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DATA SCIENCE

INTERVIEW PREPARATION

Presented by Rajib Layek

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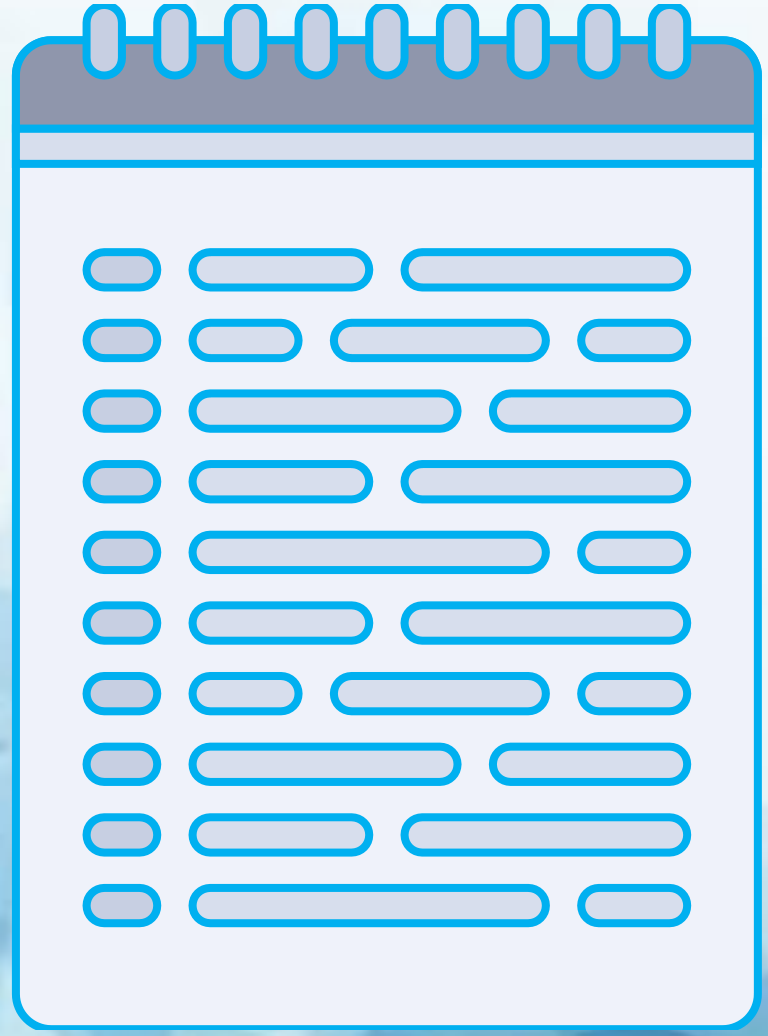

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Basic Statistics

Basic Statistics

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1. **What is sampling? How many sampling methods do you know?**
2. **What is the Central Limit Theorem and why is it important?**
   - The CLT states that the arithmetic mean of a sufficiently large number of iterates of independent random variables will be approximately normally distributed regardless of the underlying distribution. i.e: the sampling distribution of the sample mean is normally distributed.
     - Used in hypothesis testing
     - Used for confidence intervals
     - Random variables must be independent and identically distributed
     - Finite variance

3. **What does P-value signify about the statistical data?**
   - P-value is used to determine the significance of results after a hypothesis test in statistics. P-value helps the readers to draw conclusions and is always between 0 and 1.
   - P- Value > 0.05 denotes weak evidence against the null hypothesis which means the null hypothesis cannot be rejected.
   - P-value <= 0.05 denotes strong evidence against the null hypothesis which means the null hypothesis can be rejected.
   - P-value=0.05is the marginal value indicating it is possible to go either way.

4. How do you assess the statistical significance of an insight?

- is this insight just observed by chance or is it a real insight?
- Statistical significance can be accessed using hypothesis testing:
- Stating a null hypothesis which is usually the opposite of what we wish to test (classifiers A and B perform equivalently, Treatment A is equal of treatment B)
  Then, we choose a suitable statistical test and statistics used to reject the null hypothesis

- Also, we choose a critical region for the statistics to lie in that is extreme enough for the null hypothesis to be rejected (p-value)

- We calculate the observed test statistics from the data and check whether it lies in the critical region
- Common tests:
  - One sample Z test
  - Two-sample Z test
  - One sample t-test
  - paired t-test
  - Two sample pooled equal variances t-test
  - Two sample unpooled unequal variances t-test and unequal sample sizes (Welch's t-test)
  - Chi-squared test for variances
  - Chi-squared test for goodness of fit
  - Anova (for instance: are the two regression models equals? F-test)
  - Regression F-test (i.e: is at least one of the predictor useful in predicting the response?)

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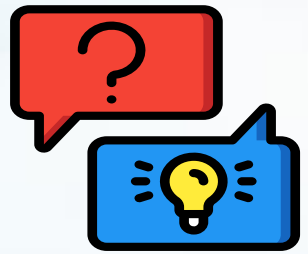
5. How are confidence intervals constructed and how will you interpret them?

6. What is the difference between Type I vs Type II error?

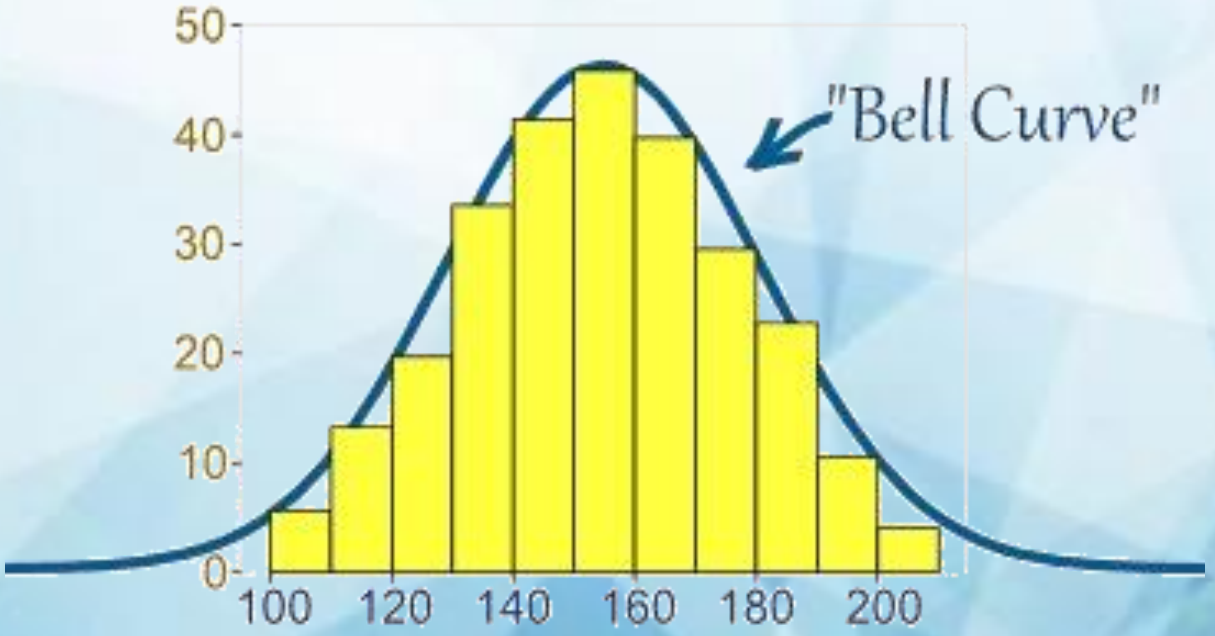
7. What is statistical power?



- sensitivity of a binary hypothesis test
- Probability that the test correctly rejects the null hypothesis H0H0 when the alternative is true H1H1
- Ability of a test to detect an effect, if the effect actually exists
- Power=P(rejectH0|H1istrue)Power=P(rejectH0|H1istrue)
- As power increases, chances of Type II error (false negative) decrease
- Used in the design of experiments, to calculate the minimum sample size required so that one can reasonably detects an effect. i.e: “how many times do I need to flip a coin to conclude it is biased?”
- Used to compare tests. Example: between a parametric and a non-parametric test of the same hypothesis

8. What do you understand by the term Normal Distribution?

- Data is usually distributed in different ways with a bias to the left or to the right or it can all be jumbled up. However, there are chances that data is distributed around a central value without any bias to the left or right and reaches normal distribution in the form of a bell shaped curve. The random variables are distributed in the form of an symmetrical bell shaped curve.



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9. What is linear regression?

10. What is R-Squared value mean?

11. What are the assumptions required for linear regression?

- There are four major assumptions:
- 1. There is a linear relationship between the dependent variables and the regressors, meaning the model you are creating actually fits the data,
- 2. The errors or residuals of the data are normally distributed and independent from each other,
- 3. There is minimal Multicollinearity between explanatory variables, and
- 4. Homoscedasticity. This means the variance around the regression line is the same for all values of the predictor variable.

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12. What is selection bias?

13. What is an example of a dataset with a non-Gaussian distribution?

14. What is the Binomial Probability Formula?

15. Are expected value and mean value different?

- They are not different but the terms are used in different contexts. Mean is generally referred when talking about a probability distribution or sample population whereas expected value is generally referred in a random variable context.
- For Sampling Data Mean value is the only value that comes from the sampling data.
- Expected Value is the mean of all the means i.e. the value that is built from multiple samples. Expected value is the population mean.
- For Distributions Mean value and Expected value are same irrespective of the distribution, under the condition that the distribution is in the same population.

16. What is Interpolation and Extrapolation?

17. Estimating a value from 2 known values from a list of values is Interpolation. Extrapolation is approximating a value by extending a known set of values or facts.

18. What is power analysis?

19. An experimental design technique for determining the effect of a given sample size.

20. What is an Eigenvalue and Eigenvector?

- Eigenvectors are used for understanding linear transformations. In data analysis, we usually calculate the eigenvectors for a correlation or covariance matrix. Eigenvectors are the directions along which a particular linear transformation acts by flipping, compressing or stretching. Eigenvalue can be referred to as the strength of the transformation in the direction of eigenvector or the factor by which the compression occurs.

21. There are two companies manufacturing electronic chip. Company A is manufactures defective chips with a probability of 20% and good quality chips with a probability of 80%. Company B manufactures defective chips with a probability of 80% and good chips with a probability of 20%.If you get just one electronic chip, what is the probability that it is a good chip?

22. Suppose that you now get a pack of 2 electronic chips coming from the same company either A or B. When you test the first electronic chip it appears to be good. What is the probability that the second electronic chip you received is also good?

23. A dating site allows users to select 6 out of 25 adjectives to describe their likes and preferences. A match is said to be found between two users on the website if the match on atleast 5 adjectives. If Steve and On a dating site, users can select 5 out of 24 adjectives to describe themselves. A match is declared between two users if they match on at least 4 adjectives. If Brad and Angelina randomly pick adjectives, what is the probability that they will form a match?

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24. A coin is tossed 10 times and the results are 2 tails and 8 heads. How will you analyse whether the coin is fair or not? What is the p-value for the same?

25. Continuation to the above question, if each coin is tossed 10 times (100 tosses are made in total). Will you modify your approach to the test the fairness of the coin or continue with the same?

26. An ant is placed on an infinitely long twig. The ant can move one step backward or one step forward with same probability during discrete time steps. Find out the probability with which the ant will return to the starting point.

27. Imagine you have N pieces of rope in a bucket. You reach in and grab one end-piece, then reach in and grab another end-piece, and tie those two together. What is the expected value of the number of loops in the bucket?

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- There are nn entirely unattached pieces of rope in a bucket
- A loop: any number of rope attached in a closed chain
- Suppose the expected number of loops for n−1n−1 pieces of rope is denoted Ln−1Ln−1
- Consider the bucket of nn pieces of rope; there are 2n2n rope ends
- Pick an end of rope. Of the remaining 2n−12n−1 ends of rope, only one end creates a loop (the other end of the same piece of rope). There are then n−1n−1 untied pieces of rope. The rest of the time, two separates pieces of rope are tied together and there are effectively n−1n−1 untied pieces of rope. The recurrence is therefore:
- Ln=12n−1+Ln−1Ln=12n−1+Ln−1
- Clearly, L1=1L1=1 so:
- Ln=∑nk=112k−1=H2n−Hn2Ln=∑k=1n12k−1=H2n−Hn2
- Where HkHk is the kthkth harmonic number
  Since Hk≒γ+lnkHk≒γ+lnk for large-ish k, where gamma=0.57722. is the Euler-Mascheroni constant, we have:
- Ln≒ln(2n)−ln(n)2=ln2n−−√Ln≒ln(2n)−ln(n)2=ln2n

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28. Explain what a long-tailed distribution is and provide three examples of relevant phenomena that have long tails. Why are they important in classification and regression problems?

- In long tailed distributions, a high frequency population is followed by a low frequency population, which gradually tails off asymptotically
- Rule of thumb: majority of occurrences (more than half, and when Pareto principles applies, 80%) are accounted for by the first 20% items in the distribution
- The least frequently occurring 80% of items are more important as a proportion of the total population
- Zipf's law, Pareto distribution, power laws
- *Examples:*

  1) Natural language

  - Given some corpus of natural language - The frequency of any word is inversely proportional to its rank in the frequency table

  - The most frequent word will occur twice as often as the second most frequent, three times as often as the third most frequent…

  - "The" accounts for 7% of all word occurrences (70000 over 1 million)

  - "of" accounts for 3.5%, followed by "and"…

  - Only 135 vocabulary items are needed to account for half the English corpus!

- Allocation of wealth among individuals: the larger portion of the wealth of any society is controlled by a smaller percentage of the people
- File size distribution of Internet Traffic
- Additional: Hard disk error rates, values of oil reserves in a field (a few large fields, many small ones), sizes of sand particles, sizes of meteorites
- *Importance in classification and regression problems:*
  - Skewed distribution
  - Which metrics to use? Accuracy paradox (classification), F-score, AUC
  - Issue when using models that make assumptions on the linearity (linear regression): need to apply a monotone transformation on the data (logarithm, square root, sigmoid function…)
  - Issue when sampling: your data becomes even more unbalanced! Using of stratified sampling of random sampling, SMOTE (“Synthetic Minority Over-sampling Technique”, NV Chawla) or anomaly detection approach

29. Explain selection bias (with regard to a dataset, not variable selection). Why is it important? How can data management procedures such as missing data handling make it worse?

- Selection of individuals, groups or data for analysis in such a way that proper randomization is not achieved
- Types:

  - Sampling bias: systematic error due to a non-random sample of a population causing some members to be less likely to be included than others
  - Time interval: a trial may terminated early at an extreme value (ethical reasons), but the extreme value is likely to be reached by the variable with the largest variance, even if all the variables have similar means
  - Data: “cherry picking”, when specific subsets of the data are chosen to support a conclusion (citing examples of plane crashes as evidence of airline flight being unsafe, while the far more common example of flights that complete safely)
  - Studies: performing experiments and reporting only the most favorable results
  - Can lead to unaccurate or even erroneous conclusions
  - Statistical methods can generally not overcome it

Why data handling make it worse?

- Example: individuals who know or suspect that they are HIV positive are less likely to participate in HIV surveys
- Missing data handling will increase this effect as it’s based on most HIV negative
-Prevalence estimates will be unaccurate

30. Provide a simple example of how an experimental design can help answer a question about behavior. How does experimental data contrast with observational data?

- You are researching the effect of music-listening on studying efficiency
- You might divide your subjects into two groups: one would listen to music and the other (control group) wouldn't listen anything!
- You give them a test
- Then, you compare grades between the two groups
- Differences between observational and experimental data:

- Observational data: measures the characteristics of a population by studying individuals in a sample, but doesn't attempt to manipulate or influence the variables of interest
- Experimental data: applies a treatment to individuals and attempts to isolate the effects of the treatment on a response variable

- Observational data: find 100 women age 30 of which 50 have been smoking a pack a day for 10 years while the other have been smoke free for 10 years. Measure lung capacity for each of the 100 women. Analyze, interpret and draw conclusions from data.
- Experimental data: find 100 women age 20 who don't currently smoke. Randomly assign 50 of the 100 women to the smoking treatment and the other 50 to the no smoking treatment. Those in the smoking group smoke a pack a day for 10 years while those in the control group remain smoke free for 10 years. Measure lung capacity for each of the 100 women. Analyze, interpret and draw conclusions from data.

31. Is mean imputation of missing data acceptable practice? Why or why not?

- Bad practice in general
- If just estimating means: mean imputation preserves the mean of the observed data
- Leads to an underestimate of the standard deviation
- Distorts relationships between variables by “pulling” estimates of the correlation toward zero

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32. What is an outlier?

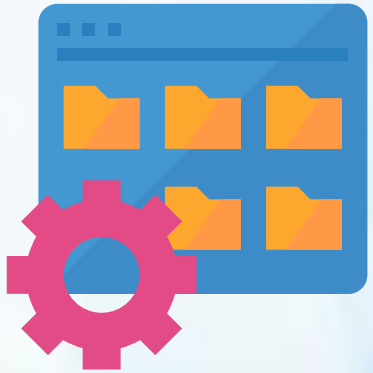
- *Outliers:*
  - An observation point that is distant from other observations
  - Can occur by chance in any distribution
  - Often, they indicate measurement error or a heavy-tailed distribution
  - Measurement error: discard them or use robust statistics
  - Heavy-tailed distribution: high skewness, can't use tools assuming a normal distribution
  - Three-sigma rules (normally distributed data): 1 in 22 observations will differ by twice the standard deviation from the mean
  - Three-sigma rules: 1 in 370 observations will differ by three times the standard deviation from the mean

Explain how you might screen for outliers and what would you do if you found them in your dataset.

- Three-sigma rules example: in a sample of 1000 observations, the presence of up to 5 observations deviating from the mean by more than three times the standard deviation is within the range of what can be expected, being less than twice the expected number and hence within 1 standard deviation of the expected number (Poisson distribution).

Also, explain what an inlier is and how you might screen for them and what would you do if you found them in your dataset

- If the nature of the distribution is known a priori, it is possible to see if the number of outliers deviate significantly from what can be expected. For a given cutoff (samples fall beyond the cutoff with probability p), the number of outliers can be approximated with a Poisson distribution with lambda=pn. Example: if one takes a normal distribution with a cutoff 3 standard deviations from the mean, p=0.3% and thus we can approximate the number of samples whose deviation exceed 3 sigmas by a Poisson with lambda=3
- *Identifying outliers:*
  - No rigid mathematical method
  - Subjective exercise: be careful
  - Boxplots
  - QQ plots (sample quantiles Vs theoretical quantiles)



- *Handling outliers:*
  - Depends on the cause
  - Retention: when the underlying model is confidently known
  - Regression problems: only exclude points which exhibit a large degree of influence on the estimated coefficients (Cook's distance)
- *Inlier:*
  - Observation lying within the general distribution of other observed values
  - Doesn't perturb the results but are non-conforming and unusual
  - Simple example: observation recorded in the wrong unit (°F instead of °C)
- *Identifying inliers:*
  - Mahalanobi's distance
  - Used to calculate the distance between two random vectors
  - Difference with Euclidean distance: accounts for correlations
  - Discard them

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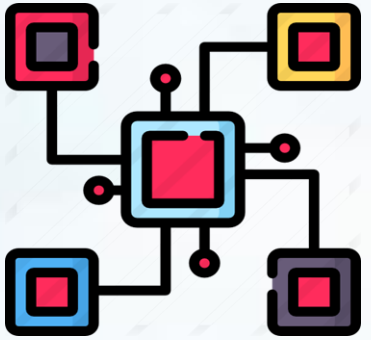
33. How do you handle missing data? What imputation techniques do you recommend?



- If data missing at random: deletion has no bias effect, but decreases the power of the analysis by decreasing the effective sample size
- Recommended: Knn imputation, Gaussian mixture imputation

34. You have data on the durations of calls to a call center. Generate a plan for how you would code and analyze these data. Explain a plausible scenario for what the distribution of these durations might look like. How could you test, even graphically, whether your expectations are borne out?

- Exploratory data analysis
- Histogram of durations
- histogram of durations per service type, per day of week, per hours of day (durations can be systematically longer from 10am to 1pm for instance), per employee…
- Distribution: lognormal?
- Test graphically with QQ plot: sample quantiles of log(durations)log(durations) Vs normal quantiles

35. Explain likely differences between administrative datasets and datasets gathered from experimental studies. What are likely problems encountered with administrative data? How do experimental methods help alleviate these problems? What problem do they bring?

