mdl ที่มีขนาดเล็กมาก จำแนกความซับซ้อนไม่ได้

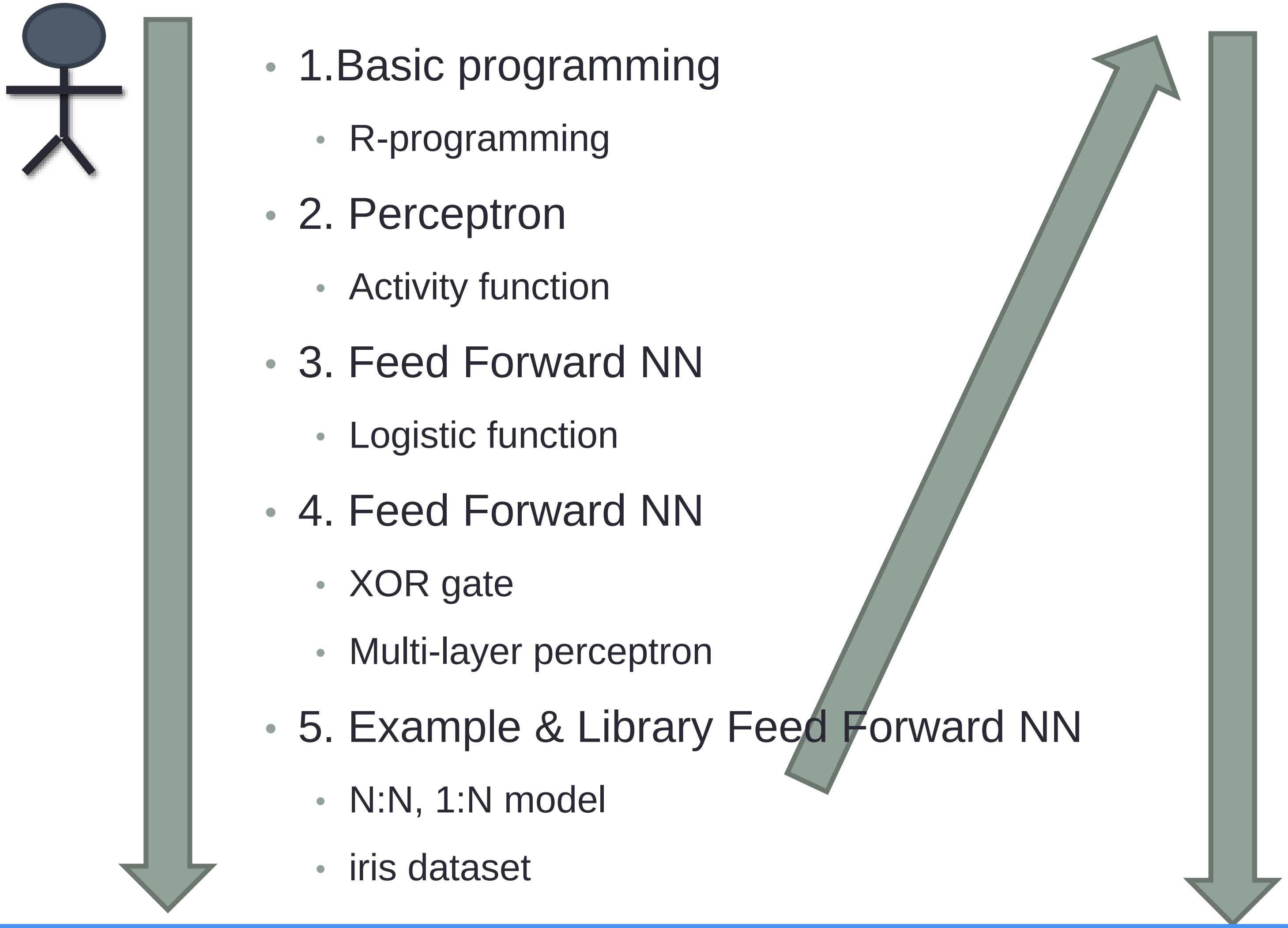
ถ้าเพิ่ม hidden เข้าก็จะจำแนกได้มากขึ้น

MULTI-LAYER PERCEPTRON

Asst.Prof.Dr.Supakit Nootyaskool

IT-KMITL

Study map



- 1.Basic programming
  - R-programming
- 2. Perceptron
  - Activity function
- 3. Feed Forward NN
  - Logistic function
- 4. Feed Forward NN
  - XOR gate
  - Multi-layer perceptron
- 5. Example & Library Feed Forward NN
  - N:N, 1:N model
  - iris dataset

- 6. Writing NN Code
  - Data scaling, Confusion matrix
  - Writing NN code
- 7. Recurrent Neural Network
- 8. Apply RNN & Library
- 9. GRU LSTM
- 10. CNN
- 11 Apply GA to NN

Learning Outcome

- Understand number of hidden relate to data complexity.
- Have an experience using neuralnet() to train and predict small data.
- Understand The condudetion matrix

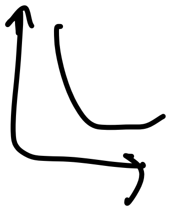
NN → $\boxed{x?}$ train ได้ดี

Overview NN Pros and Cons

Train → ปรับ weight
ท่อนมาก

save → ใช้งานเร็ว

Pros



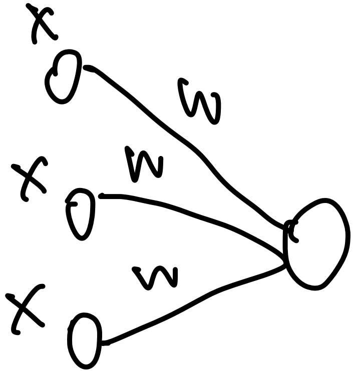
ไม่เป็นเชิงเส้น

- NN are goods for nonlinear data with large number of input such as images. sound
- After training, the predictions are fast
- NN can be trained with any number of inputs and layers } Modify
- NN works best with more data points

ปล. Train ใหม่ๆ สามารถ train แต่บางตัวได้

Cons

- NN are black boxes
- NN uses time consuming to training on the CPUs-> solved by using GPUs
- NN may leads to over-fitting.

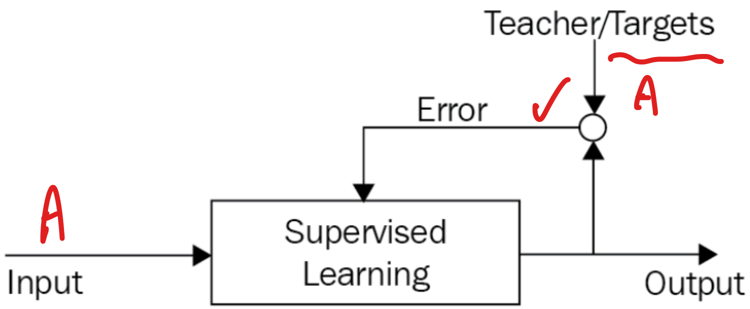


ประมวลผลผ่าน GPU

มักมีปัญหากะ over fitting

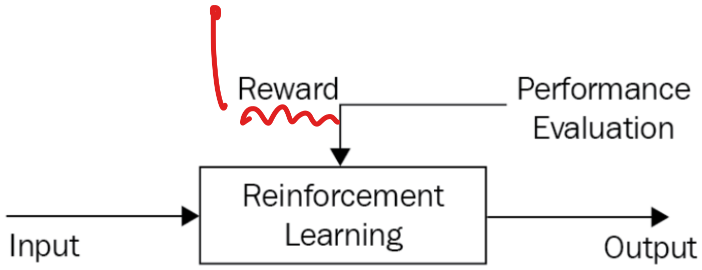
train A → NN —

Overview ML



- Supervised learning is the training data as a teacher to the model
- Machine learn from the target data

