

# 1st Oct – Day 1

What is a comic without a great story? Everyone knows that great story has great structure. Since, I was mostly free today after class, I spend my time ( most of the afternoon and evening today ) reading some books on story writing , Screenplay and Dramatic Writing itself. Then I went on to take notes and wrote my observations and studies down in a PD F that could benefit everyone involved in the Project. This include :

1. John Truby : Anatomy of Story- 22 Steps to becoming a master storyteller
2. Robert McKee- Story, Substance, Structure and the Principles
3. Blake Snyder – Save the cat! The last book you will need on Screenplays.

These books were interesting read and I compiled what I learnt about storytelling into a checklist which is available on [Teams Files](#) . I compiled the structure to be followed, scene timings, Character Development, Story Progression, Important Steps in story, etc so that members acting in writer's role for a particular week can follow and easily create a wonderful story along with the Algorithm Designers and Illustrators for the week. The books were quite an enjoyable read and I learnt a lot and I am passing on what I learnt to my team mates which will help us all in this Project. I hope everyone finds it useful and that it will take our Project to a new level. Give the PDF a read! Hope you like it. Cheers.



Writer's  
Guide- T....

## Writer's Guide:

**T.H.Arjun - 1st Oct ( Subject to Change )**

**A simple Checklist and Guide for Writers to follow while writing a Problem/Episode.**

**Aim of the story : Break the Loner Myth**

The loner myth is famous in pop culture. The aim of the story should be to break this myth.

**Story Arch:**

**Protagonist:** Has no friends, doesn't care of family etc.

**Believes :** Emotions are for the losing side. Greatness comes from shutting down emotions and only through logical thinking.

**Obsession :** To show that he can solve any problem ( will not rest unless solved )

**Characteristics:** Fast paced speech, photographic memory, deduction skills, thinking skills, lack of social skills, lack of regard for social norms ( talks without thinking) , doesn't think about other people and their feelings. Arrogant, does not work well with a team.

The character is like a Computer. His mind is a computer. His memory is the hard disk.

**JChanges in character:** Opens up, connects with people, should understand the importance of teamwork, empathy > logic.

JChanges in character: Opens up, connects with people, should understand the importance of teamwork, empathy > logic.  
Cuts out people and unwanted memories.

Changes :

The story arch should guide him away from this lonely existence. Instead of being a computer he should finally become a human being. Instead of being a cyborg, burying his emotions the character becomes better at human connections. Steadily develops compassion. Exposes human Vulnerability. Starts caring for the people around him. Learns that he can be human and still achieve his goals. Builds meaningful relationships. Works through feelings . Embrace humanity. Emotional Fortitude makes you smarter. True genius is the capacity to feel. Empathy, Collaboration are crucial. Importance of empathy in problem solving.

Antagonist 1:

Likeable, proud, smart, vengeful.

1. Worthy Opponent
2. Tests the hero to make sure he is worthy
3. Attacks on personal level

4. Attack Strengths
5. Knows the Weakness
6. Attacks the weakness : You always want everything to be clever
7. Drives character development
8. Personal growth for Protagonist
9. Gives choices
10. Knows the choice of the hero
11. Both are genius
12. Believes they will further society
13. Competes for the same goal : Solve Problems
14. Direct Competition

#### Antagonist 2:

The psychopathic character. Ruthless same characteristics as the protagonist. But lacks empathy, sympathy. Mad fellow. Unmatched Genius. Can reach great heights, Alone , no one who can relate.

#### Finale:

Does he learn to empathise, connect? The final test: Empathise with Antagonist 2, be there for the lonely.

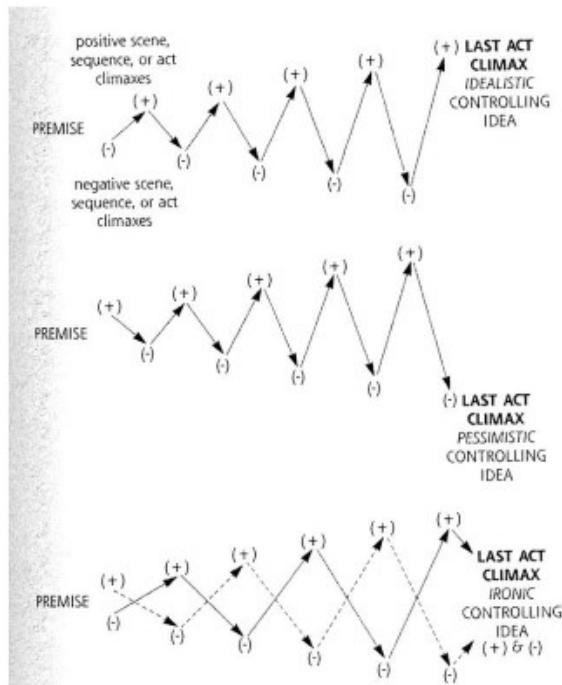
#### The Problem Structure:

1. The first thing an episode does is raise questions to the reader. Non-Linear time could be used to take advantage of this. Reveal some info but not all just to spark enthusiasm (Opening scene of the Matrix is an example)
2. Establish the Situation : The next step is to establish the current state of things. External Conflicts and Internal Conflicts against the Protagonist.
3. Decide upon the actions that create conflict. Establish the chain reaction of conflict.
4. Make sure Setting is established and the level of conflict and change in character is more intense than the last episode.
5. The decisions that the protagonist should take should be of higher order and of greater difficulty and he should change and learn something new
6. Make sure that there are enough new revelations in this episode.

Choices : The choices should be tough. Revelations should be there and it should reveal the character and his change.

Establish the Character Arc for the Episode: Show character change through action, the actions should be deep.

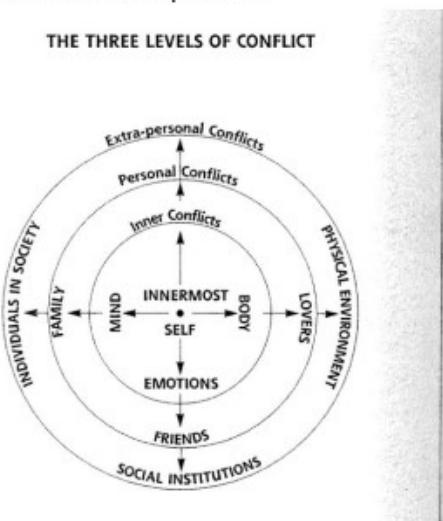
Make sure the climax is a point of no return.



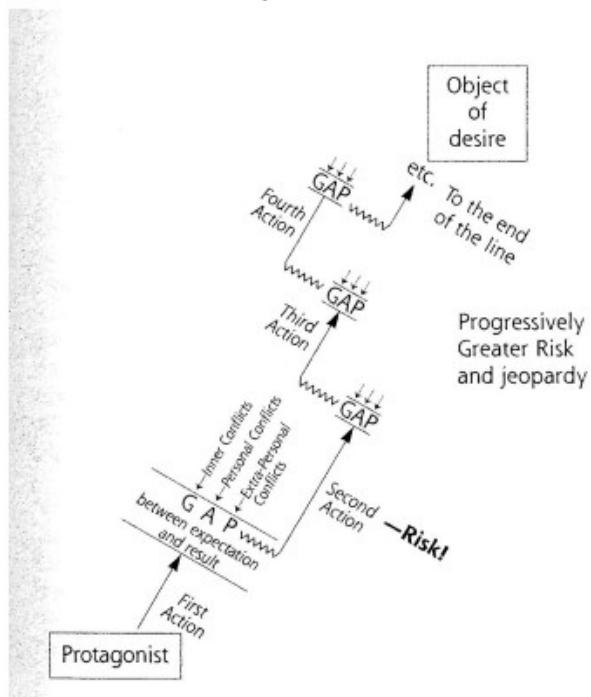
In each Episode

Establish the Current state of the Protagonist:

1. Willfulness
2. Object of Desire
3. Conscious Desire
4. Unconscious Desire
5. Need
6. Establish Empathy
7. Provoke conflict if possible

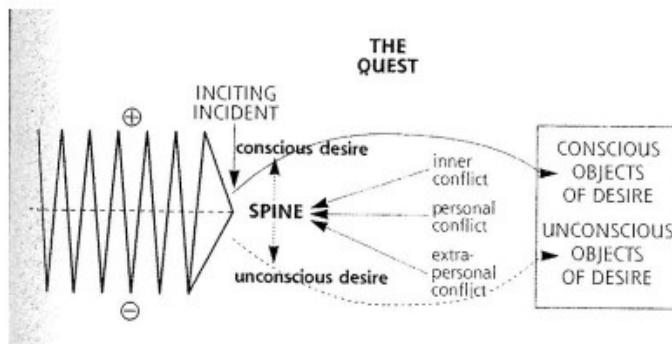


## Structure of Problem by Action



Make sure everything is a beat. A beat is an action reaction pair.

Decide the inciting incident of a problem. It should unbalance the current equilibrium. The protagonist should react to the inciting incident. Now comes the journey and point of no return.



## Steps to writing a scenes

1. Define Conflict
2. Note the opening values
3. Beats
4. Note closing value ( should change)

Make sure there is an effect of the Problem on every character and deeper effect on society

Try to include ironies.

They are as follows:

1. He gets what he wants, but too late
2. He is pushed further and further to later find out he was led right to it.
3. He throws away then finds it is his true happiness
4. His steps to achieve something makes him further away from it
5. His actions destroys what he wanted to save
6. Comes in something that will make him miserable does everything to get rid of it but later discovers it's a gift of happiness

### Setting up the Climax

1. Crisis - the final chance to achieve what he wants. Antagonism strongest. Revelation and change.
2. Move the heart of the reader
3. Resolution- the final answer

Always try to show, don't tell

**KEY POINT:** The main character is only as good as the person he fights

1. Make the opponent necessary. The single most important element of a great opponent is that he is necessary to the hero. This has a very specific structural meaning. The main opponent is the one person in the world best able to attack the great weakness of the hero. And he should attack it relentlessly. The necessary opponent either forces the hero to overcome his weakness or destroys him. Put another way, the necessary opponent makes it possible for the hero to grow
2. Make him human. A human opponent is not just a person as opposed to an animal, an object, or a phenomenon. A human opponent is as complex and as valuable as the hero.
  - The opponent-double has certain weaknesses that are causing him to act wrongly toward others or act in ways that prevent the opponent from having a better life.
  - Like the hero, the opponent-double has a need, based on those weaknesses.
  - The opponent-double must want something, preferably the same goal as the hero.
3. Give him values that oppose the values of the hero.
4. Give the opponent a strong but flawed moral argument.
5. Give him certain similarities to the hero.

A simplistic opposition between two characters kills any chance at depth, complexity, or the reality of human life in your story. For that, you need a web of oppositions.

Each opponent should use a different way of attacking the hero's great weakness.

Try to add an apparent defeat.

### Checklist :

1. Self-revelation, need, and desire
2. Ghost and story world
3. Weakness and need
4. Inciting event
5. Desire
6. Ally or allies
7. Opponent and/or mystery
8. Fake-ally opponent
9. First revelation and decision: Changed desire and motive
10. Plan
11. Opponent's plan and main counterattack
12. Drive
13. Attack by ally
14. Apparent defeat
15. Second revelation and decision: Obsessive drive, changed desire and motive
16. Audience revelation
17. Third revelation and decision
18. Gate, gauntlet, visit to death
19. Battle
20. Self-revelation
21. Moral decision
22. New equilibrium

2<sup>nd</sup> Oct - Day 2

02 October 2020 23:50

Today I spend time, thinking how much we can go in terms of detail in illustrations, I tried out various styles in illustration and came up with the level of detail that can be achieved without overcomplicating the project. The rest of the time I spend studying some character studies for Comic. I am putting below the level of detail that I am planning to maintain throughout the comic. Hope you people enjoy it! 😊

Character Study.



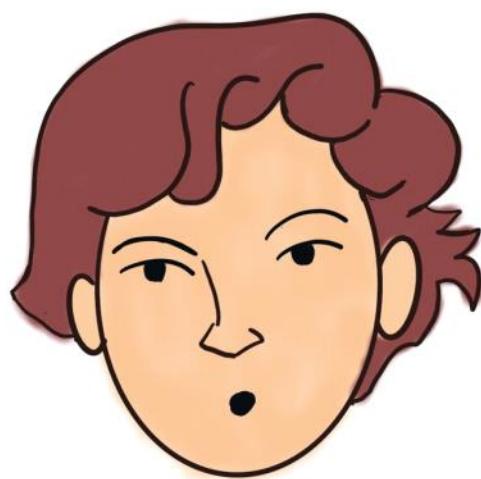
Natural Expression.

Character study.



Angry Expression.

Character study.



Surprised Expression.

My Plan is to follow this level of detail which is actually inspired by the Tintin comics. I also spend some time today working with Algorithm Designers. They should be up with something unique by Sunday which will be fun to write on and illustrate in the upcoming days.. Can't wait!! 😊

# 5-6<sup>th</sup> Oct : Day 3 and Day 4

07 October 2020 06:35

On 5<sup>th</sup> and 6<sup>th</sup> Oct , I spend my timing writing the First Draft on the idea given by Harsha on Merge Sort. Merge Sort was the best one to go for in the first episode of the Comic as it is a fairly easy to understand Algorithm. I changed the constraints provided by Harsha to emulate a computer in real world.

The changes I brought to the rules:

Each of the Boxes have some number of balls inside it 0 to 7 ( Array elements ). But they are closed ( Computer only knows the number once it accesses it ) and all are identical. All boxes are identical. The boxes are kept on plates numbered from 0 to 7 ( Array indices ). The numbers inside the boxes are intensities of Bombs Vandal is going to set in 15 mins to 8 different places throughout the country. The numbers on the plate represent the population intensity near the bomb at that particular place. 0 represents maximum population in terms of population and 7 represents maximum bomb intensity in case of bombs. It is the same as putting the boxes at their right places. Villain explains there is a catch. Hero cannot go near the boxes. If he does then all bombs explode at the same maximum intensity at all places. The conditions are given below:

1. Each time Villain will call a person from the audience ( refer story given below ). The person can open only two boxes and count the number of balls. He/ She cannot tell it to anyone. But He/ She can move as many boxes as he/she wants. He should leave and the next person comes having no idea of numbers. This will emulates a computer as a computer does not know what is inside the array and accesses it for comparison. The same happens here because of a new person. He/She has to access it each time, emulating a computer in real life.
2. There can be only at max 48 ( 2N reads per level \* no of levels \* number of elements in array ) of array opening of boxes or bombs will go off.
3. Hero has to pass on the instructions as it is done. He cannot go near them. This will help in explaining merge sort visually and through dialogues.

The passing on instructions will be merge sort.

I have added a lot of Scenes following the writer's guidelines and have put it down. But somethings are explained in plain English and needs to put into dialogues, which I am leaving for another member to enjoy doing. Hope you enjoy the first draft, I have also put the link to the editable google doc in general chat. Read the story and enjoy. Also all changes are welcome. Cheers!

Below is the first draft: ( Editable Doc in Google Docs, check General Chat for link )



Episode 1-  
First Draft...

## Comic Episode 1:

First Draft Script : T.H.Arjun

Algorithmic Situation : Nandimandalam Veera Sree Harsha Reddy  
Date: 5-6th October 2020

First Episode: We set the tone of the comic and go for an easy algo as to introduce the characters and storyline.

characters and storyline.

## Kill Sort

### **Scene 1 ( Computer Screen : Internet Chat )**

#### **Tue 10 March**

Chat 1: Did you make contact?

Chat 2: He is not that easy to get in touch with according to my contacts.

Chat 1: He is our only hope imo.

Chat 3: He calls himself a Criminal Consultant and we can't consult him?!

Chat 1: He decides who to provide service to...

Chat 3: Hmm...

Chat 1: I have contacted a person who has consulted with him before... Let us wait

#### **Thu, 12 March**

Chat 1: Hey, he made contact.. He is not ready to show himself.. Nobody in the world knows who is .. But he will help. He has grand plans..

Chat 2: But, can we trust him?

Chat 3: Heard he is quite brilliant... What do we have to lose anyways? If it works out great for us or else a bad name for him..

Chat 1: Yeah.. Let us follow his instructions...

Chat 2: I agree.. Let us stay in touch..

*The Scene starts with the following chat on a Computer Screen.. The purpose of the scene is to set the mood of the episode , and put intriguing thoughts to the reader  
The questions this scene puts forth are:*

1. Who are these people?
2. What are they up to?
3. Who is the Criminal Consultant?
4. What are his Instructions?

### **Scene 2 ( TV Studio Backstage )**

{ We see a woman getting TV make-up done ( late 30s , looks like a presenter on TV ) . A man in his late 40s, a bit fat , wearing headphones and glasses stands next to her, he looks worried. ( he has the look of a TV Director ) }

Man : Charlotte, Do you really want to do this?

Charlotte ( the woman ): How many times I have to tell you John? Yes.

John ( the man ): The man you are about to put on the show, the show that America Loves the most, the highest rarest show that this channel has is a Psychopath? Do you realise that?!!

Charlotte: As he likes to correct others, " He is a high functioning sociopath.. "

John: I don't want a madman on my show that I spend years building, destroying it in a day..

Charlotte: Audiences love quirky people... And who is more quirky than a person , a true genius.. A true genius who put a whole lot of people in danger last week so that he could prove that he was right!

John: But with the Criminal Consult now involved after the incident.. And him already telling what all nonsense about him.. You know what happens when you provoke him , Don't you?

Charlotte: If something happens.. It will only increase your ratings.. Trust me..

John: What about the Documentary? Why is he invited on the show ?

Charlotte :

*Purpose of this scene is to give a bit of context of the hero. It starts the following questions:*

1. Who is this Psychopath/high functioning sociopath?
2. What is the incident?
3. What happens when you provoke the mastermind?
4. What is happening?

### **Scene 3 ( On Stage ):**

*Charlotte walks on to stage, A lean, smart looking man, in his early 30s sits in the chair, next to him a more plump, short man of the same age..*

Charlotte: We will start in a few minutes boys... Get ready.

( She goes away to John and starts a chat )

Lean Man: Do you know how many people are there in this world with a PhD in Computer Science or Criminology?

Plump Man: A few million may be.. Wait, you have a PhD?

Lean Man : And how many went to both MIT and Harvard...

Plumb Man: How would I know?

Lean Man: I have in both..

Plumb Man: Both what?

Lean Man: So how do you distinguish yourself, since I have 4?

Plumb Man: So you want to distinguish your PhD?

Lean Man: That is not the point.. How do you distinguish yourself, Stephen?

Stephen: I consider myself a good Documentary Filmmaker.

Lean Man: **It is not about you, It is about me.**

Stephen: What about you?

Lean Man: You idiot.. I can't believe you puny living things can live with those small brains of yours..

Stephen: Jekyll, that was so rude...

Jekyll : I have a good gig for you.. Better than your current stupid documentaries about politicians and their stories..

Stephen: How dare you call them stupid?

Jekyll: We all know how hard you want to move up the filmmaking world, Stephen. The thing is I am offering a chance for you to follow a mastermind during his problem solving journey. A grand journey full of twists and real life consequences. The thing is people will love the real me and a documentary on it will be awesome. They will come to know the real Jekyll and will fall in love. And you can be a part of it.

Stephen: The thing is you want people to love you.. But deep down you know the truth

Jekyll..

( Charlotte interrupts the conversation )

Charlotte : Let us start boys...

The camera starts rolling.. ( TV Show Audience claps )

Charlotte: Welcome back to America's Favourite TV Show " Talks with Charlotte" today we have two guests, one who has made the news because of the incident that we all know which turned out to be a big controversy and another who has made the news for of the most viral heart touching documentaries on the internet. I welcome Jekyll Helm and Stephen Sputnik on to the show. So let us get this straight. You too have been trending on the internet lately in which way has it affected you.

Jekyll: My experience is better than the time that you had while during your divorce, Charlotte ( laughs)..

( John makes a told you so face, Stephen looks surprised, Charlotte irritated )

Stephen : Mine has been pleasant and the response has been great

Charlotte: How did it feel when you put the life of 100s of people on a ship in danger, Jekyll , just to prove a point that a Criminal mastermind is a Psychopath who just wants attention.  
Jekyll : The thing is finally I was correct, I didn't care about the people, because I knew I was right, people say I am no different from him, but what actually matters is I was right at the end and we all know it.. " he is a Psychopath urging for attention" and he is no smarter than a three year old.  
( Jekyll sarcastically laughs)

( The TV Studio Screens start Flashing. Everyone looks scared. The audience looks bewildered. )

( Cut to the computer screen.)

Chat 1 : The time has come

Chat 2 : Yes. It is happening.

Chat 1: I hope everything goes as planned.

Chat 3: Master is playing with no ordinary dude.

Chat 1: But if everything goes according to plan, he won't know what just hit him

( Cut back to the studio. All screens show a man sitting in darkness. We can make out his silhouette, Giovanni in Pokemon style )

Man : Stunning statements indeed, by your wonderful guest, Charlotte.. Now I see why your show is America's favourite..

John: shut it down.. no more telecast. This might go out of hand.

Assistant : Sir this is going great for us.. ratings are rising, social media shares are high, We might actually become America's favourite talk show finally..

John : We already are..

( Assistant murmurs )

Man: I challenge you, Jekyll on live TV. Prove your superiority if you think you are really that great... But there will be real consequences.

// Writer's Task - Expand the following to scenes and dialogues . Follow the style above

( People Persuade Jekyll not to.. But he is arrogant enough to accept the challenge. Show the City Police being informed. People switching on TVs. The whole country tunes in )

Man : Since you accepted the challenge.. Jekyll here we go.. The challenge is quite simple.

// Writer's Task- Break the following to scenes- should be explained visually as it is a comic  
But we need dialogues to explain the visuals. Write Appropriately

( One of the Assistants brings a bunch of Boxes placed on plates. Tells to John it in came in the mail. The man on TV tells him to call Vandal ( villain ). He starts explaining the problem. Each of the Boxes have some number of balls inside it 0 to 7. But they are closed and all are identical. All boxes are identical. The boxes are kept on plates numbered from 0 to 7. The numbers inside the boxes are intensities of Bombs Vandal is gonna set in 15 mins to 8 different places throughout the country. The numbers on the plate represent the population intensity near the bomb at that particular place. 0 represents maximum population

in terms of population and 7 represents maximum bomb intensity in case of bombs. Jekyll realises it is the same as putting the boxes at their right places. He laughs. But Vandal explains there is a catch. Jekyll, or camera cannot go near the boxes. If he does then all bombs explode at the same maximum intensity at all places. The conditions are given below: The should be made to dialogue and the coming process should be explained visually in comic:

1. Vandal will list all places of bombs at the start of the game. ( Police force relieved.. They can try something to solve the problem , Don't use dialogues for this)
2. Each time he will call a person from the audience. The person can open only two boxes and count the number of balls. He/ She cannot tell it to anyone. But He/ She Can move as many boxes as he/she wants. He should leave and the next person comes having no idea of numbers.
3. There can be only at max 48 ( 2N reads per level \* no of levels \* number of elements in array ) of array opening of boxes or bombs will go off.
4. Jekyll has to pass on the instructions as it is done. He cannot go near them

The passing on instructions will be merge sort. There are people murmuring in Audience. The screens show the places that bomb. Stephen tells that there is something about those places, something that comes to his mind. Something that connects them. But he can't actually get it. The police force at the concerned places get busy with evacuation and finding the bombs. The game begins. Charlotte tells the naive algorithm without thinking. Vandal could have put everything in descending order and that would require  $O(N^2)$  at the worst case. He tells others that they can do it using Merge Sort. This algo part is gonna be shown virtually. Jekyll starts instructing the people coming from the audience. The game gets to the final step. Stephen gets the whole thing but it is too late, those places are where Criminal Databases are located. He goes and tries to inform others. Jekyll shouts at him, and he has actually solved it. Stephen shouts back and tells them they all lost it and he won. No bombs go off. Vandal starts an evil laugh.

In between, cut to the chat:

Chat 1: That stephen guy.. He will mess it up

Chat 2: Two more seconds... Done.

Chat 1: Now we are free

Chat 2: Yes.. It's a success. He is truly a criminal mastermind.

Vandal congratulates Jekyll for finishing the task as instructed and helping him finish the actual task. While the police forces and the country were preoccupied, he and his people launched a cyber attack on criminal databases and emptied it, even the backups. Now most uncaught criminals are free. Vandal tells the biggest flaw in Jekyll is that he wants people to love him, he wants to solve problems for them to achieve this and prove he is right. He wants every problem to be grand but they are not. Jekyll gets irritated, he was used. Vandal explains the game has only started. They have found their worthy opponents.

// Writer's can go for catchy dialogues- Follow the writer's guideline to setup stuff

Frustrated People leave the studio.. On the way out Jekyll turns back tells to Stephen

: Oh by the way, the offer is still open for documentary.. Your brain is not as small as I thought. We will make a great team. The game has only started. I will crush him. Meet me at my home if interested... You don't wanna miss the real game..

He winks and leaves. Stephen smiles.