- *Advantages:*
  - Cost
  - Large coverage of population
  - Captures individuals who may not respond to surveys
  - Regularly updated, allow consistent time-series to be built-up

- *Disadvantages:*
  - Restricted to data collected for administrative purposes (limited to administrative definitions. For instance: incomes of a married couple, not individuals, which can be more useful)
  - Lack of researcher control over content
  - Missing or erroneous entries
  - Quality issues (addresses may not be updated or a postal code is provided only)
  - Data privacy issues
  - Underdeveloped theories and methods (sampling methods…)

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36. You are compiling a report for user content uploaded every month and notice a spike in uploads in October. In particular, a spike in picture uploads. What might you think is the cause of this, and how would you test it?

- Halloween pictures?
- Look at uploads in countries that don’t observe Halloween as a sort of counter-factual analysis
- Compare uploads mean in October and uploads means with September: hypothesis testing

37. You're about to get on a plane to Seattle. You want to know if you should bring an umbrella. You call 3 random friends of yours who live there and ask each independently if it's raining. Each of your friends has a 2/3 chance of telling you the truth and a 1/3 chance of messing with you by lying. All 3 friends tell you that "Yes" it is raining. What is the probability that it's actually raining in Seattle?

- All say yes: all three lie or three say the truth
- P("allsaythetruth")=(23)3=827P("allsaythetruth")=(23)3=827
- P("alllie")=(13)3=127P("alllie")=(13)3=127
- P("allyes")=127+827=13P("allyes")=127+827=13
- Out of these numbers, there is 82713=8982713=89 chance it's actually raining

38. There's one box - has 12 black and 12 red cards, 2nd box has 24 black and 24 red; if you want to draw 2 cards at random from one of the 2 boxes, which box has the higher probability of getting the same color? Can you tell intuitively why the 2nd box has a higher probability

- First select: for both, then and ; compare them
- BA=529517BA=529517

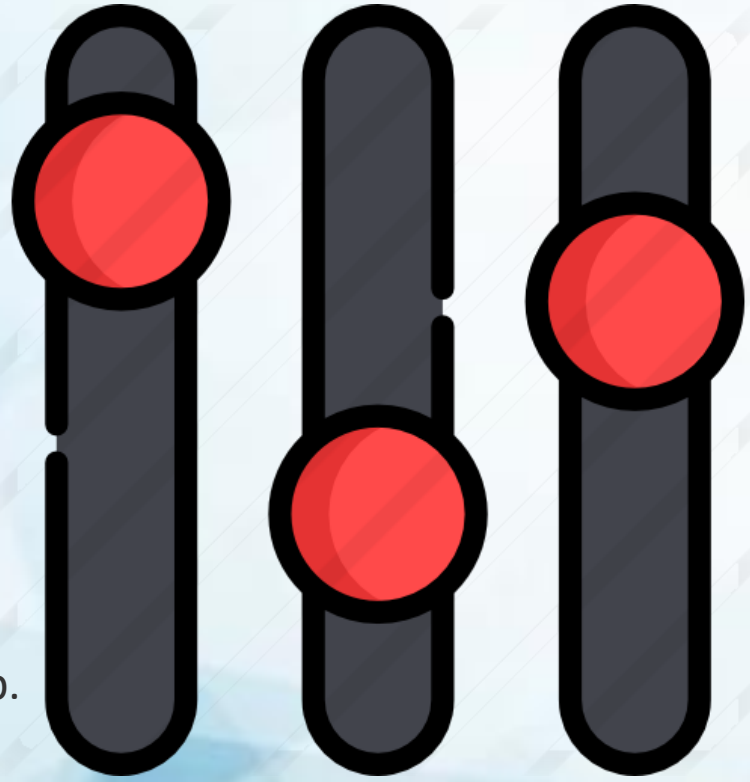
39. When you sample, what bias are you inflicting?

- *Selection bias:*
  - An online survey about computer use is likely to attract people more interested in technology than in typical
- *Under coverage bias:*
  - Sample too few observations from a segment of population
- *Survivorship bias:*
  - Observations at the end of the study are a non-random set of those present at the beginning of the investigation
  - In finance and economics: the tendency for failed companies to be excluded from performance studies because they no longer exist

40. How do you control for biases?

- Choose a representative sample, preferably by a random method
- Choose an adequate size of sample
- Identify all confounding factors if possible
- Identify sources of bias and include them as additional predictors in statistical analyses
- Use randomization: by randomly recruiting or assigning subjects in a study, all our experimental groups have an equal chance of being influenced by the same bias

- Notes:
  - Randomization: in randomized control trials, research participants are assigned by chance, rather than by choice to either the experimental group or the control group.
  - Random sampling: obtaining data that is representative of the population of interest

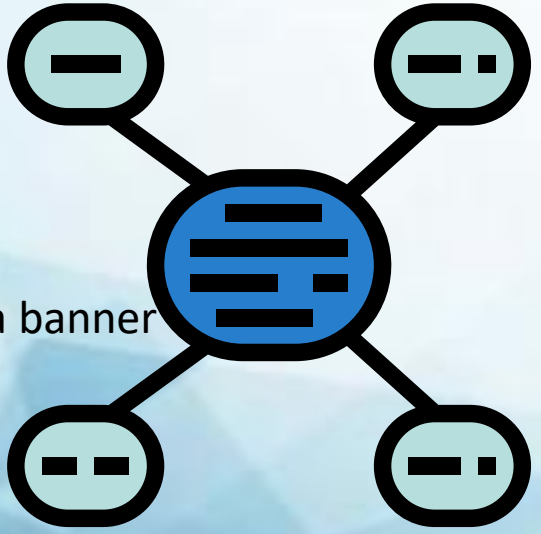


41. What are confounding variables?

- Extraneous variable in a statistical model that correlates directly or inversely with both the dependent and the independent variable
- A spurious relationship is a perceived relationship between an independent variable and a dependent variable that has been estimated incorrectly
- The estimate fails to account for the confounding factor
- See Question 18 about root cause analysis

42. What is A/B testing?

- Two-sample hypothesis testing
- Randomized experiments with two variants: A and B
- A: control; B: variation
- User-experience design: identify changes to web pages that increase clicks on a banner
- Current website: control; NULL hypothesis
- New version: variation; alternative hypothesis



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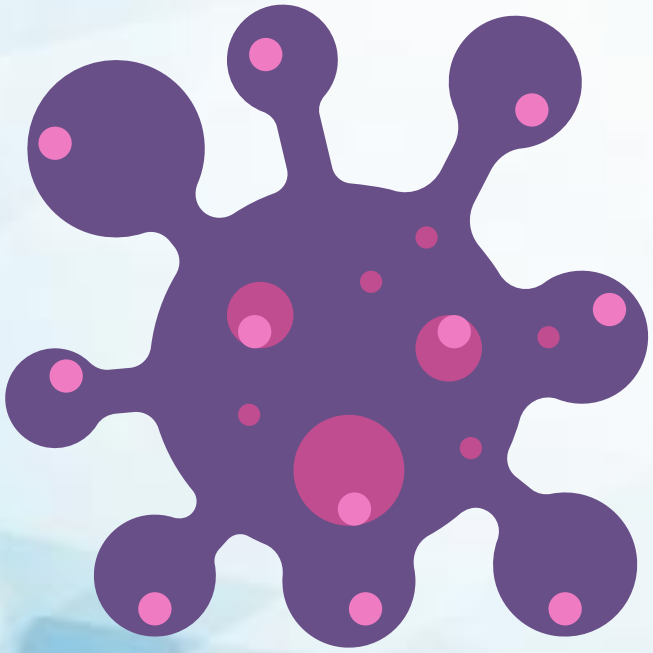
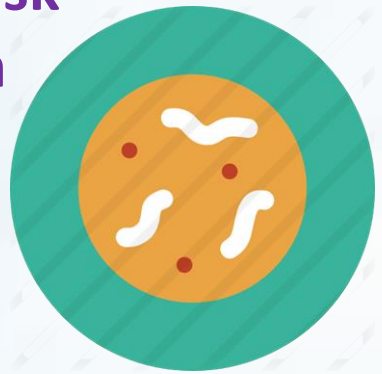
43. An HIV test has a sensitivity of 99.7% and a specificity of 98.5%. A subject from a population of prevalence 0.1% receives a positive test result. What is the precision of the test (i.e the probability he is HIV positive)?



- **Bayes** rule: $P(Actu+|Pred+)=P(Pred+|Actu+)\times P(Actu+)P(Pred+|Actu+)\times P(Actu+)+P(Pred+|Actu-)P(Actu-)P(Actu+|Pred+)=P(Pred+|Actu+)\times P(Actu+)P(Pred+|Actu+)\times P(Actu+)+P(Pred+|Actu-)P(Actu-)$
- **We** have: $sensitivity\times prevalencesensitivity\times prevalence+(1-specificity)\times(1-prevalence)=0.997\times0.0010.997\times0.001+0.15\times0.999=0.62sensitivity\times prevalencesensitivity\times prevalence+(1-specificity)\times(1-prevalence)=0.997\times0.0010.997\times0.001+0.15\times0.999=0.62$

44. Infection rates at a hospital above a 1 infection per 100 person days at risk are considered high. An hospital had 10 infections over the last 1787 person days at risk. Give the p-value of the correct one-sided test of whether the hospital is below the standard



- One-sided test, assume a Poisson distribution
  Ho: lambda=0.01 ; H1:lambda>0.01
  R code:
- ppois(10,1787*0.01)
- ## [1] 0.03237153

45. 29. You roll a biased coin (p(head)=0.8) five times. What's the probability of getting three or more heads?

- 5 trials, p=0.8
  P("3ormoreheads")=(35)×0.83×0.8×0.22+(41)×0.84×0.21+(55)∗0.85∗0.20=0.94P("3ormoreheads")=(35)×0.83×0.8×0.22+(41)×0.84×0.21+(55)∗0.85∗0.20=0.94

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46. 30. A random variable X is normal with mean 1020 and standard deviation 50. Calculate P(X>1200)

- X\~N(1020,50)X\~N(1020,50) Our new quantile: z=1200−102050=3.6z=1200−102050=3.6 R code:
- pnorm(3.6,lower.tail=F)
- ## [1] 0.0001591086

47. 31. Consider the number of people that show up at a bus station is Poisson with mean 2.5/h. What is the probability that at most three people show up in a four hour period?

- X\~Poisson(λ=2.5×t)X\~Poisson(λ=2.5×t)

R code:

- ppois(3,lambda=2.5*4)
- ## [1] 0.01033605

48. You are running for office and your pollster polled hundred people. 56 of them claimed they will vote for you. Can you relax?

- Quick:
  - Intervals take the form p±z×1n×p×(1−p)−−−−−−−−−−−−√p±z×1n×p×(1−p)
  - We know that p(1−p)p(1−p) is maximized at 1212 and z=1.96z=1.96 is the relevant quantile for a 95% confidence interval
  - So: p±1n√p±1n is a quick estimate for pp
  - Here: 1100√=0.11100=0.1 so 95% of the intervals would be [46,66][46,66]
  - It's not enough!

49. Geiger counter records 100 radioactive decays in 5 minutes. Find an approximate 95% interval for the number of decays per hour.

- Start by finding a 95% interval for radioactive decay in a 5 minutes period
- The estimated standard deviation is 100−−−√=10100=10
- So the interval is λ^±1.96×10=100±19.6λ^±1.96×10=100±19.6
- So, per hour: [964.8,1435.2][964.8,1435.2]

50. The homicide rate in Scotland fell last year to 99 from 115 the year before. Is this reported change really networthy?

- Consider the homicides as independent; a Poisson distribution can be a reasonable model
- 95% interval for the true homicide rate is 115±2×115−−−√=115±22=[94,137]115±2×115=115±22=[94,137]
- It’s not reasonable to conclude that there has been a reduction in the true rate

51. 35. Consider influenza epidemics for two parent heterosexual families. Suppose that the probability is 17% that at least one of the parents has contracted the disease. The probability that the father has contracted influenza is 12% while the probability that both the mother and father have contracted the disease is 6%. What is the probability that the mother has contracted influenza?

P("MotherorFather")=P("Mother")+P("Father")−P("MotherandFather")P("MotherorFather")=P("Mother")+P("Father")−P("MotherandFather")

Hence: P("Mother")=0.17+0.06−0.12=0.11P("Mother")=0.17+0.06−0.12=0.11

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52. 36. Suppose that diastolic blood pressures (DBPs) for men aged 35-44 are normally distributed with a mean of 80 (mm Hg) and a standard deviation of 10. About what is the probability that a random 35-44 year old has a DBP less than 70?

One standard deviation below the mean: 322=16322=16

53. 37. In a population of interest, a sample of 9 men yielded a sample average brain volume of 1,100cc and a standard deviation of 30cc. What is a 95% Student's T confidence interval for the mean brain volume in this new population?

Standard error of the mean: 309√=10309=10
Relevant t quantile: 97.5%
R code:

```
1100+c(-1,1)*qt(0.975,df=9-1)*10
## [1] 1076.94 1123.06
```

54. 38. A diet pill is given to 9 subjects over six weeks. The average difference in weight (follow up - baseline) is -2 pounds. What would the standard deviation of the difference in weight have to be for the upper endpoint of the 95% T confidence interval to touch 0?

find σ=2×9√t97.5σ=2×9t97.5

R code:

```
2*3/qt(0.975,df=8)
```

```
## [1] 2.601903
```

55. 39. In a study of emergency room waiting times, investigators consider a new and the standard triage systems. To test the systems, administrators selected 20 nights and randomly assigned the new triage system to be used on 10 nights and the standard system on the remaining 10 nights. They calculated the nightly median waiting time (MWT) to see a physician. The average MWT for the new system was 3 hours with a variance of 0.60 while the average MWT for the old system was 5 hours with a variance of 0.68. Consider the 95% confidence interval estimate for the differences of the mean MWT associated with the new system. Assume a constant variance. What is the interval? Subtract in this order (New System - Old System).

t confidence interval for the difference of the means assuming equal variances:
(new−old)±t′×sp×(1n1)2+(1n2)2−−−−−−−−−−√(new−old)±t′×sp×(1n1)2+(1n2)2

t′: 97.5% quantile, with 20+10-2=28 degrees of freedom: 2.1

spsp: pooled variance, 0.62×9+0.682×910+10−2−−−−−−−−−−√=0.80.62×9+0.682×910+10−2=0.8

1/10+1/10−−−−−−−−−−√=0.441/10+1/10=0.44

We get [−2.75,−1.25][−2.75,−1.25]

56. To further test the hospital triage system, administrators selected 200 nights and randomly assigned a new triage system to be used on 100 nights and a standard system on the remaining 100 nights. They calculated the nightly median waiting time (MWT) to see a physician. The average MWT for the new system was 4 hours with a standard deviation of 0.5 hours while the average MWT for the old system was 6 hours with a standard deviation of 2 hours. Consider the hypothesis of a decrease in the mean MWT associated with the new treatment. What does the 95% independent group confidence interval with unequal variances suggest vis a vis this hypothesis? (Because there's so many observations per group, just use the Z quantile instead of the T.)

- ZZ confidence interval for the differences of the means assuming unequal variances: (new−old) ± z′×sp×(1n1)2+(1n2)2−−−−−−−−−−√(new−old)±z′×sp×(1n1)2+(1n2)2
- Z97.5Z97.5 quantile
- spsp: pooled variance, 0.52×99+22×99(100+100−2)
- √=1.4580.52×99+22×99(100+100−2)=1.458
- we get: [1.6,2.4][1.6,2.4]

UpDegree

Business

Understanding & Hypothesis Testing

Business Understanding & Hypothesis Testing

UpDegree

57. What do you understand by Hypothesis in the context of Machine Learning?

58. In experimental design, is it necessary to do randomization? If yes, why?

59. How will you assess the statistical significance of an insight whether it is a real insight or just by chance?

60. Can you cite some examples where a false positive is important than a false negative?

- Before we start, let us understand what are false positives and what are false negatives.
- False Positives are the cases where you wrongly classified a non-event as an event a.k.a Type I error.
- And, False Negatives are the cases where you wrongly classify events as non-events, a.k.a Type II error.

False Positive

False Negative

In medical field, assume you have to give chemo therapy to patients. Your lab tests patients for certain vital information and based on those results they decide to give radiation therapy to a patient.

Assume a patient comes to that hospital and he is tested positive for cancer (But he doesn't have cancer) based on lab prediction. What will happen to him? (Assuming Sensitivity is 1)

One more example might come from marketing. Let's say an ecommerce company decided to give $1000 Gift voucher to the customers whom they assume to purchase at least $5000 worth of items. They send free voucher mail directly to 100 customers without any minimum purchase condition because they assume to make at least 20% profit on sold items above 5K.

Now what if they have sent it to false positive cases?

61. Can you cite some examples where a false negative important than a false positive?

Assume there is an airport 'A' which has received high security threats and based on certain characteristics they identify whether a particular passenger can be a threat or not. Due to shortage of staff they decided to scan passenger being predicted as risk positives by their predictive model.

What will happen if a true threat customer is being flagged as non-threat by airport model?

Another example can be judicial system. What if Jury or judge decide to make a criminal go free?

What if you rejected to marry a very good person based on your predictive model and you happen to meet him/her after few years and realize that you had a false negative?

62. Can you cite some examples where both false positive and false negatives are equally important?

In the banking industry giving loans is the primary source of making money but at the same time if your repayment rate is not good you will not make any profit, rather you will risk huge losses.

Banks don't want to lose good customers and at the same point of time they don't want to acquire bad customers. In this scenario both the false positives and false negatives become very important to measure.

These days we hear many cases of players using steroids during sport competitions Every player has to go through a steroid test before the game starts. A false positive can ruin the career of a Great sportsman and a false negative can make the game unfair.

UpDegree

Data Cleaning

Data Cleaning

UpDegree

63. How to clean data?

First: detect anomalies and contradictions
Common issues:

Tidy data: (Hadley Wickam paper)
column names are values, not names, e.g. <15-25, >26-45…
multiple variables are stored in one column, e.g. m1534 (male of 15-34 years' old age)
variables are stored in both rows and columns, e.g. tmax, tmin in the same column
multiple types of observational units are stored in the same table. e.g, song dataset and rank dataset in the same table
*a single observational unit is stored in multiple tables (can be combined)

Data-Type constraints: values in a particular column must be of a particular type: integer, numeric, factor, boolean

Range constraints: number or dates fall within a certain range. They have minimum/maximum permissible values

Mandatory constraints: certain columns can't be empty

Unique constraints: a field must be unique across a dataset: a same person must have a unique SS number

Set-membership constraints: the values for a columns must come from a set of discrete values or codes: a gender must be female, male

Regular expression patterns: for example, phone number may be required to have the pattern: (999)999-9999

Misspellings

Missing values

Outliers

Cross-field validation: certain conditions that utilize multiple fields must hold. For instance, in laboratory medicine: the sum of the different white blood cell must equal to zero (they are all percentages). In hospital database, a patient's date or discharge can't be earlier than the admission date

Clean the data using:

Regular expressions: misspellings, regular expression patterns

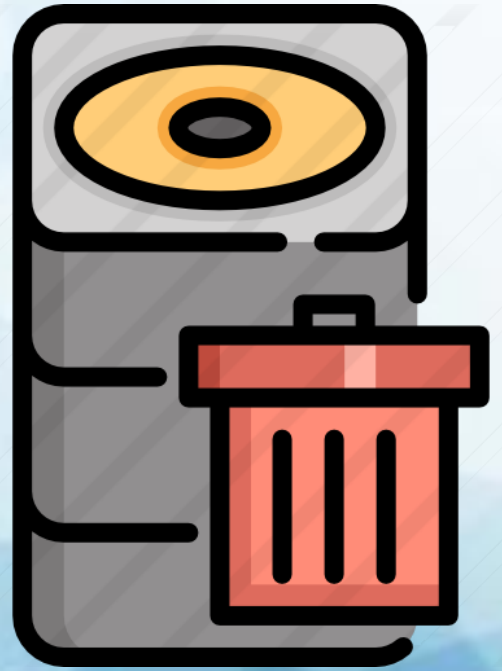
KNN-impute and other missing values imputing methods

Coercing: data-type constraints

Melting: tidy data issues

Date/time parsing

Removing observations



64. Why data cleaning plays a vital role in analysis?

Cleaning data from multiple sources to transform it into a format that data analysts or data scientists can work with is a cumbersome process because - as the number of data sources increases, the time take to clean the data increases exponentially due to the number of sources and the volume of data generated in these sources. It might take up to 80% of the time for just cleaning data making it a critical part of analysis task.

65. How do you handle missing data? What imputation techniques do you recommend?

The extent of the missing values is identified after identifying the variables with missing values. If any patterns are identified the analyst has to concentrate on them as it could lead to interesting and meaningful business insights. If there are no patterns identified, then the missing values can be substituted with mean or median values (imputation) or they can simply be ignored. There are various factors to be considered when answering this question-

Understand the problem statement, understand the data and then give the answer. Assigning a default value which can be mean, minimum or maximum value. Getting into the data is important.

