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BUGS 'N' ROBOTS



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de France

INSTITUT
DES SCIENCES ETIENNE
DU MOUVEMENT JULES
MAREY

soben

TwinswHeel

BUGS 'N' ROBOTS

TRANSLATION INTO ENGLISH BY DAVID WOOD

**WITH SPECIAL THANKS TO ANNIE GIBERT
MANAGER OF THE INSTITUTE OF MOVEMENT SCIENCES - ETIENNE-JULES MAREY
(CNRS/AIX MARSEILLE UNIVERSITY, UMR7287)**

**MANY THANKS TO SOPHIE SEGUINEL FOR PROOFREADING THIS COMIC STRIP
MANAGER AT THE INSTITUTE OF MOVEMENT SCIENCES - ETIENNE-JULES MAREY
(CNRS/AIX MARSEILLE UNIVERSITY, UMR7287)**

**WE WOULD LIKE TO THANK THE FRENCH COMPANY TWINSWHEEL
FOUNDED BY VINCENT AND BENJAMIN TALON
FOR THEIR SUPPORT IN THE CREATION OF THIS COMIC STRIP.**

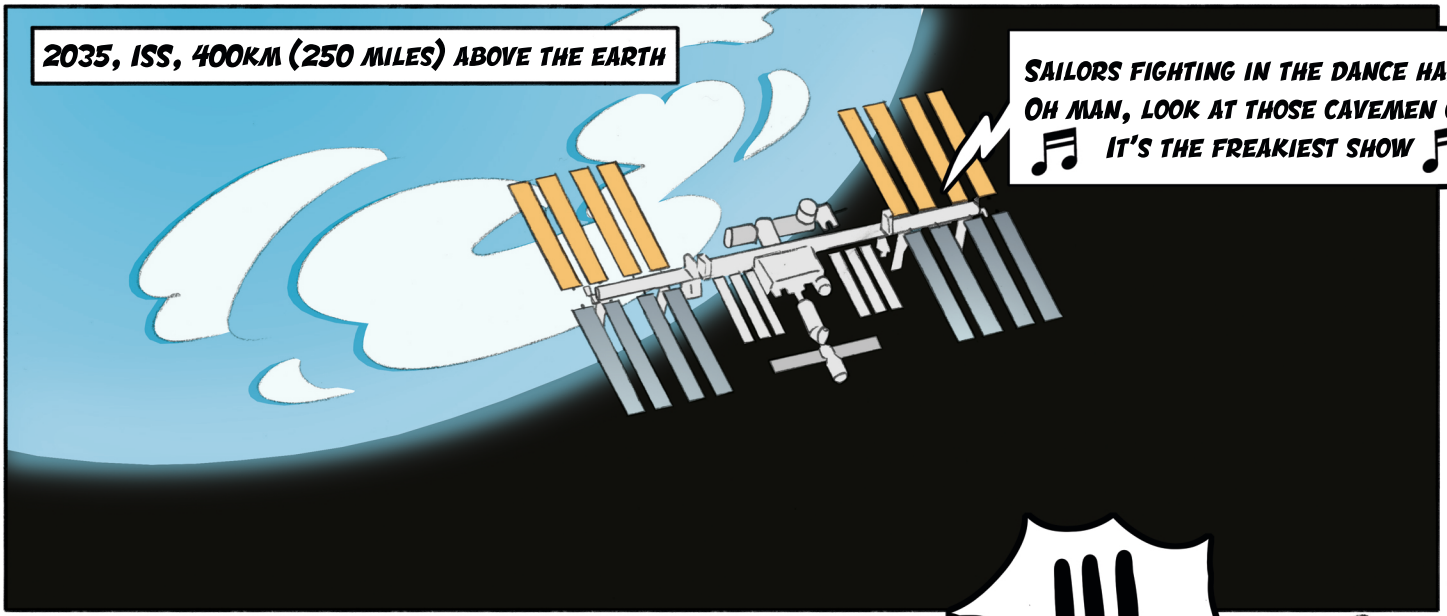
**SCRIPT: JULIEN SERRES
PROFESSOR AT AIX MARSEILLE UNIVERSITY
AND SENIOR MEMBER OF THE INSTITUT UNIVERSITAIRE DE FRANCE,
EXPERT IN BIO-INSPIRED ROBOTICS AND SENSORIMOTOR CONTROL**

