> source('~/.active-rstudio-document', echo=TRUE)

> library(keras)

> library(progress)

> library(abind)

> k\_set\_image\_data\_format('channels\_first')

> # Functions ---------------------------------------------------------------

>

> build\_generator <- function(latent\_size){

+

+ # We will map a .... [TRUNCATED]

> build\_discriminator <- function(){

+

+ # Build a relatively standard conv net, with LeakyReLUs as suggested in

+ # the reference paper

+ cn .... [TRUNCATED]

> # Parameters --------------------------------------------------------------

>

> # Batch and latent size taken from the paper

> epochs <- 50

> batch\_size <- 100

> latent\_size <- 100

> # Adam parameters suggested in https://arxiv.org/abs/1511.06434

> adam\_lr <- 0.00005

> adam\_beta\_1 <- 0.5

> # Model Definition --------------------------------------------------------

>

> # Build the discriminator

> discriminator <- build\_discriminator()

> discriminator %>% compile(

+ optimizer = optimizer\_adam(lr = adam\_lr, beta\_1 = adam\_beta\_1),

+ loss = list("binary\_crossentropy", "sparse\_catego ..." ... [TRUNCATED]

> # Build the generator

> generator <- build\_generator(latent\_size)

> generator %>% compile(

+ optimizer = optimizer\_adam(lr = adam\_lr, beta\_1 = adam\_beta\_1),

+ loss = "binary\_crossentropy"

+ )

> latent <- layer\_input(shape = list(latent\_size))

> image\_class <- layer\_input(shape = list(1), dtype = "int32")

> fake <- generator(list(latent, image\_class))

> # Only want to be able to train generation for the combined model

> freeze\_weights(discriminator)

> results <- discriminator(fake)

> combined <- keras\_model(list(latent, image\_class), results)

> combined %>% compile(

+ optimizer = optimizer\_adam(lr = adam\_lr, beta\_1 = adam\_beta\_1),

+ loss = list("binary\_crossentropy", "sparse\_categorical ..." ... [TRUNCATED]

> # Data Preparation --------------------------------------------------------

>

> # Loade mnist data, and force it to be of shape (..., 1, 28, 28) wi .... [TRUNCATED]

> mnist$train$x <- (mnist$train$x - 127.5)/127.5

> mnist$test$x <- (mnist$test$x - 127.5)/127.5

> mnist$train$x <- array\_reshape(mnist$train$x, c(60000, 1, 28, 28))

> mnist$test$x <- array\_reshape(mnist$test$x, c(10000, 1, 28, 28))

> num\_train <- dim(mnist$train$x)[1]

> num\_test <- dim(mnist$test$x)[1]

> # Training ----------------------------------------------------------------

>

> for(epoch in 1:epochs){

+

+ num\_batches <- trunc(num\_train/bat .... [TRUNCATED]

epoch 1/50 3m [=============================================================================================] 100% 0s

Testing for epoch 01:

generator (train) : loss 1.89 | 0.77 | 1.12

generator (test) : loss 1.06 | 0.96 | 0.10

discriminator (train) : loss 1.75 | 0.67 | 1.08

discriminator (test) : loss 1.00 | 0.59 | 0.41

epoch 2/50 3m [=============================================================================================] 100% 0s

Testing for epoch 02:

generator (train) : loss 0.97 | 0.87 | 0.11

generator (test) : loss 0.72 | 0.67 | 0.04

discriminator (train) : loss 1.05 | 0.66 | 0.39

discriminator (test) : loss 0.98 | 0.65 | 0.33

epoch 3/50 3m [=============================================================================================] 100% 0s

Testing for epoch 03:

generator (train) : loss 0.90 | 0.84 | 0.06

generator (test) : loss 0.65 | 0.59 | 0.07

discriminator (train) : loss 0.99 | 0.66 | 0.33

discriminator (test) : loss 1.02 | 0.70 | 0.32

epoch 4/50 3m [=============================================================================================] 100% 0s

