1   GNU R

1. ## What data types does R have
   answer

   - vector

   - list

   - environment

   Note: there are alsow classes in R, for example data.frame

2. ## What R libraries for dataframe processign do you know
   answer

   - dplyr

   - datatable

   - ggplot2

   - tidyr

3. ## Given two lists x=list(1,2) and y=list(3,4) produce list containing all values in x and y preserving their order
   answer

```
> append(list(x), list(y))
```

4. ## Given vectors $x = (1, 2, 3)$ and $y = (2, 4, 6)$ calculate linear regression

$$y \propto \beta x$$

and print β
   answer

```
> x <- c(1, 2, 3)
> y <- c(2, 4, 6)
> r <- lm( y~x )
> r$coefficients[2]
```

5. What is INNER JOIN operation between two data frames?

answer

Given sets of tuples $A = (a_l, k_l)$ and $B = (b_r, k_r)$ with key k JOIN operation produces set of tuples (a_j, b_j, k_j) so that for each j there exist some indexes l_j and r_j such that $k_{l_j} = k_{r_j}$

6. How one could join two data frames in R by common column "key"?

answer

```
> library(dplyr)
> d1 <- tibble(a=c(1,2),key=c("one","two"))
> d2 <- tibble(b=c(10,20),key=c("one","two"))
> inner_join(d1,d2,by="key")
A tibble: 2 x 3
      a key           b
  <dbl> <chr> <dbl>
1     1 one          10
2     2 two          20
```

2 Python

7. What data types are there in Python

answer

- Int
- Float
- dict
- list
- object
- np.ndarray

8. What vector/DataFrame libraries are there in python

answer

- pandas
- numpy

3 General Machine learning

9. What dimensity reduction methods you have heard about?

answer

- Principal Components analysis (PCA)
- Linear discriminant analysis (LDA)

10. What is list comprehension? Calculate squares of list 1,2,3

answer

```
[x*x for x in [1,2,3]]
```

11. Given dataframe STOCKS of stock data with three columns SYMBOL, PRICE, VOLUME how one could filter stocks with price less than $100

answer

```
STOCKS[STOCKS.price<100]
```

12. How

answer

```
STOCKS[STOCKS.price<100]
```

13. What is Principal Components Analysis

answer

TODO Source: https://medium.com/@jonathan_hui/machine-learning-singular-value-decomposition-svd-principal-component-analysis-pca-1d45e885e491

4 Math

4.1 Linear algebra

14. Which matrix corresponds to rotation on 90 degrees anti-clockwise

answer

$$\begin{matrix} cos(\phi) & -sin(\phi) \\ sin(\phi) & cos(\phi) \end{matrix}$$

For 90 degrees

$$\begin{matrix} 0 & -1 \\ 1 & 0 \end{matrix}$$

15. What is eigenvector and eigenvalue

answer

In essence, an eigenvector v of a linear transformation A is a non-zero vector that, when T is applied to it, does not change direction. Applying T to the eigenvector only scales the eigenvector by the scalar value λ, called an eigenvalue. This condition can be written as the equation

$$\mathbf{A}x = \lambda x$$

4.2 Probability

16. What is normal distribution? Why is it important?

answer

source: wikipedia

$$\phi(x) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$$

17. What is the law of big numbers and central limit theorem?

answer

Law of big numbers:

If random variables X_i are independent identically distributed with mean μ and finite variance σ^2, then their sample mean

$$S_n = \left(\frac{1}{n}\sum_{i=1}^{n} X_i\right)$$

coverges by probability and almost surely to their mean μ

Central limit theorem (Levy):

$$Z = \sqrt{n}(S_n - \mu)$$

converges in distribution to noraml distributed with mean 0 and variance σ^2

4.3 Dual problem, Convex optimization

TODO

5 Machine learning

18. ## What is linear regression?
answer

19. ## Name some clusterization (classification) algorithms
answer

   - k-means

   - suport vector machine (SVM)

20. ## What is overfitting problem?
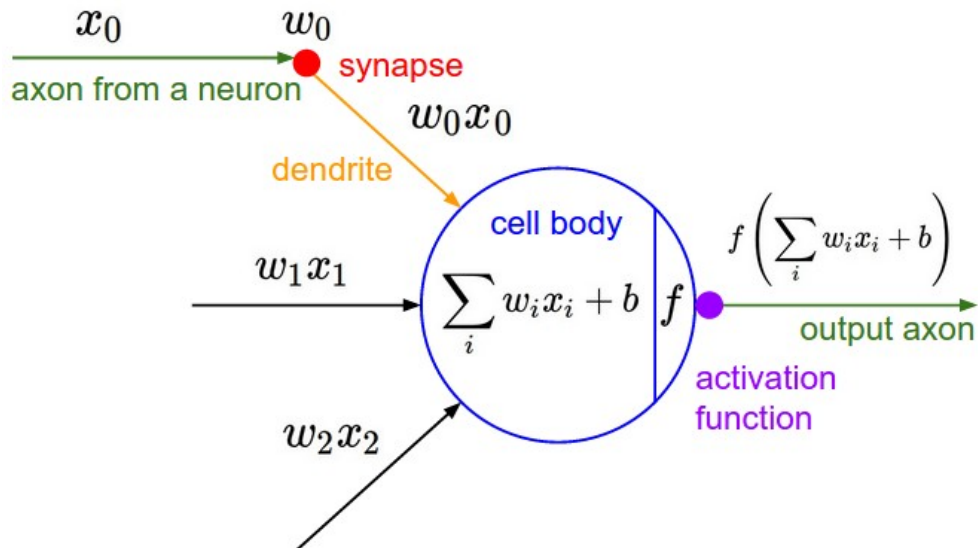answer
TODO

21. ## What is crossvalidation?
answer
TODO

6 Deep learning. Neural networks

22. ## What is neuron model
answer

source: https://www.cs.utoronto.ca/ fidler/teaching/2015/slides/CSC2523/CNN-tutorial.pdf

23. Give examples of activation functions

answer

- Step-function

$$f(x) = \begin{cases} 1, x > 0 \\ 0, x < 0 \end{cases}$$

- Sigmoid

$$f(x) = \frac{1}{1 + e^{-x}}$$

- TanH

$$f(x) = \tanh(x)$$

- ReLU

$$f(x) = \max(0, x)$$

- Maxout

$$f(x) = \max(w_0 x + b_0, w_1 x + b_1)$$

source: https://www.cs.utoronto.ca/ fidler/teaching/2015/slides/CSC2523/CNN-tutorial.pdf

24. What are the strong and weak sides of sigmoid activation function

answer

Strong:

- Captures non-linearity in the data

- Differentiable, thus could be used in gradient descent and backpropagation methods for calculating weights

Weak:

- Problem of vanishing gradients when training network

source: https://towardsdatascience.com/understanding-neural-networks-from-neuron-to-rnn-cnn-and-deep-learning-cd88e90e0a90

25. For image and speech recognition, what kind of neural networks are better used and why?

answer

- CNN (Convolution Neural Networks) are used for image recognition.

- RNN (Recurring Neural Networks) are used for speech recognition

source: https://www.cs.utoronto.ca/ fidler/teaching/2015/slides/CSC2523/CNN-tutorial.pdf