**ARTWORK AND COLOURS: JULIETTE BLANCHOT
COLOURIST OF ALYSON FORD VOL 3 AT GLÉNAT (VENTS D'OUEST)**

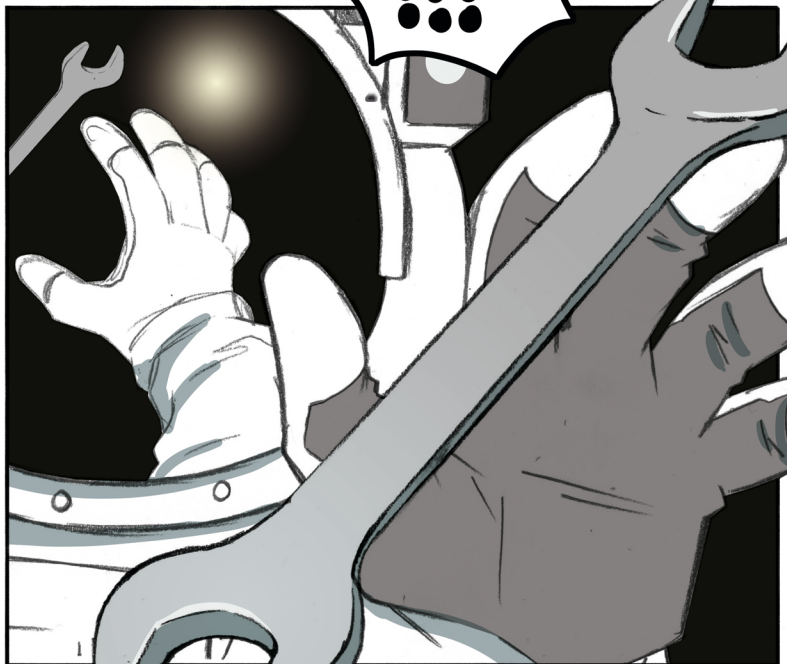
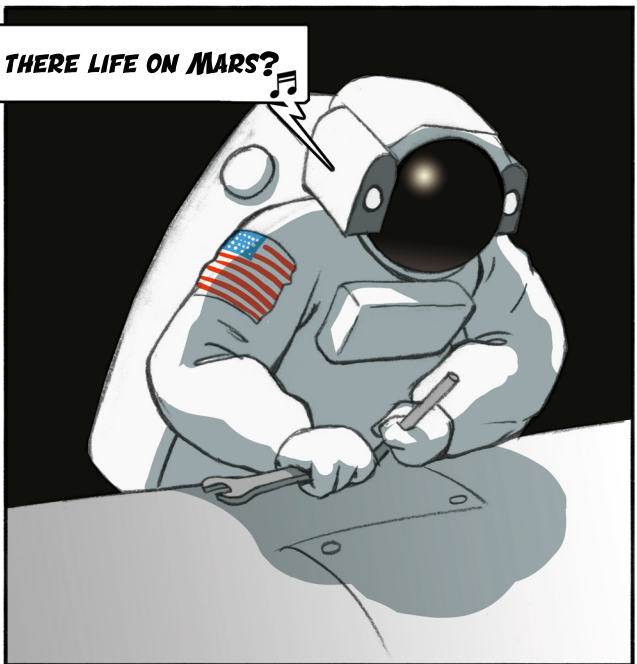
TRANSLATED FROM FRENCH BY DAVID WOOD, ENGLISH AT YOUR SERVICE