สิ่งที่ให้ตอบแทน

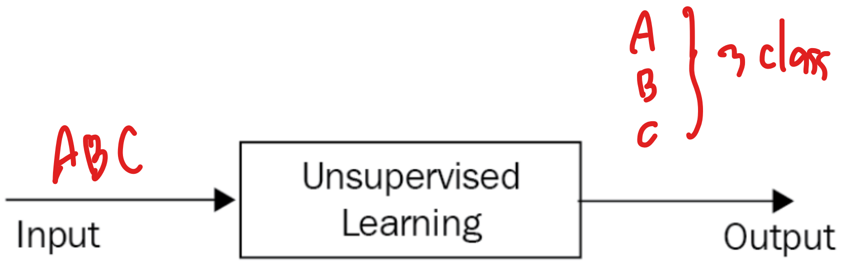


- Reinforcement learning is ML where is constant feedback given model to adapt to

T ได้ Reward

F ไม่ได้ Reward

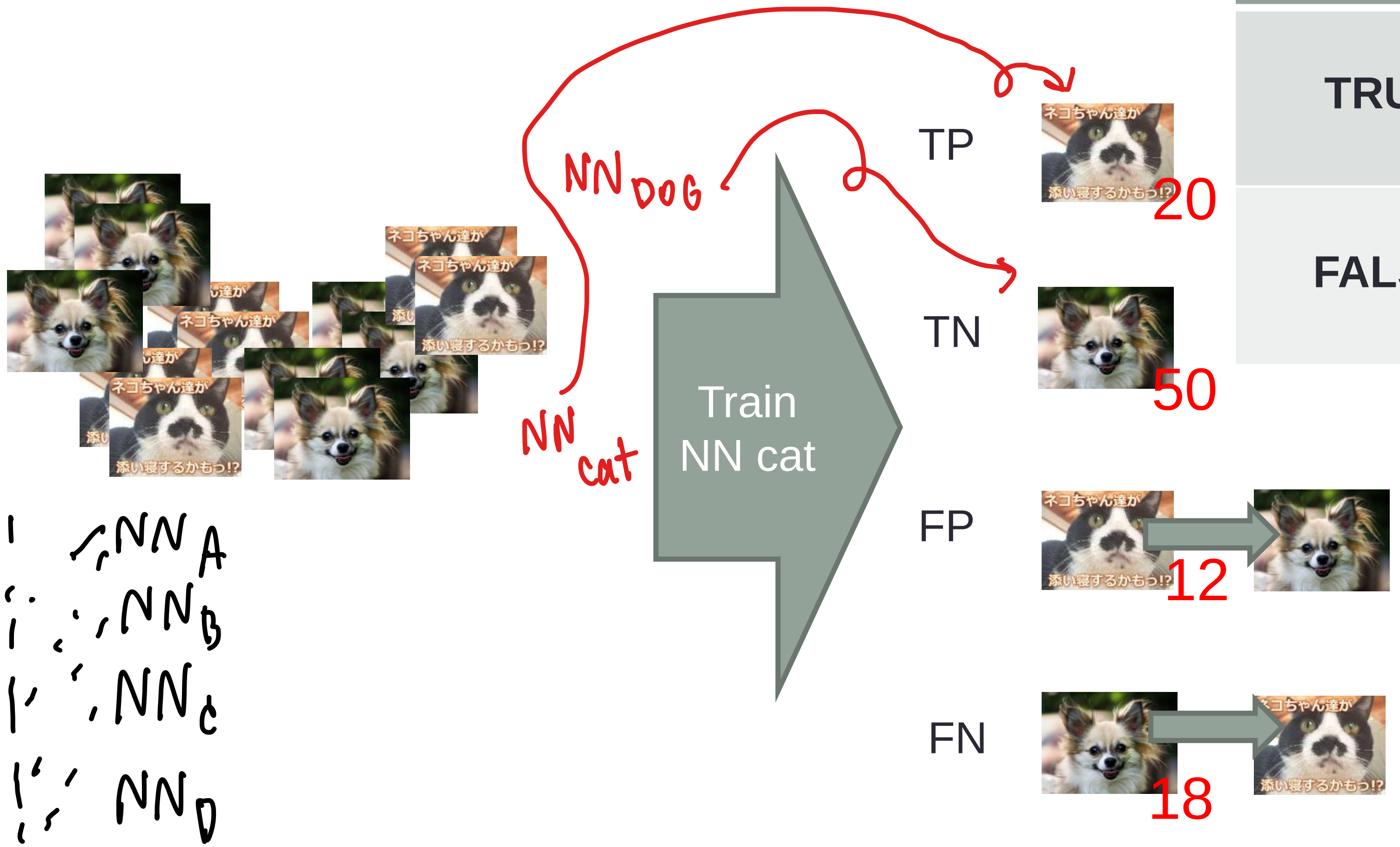
ไม่รู้ A ?



- Unsupervised is self organization
- The output is trained without a target variable
- Techniques related to unsupervised
  - K-means, hierarchical
  - Dimension reduction
  - Self organization map (SOM)

Analysis train and predict result

ค่าที่อ่านได้ Actual value	ค่าที่ทำนาย Predicted value TRUE	Predicted Value FALSE
TRUE	True Positive (TP)	False Negative (FN) err2
FALSE	False Positive (FP) err1	True Negative (TN)



A ⋮ NN_A
B ⋮ NN_B
C ⋮ NN_C
D ⋮ NN_D

ต้องเทียบกันหลายๆกรณี

ทางการแพทย์จะ
ยึด FN กะ FP ในการทำนาย
เป็นหลัก.

& RT PCR

Example: ATK results

ผลตรวจ covid

ความจริง covid

Actual value	Predicted value TRUE ผลตรวจว่าติด covid	Predicted Value FALSE ผลตรวจว่าไม่ติด
TRUE ติด covid	True Positive (TP)	เสี่ยงติด False Negative (FN) err2
FALSE ไม่ติด covid	False Positive (FP) err1 เสียเวลา	True Negative (TN)

Example: Weather forecasting

Predict

		☀	☁	🌧	❄
Actual	☀		FN		
	☁	FP	TP	FP	FP
	🌧		FN		
	❄		FN		

Overview Error Matrix

Actual value	Predicted value TRUE	Predicted Value FALSE
TRUE	True Positive (TP)	False Negative (FN) err2
FALSE	False Positive (FP) err1	True Negative (TN)

