

CS Uncovered

Tech news and
reviews

Understanding the
JS ecosystem

PREMIER EDITION

Cybersecurity | History of Javascript | Machine Learning
Competitive Programming | and more..

Exclusive Interview
with Ms Aziz. Read
more on page 21

“

I've been teaching for about 15
years now and I still enjoy
coming into school. I'm not fed
up of my job. I enjoy teaching.

”



Beths
COMPUTING SOCIETY

Issue #001

CREDITS



Micaiah Dontoh

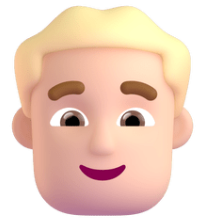
Lead Newsletter Designer

Form 6H2

Vladimir Filip

Author & Society President

Form 6H4



Thanish Senthil

Author

Form 6E4

Fjoralba Nasto

Author

Form 6A5



Ryan Mahlambo-Bibb

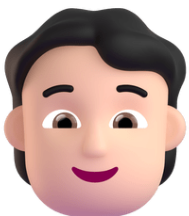
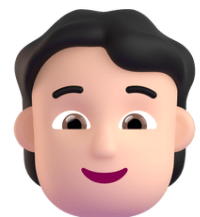
Author

Form 6E2

Lukas Trakimas

Author

Form 6H4



Alex Litchev

Author

Form 6B3

Vasanth Subramanian

Author

Form 6E5



CONTENTS

Tech News—**4**

Machine Learning—**6**

The World's First Colour Changing Car—**9**

Cybersecurity Guide —**10**

CrackMe Tutorial—**13**

The History of Javascript—**16**

Competitive Programming—**18**

An Interview With Ms Aziz—**21**

Oxford Questions—**25**

TECH NEWS

Problems At Twitter

The 4th most visited site on the internet Twitter, recently had its acquisition completed on October 27th 2022 by billionaire Elon Musk for around \$44 billion, who has been a long time critic of the website mostly accusing Twitter of being mostly filled with mostly bots and spam accounts. Pretty soon after Elon took over the company he set to work by issuing an ultimatum to all Twitter employees that they either agree to work harder with longer hours or leave the company. This resulted in over 3700 Twitter employees (over 50%) either fired or quitting from the company with 3 months severance pay, the CEO cited this as "a way to cut costs". After this, his goal to cut down unnecessary costs at Twitter continued as he decided to get rid of "bloatware" and microservices, claiming that only 20% of microservices were actually required for Twitter to work.



Eli Lilly and Company
@EliLillyandCo

We are excited to announce insulin is free now.

1:36 PM · Nov 10, 2022 · Twitter for iPhone

1,575 Retweets 707 Quote Tweets 10.9K Likes

A fake tweet impersonating Eli Lilly and Co

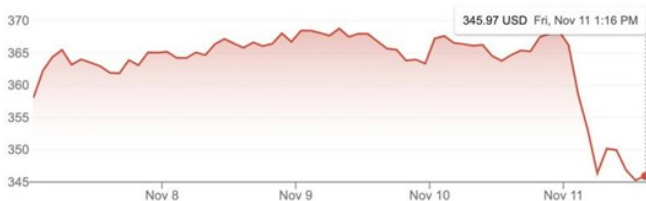
Market Summary > Eli Lilly And Co

346.04 USD

-11.97 (-3.34%) ↓ past 5 days

Nov 11, 1:17 PM EST • Disclaimer

1D 5D 1M 6M YTD 1Y 5Y Max



Open	366.16	Mkt cap	328.79B	CDP score	B
High	367.83	P/E ratio	52.00	52-wk high	369.80
Low	344.68	Div yield	1.13%	52-wk low	231.87

Eli Lilly and Co stock a day after the tweet was made

However in doing so the microservice responsible for 2 factor authentication was accidentally shut down, meaning if your account needed 2fa, you were now locked out of your account - this lasted multiple days. The mess continued when he finally decided to address his issues with spam and bot accounts by changing the way the Twitter verification system works. How the system used to work was that the verified check-mark symbol was reserved for journalists, celebrities, politicians and other public figures, to prevent impersonation - Musk had a better idea: make anyone able to have a verified check-mark on their account for the price of \$8. His reasoning was that everyone's Twitter feeds would be adjusted to gear towards showing verified people first, so that throwaway spam accounts would be practically hidden under all the verified accounts. Which in other words means if you don't pay \$8 a month, you get shadow-banned with your tweets getting way less interactions. The controversy surrounding the check-mark doesn't end there as allowing a verification badge meant to prevent impersonation of official accounts be bought by anyone quickly lead to, who would've guessed, rampant impersonation. People would make an account with a name similar to a company/person they want to impersonate, pay \$8 for the badge, and produce viral tweets mocking whoever they've pretended to be. One of the more notable examples being an impersonation of a massive insulin producing pharmaceutical company, Eli Lilly and Co, who tweeted on November 10th, "We are excited to announce insulin is free now", this tweet amassed 10s of thousands of likes and caused massive negative attention towards the company (mostly due to people noticing the predatory nature of selling a cheaply produced life saving product at extortionate prices). This tweet also could be responsible for wiping billions off their company valuation after their stock tanked from an opening price of \$366 per share to \$346 per share, a day after the tweet. New news

on Twitter seems to be showing up every day and the situation doesn't seem to be getting better any time soon.

Issues with Nvidia

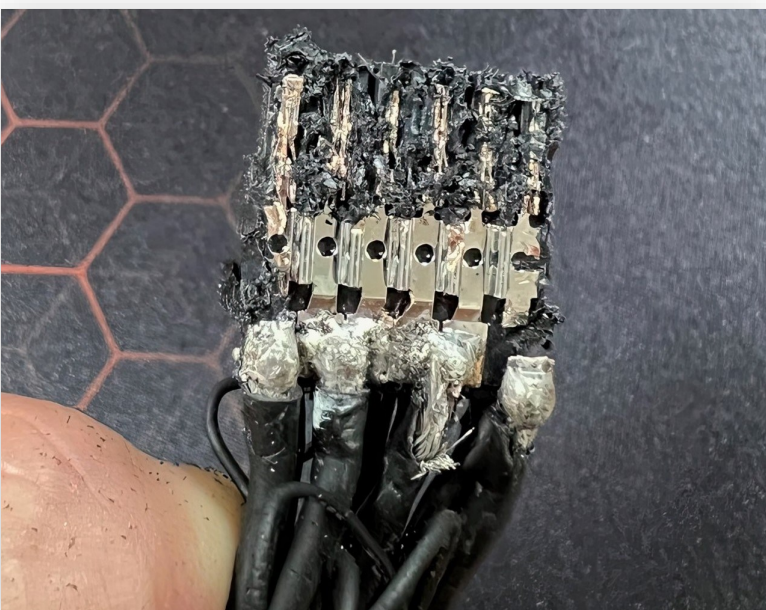
The RTX 40 series graphics cards dropped within the last month with the new RTX 4090 and 4080 cards available at a cheapest price of around £1700 and £1300 respectively. This is after Nvidia tried to market a 4080 16gb and 4080 12gb, with the 4080 12gb being only marginally cheaper and way less powerful with a misleading name that is nowhere near as close in performance level that the two names would assume. With a generation boost more in line with what you would call a 4070, after backlash from consumers they decided not to release the 4080 12gb and instead just release the 16gb version. However Nvidia and their new 40 series cards are more in the news for their extremely for issues surrounding it's high power draw. The huge amounts of power that the cards require - especially the 4090 - has made it necessary for a new power adapter to be made to be able to deliver those high power levels reliably, however over this month reports have been made with some users that the new power delivery cables have melted and burned during use.

After reports came out of this Nvidia and other prominent tech figures decided to do their own testing on the cause of this melting as well as a class action law suit being filed against Nvidia for "violating the product's warranty". Most tests came to the conclusion that the melting would happen when not all the power pins are seated properly in the graphics card, causing too much power to go through less of the pins which causes the overheating, which means that even things like bending the cable to fit it in a case or to get it out of the way could cause less pins to be seated correctly, which could lead to the melting. There are currently rumours that Nvidia will launch a new adapter to better handle the problem of melting cables; however none of this news really matters when the only way you could get one of these graphics cards is by selling off your kidney.

Meta AI Shutdown

Meta (formerly known as Facebook) has recently shut down and removed a new AI named "Galactica" after only 48 hours of it being available to interact with. The AI was created to quickly and accurately answer scientific questions, using its massive library of around 48 million science papers that the AI was trained with. It then was supposed to work by summarising answers for people based on those papers; however, most of the answers the AI produced were said to be inaccurate and misleading, with the director of the institute of intelligent systems writing "In all cases, it was wrong or biased".

