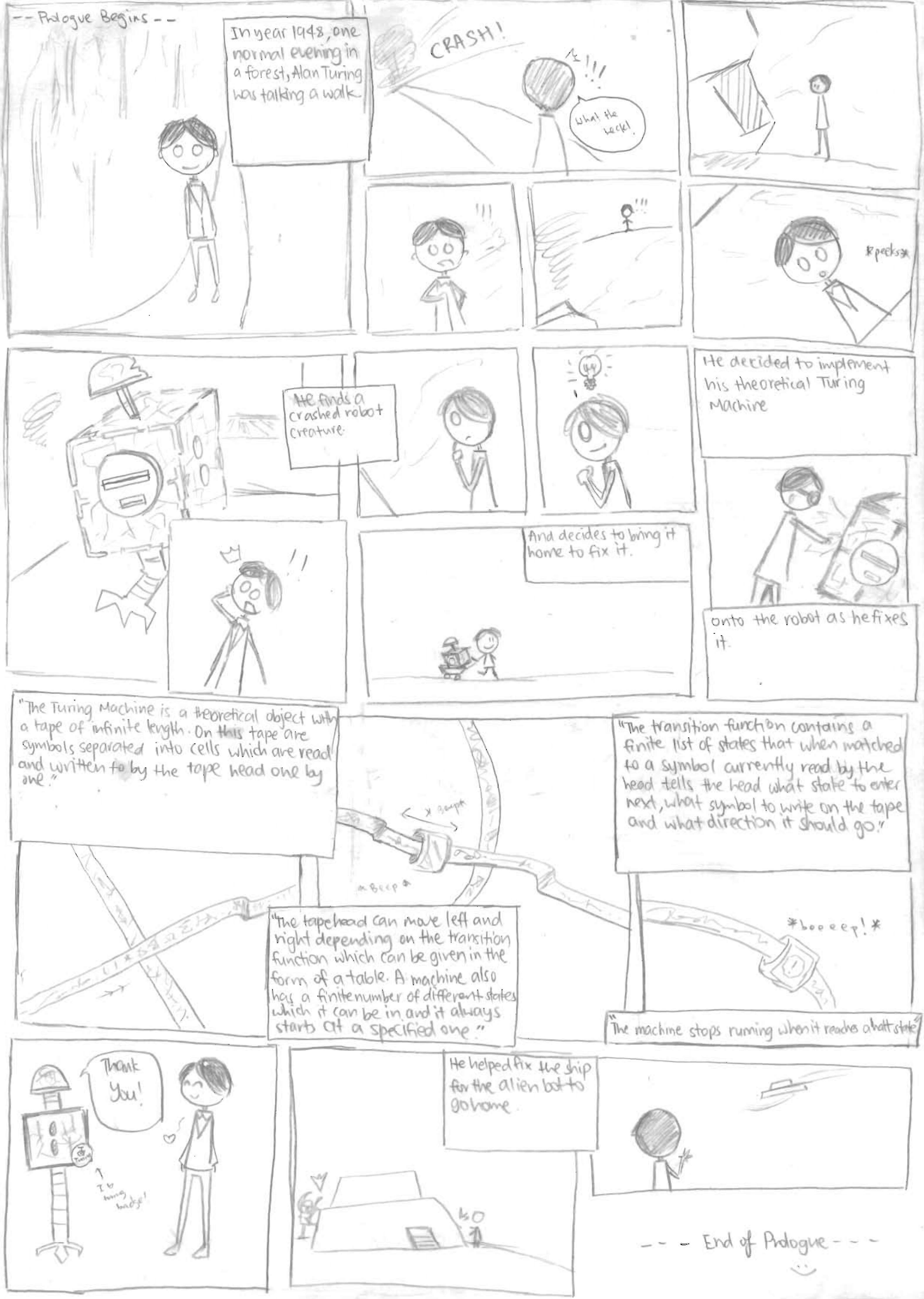
