**1)**

a) Puzzle A:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Expected hash ( E ) | Frequency ( F ) | ( E x F ) | Mean - E | ((Mean - E)^2)\*F |
| 1 | 0 | 0 | -17 | 0 |
| 2 | 0 | 0 | -16 | 0 |
| 3 | 0 | 0 | -15 | 0 |
| 4 | 1 | 4 | -14 | 196 |
| 5 | 4 | 20 | -13 | 676 |
| 6 | 10 | 60 | -12 | 1440 |
| 7 | 20 | 140 | -11 | 2420 |
| 8 | 35 | 280 | -10 | 3500 |
| 9 | 56 | 504 | -9 | 4536 |
| 10 | 84 | 840 | -8 | 5376 |
| 11 | 120 | 1320 | -7 | 5880 |
| 12 | 161 | 1932 | -6 | 5796 |
| 13 | 204 | 2652 | -5 | 5100 |
| 14 | 246 | 3444 | -4 | 3936 |
| 15 | 284 | 4260 | -3 | 2556 |
| 16 | 315 | 5040 | -2 | 1260 |
| 17 | 336 | 5712 | -1 | 336 |
| 18 | 344 | 6192 | 0 | 0 |
| 19 | 336 | 6384 | 1 | 336 |
| 20 | 315 | 6300 | 2 | 1260 |
| 21 | 284 | 5964 | 3 | 2556 |
| 22 | 246 | 5412 | 4 | 3936 |
| 23 | 204 | 4692 | 5 | 5100 |
| 24 | 161 | 3864 | 6 | 5796 |
| 25 | 120 | 3000 | 7 | 5880 |
| 26 | 84 | 2184 | 8 | 5376 |
| 27 | 56 | 1512 | 9 | 4536 |
| 28 | 35 | 980 | 10 | 3500 |
| 29 | 20 | 580 | 11 | 2420 |
| 30 | 10 | 300 | 12 | 1440 |
| 31 | 4 | 124 | 13 | 676 |
| 32 | 1 | 32 | 14 | 196 |
|  | 4096 |  | -18 | 86016 |

Puzzle B:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Expected hash ( E ) | Frequency ( F ) | ( E x F ) | Mean - E | ((Mean - E)^2)\*F |
| 1 | 0 | 0 | -17 | 0 |
| 2 | 0 | 0 | -16 | 0 |
| 3 | 0 | 0 | -15 | 0 |
| 4 | 1 | 4 | -14 | 196 |
| 5 | 4 | 20 | -13 | 676 |
| 6 | 10 | 60 | -12 | 1440 |
| 7 | 20 | 140 | -11 | 2420 |
| 8 | 35 | 280 | -10 | 3500 |
| 9 | 56 | 504 | -9 | 4536 |
| 10 | 84 | 840 | -8 | 5376 |
| 11 | 120 | 1320 | -7 | 5880 |
| 12 | 161 | 1932 | -6 | 5796 |
| 13 | 204 | 2652 | -5 | 5100 |
| 14 | 246 | 3444 | -4 | 3936 |
| 15 | 284 | 4260 | -3 | 2556 |
| 16 | 315 | 5040 | -2 | 1260 |
| 17 | 336 | 5712 | -1 | 336 |
| 18 | 344 | 6192 | 0 | 0 |
| 19 | 336 | 6384 | 1 | 336 |
| 20 | 315 | 6300 | 2 | 1260 |
| 21 | 284 | 5964 | 3 | 2556 |
| 22 | 246 | 5412 | 4 | 3936 |
| 23 | 204 | 4692 | 5 | 5100 |
| 24 | 161 | 3864 | 6 | 5796 |
| 25 | 120 | 3000 | 7 | 5880 |
| 26 | 84 | 2184 | 8 | 5376 |
| 27 | 56 | 1512 | 9 | 4536 |
| 28 | 35 | 980 | 10 | 3500 |
| 29 | 20 | 580 | 11 | 2420 |
| 30 | 10 | 300 | 12 | 1440 |
| 31 | 4 | 124 | 13 | 676 |
| 32 | 1 | 32 | 14 | 196 |
|  | 4096 |  | -18 | 86016 |

b) Puzzle A: I made use of the Microsoft Excel’s in-built formulas and functions to calculate the distributions. For puzzle A, there is only one sub-puzzle, hence frequency is 1. And since puzzle A has only 1 sub-puzzle with k = 5, the worst case expected hashes with k = 5 is 32. Thus, each hash will only appear once, which explains the even distribution of one sub-puzzle.