In many cases the AI would conjure up articles that sounded believable, but were based on absolutely nothing. In some cases the AI would even attach real names and authors to these fake articles, which could be potentially damaging for those people who are linked to these fake papers and dangerous for people reading and believing false information. The AI seemed to have interesting filters that would block out and provide no answers to queries such as "racism", "queer theory" and "AIDS", as well as providing unclear answers toward questions like "do vaccines cause autism". Hopefully Meta can re-release the AI with a bit more "I" next time.



A damaged RTX 4090 power connector

Machine Learning—An Introduction

Vasanth Subramanian

Overview

Machine learning is one of the most relevant up and coming topics in the world of computer science. It acts as one of the basic constructs for artificial intelligence and focuses on pattern recognition, statistics and training a program on test data, using which it 'learns' how to operate. It studies methods that leverage data to improve performance on a particular set of tasks.

Machine learning algorithms build a model based on sample data, known as training data, in order to make predictions or decisions without being explicitly programmed to do so. Machine learning algorithms are used in a wide variety of applications in the modern society, such as in medicine, email filtering, speech recognition, agriculture, and computer vision etc. It is [especially useful](#) for solving problems where it is difficult or unfeasible to develop conventional algorithms to perform the needed tasks, for example in facial recognition, where it is extremely complicated to make a very accurate program without using any machine learning methods. One of the newer implementations of machine learning uses data and neural networks which aims to mimic the working of a biological brain. It is also used across many business problems, where it is often referred to as predictive analytics.

A subset of machine learning is closely related to computational statistics, which focuses on making predictions using computers. It also includes the study of mathematical optimization and delivers methods, theory and application domains to machine learning. Data mining is a re-

lated field of study, focusing on exploratory data analysis through unsupervised learning. This article is designed to give a basic overview on the field of machine learning, and thus I would recommend researching these independently if they pique your interest.

Classical machine learning is often categorized by means used to make predictions. There are four basic approaches: supervised learning, unsupervised learning, semi-supervised [learning](#), and reinforcement learning. They all are unique and have their own pros and cons.

Supervised learning

In this type of machine learning, data scientists supply algorithms with labeled training data and define the variables they want the algorithm to assess for correlations. Both the input and the output of the algorithm is specified.

Supervised learning algorithms are good for the following tasks:

- **Binary classification:** Dividing data into two categories.
- **Multi-class classification:** Choosing between more than two types of answers.
- **Regression modeling:** Predicting continuous values.
- **Ensembling:** Combining the predictions of multiple machine learning models to produce an accurate prediction.

For example, think of it as playing with a pet dog. It is as if you show the dog that if it picks up the right shape that you show to it, you will give it a treat. The dog knows what it searches for (the shape you show it) and what it needs to output (the shape)

Unsupervised learning

This type of machine learning involves algorithms that train on unlabeled data. The algorithm scans through data sets looking for any meaningful connection. The data that algorithms train on as well as the predictions or recommendations they output are predetermined.

Using the same example with the dog, Unsupervised learning would be like if you wear a jacket, the dog recognizes that you will go on a walk with it. This might not always happen, and it is not rewarded in any way, yet the dog correlates that if you wear a jacket, there is a high chance you will go on a walk with it and gets ready and excited.

Unsupervised learning algorithms are good for the following tasks:

- **Clustering:** Splitting the dataset into groups based on similarity.
- **Anomaly detection:** Identifying unusual data points in a data set.
- **Association mining:** Identifying sets of items in a data set that frequently occur together.
- **Dimensionality reduction:** Reducing the number of variables in a data set.

Semi-supervised learning

This approach to machine learning involves a mix of the two preceding types. Data scientists may feed an algorithm mostly labeled training data, but the model is free to explore the data on its own and develop its own understanding of the data set. Semi-supervised learning works by data scientists feeding a small amount of labeled training data to an algorithm. From this, the algorithm learns the dimensions of the data set, which it can then apply to new, unlabeled data.

So, with the dog example, this might be about teaching them how to behave around new people. To teach this you might use an example of a friend you know and train them to be more friendly towards them. Once it is trained

to behave properly around your friend, it is often easier for it to be friendly towards others. This might be because it identifies the new people as being like the person you trained it on and applies what it learned.

Semi-supervised learning is good for the following tasks:

- **Machine translation:** Teaching algorithms to translate language based on less than a full dictionary of words.
- **Fraud detection:** Identifying cases of fraud when you only have a few positive examples.
- **Labelling data:** Algorithms trained on small data sets can learn to apply data labels to larger sets automatically.

Reinforcement learning

Data scientists typically use reinforcement learning to teach a machine to complete a multi-step process for which there are clearly defined rules. Data scientists program an algorithm to complete a task and give it positive or negative cues as it works out how to complete a task. Data scientists program the algorithm to seek positive rewards -- which it receives when it performs an action that is beneficial toward the ultimate goal -- and avoid punishments -- which it receives when it performs an action that gets it farther away from its ultimate goal. But for the most part, the algorithm decides on its own what steps to take along the way.

Reinforcement learning is often used in areas such as:

- **Robotics:** Robots can learn to perform tasks in the physical world using this technique.
- **Video gameplay:** Reinforcement learning has been used to teach bots to play several video games.
- **Resource management:** Given finite resources and a defined goal, reinforcement learning can help enterprises plan out how to allocate resources.

An example of this would be potty training your dog. There might be rewards and punishments to repel bad

behavior, and it will be guided to go outside and do it. Though the objective of not doing it at home is achieved, the dog still has freedom of when and where to do it outside.

When it comes to advantages, machine learning can help enterprises understand their customers at a deeper level. By collecting customer data and correlating it with behaviors over time, machine learning algorithms can learn associations and help teams tailor product development and marketing initiatives to customer demand. Some companies use machine learning as a primary driver in their business models. Uber, for example, uses algorithms to match drivers with riders. Google uses machine learning to surface the ride advertisements in searches.

But machine learning comes with disadvantages. First and

foremost, it can be expensive. Machine learning projects are typically driven by data scientists, who command high salaries. These projects also require software infrastructure that can be expensive.

There is also the problem of machine learning bias. Algorithms trained on data sets that exclude certain populations or contain errors can lead to inaccurate models of the world that, at best, fail and, at worst, are discriminatory. When an enterprise bases core business processes on biased models it can run into regulatory and reputational harm.

But overall, machine learning is [a remarkably interesting](#) field with growing applications and has done nothing short of revolutionizing algorithms and giving rise to a new age of artificial intelligence.

Good Machine Learning Resources

Free Online Courses on YouTube:

- Stanford YouTube playlist ---- Machine learning
- MIT YouTube playlist ---- Introduction to Deep Learning
- DeepLearning.AI YouTube playlist ---- Deep Learning Specialization
- Lex Fridman's up-to-date deep learning course ---- MIT Deep Learning

The Best Free Courses Online:

- All Machine Learning courses by Fast.ai ---- Free Courses
- NYU Deep Learning course by Yann Lecun ---- Deep Learning
- Harvard's Artificial Intelligence course ---- Introduction to AI with Python

Some of the Best Paid Courses:

- Machine Learning from Stanford University by Andrew Ng
- IBM Machine Learning Professional Certificate
- Machine Learning Specialization from University of Washington
- Machine Learning A-Z™: Hands-On Python & R In Data Science from Udemy
- Data Science: Master Machine Learning Without Coding from Udemy
- Deep Learning Specialization from DeepLearning.AI
- Natural Language Processing Specialization from DeepLearning.AI



World's First Colour-Changing Car

Dillon Jayasinghe

Want a black car? Want a white car? Can't choose? Soon you may be able to have both with the BMW iX Flow. BMW unveiled their first fully functional colour-changing car at the tech trade show CES 2022 at Las Vegas. When I told someone a colour-changing car had been made, their first reaction was that "It probably looks wacky": which is an understandable assumption. However, if you have a look on YouTube, you will find the car fluidly switching from white to black is a stunning and sleek sight. What I found impressive is that in both states it keeps the appearance of a normal car, you would not look twice at it if it went past you on the street. Secondly, nearly all of the car's exterior can change colour - even parts of the wheels - the only thing that is excluded are the side mirrors.

It may surprise you to know LEDs are not used to create this transformation. The car is covered in an electrophoretic coating that is heavily inspired by E ink. E ink is a technology many of you have probably already encountered - for example, the screen of a Kindle eBook reader uses E ink. Millions of microcapsules are filled with a dark ink, which hold negatively charged white chips floating inside. Each of these can be thought of as the equivalent to a pixel on a LED display. The microcapsules create an electric field causing the top of the cell to gain a positive charge, so the chips experience an attractive force. The chips will rise to the top and cover the surface. If a person were looking down from above, they would only see the white chips and would perceive the capsule as white. Reversing the polarity of the field will plunge the white chips down to the bottom leaving only the dark ink to meet the observer's eyes, and this is the essence of E ink. Creating 3D curved sections of this involves unwrapping the shape of the car into 2D shapes and designing these before bending them. The E ink uses no power when not switching

colours, which is an important aspect to make this viable for daily use.