Testing for epoch 04:

generator (train) : loss 0.95 | 0.90 | 0.05

generator (test) : loss 0.67 | 0.63 | 0.04

discriminator (train) : loss 0.95 | 0.65 | 0.30

discriminator (test) : loss 0.96 | 0.68 | 0.28

epoch 5/50 3m [=============================================================================================] 100% 0s

Testing for epoch 05:

generator (train) : loss 0.83 | 0.80 | 0.03

generator (test) : loss 0.65 | 0.63 | 0.02

discriminator (train) : loss 0.96 | 0.68 | 0.28

discriminator (test) : loss 0.94 | 0.68 | 0.26

epoch 6/50 3m [=============================================================================================] 100% 0s

Testing for epoch 06:

generator (train) : loss 0.81 | 0.78 | 0.03

generator (test) : loss 0.71 | 0.68 | 0.03

discriminator (train) : loss 0.96 | 0.69 | 0.26

discriminator (test) : loss 0.95 | 0.69 | 0.26

epoch 7/50 3m [=============================================================================================] 100% 0s

Testing for epoch 07:

generator (train) : loss 0.79 | 0.76 | 0.03

generator (test) : loss 0.74 | 0.73 | 0.01

discriminator (train) : loss 0.94 | 0.69 | 0.25

discriminator (test) : loss 0.91 | 0.67 | 0.24

epoch 8/50 3m [=============================================================================================] 100% 0s

Testing for epoch 08:

generator (train) : loss 0.76 | 0.74 | 0.02

generator (test) : loss 0.70 | 0.67 | 0.02

discriminator (train) : loss 0.93 | 0.69 | 0.24

discriminator (test) : loss 0.93 | 0.70 | 0.23

epoch 9/50 3m [=============================================================================================] 100% 0s

Testing for epoch 09:

generator (train) : loss 0.74 | 0.72 | 0.02

generator (test) : loss 0.66 | 0.64 | 0.01

discriminator (train) : loss 0.93 | 0.70 | 0.23

discriminator (test) : loss 0.93 | 0.70 | 0.22

epoch 10/50 3m [============================================================================================] 100% 0s

Testing for epoch 10:

generator (train) : loss 0.74 | 0.72 | 0.02

generator (test) : loss 0.69 | 0.68 | 0.01

discriminator (train) : loss 0.92 | 0.70 | 0.22

discriminator (test) : loss 0.90 | 0.69 | 0.22

epoch 11/50 3m [============================================================================================] 100% 0s

Testing for epoch 11:

generator (train) : loss 0.73 | 0.71 | 0.01

generator (test) : loss 0.66 | 0.66 | 0.01

discriminator (train) : loss 0.92 | 0.70 | 0.22

discriminator (test) : loss 0.90 | 0.69 | 0.21

epoch 12/50 3m [============================================================================================] 100% 0s

Testing for epoch 12:

generator (train) : loss 0.73 | 0.72 | 0.01

generator (test) : loss 0.69 | 0.68 | 0.01

discriminator (train) : loss 0.91 | 0.70 | 0.21

discriminator (test) : loss 0.90 | 0.69 | 0.20

epoch 13/50 3m [============================================================================================] 100% 0s

Testing for epoch 13:

generator (train) : loss 0.73 | 0.71 | 0.01

generator (test) : loss 0.70 | 0.70 | 0.01

discriminator (train) : loss 0.91 | 0.70 | 0.21

discriminator (test) : loss 0.89 | 0.69 | 0.20

epoch 14/50 3m [============================================================================================] 100% 0s

Testing for epoch 14:

generator (train) : loss 0.72 | 0.71 | 0.01

generator (test) : loss 0.65 | 0.64 | 0.01

discriminator (train) : loss 0.90 | 0.70 | 0.20

discriminator (test) : loss 0.90 | 0.70 | 0.20

epoch 15/50 3m [============================================================================================] 100% 0s