( Jekyll considers Stephen as an equal now. Both have earned the respect for each other )



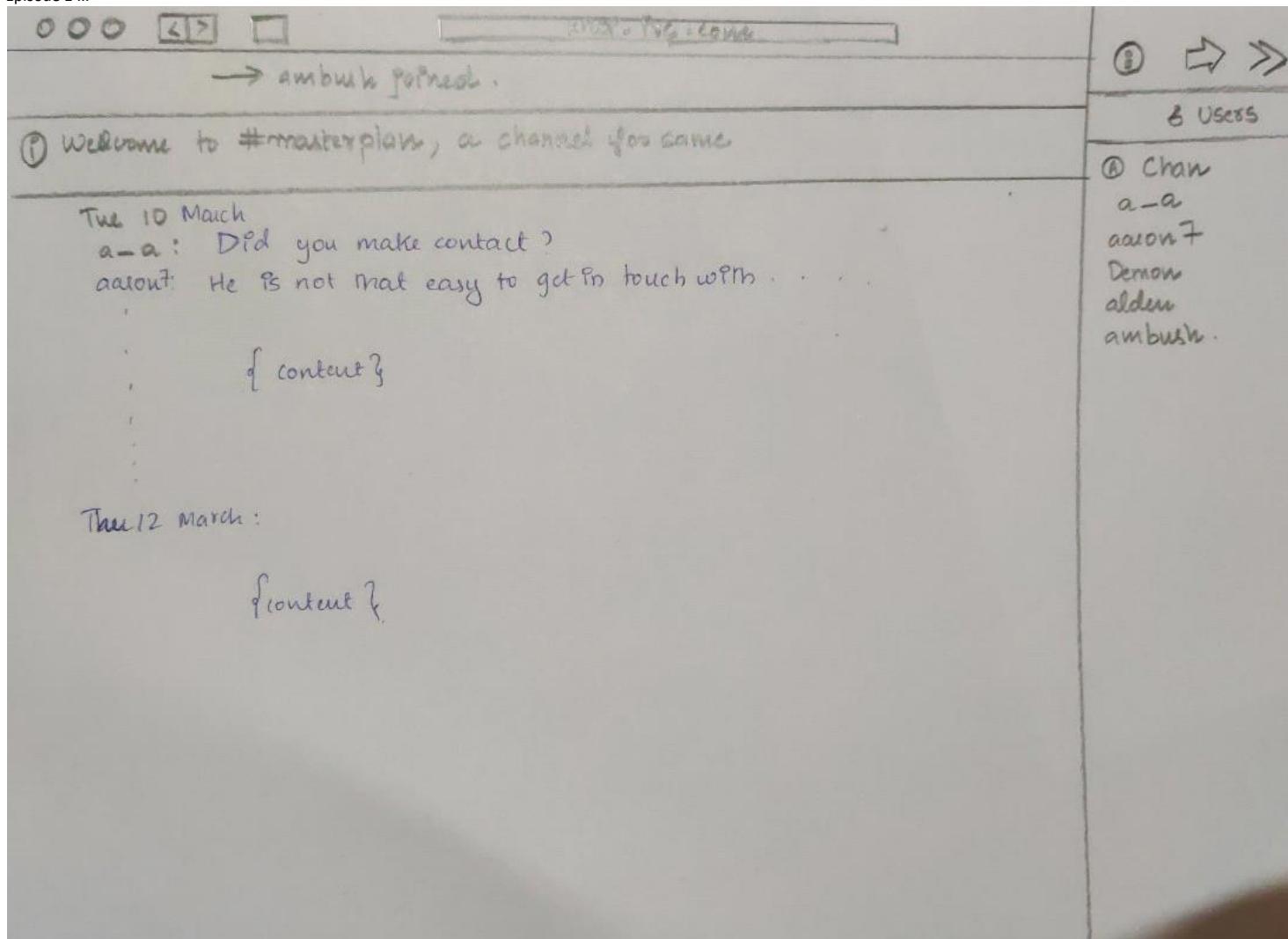
19<sup>th</sup> Oct- Day 5

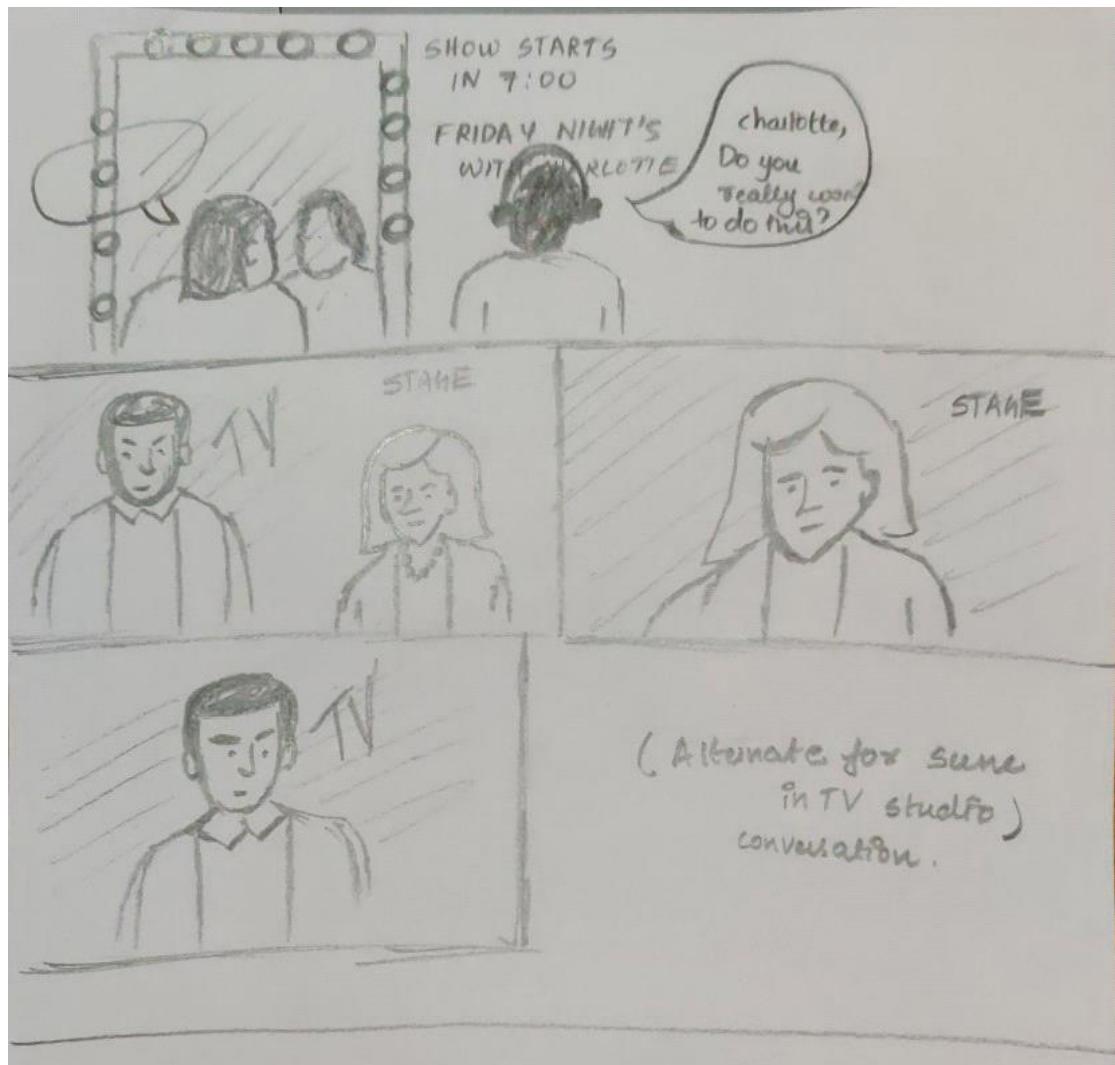
20 October 2020 00:07

Today, after a long schedule of deadlines and exams, I was able to get back to work on the comic. I spend my time drawing the templates or composition of various frames to be used in comic. I hope to convert them to digital form in the coming days and add dialogue and all. Attaching here, the composition drawing, Episode one should be done in the coming days with this as basis. Cheers! Hoping to complete Episode 1 soon. :)



Comic  
Episode 1 ...







# 20-22 Oct Day 6,7,8 – Awesome 18+ Hours of Illustrations!! - T.H.Arjun

22 October 2020 05:35

On the three days of Oct 20, Oct 21 and Oct 22 early morning, I spend my time finishing up episode 1 of the comic. It was exciting and very interesting to work on it. Couldn't get time to write a post for each day. So writing it here, as a single file.

## All the files that was used in Episode 1

Package of InDesign Files also included.

I started working on iPad for the illustrations on 20<sup>th</sup> Oct. And created the following statistics for work from procreate app. Proud to say that such effort was put in and I am proud of the final result.

Jekyll art- 898 brush strokes, Tracked time: 1 hr 11 min

Director and Interviewer Art – 361 brush strokes Tracked time : 29 min

Director Art – 444 strokes, 33 min

Interviewer Art - 290 strokes, 20 min

Talk Show Art – 354 strokes, 1 hr

Stephen Art – 159 strokes, 22 min

Vandal Art – 179 strokes, 1 hr 22 min

This is tracked time, much more time was spent on the art for conceptualising and all.

The next part took me to putting all art work from iPad to my laptop and editing in Photoshop and converting to layers. Some parts of the comic were designed in Adobe Illustrator ( like the chat part)

Then I moved onto work in Adobe InDesign to put everything together, the dialogues, the pictures that I drew on iPad, info from Harsha on Algos etc. Hours were spent in compiling everything in InDesign. After Editing, all the files were exported in Adobe formats, which are uploaded in the TEAMS file section. All files are pdf, eps, png, .ai, .psd, .idml formats. These can be opened using Adobe Software.

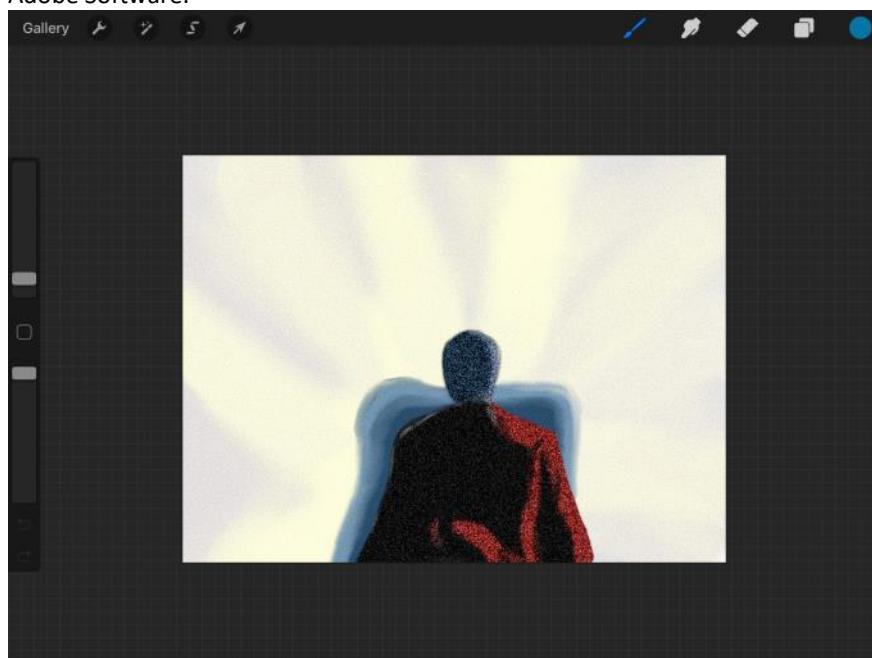


Fig. Initial art work was done in Procreate App on iPad using Apple Pencil which was later exported to PSD format to bring in Photoshop on Mac.

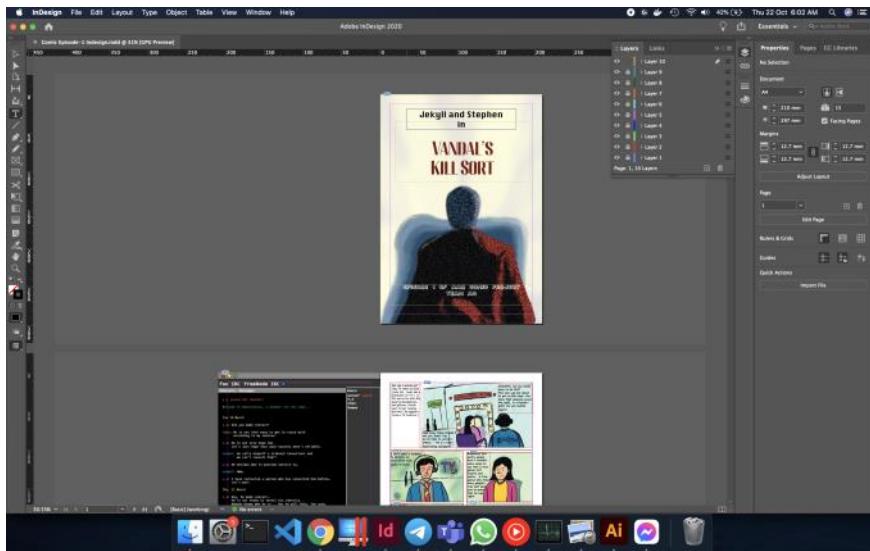
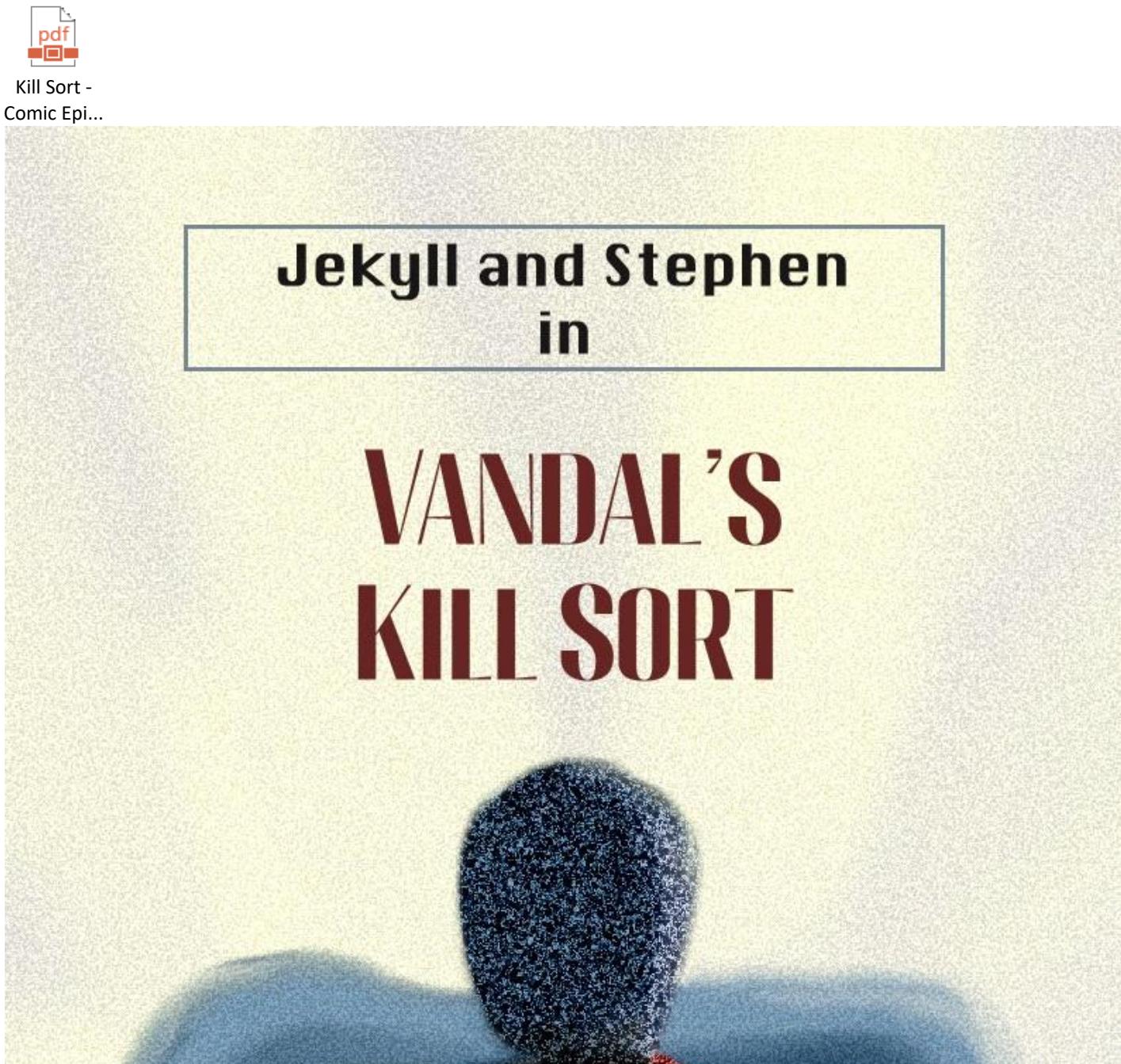


Fig. Compiling Artwork, Editing Dialogues etc done in Adobe InDesign

After 18+ hours of Illustration, Editing, Compiling, and other Miscellaneous work I was able to finish my work on episode 1 of comic. The comic is given below. Hope you like it . Cheers 😊 . And also couldn't have done it without the awesome team who helped along the way! More coming soon!





**EPISODE 1 OF AAD COMIC PROJECT  
TEAM AQ**

Foo IRC FreeNode IRC

Channels- Messages

a\_a joined the channel!

Welcome to #masterplan, a channel for the same...

Tue 10 March

a\_a: Did you make contact?

Chan: He is not that easy to get in touch with according to my sources.

a\_a: He is our only hope imo.  
Let's just hope that your sources aren't reliable.

aaron7: He calls himself a Criminal Consultant and we can't consult him?!

a\_a: He decides who to provide service to...

aaron7: Hmm...

a\_a: I have contacted a person who has consulted him before...  
Let's wait

Thu, 12 March

a\_a: Hey, he made contact..  
He is not ready to reveal his identity..  
Nobody knows who he is .. But he will help, for sure.  
He has big plans..

Chan: But, can we trust him?

aaron7: I've heard that he is quite brilliant...  
What have we got to lose anyways?  
Either we get what we want or he loses his fame,  
it's a win-win.

a\_a: Yeah.. Let us follow his instructions...

Chan: I agree.. Let's stay in touch..

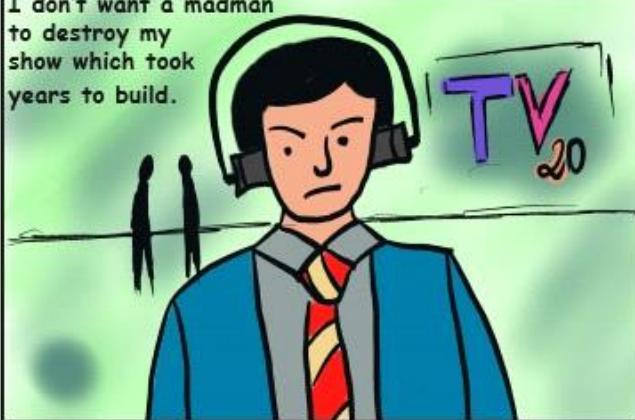
Users

aaron7 (admin)  
a\_a  
Chan  
Demon

We see a woman getting TV make-up done ( late 30s , looks like a presenter on TV ) . A fat man in his late 40s, wearing headphones and glasses, stands next to her, looking worried. ( he appears to be a TV Director )



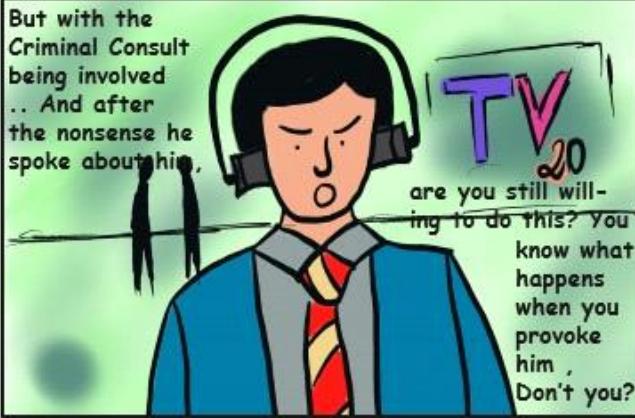
I don't want a madman to destroy my show which took years to build.



Audiences love quirky people... And it wouldn't make sense to say that a true genius isn't bizarre and quirky.. A true genius who risked many people's lives last week just to prove that he was right!



But with the Criminal Consult being involved ... And after the nonsense he spoke about him,



No incident would hamper your show's ratings.. Trust me..



What about the Documentary guy? Why is he invited on the show ?



Charlotte walks on to stage. A lean, smart looking man, in his early 30s sits in the chair, next to him a more plump, short man of the same age..

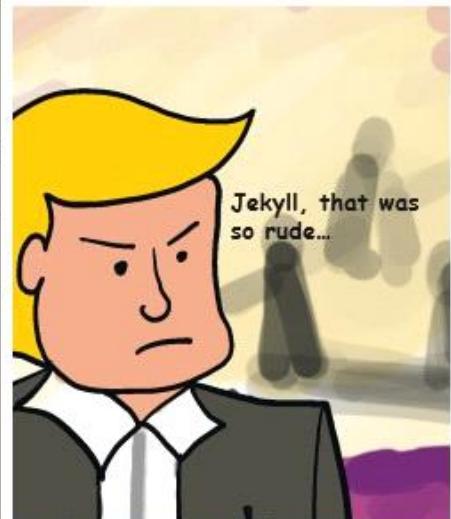
We will start in a few minutes boys... Get ready.



What about you?

You idiot.. I can't believe you puny living things can live with those small brains of yours..

Talk show with Charlotte



I have a good gig for you..  
Better than your current  
stupid documentaries about  
politicians and their stories..

How dare you call them stu-  
pid?



We all know how hard you work to develop the filmmaking world, Stephen. The thing is I am offering a chance for you to accompany a mastermind during his problem solving journey. A grand journey full of twists and real life consequenc- es. The thing is people will love the real me, and a documentary on it will be awesome. They will come to know the real Jekyll and will fall in love with him. And you get to be a part of it.



You want everybody to love  
you.. But deep down you know  
the truth Jekyll..

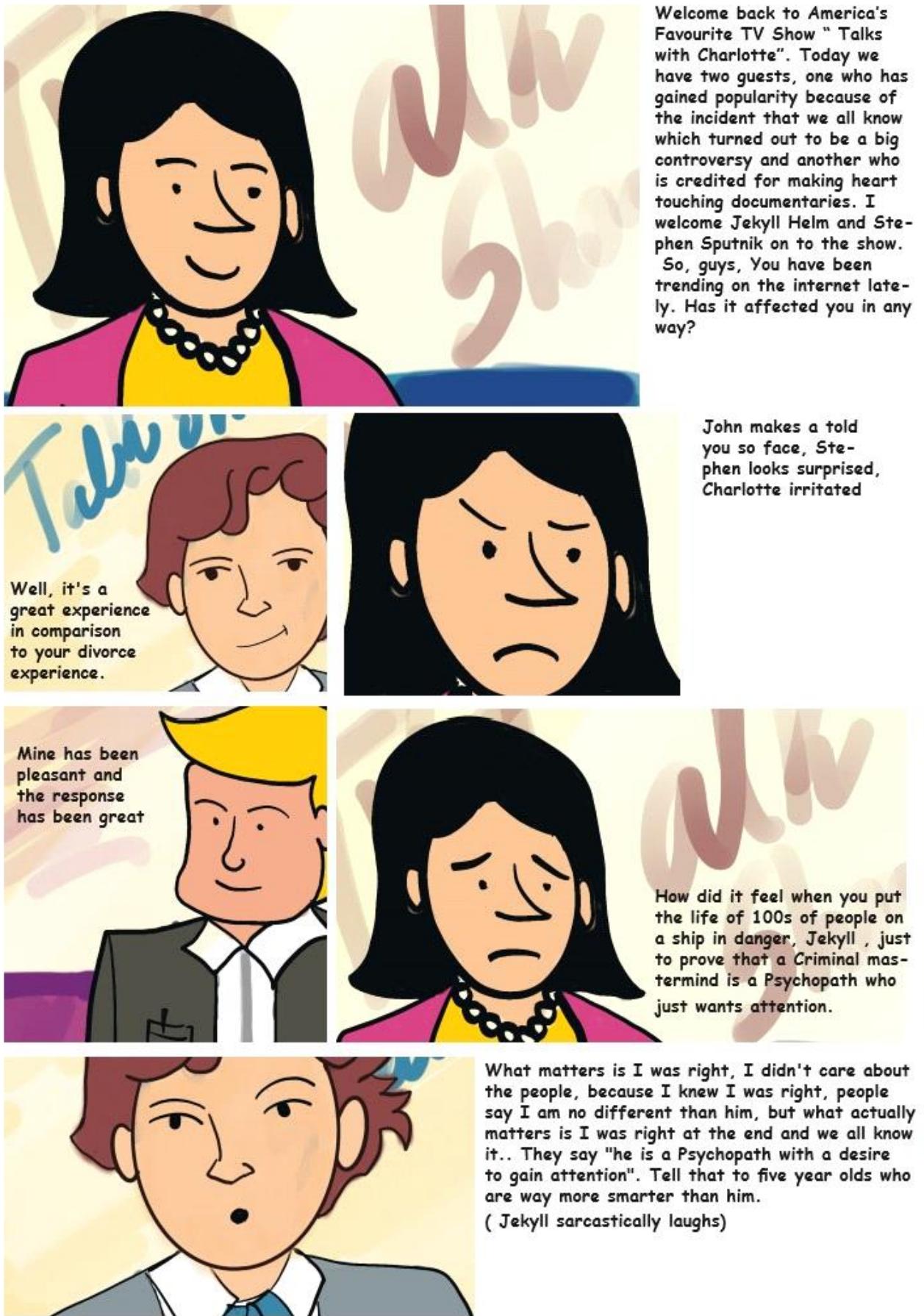


( Charlotte interrupts the conversation )

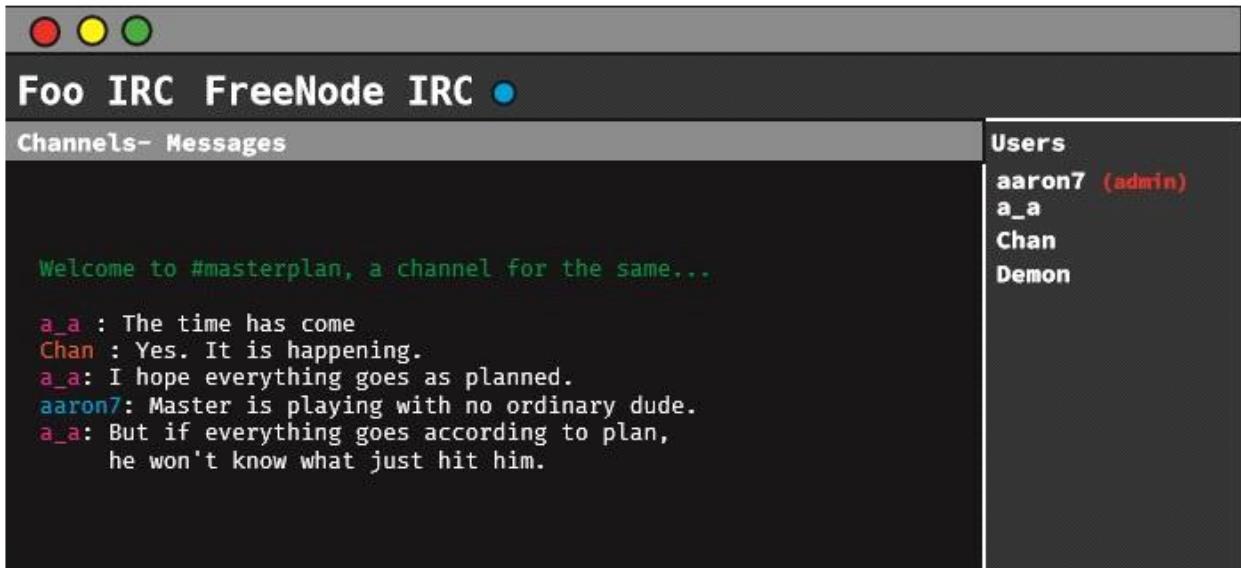
Let us start boys...