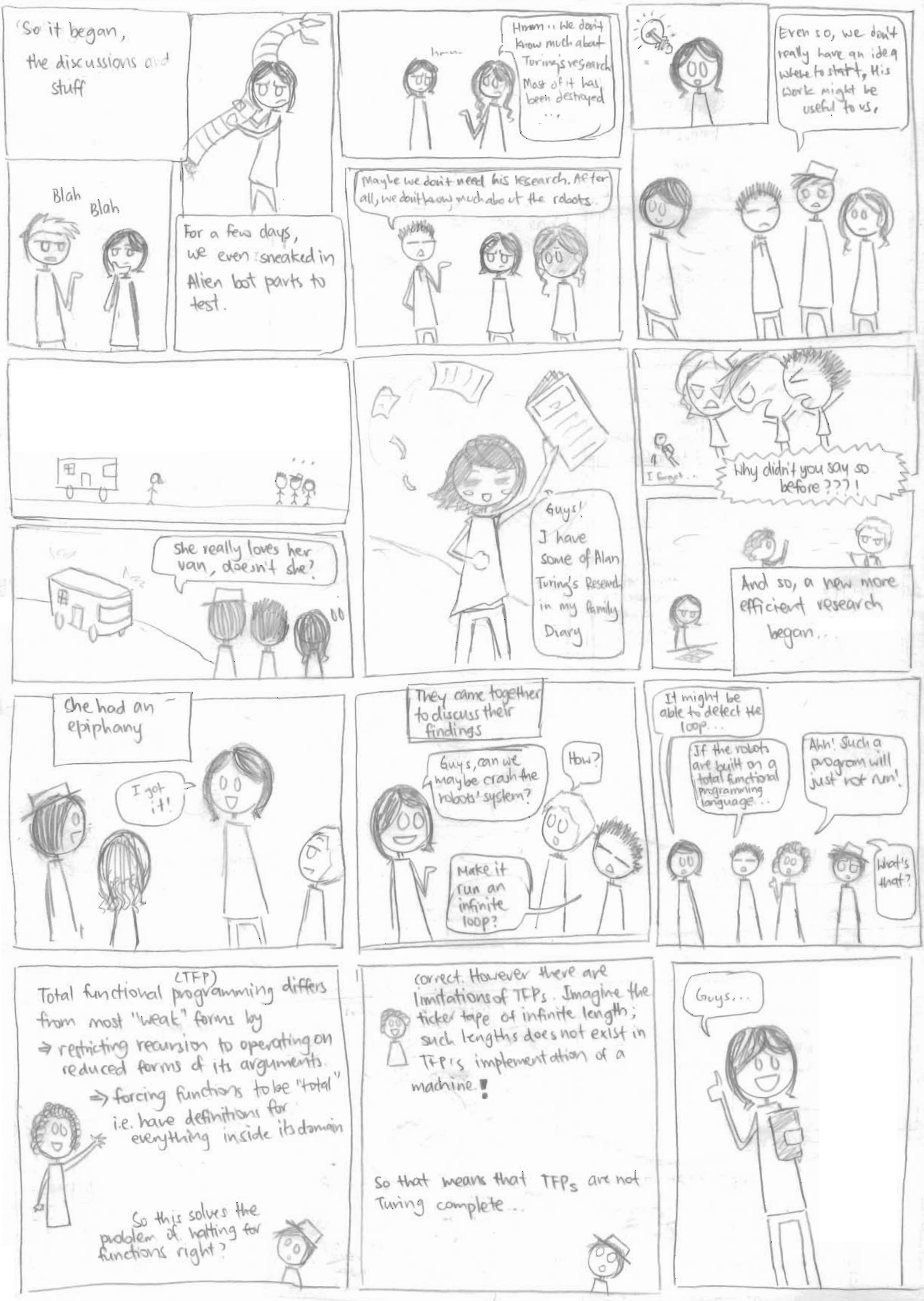