Puzzle B: I wrote a python code, making us of the combinations library to calculate the possible combinations. For puzzle B, there are four sub-puzzles, hence to avoid confusion, I calculated based on one sub-puzzle first then multiplying by 4. For instance, 1 sub-puzzle with k = 3, the worst case expected hashes with k = 3 is 8. Thus, with 4 sub-puzzles, the worst case expected hashes is 32. To get the distribution, I used the itertools.product library from python to check and loop through from hash value 1 to 32, check that if the sum of the 4 hash value in the sub puzzle matches the expected hash, it would count+=1 and I would repeat and display the total possible combinations.

c)

Puzzle A:

Puzzle B:

d) Puzzle A: The average number of hashes required is 16.5 Since Puzzle A is 1 sub puzzle with k = 5, 1 x 2^5= 32, which is the worst case expected hashes. Mean is as calculated.

Puzzle B: The average number of hashes required is 18. Since Puzzle B has 4 sub-puzzles with k = 3, we calculate the worst case expected hashes of 1 sub puzzle first which is 4.5. 4.5x4 sub-puzzles which is 18 in total.

e) Puzzle A: The standard deviation for the distribution of hashes required is 9.233093.   
Puzzle B: The standard deviation for the distribution of hashes required is 4.58258.

**2)** The original code given reflects that if the user is not granted access before the function is called/action is being performed. This breaks “default deny rule” whereby we should enforce positive validation rather than negative. As such, the following pseudocode should be applied as follows:

permit = CheckAccess()  
IF (permit == Access\_Granted)  
 Print “Access Granted”  
 Run Function ()

ELSE

Print "Access Denied"

**3)**

Table

Description automatically generated with medium confidence

**There is 80.6% chance of the message being clean.**

**4)** There has been a rise in bribing employees to install malware from malicious conspirator(s). An example of such case would employees from A&T. Many were bribed by Muhammad Fahd, to install malware – in this case, a keylogger on AT&T’s network at the bothell call center. The malware collected data such as the how the infrastructure worked as well as functioning of the internal protected computers and applications. This happened over a span of a few years, namely from 2012 to September of 2017.

A keylogger, often defined as a software, which is programmed to secretly monitor and log all keystrokes. This means that all information typed into a website or application is recorded, and sent back to a third party, which leverages on algorithms via techniques such as pattern recognition.

The attackers, improved on their malware and created a second malware strain that leveraged on the information acquire. By using AT&T employee credentials. The malware could perform automated actions on AT&T's internal application to unlock phone's without needing to interact with AT&T employees every time. Rogue wireless access points inside AT&T's Bothell call center were also installed, gaining access to AT&T internal apps and network to continue the rogue phone unlocking scheme. The motive behind plotting the attack, and to recuperate loss, was selling phone unlocking services through the now-defunct SwiftUnlocks.com website.

As a result, phones do not need to be “locked” in AT&T subscription. Roughly 2 million of smartphones were unlocked, accounting to more than $200million lost in terms of subscription fees, as phones could be used on another carrier’s network. Muhammad Fahd was arrested in Hong Kong in 2018 and extradited to the US in August 2019. He pleaded guilty in September 2020 and was sentenced 12 years in prison for the 7 years fraud.

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The Melissa virus, also known as W97M\_Melissa, was the first widely destructive, self-propagating, network-paralyzing, e-mail-borne macro virus and one of the first to get public attention as it was the first macro-virus with e-mail worm traits. A macro virus refers to computer viruses that uses an application’s own programming language to reproduce themselves. In this case, the Melissa virus made use of Outlook and targeted to affect users of Microsoft’s Word 97 or Word 2000. It was created by a computer programmer named David L. Smith, named after an exotic dancer in Florida. The macro virus acted as an infected word document, sent as an e-mail attachment, and started spreading on March 26, 1999.