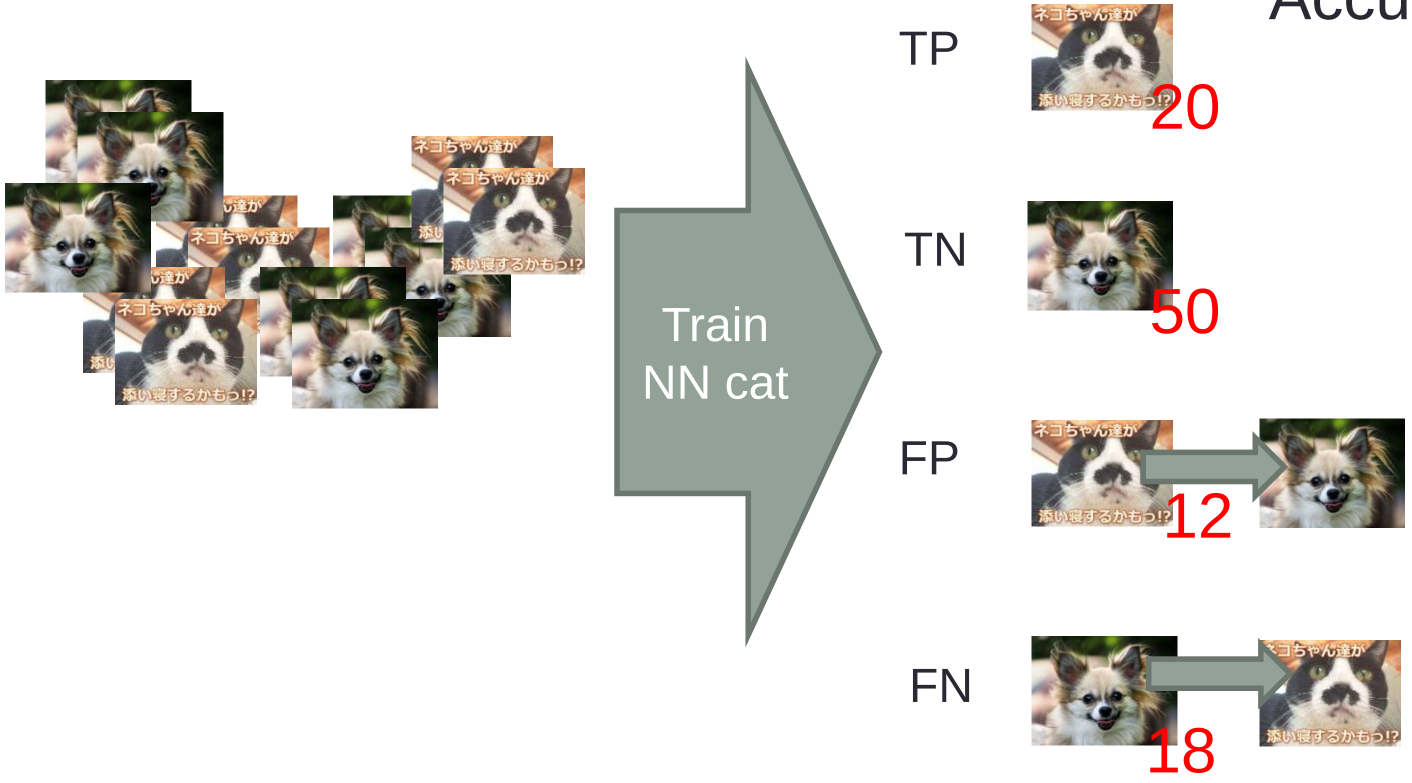
ความแม่นยำ

$$\text{Accuracy} = (TP + TN) / (TP + TN + FP + FN)$$

ความเที่ยงตรง

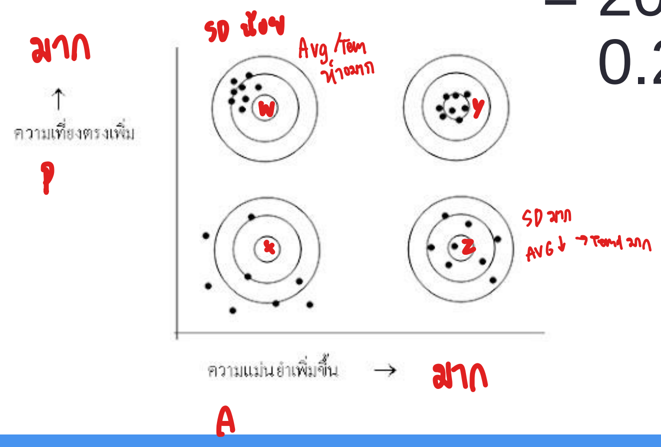
$$\text{Precision} = TP / (TP + FN)$$

Calculate accuracy (แม่นยำ) and precision (เที่ยงตรง)



Accuracy = (TP + TN) / (TP + TN + FP + FN)
= (20 + 50) / (20+50+12+18)
= 70 / 100
= 0.7

Precision = TP / (TP + FN)
= 20 / (20 + 50)
0.28

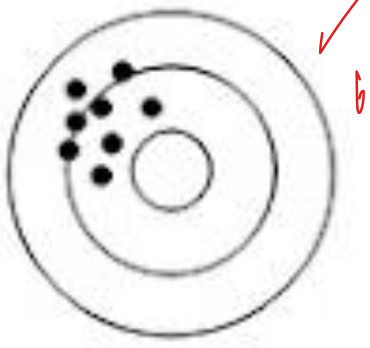


Calculate accuracy (แม่นยำ) and precision (เที่ยงตรง)

Accuracy = (TP + TN) / (TP + TN + FP + FN)
= (20 + 50) / (20+50+12+18)
= 70 / 100
= 0.7

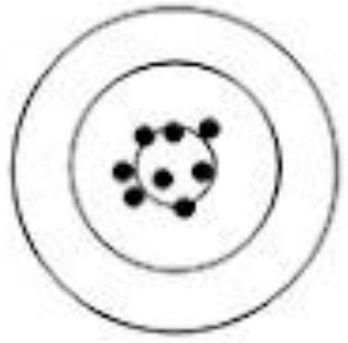
Precision = TP / (TP + FN)
= 20 / (20 + 50)
= 0.28

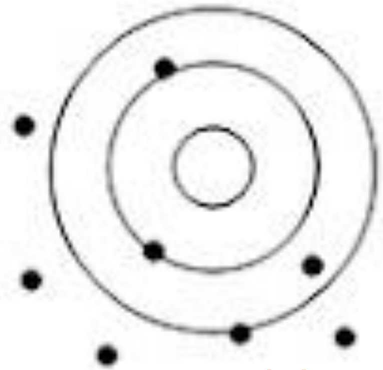
High precision
Low accuracy
เที่ยงตรงแต่ไม่แม่นยำ



✓ เลือกใช้

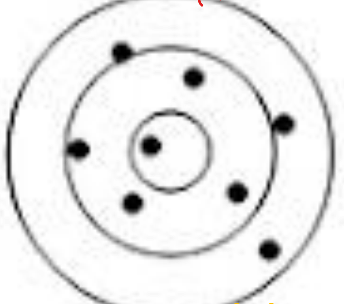
High precision
High accuracy
เที่ยงตรง และแม่นยำ