2035, ISS, 400KM (250 MILES) ABOVE THE EARTH

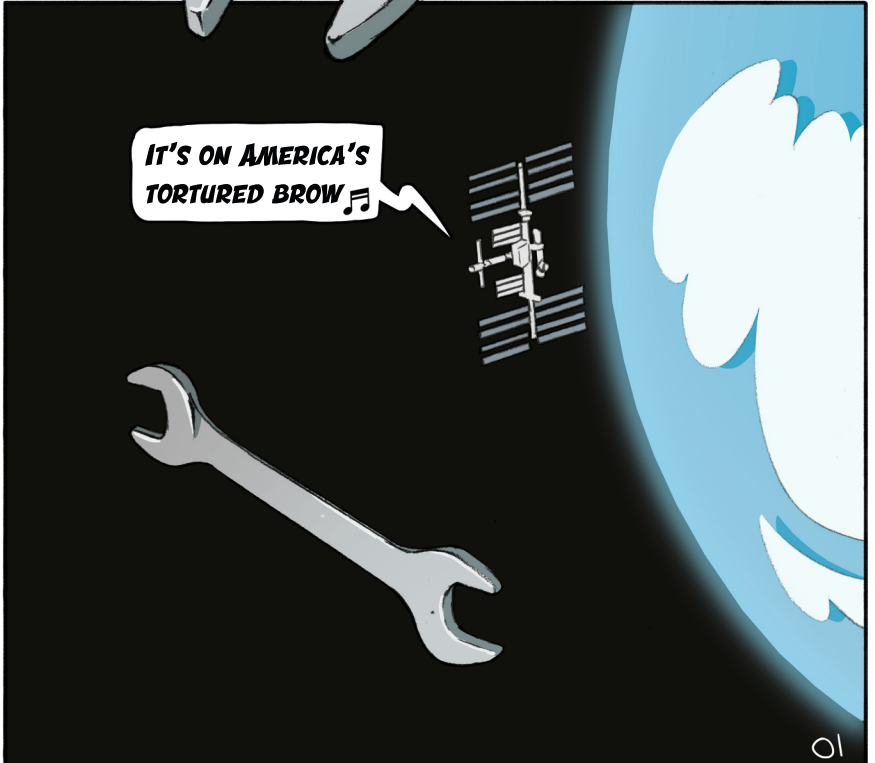
SAILORS FIGHTING IN THE DANCE HALL
OH MAN, LOOK AT THOSE CAVEMEN GO
🎵 IT'S THE FREAKIEST SHOW 🎵