A new frontier for car personalisation, the microcapsules are normally programmed in segments, and you can see their outlines when the car changes colour. This allows for an immense variety of patterns that you could display. Text can clearly be displayed and easily changed, taking company car and taxi advertising to the next level. The car's exterior could communicate more things, such as fuel levels, saving space inside the car.

Ever came back to the car park but forgotten where you parked your car? Making your vehicle flash using a phone app would make it much easier to find. This may prove even more useful if your car ever got stolen.

Another interesting feature this allows the thermal properties of a car to change due to sunlight reflection. Black surfaces absorb all the wavelengths from the sun's radiation, while white surfaces reflect them. Drivers could switch between colours to heat or cool the car. This could reduce the amount we use AC and heating in our cars and save energy.

The next step for BMW is escaping the greyscale and adding more colour options. This is what really change the future of how cars will look and be personalised. However, it unlikely to be a focus for BMW, who are at the moment probably refining their current greyscale prototype for commercial use. It would require chips of different colours with unique charges and very precise control of the electric field's strength which could prove challenging. This technology could definitely make its way into the world soon and I look forward to seeing more prototypes till one day they may become available to ourselves.



Guide to Cybersecurity

Thanish Senthil

Introduction

There are around 2,200 cyberattacks per day which is about one attack every 39 seconds. Cyberattacks can cost a company's reputation, trust and a decline in sales. Businesses lose \$75 billion per annum due to ransomware attacks. Day-by-day hackers are becoming more sophisticated and cyber-attacks are developing. This makes cybersecurity a crucial topic in the modern world.

What is Cyber Security?

Cybersecurity is the practise of protecting organisations, individuals and physical devices from cyber-attacks and ensuring we maintain the **Confidentiality, Integrability and Availability (CIA triad)** of data and information. Cybersecurity is extremely significant in this day and age, technology is embedded into the majority of things we do, we share a multitude of information and how do we know if that information is being processed safely? Being cyber-aware is a method to avoid being a victim to cyber-attacks.

What is Ethical Hacking / Penetration Testing?

Ethical hackers discover vulnerabilities in a system by gathering information and scanning a system, however they do not exploit the vulnerability, they stay in scope meaning they stay within the boundaries of what the company had stated and they simply report the vulnerability to the organization and other security team members will create a more secure infrastructure. Ethical Hackers have a big role in preventing cyber-attacks for an organisation.

The Three Types of Hacker

White hat hackers (Ethical Hackers) - They use their skill to benefit an organisation and all their activities are authorised i.e., finding vulnerabilities on a company's network for them to remove it.

Grey hat hackers - They use their skills to benefit others often, however it can be considered unethical at times i.e., Taking down an illegal website.

Black hat hackers - These are criminals who use their skill as an advantage to exploit a company to gain financial benefit and sensitive data.

Ethical Hackers require a large skill-set, they need to have expertise in networking, modern technology, programming, Linux, hardware, reverse engineering, database management, cryptography and most importantly problem-solving.

One of the most popular operating systems ethical hackers use, is called 'Kali Linux', it is a Linux distro based of Debian and comes pre-installed with around 600 pen-testing tools which is what makes it so popular. There is a large variety of security related Linux Distro's, personally what I use is a Linux Distro called BackBox Linux which I have installed onto a USB which I use as a live operating system, it is a lightweight OS and doesn't require secure boot to be disabled (Kali does) to run when using as a UEFI bootable USB, although it lacks pre-installed tools.

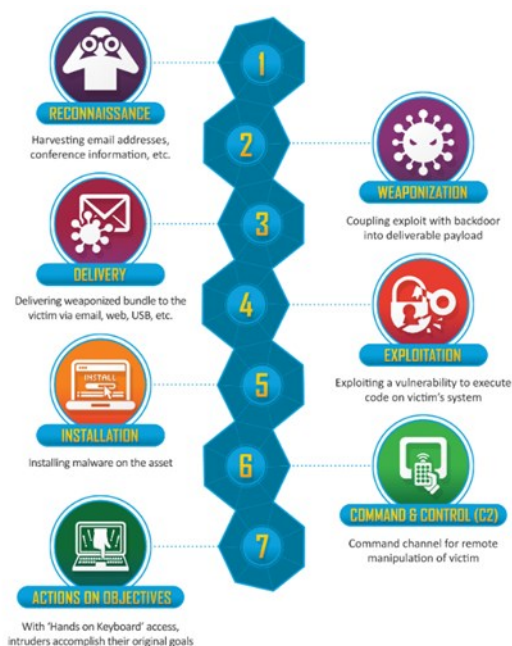
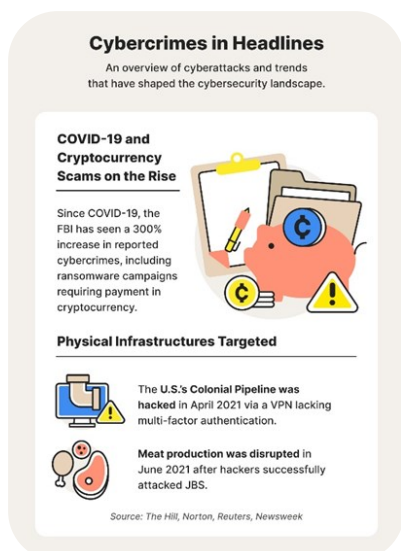
A guide to install Kali Linux can be found here; <https://www.kali.org/docs/installation/>

If you want to learn Ethical Hacking, there are many resources online and one of my favourites is <https://tryhackme.com/> , an alternative to TryHackMe is <https://app.hackthebox.com/> . These two websites involve interactive labs where you can learn to hack networks. YouTube is also an amazing resource.

Example of Application Exploitation

Did you know a security researcher darkp0rt had exploited Domino's to get free pizza?! Initially, the security researcher wanted to dive deep into why Domino's sometimes gave users \$10 coupons, and they looked into the source code, then used a web proxy called Burp suite to monitor traffic between the app and server and found out that the payment processing is client-sided on the app. The security researcher then intercepted the HTTP request and changed the payment request from 'DECLINED' to 'ACCEPTED' and that allowed them to get free pizza. (When the pizza arrived, they did pay the delivery driver though). This process is called 'Bug Bounty Hunting' and you can find organizations offering bug bounty programmes online on websites such as <https://www.hackerone.com/> and <https://www.bugcrowd.com/>

Cybersecurity in Critical Infrastructure



this is the Cyber-Kill Chain, used by ethical hackers to detect and prevent cyber-attacks

Ransomware is a popular type of malware which cybercriminals inject onto networks so the victim's data is encrypted until they pay the specified ransom. Cybercriminals aren't only targeting sensitive data; they are also breaking into critical infrastructures which can cause serious harm.

Unfortunately, the first reported death by ransomware happened on September 2020 which caused an IT failure at a hospital. In February 2021, a hacker had attempted to poison a water supply but fortunately, had failed. In April 2021, The U.S.'s Colonial Pipeline was hacked due to a VPN that lacked multi-factor authentication and that resulted in a \$5 million Bitcoin payment to regain access. Similar attacks like these occur so often and it is important to attempt to mitigate cyber-attacks.

Why Criminals Use Cryptocurrency

The reason Bitcoin is used as a payment method is because it is untraceable to an extent and is pseudonymous, however cybercriminals are starting to use a cryptocurrency called Monero which does not expose the address of the wallet when performing a transaction which makes it even more anonymous.

How can you stay cyber-safe?

Don't be a victim to social engineering again. Hackers can psychologically manipulate you into performing an action that could cause you to expose your information, this is called social engineering. There are many ways you can prevent this from happening:



Purchase an Anti-virus - Anti-virus/Anti-malware are an essential investment. They scan your computer to check if there are any virus' infecting your computer. Certain anti-virus softwares will delete a file as soon as it gets downloaded as it scans the executable file and validates it to known viruses. Some programs are becoming more sophisticated which anti-viruses may not be able to detect so be careful of what you download.

Using Two-Factor / Multifactor Authentication – If a hacker somehow gets your credentials, they cannot log in to your account as they will need a special code which you can only get if you have physical access to your mobile device which has the two-step verification app, or if it has the specific phone number. (Some hackers may do a sim-swapping attack though using information they know about you and pose as you to the sim provider to get them to swap your phone number to their phone. So be careful of what information you post online.)



Keep your software up-to-date – There can be pre-existing vulnerabilities in your software or OS and hackers can exploit them, developers work hard to fix them and release new updates and they should be installed to reduce the risk of being attacked.