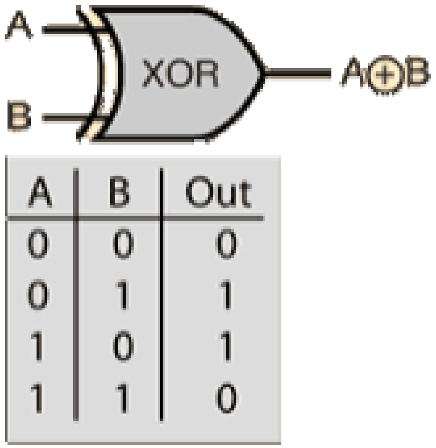
Low precision
High accuracy

กระจายมากไป

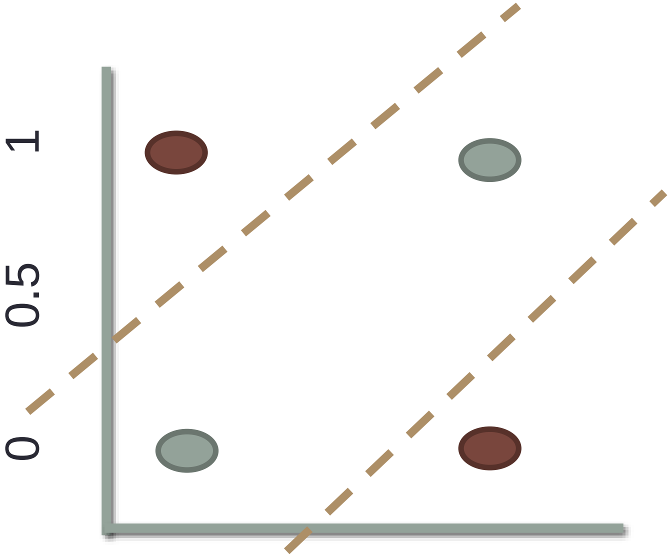


Low precision
High accuracy
ไม่เที่ยงตรงแต่แม่นแม่นยำ

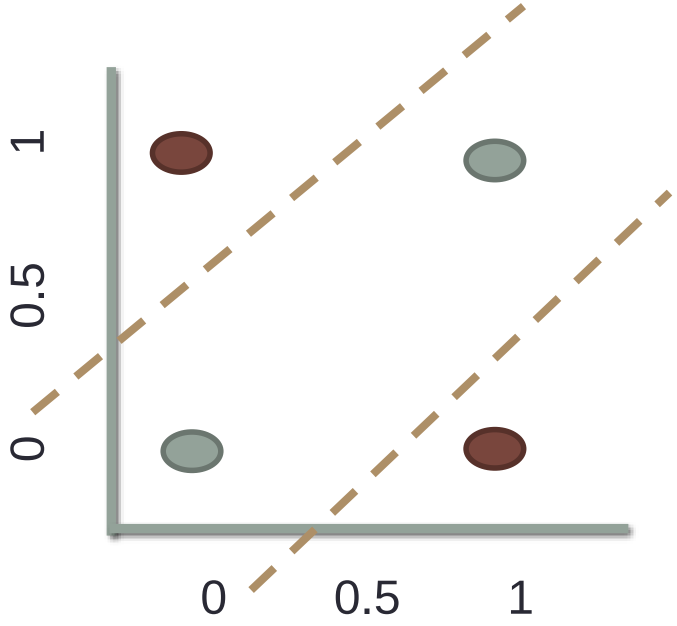
Activity 4.1 Create XOR on Perceptron

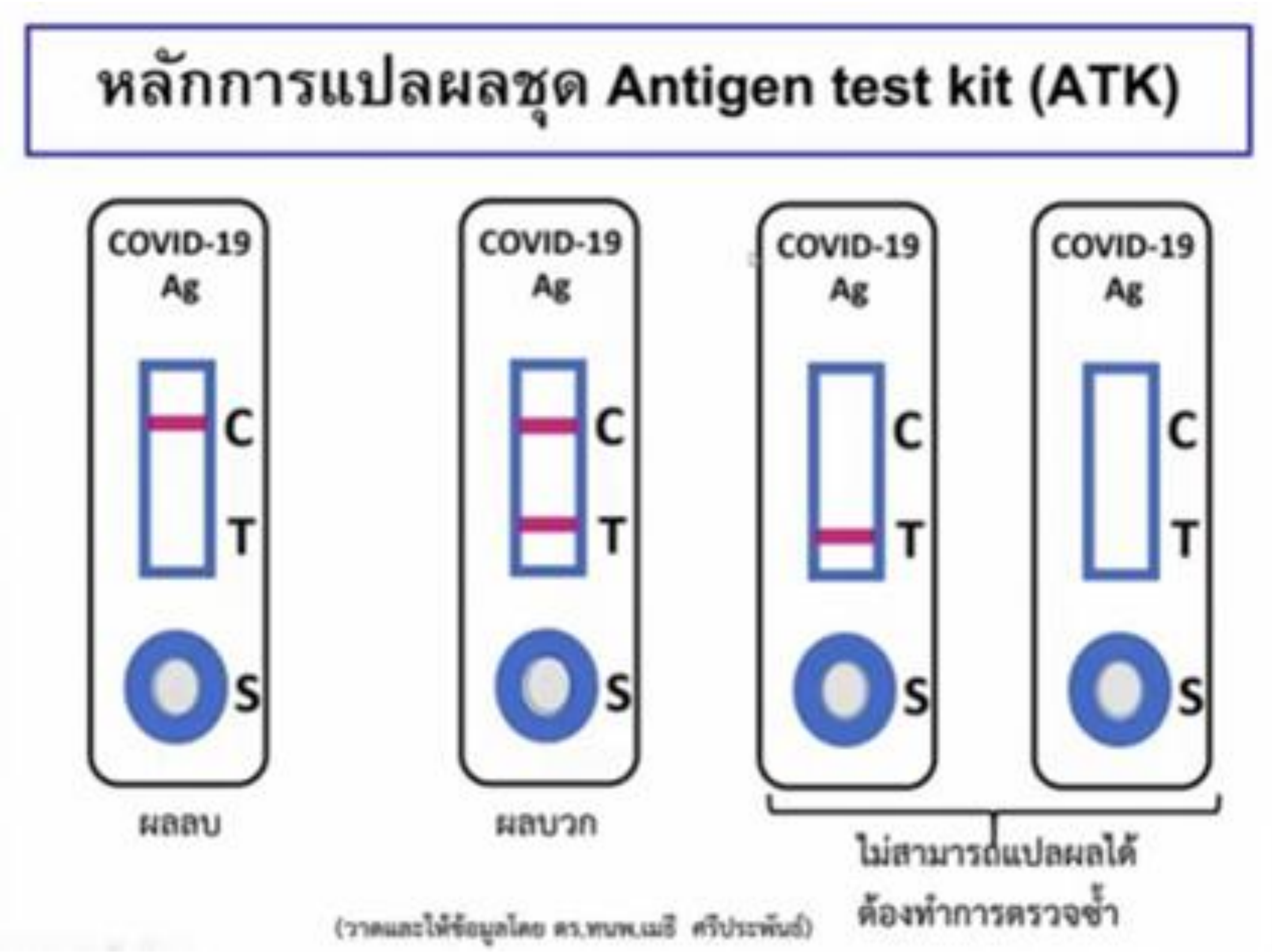


A	B	Out
0	0	0
0	1	1
1	0	1
1	1	0



```
library("neuralnet")

XOR = c(0,1,1,0)
truthtable = expand.grid(c(0,1), c(0,1))
XOR.data <- data.frame(truthtable, XOR)
print(XOR.data)

model <- neuralnet( XOR~Var1+Var2,
            XOR.data,
            hidden=0, ##<--Change here
            rep = 5,
            linear.output = FALSE,
            err.fct = "ce")

print(model)
plot(model)
```



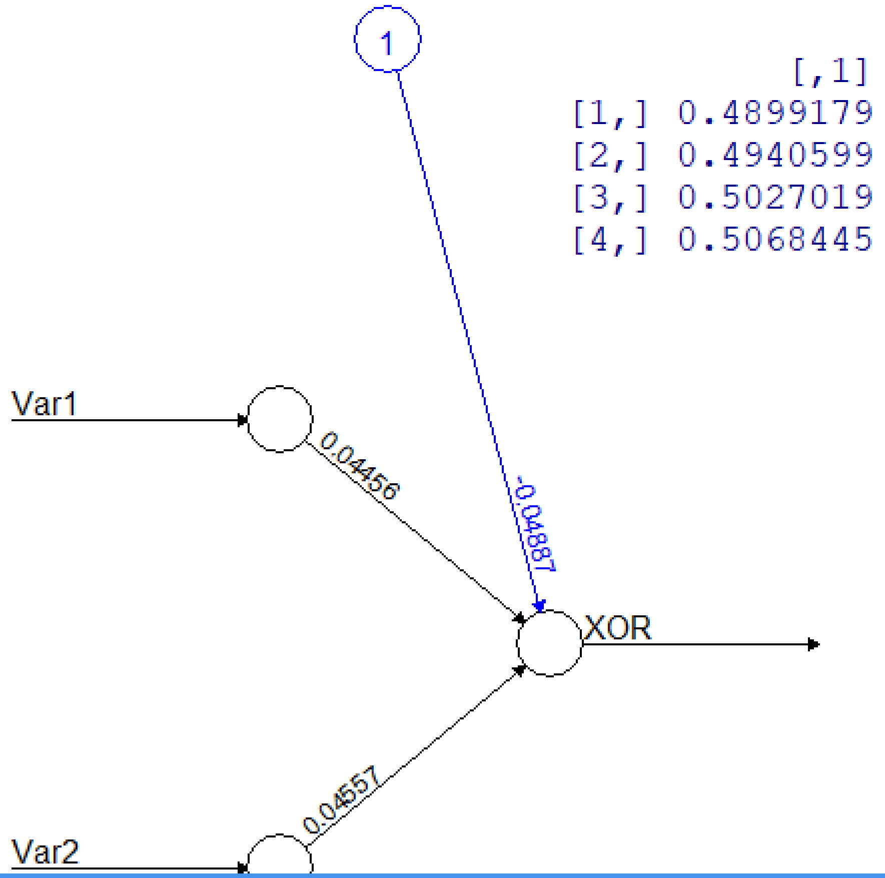


หลักการแปลผลชุด Antigen test kit (ATK)

(วาดและให้ข้อมูลโดย ดร.ทนพ.เมธี ศรีประพันธ์)