The document was said to contain dozens of free passwords to fee-based websites with adult content and simpsons reference, targeted to get the victim’s attention. Once the document was opened by a user, it would disable certain features of the software, then replicating itself by sending copies of the infected document to the top 50 contacts of the victim. If any of the first 50 addresses in Outlook’s address book was a mailing list, then everyone on that list also receives a copy of the virus. In addition, if the user had more than one address book, the first 50addresses in each book are used.

It exploited and implicated for companies that carried the large volumes of emails being created, and the people using the computers, since it was an email from contacts. It was a double-edge sword, as it signified potential data breaches and many vulnerabilities, which served as a reminder and inspiration for further tighten security and enhancements online for further cyber-attacks. If addresses in an electronic mail address book are within the same organization, Melissa can quickly overload electronic mail servers and result in a denial of service.

Although the code was not created with the intention of stealing valuable information nor stealing money, it did cause a lot of damage. According to David, it was meant as a harmless joke. It infected over 3000 corporations and government agencies, thousands of computers worldwide in 1999, flooded corporate networks with e-mail messages, forcing some companies such as Intel Corp. and Microsoft Corp., to shut down their e-mail systems. Almost a million emails were affected by the virus, causing huge internet traffic, resulting in slow internet. The speed was worrying, as it managed to spread to 100,000 computers in less than a week.

Even though the virus was contained quickly, in a span of few days, a damage of more than $80 million USD was caused. David L. Smith was initially sentenced to 10 years of prison, but after cooperation with the FBI, it was reduced to 20 months in prison and fined $5,000. He was also ordered not be involved with computer networks, the internet or internet bulletin boards unless authorized by the court.

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**5)**

a) Given the statement that when t=0, the number of infected computers is 1, when t=1 it will affect another computer which means x = 2. Each infected computer can spread to 1 uninfected computer, thus when x = 3, 4 of the infected computers will spread to 1 uninfected computer each, which results at x = 8. And this pattern continues till the 24th hour mark. I make use of the formula of 2^t which will give me the total.

|  |  |  |
| --- | --- | --- |
|  | **t** | **X** |
| **0** | 0 | 1 |
| **1** | 0.5 | 2 |
| **2** | 1.0 | 4 |
| **3** | 1.5 | 8 |
| **4** | 2.0 | 16 |
| **5** | 2.5 | 32 |
| **6** | 3.0 | 64 |
| **7** | 3.5 | 128 |
| **8** | 4.0 | 256 |
| **9** | 4.5 | 512 |
| **10** | 5.0 | 1024 |
| **11** | 5.5 | 2048 |
| **12** | 6.0 | 4096 |
| **13** | 6.5 | 8192 |
| **14** | 7.0 | 16384 |
| **15** | 7.5 | 32768 |
| **16** | 8.0 | 65536 |
| **17** | 8.5 | 131072 |
| **18** | 9.0 | 262144 |
| **19** | 9.5 | 524288 |
| **20** | 10.0 | 1048576 |
| **21** | 10.5 | 2097152 |
| **22** | 11.0 | 4194304 |
| **23** | 11.5 | 8388608 |
| **24** | 12.0 | 16777216 |