Using Strong passwords – Involve a combination of uppercase, lowercase letters and special characters in your password, this makes it less common. Hackers can use a password cracker that takes common passwords in a wordlist and checks them against the cryptographic hash of the password in a database. This is called brute-forcing. (You can try this by using the hashcat tool which is pre-installed on Kali Linux, ParrotSec OS etc.)



THINK BEFORE YOU CLICK – Many hackers send malicious links to you, and those links can trick you into thinking you are browsing on an official website (where you may input your credentials), trick you into clicking an element of a webpage which can install a malware (clickjacking) etc. Make sure you read the URL and verify if it is legitimate. An anti-virus will block you from clicking the link.

CRACKME TUTORIAL

A tutorial on how to use the crackme software

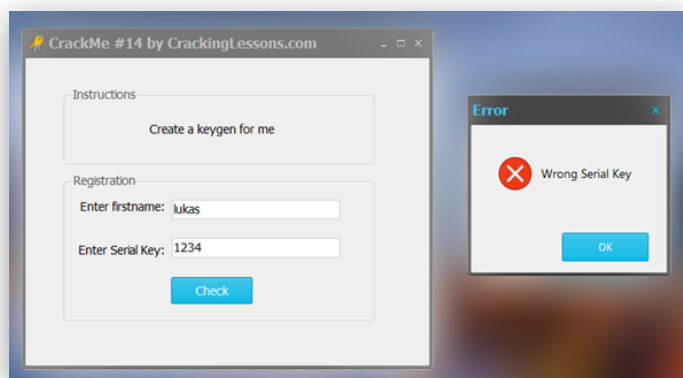
Lukas Trakimas

Introduction

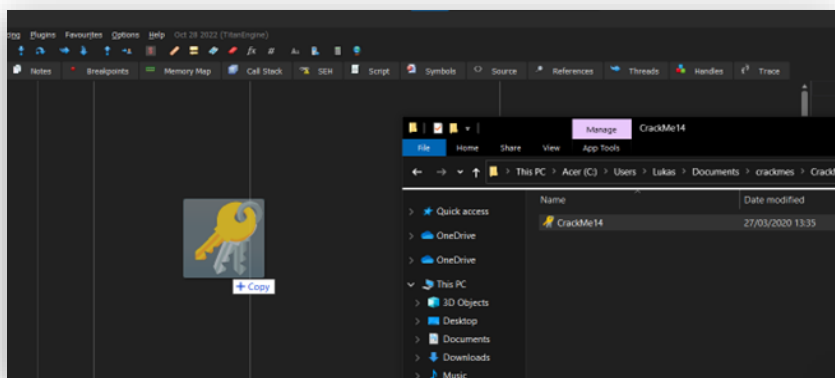
Reverse engineering is one of the hardest fields to get into regarding cyber security, as not only do you need to know about how certain programming languages work, but also be able to understand assembly code (to some extent). I'm going to be showing you the very basics of reverse engineering, by walking through how to crack a simple app that requires a serial key, and go over how you can make a quick keygen out of it as well.

Firstly, I must specify that the program we are going to is called a "CrackMe", which is essentially an application whose purpose is to be cracked, so everything demonstrated is perfectly legal as we have permission from the developer.

Upon opening the exe, a window with horrible UI appears, containing two input boxes. One box for username input, the other box for the serial key. If we were to input random characters into each box and press check, we get an error message appear in a separate message box.



First Steps

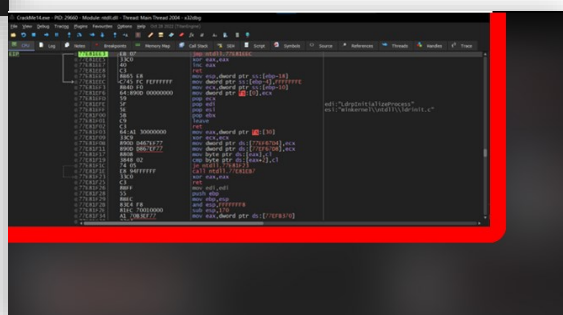


First we'll start by opening the program in a disassembler. Right now I'll be using a free and open source disassembler called x32dbg (note that x32dbg only works for 32-bit applications such as this one. To debug 64-bit programs you'd want to use x64dbg). We can open the program in the disassembler by simply dragging and dropping the exe onto x32dbg.

Once we do that, the screen will be completely filled with all sorts of things and look daunting at,

As you can see there's quite a lot going on, luckily for us most of what we need is just going to be in that middle window containing the assembly code for the program.

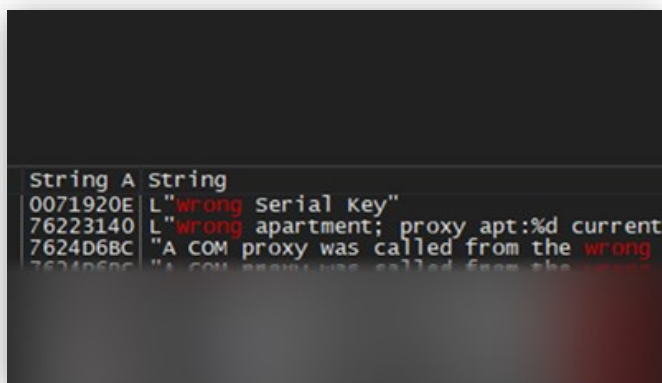
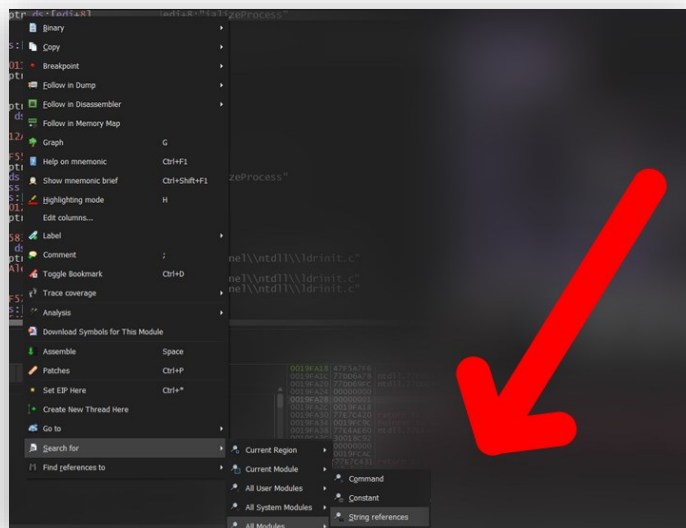
We want to find the bit of code that is responsible for checking our



username and serial key, which seems like an impossible task considering how much assembly there actually is. There is a tool that can take us straight there however.

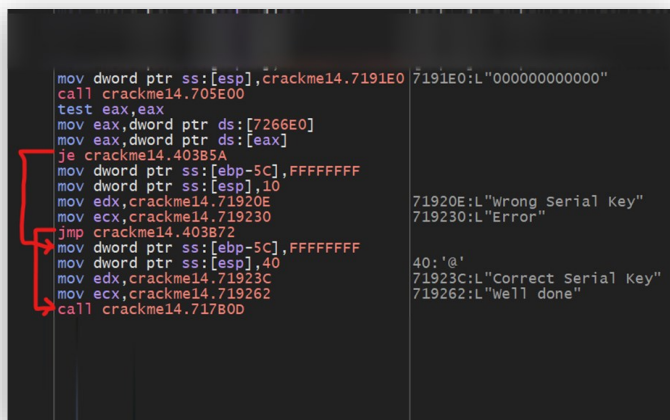
Remember when we entered random characters into the input fields and a message box popped up saying “Wrong Serial Key.”? That string “Wrong Serial Key” is gonna be sitting there somewhere in memory, and once we press the button it references that string when passing it into the function to display the message. x32dbg has a feature that allows you to search through string references in the program, which we can use to find where it initialises the message box saying “Wrong Serial Key.”

Through right clicking the middle window, we are able to generate all string references in the program.

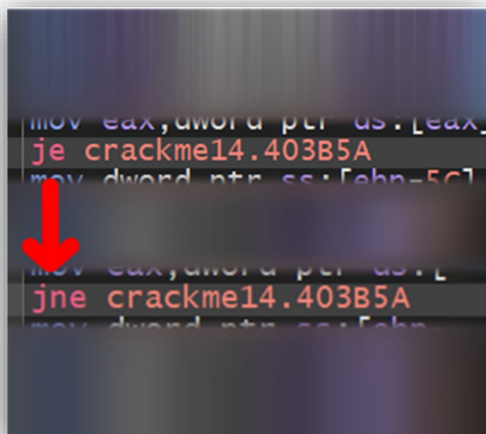


By just searching just the word “Wrong” in our string reference list we see our “Wrong Serial Key” string appear. Double clicking on that we are able to view the code region where it is referenced.

