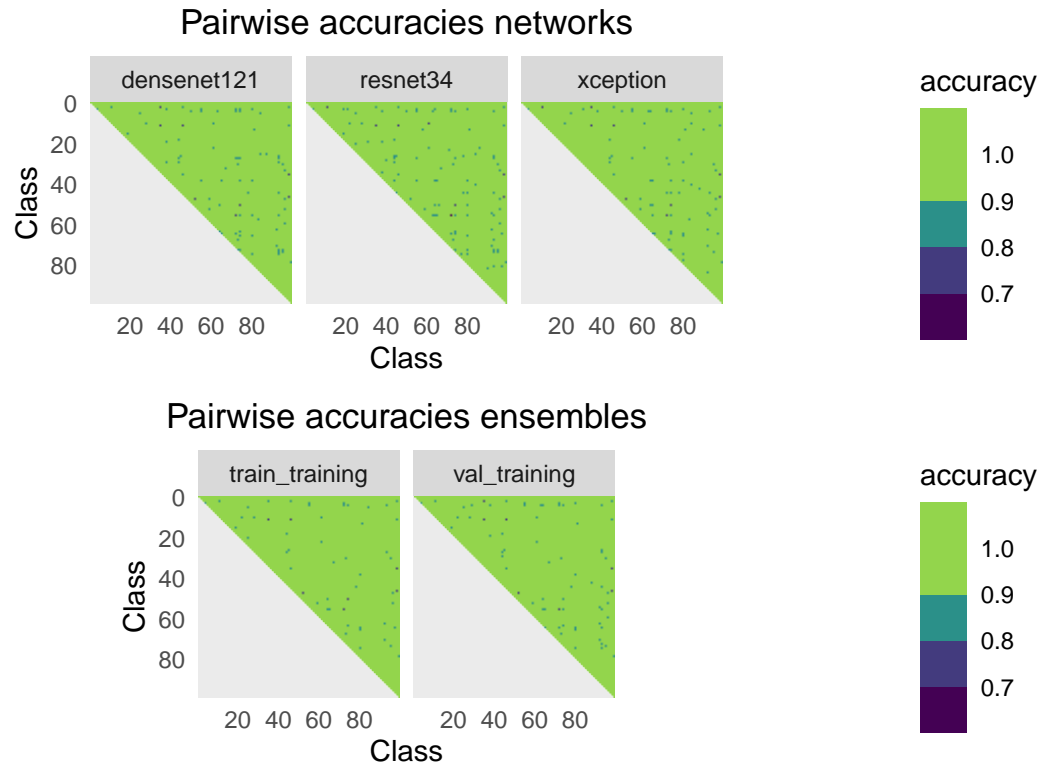
Replication 3 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 4 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles
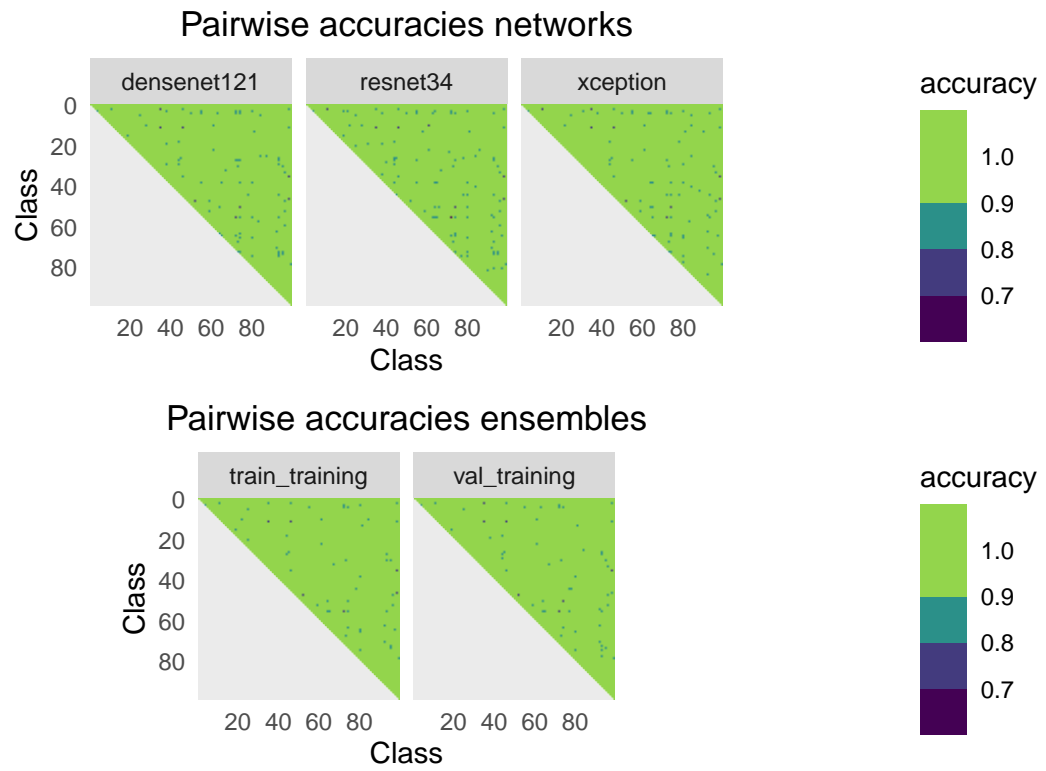
Replication 4 , fold 1