Testing for epoch 15:

generator (train) : loss 0.72 | 0.71 | 0.01

generator (test) : loss 0.67 | 0.67 | 0.01

discriminator (train) : loss 0.90 | 0.70 | 0.20

discriminator (test) : loss 0.88 | 0.69 | 0.19

epoch 16/50 3m [============================================================================================] 100% 0s

Testing for epoch 16:

generator (train) : loss 0.72 | 0.71 | 0.01

generator (test) : loss 0.69 | 0.68 | 0.01

discriminator (train) : loss 0.89 | 0.70 | 0.19

discriminator (test) : loss 0.88 | 0.69 | 0.19

epoch 17/50 3m [============================================================================================] 100% 0s

Testing for epoch 17:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.66 | 0.66 | 0.01

discriminator (train) : loss 0.89 | 0.70 | 0.19

discriminator (test) : loss 0.88 | 0.69 | 0.18

epoch 18/50 3m [============================================================================================] 100% 0s

Testing for epoch 18:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.66 | 0.65 | 0.01

discriminator (train) : loss 0.89 | 0.70 | 0.19

discriminator (test) : loss 0.87 | 0.69 | 0.18

epoch 19/50 3m [============================================================================================] 100% 0s

Testing for epoch 19:

generator (train) : loss 0.71 | 0.71 | 0.01

generator (test) : loss 0.67 | 0.67 | 0.01

discriminator (train) : loss 0.88 | 0.70 | 0.18

discriminator (test) : loss 0.86 | 0.69 | 0.18

epoch 20/50 3m [============================================================================================] 100% 0s

Testing for epoch 20:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.66 | 0.00

discriminator (train) : loss 0.88 | 0.70 | 0.18

discriminator (test) : loss 0.86 | 0.69 | 0.17

epoch 21/50 3m [============================================================================================] 100% 0s

Testing for epoch 21:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.71 | 0.70 | 0.00

discriminator (train) : loss 0.88 | 0.70 | 0.18

discriminator (test) : loss 0.87 | 0.69 | 0.17

epoch 22/50 3m [============================================================================================] 100% 0s

Testing for epoch 22:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.66 | 0.00

discriminator (train) : loss 0.87 | 0.70 | 0.17

discriminator (test) : loss 0.86 | 0.69 | 0.17

epoch 23/50 3m [============================================================================================] 100% 0s

Testing for epoch 23:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.87 | 0.70 | 0.17

discriminator (test) : loss 0.86 | 0.69 | 0.17

epoch 24/50 3m [============================================================================================] 100% 0s

Testing for epoch 24:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.87 | 0.70 | 0.17

discriminator (test) : loss 0.86 | 0.70 | 0.16

epoch 25/50 3m [============================================================================================] 100% 0s

Testing for epoch 25:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.87 | 0.70 | 0.17

discriminator (test) : loss 0.86 | 0.70 | 0.16

epoch 26/50 3m [============================================================================================] 100% 0s

Testing for epoch 26:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.66 | 0.00

discriminator (train) : loss 0.86 | 0.70 | 0.16

discriminator (test) : loss 0.86 | 0.70 | 0.16

epoch 27/50 3m [============================================================================================] 100% 0s

Testing for epoch 27:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.71 | 0.71 | 0.00

discriminator (train) : loss 0.86 | 0.70 | 0.16

discriminator (test) : loss 0.85 | 0.69 | 0.16

epoch 28/50 3m [============================================================================================] 100% 0s

Testing for epoch 28:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.86 | 0.70 | 0.16

discriminator (test) : loss 0.86 | 0.70 | 0.16

epoch 29/50 3m [============================================================================================] 100% 0s

Testing for epoch 29:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.86 | 0.70 | 0.16

discriminator (test) : loss 0.85 | 0.70 | 0.16

epoch 30/50 3m [============================================================================================] 100% 0s