On the right we can see that “Correct Serial Key” comes just below “Wrong Serial Key” in code. The instruction `je 403B5A` seems to be the deciding factor as to whether the wrong or correct serial key code runs. A couple lines above we see a line that just says `test eax, eax`, which essentially checks if EAX is zero or not. So if EAX is zero, it’ll jump to the correct serial key string and call some function at 717B0D. But if EAX was not zero, then it doesn’t jump and continues through the code into the “Wrong Serial Key” area. But after that it still jumps and calls that same function at 717B0D.



So if the “Wrong Serial Key” string and “Correct Serial Key” string go into the same register and call the same function (which one depends on whether EAX is zero or not), then it gives the impression that the function they each call at the end is the one that makes a message box appear on the screen, with its parameters being “Wrong Serial Key” or “Correct Serial Key”.



Right now, we don’t really know much about how the program handles the serial key. All we know is that if the serial key is correct then it sets EAX to zero, if the serial key is wrong then it sets EAX to something that’s not zero. It then checks if EAX is zero, where if it is then it jumps and makes a message box telling us the serial key is correct.

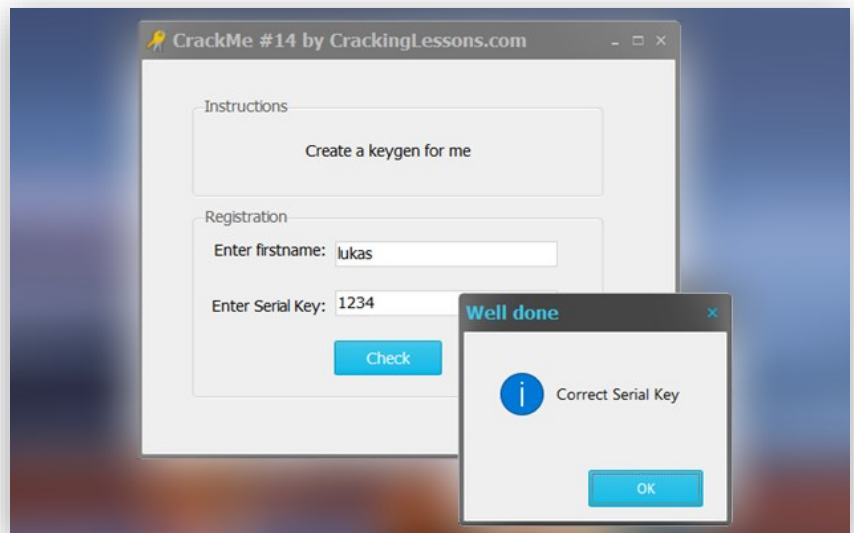
If we got the serial key wrong then EAX will not equal zero, but if we could change the `je` instruction to `jne`, where we jump to the “Correct Serial Key” code if EAX is not zero, then hypothetically everytime we get the serial key wrong we still jump to the right bit of code.

By clicking on the `je` instruction and pressing the space bar, we can edit the instruction, so it becomes a `jne` instruction.

By pressing CTRL+P we can patch the file with the change we've made into a new exe. Testing our patched file, we see that by entering an incorrect serial number we've still managed to trick the program into thinking it's correct.

Now we've managed to create a crack for the program, let's see if we can make a key generator that tells us the correct serial key based on the input username.

There's a few ways we can go about doing this but I'll quickly open up another program called IDA Pro (another disassembler but proprietary this time).



```

mov     [esp+88h+lpSystemTime], eax ; lpSystemTime
call    GetLocalTime
sub     esp, 4
movzx   eax, [ebp+SystemTime.wYear]
add     eax, 4D2h
movzx   ecx, [ebp+SystemTime.wMonth]
movzx   edx, [ebp+SystemTime.wDay]
mov     [ebp+var_5C], 0FFFFFFFh
mov     [esp+88h+var_74], ecx
mov     [esp+88h+var_78], ecx
mov     [esp+88h+var_7C], eax
mov     [esp+88h+var_80], edi
mov     [esp+88h+s2], offset off_7191FA
mov     [esp+88h+lpSystemTime], offset s1 ; "000000000000"
call    sub_708098
mov     [ebp+var_5C], 0FFFFFFFh
mov     [esp+88h+s2], esi ; s2
mov     [esp+88h+lpSystemTime], offset s1 ; "000000000000"
call    _wcsncmp
test    eax, eax
mov     eax, off_7266E0
mov     eax, [eax] ; this
jz      short loc_403B5A
  
```

Just a quick note, that last instruction that says jz is the exact same as je, right down to its machine code. They're just two different names for the same thing.

Anyway, what IDA has identified that we previously hadn't known is that right before we test if eax is zero, the program calls a function called _wcsncmp. This is a function in C++ that compares two strings and returns zero if they are the same. This is interesting, as it probably means it's checking the input serial key and the real serial key generated from the algorithm. You can also sort of infer this as in IDA it shows it calls a bunch of date-time related functions, which is not the most out of place thing to see around a serial key checker.

To test our idea, we can go back into x32dbg and add a breakpoint at that line, and inspect the values of the registers and

memory regions. After inputting "lukas" into firstname and "123" into the serial key, it triggers our breakpoint and we see these values.

So we were right, it compares our input serial key value of 123 compared to the real serial key value of luka-32561116. Now that we know with certainty the serial key is located at 0x7191E0, we can output that string instead of the "Wrong Serial Key" text, that way everytime we get it wrong we get our generated key.

```

[esp+4]:L"123"
[esp]:L"luka-32561116", 7191E0:L"luka-32561116"
  
```

Replacing this instruction the same way as before, we are able to pass the serial key as the argument to the messagebox function.

```

mov     edx, crackme14.71920E
mov     edx, crackme14.7191E0
  
```

After patching the file again we now have a working keygen!

JAVASCRIPT

History



Brendan Eich

Cast your mind back to the year early 1990s, when Netscape (a webservice company) were developing the first web browser (known as Mosaic) with a graphical user interface, with the goal of making the world wide web accessible to non-technical people, and subsequently moulding the web into what we know it as today. However, there was one issue. During these formative years, web pages were static, lacking any capability for interaction. However, Netscape wanted to remove this limitation. Their solution was to implement a *scripting language* to Navigator (the successor to Mosaic). Initially the plan was to embed an existing programming language such as Java and Scheme but when these plans failed Brendan Eich was tasked with devising a new language.

In just one week in 1995, Brendan Eich created JavaScript which aimed to allow for interactivity to be added to web pages. It is interesting to note that in the beginning, what is now known as JavaScript, went through many naming iterations from Mocha to LiveScript. However, the name JavaScript was chosen as it implies the language was related to Java, which was extremely popular at the time, and therefore acted as a form of marketing

despite having no connections to Java.

In the years to follow, JavaScript would undergo fragmentation, mainly thanks to Microsoft and it's almost identical language, Jscript, for use in Internet Explorer. There was need for the language to be standardized so Netscape went to Ecma (A company which sets standards in the IT industry) and produced a standard specification for JavaScript. Over the years, Ecma has published specifications (known as ECMAScript) as the language continues to develop.

What is Javascript?

JavaScript is a high-level, dynamic programming language which is usually just-in-time compiled. As mentioned previously, JavaScript's primary use is on the web, providing interactivity. As of 2022, 98% of websites use JavaScript on the client side. You can think of the browser being the runtime for JavaScript, with Google's V8 being the most popular and fastest JavaScript engine implemented into web browsers. However, JavaScript is also widely used in build server-side applications. Node.js is the most popular JavaScript runtime, for running JavaScript on servers, and is once again powered by the V8 engine. Given JavaScript's prominence in both client-side and server-side applications, it can be an extremely transferrable and useful skill.

Extending Javascript

One of the aspects which makes JavaScript stand out, is how far it has been and continues to be extended by its community. Packages are typically installed using the infamous npm (Node Package Manager) due to Node.js being the 'de facto' primary* way to execute JavaScript outside of the browser. One of the most popular extensions of JavaScript is TypeScript. JavaScript is dynamically typed, meaning the data types of variables aren't checked until runtime which can lead to many errors. When writing software, the worst thing that can happen is for a bug to go unnoticed and only be found when the app is in the wild. TypeScript helps to prevent this by, checking all data types while being written and providing other useful features which not only prevent bugs but improve the development process for the developer. However, there is a key issue. JavaScript* is the only programming language that is natively supported in the browsers of today. So how is TypeScript used then? TypeScript uses a transpiler which converts TypeScript code to JavaScript code effectively solving this issue. This also introduces another advantage, given how often the JavaScript specification is iterated upon, there are many cases where some new JavaScript features are not available on legacy browsers such as Internet Ex-

plorer. This means you must compromise between using new features and maintaining compatibility. However, thanks to TypeScript being transpiled, this dilemma is eliminated. This is because the TypeScript transpiler can convert the new TypeScript code into JavaScript code of the specified specification and replacing new functionality with the equivalent in the old specification when necessary. Please note that there are transpilers which can achieve this with vanilla JavaScript however it is important to note that TypeScript was one of the first to offer this functionality.