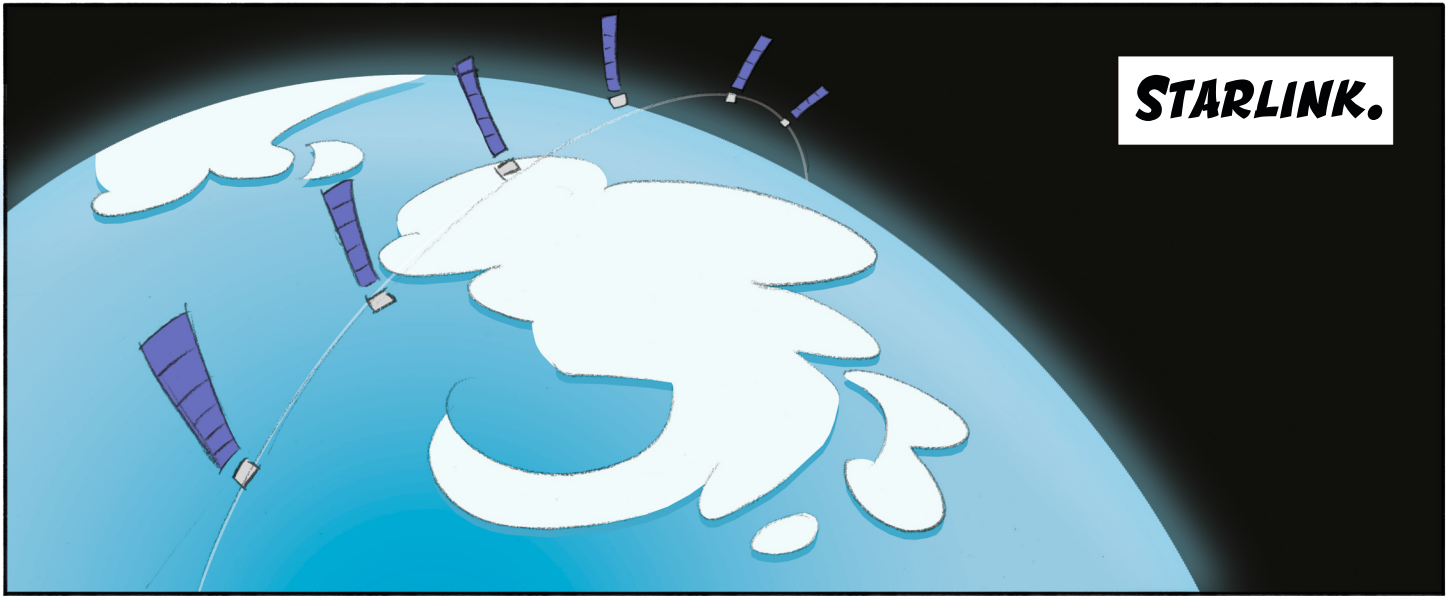


🎵 IS THERE LIFE ON MARS? 🎵

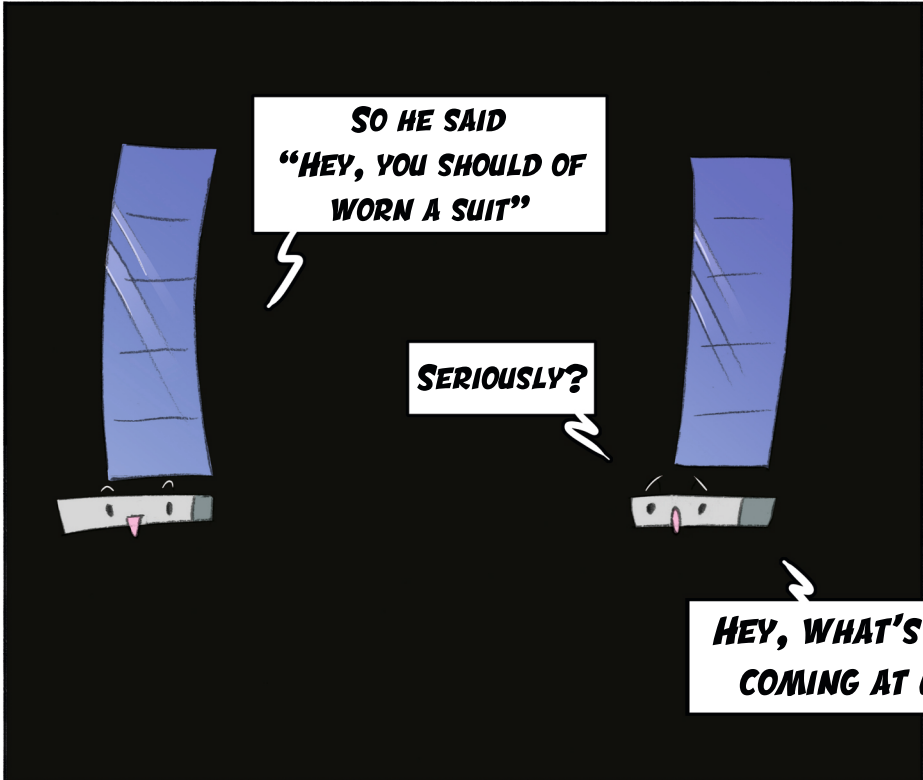


IT'S ON AMERICA'S
TORTURED BROW 🎵





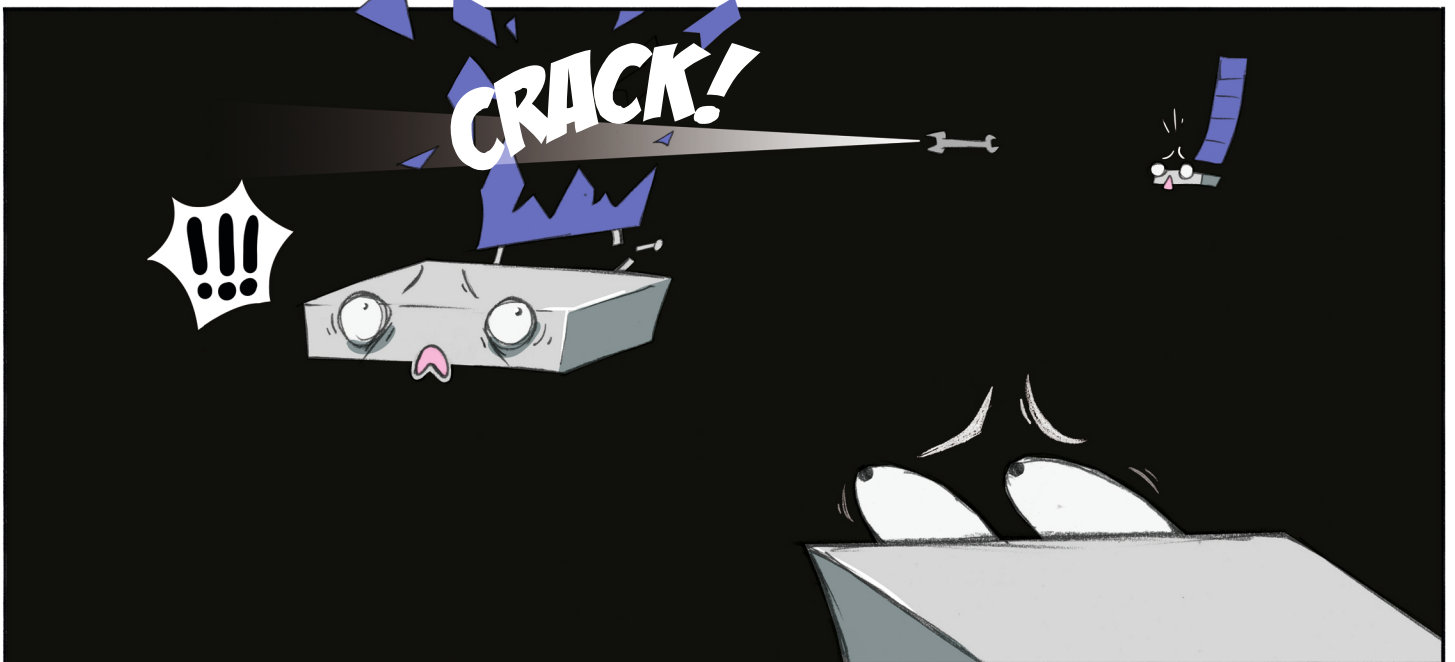
STARLINK.