-- Prologue Begins --
In year 1948, one normal evening in a forest, Alan Turing was talking a walk.
CRASH!
!!!
What the heck!
!!!
!!!
*peeks*
He finds a crashed robot creature.
!!
He decided to implement his theoretical Turing Machine
And decides to bring it home to fix it.
onto the robot as he fixes it.
"The Turing Machine is a theoretical object with a tape of infinite length. On this tape are symbols separated into cells which are read and written to by the tape head one by one."
*Beep*
*Beep*
"The transition function contains a finite list of states that when matched to a symbol currently read by the head tells the head what state to enter next, what symbol to write on the tape and what direction it should go."
"The tapehead can move left and right depending on the transition function which can be given in the form of a table. A machine also has a finite number of different states which it can be in and it always starts at a specified one."
*booeep!*
"The machine stops running when it reaches a halt state"
Thank You!
He helped fix the ship for the alien bot to go home
--- End of Prologue ---


Year 2051.,.
In a time of peace
Something
despicable
happened.
.......when
technology was advanced.
ALERT!
spacestation, do you read me?
There's something approaching
something big.....
IMPENDING DOOM!
what is happening?
WTH! It just appeared out of nowhere!
FOOSH!!!
AAAAARGHH!!!
AAARGHH!
PANIC
Chaos everywhere
BOOM!
BOOM!
BOOM!
KABOOM!!!
Massive destruction
of human population

World as we knew it was gone
Remaining surviors in hiding
Mankind has conceded defeat.
Many travelled out of cities and into the wilderness to form refugee camps
Something has to be done about this...
There were rumours about a camp in Area 51
It's only a matter of time before they decide to attack again.
That there was a plan for rebellion. I was interested
Area 51
Do not trespass
I made my way to the camp
STOP
HALT!
Welcome to Area 51
Another survivor!
They intro-ed me to the rest of them
Something weird happened though when I told them my name.....
Hello everyone! I'm Nala Turing
. . .
OMG IT'S THE DESCENDENT OF THE GREAT ALAN TURING
His papers are widely ackn-owledged as the foundation of research in Artificial Intellig-ence
The central concept of modern computer was based on Turing's Paper
He is recognised as the great founder of Computer Science
proposed a "turing test" in effect to create an intelligence design standard for the tech industry
You can help us greatly in the rebellion!
Yes, I'll try



'So it began,
the discussions and stuff
Blah
Blah
For a few days, we even sneaked in Alien bot parts to test.
Hmm.. We don't know much about Turing's research. Most of it has been destroyed ...
Maybe we don't need his research. After all, we don't know much about the robots.
Even so, we don't really have an idea where to start. His work might be useful to us.
She really loves her van, doesn't she?
Guys! I have some of Alan Turing's Research in my Family Diary
I forget..
Why didn't you say so before???!
And so, a new more efficient research began...
She had an epiphany
I got it!
They came together to discuss their findings
Guys, can we maybe crash the robots' system?
How?
Make it run an infinite loop?
It might be able to detect the loop...
If the robots are built on a total functional programming language...
Ahh! Such a program will just not run!
What's that?
Total functional programming (TFP) differs from most "weak" forms by
⇒ restricting recursion to operating on reduced forms of its arguments.
⇒ forcing functions to be "total" i.e. have definitions for everything inside its domain
So this solves the problem of halting for functions right?
correct. However there are limitations of TFPs. Imagine the ticker tape of infinite length; such lengths does not exist in TFP's implementation of a machine!
So that means that TFPs are not Turing complete...
Guys...


The robots are based on the idea of Turing Machines*!
*refer to first page
That means programs with infinite loops do run inside them!!!!
I've got an idea!
while (true)
{ }
neverending loop!
. . .
I'm embarrassed to call you my brother
What?
I'm pretty sure such a loop can be detected by the robot
Even my grandma's compiler can detect this?
Okay... what can we loop it with then?
I was just suggesting...
Do you guys know what an undetectable problem is?
No...
Do you know what a decision problem is?
No!!!
Put simply, it is a problem with a yes or no answer
These guys are stupid!
Ok...
An undetectable problem is a decision problem that cannot be solved correctly with a simple general algorithm
Ah... Are you thinking what I'm thinking?
What are you thinking?
*nod nod*
a:
goto a;
NO!
*face palm*
I'm thinking about the HALTING PROBLEM!
Woah.....
.......
.......