Pairwise accuracies networks
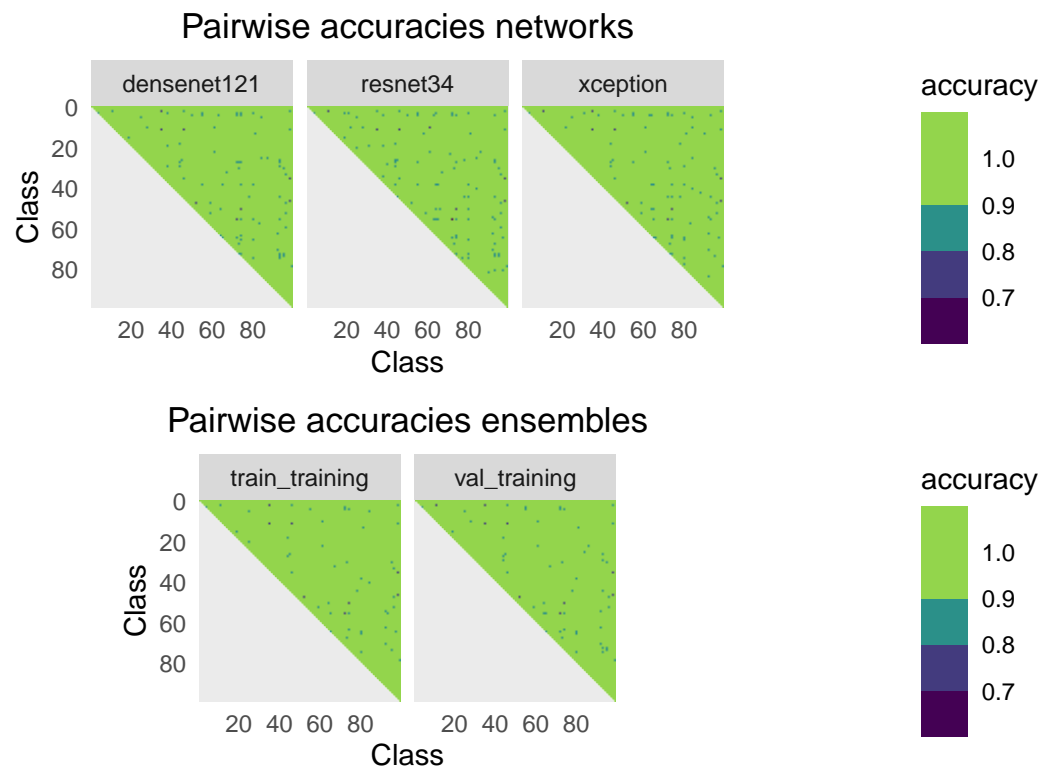

Pairwise accuracies ensembles

Replication 4 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 4 , fold 3