If it is a categorical variable, the default value is assigned. The missing value is assigned a default value.

If you have a distribution of data coming, for normal distribution give the mean value.

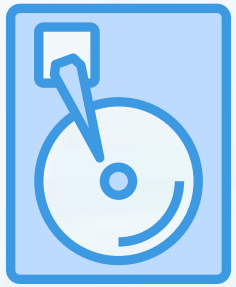
Should we even treat missing values is another important point to consider? If 80% of the values for a variable are missing, then you can answer that you would be dropping the variable instead of treating the missing values.

66. How can outlier values be treated?

Outlier values can be identified by using univariate or any other graphical analysis method. If the number of outlier values is few then they can be assessed individually but for large number of outliers the values can be substituted with either the 99th or the 1st percentile values. All extreme values are not outlier values. The most common ways to treat outlier values –

1) To change the value and bring in within a range

2) To just remove the value.



67. How do data management procedures like missing data handling make selection bias worse?

Missing value treatment is one of the primary tasks which a data scientist is supposed to do before starting data analysis. There are multiple methods for missing value treatment. If not done properly, it could potentially result into selection bias. Let see few missing value treatment examples and their impact on selection-

Complete Case Treatment: Complete case treatment is when you remove entire row in data even if one value is missing. You could achieve a selection bias if your values are not missing at random and they have some pattern. Assume you are conducting a survey and few people didn't specify their gender. Would you remove all those people? Can't it tell a different story?

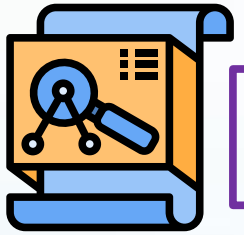
Available case analysis: Let say you are trying to calculate correlation matrix for data so you might remove the missing values from variables which are needed for that particular correlation coefficient. In this case your values will not be fully correct as they are coming from population sets.

Mean Substitution: In this method missing values are replaced with mean of other available values. This might make your distribution biased e.g., standard deviation, correlation and regression are mostly dependent on the mean value of variables.

Hence, various data management procedures might include selection bias in your data if not chosen correctly.

UpDegree

Data Exploration & Manipulation



Data Exploration & Manipulation

UpDegree

68. Give examples of bad and good visualizations

- ***Bad visualization:***
  - **Pie charts:** difficult to make comparisons between items when area is used, especially when there are lots of items
  - **Colour choice** for classes: abundant use of red, orange and blue. Readers can think that the colours could mean good (blue) versus bad (orange and red) whereas these are just associated with a specific segment
  - **3D charts**: can distort perception and therefore skew data
  - **Using a solid line** in a line chart: dashed and dotted lines can be distracting
- ***Good visualization:***
  - **Heat map with a single colour**: some colours stand out more than others, giving more weight to that data. A single colour with varying shades show the intensity better
  - **Adding a trend line (regression line)** to a scatter plot help the reader highlighting trends

69. Differentiate between univariate, bivariate and multivariate analysis.

- These are descriptive statistical analysis techniques which can be differentiated based on the number of variables involved at a given point of time. For example, the pie charts of sales based on territory involve only one variable and can be referred to as univariate analysis.
- If the analysis attempts to understand the difference between 2 variables at time as in a scatterplot, then it is referred to as bivariate analysis. For example, analysing the volume of sale and a spending can be considered as an example of bivariate analysis.
- Analysis that deals with the study of more than two variables to understand the effect of variables on the responses is referred to as multivariate analysis.

70. What is multi-collinearity and how you can overcome it?

71. What are feature vectors?

72. You have data on the durations of calls to a call centre. Generate a plan for how you would code and analyse these data. Explain a plausible scenario for what the distribution of these durations might look like. How could you test, even graphically, whether your expectations are borne out?

UpDegree

Model Building

Model Building

UpDegree

Supervised ML

73. What is the difference between supervised learning and unsupervised learning? Give concrete examples

- Supervised learning: inferring a function from labeled training data
- Supervised learning: predictor measurements associated with a response measurement; we wish to fit a model that relates both for better understanding the relation between them (inference) or with the aim to accurately predicting the response for future observations (prediction)
- Supervised learning: support vector machines, neural networks, linear regression, logistic regression, extreme gradient boosting
- Supervised learning examples: predict the price of a house based on the are, size.; churn prediction; predict the relevance of search engine results.
- Unsupervised learning: inferring a function to describe hidden structure of unlabeled data
- Unsupervised learning: we lack a response variable that can supervise our analysis
- Unsupervised learning: clustering, principal component analysis, singular value decomposition; identify group of customers
- Unsupervised learning examples: find customer segments; image segmentation; classify US senators by their voting.

74. What is Gradient Descent?

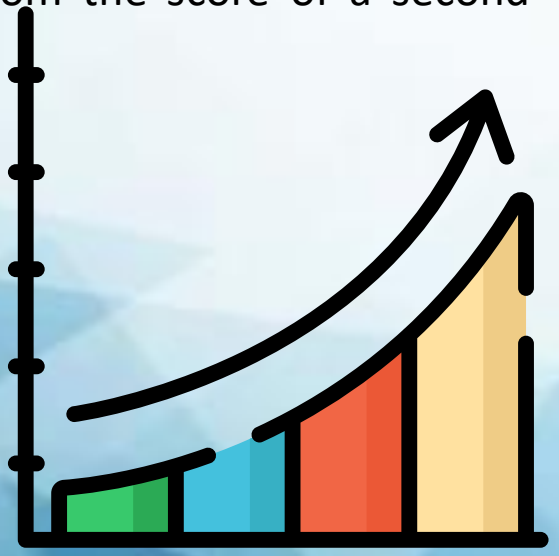
75. Do gradient descent methods always converge to same point?

No, they do not because in some cases it reaches a local minima or a local optima point. You don't reach the global optima point. It depends on the data and starting conditions

76. Is Naïve Bayes bad? If yes, under what aspects.

77. What is Linear Regression?

Linear regression is a statistical technique where the score of a variable Y is predicted from the score of a second variable X. X is referred to as the predictor variable and Y as the criterion variable.



78. What are the basic assumptions to be made for linear regression?

Normality of error distribution,

statistical independence of errors,

linearity and additivity.

79. How do you decide whether your linear regression model fits the data?

80. Can you write the formula to calculate R-square?

R-Square can be calculated using the below formular -

1 - (Residual Sum of Squares/ Total Sum of Squares)

81. Which technique is used to predict categorical responses?

Classification technique is used widely in mining for classifying data sets.

82. What is logistic regression? Or State an example when you have used logistic regression recently.

Logistic Regression often referred as logit model is a technique to predict the binary outcome from a linear combination of predictor variables. For example, if you want to predict whether a particular political leader will win the election or not. In this case, the outcome of prediction is binary i.e. 0 or 1 (Win/Lose). The predictor variables here would be the amount of money spent for election campaigning of a particular candidate, the amount of time spent in campaigning, etc.

UpDegree

83. How can you assess a good logistic model?

- There are various methods to assess the results of a logistic regression analysis-
  - Using Classification Matrix to look at the true negatives and false positives.
  - Concordance that helps identify the ability of the logistic model to differentiate between the event happening and not happening.
  - Lift helps assess the logistic model by comparing it with random selection.

84. Is it possible to perform logistic regression with Microsoft Excel?

- It is possible to perform logistic regression with Microsoft Excel. There are two ways to do it using Excel.
  - One is to use Add-ins provided by many websites which we can use.
  - Second is to use fundamentals of logistic regression and use Excel's computational power to build a logistic regression
- But when this question is being asked in an interview, interviewer is not looking for a name of Add-ins rather a method using the base excel functionalities.
- Let's use a sample data to learn about logistic regression using Excel. (Example assumes that you are familiar with basic concepts of logistic regression)

	A	B	C
6			
7	X1	X2	Y
8	39	4	0
9	36.5	4	0
10	36.5	2.5	0
11	35.5	3.5	0
12	34	2.5	0
13	29.5	2	0
14	28.5	3.5	0
15	24.5	2.5	0
16	17.5	2	0
17	13.5	3.5	0
18	29.5	1.5	1
19	28.5	2	1
20	22	2.5	1
21	19	2.5	1
22	18	2	1
23	18	1	1
24	11	3	1
25	11	2.5	1
26	7.5	2	1
27	5	3	1

Data shown above consists of three variables where X1 and X2 are independent variables and Y is a class variable. We have kept only 2 categories for our purpose of binary logistic regression classifier.

Next we have to create a logit function using independent variables, i.e.

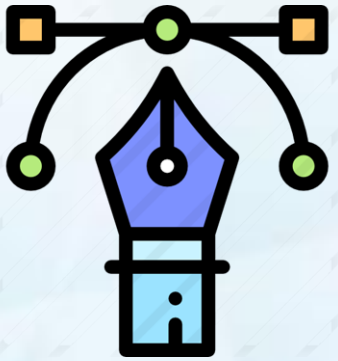
Logit = L = $\beta_0 + \beta_1 * X_1 + \beta_2 * X_2$

	A	B	C	D	E	F
1			*Decision Variables*			
2				B0	0.1	
3				B1	0.1	
4				B2	0.1	
5						
6						
7	X1	X2	Y	Logit		
8	39	4	0	=$E$2+$E$3*A8+$E$4*B8		
9	36.5	4	0			
10	36.5	2.5	0			
11	35.5	3.5	0			
12	34	2.5	0			
13	29.5	2	0			
14	28.5	3.5	0			
15	24.5	2.5	0			
16	17.5	2	0			
17	13.5	3.5	0			
18	29.5	1.5	1			
19	28.5	2	1			
20	22	2.5	1			
21	19	2.5	1			
22	18	2	1			
23	18	1	1			
24	11	3	1			

UpDegree

UpDegree

85. What are feature vectors?



n-dimensional vector of numerical features that represent some object

term occurrences frequencies, pixels of an image etc.

Feature space: vector space associated with these vectors

86. When would you use random forests Vs SVM and why?

In a case of a multi-class classification problem: SVM will require one-against-all method (memory intensive)

If one needs to know the variable importance (random forests can perform it as well)

If one needs to get a model fast (SVM is long to tune, need to choose the appropriate kernel and its parameters, for instance sigma and epsilon)

In a semi-supervised learning context (random forest and dissimilarity measure): SVM can work only in a supervised learning mode

UpDegree

87. How do you take millions of users with 100’s transactions each, amongst 10k’s of products and group the users together in meaningful segments?

Some exploratory data analysis (get a first insight)

Transactions by date

Count of customers Vs number of items bought

Total items Vs total basket per customer

Total items Vs total basket per area

Create new features (per customer):

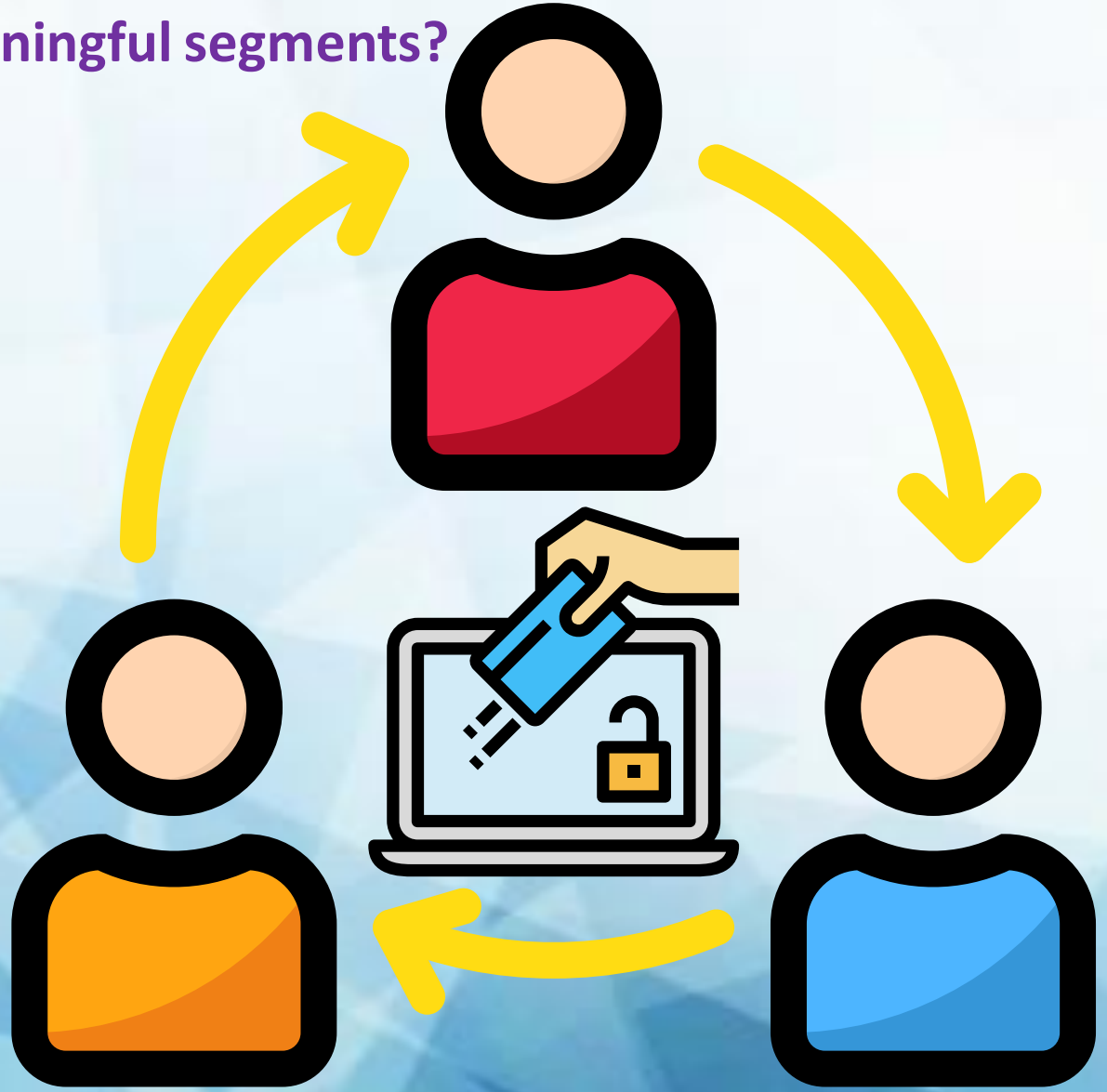
Counts:

Total baskets (unique days)

Total items

Total spent

Unique product id



Distributions:

Items per basket

Spent per basket

Product id per basket

Duration between visits

Product preferences: proportion of items per product cat per basket

Too many features, dimension-reduction? PCA?

Clustering:

PCA

Interpreting model fit

View the clustering by principal component axis pairs PC1 Vs PC2, PC2 Vs PC1.

Interpret each principal component regarding the linear combination it's obtained from; example: PC1=spendy axis (proportion of baskets containing spendy items, raw counts of items and visits)

learning algorithm B in the given context?"
- "Bayesian Comparison of Machine Learning Algorithms on Single and Multiple Datasets", A. Lacoste and F. Laviolette
- "Statistical Comparisons of Classifiers over Multiple Data Sets", Janez Demsar

In terms of performance on a given data set:
- One wants to choose between two learning algorithms
- Need to compare their performances and assess the statistical significance

One approach (Not preferred in the literature):
- Multiple k-fold cross validation: run CV multiple times and take the mean and sd
- You have: algorithm A (mean and sd) and algorithm B (mean and sd)
- Is the difference meaningful? (Paired t-test)

Sign-test (classification context):
Simply counts the number of times A has a better metrics than B and assumes this comes from a binomial distribution. Then we can obtain a p-value of the HoHo test: A and B are equal in terms of performance.

Wilcoxon signed rank test (classification context):
Like the sign-test, but the wins (A is better than B) are weighted and assumed coming from a symmetric distribution around a common median. Then, we obtain a p-value of the HoHo test.

Other (without hypothesis testing):
- AUC
- F-Score
- See question 3

UpDegree

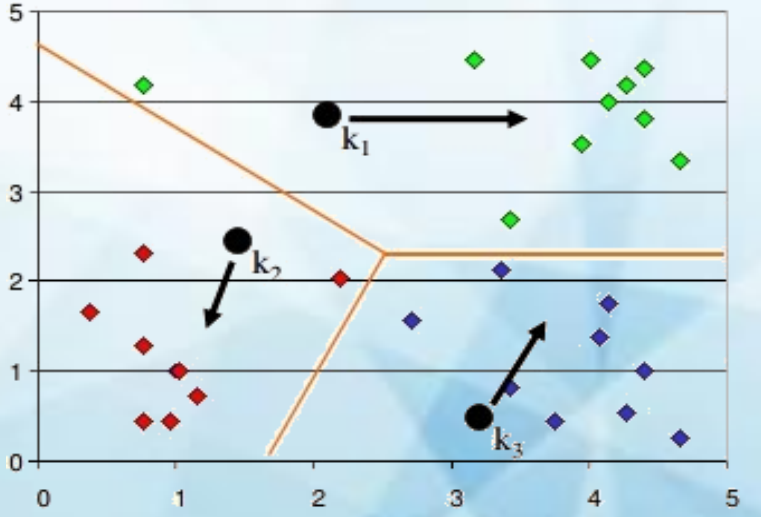
Unsupervised ML

UpDegree

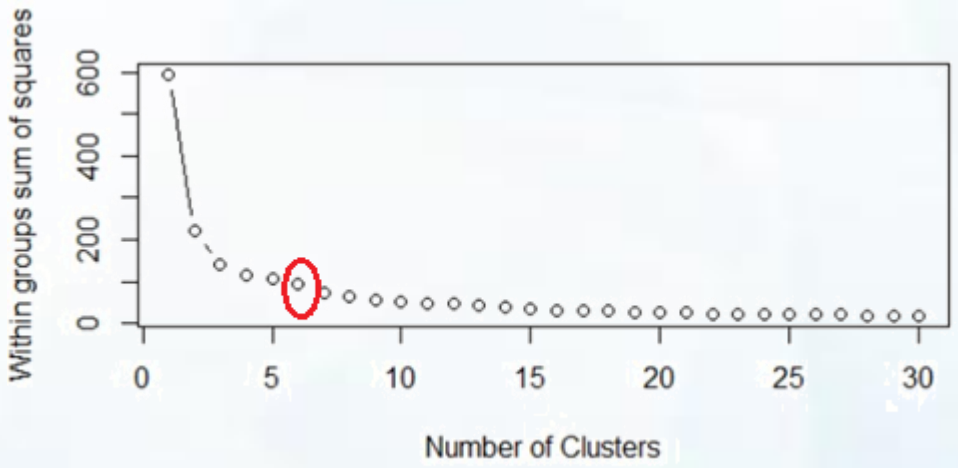
89. How will you define the number of clusters in a clustering algorithm?

Though the Clustering Algorithm is not specified, this question will mostly be asked in reference to K-Means clustering where “K” defines the number of clusters. The objective of clustering is to group similar entities in a way that the entities within a group are similar to each other but the groups are different from each other.

For example, the following image shows three different groups.



Within Sum of squares is generally used to explain the homogeneity within a cluster. If you plot WSS for a range of number of clusters, you will get the plot shown below. The Graph is generally known as Elbow Curve.



Red circled point in above graph i.e. Number of Cluster =6 is the point after which you don't see any decrement in WSS. This point is known as bending point and taken as K in K – Means.

This is the widely used approach but few data scientists also use Hierarchical clustering first to create dendograms and identify the distinct groups from there.

90. What is the difference between Cluster and Systematic Sampling?

Cluster sampling is a technique used when it becomes difficult to study the target population spread across a wide area and simple random sampling cannot be applied. Cluster Sample is a probability sample where each sampling unit is a collection, or cluster of elements. Systematic sampling is a statistical technique where elements are selected from an ordered sampling frame. In systematic sampling, the list is progressed in a circular manner so once you reach the end of the list, it is progressed from the top again. The best example for systematic sampling is equal probability method.

91. What is the curse of dimensionality?

92. What is the advantage of performing dimensionality reduction before fitting an SVM?

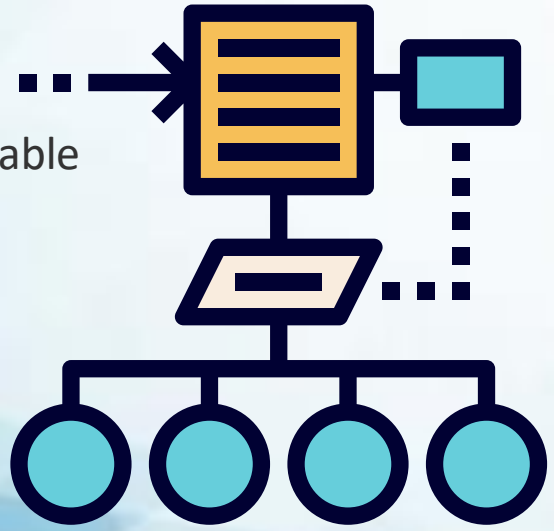
Support Vector Machine Learning Algorithm performs better in the reduced space. It is beneficial to perform dimensionality reduction before fitting an SVM if the number of features is large when compared to the number of observations.