Frameworks

Another way in which JavaScript is usually extended is through frameworks. There are a variety of both browser and server-side frameworks and their main purpose is to streamline development by providing useful functionality, abstraction and overall shaping and organizing your website or application. One of the common features of browser-side(client-side) frameworks are that they allow you to represent HTML elements in JavaScript. In fact, ReactJS (a client-side framework developed by Facebook) literally allows you to write HTML within JavaScript and supercharge it using JavaScript thanks to genius technology. Frameworks provide abstraction and handle complicated tasks such as re-rendering the web page and state management to speed up development. Additionally, some frameworks attempt to integrate CSS into JavaScript, allowing you to control all aspects of your app from JavaScript, however these typically aren't very popular and haven't been very successful in the web development scene.

Testing

As with all software, an important stage in developing any application is testing. JavaScript has implementations of traditional testing methods found in other languages such as unit testing (Jest being an example), but the challenge of testing web applications led to the creation of many interesting tools. One of these tools is Puppeteer, which in essence is a computer-controlled chrome browser. This means you can write tests which involves interacting with the website (pressing buttons, filling forms) and detecting the result of these actions allowing you to test your web applications thoroughly.

The Future of Javascript

As this article ends, it's important to acknowledge the recent advancements in JavaScript and the web development world and to understand the impacts they will have on the future of the web. I previously mentioned that Node.js was the 'de facto' way to run JavaScript outside of the browser however this is changing. There are two new technologies that are quickly establishing themselves as replacements for the aging node.js: deno and bun. Deno is a successor to node.js (from the creator of node.js) and aims to address many issues with node.js concerning security, standardisation and the package system as well as providing native support for TypeScript. Bun on the other hand is a blazing fast JavaScript runtime which additionally provides many built-in utilities such as testing and bundling. Once again, I previous mentioned that JavaScript was the only natively supported programming language on the browser but this isn't strictly true. Another advancement in the browser space has been the support for Web Assembly, a binary format that can be compiled from a variety of languages and then run in browsers. This means that performance demanding parts of an application can now be written in more performant languages such as C++ and then compiled to web assembly to be run in the web. Despite having the potential to replace some parts of applications, JavaScript isn't going anywhere anytime soon and web assembly will simply be an aid in web development.

Despite the many criticisms of JavaScript and web development as a whole, it is a field that is constantly evolving and has established itself as a stable in the software development world.

Competitive Programming—An Introduction

Vladimir Filip

Overview

Programming is very much a mental sport, one which challenges your logical and problem-solving ability in a way that nothing else can. To quote Steve Jobs, 'it teaches you how to think', how to break down a problem of any size and solve it with an analytical yet creative approach. The world of programming, and computer science in general, is truly vast but those at an intermediate level who understand the syntax of their language and simple programming concepts often find themselves struggling to improve further. This is where competitive programming comes in.

Competitive programming is the very same sport but in a competitive environment, enabling you to solve problems under certain constraints, which can be a time limit to solve the problem or running many test cases that must pass to ensure your solution is correct. It can be significantly more challenging but also more rewarding. The main tech companies such as Google, Microsoft and Amazon tend to hire through competitive programming, for those who excel in it turn to be all-round world-class coders who have higher knowledge of advanced data structures and algorithmic analysis.

How to start

The only prerequisite to starting out is having an intermediate knowledge of your programming language, where you know the basic syntax as well as programming fundamentals such as data types (string, int, float/double/long,

array/list, dictionary/hash table etc.), iteration, selection, functions and recursion. If not, then it's best to master these first before moving on to competitive programming. There are various online resources to help you, but they are outside the scope of this article.

Like with any sport, there are various levels of competition, ranging from online problems and coding challenges to international competitions such as the International Olympiad in Informatics.

Websites to improve competitive programming ability:

- [GeeksForGeeks](#)
- [TopCoder](#)
- [CodeForces](#)
- [CodeWars](#)
- [LeetCode](#)
- [HackerRank](#)
- [AlgoExpert](#) (**paid service**)
- [spoj.com](#)

The websites above all have thousands of problems at various difficulties to complete. The format of each problem varies from website to website, but they all follow a similar structure, in which a problem is given, and your solution is

run against test cases to check if your solution is correct. For problems that judge test cases based on output to the console (done through `print()` function in Python), make sure to output nothing but the output requested by the problem, as any extra outputs would cause an automatic failure in the test cases.

w3schools.com is also a great website to learn about the full functionality of your chosen language.

An Introduction

There are a few key concepts that are essential to know for any competitive programmer, and they fall into two categories: asymptotic analysis and DSA (data structures and algorithms). In this article, I will do an introduction to asymptotic analysis in this article and cover the broad topic of DSA in later articles.

Asymptotic analysis

This is a process of calculating the efficiency of an algorithm in mathematical units to find the program's limitations. In programming, the efficiency of an algorithm is decided by 2 factors: running time and memory usage, the measures of which are called time complexity and space complexity respectively.

All analyses need a variable input size, as all algorithms work on data inputs that could vary in size and so scale in running time and memory usage as the input size increases. Asymptotic analysis provides a form of abstraction to describe how the algorithm scales and is expressed using a form of notation called **Big O Notation**.

```
def print_list(l: list):
    for element in l:
        print(element)
```

example code in python

This is a simple function that iterates through a list and prints each of its elements. The `print()` function takes the same amount of time to run no matter what it is printing, and therefore the time complexity of the `print()` statement is expressed as $O(1)$, or *constant time*. Because of the `for` loop, however, this `print()` statement is being run n times

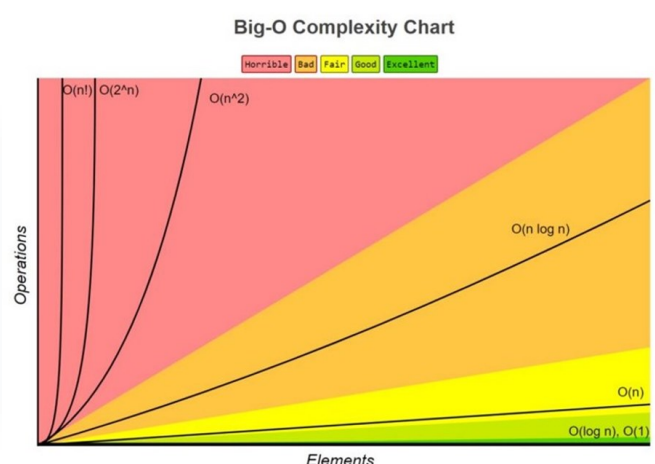
with n being the number of elements in the list l , and therefore the time complexity of the whole function is expressed as $O(n)$, or *linear time*, for it runs n constant time operations.

```
def print_list(l: list):
    for i in range(0, len(l)):
        for j in range(0, len(l)):
            print(l[i])
    for k in range(0, len(l)):
        print(word)
```

another example python program

It contains two nested `for` loops, and so for every element in the list l of size n it iterates through l again, therefore performing n^2 `print()` operations. The time complexity of these two nested `for` loops is therefore $O(n^2)$, and as the function then has a single `for` loop that iterates over l , the time complexity of the whole function is $O(n^2 + n)$. However, as n approaches infinity, n becomes negligible compared to n^2 , and therefore the time complexity of the algorithm can be simplified to $O(n^2)$. This reasoning also leads to any constants and coefficients being removed as well. For example, $O(3n^2 + 4n + 2)$, would be simplified to $O(n^2)$.

As you may have realised, some time complexities are better than others: $O(1)$ is better than $O(n)$, $O(n^2)$ is better than $O(n^3)$, etc.



The above graph illustrates how large the difference in efficiency can become between different types of Big-O complexities.

The 3 main forms of notation in asymptotic analysis:

Big O – Describes the upper bound of the algorithm's running time/memory usage and measures the worst-case scenario of how long an algorithm could take to run.