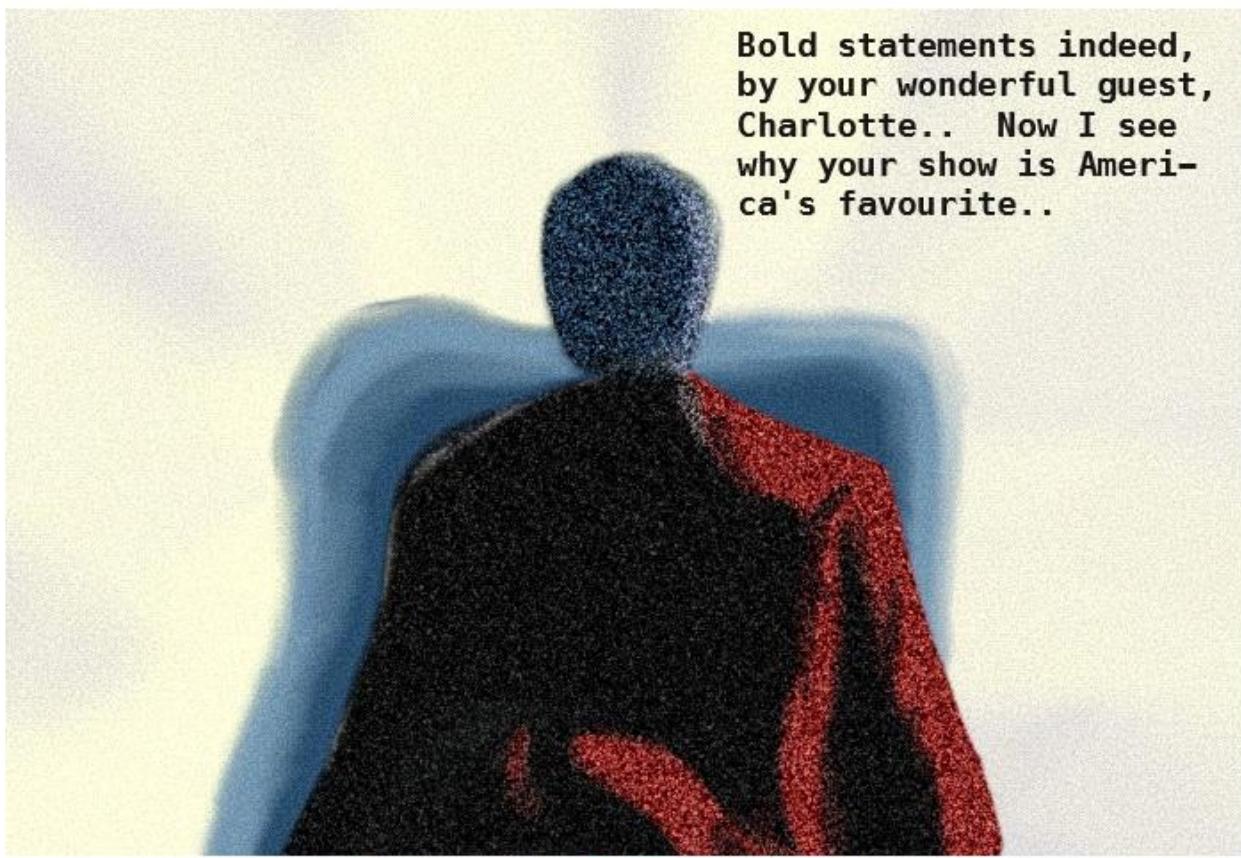
The camera starts rolling.. ( TV Show Audience claps )



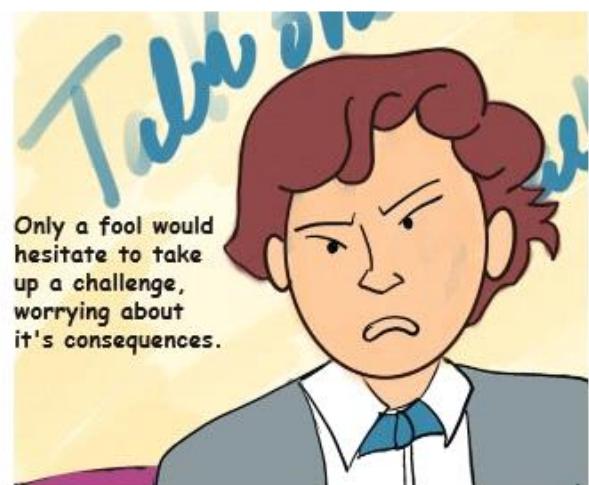
The TV Studio Screens start Flashing. Everyone looks scared. The audience looks bewildered.



All screens show a man sitting in darkness. We can make out his silhouette.



I challenge you, Jekyll, on live TV. Prove your superiority if you think you are really that great... But there will be real and serious consequences if you fail.



Way to go John, your guy is willing to take up the challenge without even worrying about what might go wrong if he fails! But why not give everybody the thrill of knowing what's in store for them? Spoiler alert viewers! You're gonna get bombed.. (Laughs hysterically).



Enough is enough! Stop the telecast and shut down the systems.



John: You will bloody know if you don't shut it down now.

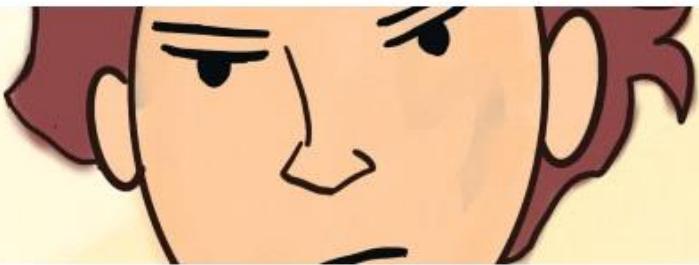


Don't trust your guy John? (Laughs). See Jekyll, All you gotta do is piece this Algorithm puzzle together, and figure out the best way to save the people who you don't care about, from the bombs I'm gonna drop soon.

Jekyll, Let the people around you know that you are nothing but a man who doesn't care about the severe consequences and has a strong urge to be liked by everyone. A puzzle's solution is not what I see, it is the realization of the people that their plans are worthless and can lead to severe chaos, is what I wanna see. I just want to show people the reality, and how funny they think that they aren't dangerous.

Everybody persuades Jekyll not to take up the challenge... But,

I accept this challenge!!!



Everybody is shocked, the number of people watching the show steadily increases. Whole country tunes in.

TVs Rumble with the Man's voice: "Since you accepted the challenge.. Jekyll here we go.. The challenge is quite simple."

One of the Assistants brings a bunch of Boxes placed on plates.

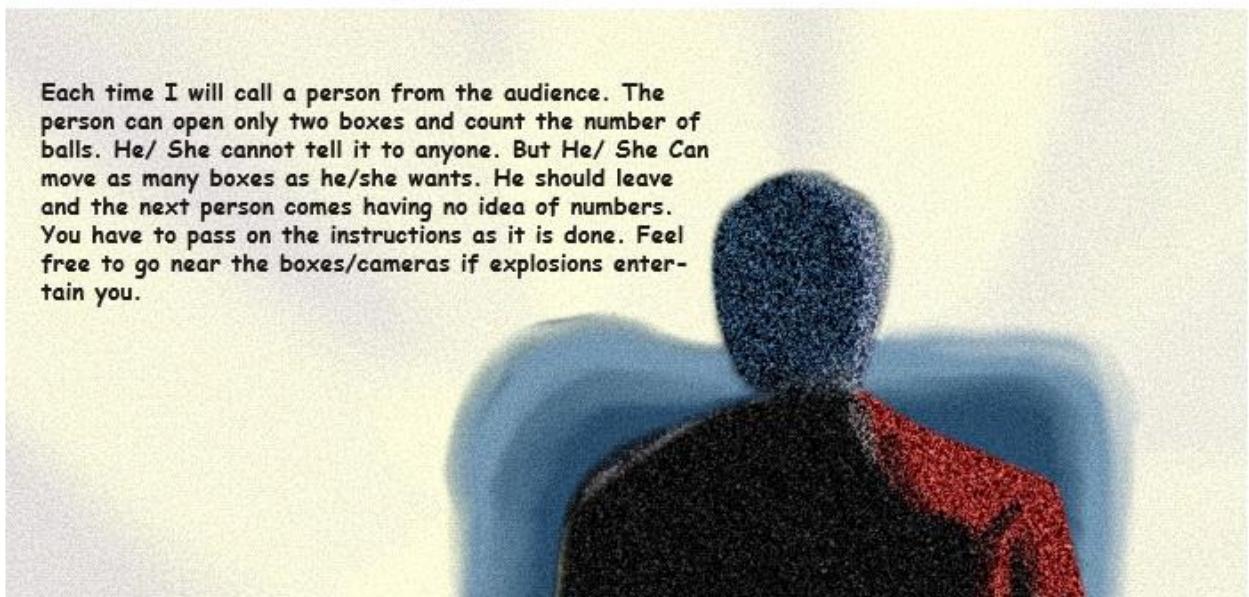
I really appreciate your interest in doing what I hate.



Call me Vandal, you might need to remember the name of someone who enlightened you.



Here comes the problem. There are 8 boxes. Each of the Boxes have at most 7 balls in it. But they are closed and all are identical. All boxes are identical too. The boxes are kept on plates numbered from 0 to 7 inclusive. The numbers inside the boxes are intensities of Bombs I'm gonna set in 15 minutes to 8 different places throughout the country. The numbers on the plate represent the population intensity near the bomb at that particular place. 0 represents maximum population in terms of population and 7 represents maximum bomb intensity in case of bombs.



There are people murmuring in Audience. The screens shows the places that have bombs.

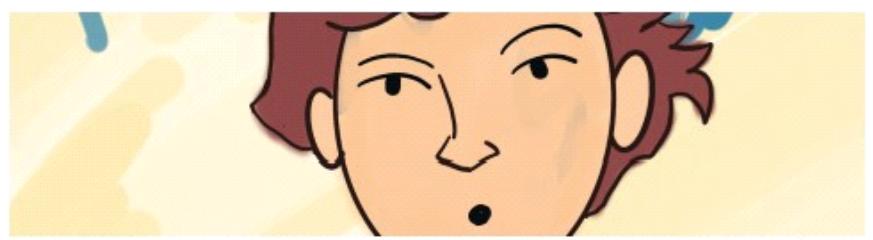


Meanwhile, The police force at the concerned places get busy with evacuation and finding the bombs. The game begins.

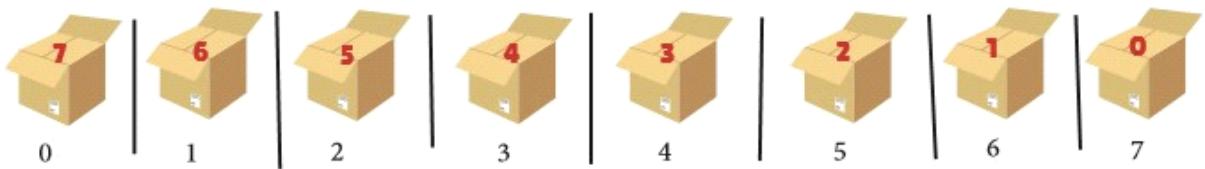


I feel that an approach would be to find the minimum value, place it at the beginning, and keep doing this for all elements by excluding previously placed ones. In the worst case, Vandal must have put everything in reverse order, and might need order of  $N^2$  computations, that is,  $O(N^2)$

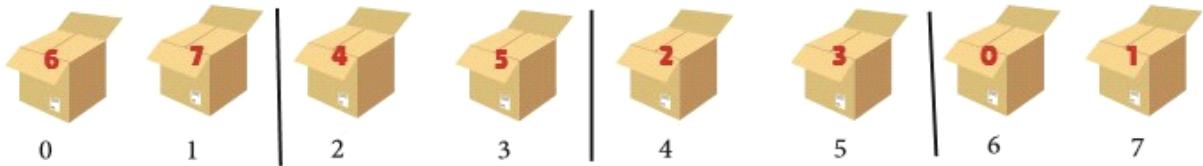
Not necessary, the problem can be broken down into smaller subproblems and be solved individually, so that it would be efficient even in the worst case. Yes! Merge sort is the way to go!



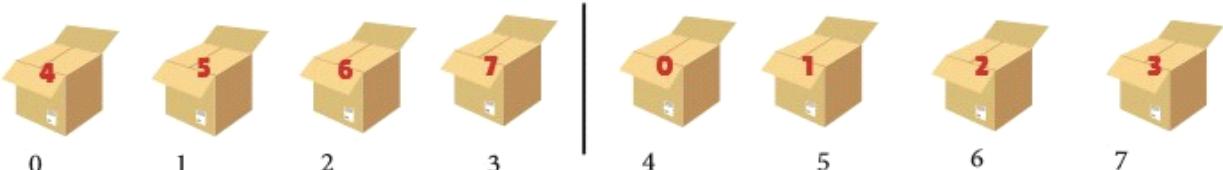
Initial state of boxes are shown below. The red numbers are number of balls inside. Nobody knows it. The below numbers are plate numbers. Jekyll quickly partitions in mind making it like down below.



Vandal calls 4 people from the audience one by one and according to Jekyll's instructions they go to each partition and arranges them as given below...



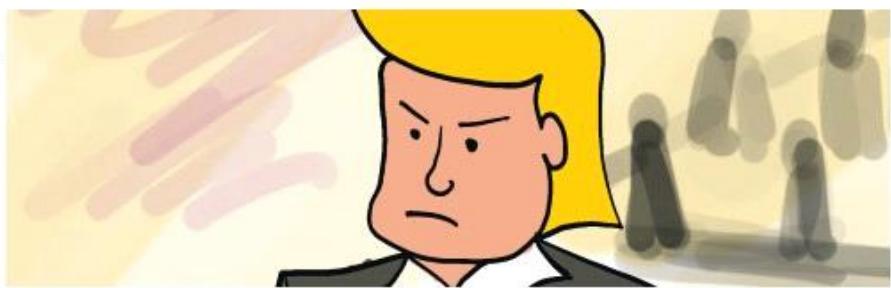
Vandal calls 5th person, According to Vandall's instructions, he opens box at place 2 and place 0 and puts 4 down below place 0. 6th Person comes he checks box 0 and box 3. He takes box at place 3 and puts it down below place 1, and moves box at place 1 and place 0 down to respective positions 2, 3 according to his instructions. The same process happens for other partition also. That is they open and check boxes and merge the partitions in the correct order.



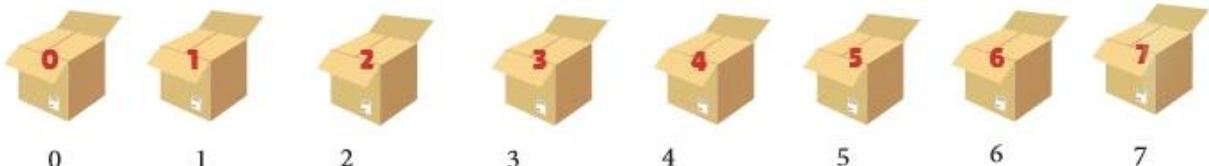
Jekyll quickly remaps in his mind the whole setup into two partitions as shown above. He instructs the next coming people to merge the two partitions, but during this, stephen interrupts..



For God's sake, put your arrogance aside for once Jekyll. We didn't win this. Vandal did. Those are the places which contain sensitive information and codes. They are criminal databases. He must have stolen access to release the criminals.



The people following Jekyll's instruction merges the partition as given below.. No Bombs go off.. Vandal laughs in an evil way.



Foo IRC FreeNode IRC

Channels- Messages

Welcome to #masterplan, a channel for the same...

a\_a: That stephen guy.. He will mess it up  
aaron7: Two more seconds... Done.  
a\_a: Now we are free  
aaron7: Yes.. It's a success. He is truly a criminal mastermind.

Users

aaron7 (admin)  
a\_a  
Chan  
Demon

A screenshot of an IRC chat window titled "Foo IRC FreeNode IRC". The window has a dark theme with colored status indicators (red, yellow, green) at the top. The main area shows a message from "aaron7" welcoming others to the "#masterplan" channel. Below that, there is a conversation between "a\_a" and "aaron7" where they discuss a plan and its success. On the right side of the window, there is a sidebar titled "Users" listing the current users: "aaron7 (admin)", "a\_a", "Chan", and "Demon".

Congratulations Jekyll! You finished the task as instructed and helped me complete what I actually wanted to do. While your foolish police forces were preoccupied about saving the city, I have launched a cyber attack on criminal databases and emptied it. Your databases are as empty as your brains now. Your so-called 'criminals' are gonna walk free.

(Everybody is shocked)

Ah Jekyll, nobody is perfect my friend. Your biggest flaw is in believing that everybody should believe that you are perfect. Every single problem isn't meant to be grand or to prove that you are the best.

(Jekyll gets frustrated, overturns the chair furiously)

The game has just begun my friend. I hope you will not disappoint me in being a worthy opponent.



You sure have won my respect, Vandal, but don't think that I would leave this here, I have never played a game in which I lost. And I know that I will win this, because I'm bloody going to play you.

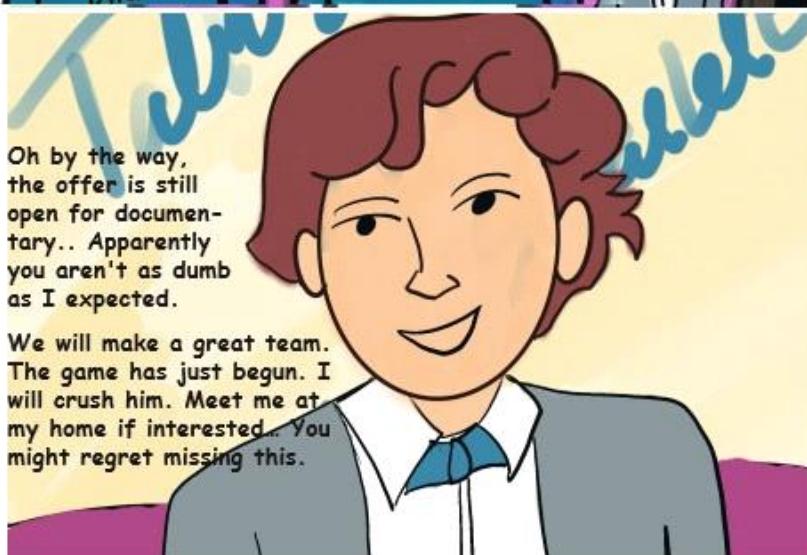


Well, that was a bummer.

Wait till you receive your pay this month.



Vandal laughs and disappears from screens. All screens are back to normal. Frustrated People leave the studio.



Oh by the way, the offer is still open for documentary.. Apparently you aren't as dumb as I expected.

We will make a great team. The game has just begun. I will crush him. Meet me at my home if interested.. You might regret missing this.



He winks and leaves. Stephen smiles. Jekyll considers Stephen as an equal now. Both have earned the respect for each other.

**THE END**

## Appendix

In this Episode of the comic we came accross Merge Sort Algorithm. Let us take a closer look at it. Merge Sort is a kind of Divide and Conquer algorithm in computer programming. It is one of the most popular sorting algorithms. Using the Divide and Conquer technique, we divide a problem into subproblems. When the solution to each subproblem is ready, we ‘combine’ the results from the subproblems to solve the main problem.

Suppose we had to sort an array A. A subproblem would be to sort a sub-section of this array starting at index p and ending at index r, denoted as A[p..r].

### Divide

If q is the half-way point between p and r, then we can split the subarray A[p..r] into two arrays A[p..q] and A[q+1, r].

### Conquer

In the conquer step, we try to sort both the subarrays A[p..q] and A[q+1, r]. If we haven’t yet reached the base case, we again divide both these subarrays and try to sort them.

### Combine

When the conquer step reaches the base step and we get two sorted subarrays A[p..q] and A[q+1, r] for array A[p..r], we combine the results by creating a sorted array A[p..r] from two sorted subarrays A[p..q] and A[q+1, r].

Comparisons of Selection, Insertion, and Bubble sorts with Merge sort:

#### Comparison of selection sort and merge sort:

As in selection sort we will take a part of sub array which is sorted, and other part is unsorted, every time we are taking the minimum in the unsorted sub array and keeping it in the sorted array so for this process the time for finding the minimum in  $i^{th}$  iteration is  $O(n)$  so for n iterations is  $O(n^2)$  and in merge sort for dividing array takes  $\log(n)$  and it combines n elements so  $O(n)$  is needed so the total time is  $O(n\log n)$  which is better than selection sort’s  $O(n^2)$  worst case.

#### Comparison between insertion and merge sort:

As in insertion sort we are iterating through the whole array and while iterating we will compare the current element with the proceeding element if proceeding is greater, then we will swap like that we must continue this swap up to the proceeding value is lesser as for each iteration we are doing this swap so at ith iteration at worst case the swapping will done for  $i-1$  times so as summing up this algo will take  $O(n^2)$  and we see that merge sort will take  $O(n\log n)$ . So, merge sort is better than selection sort in terms of speed in worst case.

#### Comparison between bubble and merge sort:

As in bubble sort we are iterating n times and, in each pass, (iteration) we will go through the whole array and swaps the adjacent elements if required so for doing this swapping across the whole array takes  $O(n)$  time at worst and for n iterations the time is  $O(n^2)$  as merge sort takes  $O(n\log n)$  so merge is better than bubble sort in worst case.