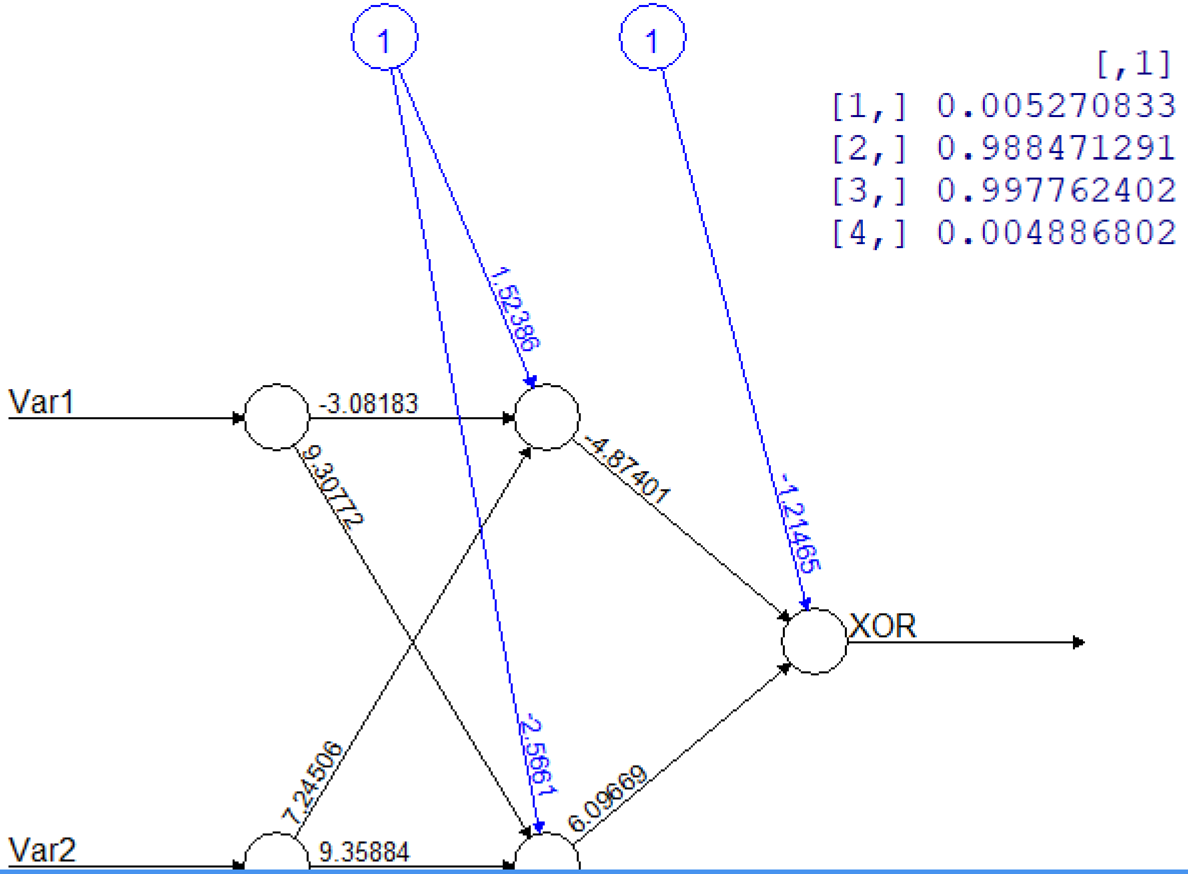
Activity 4.1 Create XOR on Perceptron

Hidden 0



```
        [,1]
[1,] 0.4899179
[2,] 0.4940599
[3,] 0.5027019
[4,] 0.5068445
```

Hidden 2



```
         [,1]
[1,] 0.005270833
[2,] 0.988471291
[3,] 0.997762402
[4,] 0.004886802
```

Activity 4.2 Predict the model XOR gate

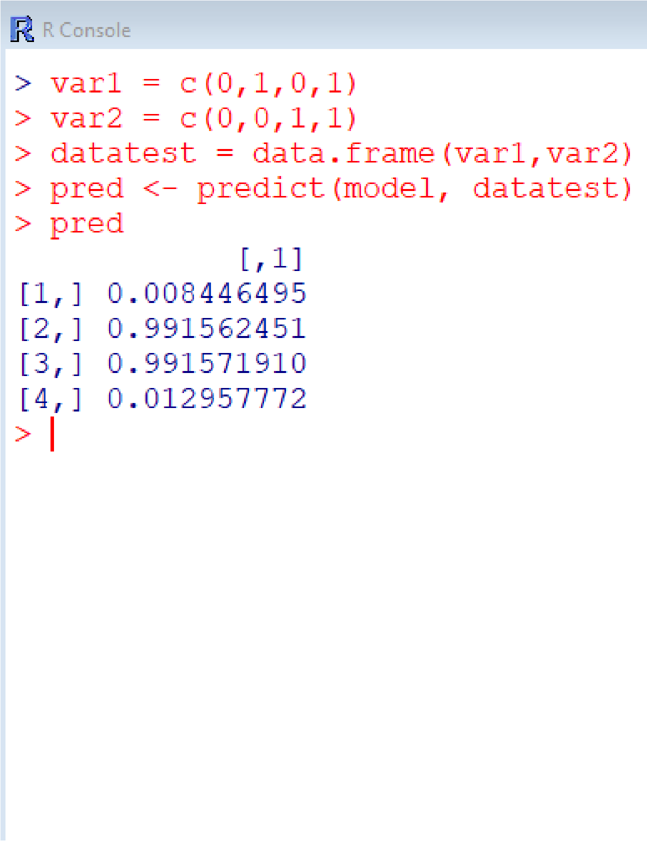
var1 = c(0,1,0,1)

var2 = c(0,0,1,1)

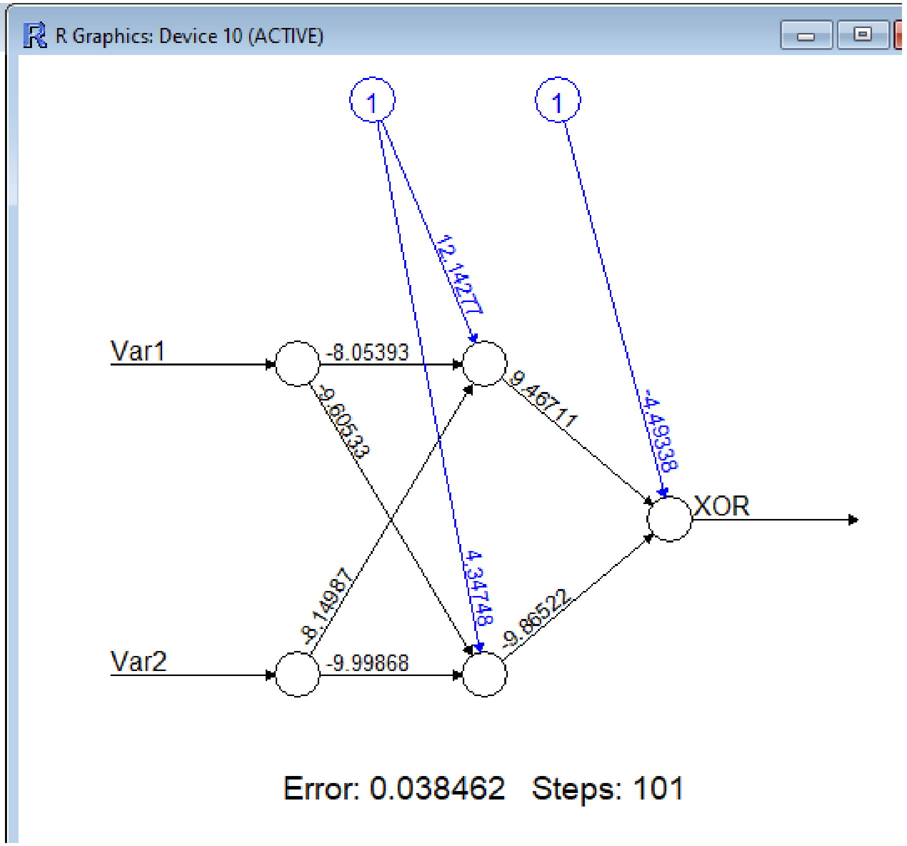
datatest = data.frame(var1,var2)