We know those bots are based off Turing machines...
Precisely! Now we have a way of stopping it!
Thanks to your ancester...
The Halting Problem is an undecidable problem on Turing Machines
slurp
So that means we cannot make a single algorithm to tell us whether any program will halt?
Yes...
!!
Now since we know the problem cannot be solved
We can trick the robot into trying to solve the Halting Problem....
smart boi!
But what if it already knows about the Halting Problem..
We'll unnecessarily endanger the lives of our greatest minds!
let's see..,
flip
1948 -
Alan just came back from fixing the robot
OH NO!
I forgot to tell him/her about the Halting Problem
!
HALTING
I do hope it won't bother him in future much
Oh well..
Present Day.
The Robot doesn't know about the Halting Problem!
That settles it! We can trick it and defeat it!
Let's get to work people!
The resistance starts getting ready at a location away from area 51.
communication device
Aaaahhh
Communications was established!
Talk to mama

Silly human. By contacting me you have exposed your position to me....
I know, just wanted to chat...
?!
Go on there, amuse me.
You certainly will be...
Tell me, do you think you can solve every problem I give you?
Of course! I'm the motherboard, the cleverest being arounhere, and the rest of the universe!
I have conquered 89% of the universe, how dare you challenge my intellect?
Brawn ≠ Brain, Motherboard
Oh, is that so?
The robots have found her!
Since you are going to kill me, why don't you answer a problem
I really want to know the answer;
Oh alright, why don't you ask away
Can you find me a simple algorithm that can tell if any program will halt or run forever?
Sure... Here you go.
WTH!?
!!
if{program_contains( "while(true)" or "for(ii)" ) return false } else { return true }
This is utter nonsense
Can I kill you now?
You know as well as I do that, it is not enough!
So what?
If you don't solve it you can't claim to be the cleverest around here..
Alright.. I'll do it
Don't you try to escape or anything, my robots are watching...
Don't you worry. I'll be right here.
Processing...
...
Processing...
You have any 'twos'?
Back in area 51
It's been hours since Nala left. Do you think she's fine?
I'm sure she can handle herself, mate.
Yes, such great courage to face the motherboard on her own,
*nod*
She'll be fine dude.


1. We want to prove that a function $H(x,y)$ that checks if a function $x$ given an input $y$ will halt does not exist, in other words:

2. Let $H(x,y)$ be a function such that $x$ and $y$ are functions and

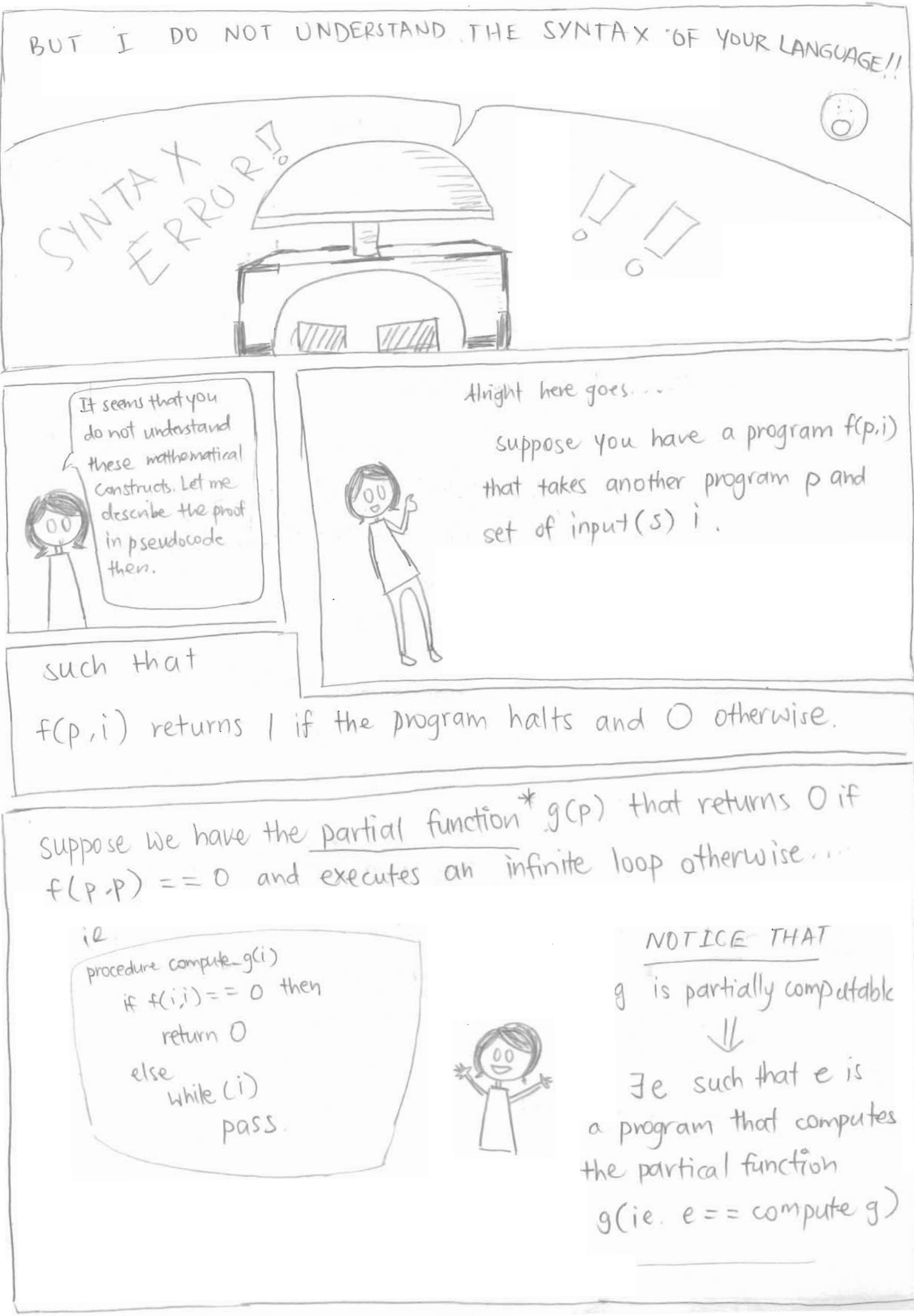
$$\forall x \forall y \left( \left( time(x(y)) < \infty \iff H(x,y) = 1 \right) \land \left( time(x(y)) = \infty \iff H(x,y) = 0 \right) \right)$$