Pairwise accuracies networks

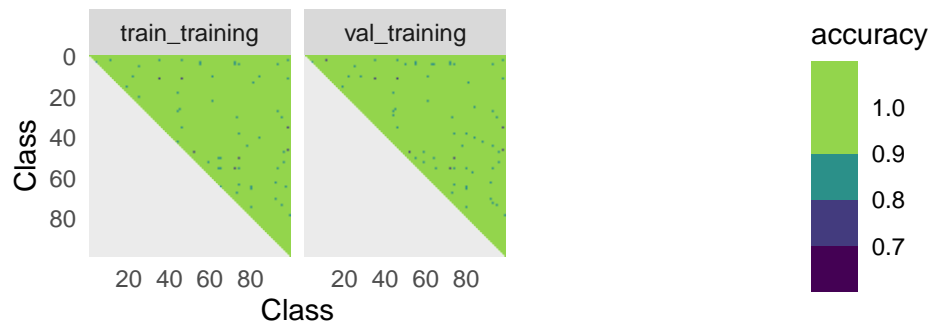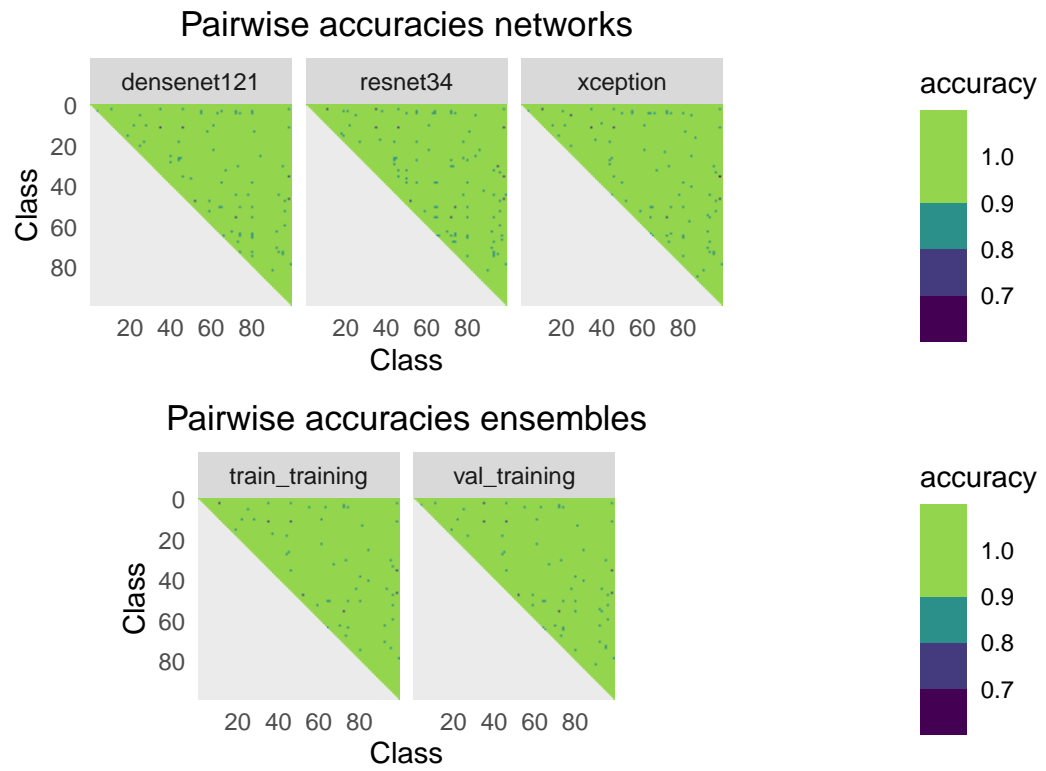## Pairwise accuracies ensembles