pred <- predict(**model**, datatest)

pred

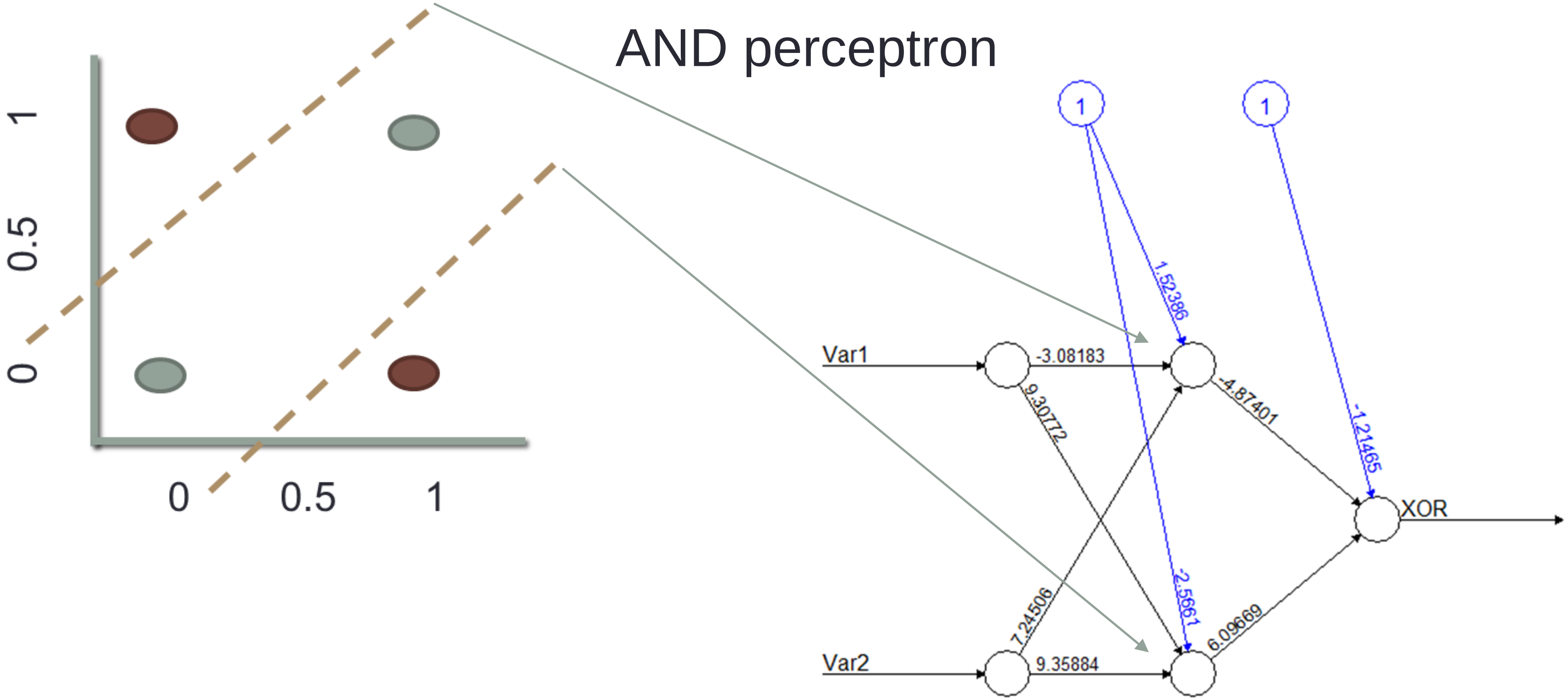


```
> var1 = c(0,1,0,1)
> var2 = c(0,0,1,1)
> datatest = data.frame(var1,var2)
> pred <- predict(model, datatest)
> pred
             [,1]
[1,] 0.008446495
[2,] 0.991562451
[3,] 0.991571910
[4,] 0.012957772
> |
```



Why does the XOR gate need two hidden nodes?

- Uses two classifier
- XOR is a three-layer network combining OR and AND perceptron



Multi-Layer Perceptron (MLP)

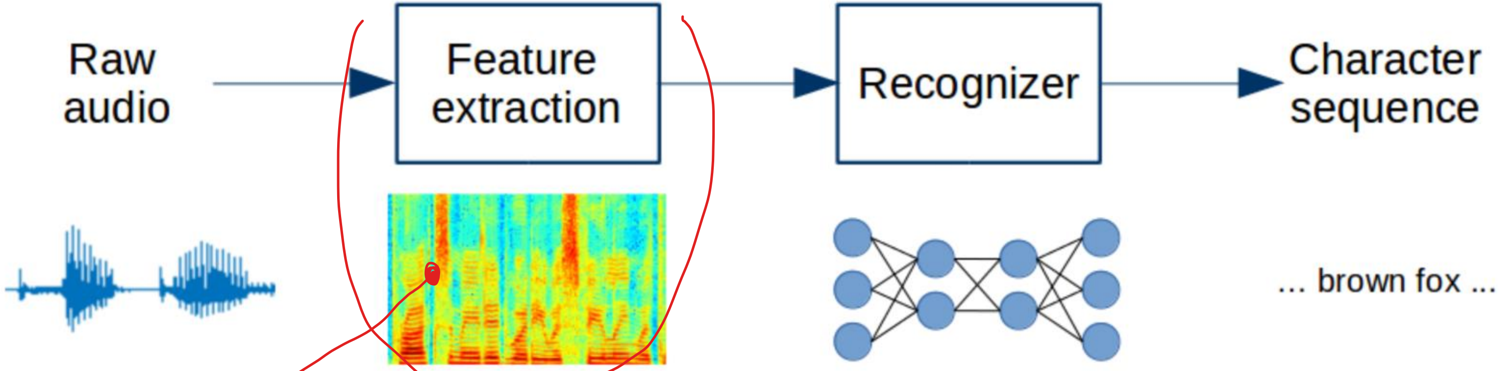
ซับซ้อน มากขึ้น

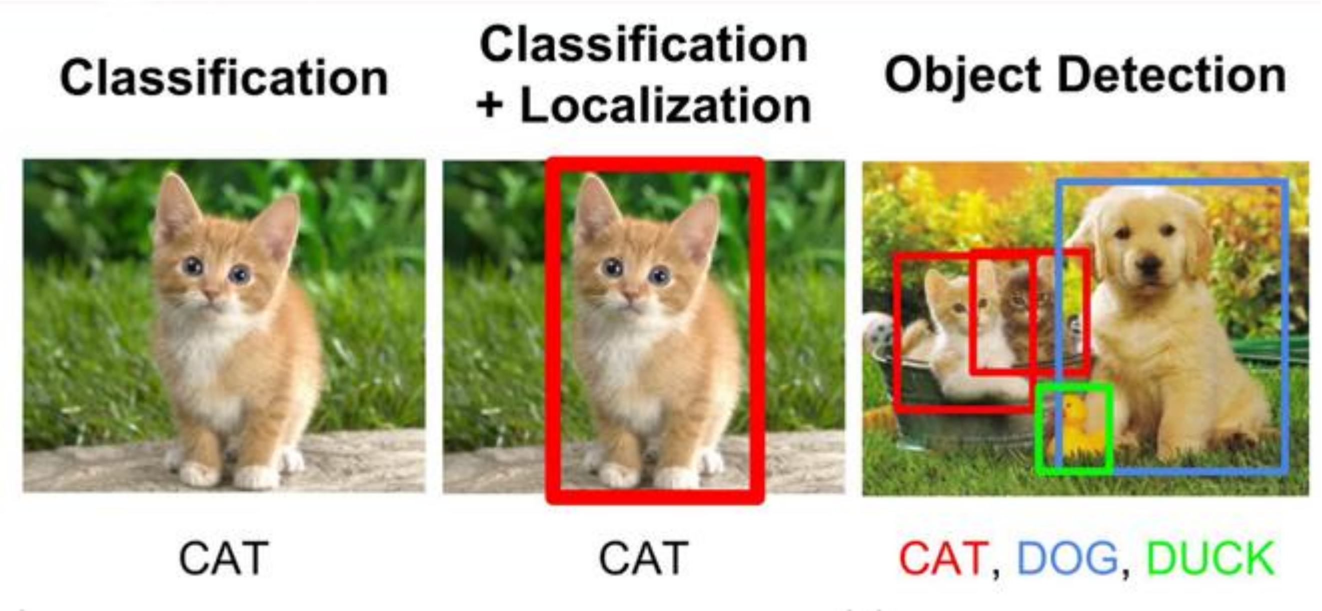
- MLPs are extremely useful for complex problems in the research.
- MLP are used in diverse fields, such as speech recognition,, object recognition, image classification, object localization, object detection, image segmentation, and language translation.