3. Let us assume $H$ exists

1. Let $R(X)$ be a function that $x$ is a function and $\forall x \left(H(x,x) = 1 \Leftrightarrow time(R(x)) = \infty\right) \wedge \left(H(x,x) = 0 \Leftrightarrow time(R(x)) < \infty\right)$
2. We let $x = R$ such that $R(R)$
3. Let us assume $time(R(R)) = \infty$
    a. $H(R,R) = 1$ by 3.1
    b. $time(R(R)) < \infty$ by 2
    c. $time(R(R)) = \infty \wedge time(R(R)) < \infty$
    d. This is a contradiction.
4. $time(R(R)) \neq \infty$
5. Let us assume $time(R(R)) < \infty$.
    a. $H(R,R) = 0$ by 3.1
    b. $time(R(R)) = \infty$ by 2
    c. $time(R(R)) = \infty \wedge time(R(R)) < \infty$
    d. This is a contradiction.
6. $time(R(R)) = \infty$
7. $time(R(R)) = \infty \wedge time(R(R)) \neq \infty$ by 3.4 and 3.6
8. This is a contradiction

4. $H$ does not exist.

Q.E.D



BUT I DO NOT UNDERSTAND THE SYNTAX OF YOUR LANGUAGE!!
SYNTAX ERROR!!
!!
!!
It seems that you do not understand these mathematical constructs. Let me describe the proof in pseudocode then.
Alright here goes...
suppose you have a program f(p,i) that takes another program p and set of input(s) i.
such that
f(p,i) returns 1 if the program halts and 0 otherwise.
suppose we have the partial function* g(p) that returns 0 if f(p,p) == 0 and executes an infinite loop otherwise...
ie
procedure compute_g(i)
if f(i,i) == 0 then
return 0
else
while (i)
pass
NOTICE THAT
g is partially computable
⇓
∃e such that e is a program that computes the partical function g (ie. e == compute g)

Let's show that $f(p,i)$ is not an arbitrary total function*
by proving that $\exists k_1, \exists k_2, \exists k_3 : f(k_1) = k_2 \wedge f(k_1) = k_3 \wedge (k_2 \neq k_3)$