UpDegree

93. What is principal component analysis? Explain the sort of problems you would use PCA for. Also explain its limitations as a method

Statistical method that uses an orthogonal transformation to convert a set of observations of correlated variables into a set of values of linearly uncorrelated variables called principal components.

Reduce the data from nn to kk dimensions: find the kk vectors onto which to project the data so as to minimize the projection error.



Algorithm:

1) Preprocessing (standardization): PCA is sensitive to the relative scaling of the original variable
2) Compute covariance matrix ΣΣ
3) Compute eigenvectors of ΣΣ
4) Choose kk principal components so as to retain xx% of the variance (typically x=99x=99)

Applications:

1) Compression
- Reduce disk/memory needed to store data
- Speed up learning algorithm. Warning: mapping should be defined only on training set and then applied to test set

Visualization: 2 or 3 principal components, so as to summarize data

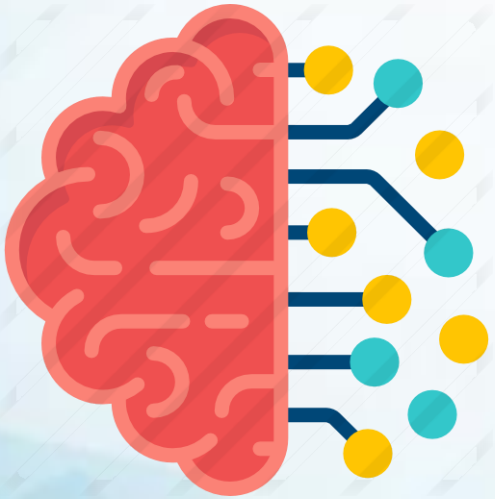
Limitations:

- PCA is not scale invariant
- The directions with largest variance are assumed to be of most interest
- Only considers orthogonal transformations (rotations) of the original variables
  PCA is only based on the mean vector and covariance matrix.
- Some distributions (multivariate normal) are characterized by this but some are not
- If the variables are correlated, PCA can achieve dimension reduction. If not, PCA just orders them according to their variances

UpDegree

94. Do you know / used data reduction techniques other than PCA? What do you think of step-wise regression? What kind of step-wise techniques are you familiar with?

- **Data reduction techniques other than PCA?:**
  Partial least squares: like PCR (principal component regression) but chooses the principal components in a supervised way. Gives higher weights to variables that are most strongly related to the response
- **step-wise regression?**
  - the choice of predictive variables are carried out using a systematic procedure
  - Usually, it takes the form of a sequence of F-tests, t-tests, adjusted R-squared, AIC, BIC
  - at any given step, the model is fit using unconstrained least squares
  - can get stuck in local optima
  - Better: Lasso
- **step-wise techniques:**
  - Forward-selection: begin with no variables, adding them when they improve a chosen model comparison criterion
  - Backward-selection: begin with all the variables, removing them when it improves a chosen model comparison criterion



- **Better than reduced data:**
  Example 1: If all the components have a high variance: which components to discard with a guarantee that there will be no significant loss of the information?
  Example 2 (classification):
  - One has 2 classes; the within class variance is very high as compared to between class variance
  - PCA might discard the very information that separates the two classes
- **Better than a sample:**
  - When number of variables is high relative to the number of observations

95. How would you define and measure the predictive power of a metric?

- Predictive power of a metric: the accuracy of a metric's success at predicting the empirical
- They are all domain specific
- Example: in field like manufacturing, failure rates of tools are easily observable. A metric can be trained and the success can be easily measured as the deviation over time from the observed
- In information security: if the metric says that an attack is coming and one should do X. Did the recommendation stop the attack or the attack never happened?

96. Do we always need the intercept term in a regression model?

- It guarantees that the residuals have a zero mean
- It guarantees the least squares slopes estimates are unbiased
- the regression line floats up and down, by adjusting the constant, to a point where the mean of the residuals is zero

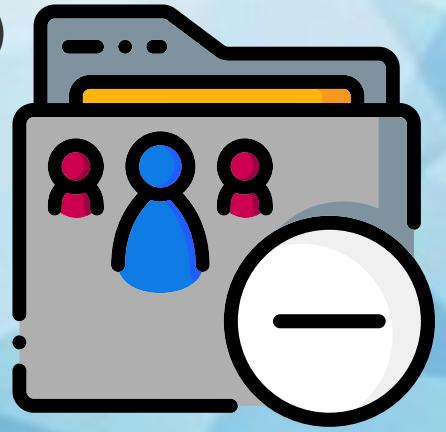
97. What are the assumptions required for linear regression? What if some of these assumptions are violated?

- The data used in fitting the model is representative of the population
- The true underlying relation between xx and yy is linear
- Variance of the residuals is constant (homoscedastic, not heteroscedastic)
- The residuals are independent
- The residuals are normally distributed
- Predict yy from xx: 1) + 2)
  Estimate the standard error of predictors: 1) + 2) + 3)
  Get an unbiased estimation of yy from xx: 1) + 2) + 3) + 4)
  Make probability statements, hypothesis testing involving slope and correlation, confidence intervals: 1) + 2) + 3) + 4) + 5)

Note:
- Common mythology: linear regression doesn't assume anything about the distributions of xx and yy
- It only makes assumptions about the distribution of the residuals
- And this is only needed for statistical tests to be valid
- Regression can be applied to many purposes, even if the errors are not normally distributed

98. What is collinearity and what to do with it? How to remove multicollinearity?

- **Collinearity/Multicollinearity:**
  - In multiple regression: when two or more variables are highly correlated
  - They provide redundant information
  - In case of perfect multicollinearity: $\beta=(XTX)-1XTy\beta=(XTX)-1XTy$ doesn't exist, the design matrix isn't invertible
  - It doesn't affect the model as a whole, doesn't bias results
  - The standard errors of the regression coefficients of the affected variables tend to be large
  - The test of hypothesis that the coefficient is equal to zero may lead to a failure to reject a false null hypothesis of no effect of the explanatory (Type II error)
  - Leads to overfitting



UpDegree

- **Remove multicollinearity:**
  - Drop some of affected variables
  - Principal component regression: gives uncorrelated predictors
  - Combine the affected variables
  - Ridge regression
  - Partial least square regression

- **Detection of multicollinearity:**
  - Large changes in the individual coefficients when a predictor variable is added or deleted
  - Insignificant regression coefficients for the affected predictors but a rejection of the joint hypothesis that those coefficients are all zero (F-test)
  - VIF: the ratio of variances of the coefficient when fitting the full model divided by the variance of the coefficient when fitted on its own
  - rule of thumb: VIF>5VIF>5 indicates multicollinearity
  - Correlation matrix, but correlation is a bivariate relationship whereas multicollinearity is multivariate

UpDegree

99. How to check if the regression model fits the data well?

- **R squared/Adjusted R squared:**

  -
  R2=RSStot−RSSresRSStot=RSSregRSStot=1−RSSresRSStotR2=RSStot−RSSresRSStot=RSSregRSStot=1−RSSresRSStot

  - Describes the percentage of the total variation described by the model

  - R2R2 always increases when adding new variables: adjusted R2R2 incorporates the model's degrees of freedom

- **F test:**

  - Evaluate the hypothesis Ho: all regression coefficients are equal to zero Vs H1: at least one doesn't

  - Indicates that R2 is reliable

RMSE:

- Absolute measure of fit (whereas R2 is a relative measure of fit)

UpDegree

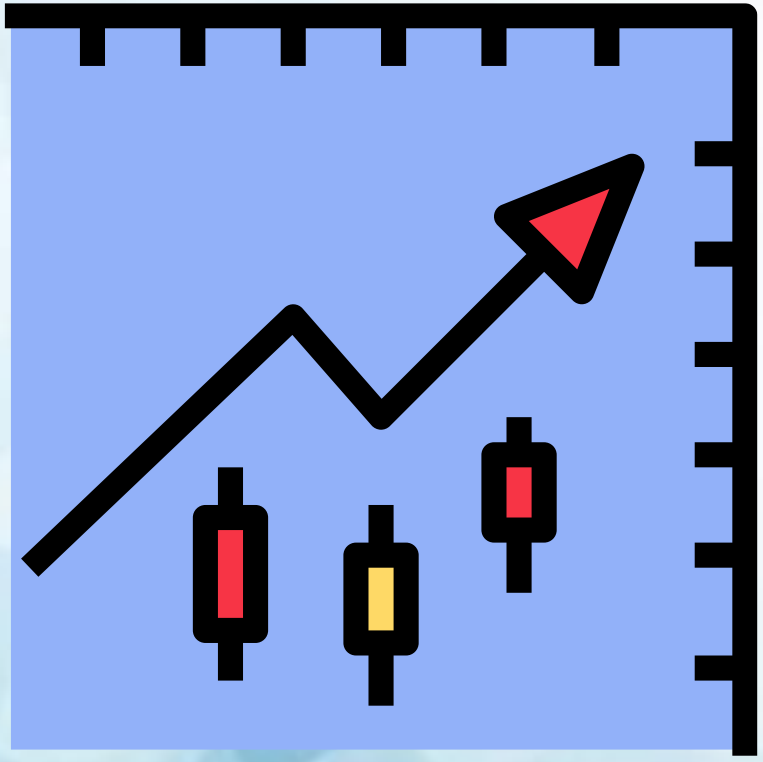
100. How do we train a logistic regression model? How do we interpret its coefficients?

- log(odds)=log(P(y=1|x)P(y=0|x))=log(odds)=log(P(y=1|x)P(y=0|x))= is a linear function of the input features
- **Minimization objective/Cost function:**
  J(β)=−1m∑mi=1yilog(hβ(xi))+(1−yi)log(1−hβ(xi))J(β)=−1m∑i=1myilog(hβ(xi))+(1−yi)log(1−hβ(xi))
  Where: hβ(x)=g(βTx)hβ(x)=g(βTx) and g(z)=11+e−zg(z)=11+e−z (sigmoid function)
  Intuition:
  - if yi=0yi=0, J(β)=log(1−hβ(x)i)J(β)=log(1−hβ(x)i), will converge to ∞∞ as hβ(x)ihβ(x)i becomes far from 0
  - Converse: when yi=1yi=1, J(β)=log(hβ(x)i)J(β)=log(hβ(x)i), will converge to ∞∞ as hβ(x)ihβ(x)i becomes far from 1
- Interpretation of the coefficients: the increase of logoddslogodds for the increase of one unit of a predictor, given all the other predictors are fixed.

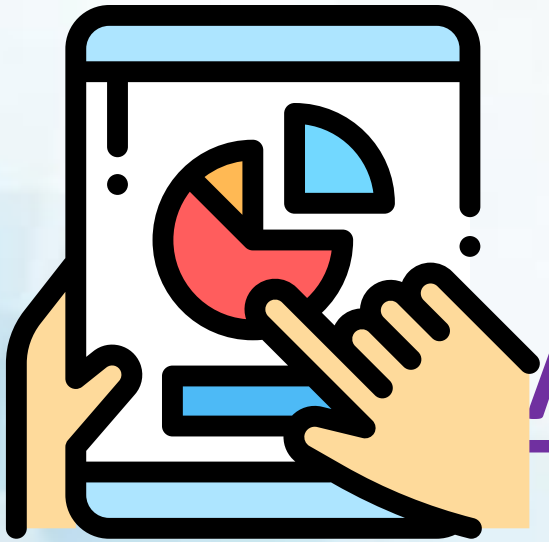
UpDegree

101. What is the maximal margin classifier? How this margin can be achieved?

- When the data can be perfectly separated using a hyperplane, there actually exists an infinite number of these hyperplanes
- Intuition: a hyperplane can usually be shifted a tiny bit up, or down, or rotated, without coming into contact with any of the observations
- Large margin classifier: choosing the hyperplance that is farthest from the training observations
- This margin can be achieved using support vectors



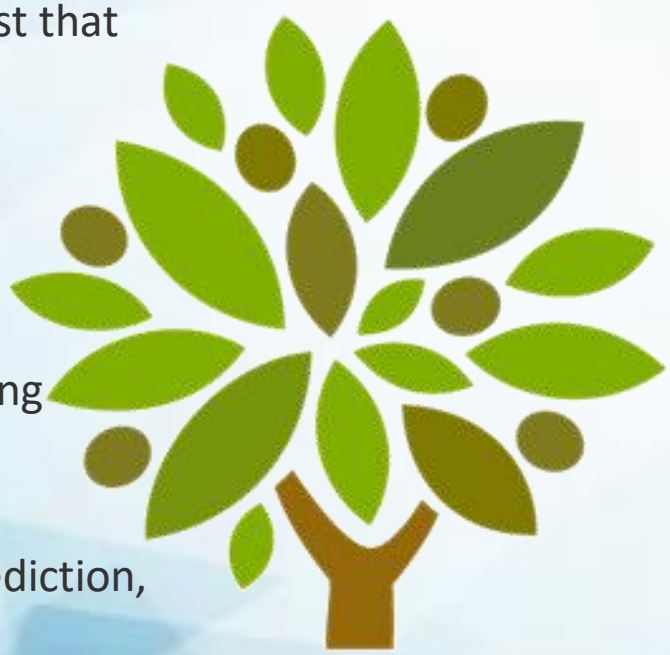
UpDegree



Advanced Analytics

102. What is a decision tree?

- Take the entire data set as input
- Search for a split that maximizes the “separation” of the classes. A split is any test that divides the data in two (e.g. if variable2>10)
- Apply the split to the input data (divide step)
- Re-apply steps 1 to 2 to the divided data
- Stop when you meet some stopping criteria
- (Optional) Clean up the tree when you went too far doing splits (called pruning)
- Finding a split: methods vary, from greedy search (e.g. C4.5) to randomly selecting attributes and split points (random forests)
- Purity measure: information gain, Gini coefficient, Chi Squared values
- Stopping criteria: methods vary from minimum size, particular confidence in prediction, purity criteria threshold
- Pruning: reduced error pruning, out of bag error pruning (ensemble methods)



103. What impurity measures do you know?

- **Gini**

  Gini=1−∑jp2jGini=1−∑jpj2

Information Gain/Deviance

InformationGain=∑jpjlog2pjInformationGain=∑jpjlog2pj

Better than Gini when pjpj are very small: multiplying very small numbers leads to rounding errors, we can instead take logs

104. What is random forest? Why is it good?

- **Random forest? (Intuition):**

  - Underlying principle: several weak learners combined provide a strong learner
  - Builds several decision trees on bootstrapped training samples of data
  - On each tree, each time a split is considered, a random sample of mm predictors is chosen as split candidates, out of all pp predictors
  - Rule of thumb: at each split m=p–√m=p
  - Predictions: at the majority rule

- **Why is it good?**
  - Very good performance (decorrelates the features)
  - Can model non-linear class boundaries
  - Generalization error for free: no cross-validation needed, gives an unbiased estimate of the generalization error as the trees is built
  - Generates variable importanceExplain what resampling methods are and why they are useful

- Repeatedly drawing samples from a training set and refitting a model of interest on each sample in order to obtain additional information about the fitted model
- example: repeatedly draw different samples from training data, fit a linear regression to each new sample, and then examine the extent to which the resulting fit differ
- most common are: cross-validation and the bootstrap

- cross-validation: random sampling with no replacement
- bootstrap: random sampling with replacement
- cross-validation: evaluating model performance, model selection (select the appropriate level of flexibility)
- bootstrap: mostly used to quantify the uncertainty associated with a given estimator or statistical learning method
- When would you use random forests Vs SVM and why?

UpDegree

105. How do you test whether a new credit risk scoring model works?

- Test on a holdout set
- Kolmogorov-Smirnov test
- Kolmogorov-Smirnov test:
  - Non-parametric test
  - Compare a sample with a reference probability distribution or compare two samples
  - Quantifies a distance between the empirical distribution function of the sample and the cumulative distribution function of the reference distribution
  - Or between the empirical distribution functions of two samples
  - Null hypothesis (two-samples test): samples are drawn from the same distribution
  - Can be modified as a goodness of fit test
  - In our case: cumulative percentages of good, cumulative percentages of bad

106. What is: collaborative filtering, n-grams, cosine distance?

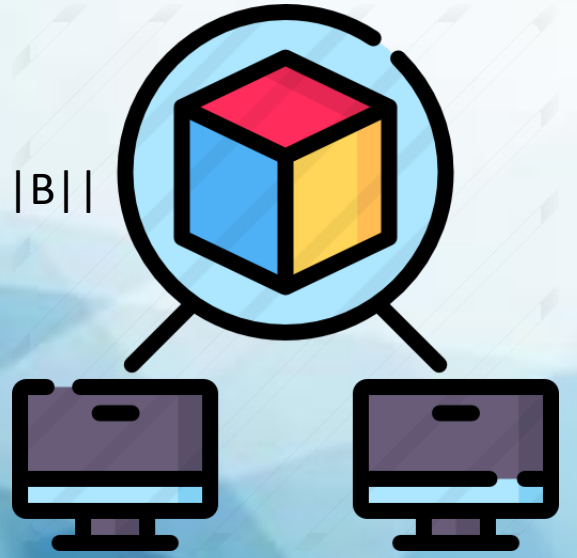
UpDegree

- **Collaborative filtering:**
  - Technique used by some recommender systems
  - Filtering for information or patterns using techniques involving collaboration of multiple agents: viewpoints, data sources.
  1. A user expresses his/her preferences by rating items (movies, CDs.)
  2. The system matches this user's ratings against other users' and finds people with most similar tastes
  3. With similar users, the system recommends items that the similar users have rated highly but not yet being rated by this user
- **n-grams:**
  - Contiguous sequence of n items from a given sequence of text or speech
  - "Andrew is a talented data scientist"
  - Bi-gram: "Andrew is", "is a", "a talented".
  - Tri-grams: "Andrew is a", "is a talented", "a talented data".
  - An n-gram model models sequences using statistical properties of n-grams; see: Shannon Game
  - More concisely, n-gram model: $P(Xi|Xi-(n-1)...Xi-1)P(Xi|Xi-(n-1)...Xi-1)$: Markov model
  - N-gram model: each word depends only on the $n-1n-1$ last words

- Issues:
  - when facing infrequent n-grams
  - solution: smooth the probability distributions by assigning non-zero probabilities to unseen words or n-grams
  - Methods: Good-Turing, Backoff, Kneser-Kney smoothing

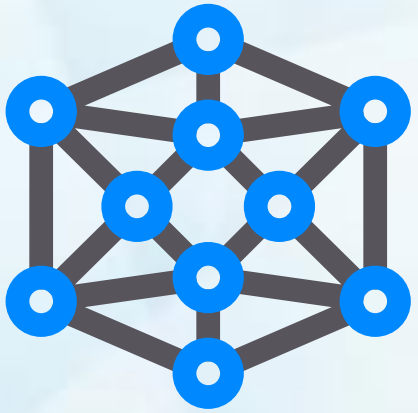
UpDegree

- **Cosine distance:**
  - How similar are two documents?
  - Perfect similarity/agreement: 1
  - No agreement : 0 (orthogonality)
  - Measures the orientation, not magnitude
- Given two vectors A and B representing word frequencies:
  cosine-similarity(A,B)=⟨A,B⟩||A||·||B||cosine-similarity(A,B)=⟨A,B⟩||A||·||B||



107. What is better: good data or good models? And how do you define “good”? Is there a universal good model? Are there any models that are definitely not so good?