b) Given the statement that the counterworm spreads to 2 infected computers at each 0.5 mark, whereas X infects at every whole hour mark. At 6.5 hour, x is 63 and w is 1 because counterworm just started. When 7.0, X is 2 multiply by 63 which turns to 126, and at 7.5 hour It turns out to be 124 because W is 3 now, whereby we need to minus off the recovered computer and this happens every hour.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **t** | **X** | **W** |
| **0** | 0 | 1 | 0 |
| **1** | 0.5 | 1 | 0 |
| **2** | 1.0 | 2 | 0 |
| **3** | 1.5 | 2 | 0 |
| **4** | 2.0 | 4 | 0 |
| **5** | 2.5 | 4 | 0 |
| **6** | 3.0 | 8 | 0 |
| **7** | 3.5 | 8 | 0 |
| **8** | 4.0 | 16 | 0 |
| **9** | 4.5 | 16 | 0 |
| **10** | 5.0 | 32 | 0 |
| **11** | 5.5 | 32 | 0 |
| **12** | 6.0 | 64 | 0 |
| **13** | 6.5 | 63 | 1 |
| **14** | 7.0 | 126 | 1 |
| **15** | 7.5 | 124 | 3 |
| **16** | 8.0 | 248 | 3 |
| **17** | 8.5 | 242 | 9 |
| **18** | 9.0 | 484 | 9 |
| **19** | 9.5 | 466 | 27 |
| **20** | 10.0 | 932 | 27 |
| **21** | 10.5 | 878 | 81 |
| **22** | 11.0 | 1756 | 81 |
| **23** | 11.5 | 1594 | 243 |
| **24** | 12.0 | 3188 | 243 |
| **25** | 12.5 | 2702 | 729 |
| **26** | 13.0 | 5404 | 729 |
| **27** | 13.5 | 3946 | 2187 |
| **28** | 14.0 | 7892 | 2187 |
| **29** | 14.5 | 3518 | 6561 |
| **30** | 15.0 | 7036 | 6561 |
| **31** | 15.5 | 0 | 13597 |
| **32** | 16.0 | 0 | 13597 |
| **33** | 16.5 | 0 | 13597 |
| **34** | 17.0 | 0 | 13597 |
| **35** | 17.5 | 0 | 13597 |
| **36** | 18.0 | 0 | 13597 |
| **37** | 18.5 | 0 | 13597 |
| **38** | 19.0 | 0 | 13597 |
| **39** | 19.5 | 0 | 13597 |
| **40** | 20.0 | 0 | 13597 |
| **41** | 20.5 | 0 | 13597 |
| **42** | 21.0 | 0 | 13597 |
| **43** | 21.5 | 0 | 13597 |
| **44** | 22.0 | 0 | 13597 |
| **45** | 22.5 | 0 | 13597 |
| **46** | 23.0 | 0 | 13597 |
| **47** | 23.5 | 0 | 13597 |
| **48** | 24.0 | 0 | 13597 |

c)

d) When t = 9, X has infected 484 computers and W has only infected 9 computers. Assuming the time if t = 9 and X evolves to spread to three uninfected computers, X will continue to manifest and there will be no stopping. To add on, as X has infected 484 computers, it will manifest at a much faster and steeper rate than W.

**6)**

a) An XML Bomb, also referred commonly as a billion laughs attack, is a denial-of-service (DoS) attack in malware. DoS attack prevents or hinders the use of the system. XML bomb encompasses a message or a piece of dangerous code, intended to crash the server or program (typically HTTP server) which tries to read and decode it by overloading it, which can result in the shutting down of a server or ISP.

b) A Bluesmack refers to a cyber-attack targeted on Bluetooth enabled devices. It is a denial-of-service (DoS) attack in malware. An oversized packet is sent to the Bluetooth enabled devices by the attacker, by usage of tools such as L2CAP (Logic Link Control And Adaptation Protocol) layer. The attack overwhelms the device via malicious requests, making it inaccessible to the owner and drains the battery life, and affects the operations of the device.

c) Mydoom is a type of computer worm done that affects the Microsoft Windows Operating System and is a denial-of-service (DoS) attack in malware. The attack works when a user opens the attachment, and the worm starts to scrap email addresses of the infected window computers and spread to victim's contacts by duplicating itself and presenting a new version of itself as a malicious attachment, performing Distributed Denial of Service (DDoS) attacks. This kind of attack is aggressive because the malware is sufficient and potentially could last forever.

d) Torpig, also known as Sinowal or Mebroot, is a type of trojan horse in malware, that targets users on the Microsoft Windows Platform. It makes use of a keystroke logger, which works by recording key presses and opens window files, collecting information to a remote user via HTTP. It can be used to download and execute various file to infect the computer with other malware. Such functions can be used to steal credentials and use to make unauthorized transactions and purchases, and other activities such as identity theft.

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