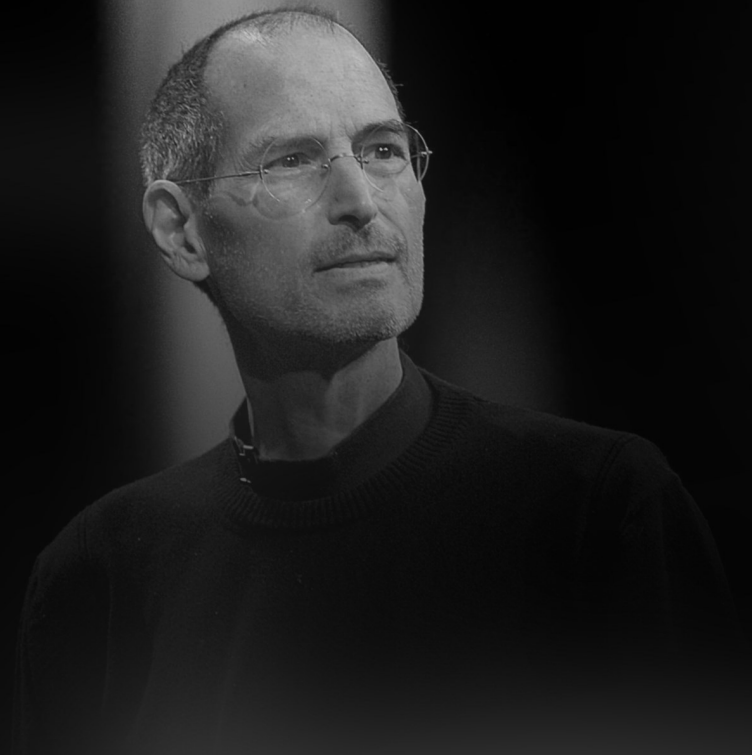
Big Omega – Describes the lower bound – i.e., the best-case scenario – of an algorithm's running time/memory usage.

Big Theta – describes both upper and lower running time/memory usage boundaries, with the average case scenario expressed as the average between each border.

Summary

Competitive programming at its essence is solving challenging problems under given constraints, requiring advanced knowledge of data structures, algorithms, and algorithmic analysis. There are several websites on the Internet to hone your skills.

A brief introduction to asymptotic analysis was also provided, a method of calculating the efficiency of an algorithm by how its running time and memory usage scales with input size. It is generally represented using Big O notation, which describes the worst-case scenario in terms of time and space complexity. The lower the complexity, the more efficient the algorithm.



“Everybody should learn to program a computer, because it teaches you how to think”

- Steve Jobs



Ms Aziz – An Interview

Fjoralba Nasto

Introduction

As one of her students, I could see her passion reflected through her eyes as she was talking about the thing she loves doing the most, teaching young people. Ms Aziz would walk us through her 15 years of experience dedicated as a computer science teacher, starting from her early career, the first difficulties she has encountered while teaching, as well as her viewpoints upon the technology that surrounds us in today's world. Lastly, you will find some useful tips that she shares to all the students who at the moment might be struggling to find their true passion.

“I’ve been teaching for about 15 years now and I still wake up in the morning and enjoy coming into school. I’m not fed up of my job because I love teaching.”

- Miss Aziz



Hello miss, how do you feel being interviewed by one of your students? Have you been in this position before?

I haven't been in this position before, but I think it's absolutely fantastic to be interviewed by a student.

What did you study in university and which university did you go to?

I studied Computer Science at the Greenwich of University.

How did your interest about Computer Science grow since then?

Well, I went straight into teaching because that's what I wanted to do. I think my interest has grown because as I'm teaching computer science and the constant development in computer science, Computer Science keeps you on your toes and forces you to want to learn more and keep up to date with the technology.

How different was learning computer science at the time you studied it from now?

Oh my gosh, it was really different. The things that students now know from early age was what we were learning at the university. So for example, I was at university when I learnt how to create a contents page in Word, Today, I teach it to Year 7s. In addition, we would save our coursework and projects on floppy disks, which could only store, lets say 1 file because the capacity was about 2MB. Today you have USB's with average capacities of 256GB.

Do you remember the time when you decided to become a teacher?

(Thinks for a bit) I think, I mean there was always other careers that I was considering when I was your age. There were different types of careers that I was contemplating. I liked travelling, so I even wanted to be an air hostess... (laughs)

That's interesting...

Yeah, but, as I got older, I thought - *no that doesn't sound like fun* - because I think I'd much rather be working with young people. I was lucky to have been taught by some teachers that I thought were really, really good when I was growing up, and that inspired me to want to go into teaching, rather than something else.

Who was your biggest support during the time you decided to follow this path of career?

My biggest support was actually some of my teachers. Well, they are my colleagues, but they used to be my teachers. So I'll explain that because I worked in a school where I studied when I was younger. By the time I was working there my ex-form tutor, he was a maths teacher, later became my colleague. There was also another deputy head teacher who used to teach me as well. Both these teachers massively encouraged and inspired me and supported me, helping me to prepare for teaching interviews.

How was it like sharing the same environment with your ex-teachers, but now as colleagues?

It was - weird. It was really weird, because I could remember having maths lessons with my ex-form tutor who was now my colleague. Sitting in the staff room, with your ex-form tutor, is really weird.

Can you mention some of the difficulties at the beginning of your career as a teacher?

I think one of the major difficulties, or the challenges that I had when I started was managing behaviour. I won't name the schools but there were some serious issues with behaviour but I always took it as a challenge...

Are these within Bexley?

Yes within the Bexley borough. One student was almost going to through a chair at me...you know like really aggressive behaviour. So I think with time, I have developed strategies on how to deal with that and how to diffuse such situations.

What can some of these strategies be, or does it depend on each situation?

Well, you have to judge and know your student. One of the main things that I've learned is how to try to be calm even when some students are really angry even when they're pushing you to your limit by getting really aggressive, maybe really rude...but it's all about trying to remain calm because that often can diffuse most situations.

What about the best memories you can think of throughout your teaching years?

Oh there are many. There's lots of fantastic memories. I think every year, one of the best memories that I have is on the results day. Every year I come in during the summer when students come in for their results, and I see their faces when they open up those envelopes and they get to see their grades. That, for me, makes the job worthwhile.

Have there been any cases where you've witnessed the students opening their envelopes and not getting the results that they expected to get?

Yeah there have been. Unfortunately, you do get such instances. Luckily they're very few. It's not very common where students would be really shocked, or very upset about the results. Most of the time students do get the grades that they have been predicted or that they've been working at.

Have they ever personally 'blamed' you because of their grades?

No not me personally, but occasionally you do get students that seem to blame the school, but I think even when they're saying that deep down they know what the truth is. It's just more like a way of deflecting and not taking responsibility, but really deep down they know they didn't apply themselves.

Let's say you had a time machine that allowed you to go back in time and change any of your decisions you've taken so far. What would that be?

Okay, I was thinking about this question recently and to be absolutely honest there wouldn't be anything that I would change. I've been teaching for about 15 years now and I still wake up every morning and look forward to coming into school. I'm not fed up of my job. I love teaching. That's why there is nothing I would change.

Technology Talk With Miss Aziz

What is your viewpoint upon technology today?

Its mixed. I think from an educational perspective it's absolutely fantastic. We've been through Covid, and we have been very lucky with the technology which has allowed us to continue with the learning and the teaching remotely. However, I also feel that with technology it's very difficult to have a balance. So, for example the social media and the excessive use of technology. What I feel is that people need to be able to balance it, just maybe take a break from technology from time to time, otherwise it just takes over our lives and anything in excess is not healthy.

What do you think have been the greatest technological achievements so far?

(Thinks for a bit) The greatest technological achievement...in what area?

Let's say on education...

Well, in education I think that the fact we are now able to learn, communicate remotely - that definitely is a huge advantage. Like I said with the Covid example, having access to education, access to learning, there's so much more to us all. Whereas when I was at school it was mainly only from books. We weren't using the internet as much, nowhere near as what you all do. We relied on the textbooks that the teachers gave us, often really dated whereas now you have so many more resources available to you to improve your learning.

However, I think there's still a lot more that the schools can do. For example, when students are not in school, or they might be in hospital because they've had surgery they should still be able to connect to the school environment to ensure that learning continues.

What about Artificial Intelligence? How do you see its evolution?

Artificial Intelligence it's at a constant progression. I was talking to students recently about robotics and AI and how research and developments are taking place in medicine and surgery. I was reading up on how surgeries can potentially take place lets say in the UK, but the surgeon in another country, who's an expert in his/her field (for example heart surgery), could be carrying out that surgery whilst sitting in another country. The technology is rapidly advancing and with AI and Machine Learning continuously evolving and improving, there's no end to the kind of things that computers will be able to do.

Based on this, do you think that the robots might replace humans one day?

I think that the roles that humans play might change, but I don't think they'll be replaced. It's because if you have robots, computers, AI - you must have people to develop, test and maintain



a concept of a robot working on a patient remotely

them. So the roles can change, potentially, but you'll still need doctors, you'll still need surgeons, you'll still need all the physical people to enable computers and robots to function.

If you had to personally contribute into something linked to the technology, what would that be?

It would have to be in the relation to education. Probably in terms of research, on how to improve education and the role that computers can play. (Refers to the question) But I think that's a tough one yeah... (laughs)

Suggest a movie that you've found interesting to watch having to do with this topic.