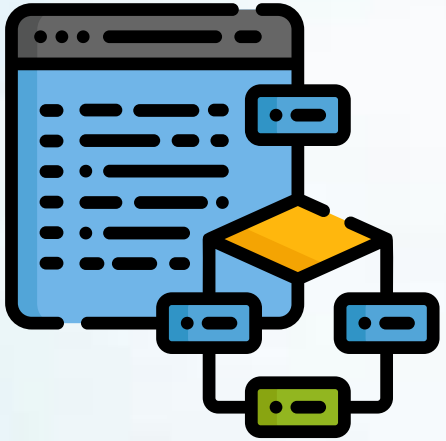
- Good data is definitely more important than good models
- If quality of the data wasn’t of importance, organizations wouldn’t spend so much time cleaning and pre-processing it!
- Even for scientific purpose: good data (reflected by the design of experiments) is very important
- **How do you define good?**
  - good data: data relevant regarding the project/task to be handled
  - good model: model relevant regarding the project/task
  - good model: a model that generalizes on external data sets



- **Is there a universal good model?**
  - No, otherwise there wouldn’t be the overfitting problem!
  - Algorithm can be universal but not the model
  - Model built on a specific data set in a specific organization could be ineffective in other data set of the same organization
  - Models have to be updated on a somewhat regular basis
- **Are there any models that are definitely not so good?**
  - “all models are wrong but some are useful” George E.P. Box
  - It depends on what you want: predictive models or explanatory power
  - If both are bad: bad model

UpDegree

108. Why is naive Bayes so bad? How would you improve a spam detection algorithm that uses naive Bayes?



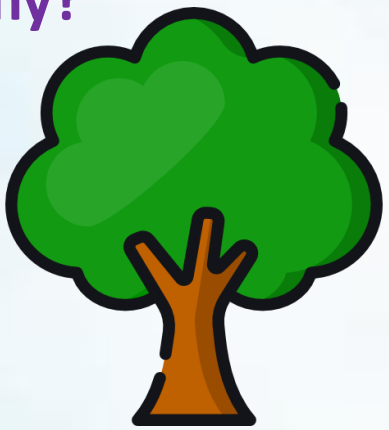
- Naïve: the features are assumed independent/uncorrelated
- Assumption not feasible in many cases
- Improvement: decorrelate features (covariance matrix into identity matrix)

109. What are the drawbacks of linear model? Are you familiar with alternatives (Lasso, ridge regression)?

- Assumption of linearity of the errors
- Can’t be used for count outcomes, binary outcomes
- Can’t vary model flexibility: overfitting problems
- Alternatives: see question 4 about regularization

UpDegree

110. Do you think 50 small decision trees are better than a large one? Why?



- Yes!
- More robust model (ensemble of weak learners that come and make a strong learner)
- Better to improve a model by taking many small steps than fewer large steps
- If one tree is erroneous, it can be auto-corrected by the following
- Less prone to overfitting

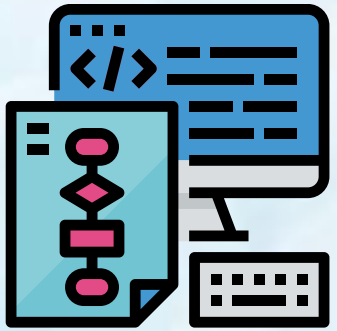
111. Why is mean square error a bad measure of model performance? What would you suggest instead?

- see question 3 about metrics in regression
- It puts too much emphasis on large deviations (squared)
- Alternative: mean absolute deviation

UpDegree

112. How can you prove that one improvement you've brought to an algorithm is really an improvement over not doing anything? Are you familiar with A/B testing?

- **Example with linear regression:**
  - F-statistic (ANOVA)
- $F=RSS1−RSS2p2−p1RSS2n−p2F=RSS1−RSS2p2−p1RSS2n−p2$
- p1p1: number of parameters of model 1
  p2p2: number of parameters of model 2
  nn: number of observations



- Under the null hypothesis that model 2 doesn't provide a significantly better fit than model 1, FF will have an FF distribution with $(p2−p1,n−p2)(p2−p1,n−p2)$degrees of freedom. The null hypothesis is rejected if the FF calculated from the data is greater than the critical value of the FF distribution for some desired significance level.
- Others: AIC/BIC (regression), cross-validation: assessing test error on a test/validation set

113. How would you create a taxonomy to identify key customer trends in unstructured data?

The best way to approach this question is to mention that it is good to check with the business owner and understand their objectives before categorizing the data. Having done this, it is always good to follow an iterative approach by pulling new data samples and improving the model accordingly by validating it for accuracy by soliciting feedback from the stakeholders of the business. This helps ensure that your model is producing actionable results and improving over the time.

114. Give some situations where you will use an SVM over a RandomForest Machine Learning algorithm and vice-versa.

SVM and Random Forest are both used in classification problems.

a) If you are sure that your data is outlier free and clean then go for SVM. It is the opposite - if your data might contain outliers then Random forest would be the best choice

b) Generally, SVM consumes more computational power than Random Forest, so if you are constrained with memory go for Random Forest machine learning algorithm.

c) Random Forest gives you a very good idea of variable importance in your data, so if you want to have variable importance then choose Random Forest machine learning algorithm.

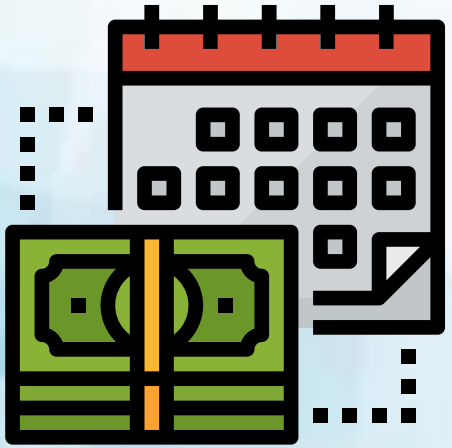
d) Random Forest machine learning algorithms are preferred for multiclass problems.

e) SVM is preferred in multi-dimensional problem set - like text classification

but as a good data scientist, you should experiment with both of them and test for accuracy or rather you can use ensemble of many Machine Learning techniques.

115. What are the advantages and disadvantages of using regularization methods like Ridge Regression?

UpDegree



Time Series Modelling

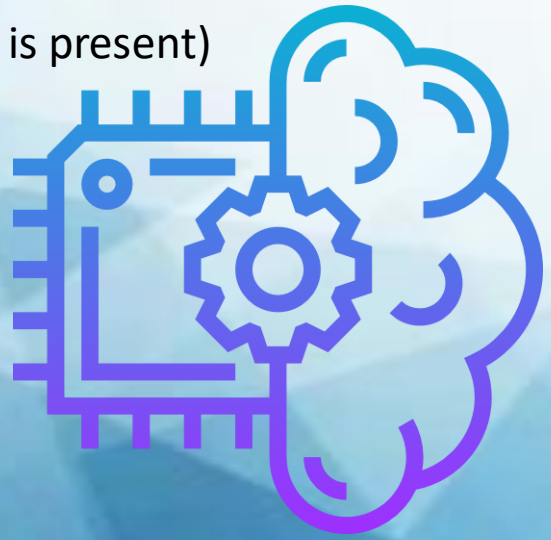
Time Series Modelling

UpDegree

116. 58) How can you deal with different types of seasonality in time series modelling?

Seasonality in time series occurs when time series shows a repeated pattern over time. E.g., stationary sales decreases during holiday season, air conditioner sales increases during the summers etc. are few examples of seasonality in a time series.

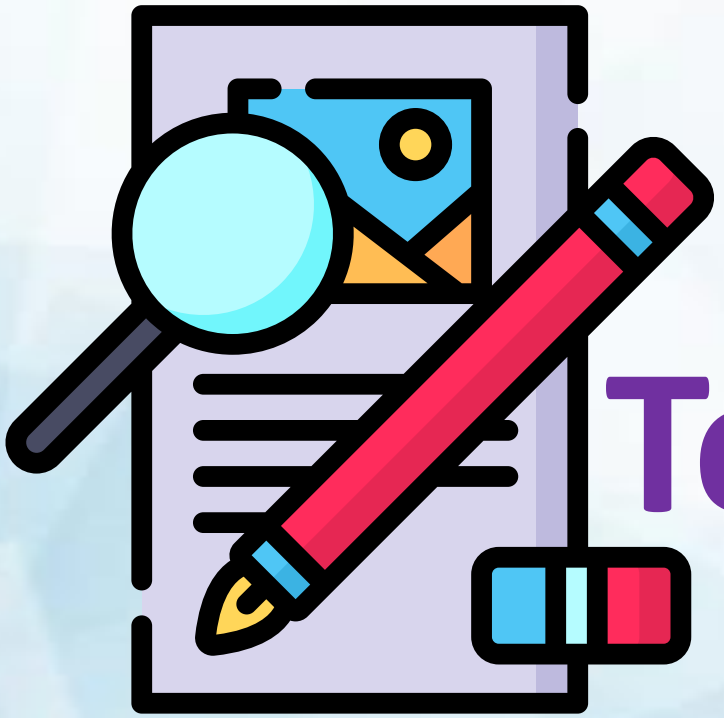
Seasonality makes your time series non-stationary because average value of the variables at different time periods. Differentiating a time series is generally known as the best method of removing seasonality from a time series. Seasonal differencing can be defined as a numerical difference between a particular value and a value with a periodic lag (i.e. 12, if monthly seasonality is present)



117. Can you use machine learning for time series analysis?

Yes, it can be used but it depends on the applications.

UpDegree



Text Analytics

Text Analytics

UpDegree

118. What does NLP stand for?

13. What does NLP stand for?

“Natural language processing”!

Interaction with human (natural) and computers languages

Involves natural language understanding

Major tasks:
- Machine translation
- Question answering: “what’s the capital of Canada?”
- Sentiment analysis: extract subjective information from a set of documents, identify trends or public opinions in the social media
- Information retrieval

119. Python or R – Which one would you prefer for text analytics?

The best possible answer for this would be Python because it has Pandas library that provides easy to use data structures and high performance data analysis tools.

UpDegree

Model Evaluation

Model Evaluation

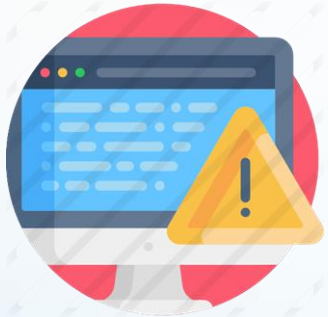
UpDegree

120. What do you think about the idea of injecting noise in your data set to test the sensitivity of your models?

- Effect would be similar to regularization: avoid overfitting
- Used to increase robustness

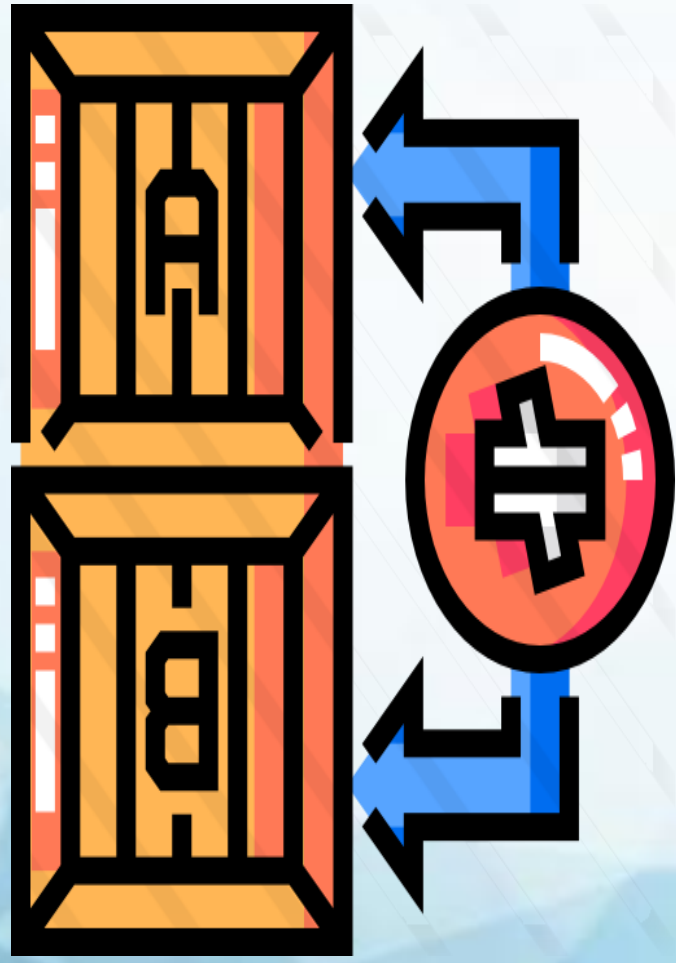
121. What is cross-validation? How to do it right?

- It’s a model validation technique for assessing how the results of a statistical analysis will generalize to an independent data set. Mainly used in settings where the goal is prediction and one wants to estimate how accurately a model will perform in practice. The goal of cross-validation is to define a data set to test the model in the training phase (i.e. validation data set) in order to limit problems like overfitting, and get an insight on how the model will generalize to an independent data set.
- Examples: leave-one-out cross validation, K-fold cross validation
- How to do it right?
- the training and validation data sets have to be drawn from the same population
- predicting stock prices: trained for a certain 5-year period, it’s unrealistic to treat the subsequent 5-year a draw from the same population



UpDegree

- common mistake: for instance the step of choosing the kernel parameters of a SVM should be cross-validated as well
- *Bias-variance trade-off for k-fold cross validation*:
- Leave-one-out cross-validation: gives approximately unbiased estimates of the test error since each training set contains almost the entire data set (n−1n−1 observations).
- But: we average the outputs of n fitted models, each of which is trained on an almost identical set of observations hence the outputs are highly correlated. Since the variance of a mean of quantities increases when correlation of these quantities increase, the test error estimate from a LOOCV has higher variance than the one obtained with k-fold cross validation
- Typically, we choose k=5k=5 or k=10k=10, as these values have been shown empirically to yield test error estimates that suffer neither from excessively high bias nor high variance.



UpDegree

122. How to define/select metrics?

- Type of task: regression? Classification?
- Business goal?

123. What is the distribution of the target variable?

124. What metric do we optimize for?

- Regression: RMSE (root mean squared error), MAE (mean absolute error), WMAE(weighted mean absolute error), RMSLE (root mean squared logarithmic error)…
- Classification: recall, AUC, accuracy, misclassification error, Cohen's Kappa…
- Common metrics in regression:
- Mean Squared Error Vs Mean Absolute Error RMSE gives a relatively high weight to large errors. The RMSE is most useful when large errors are particularly undesirable.

The MAE is a linear score: all the individual differences are weighted equally in the average. MAE is more robust to outliers than MSE.

RMSE=1n∑ni=1(yi−y^i)2−−−−−−−−−−−−−√RMSE=1n∑i=1n(yi−y^i)2

MAE=1n∑ni=1|yi−y^i|MAE=1n∑i=1n|yi−y^i|

- Root Mean Squared Logarithmic Error
  RMSLE penalizes an under-predicted estimate greater than an over-predicted estimate (opposite to RMSE)
  RMSLE=1n∑ni=1(log(pi+1)−log(ai+1))2−−−−−−−−−−−−−−−−−−−−−−−−√RMSLE=1n∑i=1n(log(pi+1)−log(ai+1))2
  Where pipi is the ith prediction, aiai the ith actual response, log(b)log(b) the natural logarithm of bb.
- Weighted Mean Absolute Error
  The weighted average of absolute errors. MAE and RMSE consider that each prediction provides equally precise information about the error variation, i.e. the standard variation of the error term is constant over all the predictions.
  Examples: recommender systems (differences between past and recent products)
  WMAE=1∑wi∑ni=1wi|yi−y^i|WMAE=1∑wi∑i=1nwi|yi−y^i|
- Common metrics in classification:
- Recall / Sensitivity / True positive rate:
  High when FN low. Sensitive to unbalanced classes.
  Sensitivity=TPTP+FNSensitivity=TPTP+FN

UpDegree

•Precision / Positive Predictive Value
High when FP low. Sensitive to unbalanced classes.
Precision=TPTP+FPPrecision=TPTP+FP
•Specificity / True Negative Rate
High when FP low. Sensitive to unbalanced classes.
Specificity=TNTN+FPSpecificity=TNTN+FP
•Accuracy
High when FP and FN are low. Sensitive to unbalanced classes (see "Accuracy paradox")
Accuracy=TP+TNTN+TP+FP+FNAccuracy=TP+TNTN+TP+FP+FN
•ROC / AUC
ROC is a graphical plot that illustrates the performance of a binary classifier (SensitivitySensitivity Vs 1−Specificity1−Specificity or SensitivitySensitivity Vs SpecificitySpecificity). They are not sensitive to unbalanced classes.
AUC is the area under the ROC curve. Perfect classifier: AUC=1, fall on (0,1); 100% sensitivity (no FN) and 100% specificity (no FP)

UpDegree

- Logarithmic loss

Punishes infinitely the deviation from the true value! It’s better to be somewhat wrong than emphatically wrong!

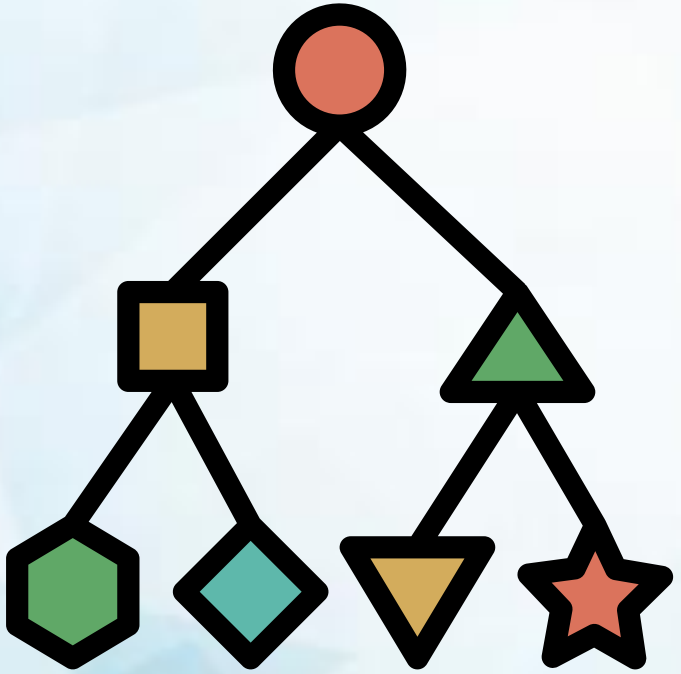
$$logloss=-1N\sum ni=1(yilog(pi)+(1-yi)log(1-pi))logloss=-1N\sum i=1n(yilog(pi)+(1-yi)log(1-pi))$$

- Misclassification Rate

$$Misclassification=1n\sum il(yi\neq y\hat{}i)Misclassification=1n\sum il(yi\neq y\hat{}i)$$

- F1-Score

Used when the target variable is unbalanced. $F1Score=2Precision\times RecallPrecision+RecallF1Score=2Precision\times RecallPrecision+Recall$



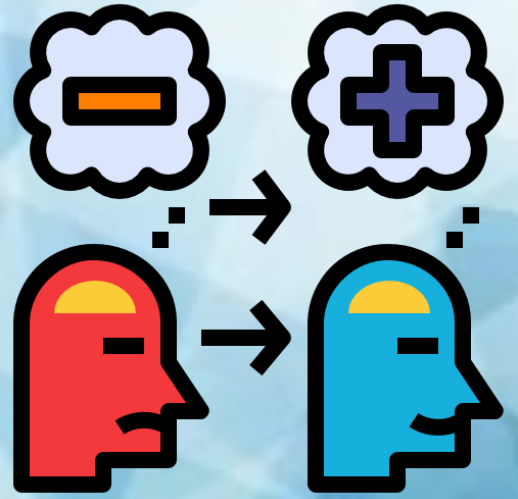
UpDegree

125. Can you explain the difference between a Test Set and a Validation Set?

- Validation set can be considered as a part of the training set as it is used for parameter selection and to avoid Overfitting of the model being built. On the other hand, test set is used for testing or evaluating the performance of a trained machine leaning model.
- In simple terms, the differences can be summarized as-
- Training Set is to fit the parameters i.e. weights.
- Test Set is to assess the performance of the model i.e. evaluating the predictive power and generalization.
- Validation set is to tune the parameters.

126. Explain what a false positive and a false negative are. Why is it important these from each other? Provide examples when false positives are more important than false negatives, false negatives are more important than false positives and when these two types of errors are equally important

- False positive
  Improperly reporting the presence of a condition when it's not in reality. Example: HIV positive test when the patient is actually HIV negative
- False negative
  Improperly reporting the absence of a condition when in reality it's the case. Example: not detecting a disease when the patient has this disease.
- When false positives are more important than false negatives:
  - In a non-contagious disease, where treatment delay doesn't have any long-term consequences but the treatment itself is grueling
  - HIV test: psychological impact
- When false negatives are more important than false positives:
  - If early treatment is important for good outcomes
  - In quality control: a defective item passes through the cracks!
  - Software testing: a test to catch a virus has failed



127. What do you understand by statistical power of sensitivity and how do you calculate it?

- Sensitivity is commonly used to validate the accuracy of a classifier (Logistic, SVM, RF etc.). Sensitivity is nothing but “Predicted TRUE events/ Total events”. True events here are the events which were true and model also predicted them as true.
- Calculation of seasonality is pretty straight forward-
- Seasonality = True Positives /Positives in Actual Dependent Variable
- Where, True positives are Positive events which are correctly classified as Positives.