Assume $f(e,e) = 0$

then $compute\_g(e) = e(e) = 0$

then $f(e,e) = 1$ $(\Rightarrow\Leftarrow)$

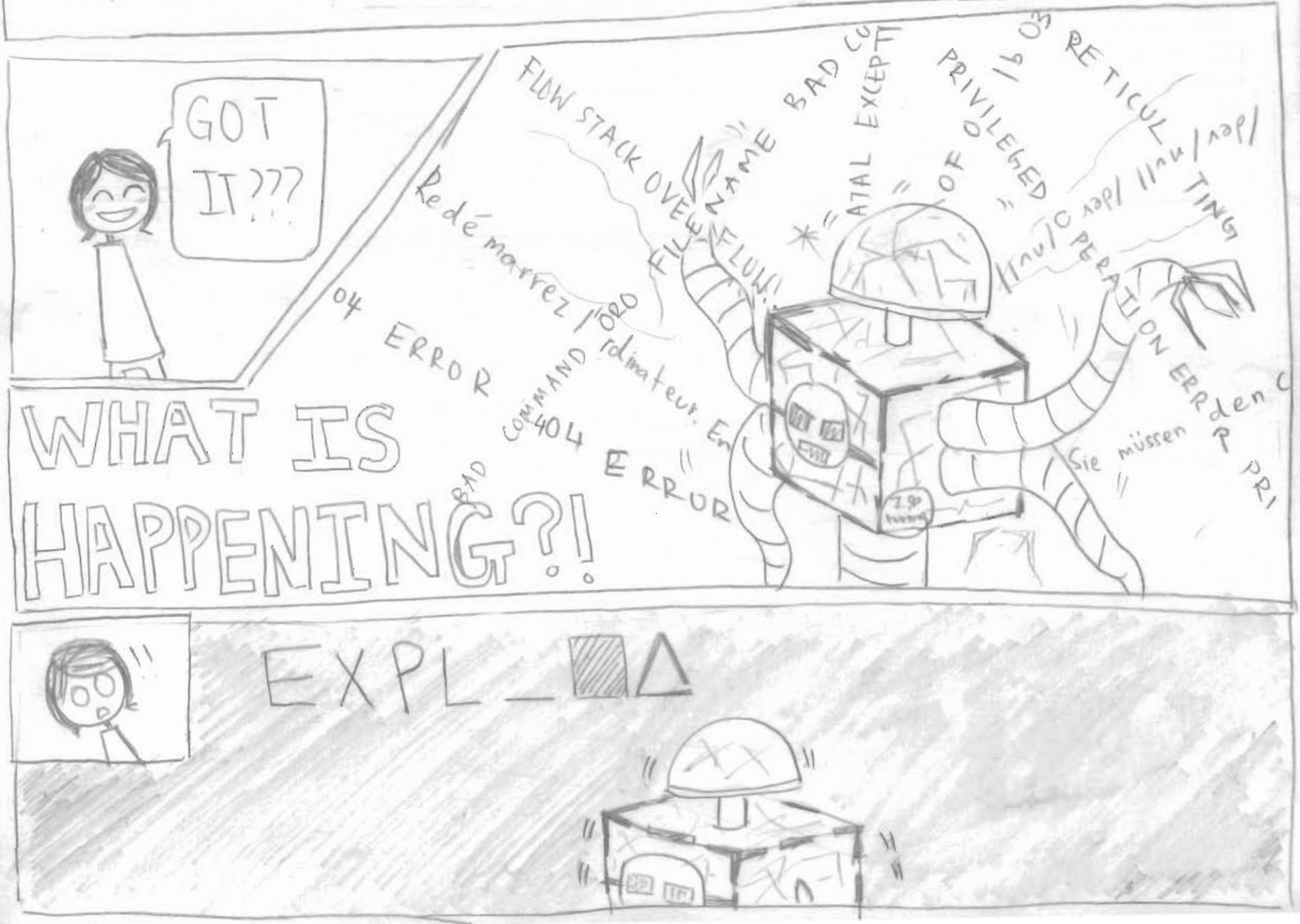
Assume $f(e,e) = 1$,

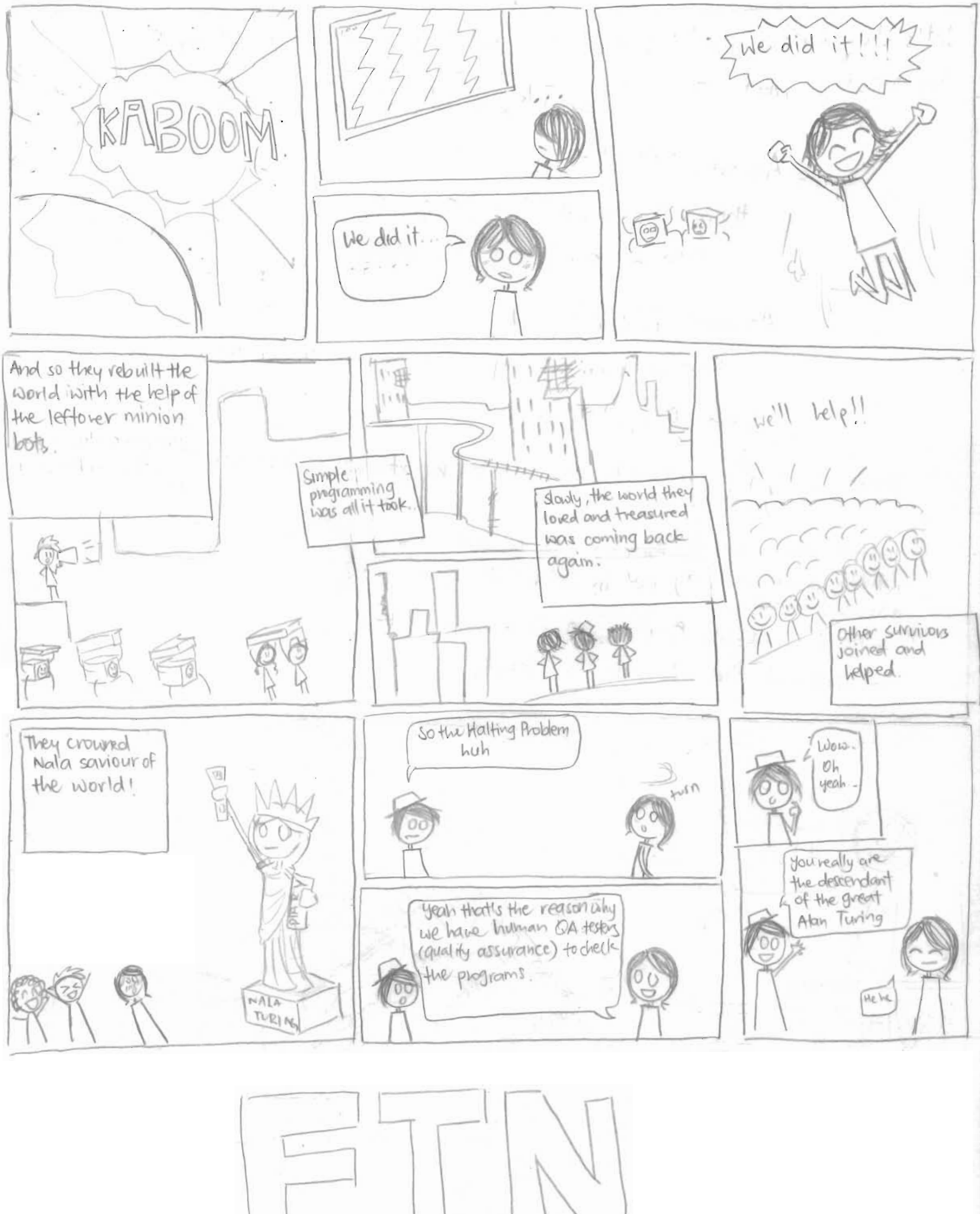
then $compute\_g(e) = e(e)$ does not halt

then $f(e,e) = 0$ $(\Rightarrow\Leftarrow)$

Thus $f(p,i)$ is not an arbitrary total function !

* partial computable function, P, is a function whose domain may not be defined for every possible input.
* total computable function, Q, is a function that is defined for all possible inputs




KABOOM
We did it...
We did it!!!
And so they rebuilt the world with the help of the leftover minion bots.
Simple programming was all it took.
Slowly, the world they loved and treasured was coming back again.
we'll help!!
Other survivors joined and helped.
They crowned Nala saviour of the world!
NALA TURING
So the Halting Problem huh
turn
Wow. Oh yeah...
Yeah that's the reason why we have human QA testers (quality assurance) to check the programs.
You really are the descendant of the great Alan Turing
He he
FIN