Replication 4 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 5 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 5 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles
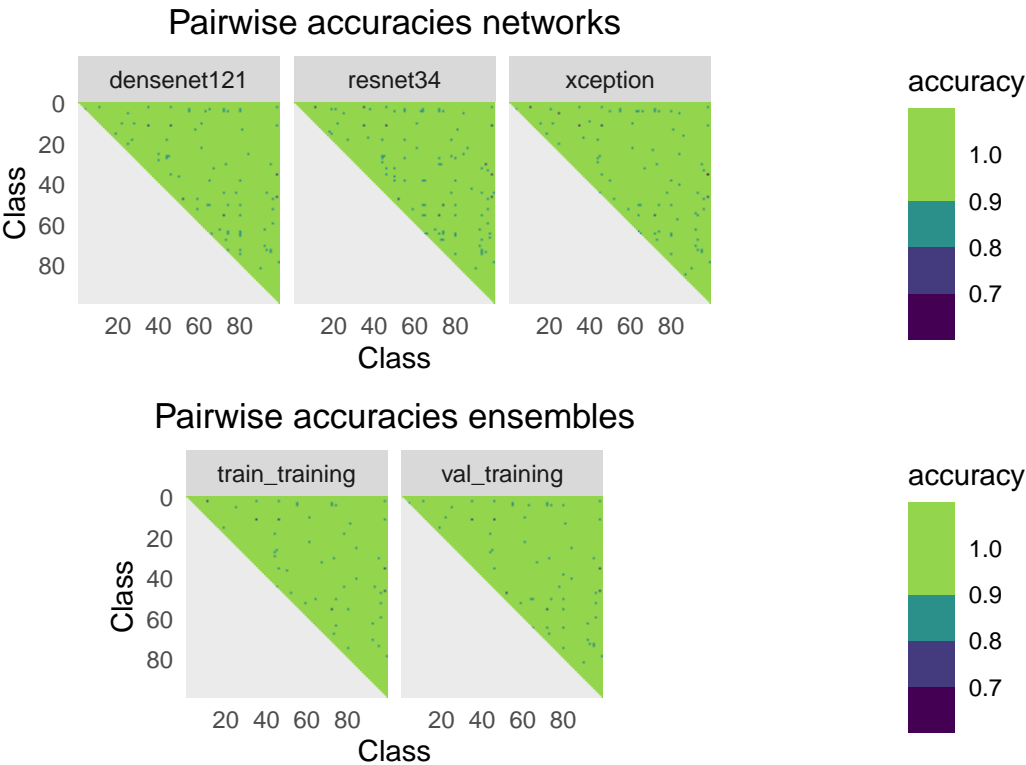
Replication 5 , fold 2

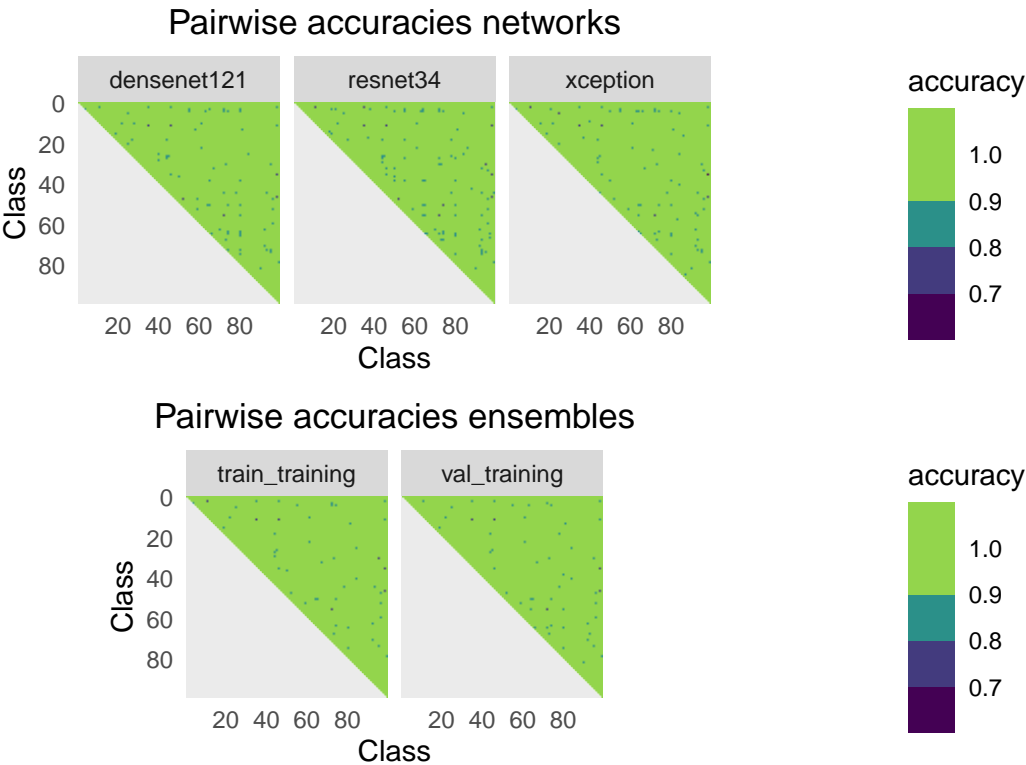## Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 5 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 5 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 6 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 6 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 6 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 6 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 6 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 7 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 7 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 7 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 7 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 7 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 8 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 8 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 8 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 8 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 8 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 9 , fold 0

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 9 , fold 1

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 9 , fold 2

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 9 , fold 3

Pairwise accuracies networks

Pairwise accuracies ensembles

Replication 9 , fold 4

Pairwise accuracies networks

Pairwise accuracies ensembles

Need some other way to visualize this.