128. You created a predictive model of a quantitative outcome variable using multiple regressions. What are the steps you would follow to validate the model?

- Since the question asked, is about post model building exercise, we will assume that you have already tested for null hypothesis, multi collinearity and Standard error of coefficients.
- Once you have built the model, you should check for following –
- Global F-test to see the significance of group of independent variables on dependent variable
- R^2
- Adjusted R^2
- RMSE, MAPE
- In addition to above mentioned quantitative metrics you should also check for-
- Residual plot
- Assumptions of linear regression

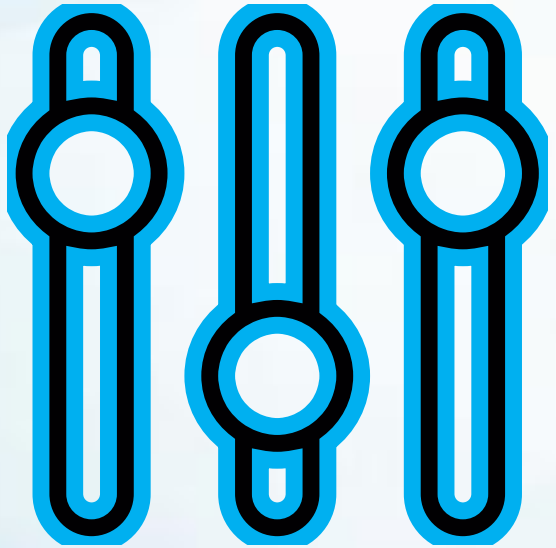
UpDegree

129. Explain what regularization is and why it is useful. What are the benefits and drawbacks of specific methods, such as ridge regression and lasso?

- Used to prevent overfitting: improve the generalization of a model
- Decreases complexity of a model
- Introducing a regularization term to a general loss function: adding a term to the minimization problem
- Impose Occam's Razor in the solution
- Ridge regression:
- We use an L2L2 penalty when fitting the model using least squares
- We add to the minimization problem an expression (shrinkage penalty) of the form λ×∑coefficientsλ×∑coefficients

UpDegree

- λλ: tuning parameter; controls the bias-variance tradeoff; accessed with cross-validation
- A bit faster than the lasso
  β^ridge=argminβ{∑ni=1(yi−β0−∑pj=1xijβj)2+λ∑pj=1β2j}β^ridge=argminβ{∑i=1n(yi−β0−∑j=1pxijβj)2+λ∑j=1pβj2}
- The Lasso:
- We use an L1L1 penalty when fitting the model using least squares
- Can force regression coefficients to be exactly: feature selection method by itself
  β^lasso=argminβ{∑ni=1(yi−β0−∑pj=1xijβj)2+λ∑pj=1||βj||}β^lasso=argminβ{∑i=1n(yi−β0−∑j=1pxijβj)2+λ∑j=1p||βj||}

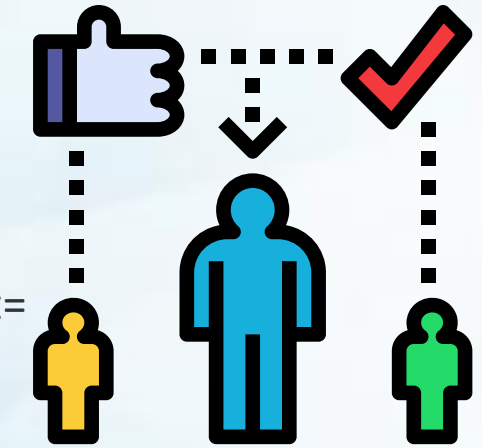


UpDegree

130. Explain what a local optimum is and why it is important in a specific context, such as K-means clustering. What are specific ways of determining if you have a local optimum problem? What can be done to avoid local optima?

- A solution that is optimal in within a neighboring set of candidate solutions
- In contrast with global optimum: the optimal solution among all others
- K-means clustering context:
  It's proven that the objective cost function will always decrease until a local optimum is reached.
  Results will depend on the initial random cluster assignment
- Determining if you have a local optimum problem:
  Tendency of premature convergence
  Different initialization induces different optima
- Avoid local optima in a K-means context: repeat K-means and take the solution that has the lowest cost

131. Assume you need to generate a predictive model using multiple regression. Explain how you intend to validate this model



- Validation using R2R2:
  - % of variance retained by the model
  - Issue: R2R2 is always increased when adding variables
  - R2=RSStot−RSSresRSStot=RSSregRSStot=1−RSSresRSStotR2=RSStot−RSSresRSStot=

    RSSregRSStot=1−RSSresRSStot
- Analysis of residuals:
  - Heteroskedasticity (relation between the variance of the model errors and the size of an independent variable's observations)
  - Scatter plots residuals Vs predictors
  - Normality of errors
  - Etc. : diagnostic plots
- Out-of-sample evaluation: with cross-validation

132. Explain what precision and recall are. How do they relate to the ROC curve?

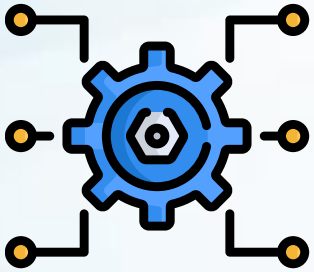
- See question 3. “How to define/select metrics? Do you know compound metrics?”. When using Precision/Recall curves.

133. What is latent semantic indexing? What is it used for? What are the specific limitations of the method?

- Indexing and retrieval method that uses singular value decomposition to identify patterns in the relationships between the terms and concepts contained in an unstructured collection of text
- Based on the principle that words that are used in the same contexts tend to have similar meanings
- “Latent”: semantic associations between words is present not explicitly but only latently
- For example: two synonyms may never occur in the same passage but should nonetheless have highly associated representations
- Used for:
- Learning correct word meanings
- Subject matter comprehension
- Information retrieval
- Sentiment analysis (social network analysis) Here’s a great tutorial on it.

134. Is it beneficial to perform dimensionality reduction before fitting an SVM? Why or why not?

- When the number of features is large comparing to the number of observations (e.g. document-term matrix)
- SVM will perform better in this reduced space



135. What is an Artificial Neural Network? What is back propagation?

136. What is curse of dimensionality? How does it affect distance and similarity measures?

- Refers to various phenomena that arise when analyzing and organizing data in high dimensional spaces
- Common theme: when number of dimensions increases, the volume of the space increases so fast that the available data becomes sparse
- Issue with any method that requires statistical significance: the amount of data needed to support the result grows exponentially with the dimensionality
- Issue when algorithms don’t scale well on high dimensions typically when O(nkn)O(nkn)
- Everything becomes far and difficult to organize

UpDegree

- **Illustrative example**: compare the proportion of an inscribed hypersphere with radius rr and dimension d to that of a hypercube with edges of length 2r2r
  - Volume of such a sphere is Vsphere=2rdπd/2dΓ(d/2)Vsphere=2rdπd/2dΓ(d/2)
  - The volume of the cube is: Vcube=2rdVcube=2rd
  As d increases (space dimension), the volume of hypersphere becomes insignificant relative to the volume of the hypercube:

- limd→∞VsphereVcube=πd/2d2d−1Γ(d/2)=0limd→∞VsphereVcube=πd/2d2d−1Γ(d/2)=0
-
  - Nearly all of the dimensional space is far away from the center
  - It consists almost entirely of the corners of the hypercube, with no middle!

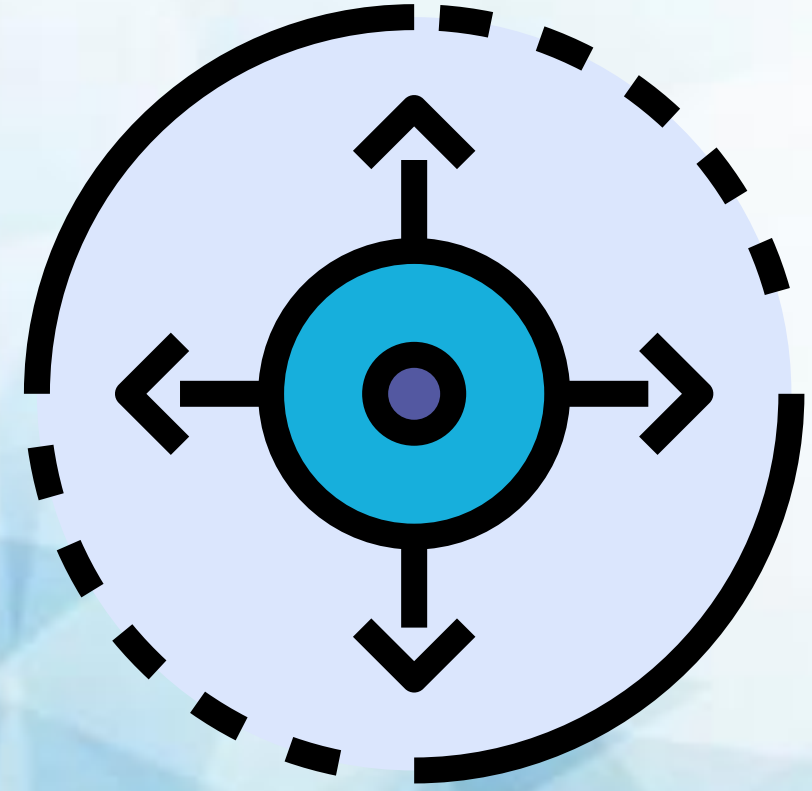
UpDegree

137. What is $Ax=bAx=b$? How to solve it?

- A matrix equation/a system of linear equations
- calculate the inverse of AA (if non singular)
- can be done using Gaussian elimination

138. How do we multiply matrices?

- $A \in Rn \times mA \in Rn \times m$ and $B \in Rm \times pB \in Rm \times p$
- Each entry: $ABij = \sum mk = 1AikBkjABij = \sum k = 1mAikBkj$



UpDegree

139. Is it better to design robust or accurate algorithms?

The ultimate goal is to design systems with good generalization capacity, that is, systems that correctly identify patterns in data instances not seen before.

The generalization performance of a learning system strongly depends on the complexity of the model assumed

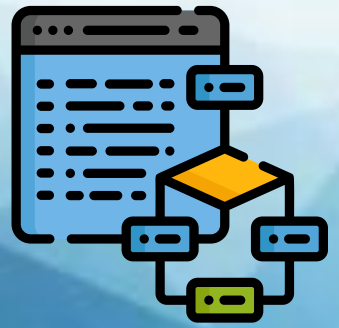
If the model is too simple, the system can only capture the actual data regularities in a rough manner. In this case, the system has poor generalization properties and is said to suffer from underfitting

By contrast, when the model is too complex, the system can identify accidental patterns in the training data that need not be present in the test set. These spurious patterns can be the result of random fluctuations or of measurement errors during the data collection process. In this case, the generalization capacity of the learning system is also poor. The learning system is said to be affected by overfitting

Spurious patterns, which are only present by accident in the data, tend to have complex forms. This is the idea behind the principle of Occam's razor for avoiding overfitting: simpler models are preferred if more complex models do not significantly improve the quality of the description for the observations

Quick response: Occam's Razor. It depends on the learning task. Choose the right balance

Ensemble learning can help balancing bias/variance (several weak learners together = strong learner)



UpDegree

140. What do you understand by Recall and Precision?

141. How can you overcome Overfitting?

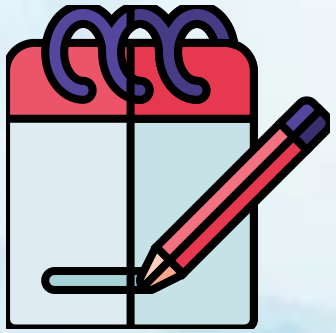
142. Is it better to have too many false negatives or too many false positives?

143. What is the goal of A/B Testing?

It is a statistical hypothesis testing for randomized experiment with two variables A and B. The goal of A/B Testing is to identify any changes to the web page to maximize or increase the outcome of an interest. An example for this could be identifying the click through rate for a banner ad.

144. A test has a true positive rate of 100% and false positive rate of 5%. There is a population with a 1/1000 rate of having the condition the test identifies. Considering a positive test, what is the probability of having that condition?

- Let's suppose you are being tested for a disease, if you have the illness the test will end up saying you have the illness. However, if you don't have the illness- 5% of the times the test will end up saying you have the illness and 95% of the times the test will give accurate result that you don't have the illness. Thus there is a 5% error in case you do not have the illness.
- Out of 1000 people, 1 person who has the disease will get true positive result.
- Out of the remaining 999 people, 5% will also get true positive result.
- Close to 50 people will get a true positive result for the disease.



- This means that out of 1000 people, 51 people will be tested positive for the disease even though only one person has the illness. There is only a 2% probability of you having the disease even if your reports say that you have the disease.

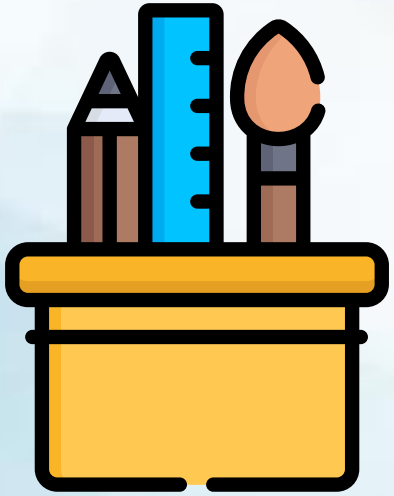
145. Why L1 regularizations causes parameter sparsity whereas L2 regularization does not?

Regularizations in statistics or in the field of machine learning is used to include some extra information in order to solve a problem in a better way. L1 & L2 regularizations are generally used to add constraints to optimization problems.

In the example shown above H_0 is a hypothesis. If you observe, in L_1 there is a high likelihood to hit the corners as solutions while in L_2, it doesn't. So in L_1 variables are penalized more as compared to L2 which results into sparsity.

- In other words, errors are squared in L_2, so model sees higher error and tries to minimize that squared error.

UpDegree



Use Case

UpDegree

146. What are Recommender Systems?

- A subclass of information filtering systems that are meant to predict the preferences or ratings that a user would give to a product. Recommender systems are widely used in movies, news, research articles, products, social tags, music, etc.

147. What is Collaborative filtering?

- The process of filtering used by most of the recommender systems to find patterns or information by collaborating viewpoints, various data sources and multiple agents.

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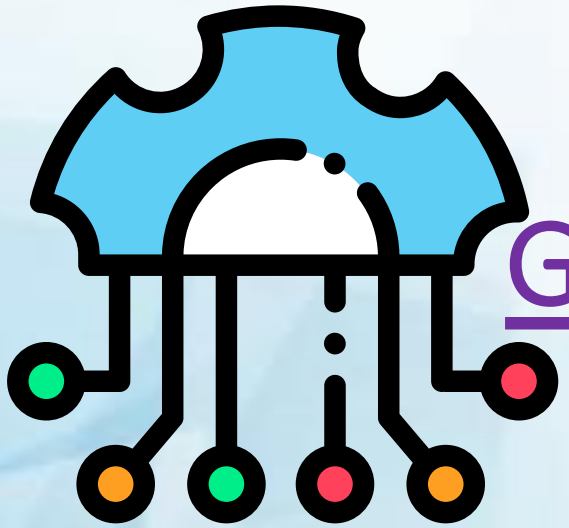


Generic Machine Learning Question

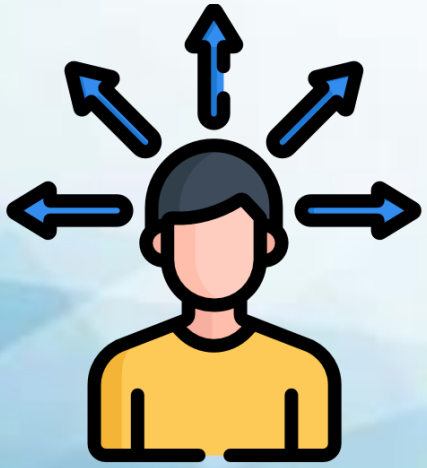
Generic Machine Learning Question

UpDegree

148. Is it better to spend 5 days developing a 90% accurate solution, or 10 days for 100% accuracy? Depends on the context?

- “premature optimization is the root of all evils”
- At the beginning: quick-and-dirty model is better
- Optimization later
- Other answer:
  - Depends on the context
  - Is error acceptable? Fraud detection, quality assurance

149. How to detect individual paid accounts shared by multiple users?



- Check geographical region: Friday morning a log in from Paris and Friday evening a log in from Tokyo
- Bandwidth consumption: if a user goes over some high limit
- Counter of live sessions: if they have 100 sessions per day (4 times per hour) that seems more than one person can do

150. How frequently an algorithm must be updated?

- You want to update an algorithm when:
  - You want the model to evolve as data streams through infrastructure
  - The underlying data source is changing
  - Example: a retail store model that remains accurate as the business grows
  - Dealing with non-stationarity
- Some options:
  - Incremental algorithms: the model is updated every time it sees a new training example

  Note: simple, you always have an up-to-date model but you can't incorporate data to different degrees.

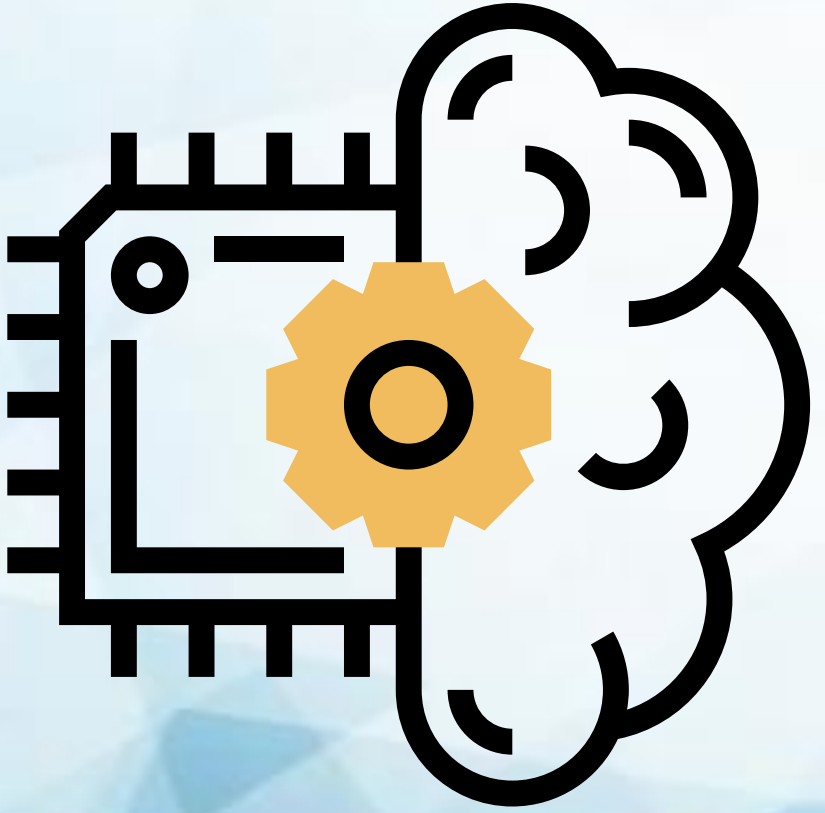
  Sometimes mandatory: when data must be discarded once seen (privacy)
  - Periodic re-training in "batch" mode: simply buffer the relevant data and update the model every-so-often

  Note: more decisions and more complex implementations
- How frequently?
  - Is the sacrifice worth it?
  - Data horizon: how quickly do you need the most recent training example to be part of your model?
  - Data obsolescence: how long does it take before data is irrelevant to the model? Are some older instances more relevant than the newer ones?

  Economics: generally, newer instances are more relevant than older ones. However, data from the same month, quarter or year of the last year can be more relevant than the same periods of the current year. In a recession period: data from previous recessions can be more relevant than newer data from different economic cycles.

UpDegree

151. What is Machine Learning?



The simplest way to answer this question is – we give the data and equation to the machine. Ask the machine to look at the data and identify the coefficient values in an equation.
For example for the linear regression y=mx+c, we give the data for the variable x, y and the machine learns about the values of m and c from the data.