#### Merge Sort Complexity

##### Time Complexity

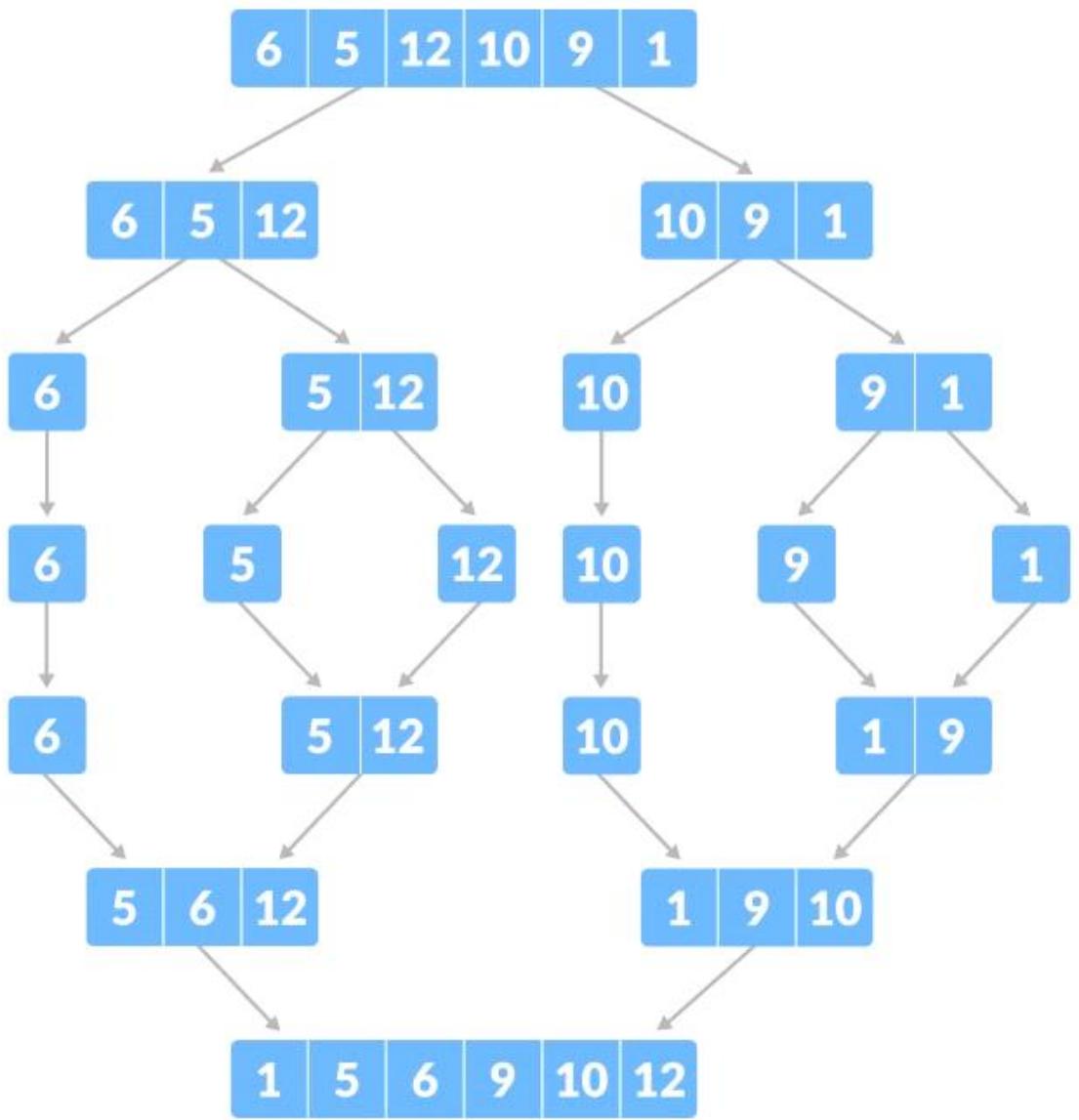
Best Case Complexity:  $O(n \log n)$

Worst Case Complexity:  $O(n \log n)$

Average Case Complexity:  $O(n \log n)$

##### Space Complexity

The space complexity of merge sort is  $O(n)$ .



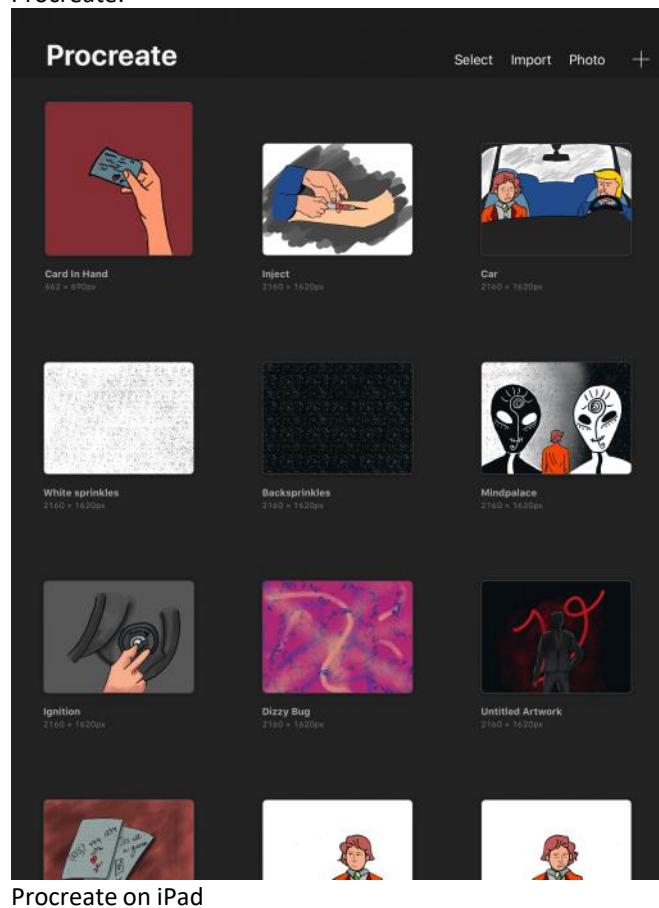
An Example of a Run of Merge Sort Algorithm on an Array

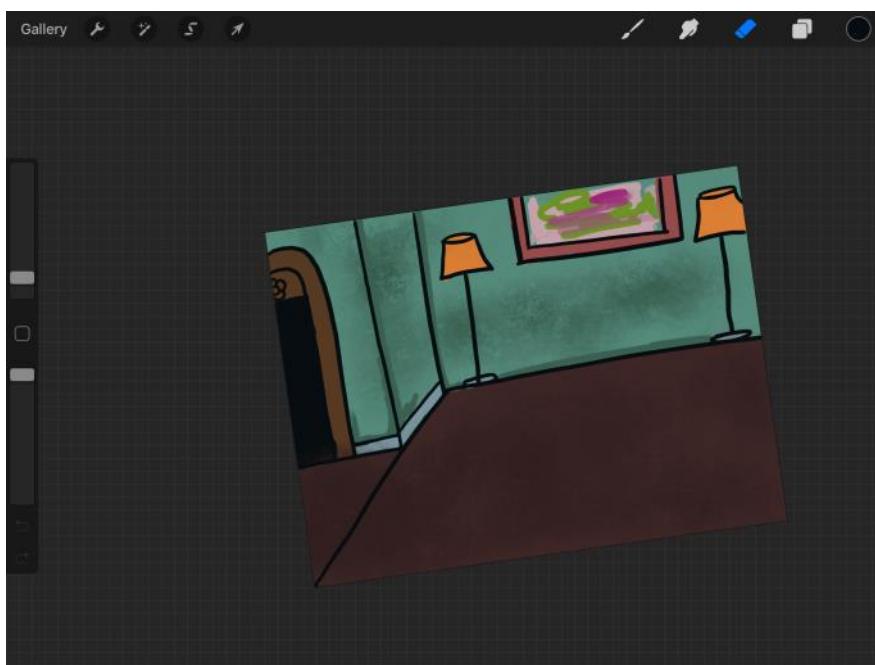
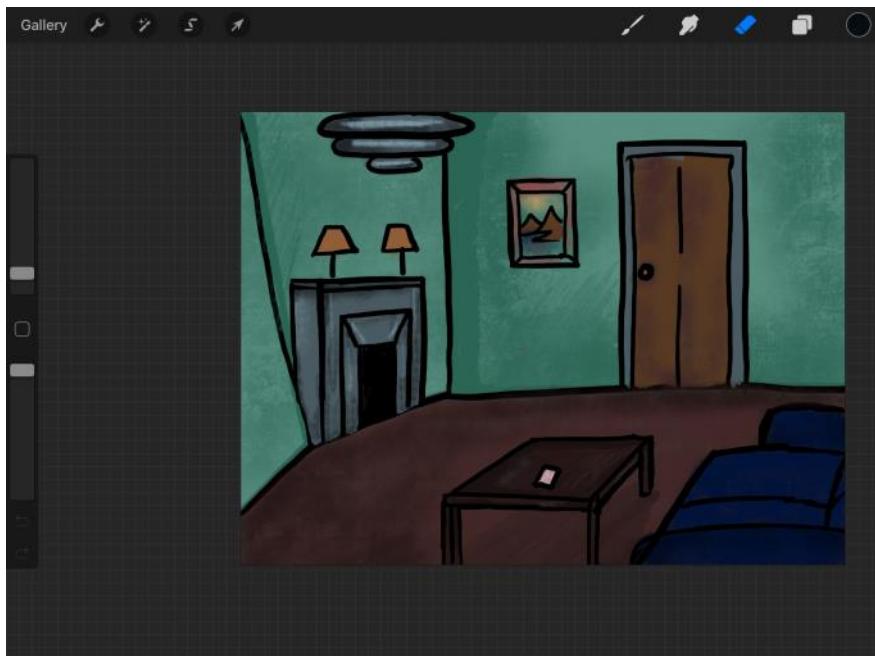
# 7<sup>th</sup> - 11<sup>th</sup> November –40+ hours of Awesomeness!!- Day 9, 10, 11, 12 ,13 – Finishing off Episode 2

10 November 2020 00:03

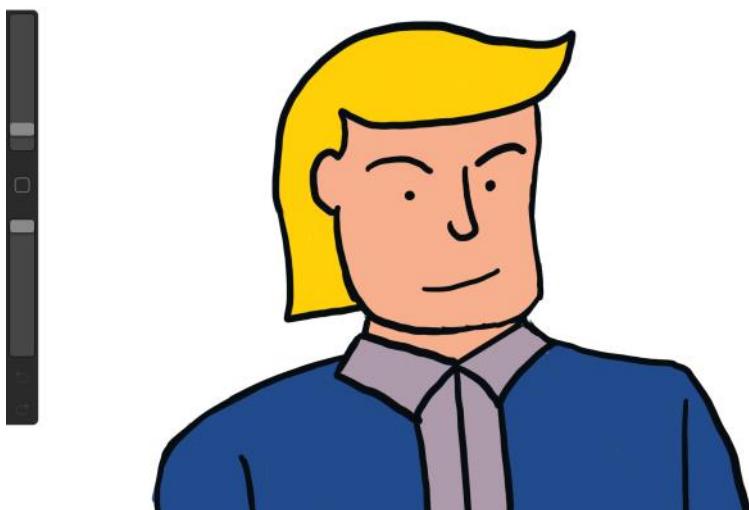
On these days of November I spend my days making the illustration for episode 2 of the comic. Because I was so immersed in the work, I didn't get time to note down what I did on each day. So I am providing a detailed report for these days. The story idea was contributed by Sri Ram and Trinadh who did an awesome job on coming up with a great Algorithm Idea for the story , the 44 Year Old Algorithm Travelling Sales Man. Harsha coded the problems and made testcases and graphs. The whole comic episode wouldn't be possible without the awesome dialogues and writing by Gokul and Arvindh. By the joint effort of my Team mates I got a masterpiece script to illustrate on Sat and thus starts my work. Pouring art into the script.

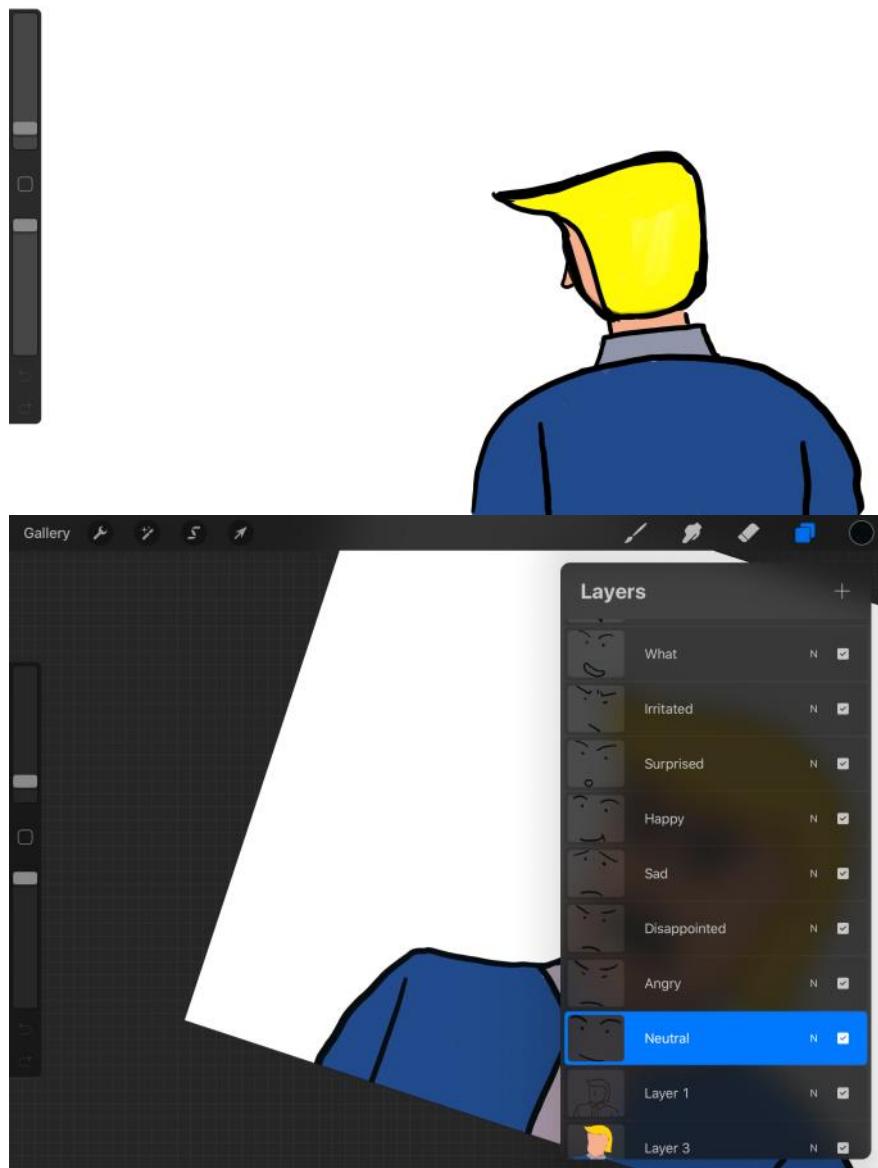
On Saturday I set out to draw out Stephen, Jekyll, their apartment and Vandall on my iPad using Procreate:





Drawing the Apartment Scenes meeting the mood set by Arvindh and Gokul in story..







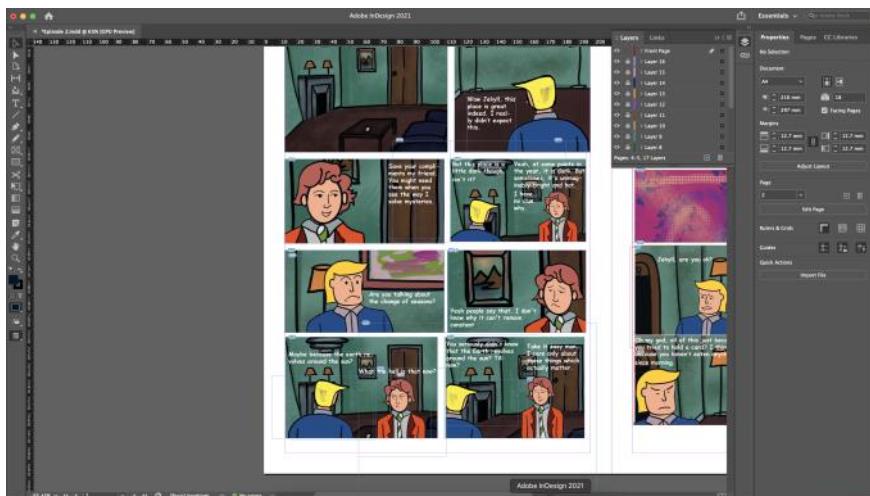
Drawing Jekyll ...

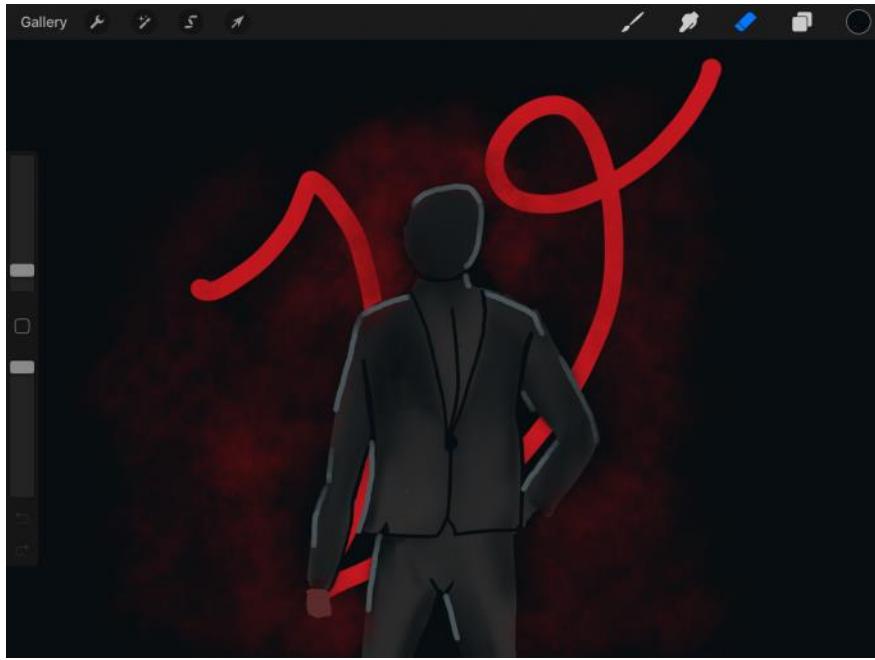
On Sunday, the work continues.. It was time to put these together in InDesign with the dialogues.. Some Photoshop and Illustrator was also used to edit these files.

InDesign, Photoshop and Illustrator involved 7+ hours on Sunday.. Given below are some screenshots...



InDesign was used to put together the illustrations and Dialogues...

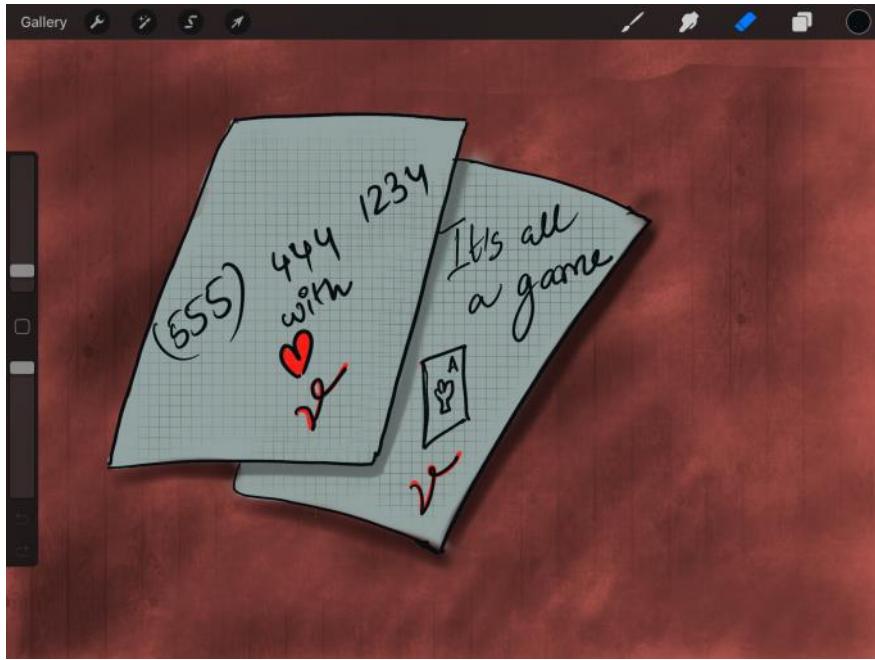




Drawing Vandall the Villain

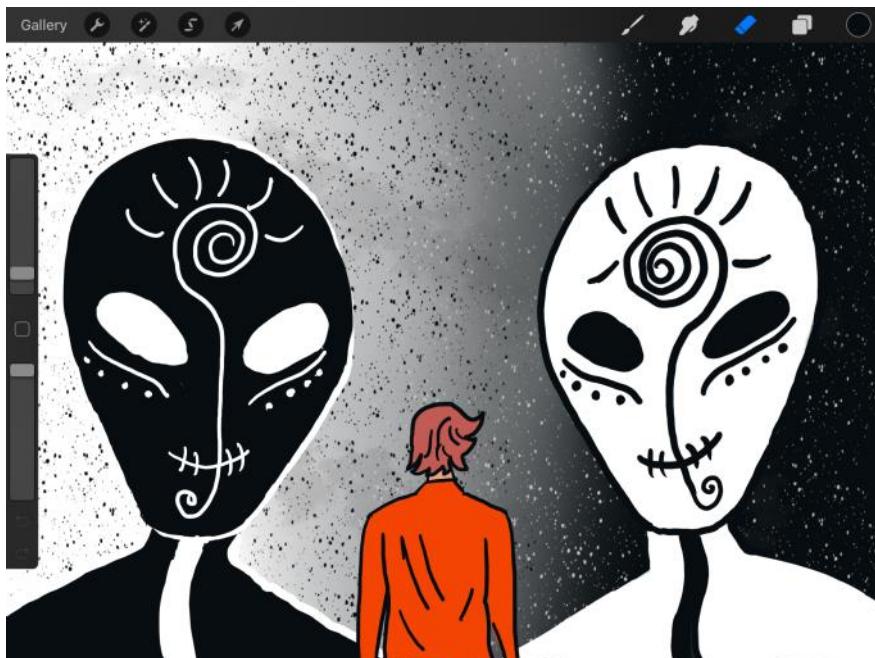
On Monday, I set out to make more art work like for the Card, Dizzy Jekyll, and the Mind Palace Scene...

I am extremely satisfied with the Mind Palace scene... It shows the thinking inside Jekyll's mind... Monday was extremely fun and accounts for 8 hours of work...



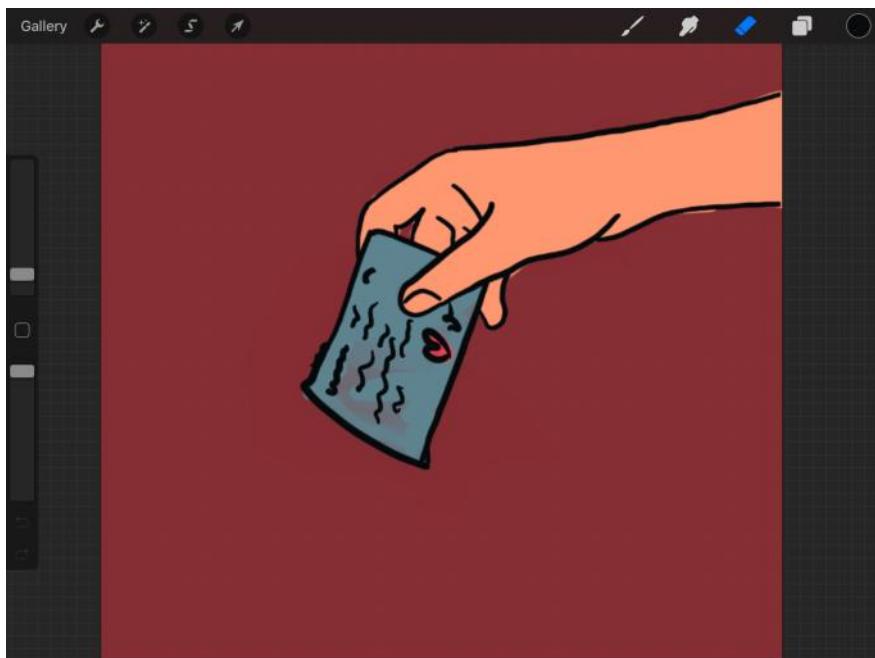
The story is all because of these cards.. How can I leave them without good illustrations??

I am really proud of the Mind Palace Scene.. It's a real wow...

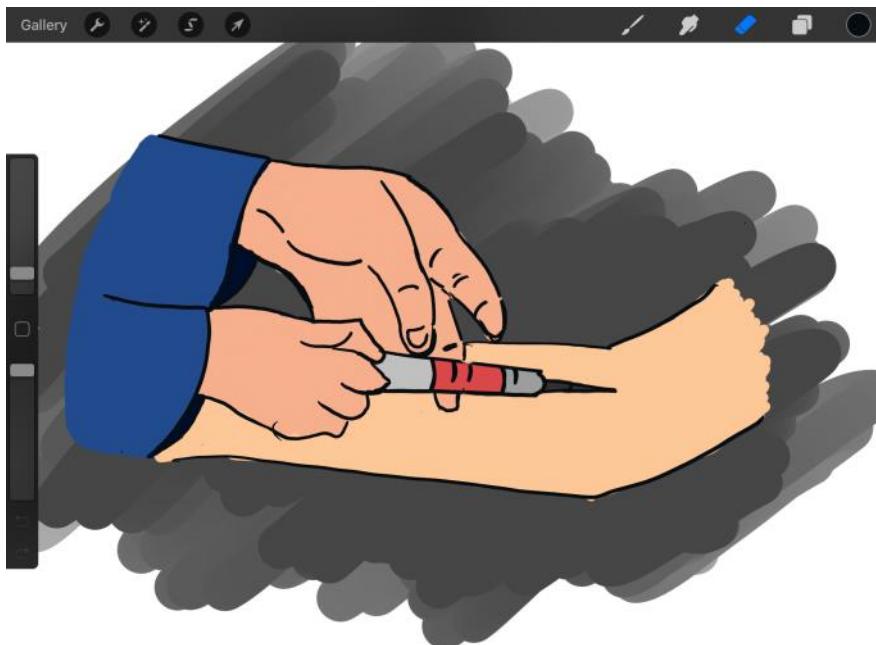


Drawing the Mind Palace in ProCreate

On Tuesday the work continued on Procreate, Photoshop and Illustrator on some more files and illustrations like the car scene, Injection, Cards etc... Also it involved putting all these files together in InDesign.