หาลักษณะเด่นที่เอามาแยกได้

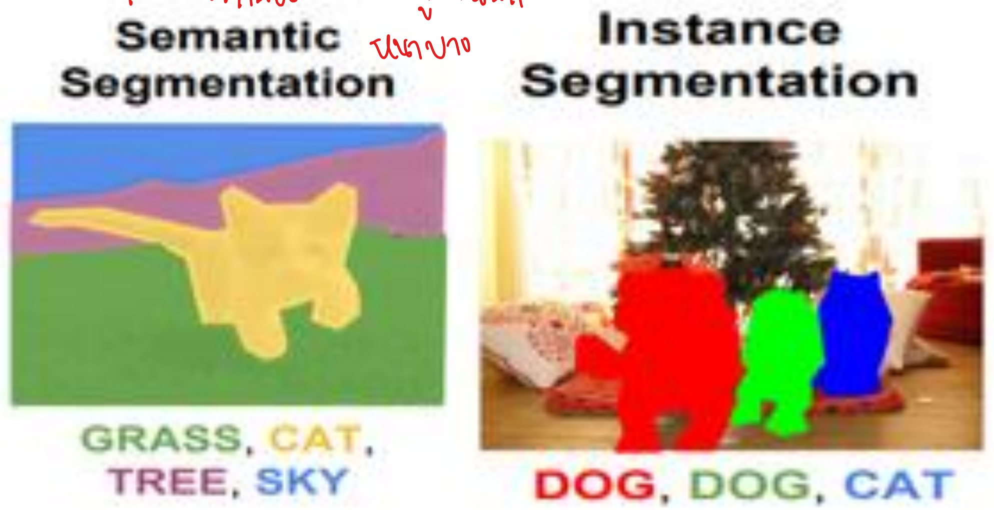
Chain Code

ซึ่งเป็นเส้นๆ



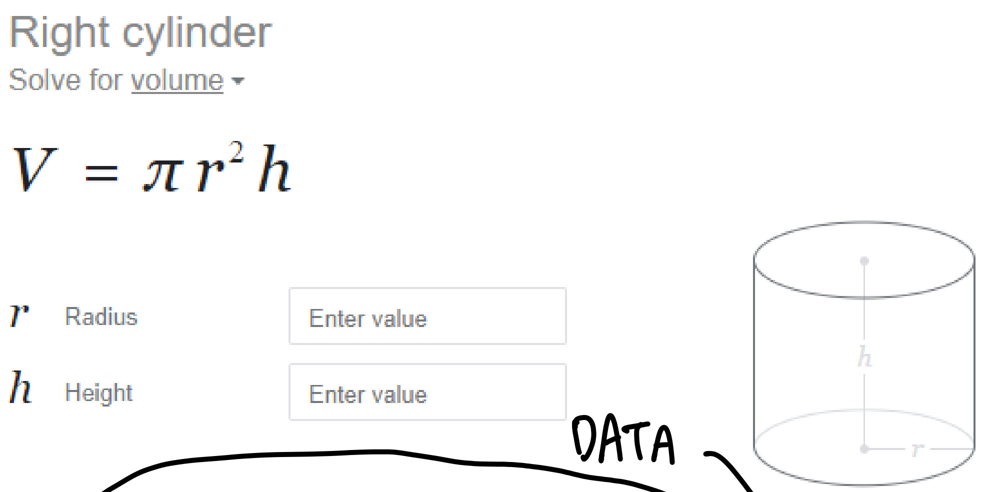


ตามสี ใช้กล้อง 2กล้องดูตื้นลึก
หนาบาง



https://www.geeksforgeeks.org/object-detection-vs-object-recognition-vs-image-segmentation/

Activity 4.3 Calculate volume of cylinder with NN



Right cylinder

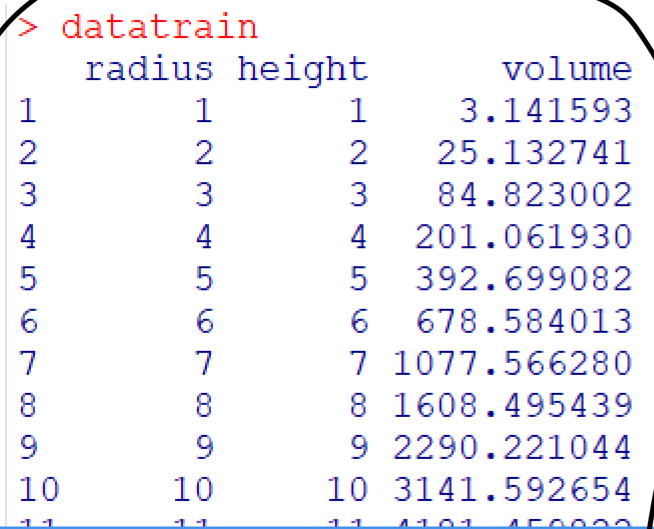
Solve for volume ▾

$$V = \pi r^2 h$$

r Radius Enter value

h Height Enter value

DATA → NN → NN wedght



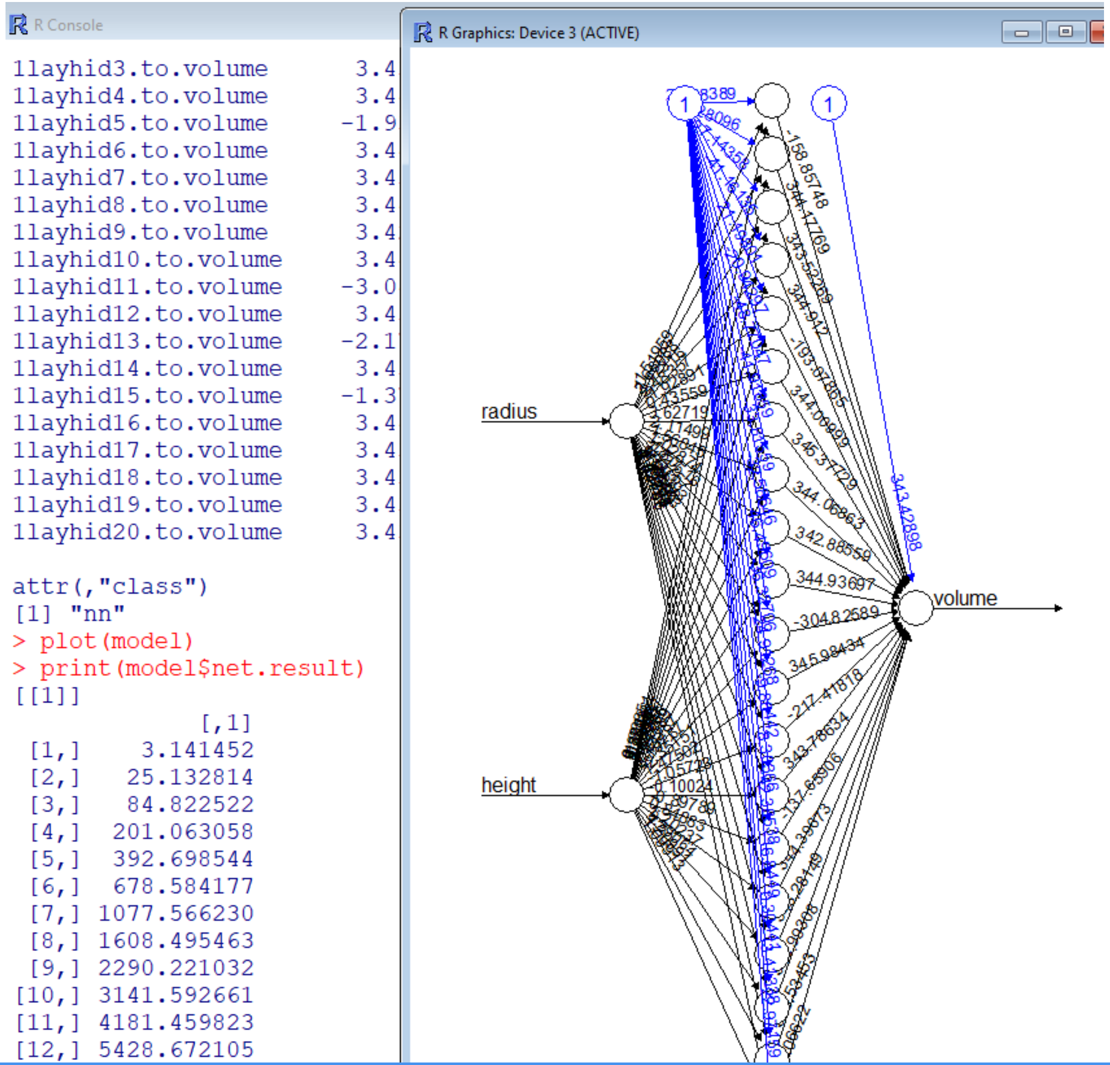
```
> datatrain
   radius height      volume
1       1      1    3.141593
2       2      2   25.132741
3       3      3   84.823002
4       4      4  201.061930
5       5      5  392.699082
6       6      6  678.584013
7       7      7 1077.566280
8       8      8 1608.495439
9       9      9 2290.221044
10     10     10 3141.592654
```

```
#CREATE DATA TRAIN

library("neuralnet")

radius = 1:12

height = 1:12

volume = pi*radius*radius*height

datatrain = data.frame(radius,height,volume)

datatrain
```