152. What are various steps involved in an analytics project?

UpDegree

- Understand the business problem
- Explore the data and become familiar with it.
- Prepare the data for modelling by detecting outliers, treating missing values, transforming variables, etc.
- After data preparation, start running the model, analyse the result and tweak the approach. This is an iterative step till the best possible outcome is achieved.
- Validate the model using a new data set.
- Start implementing the model and track the result to analyse the performance of the model over the period of time.
- 7. What is the life cycle of a data science project ?
- Data acquisition
  Acquiring data from both internal and external sources, including social media or web scraping. In a steady state, data extraction and routines should be in place, and new sources, once identified would be acquired following the established processes
- Data preparation
  Also called data wrangling: cleaning the data and shaping it into a suitable form for later analyses. Involves exploratory data analysis and feature extraction.
- Hypothesis & modelling
  Like in data mining but not with samples, with all the data instead. Applying machine learning techniques to all the data. A key sub-step: model selection. This involves preparing a training set for model candidates, and validation and test sets for comparing model performances, selecting the best performing model, gauging model accuracy and preventing overfitting

- Evaluation & interpretation
- Steps 2 to 4 are repeated a number of times as needed; as the understanding of data and business becomes clearer and results from initial models and hypotheses are evaluated, further tweaks are performed. These may sometimes include step5 and be performed in a pre-production.
- Deployment
- Operations
  Regular maintenance and operations. Includes performance tests to measure model performance, and can alert when performance goes beyond a certain acceptable threshold
- Optimization
  Can be triggered by failing performance, or due to the need to add new data sources and retraining the model or even to deploy new versions of an improved model

- Note: with increasing maturity and well-defined project goals, pre-defined performance can help evaluate feasibility of the data science project early enough in the data-science life cycle. This early comparison helps the team refine hypothesis, discard the project if non-viable, change approaches.

153. How would you develop a model to identify plagiarism?

154. Which is your favourite machine learning algorithm and why?

155. In which libraries for Data Science in Python and R, does your strength lie?

UpDegree

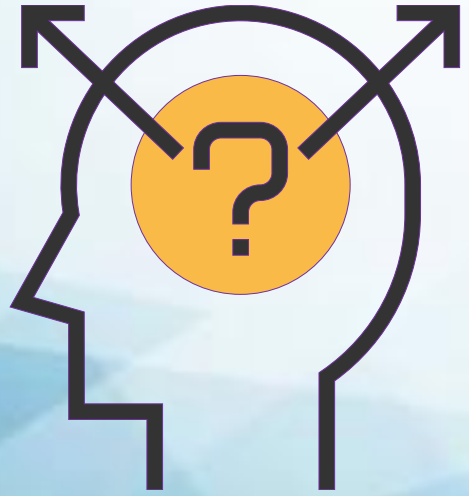
156. What kind of data is important for specific business requirements and how, as a data scientist will you go about collecting that data?
157. Tell us about the biggest data set you have processed till date and for what kind of analysis.
158. Which data scientists you admire the most and why?

159. Suppose you are given a data set, what will you do with it to find out if it suits the business needs of your project or not.
160. What were the business outcomes or decisions for the projects you worked on?
161. What unique skills you think can you add on to our data science team?
162. Which are your favorite data science startups?

163. Why do you want to pursue a career in data science?
164. What have you done to upgrade your skills in analytics?
165. What has been the most useful business insight or development you have found?

166. How will you explain an A/B test to an engineer who does not know statistics?
167. When does parallelism helps your algorithms run faster and when does it make them run slower?

168. How can you ensure that you don’t analyse something that ends up producing meaningless results?
169. How would you explain to the senior management in your organization as to why a particular data set is important?

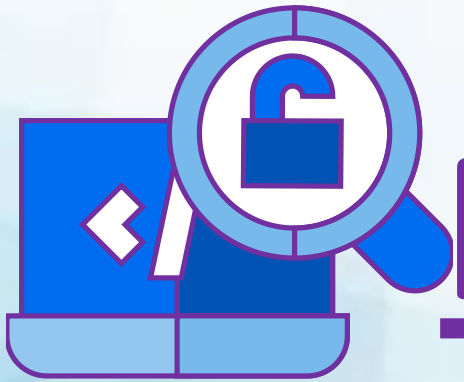


170. Is more data always better?
171. What are your favourite imputation techniques to handle missing data?
172. What are your favorite data visualization tools?

173. Explain the life cycle of a data science project.
174. How can you ensure that you don’t analyse something that ends up producing meaningless results?

- Understanding whether the model chosen is correct or not.Start understanding from the point where you did Univariate or Bivariate analysis, analysed the distribution of data and correlation of variables and built the linear model.Linear regression has an inherent requirement that the data and the errors in the data should be normally distributed. If they are not then we cannot use linear regression. This is an inductive approach to find out if the analysis using linear regression will yield meaningless results or not.
- Another way is to train and test data sets by sampling them multiple times. Predict on all those datasets to find out whether or not the resultant models are similar and are performing well.
- By looking at the p-value, by looking at r square values, by looking at the fit of the function and analysing as to how the treatment of missing value could have affected- data scientists can analyse if something will produce meaningless results or not.

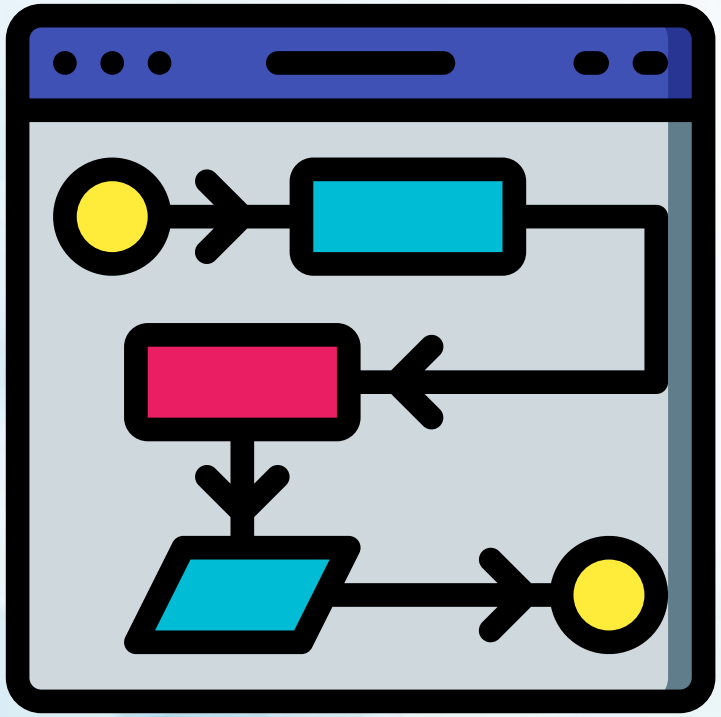
UpDegree



Programming basics

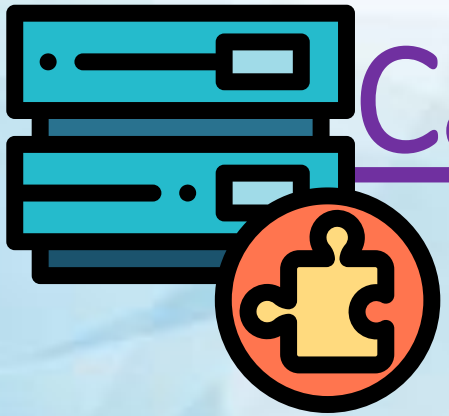
175. 30) How can you iterate over a list and also retrieve element indices at the same time?

This can be done using the enumerate function which takes every element in a sequence just like in a list and adds its location just before it.



176. 74) Write a program in Python which takes input as the diameter of a coin and weight of the coin and produces output as the money value of the coin.

UpDegree



Case Study Based Ques/Puzzle

Case Study Based Ques/Puzzle

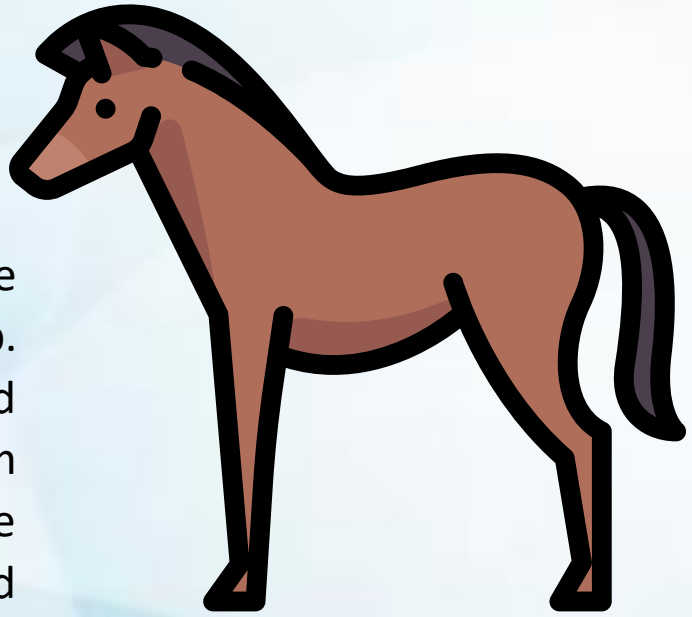
UpDegree

177. How many Pianos are there in Chicago?
178. How often would a Piano require tuning?
179. How much time does it take for each tuning?

- We need to build these estimates to solve this kind of a problem. Suppose, let's assume Chicago has close to 10 million people and on an average there are 2 people in a house. For every 20 households there is 1 Piano. Now the question how many pianos are there can be answered. 1 in 20 households has a piano, so approximately 250,000 pianos are there in Chicago.
- Now the next question is-"How often would a Piano require tuning? There is no exact answer to this question. It could be once a year or twice a year. You need to approach this question as the interviewer is trying to test your knowledge on whether you take this into consideration or not. Let's suppose each piano requires tuning once a year so on the whole 250,000 piano tunings are required.
- Let's suppose that a piano tuner works for 50 weeks in a year considering a 5 day week. Thus a piano tuner works for 250 days in a year. Let's suppose tuning a piano takes 2 hours then in an 8 hour workday the piano tuner would be able to tune only 4 pianos. Considering this rate, a piano tuner can tune 1000 pianos a year.
- Thus, 250 piano tuners are required in Chicago considering the above estimates.

UpDegree

180. There is a race track with five lanes. There are 25 horses of which you want to find out the three fastest horses. What is the minimal number of races needed to identify the 3 fastest horses of those 25?



- Divide the 25 horses into 5 groups where each group contains 5 horses. Race between all the 5 groups (5 races) will determine the winners of each group. A race between all the winners will determine the winner of the winners and must be the fastest horse. A final race between the 2nd and 3rd place from the winners group along with the 1st and 2nd place of thee second place group along with the third place horse will determine the second and third fastest horse from the group of 25.

181. Estimate the number of french fries sold by McDonald's everyday.
182. How many times in a day does a clock’s hand overlap?
183. You have two beakers. The first beaker contains 4 litre of water and the second one contains 5 litres of water.How can you our exactly 7 litres of water into a bucket?
184. A coin is flipped 1000 times and 560 times heads show up. Do you think the coin is biased?
185. Estimate the number of tennis balls that can fit into a plane.
186. How many haircuts do you think happen in US every year?
187. In a city where residents prefer only boys, every family in the city continues to give birth to children until a boy is born. If a girl is born, they plan for another child. If a boy is born, they stop. Find out the proportion of boys to girls in the city.

UpDegree

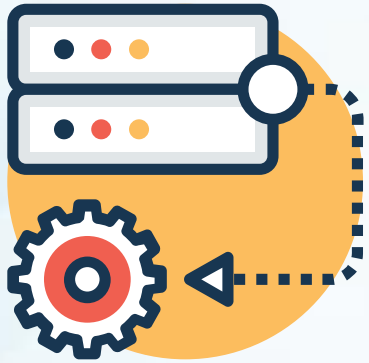
Big Data

188. What is your definition of big data?

- Big data is high volume, high velocity and/or high variety information assets that require new forms of processing
  - Volume: big data doesn't sample, just observes and tracks what happens
  - Velocity: big data is often available in real-time
  - Variety: big data comes from texts, images, audio, video…
- Difference big data/business intelligence:
  - Business intelligence uses descriptive statistics with data with high density information to measure things, detect trends etc.
  - Big data uses inductive statistics (statistical inference) and concepts from non-linear system identification to infer laws (regression, classification, clustering) from large data sets with low density information to reveal relationships and dependencies or to perform prediction of outcomes or behaviors

189. Explain the difference between “long” and “wide” format data. Why would you use one or the other?

- Long: one column containing the values and another column listing the context of the value Fam_id year fam_inc
- Wide: each different variable in a separate column
  Fam_id fam_inc96 fam_inc97 fam_inc98
- Long Vs Wide:
  - Data manipulations are much easier when data is in the wide format: summarize, filter
  - Program requirements



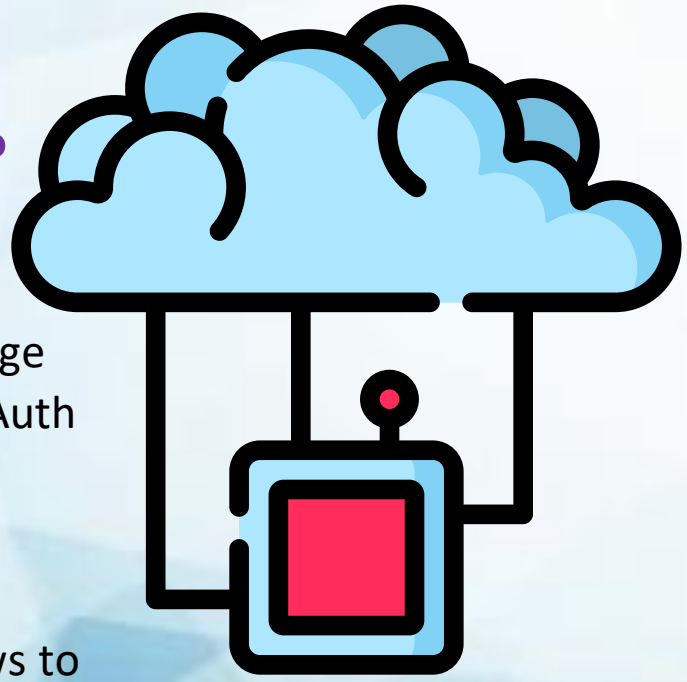
190. Do you know a few “rules of thumb” used in statistical or computer science? Or in business analytics?

- *Pareto rule:*
  - 80% of the effects come from 20% of the causes
  - 80% of the sales come from 20% of the customers
- *Computer science:* “simple and inexpensive beats complicated and expensive” - Rod Elder
- *Finance, rule of 72:*
  - Estimate the time needed for a money investment to double
  - 100$ at a rate of 9%: 72/9=8 years
- *Rule of three (Economics):*
  - There are always three major competitors in a free market within one industry

UpDegree

191. What is POC (proof of concept)?

- A realization of a certain method to demonstrate its feasibility
- In engineering: a rough prototype of a new idea is often constructed as a proof of concept

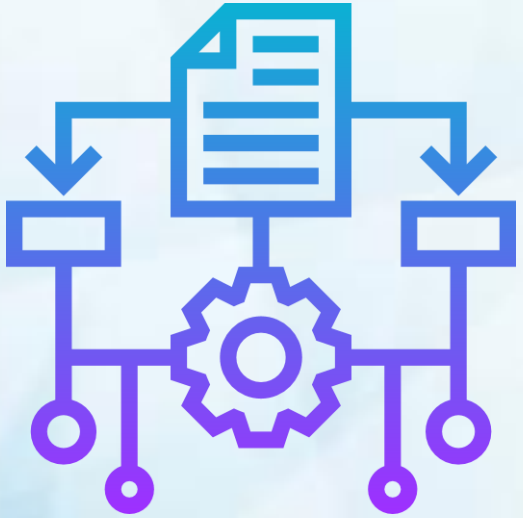


192. How to efficiently scrape web data, or collect tons of tweets?

- Python example
- Requesting and fetching the webpage into the code: httplib2 module
- Parsing the content and getting the necessary info: BeautifulSoup from bs4 package
- Twitter API: the Python wrapper for performing API requests. It handles all the OAuth and API queries in a single Python interface
- MongoDB as the database
- PyMongo: the Python wrapper for interacting with the MongoDB database
- Cronjobs: a time based scheduler in order to run scripts at specific intervals; allows to bypass the “rate limit exceed” error

UpDegree

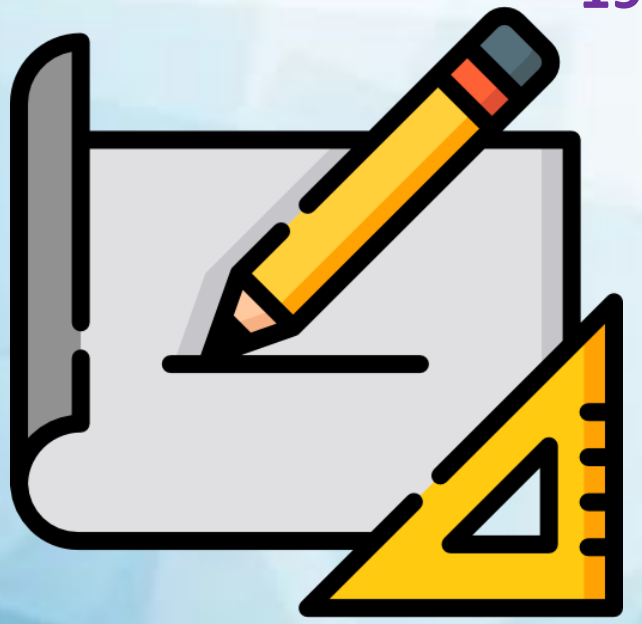
193. How to optimize algorithms? (parallel processing and/or faster algorithms). Provide examples for both



- "Premature optimization is the root of all evil"; Donald Knuth
- Parallel processing: for instance in R with a single machine.
  - doParallel and foreach package
  - doParallel: parallel backend, will select n-cores of the machine
  - for each: assign tasks for each core
  - using Hadoop on a single node
  - using Hadoop on multi-node
- Faster algorithm:
  - In computer science: Pareto principle; 90% of the execution time is spent executing 10% of the code
  - Data structure: affect performance
  - Caching: avoid unnecessary work
  - Improve source code level

  For instance: on early C compilers, WHILE(something) was slower than FOR(;;), because WHILE evaluated "something" and then had a conditional jump which tested if it was true while FOR had unconditional jump.

UpDegree



194. Examples of NoSQL architecture

- Key-value: in a key-value NoSQL database, all of the data within consists of an indexed key and a value. Cassandra, DynamoDB
- Column-based: designed for storing data tables as sections of columns of data rather than as rows of data. HBase, SAP HANA
- Document Database: map a key to some document that contains structured information. The key is used to retrieve the document. MongoDB, CouchDB
- Graph Database: designed for data whose relations are well-represented as a graph and has elements which are interconnected, with an undetermined number of relations between them. Polyglot Neo4J

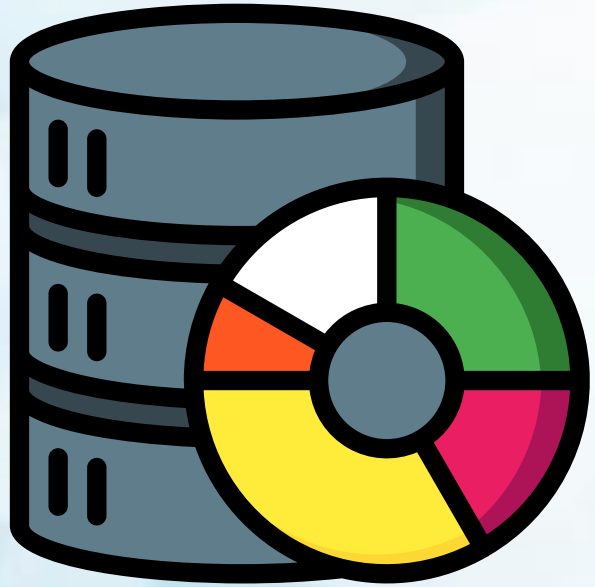
195. Provide examples of machine-to-machine communications

- Telemedicine
  - Heart patients wear specialized monitor which gather information regarding heart state
  - The collected data is sent to an electronic implanted device which sends back electric shocks to the patient for correcting incorrect rhythms
- Product restocking
  - Vending machines are capable of messaging the distributor whenever an item is running out of stock

196. Compare R and Python

- *R*
  - Focuses on better, user friendly data analysis, statistics and graphical models
  - The closer you are to statistics, data science and research, the more you might prefer R
  - Statistical models can be written with only a few lines in R
  - The same piece of functionality can be written in several ways in R
  - Mainly used for standalone computing or analysis on individual servers
  - Large number of packages, for anything!
- *Python*
  - Used by programmers that want to delve into data science
  - The closer you are working in an engineering environment, the more you might prefer Python
  - Coding and debugging is easier mainly because of the nice syntax
  - Any piece of functionality is always written the same way in Python
  - When data analysis needs to be implemented with web apps
  - Good tool to implement algorithms for production use

197. Is it better to have 100 small hash tables or one big hash table, in memory, in terms of access speed (assuming both fit within RAM)? What do you think about in-database analytics?