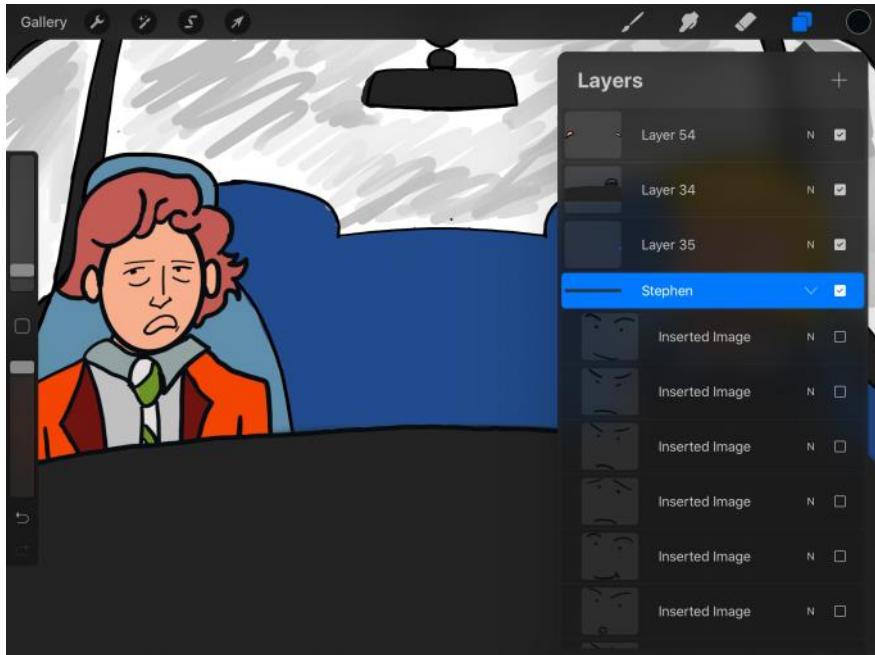


Drawing the final cards...

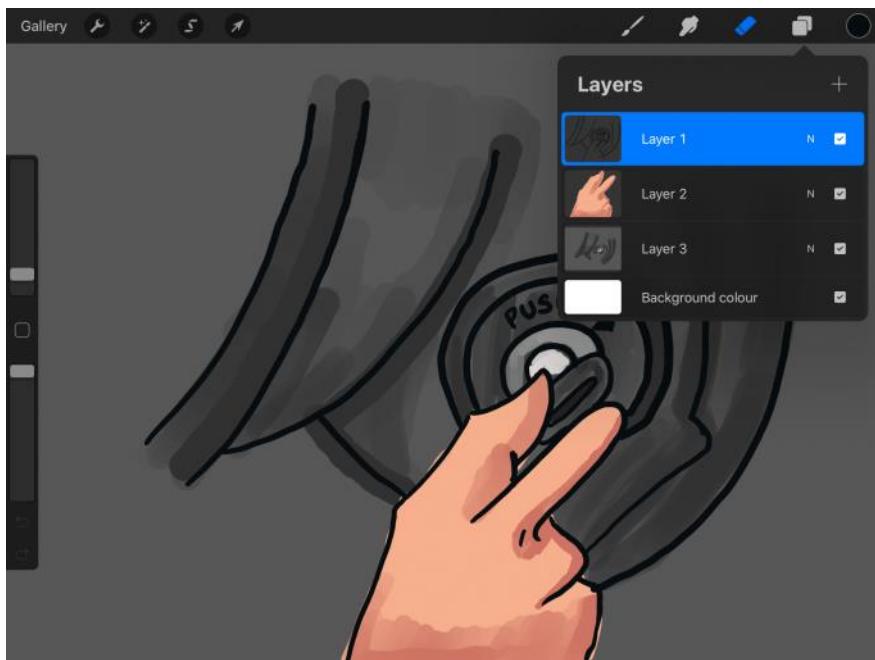


Drawing the injection scene





Episode 2 included a lot of Driving scenes.. Ignition on and go !!



On Wednesday, the InDesign work continued... Also Harsha sent me the code of the problem so I used Polacode plugin of VSCode to embed the code into InDesign and he also send me test case graphs which I added to the comic. I also added the Appendix written by Algorithm Team to the InDesign File..

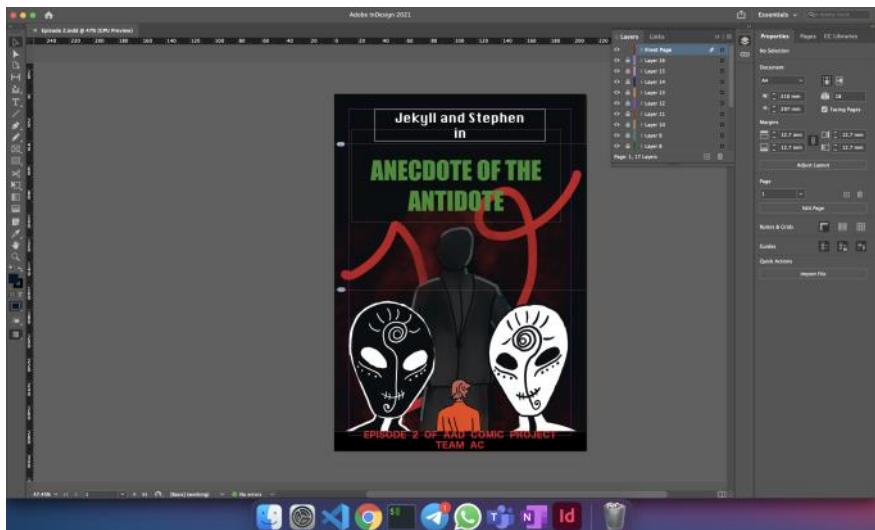
```

237     {18, 12, 13, 25, 22, 37, 84, 13,
238     };
239   };
240   cout << "\n\nTotal Cost is \n" << solve(costMatrix);
241 }
242
243 for(int i=0;i<pat.size();i++)
244 {
245   cout<<pat[i]<<" ";
246 }
247 cout<<pat[pat.size()-1]<<endl;
248 for(int i = 0; i < pat.size() - 1; i++)
249 {
250   cout << " " << colour[pat[i]-1] << " --- ";
251 }
252 cout << colour[pat[pat.size() - 1]-1];
253

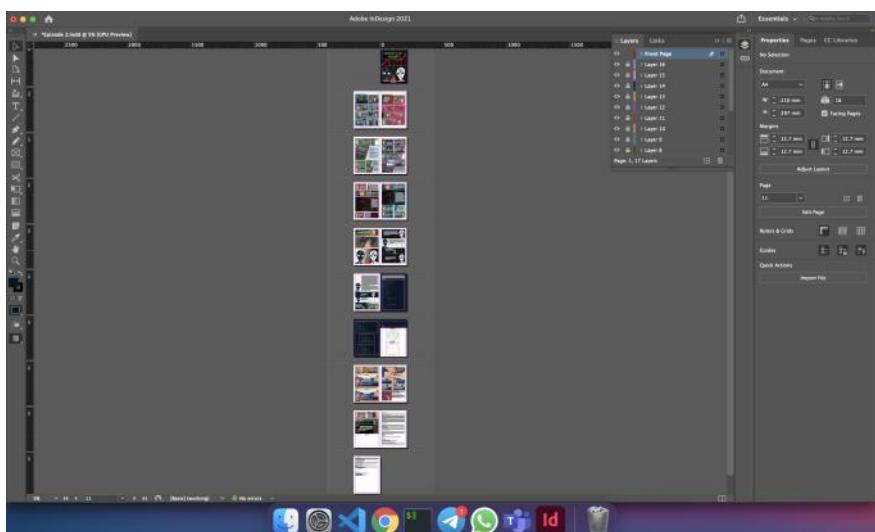
```

Total Cost is  
1 → 8  
8 → 5  
5 → 4  
4 → 18  
18 → 6  
6 → 3  
3 → 7  
7 → 2  
2 → 11  
11 → 9  
9 → 1  
25  
1→8→5→4→18→6→3→7→2→11→9→1  
Amsterdam →> Norwich →> Mechanicville →> Middletown →> Jamestown →> Rochester →> Hudson →> Kingston →> New York →> Cortland →> Niagara Falls →> Amsterdam

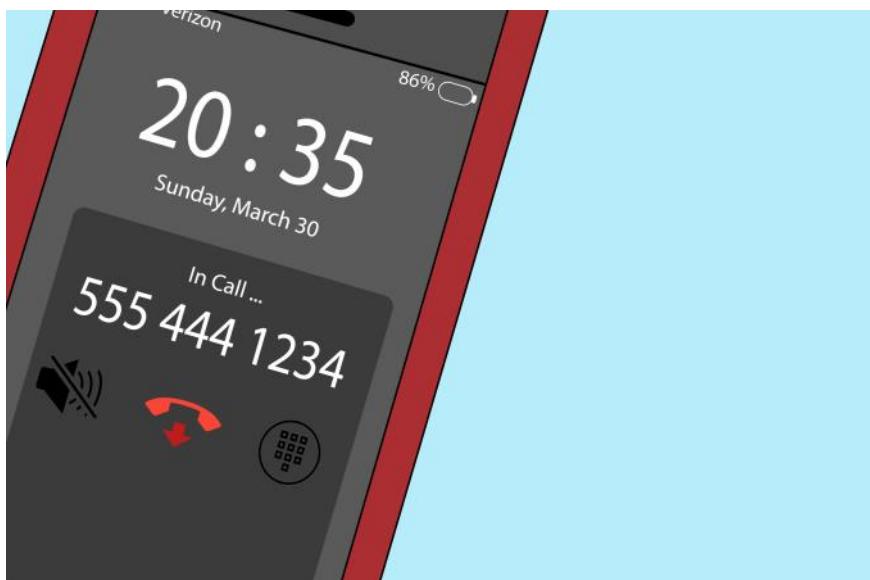
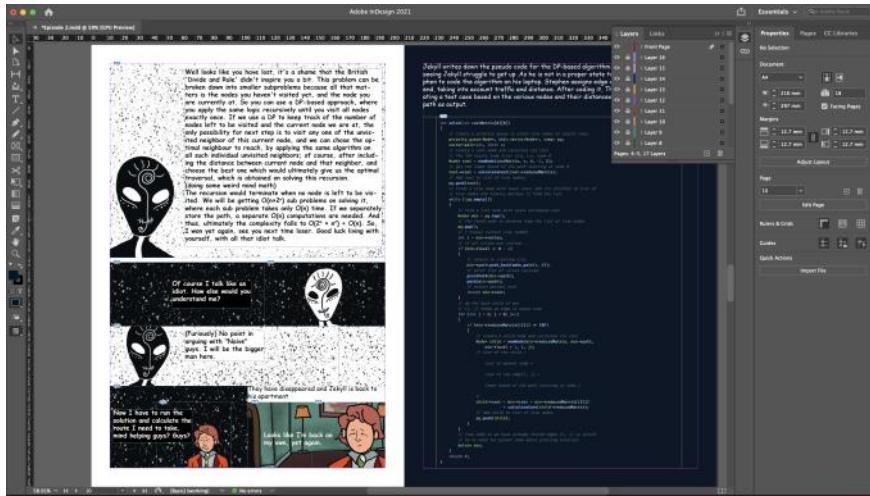
Using PolaCode Plugin of VSCode for code in InDesign



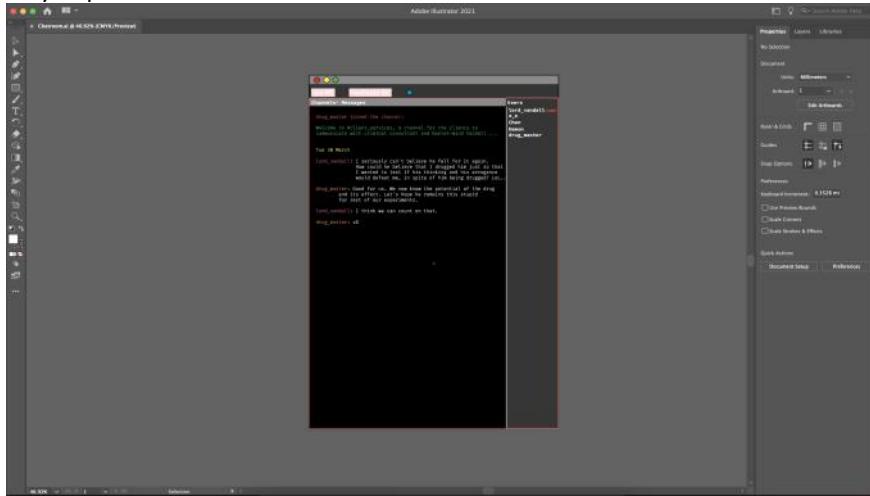
Designing the cover Using InDesign, Illustrator and Photoshop on mac.



18 pages of Awesomeness gets done in InDesign on Wednesday...



Jekyll's phone an illustration ...



Chat Scene created in Illustrator ...

Me and Harsha also discussed the various possible ways to effectively show the Algorithm in the comic in a Teams call. Also Putting together Illustrations, Dialogues and all were extremely fun.

By evening everything was coming together.. I worked with my team mates to get feedback and corrected some errors in the Comic. And now I am proud to present the comic.. It is shown below.. 40 + hours of work over 5 days... It was fun and wouldn't have been possible without my awesome Team!! Cheers!!

All files used in this Episode are uploaded in Files section. [Link](#).

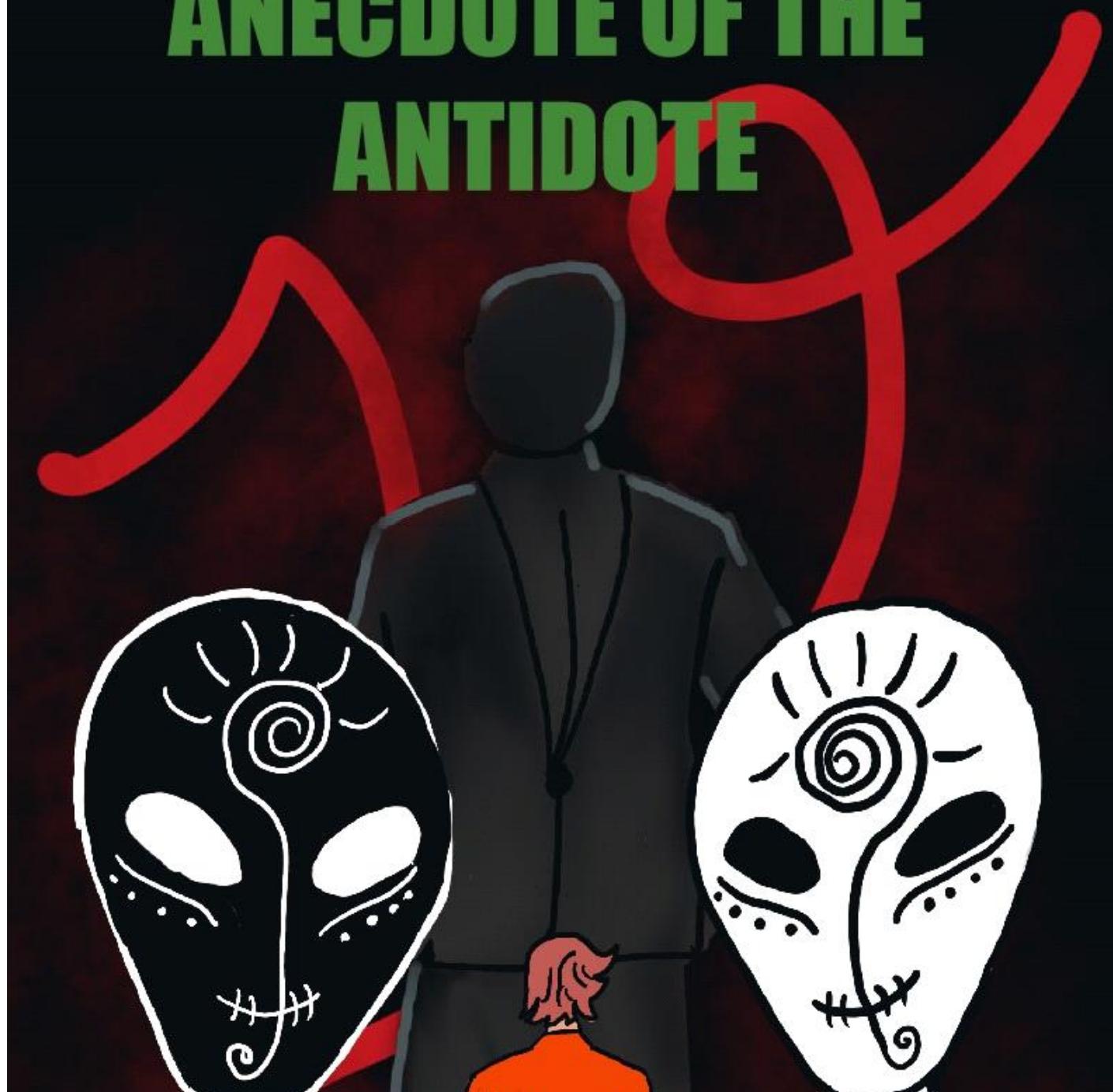
THE END RESULT: COMIC EPISODE 2: Jekyll and Stephen in " Anecdote of the Antidote "



Episode 2

# Jekyll and Stephen in

## ANECDOTE OF THE ANTIDOTE



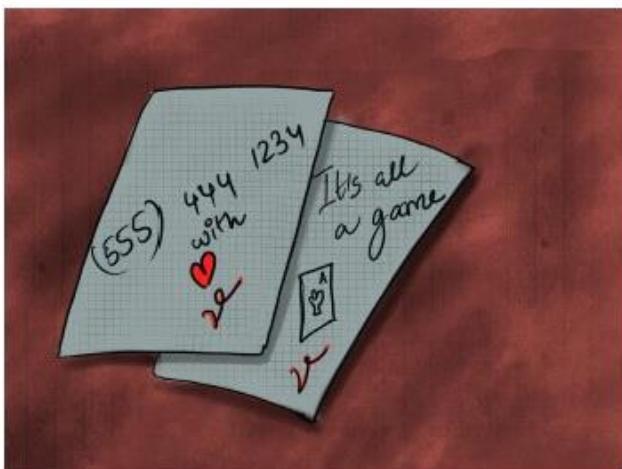


**EPISODE 2 OF AAD COMIC PROJECT  
TEAM AC**

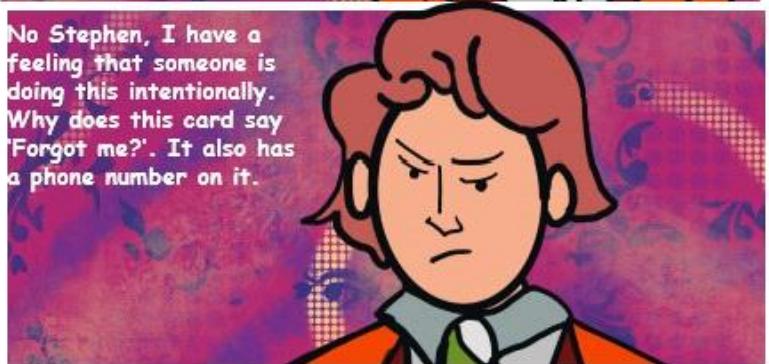
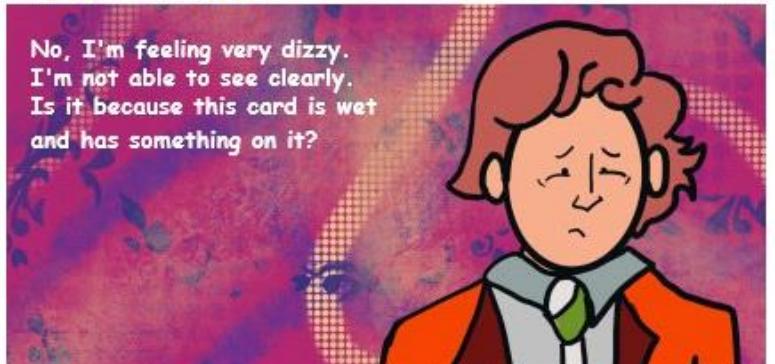
At Jekyll's residence, Stephen moves in with Jekyll

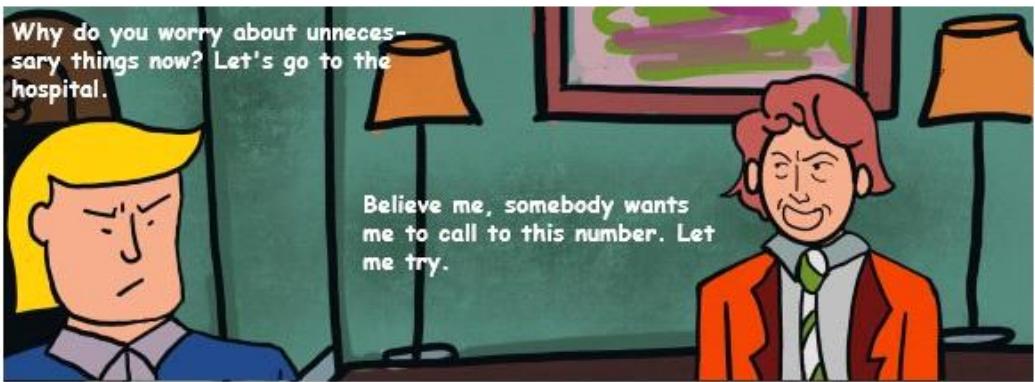


Jekyll sees a card on the table, from a distance

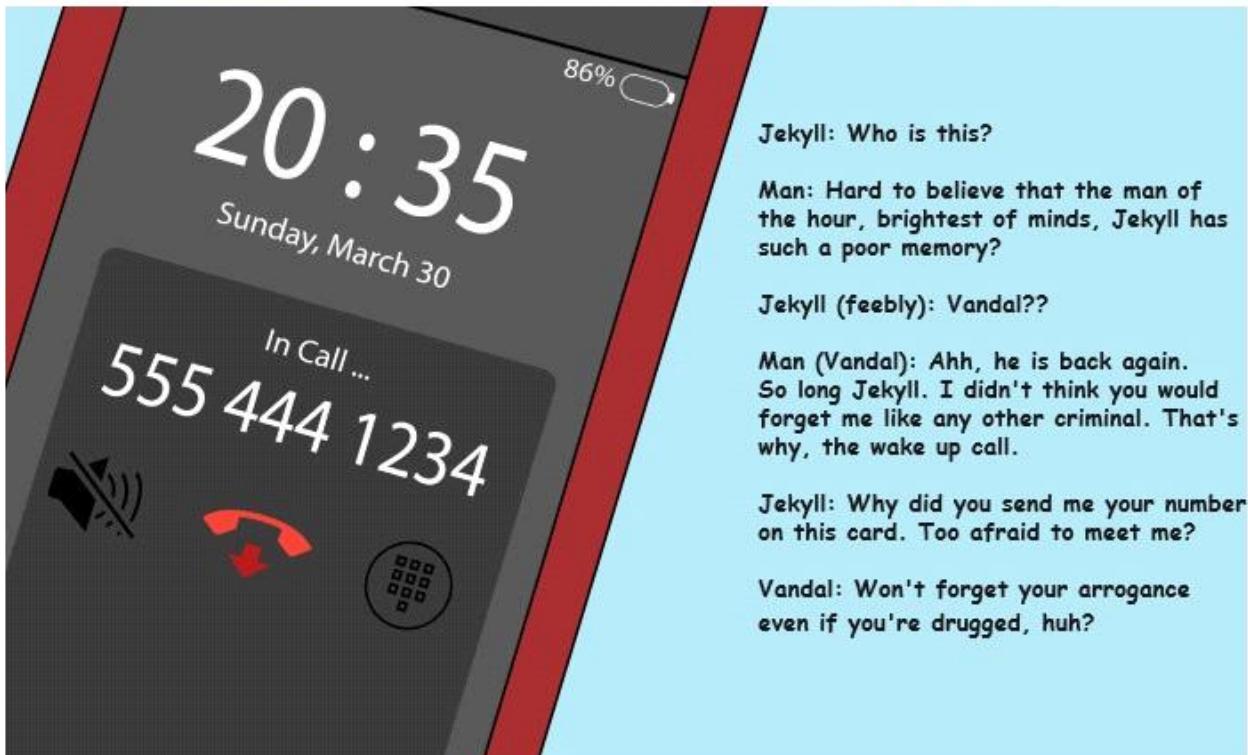


Jekyll tries to touch the card and read what's written on it, but he starts to feel dizzy...





Jekyll dials the number on the card, Man answers.



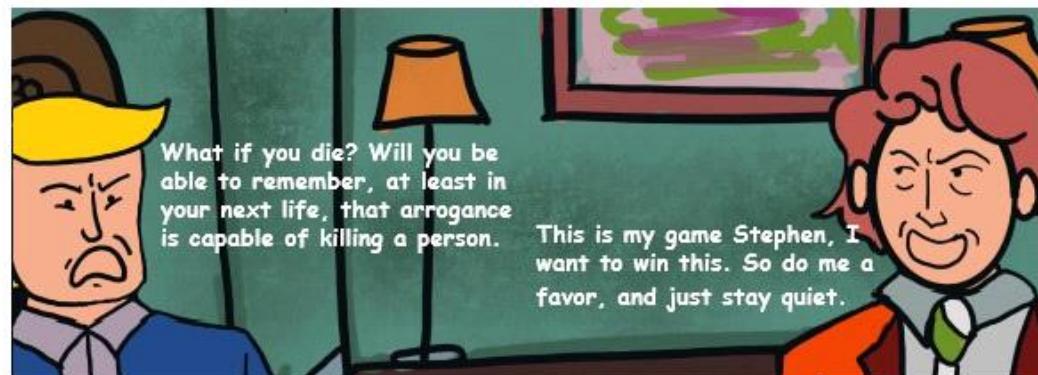
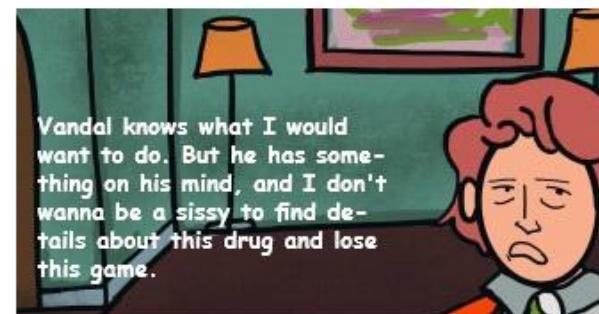
Vandal: Oh, looks like I should help you figure it out. The card you just took, had a very toxic liquid drug laced to its sharp edges. When you tried to catch the card, this drug, which is powerful and slick enough to penetrate through your skin layers, entered your blood veins.