Testing for epoch 30:

generator (train) : loss 0.71 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.66 | 0.00

discriminator (train) : loss 0.86 | 0.70 | 0.16

discriminator (test) : loss 0.85 | 0.70 | 0.15

epoch 31/50 3m [============================================================================================] 100% 0s

Testing for epoch 31:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.85 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.69 | 0.15

epoch 32/50 3m [============================================================================================] 100% 0s

Testing for epoch 32:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.66 | 0.00

discriminator (train) : loss 0.85 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.70 | 0.15

epoch 33/50 3m [============================================================================================] 100% 0s

Testing for epoch 33:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.70 | 0.70 | 0.00

discriminator (train) : loss 0.85 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.70 | 0.15

epoch 34/50 3m [============================================================================================] 100% 0s

Testing for epoch 34:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.67 | 0.00

discriminator (train) : loss 0.85 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.69 | 0.15

epoch 35/50 3m [============================================================================================] 100% 0s

Testing for epoch 35:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.67 | 0.00

discriminator (train) : loss 0.85 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.70 | 0.15

epoch 36/50 3m [============================================================================================] 100% 0s

Testing for epoch 36:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.85 | 0.70 | 0.15

discriminator (test) : loss 0.84 | 0.69 | 0.15

epoch 37/50 3m [============================================================================================] 100% 0s

Testing for epoch 37:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.67 | 0.66 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.70 | 0.15

epoch 38/50 3m [============================================================================================] 100% 0s

Testing for epoch 38:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.15

discriminator (test) : loss 0.85 | 0.70 | 0.15

epoch 39/50 3m [============================================================================================] 100% 0s

Testing for epoch 39:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.70 | 0.70 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.69 | 0.15

epoch 40/50 3m [============================================================================================] 100% 0s

Testing for epoch 40:

generator (train) : loss 0.70 | 0.70 | 0.01

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.70 | 0.15

epoch 41/50 3m [============================================================================================] 100% 0s

Testing for epoch 41:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.70 | 0.14

epoch 42/50 3m [============================================================================================] 100% 0s

Testing for epoch 42:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.70 | 0.14

epoch 43/50 3m [============================================================================================] 100% 0s

Testing for epoch 43:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.70 | 0.14

epoch 44/50 3m [============================================================================================] 100% 0s

Testing for epoch 44:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.68 | 0.68 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.70 | 0.14

epoch 45/50 3m [============================================================================================] 100% 0s

Testing for epoch 45:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.84 | 0.70 | 0.14

discriminator (test) : loss 0.83 | 0.69 | 0.14

epoch 46/50 3m [============================================================================================] 100% 0s

Testing for epoch 46:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.83 | 0.70 | 0.14

discriminator (test) : loss 0.84 | 0.69 | 0.14

epoch 47/50 3m [============================================================================================] 100% 0s

Testing for epoch 47:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.69 | 0.68 | 0.00

discriminator (train) : loss 0.83 | 0.70 | 0.14

discriminator (test) : loss 0.83 | 0.69 | 0.14

epoch 48/50 3m [============================================================================================] 100% 0s

Testing for epoch 48:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.70 | 0.70 | 0.00

discriminator (train) : loss 0.83 | 0.70 | 0.13

discriminator (test) : loss 0.83 | 0.69 | 0.14

epoch 49/50 3m [============================================================================================] 100% 0s

Testing for epoch 49:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.69 | 0.69 | 0.00

discriminator (train) : loss 0.83 | 0.70 | 0.13

discriminator (test) : loss 0.84 | 0.70 | 0.14

epoch 50/50 3m [============================================================================================] 100% 0s

Testing for epoch 50:

generator (train) : loss 0.70 | 0.70 | 0.00

generator (test) : loss 0.68 | 0.67 | 0.00

discriminator (train) : loss 0.83 | 0.70 | 0.13

discriminator (test) : loss 0.83 | 0.70 | 0.14