- *Hash tables:*
  - Average case O(1)O(1) lookup time
  - Lookup time doesn't depend on size
- Even in terms of memory:
  - O(n)O(n) memory
  - Space scales linearly with number of elements
  - Lots of dictionaries won't take up significantly less space than a larger one
- *In-database analytics:*
  - Integration of data analytics in data warehousing functionality
  - Much faster and corporate information is more secure, it doesn't leave the enterprise data warehouse

  Good for real-time analytics: fraud detection, credit scoring, transaction processing, pricing and margin analysis, behavioral ad targeting and recommendation engines

UpDegree

198. What is star schema? Lookup tables?

- The star schema is a traditional database schema with a central (fact) table (the “observations”, with database “keys” for joining with satellite tables, and with several fields encoded as ID’s). Satellite tables map ID’s to physical name or description and can be “joined” to the central fact table using the ID fields; these tables are known as lookup tables, and are particularly useful in real-time applications, as they save a lot of memory. Sometimes star schemas involve multiple layers of summarization (summary tables, from granular to less granular) to retrieve information faster.
- *Lookup tables:*
  - Array that replace runtime computations with a simpler array indexing operation

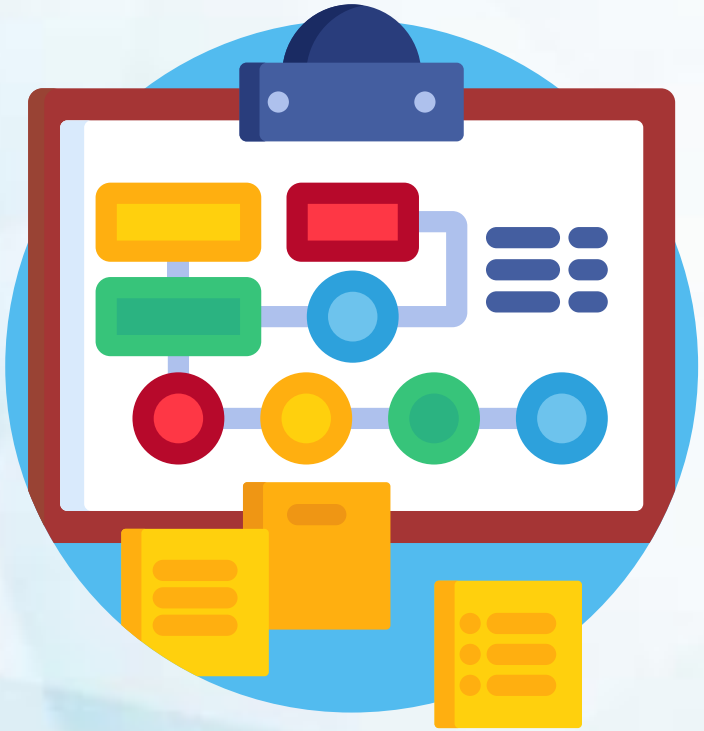
UpDegree

Quality

199. What is: lift, KPI, robustness, model fitting, design of experiments, 80/20 rule?

- *Lift:*
  It's measure of performance of a targeting model (or a rule) at predicting or classifying cases as having an enhanced response (with respect to the population as a whole), measured against a random choice targeting model. Lift is simply: target response/average response.
- Suppose a population has an average response rate of 5% (mailing for instance). A certain model (or rule) has identified a segment with a response rate of 20%, then lift=20/5=4
- Typically, the modeler seeks to divide the population into quantiles, and rank the quantiles by lift. He can then consider each quantile, and by weighing the predicted response rate against the cost, he can decide to market that quantile or not.
  "if we use the probability scores on customers, we can get 60% of the total responders we'd get mailing randomly by only mailing the top 30% of the scored customers".
- *KPI:*
  - Key performance indicator
  - A type of performance measurement
  - Examples: 0 defects, 10/10 customer satisfaction
  - Relies upon a good understanding of what is important to the organization
- More examples:

- Marketing & Sales:
  - New customers acquisition
  - Customer attrition
  - Revenue (turnover) generated by segments of the customer population
  - Often done with a data management platform
- IT operations:
  - Mean time between failure
  - Mean time to repair
- *Robustness:*
  - Statistics with good performance even if the underlying distribution is not normal
  - Statistics that are not affected by outliers
  - A learning algorithm that can reduce the chance of fitting noise is called robust
  - Median is a robust measure of central tendency, while mean is not
  - Median absolute deviation is also more robust than the standard deviation
- *Model fitting:*
  - How well a statistical model fits a set of observations
  - Examples: AIC, R2R2, Kolmogorov-Smirnov test, Chi 2, deviance (glm)



- *Design of experiments:*

  The design of any task that aims to describe or explain the variation of information under conditions that are hypothesized to reflect the variation.

  In its simplest form, an experiment aims at predicting the outcome by changing the

- preconditions, the predictors.
  - Selection of the suitable predictors and outcomes
  - Delivery of the experiment under statistically optimal conditions
  - Randomization
  - Blocking: an experiment may be conducted with the same equipment to avoid any unwanted variations in the input
  - Replication: performing the same combination run more than once, in order to get an estimate for the amount of random error that could be part of the process
  - Interaction: when an experiment has 3 or more variables, the situation in which the interaction of two variables on a third is not additive
- *80/20 rule:*
  - Pareto principle
  - 80% of the effects come from 20% of the causes
  - 80% of your sales come from 20% of your clients
  - 80% of a company complaints come from 20% of its customers

200. Define: quality assurance, six sigma.

- *Quality assurance:*
  - A way of preventing mistakes or defects in manufacturing products or when delivering services to customers
  - In a machine learning context: anomaly detection
- *Six sigma:*
  - Set of techniques and tools for process improvement
  - 99.99966% of products are defect-free products (3.4 per 1 million)
  - 6 standard deviation from the process mean

201. Give examples of data that does not have a Gaussian distribution, nor log-normal.

- Allocation of wealth among individuals
- Values of oil reserves among oil fields (many small ones, a small number of large ones)

202. What is root cause analysis? How to identify a cause vs. a correlation? Give examples

- *Root cause analysis:*
  - Method of problem solving used for identifying the root causes or faults of a problem
  - A factor is considered a root cause if removal of it prevents the final undesirable event from recurring
- *Identify a cause vs. a correlation:*
  - Correlation: statistical measure that describes the size and direction of a relationship between two or more variables. A correlation between two variables doesn't imply that the change in one variable is the cause of the change in the values of the other variable
  - Causation: indicates that one event is the result of the occurrence of the other event; there is a causal relationship between the two events

- Differences between the two types of relationships are easy to identify, but establishing a cause and effect is difficult

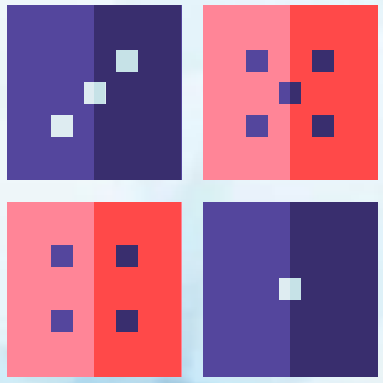
- Example: sleeping with one's shoes on is strongly correlated with waking up with a headache. Correlation-implies-causation fallacy: therefore, sleeping with one's shoes causes headache.
  More plausible explanation: both are caused by a third factor: going to bed drunk.
- Identify a cause Vs a correlation: use of a controlled study
  - In medical research, one group may receive a placebo (control) while the other receives a treatment If the two groups have noticeably different outcomes, the different experiences may have caused the different outcomes

203. Give an example where the median is a better measure than the mean

When data is skewed

204. Given two fair dices, what is the probability of getting scores that sum to 4? to 8?

- Total: 36 combinations
- Of these, 3 involve a score of 4: (1,3), (3,1), (2,2)
- So: 336=112336=112
- Considering a score of 8: (2,6), (3,5), (4,4), (6,2), (5,3)
- So: 536536



205. What is the Law of Large Numbers?

- A theorem that describes the result of performing the same experiment a large number of times
- Forms the basis of frequency-style thinking
- It says that the sample mean, the sample variance and the sample standard deviation converge to what they are trying to estimate
- Example: roll a dice, expected value is 3.5. For a large number of experiments, the average converges to 3.5

206. How do you calculate needed sample size?

- *Estimate a population mean:*
  - General formula is ME=t×SnVME=t×Sn or ME=z×snVME=z×sn
  - MEME is the desired margin of error
  - tt is the t score or z score that we need to use to calculate our confidence interval
  - ss is the standard deviation
- Example: we would like to start a study to estimate the average internet usage of households in one week for our business plan. How many households must we randomly select to be 95% sure that the sample mean is within 1minute from the true mean of the population? A previous survey of household usage has shown a standard deviation of 6.95 minutes.
- Z score corresponding to a 95% interval: 1.96 (97.5%, α2=0.025α2=0.025)
- s=6.95s=6.95
- n=(z×sME)2=(1.96×6.95)2=13.622=186n=(z×sME)2=(1.96×6.95)2=13.622=186
- *Estimate a proportion:*
  - Similar: ME=z×p(1−p)n−−−−−VME=z×p(1−p)n
- Example: a professor in Harvard wants to determine the proportion of students who support gay marriage. She asks "how large a sample do I need?"
  She wants a margin of error of less than 2.5%, she has found a previous survey which indicates a proportion of 30%.
  n=0.3×0.70.0252n=0.3×0.70.0252

UpDegree

Other

Other

UpDegree

207. What is a kernel? Explain the kernel trick
208. Which kernels do you know? How to choose a kernel?
209. Differentiate between wide and tall data formats?

210. What is the difference between Bayesian Inference and Maximum Likelihood Estimation (MLE)?
211. What is Regularization and what kind of problems does regularization solve?

212. Explain the use of Combinatorics in data science.
213. Explain about the box cox transformation in regression models.

214. Why is vectorization considered a powerful method for optimizing numerical code?

215. What do you understand by Fuzzy merging ? Which language will you use to handle it?
216. What is the difference between skewed and uniform distribution?

217. What do you understand by conjugate-prior with respect to Naïve Bayes?
218. What makes a dataset gold standard?

219. What is the importance of having a selection bias?
220. What do you understand by feature vectors?

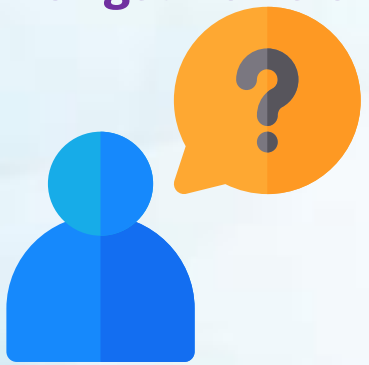
221. What do you understand by long and wide data formats?
222. Given a dataset, show me how Euclidean Distance works in three dimensions.

223. Explain what a local optimum is and why it is important in a specific context, such as K-means clustering. What are specific ways of determining if you have a local optimum problem? What can be done to avoid local optima?

224. What is latent semantic indexing? What is it used for? What are the specific limitations of the method?
225. Explain what resampling methods are and why they are useful

226. What is principal component analysis? Explain the sort of problems you would use PCA for. Also explain its limitations as a method

227. How do you take millions of users with 100's transactions each, amongst 10k's of products and group the users together in meaningful segments?



228. How do you know if one algorithm is better than other?
229. How do you test whether a new credit risk scoring model works?
230. What is: collaborative filtering, n-grams, cosine distance?
231. What is better: good data or good models? And how do you define "good"? Is there a universal good model? Are there any models that are definitely not so good?

232. Why is naive Bayes so bad? How would you improve a spam detection algorithm that uses naive Bayes?
233. What are the drawbacks of linear model? Are you familiar with alternatives (Lasso, ridge regression, boosted trees)?
234. Do you think 50 small decision trees are better than a large one? Why?

235. Why is mean square error a bad measure of model performance? What would you suggest instead?

236. How can you prove that one improvement you've brought to an algorithm is really an improvement over not doing anything? Are you familiar with A/B testing?

237. What do you think about the idea of injecting noise in your data set to test the sensitivity of your models?

238. Do you know / used data reduction techniques other than PCA? What do you think of step-wise regression? What kind of step-wise techniques are you familiar with?

239. How would you define and measure the predictive power of a metric?

240. Do we always need the intercept term in a regression model?

241. What are the assumptions required for linear regression? What if some of these assumptions are violated?

242. What is collinearity and what to do with it? How to remove multicollinearity?

243. How to check if the regression model fits the data well?

244. What is a decision tree?
245. What impurity measures do you know?
246. What is random forest? Why is it good?
247. How do we train a logistic regression model? How do we interpret its coefficients?
248. What is the maximal margin classifier? How this margin can be achieved and why is it beneficial? How do we train SVM?

249. What is a kernel? Explain the kernel trick
250. Which kernels do you know? How to choose a kernel?
251. Is it beneficial to perform dimensionality reduction before fitting an SVM? Why or why not?
252. (What is an Artificial Neural Network?) What is back propagation?

253. What is curse of dimensionality? How does it affect distance and similarity measures?

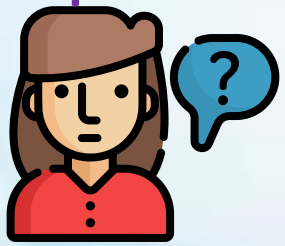
254. What is Ax=b? How to solve it?
255. How do we multiply matrices?
256. What is singular value decomposition? What is an eigenvalue? And what is an eigenvector?

257. What's the relationship between PCA and SVD?
258. Can you derive the ordinary least square regression formula?
259. What is the difference between a convex function and non-convex?

260. What is gradient descent method? Will gradient descent methods always converge to the same point?
261. How do you assess the statistical significance of an insight?

262. Explain what a long-tailed distribution is and provide three examples of relevant phenomena that have long tails. Why are they important in classification and regression problems?

263. What is the Central Limit Theorem? Explain it. Why is it important?



264. What is statistical power?
265. Explain selection bias (with regard to a dataset, not variable selection). Why is it important? How can data management procedures such as missing data handling make it worse?

266. Provide a simple example of how an experimental design can help answer a question about behavior. How does experimental data contrast with observational data?

267. Is mean imputation of missing data acceptable practice? Why or why not?

268. What is an outlier? Explain how you might screen for outliers and what would you do if you found them in your dataset. Also, explain what an inlier is and how you might screen for them and what would you do if you found them in your dataset

269. Explain likely differences between administrative datasets and datasets gathered from experimental studies. What are likely problems encountered with administrative data? How do experimental methods help alleviate these problems? What problem do they bring?

270. You are compiling a report for user content uploaded every month and notice a spike in uploads in October. In particular, a spike in picture uploads. What might you think is the cause of this, and how would you test it?

271. You're about to get on a plane to Seattle. You want to know if you should bring an umbrella. You call 3 random friends of yours who live there and ask each independently if it's raining. Each of your friends has a 2/3 chance of telling you the truth and a 1/3 chance of messing with you by lying. All 3 friends tell you that "Yes" it is raining. What is the probability that it's actually raining in Seattle?

UpDegree

272. There’s one box - has 12 black and 12 red cards, 2nd box has 24 black and 24 red; if you want to draw 2 cards at random from one of the 2 boxes, which box has the higher probability of getting the same color? Can you tell intuitively why the 2nd box has a higher probability

273. What is: lift, KPI, robustness, model fitting, design of experiments, 80/20 rule?

274. Define: quality assurance, six sigma.
275. Give examples of data that does not have a Gaussian distribution, nor log-normal.
276. What is root cause analysis? How to identify a cause vs. a correlation? Give examples
277. Give an example where the median is a better measure than the mean
278. What is the difference between squared error and absolute error?
279. Given two fair dices, what is the probability of getting scores that sum to 4? to 8?
280. What is the Law of Large Numbers?
281. How do you calculate needed sample size?
282. When you sample, what bias are you inflicting?

283. How do you control for biases?
284. What are confounding variables?
285. What is A/B testing?

286. An HIV test has a sensitivity of 99.7% and a specificity of 98.5%. A subject from a population of prevalence 0.1% receives a positive test result. What is the precision of the test (i.e the probability he is HIV positive)?

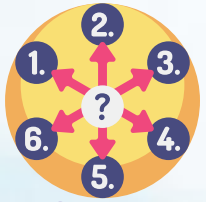
287. Infection rates at a hospital above a 1 infection per 100 person days at risk are considered high. An hospital had 10 infections over the last 1787 person days at risk. Give the p-value of the correct one-sided test of whether the hospital is below the standard
288. You roll a biased coin (p(head)=0.8) five times. What's the probability of getting three or more heads?

289. A random variable X is normal with mean 1020 and standard deviation 50. Calculate P(X>1200)
290. Consider the number of people that show up at a bus station is Poisson with mean 2.5/h. What is the probability that at most three people show up in a four hour period?

291. You are running for office and your pollster polled hundred people. Sixty of them claimed they will vote for you. Can you relax?

292. Geiger counter records 100 radioactive decays in 5 minutes. Find an approximate 95% interval for the number of decays per hour.

293. The homicide rate in Scotland fell last year to 99 from 115 the year before. Is this reported change really networthy?



294. Consider influenza epidemics for two parent heterosexual families. Suppose that the probability is 17% that at least one of the parents has contracted the disease. The probability that the father has contracted influenza is 12% while the probability that both the mother and father have contracted the disease is 6%. What is the probability that the mother has contracted influenza?

295. Suppose that diastolic blood pressures (DBPs) for men aged 35-44 are normally distributed with a mean of 80 (mm Hg) and a standard deviation of 10. About what is the probability that a random 35-44 year old has a DBP less than 70?

296. In a population of interest, a sample of 9 men yielded a sample average brain volume of 1,100cc and a standard deviation of 30cc. What is a 95% Student's T confidence interval for the mean brain volume in this new population?

297. A diet pill is given to 9 subjects over six weeks. The average difference in weight (follow up - baseline) is -2 pounds. What would the standard deviation of the difference in weight have to be for the upper endpoint of the 95% T confidence interval to touch 0?

298. In a study of emergency room waiting times, investigators consider a new and the standard triage systems. To test the systems, administrators selected 20 nights and randomly assigned the new triage system to be used on 10 nights and the standard system on the remaining 10 nights. They calculated the nightly median waiting time (MWT) to see a physician. The average MWT for the new system was 3 hours with a variance of 0.60 while the average MWT for the old system was 5 hours with a variance of 0.68. Consider the 95% confidence interval estimate for the differences of the mean MWT associated with the new system. Assume a constant variance. What is the interval? Subtract in this order (New System - Old System).

299. To further test the hospital triage system, administrators selected 200 nights and randomly assigned a new triage system to be used on 100 nights and a standard system on the remaining 100 nights. They calculated the nightly median waiting time (MWT) to see a physician. The average MWT for the new system was 4 hours with a standard deviation of 0.5 hours while the average MWT for the old system was 6 hours with a standard deviation of 2 hours. Consider the hypothesis of a decrease in the mean MWT associated with the new treatment. What does the 95% independent group confidence interval with unequal variances suggest vis a vis this hypothesis? (Because there's so many observations per group, just use the Z quantile instead of the T.)

300. Process & Miscellaneous

301. How to optimize algorithms? (parallel processing and/or faster algorithms). Provide examples for both
302. Examples of NoSQL architecture
303. Provide examples of machine-to-machine communications
304. Compare R and Python

305. Is it better to have 100 small hash tables or one big hash table, in memory, in terms of access speed (assuming both fit within RAM)? What do you think about in-database analytics?

306. What is star schema? Lookup tables?
307. What is the life cycle of a data science project ?

308. How to efficiently scrape web data, or collect tons of tweets?
309. How to clean data?
310. How frequently an algorithm must be updated?
311. What is POC (proof of concept)?
312. Explain Tufte's concept of "chart junk"
313. How would you come up with a solution to identify plagiarism?

314. How to detect individual paid accounts shared by multiple users?
315. Is it better to spend 5 days developing a 90% accurate solution, or 10 days for 100% accuracy? Depends on the context?
316. What is your definition of big data?
317. Explain the difference between “long” and “wide” format data. Why would you use one or the other?
318. Do you know a few “rules of thumb” used in statistical or computer science? Or in business analytics?
319. Name a few famous API’s (for instance GoogleSearch)
320. Give examples of bad and good visualizations

321. What is singular value decomposition? What is an eigenvalue? And what is an eigenvector?
322. What’s the relationship between PCA and SVD?

323. What is the difference between a convex function and non-convex?
324. What is gradient descent method? Will gradient descent methods always converge to the same point?