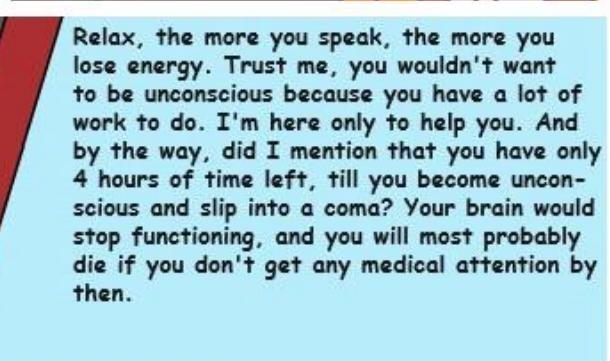
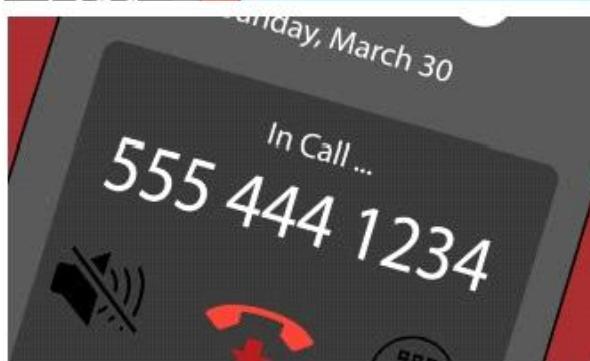
Vandal: That is not who I am Jekyll. The actual game hasn't begun yet. Just wait for a while in misery till I call you again.

(Vandal cuts the call)

Jekyll and Stephen wait for the call from Vandal. Stephen cannot see clearly but is trying hard to stay conscious



30 minutes later, Vandal calls again

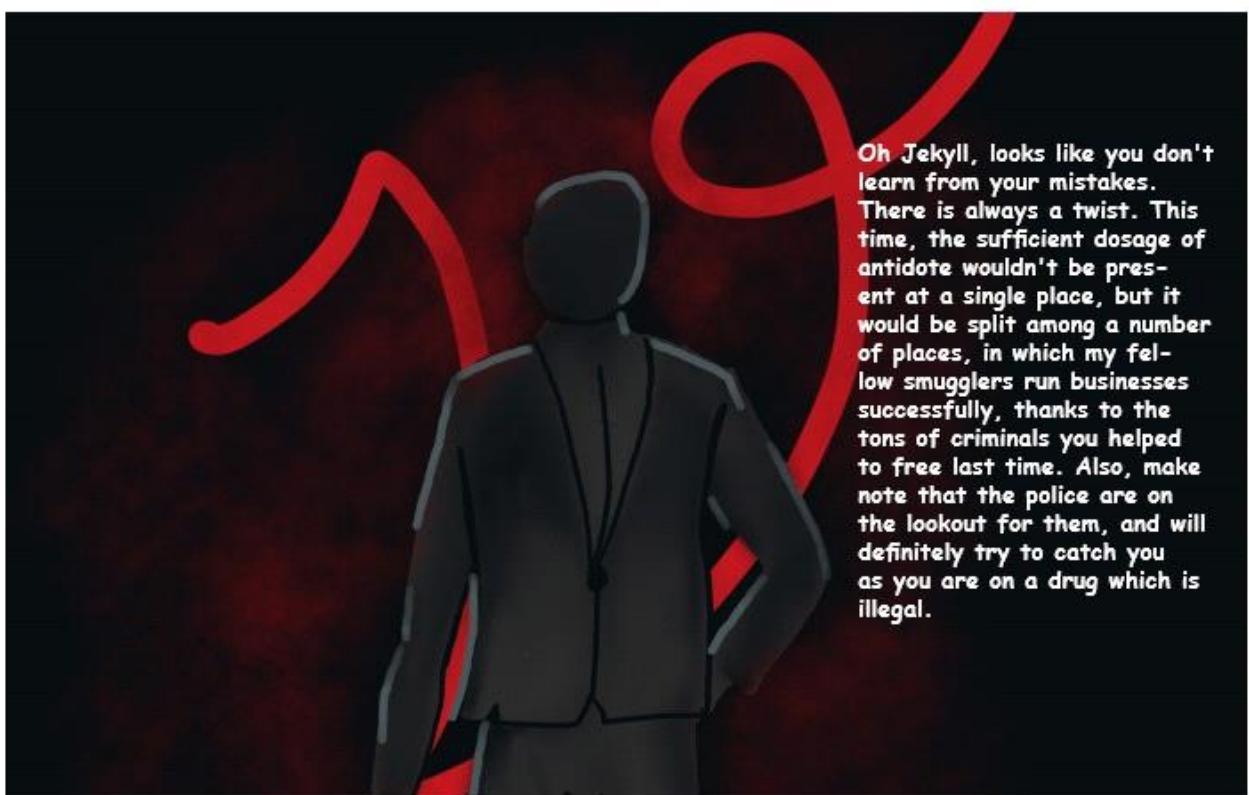




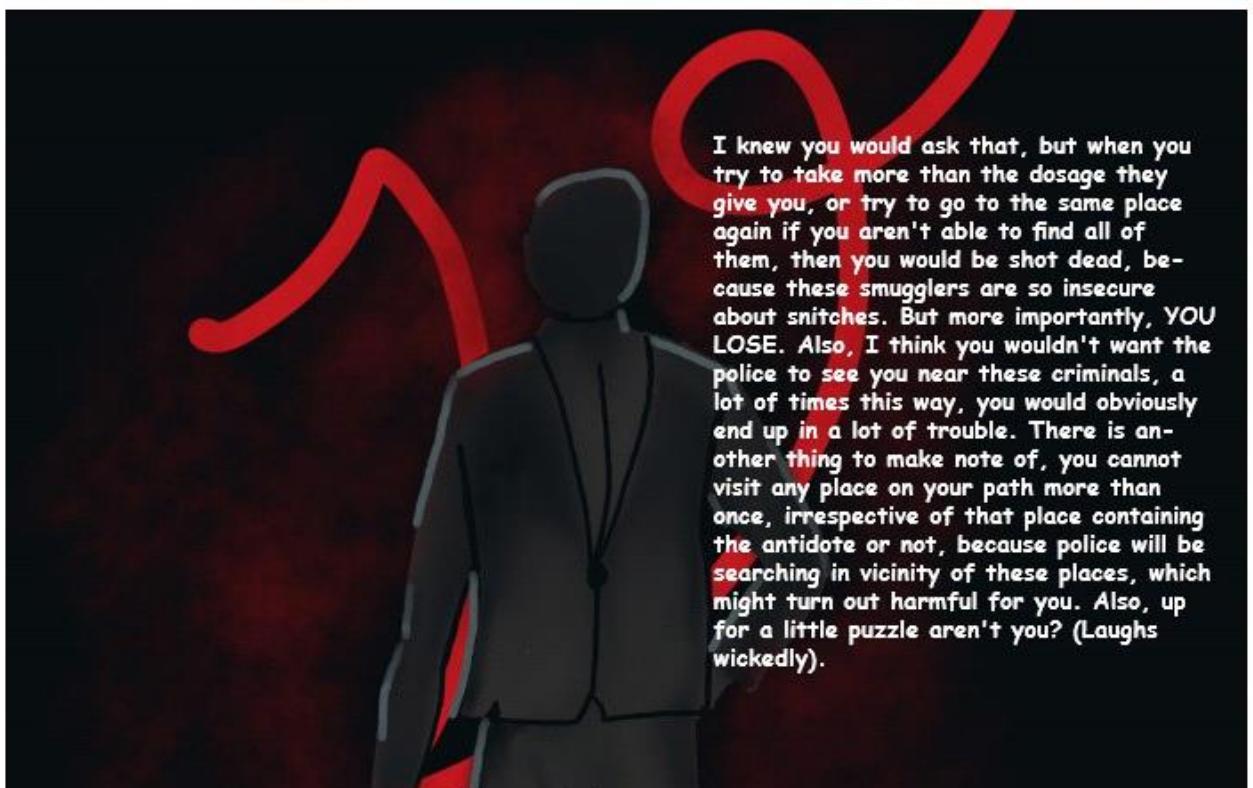
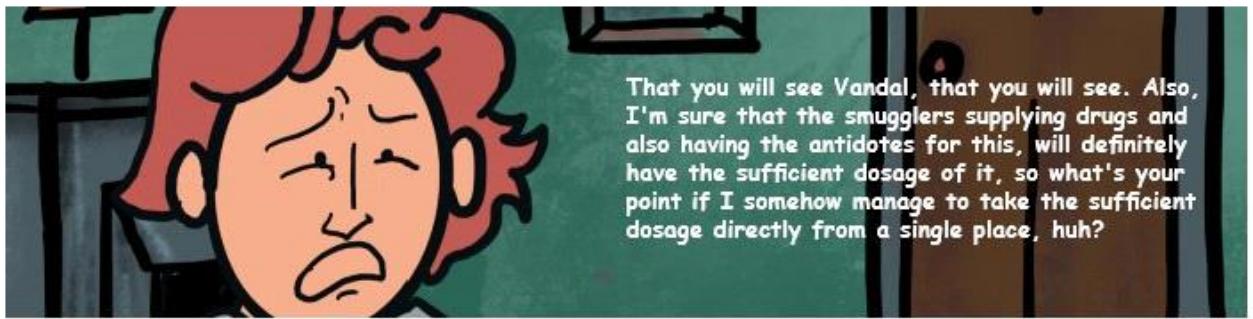
5

Oh I pity my ear drums, they wouldn't be able to listen to all this yelling after some time.(Laughs wickedly). This drug is extremely rare, and you cannot find the antidote to this anywhere. This is highly illegal, and it costs millions, so you wouldn't be given access to this without proper authorization, in big hospitals. But as I'm your guardian angel, I will give you hints about where to find the antidote.

4



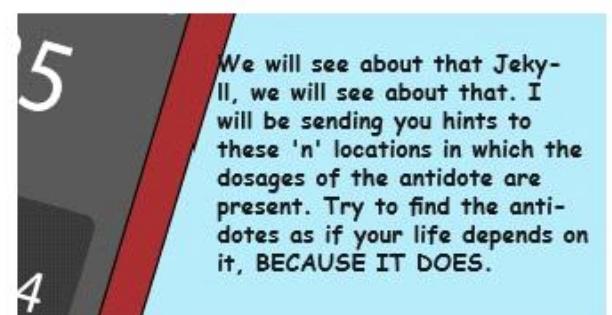
I gotta admit Jekyll, your arrogance didn't take a beating even under such a situation. In fact, I really wanted to mess with it, and see how far it can help you to achieve your goal, and how much it would affect your thinking. That was my motivation for this, not gonna lie.



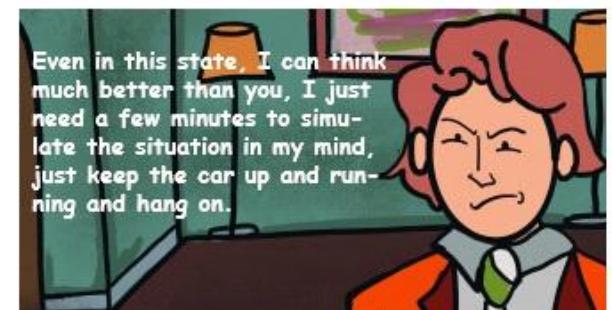
Jekyll and Stephen try to solve the problem

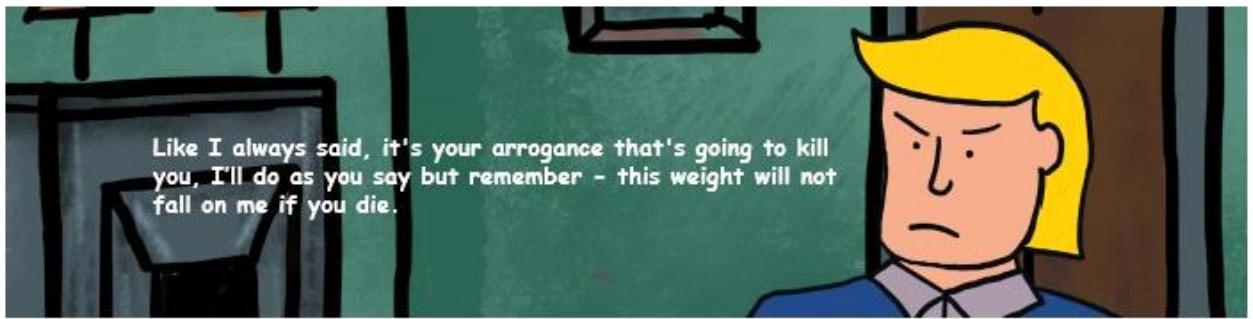


Jekyll sits down on his chair, closes his eyes and gestures Stephen to remain quiet and do as commanded



4





Stephen leaves Jekyll alone in the apartment reaches his car, opens the door frustratingly, starts the engine, regretting ever befriending Jekyll



While inside Jekyll's mind palace





I think Naive solution would be better in this case, as we all obviously know that this scenario is very similar to the "Travelling Salesman problem", but we need to store the vertices, I mean the places with antidotes here, that's going to be a problem which may result in higher time complexity.



Get a load of this guy. "Naive" haha. The name speaks for itself, do you think Vandal is going to give you a Naive problem, cannot believe this guy is a version of myself. Imagine being this dumb. This is clearly a modified Travelling Salesman problem.



Come on guys, we don't have time to keep arguing, I'm losing control of my body already



The Naive way is to permute through all possible routes and choose the one with the lowest cost at last which brings the complexity to  $O(n!)$



Well looks like you have lost, it's a shame that the British 'Divide and Rule' didn't inspire you a bit. This problem can be broken down into smaller subproblems because all that matters is the nodes you haven't visited yet, and the node you are currently at. So you can use a DP-based approach, where you apply the same logic recursively until you visit all nodes exactly once. If we use a DP to keep track of the number of nodes left to be visited and the current node we are at, the only possibility for next step is to visit any one of the unvisited neighbor of this current node, and we can choose the optimal neighbour to reach, by applying the same algorithm on all such individual unvisited neighbors; of course, after including the distance between current node and that neighbor, and choose the best one which would ultimately give us the optimal traversal, which is obtained on solving this recursion. (doing some weird mind math)

The recursion would terminate when no node is left to be visited. We will be getting  $O(n \times 2^n)$  sub problems on solving it, where each sub problem takes only  $O(n)$  time. If we separately store the path, a separate  $O(n)$  computations are needed. And thus, ultimately the complexity falls to  $O(2^n \times n^2) + O(n)$ . So, I won yet again, see you next time loser. Good luck living with yourself, with all that idiot talk.



Of course I talk like an idiot. How else would you understand me?



(Furiously) No point in arguing with "Naive" guys. I will be the bigger man here.



They have disappeared and Jekyll is back to his apartment



Now I have to run the solution and calculate the route I need to take, mind helping guys? Guys?

Looks like I'm back on my own, yet again.

Jekyll writes down the pseudo code for the DP-based algorithm. Stephen enters the room seeing Jekyll struggle to get up .As he is not in a proper state to code it, he instructs Stephen to code the algorithm on his laptop. Stephen assigns edge weights for the roads to this end, taking into account traffic and distance. After coding it, They run the algorithm by creating a test case based on the various nodes and their distances, and thus obtain the optimal path as output.

```

int solve(int costMatrix[N][N])
{
    // Create a priority queue to store live nodes of search tree;
    priority_queue<Node*, std::vector<Node*>, comp> pq;
    vector<pair<int, int>> v;
    // create a root node and calculate its cost
    // The TSP starts from first city i.e. node 0
    Node* root = newNode(costMatrix, v, 0, -1, 0);
    // get the lower bound of the path starting at node 0
    root->cost = calculateCost(root->reducedMatrix);
    // Add root to list of live nodes;
    pq.push(root);
    // Finds a live node with least cost, add its children to list of
    // live nodes and finally deletes it from the list
    while (!pq.empty())
    {
        // Find a live node with least estimated cost
        Node* min = pq.top();
        // The found node is deleted from the list of live nodes
        pq.pop();
        // i stores current city number
        int i = min->vertex;
        // if all cities are visited
        if (min->level == N - 1)
        {
            // return to starting city
            min->path.push_back(make_pair(i, 0));
            // print list of cities visited;
            printPath(min->path);
            path(min->path);
            // return optimal cost
            return min->cost;
        }
        // do for each child of min
        // (i, j) forms an edge in space tree
        for (int j = 0; j < N; j++)
        {
            if (min->reducedMatrix[i][j] != INF)
            {
                // create a child node and calculate its cost
                Node* child = newNode(min->reducedMatrix, min->path,
                                      min->level + 1, i, j);
                /* Cost of the child =
                   cost of parent node +
                   cost of the edge(i, j) +
                   lower bound of the path starting at node j
                */
                child->cost = min->cost + min->reducedMatrix[i][j]
                               + calculateCost(child->reducedMatrix);
                // Add child to list of live nodes
                pq.push(child);
            }
        }
        // free node as we have already stored edges (i, j) in vector.
        // So no need for parent node while printing solution.
        delete min;
    }
    return 0;
}

```

```

// Function to get the lower bound on
// on the path starting at current min node
int calculateCost(int reducedMatrix[N][N])
{
    // initialize cost to 0
    int cost = 0;
    // Row Reduction
    int row[N];
    rowReduction(reducedMatrix, row);
    // Column Reduction
    int col[N];
    columnReduction(reducedMatrix, col);
    // the total expected cost
    // is the sum of all reductions
    for (int i = 0; i < N; i++)
        cost += (row[i] != INT_MAX) ? row[i] : 0,
        cost += (col[i] != INT_MAX) ? col[i] : 0;
    return cost;
}

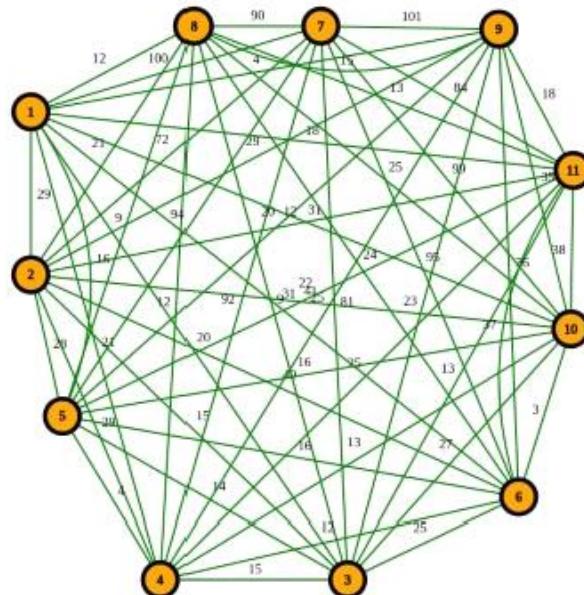
int rowReduction(int reducedMatrix[N][N], int row[N])
{
    // initialize row array to INF
    fill_n(row, N, INF);
    // row[i] contains minimum in row i
    for (int i = 0; i < N; i++)
        for (int j = 0; j < N; j++)
            if (reducedMatrix[i][j] < row[i])
                row[i] = reducedMatrix[i][j];
    // reduce the minimum value from each element in each row
    for (int i = 0; i < N; i++)
        for (int j = 0; j < N; j++)
            if (reducedMatrix[i][j] != INF && row[i] != INF)
                reducedMatrix[i][j] -= row[i];
    return 0;
}

// Function to reduce each column in such a way that
// there must be at least one zero in each column
int columnReduction(int reducedMatrix[N][N], int col[N])
{
    // initialize col array to INF
    fill_n(col, N, INF);
    // col[j] contains minimum in col j
    for (int i = 0; i < N; i++)
        for (int j = 0; j < N; j++)
            if (reducedMatrix[i][j] < col[j])
                col[j] = reducedMatrix[i][j];
    // reduce the minimum value from each element in each column
    for (int i = 0; i < N; i++)
        for (int j = 0; j < N; j++)
            if (reducedMatrix[i][j] != INF && col[j] != INF)
                reducedMatrix[i][j] -= col[j];
    return 0;
}

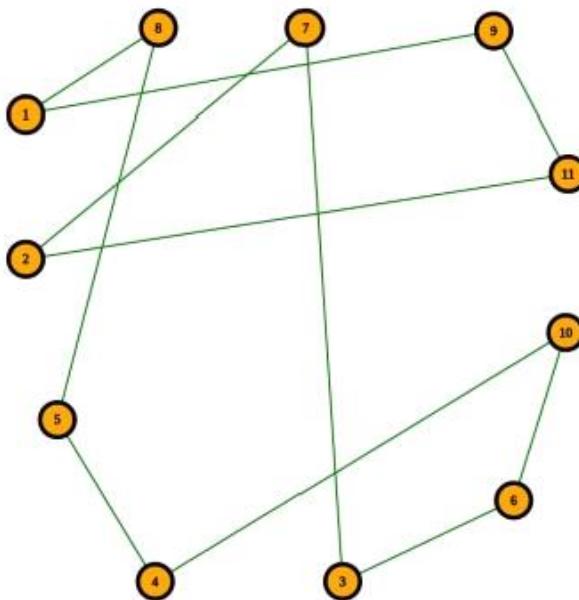
```



## Vandall's Problem



## Jekyll's Solution



Jekyll tries to get up but his body won't cooperate, he tries a few more times but couldn't..



Stephen offers support to Jekyll which initially he rejects but ultimately ends up taking and they get inside the car.

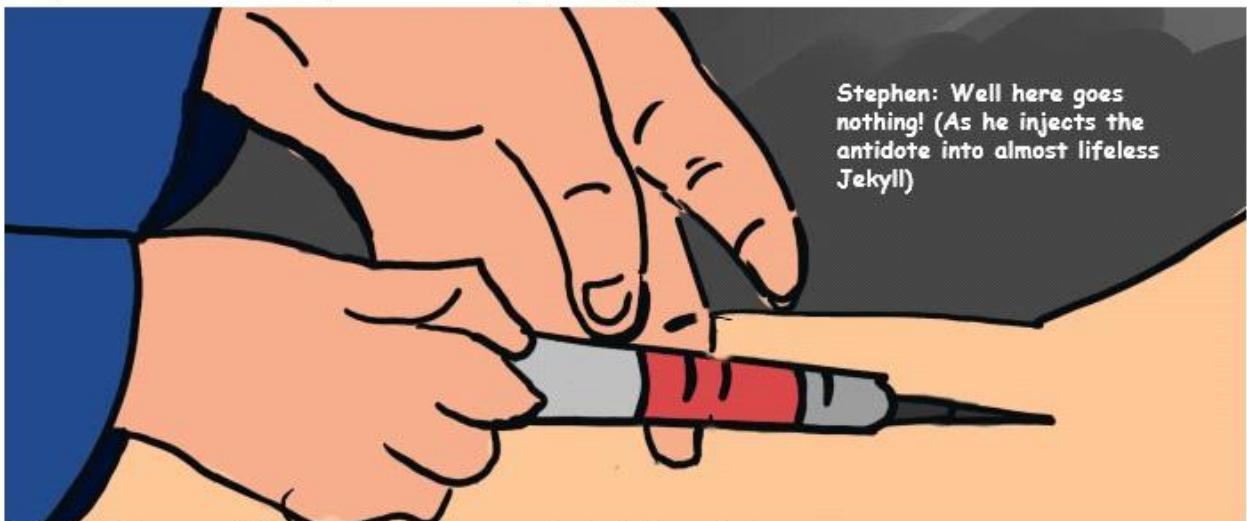


Jekyll's Note:

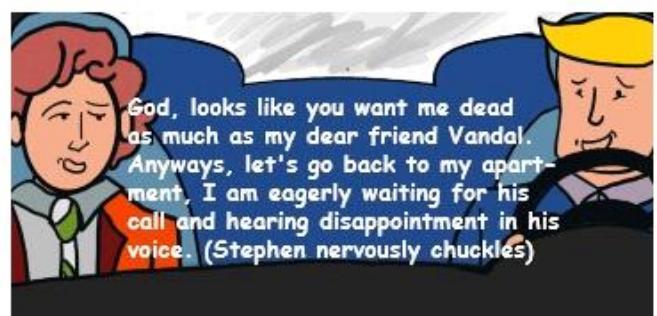
Amsterdam ---> Norwich ---> Mechanicville ---> Middletown ---> Jamestown ---> Rochester  
---> Hudson ---> Kingston ---> New York ---> Cortland ---> Niagara Falls ---> Amsterdam



They follow the plotted path and end up getting the antidote



Jekyll wakes up midway on their journey back to hospital



They drive back to his apartment and see another card on the table



Jekyll: Looks like Vandal wants a rematch, wants to get used to losing to me I suppose.

(Picks up the card carefully this time)

"I expected you to be here much sooner, losing your edge? Can't wait to see you failing to get up from your chair again, that was a sight to behold. Stay alive till the time I contact you again, don't want to lose my favorite player yet"



Foo IRC      FreeNode IRC

Channels- Messages

drug\_master joined the channel!