1:12 → 1- 12

Activity 4.3 Calculate volume of cylinder with NN

```
# TRAIN THE DATA

model <- neuralnet( volume~radius+height,

        datatrain,

        hidden=20, ##<--Change here

        rep = 1,

        linear.output = TRUE)

print(model)

plot(model)

print(model$net.result)
```



```
1layhid3.to.volume       3.4
1layhid4.to.volume       3.4
1layhid5.to.volume      -1.9
1layhid6.to.volume       3.4
1layhid7.to.volume       3.4
1layhid8.to.volume       3.4
1layhid9.to.volume       3.4
1layhid10.to.volume      3.4
1layhid11.to.volume     -3.0
1layhid12.to.volume      3.4
1layhid13.to.volume     -2.1
1layhid14.to.volume      3.4
1layhid15.to.volume     -1.3
1layhid16.to.volume      3.4
1layhid17.to.volume      3.4
1layhid18.to.volume      3.4
1layhid19.to.volume      3.4
1layhid20.to.volume      3.4

attr(,"class")
[1] "nn"
> plot(model)
> print(model$net.result)
[[1]]
             [,1]
 [1,]    3.141452
 [2,]   25.132814
 [3,]   84.822522
 [4,]  201.063058
 [5,]  392.698544
 [6,]  678.584177
 [7,] 1077.566230
 [8,] 1608.495463
 [9,] 2290.221032
[10,] 3141.592661
[11,] 4181.459823
[12,] 5428.672105
```

Activity 4.3 Calculate volume of cylinder with NN

. dat ใช้กับ Data ทั่วไป
กรณีนี้ ใช้ไม่ได้ save RDS

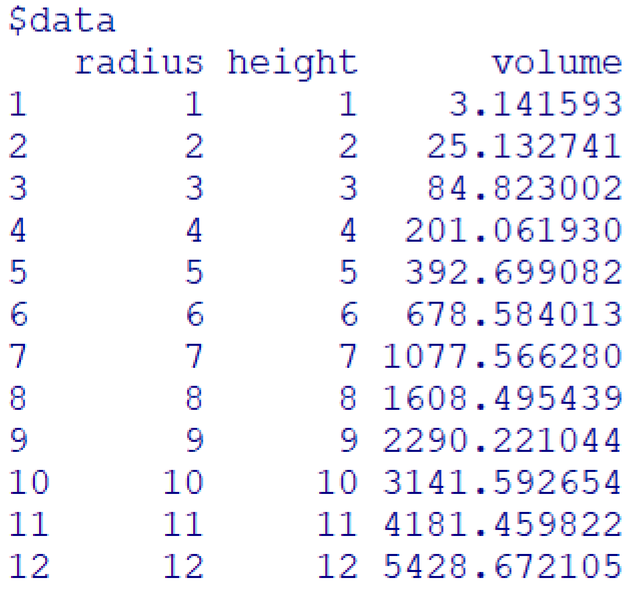
```
# SAVE THE MODEL TO A BINARY FILE
save(model,file = "nnmodel.dat")
```

```
# PREPARING TEST DATA
radius = runif(12,1,12)
height = radius
datatest = data.frame(radius,height)
```

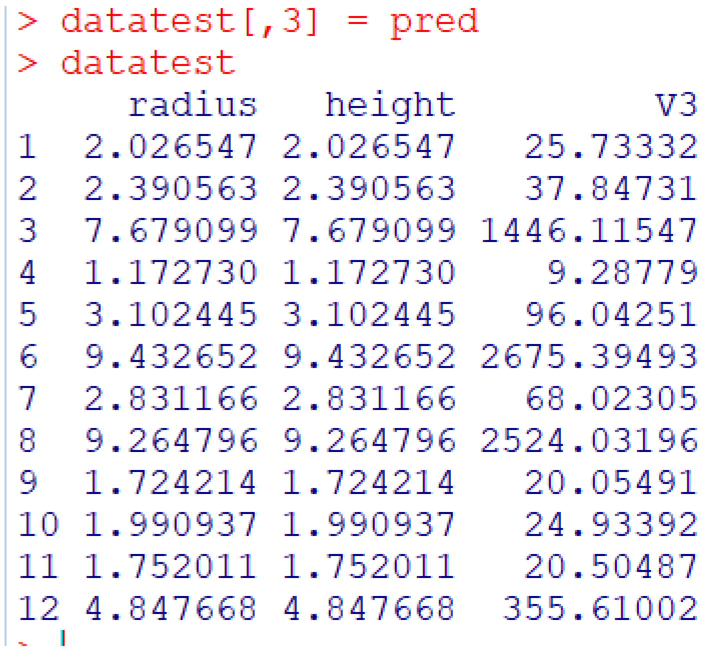
สุ่มเลข 1-12 → 12 ค่า

```
# LOAD THE MODEL
model_test = load("nnmodel.dat")
pred <- predict(model, datatest)
pred
datatest[,3] = pred
datatest
```

Read RDS



```
$data
   radius height      volume
1       1      1    3.141593
2       2      2   25.132741
3       3      3   84.823002
4       4      4  201.061930
5       5      5  392.699082
6       6      6  678.584013
7       7      7 1077.566280
8       8      8 1608.495439
9       9      9 2290.221044
10     10     10 3141.592654
11     11     11 4181.459822
12     12     12 5428.672105
```



```
> datatest[,3] = pred
> datatest
     radius   height         V3
1  2.026547 2.026547   25.73332
2  2.390563 2.390563   37.84731
3  7.679099 7.679099 1446.11547
4  1.172730 1.172730    9.28779
5  3.102445 3.102445   96.04251
6  9.432652 9.432652 2675.39493
7  2.831166 2.831166   68.02305
8  9.264796 9.264796 2524.03196
9  1.724214 1.724214   20.05491
10 1.990937 1.990937   24.93392
11 1.752011 1.752011   20.50487
12 4.847668 4.847668  355.61002
```

compare

Activity 4.4

Summary