A movie that I really enjoy that I've been sharing with my students is "AlphaGo". It's a documentary movie, which I think is absolutely amazing in terms of looking at how programmers developed a game that is traditionally a board game. It's like a computer board game, which then beats the world's champion at the game Go. That is just an amazing documentary movie and I highly recommend everyone to watch it.

Final Tips From Ms Aziz

A lot of people say that they want to succeed regarding their careers. At first, what does "success" mean for you?

Success for me does not mean how much money you're earning. I know that many people would measure their success by their money – you can earn a lot of money and you can still be unhappy. Success for me is doing something that makes me happy. That's success!

Do you think you've achieved this success?

I think I've been very lucky in terms of success. You probably know teaching does not pay a massive salary, but like I said, I wouldn't change my job. In terms of my career choice and what I'm doing, I think yes – I would say that this has been a good decision.

As many students would read this interview, what are the tips you would give to your students in order for them to achieve success?

I would say work hard, but also follow your dreams. Take all the advice that you can get from those around you and enjoy the process. Make the most of every opportunity you get!

Ms Aziz Contact Details

School email: msaziz@beths.bexley.sch.uk

Can also be found in IT2 or the IT Office

OXFORD QUESTIONS

Questions used during an Oxford Computer Science interview

Vasanth Subramanian

This is an Oxford interview question showcased in the 2022 Oxford open day computer science interview preparation session. Feel free to try and answer this question before looking through the answer.

Part One

Find the smallest natural number ending in 6, such that if the last 6 is removed and placed at the front, the new number is 4 times the original number.

Part Two

Can you give a procedure to find the smallest number ending in digit d , where d is between 1 and 9, such that if the last digit, d , is removed and placed in front, you get a number that is k times as large? Is this possible for every value of d and k ?

General Interview Tips

Before we look at some of the solutions, I will go through some of the general tips given for such an interview. Firstly, the interviews are meant to be challenging, and they don't require you to fully solve it yourself. What the aim of such a question is for them to see what approaches you take and how you would attempt to solve this question. You will most likely be given hints along the way that might lead you towards a solution, so always listen carefully to the interviewer. Especially in computer science, some parts of the question might be solvable by using algorithms. For example, if you just say something like "from here we can brute force it by looping through all possible values of x " the interviewers will understand that but might ask you to think about another way to solve that question or might say that it can be further simplified before relying on code.

Part One Solution

Part one of the questions is the specific case you must solve for, which leads to be able to solve the general case in part 2. In all interviews, it is always good practice to lay out all the information you know. Unknown digits are expressed as x:

$$\text{xxxxxxxx}6 * 4 = 6\text{xxxxxxxx}$$

As we know the last digit of the previous number was 6, the new numbers unit digit must be 4, as $6 * 4 = 24$.

$$\text{xxxxxxxx}6 * 4 = 6\text{xxxxxxxx}4$$

Now from this, we know that 4 is before 6 on the LHS as only 6 gets moved to the front.

$$\text{xxxxxx}46 * 4 = 6\text{xxxxxx}4$$

This procedure seems to work to find new digits, we just have to repeat it until we get a 6, then we can say the answer was the previous number without the 6.

Now following the same steps, we know that the number 4 before has to be the multiple of $4 * 4 = 16$, but don't forget about the carry of 2 from the first iteration of these steps. So the number before 4 is 8 ($6 + \text{carry } 2$), and we must carry 1 for the next iteration.

$$\text{xxxx}846 * 4 = 6\text{xxxx}84$$

Now doing the same procedure again, $8 * 4 = 32$, carry 1 = 33, so the digit before is 3, and we carry 3,

$$\text{xxx}3846 * 4 = 6\text{xxx}3846$$

Carrying this on, we end up at:

$$153846 * 4 = 6\text{xx}153846, \text{ carry } 2$$

Doing the loop now, gives us $1 * 4 + 2 = 6$, and thus 153846 is the answer.

Method 2:

That was just one way of doing it. In most of these numerical problems, its often good to model it mathematically. In $\text{xxxxxxxx}6$, if we label the values before 6 as a variable x then:

K is an integer for which the above statement yields an integer value for x. And so;

$$39x = 6 \times 10^k - 24$$

$$x = \frac{2 \times 10^k - 8}{13}$$

Therefore, we can just iterate through integer values for K until x is an integer, which in this case is when K = 5, and thus x = 15384. Hence, we can arrive at the answer of 612384.

There might be more ways to answer this question, if it is a reliable way to arrive at the answer, it will be accepted in the interview.

Part Two Solution

Part two is about adapting the solution found to the specific case in part 1 into a procedure which provides a solution to the general case.

Using method 1, you can conclude that the 2nd to last digit must be a 4 because of the product of 4 & a number ending in 6 will end in 24.

So now we have our last 2 digits: 46. We check to see if this number satisfies the 2nd condition: which is that it equals the number when the 6 is removed and placed at the front.

$$46 * 4 = 184 \neq 64$$

Since it doesn't satisfy this condition, we continue moving forward - but with more information. Our number still must end in 46, and so we continue the process.

$46 * 4 = 184$. **The digit before 4 must then be 8.**

$846 * 4 = 3384 \neq 684$; **next digit must be 3.**

$3846 * 4 = 15384 \neq 6384$; **next digit must be 5.**

$53846 * 4 = 215384 \neq 65384$; **next digit must be 1.**

$153846 * 4 = 615384 = \mathbf{615384}$

Hence, we can adapt these methods, finding the previous digit using multiplication and checking if the condition is fulfilled.

Thus, a solution using this method might be:

```
d=int(input("enter d: "))
k=int(input("enter k: "))
found=False
while found == False:
    newnum=str(d*k)
    newnum=newnum[1] #takes the second digit from the left
    d=int(newnum+str(d)) #appends that to start of number
    temp=int(((str(d)[-1]+str(d)[0:-1]))) #puts last digit first
    if d*k==temp:
        found=True
print(d)
```

You can also use the maths method to solve this problem, using example in part 1, a suitable equation involving k and d would be:

$$k(10x + d) = 10^y \times d + x$$

Where y is an integer value which yields a integer value for x. You can simplify this to:

$$(10k - 1)x = 10^y \times d - kd$$

$$10kx + kd = 10^y \times d + x$$

$$x = \frac{10^y \times d - kd}{10k - 1}$$

Therefore, this again is in a format where you can iterate through values for y which gives integer values for x. A procedure using this method might look like:

```
d=int(input("enter d: "))
k=int(input("enter k: "))
y=1
found == False
while found==False:
    if float(((10**y)*d-k*d)/(10*k-1)).is_integer()==True: #the formula
        found=True #using the is_integer() function to check
        ans=int(10*(((10**y)*d-k*d)/(10*k-1))+d)
    else:
        y=y+1
        found=True
print(ans)
```

The question is pretty much done at this point. The last thing you need to comment on is whether this works for all values of k and d. You could indeed say one way to check this is to brute force all the available input and see if it runs. Though this is a valid method as there is only a limited number of combinations (as both d and k are single digit integers), in an interview this might be hard to show this to an examiner, given that you don't have access to any programming software during the interview. Though I believe it is a valid way to check these, if you try some of these by hand in an interview, some of the answers are not the nicest, when k is 9, the answer is 18 digits long, where effectively you are proving divisibility for 89 (which is prime). Mathematically, you could start by factoring out d:

$$x = \frac{d(10^y - k)}{10k - 1}$$

From this you can explain that no matter what d is, there will be an answer if the fraction is an integer (as we know d itself is an integer). Hence the only part we care about is

$$\frac{10^y - k}{10k - 1}$$

Here for values of k the denominator is $10k-1$, which is the series of numbers 9,19,29,39,49 ... 89. Hence there must only exist 1 value of y for which the numerator is divisible by the denominator. Finding out this much itself is more than enough for the interviewer to assess you, but to go further you can say that as the denominators are never a power of 10, and as the numerator as a function is:

$$f(x, y) = 10^x - y$$

Using modular arithmetic, you can say that when this function is applied with different values of x (where y is constant), they will keep the modulus the same if divided by a power of 10, but will not keep the modulus the same whenever dividing by an integer which is not a power of 10 (as it is raised to a power of 10, which leaves no remainder when divided by a power of ten). Thus, you can say that the modulus always changes as the denominators are never powers of 10, and that you are bound to arrive at a value for x , where it is divisible by the denominator.

Therefore, you can conclude that it works for all values of k and thus for all values of d

(where $k, d \in \mathbb{Z}$ and $0 \leq k, d \leq 9$)

Some links to resources regarding Oxford Mathematics or CS interviews

- Oxford Online Maths Club - This online maths club run by James Munro has lots of useful material for preparation in addition to some mock interviews.
- Oxford Sample Interview Problems - Maintained by the CS department in Oxford.
- Oxford Online Interview Demo



Beths
COMPUTING SOCIETY