Welcome to #client\_services, a channel for the clients to communicate with criminal consultant and master-mind Vandall ...

Tue 30 March

lord\_vandall: I seriously can't believe he fell for it again. How could he believe that I drugged him just so that I wanted to test if his thinking and his arrogance would defeat me, in spite of him being drugged? LoL..

drug\_master: Good for us. We now know the potential of the drug and its effect. Let's hope he remains this stupid for rest of our experiments.

lord\_vandall: I think we can count on that.

drug\_master: xD

Users

lord\_vandall(adm)  
a\_a  
Chan  
Demon  
drug\_master

THE END

# APPENDIX

The problem is a famous traveling salesman problem. It is NP -complete problem. The problem can be seen as follows:

The input is simply an undirected graph.

The responsibility of the algorithm is to figure out the minimum cost way of visiting each vertex exactly once, that is you're supposed to output a tour, a permutation on the vertices. That minimizes the sum of the corresponding end edges. It is a dynamic programming problem. On the first go subproblem can be as modified as the Bellman Ford problem since they sound similar. So we would take a subproblem as  $S_{ij}$  as the path from source to j using exactly i edges and with no repeated vertices. So  $S_{ij} = \min\{S_{i-1,k} + C_{kj}\}$  but here comes the problem the smaller problems may not form the solution for bigger problems. Since the shortest path with no repeated vertices could contain the vertex j.

The solution we're going to use is in some sense a logical next step from this recurrence here. We need to be able to know more information about sub problems than just where they end, we actually need to know the identities of the vertices on the path used to travel from 1 to K, we need to know whether or not V is on that path. So we're going to look at a much bigger set of subproblems where we remember not just destinations, but also all of the intermediate stops. To enforce the constraint that each vertex is visited exactly once, one needs to remember the identities of the vertices visited.

## SUB-PROBLEM

We still want to keep track of where this path ends so we still have our destination j, and rather than just specifying a number of vertices that you visit on this path, we specify exactly which vertices get visited. For that we will use a subset S (of the vertices). A will always be containing the source vertex(1) and the final vertex. Now we define the subproblem  $L_{s,j}$ .

We define  $L_{s,j}$  as the length of a shortest path. The path starts at vertex 1, ends at vertex j. Visits precisely the vertices in S, exactly once each.

There are exponential choices for subset S (2 raised to the power of number of vertices). The computational savings come from that we are not storing the order in which they occur, we are just considering a group of vertices.

## OPTIMAL SUBSTRUCTURE:

Let P be the shortest path from source vertex to j that visits the vertices present in S exactly once. If the last but one vertex of the path P is k, then say P1 is the shortest path from 1 to k that visits every vertex of  $S-\{j\}$  exactly once (The P1 is shortest it follows the same proof as in the bellman ford algorithm).

RECURRANCE:

$L_{s,j} = \min\{L_{s-\{j\},k} + C_{kj}\}$  where  $k \neq j$ , k belongs to S.

Base cases:

$L_{s,j} = 0$  if  $S = \{1\}$ ;

Else

$L_{s,j} = +\infty$ . Since there is no way of visiting only once . we would definitely 1 twice.

## SOLVING:

For m = 2,3,4,...,n:

For each set S (subset of vertices) of size m containing vertex 1:

For each j belongs to S and  $j \neq 1$ :

$L_{s,j} = \min\{L_{s-\{j\},k} + C_{kj}\}$  where  $k \neq j$ , k belongs to S.

Here to find the solution we need to do a little bit of work since we have to stop at one adjacent vertex of source , we go through all of them and return the minimum thing.

Answer is  $\min(L_{\{1,2,3,\dots,n\},j} + C_{1,j})$  for  $j=2$  to  $j=n$  , even though it is good to do only for adjacent vertices.

## **TIME COMPLEXITY:**

The overhead is choosing the subsets of the set of vertices. There are  $2^n$  raised to power of the number of vertex subsets. Let the number of vertices be  $n$ . There are  $n$  choices of  $j$ . These two complete all combinations of  $L_s, j$ . For the  $k$  we have  $n$  choices.

Hence the time complexity is  $O(2^n \times n^2)$ .

Since it is a NP complete one we have to respect the time complexity and as every time the question of "CAN WE DO BETTER ??!!!" stays...

The code for the Solution (shown as being used by Jekyll) can be found [here](#) on Harsha's Github.

What inspired us to take up TSP :

In News:

Computer Scientists find a better approximation to the 44-year-old TSP: A (Slightly) Improved Approximation Algorithm for Metric TSP

[Link to Research Paper](#)

## CREDITS:

Story Idea, Algorithm Research - Trinadh, Sri Ram

Dialogue - Gokul, Arvindh

Illustrations - Arjun

Code, Test Case, Graphs - Harsha

# 15<sup>th</sup> - 22<sup>nd</sup> November – 50+ hours of Awesomeness.. Episode 3 and 4. Illustration and Story. Days 14-20

Sunday, November 22, 2020 8:31 AM

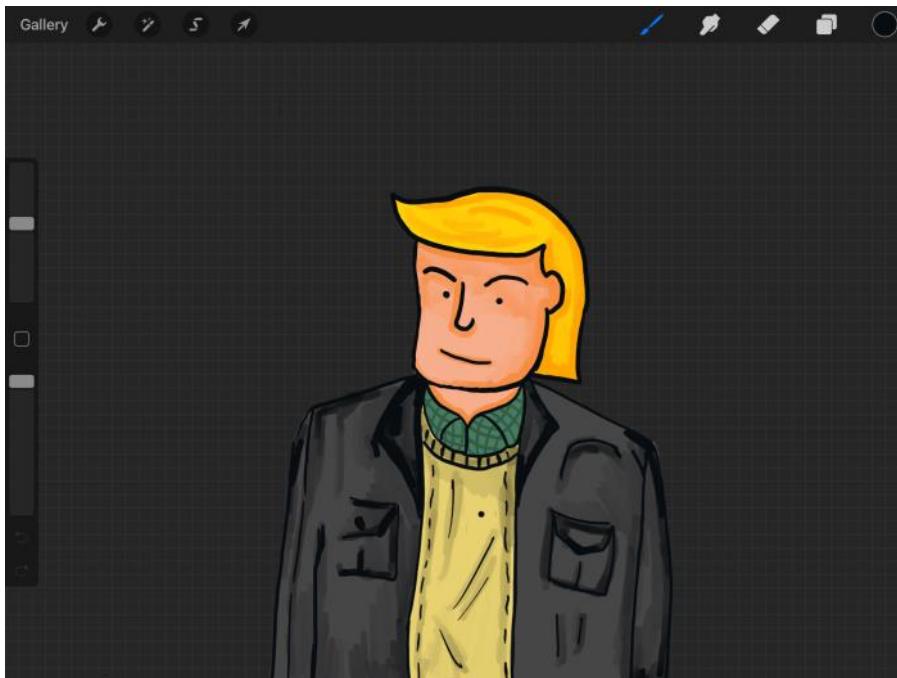
This being the last week, there were a bunch of things which had to be taken care of. I spent about 50 hours working on this project in this week. I have spent this quality time in illustrating the final scripts of both the 3<sup>rd</sup> episode (Pandemic Purgatory) and the final 4<sup>th</sup> episode (The Final Puzzle). The illustrations had a lot of minor details and were designed with care intricately, with vibrant colors, which consumed a lot of time. The illustrations were hand-made with intricate detailing and took a lot of time.

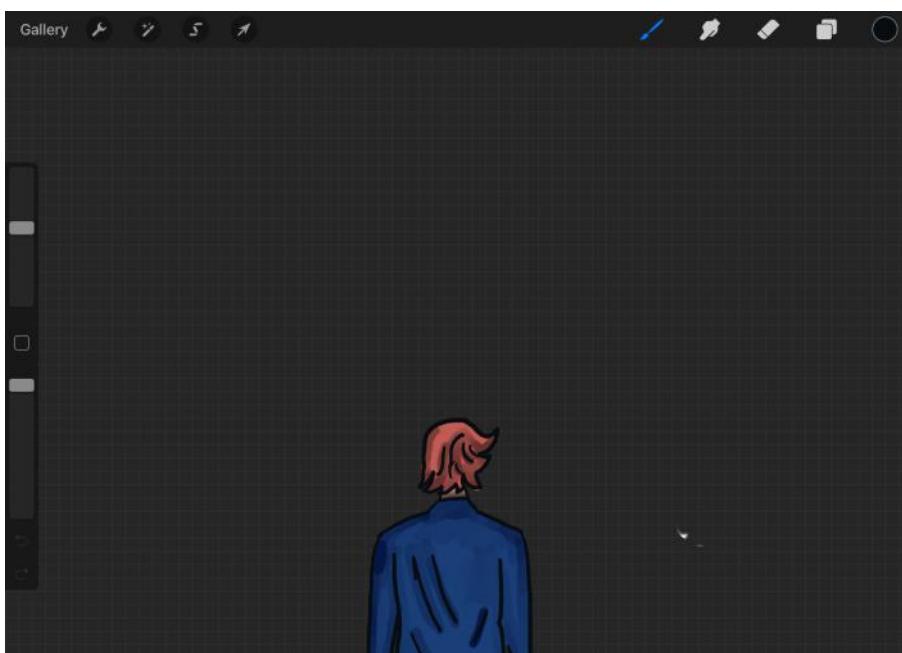
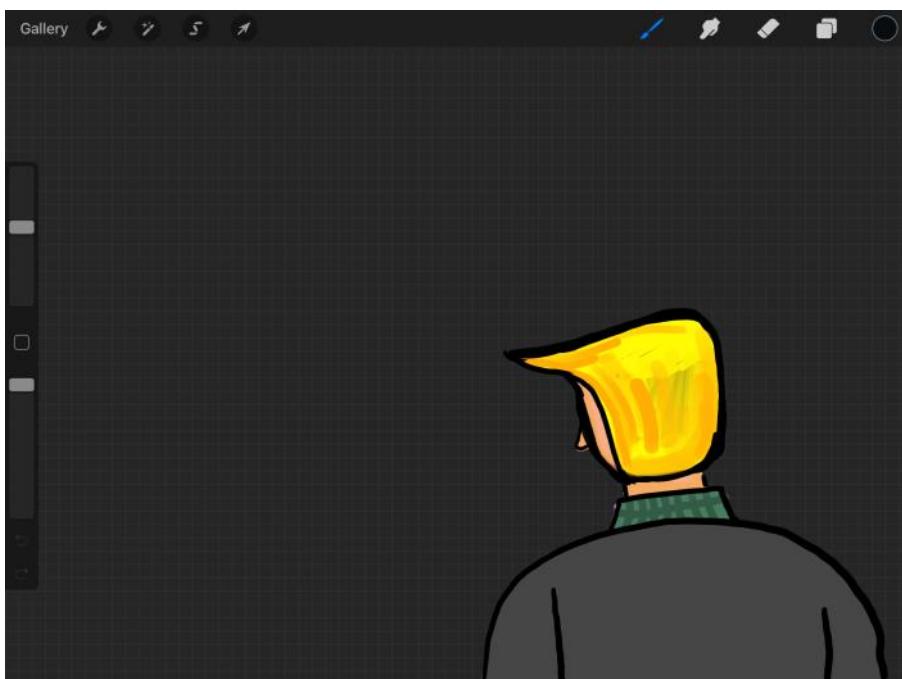
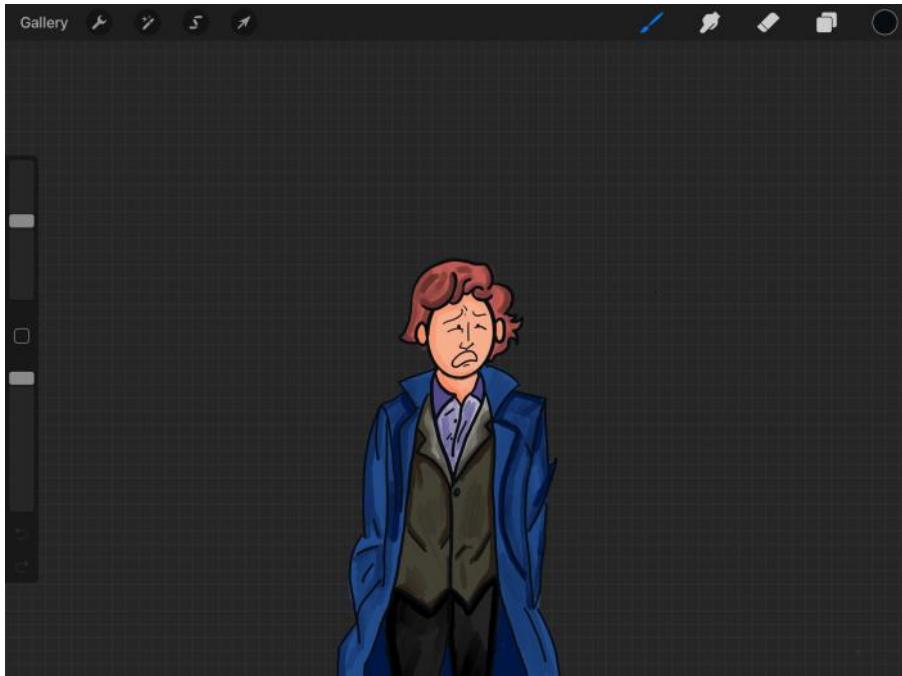
I also assisted in the story development of the 4<sup>th</sup> episode, which acts as the finale for this comic. This basic story which I provided, was improvised and had its screenplay and dialogues written by the writing department.

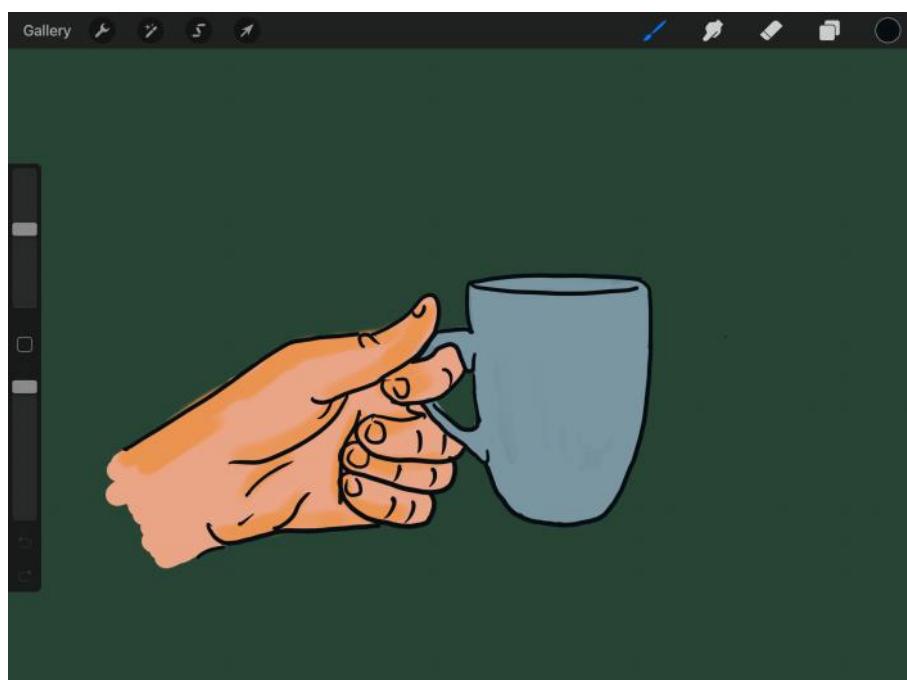
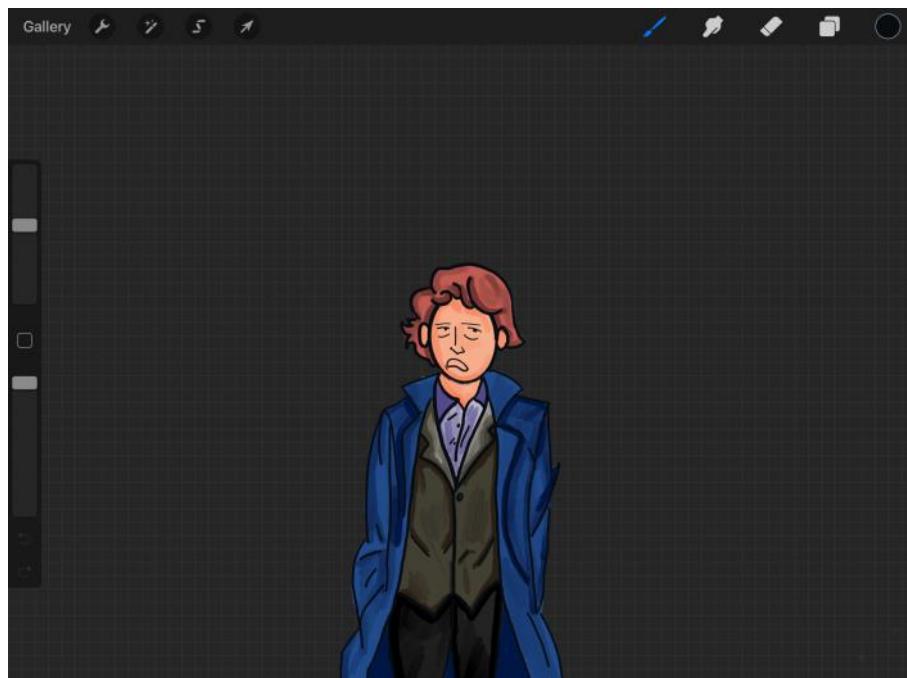
The first few days included me working on the story of episode 4 as well as Illustrations for Episode 3.. Since Episode 4 is the finale I thought a lot about some great twists and good flash backs . We had already decided from the first episode itself that \*Spoiler Alert Ahead\* Stephen is Vandall. But we needed a good way to make this twist. I came up with the idea of the backstory and shared it with a rest of the group after writing the basic timeline for episode 4.

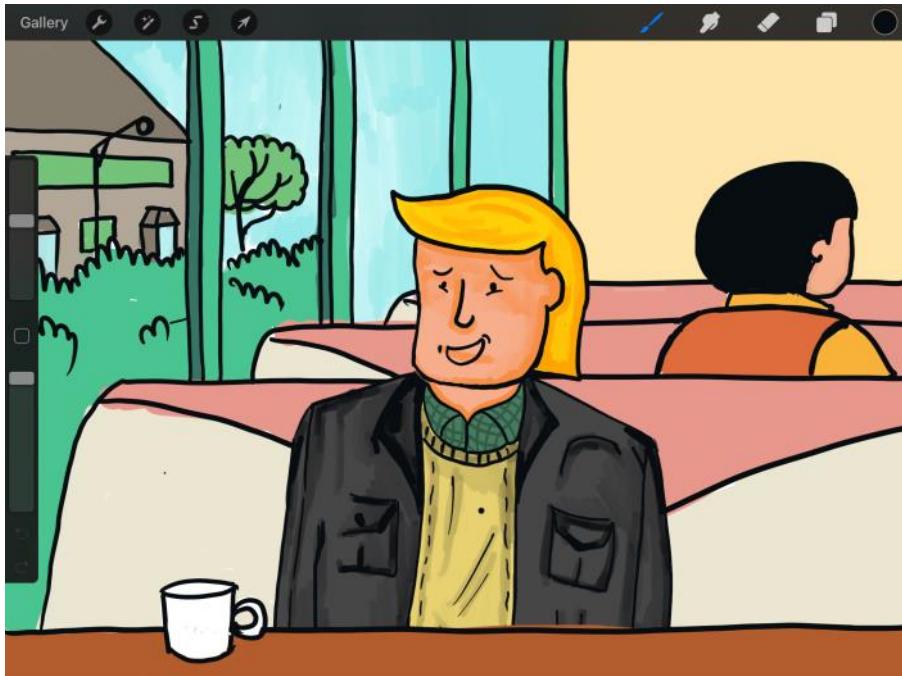
The illustration work included illustrating in Procreate on iPad as always... It also included working in Adobe Illustrator, Photoshop.

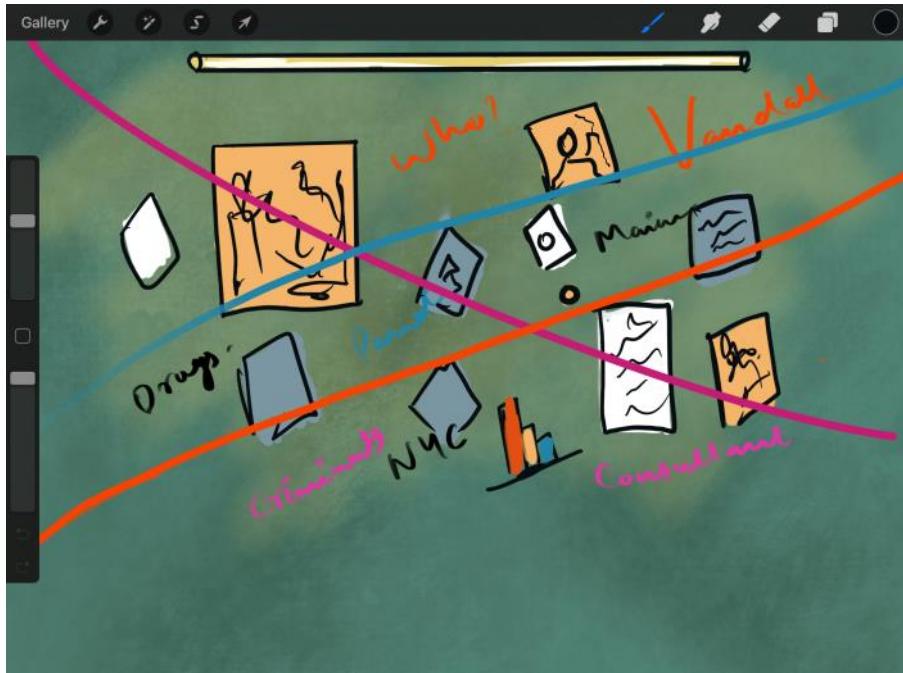
The screenshots show some of the work done:

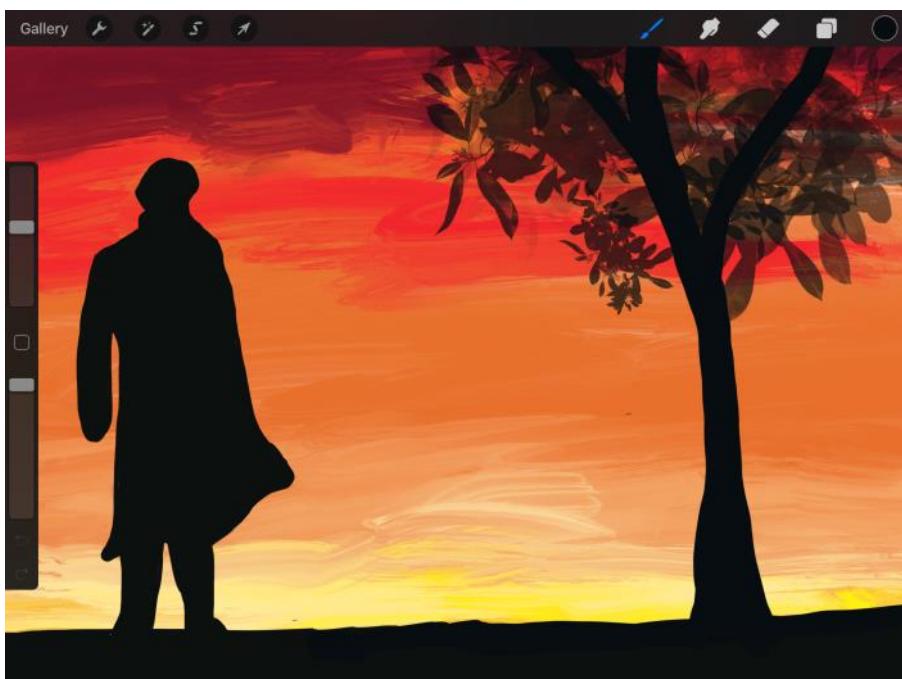
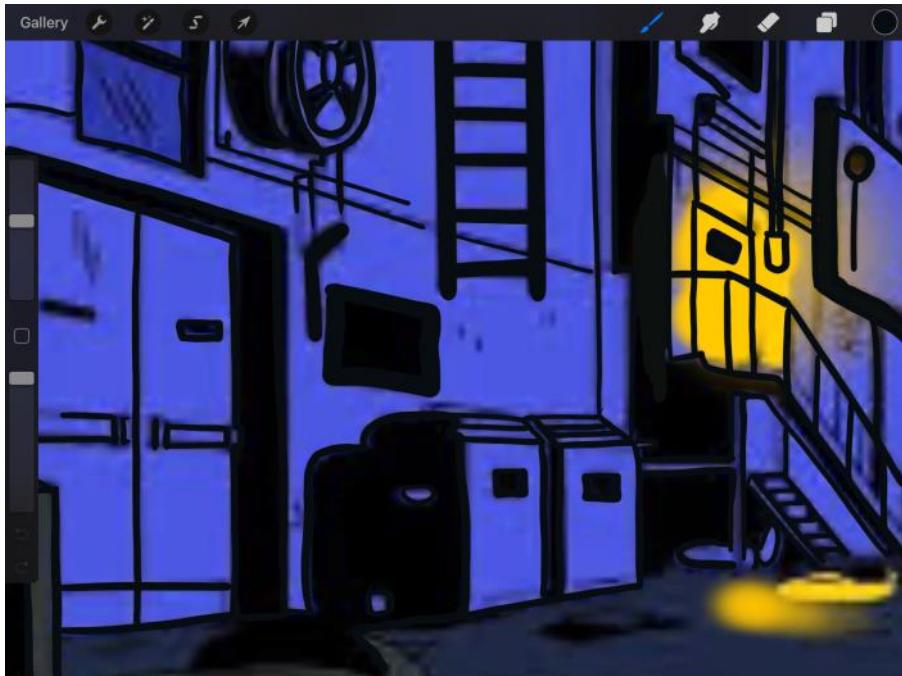


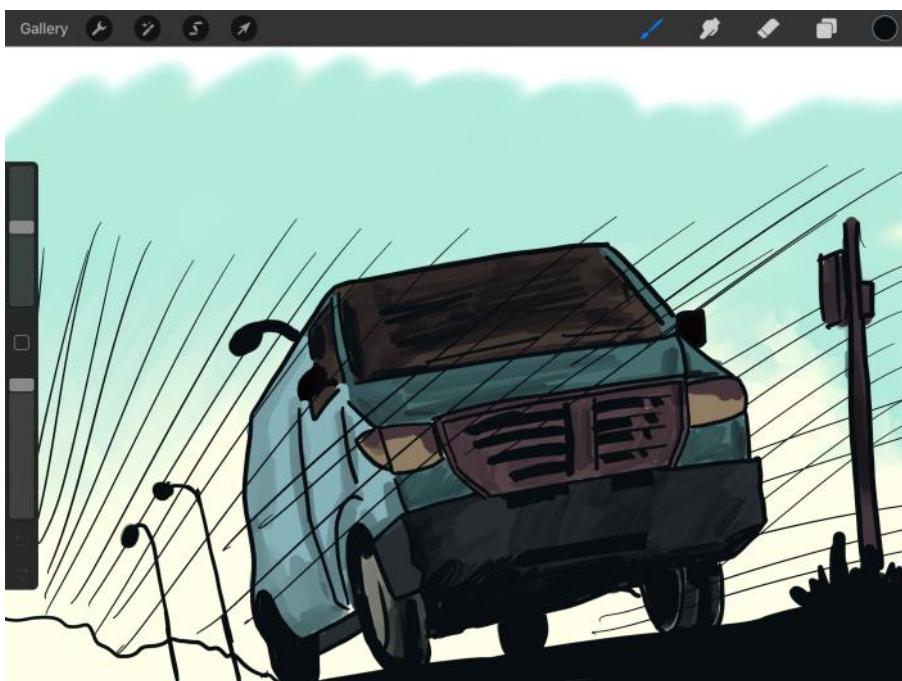




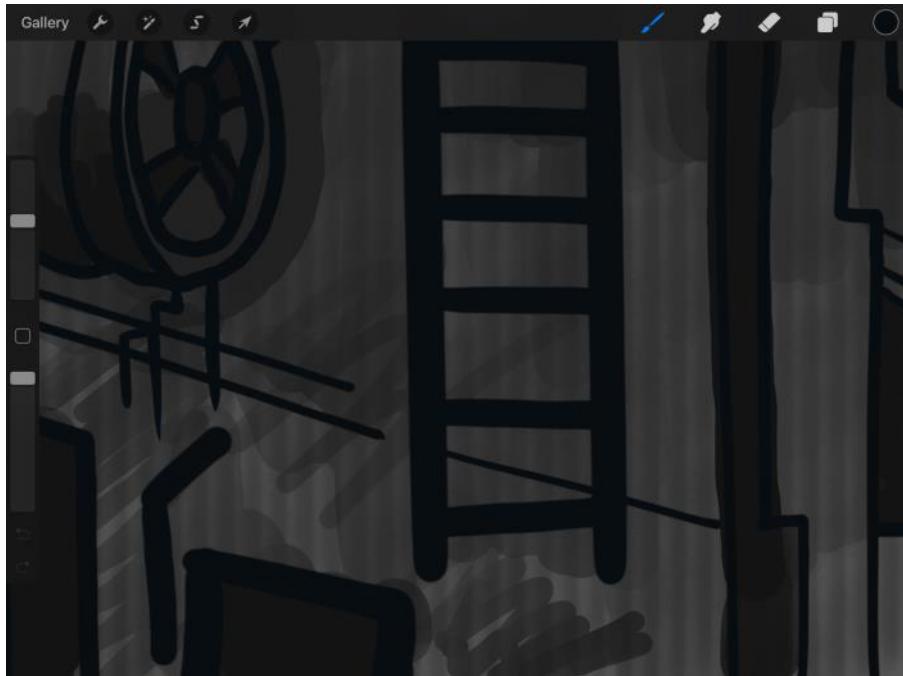


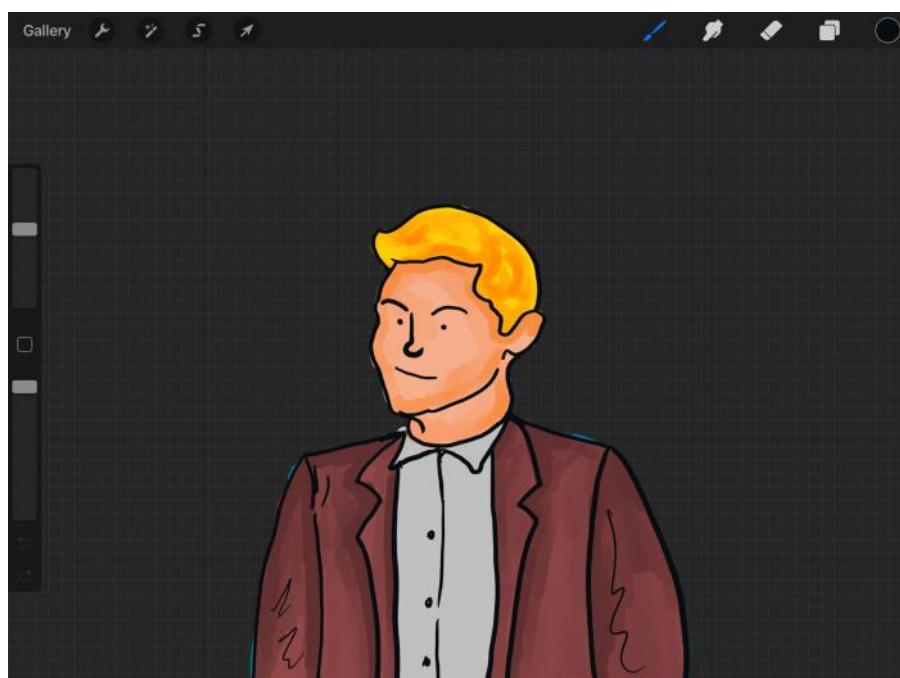
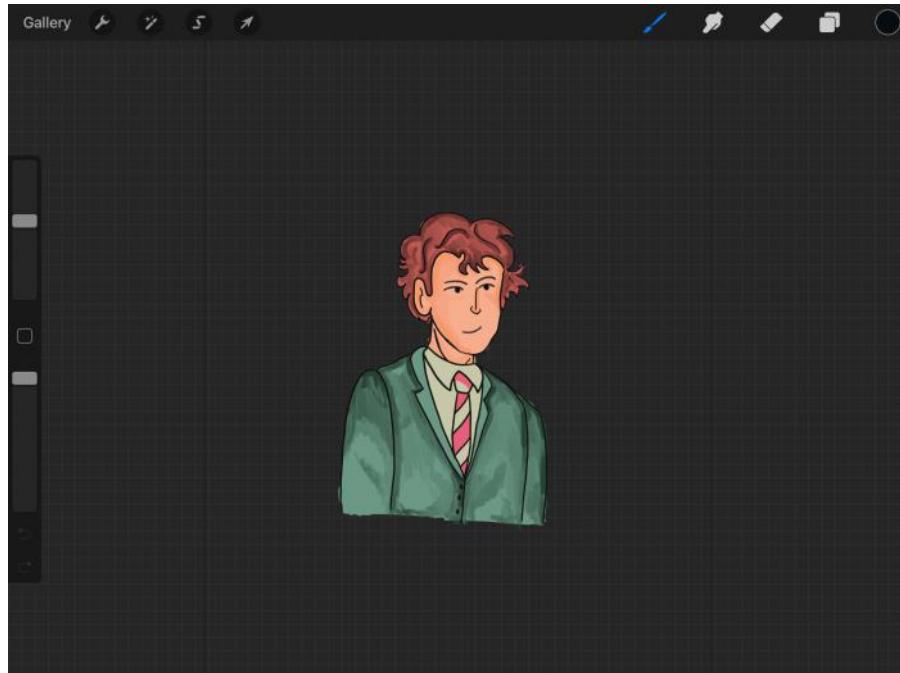


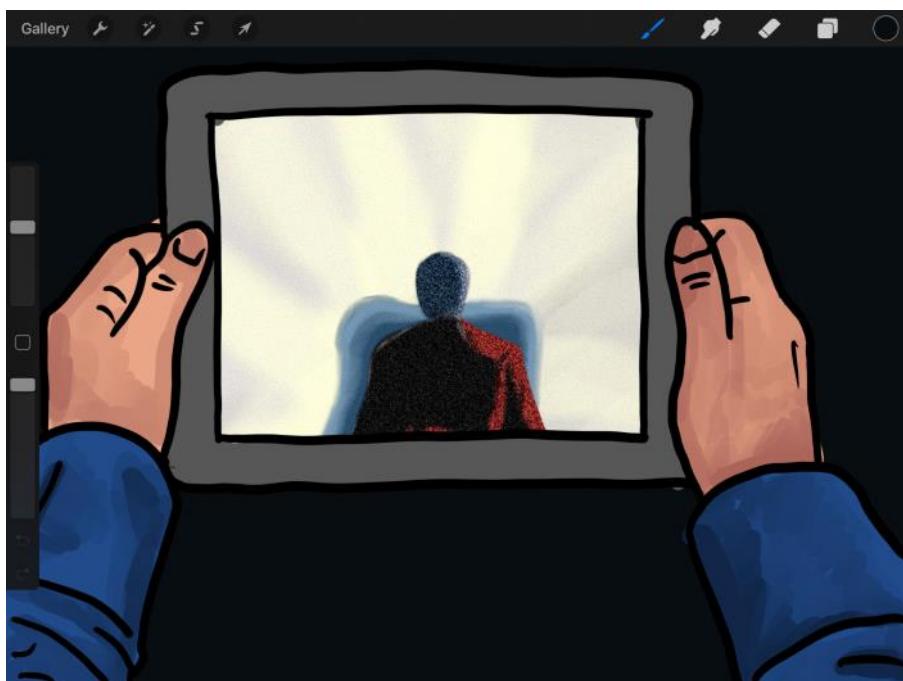


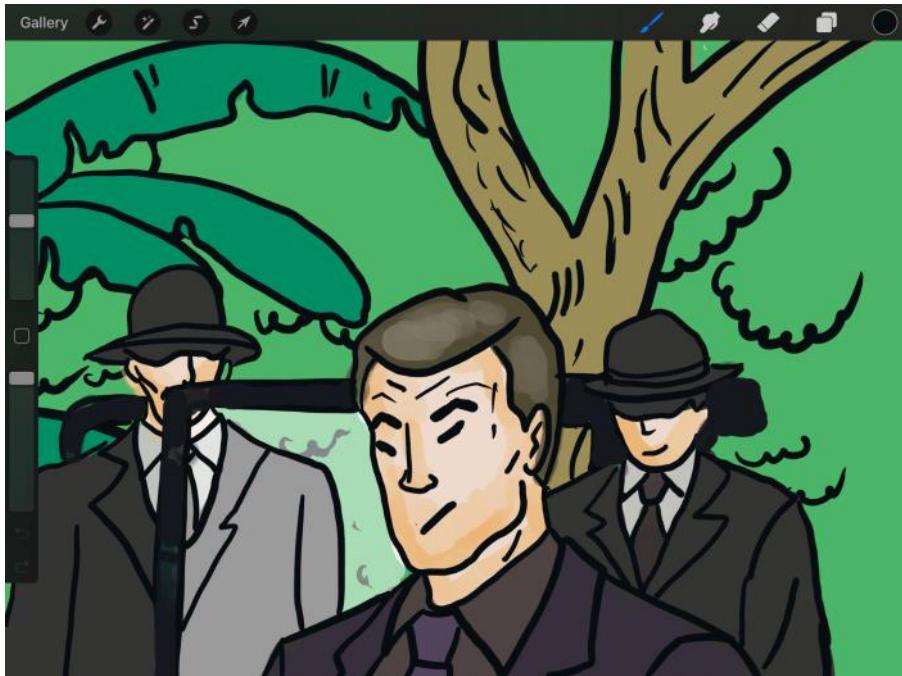


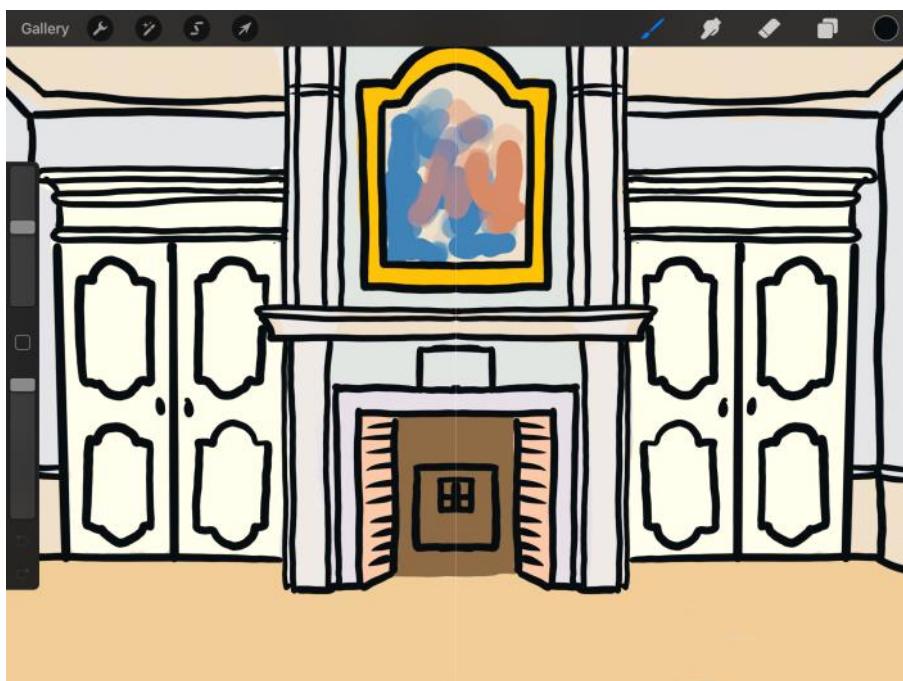
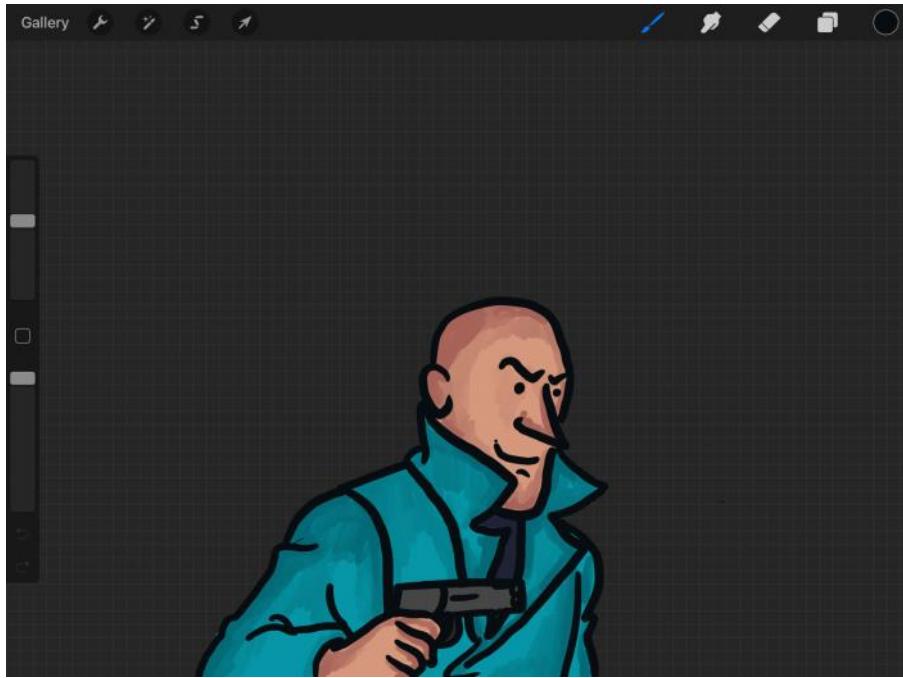


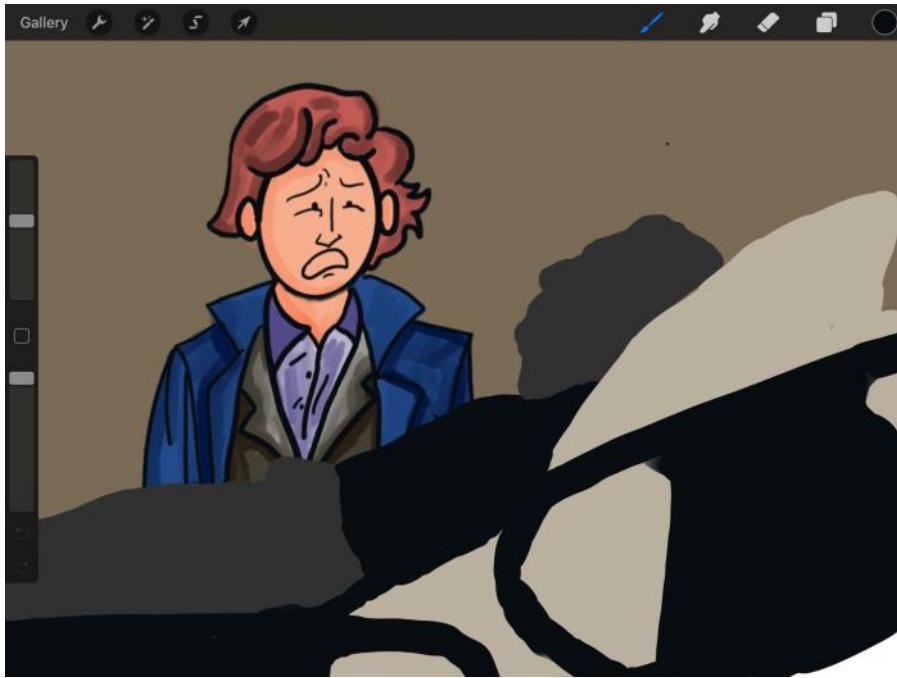




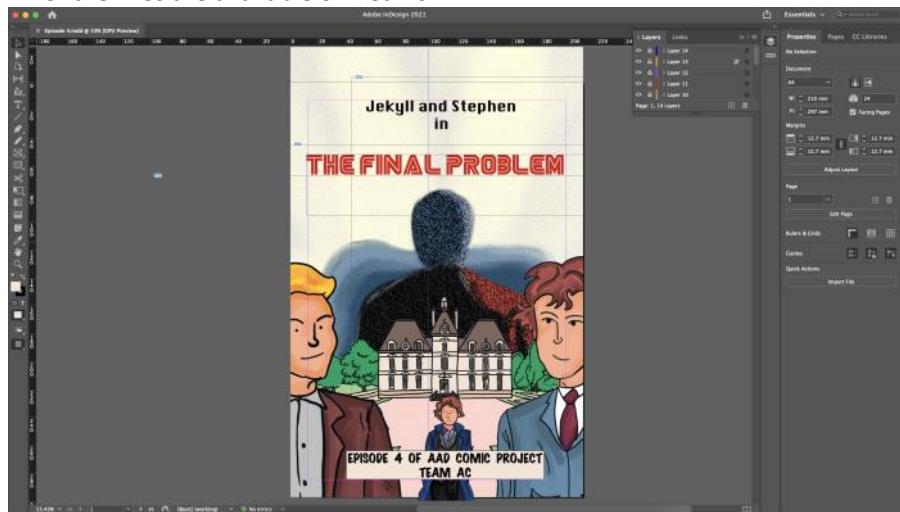


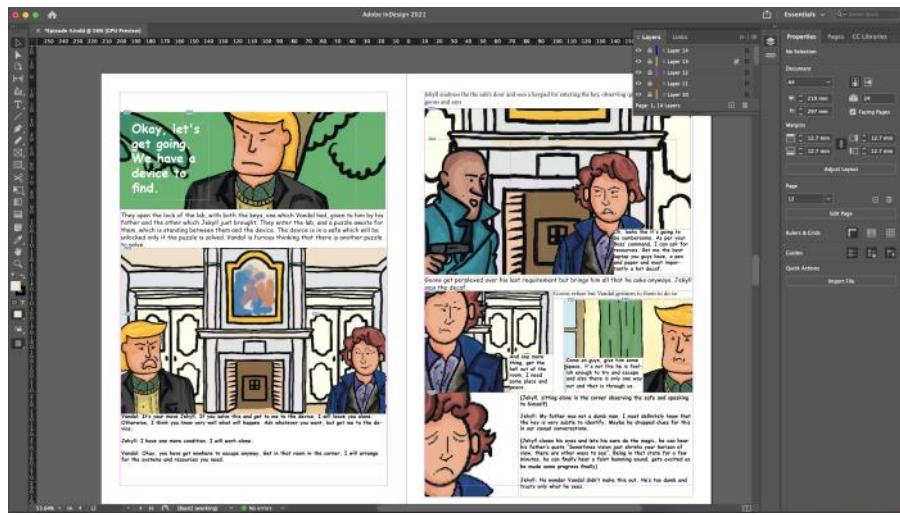


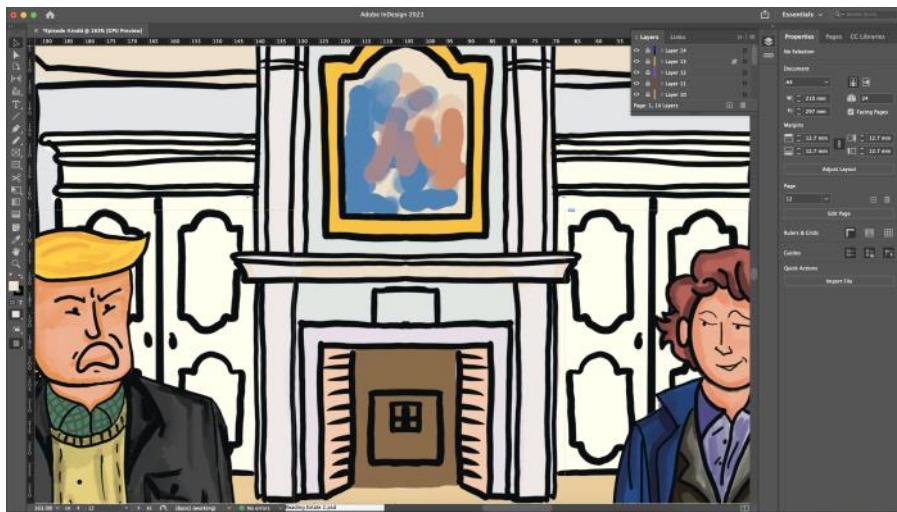


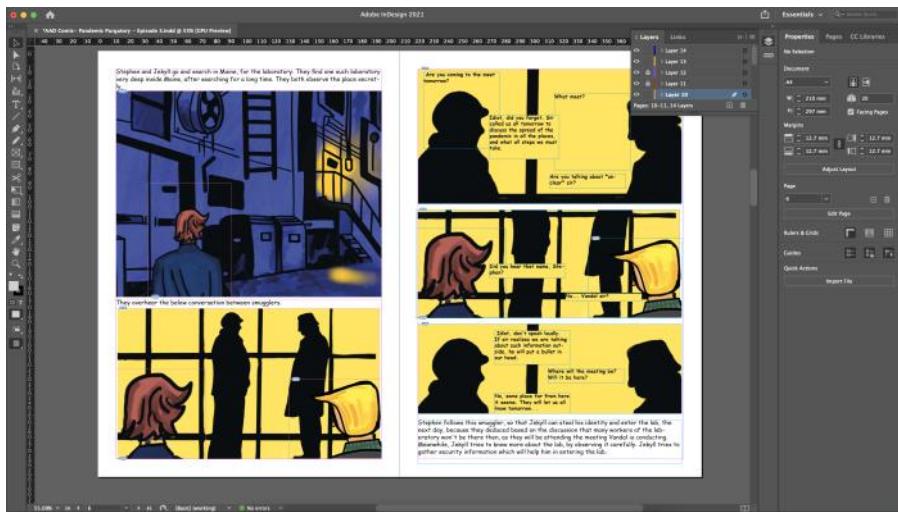


The last few days were spent on putting everything together in InDesign which are shown below..  
The InDesign work included hours...  
All of the Files are available on Teams..









Finally during the whole over the span of over 50+ hours I completed the illustrations for episode 3 and episode 4, which I took to real professional comic levels in terms of detail. I am very happy with outcomes and these episodes have given me immense satisfaction in terms of quality in illustrations. I also worked on the story and flashbacks of episode 4 and episode 4 is the modification of that basic flashback idea. The idea and the initial storyline was worked upon by Arvindh and Gokul with some of the best dialogues that I have read.

With me finishing off this work, we finish the Comic Project, and I am proud to announce it as well. Cheers!!

All the files are available here:

[Episode 3 Files](#)

[Episode 4 Files](#)

Read the issues here,

[Episode 3](#)

[Episode 4](#)

# 23<sup>rd</sup> November-Day 21- Making the Website

23 November 2020 17:54