SO HE SAID
"HEY, YOU SHOULD OF
WORN A SUIT"

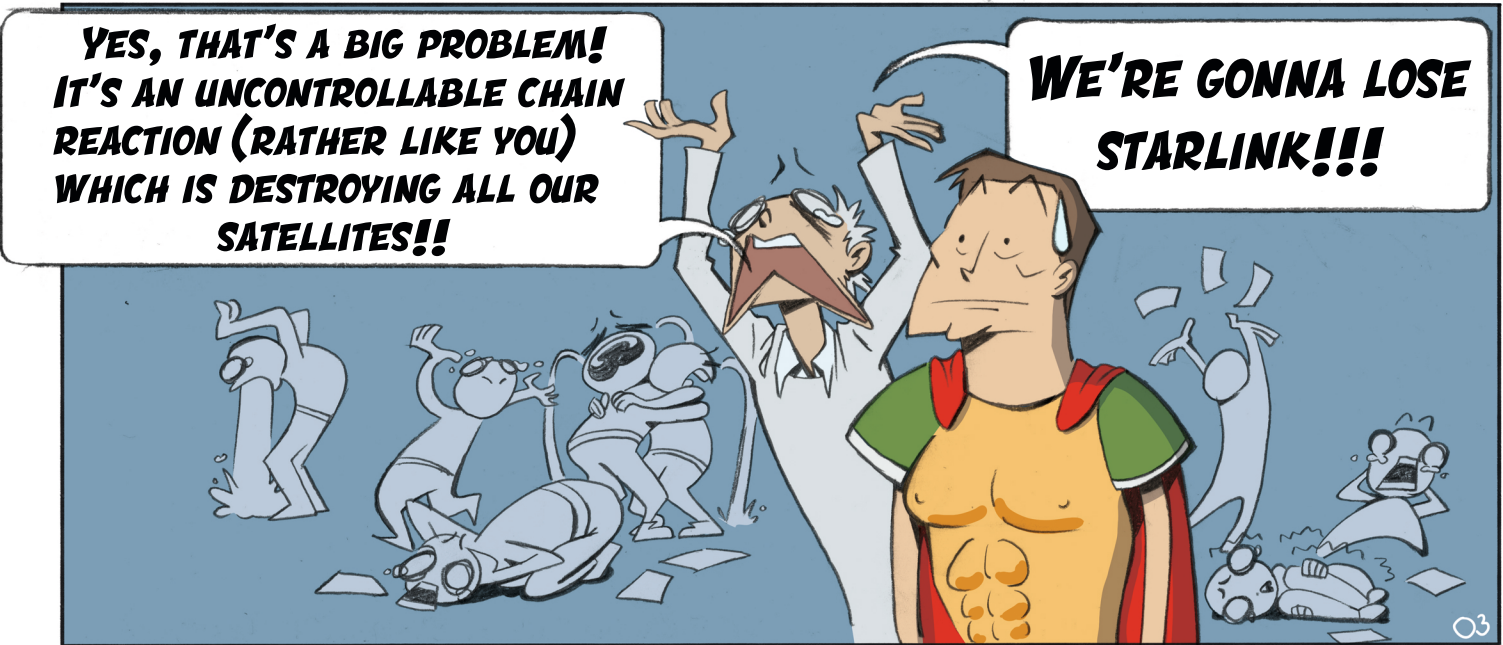
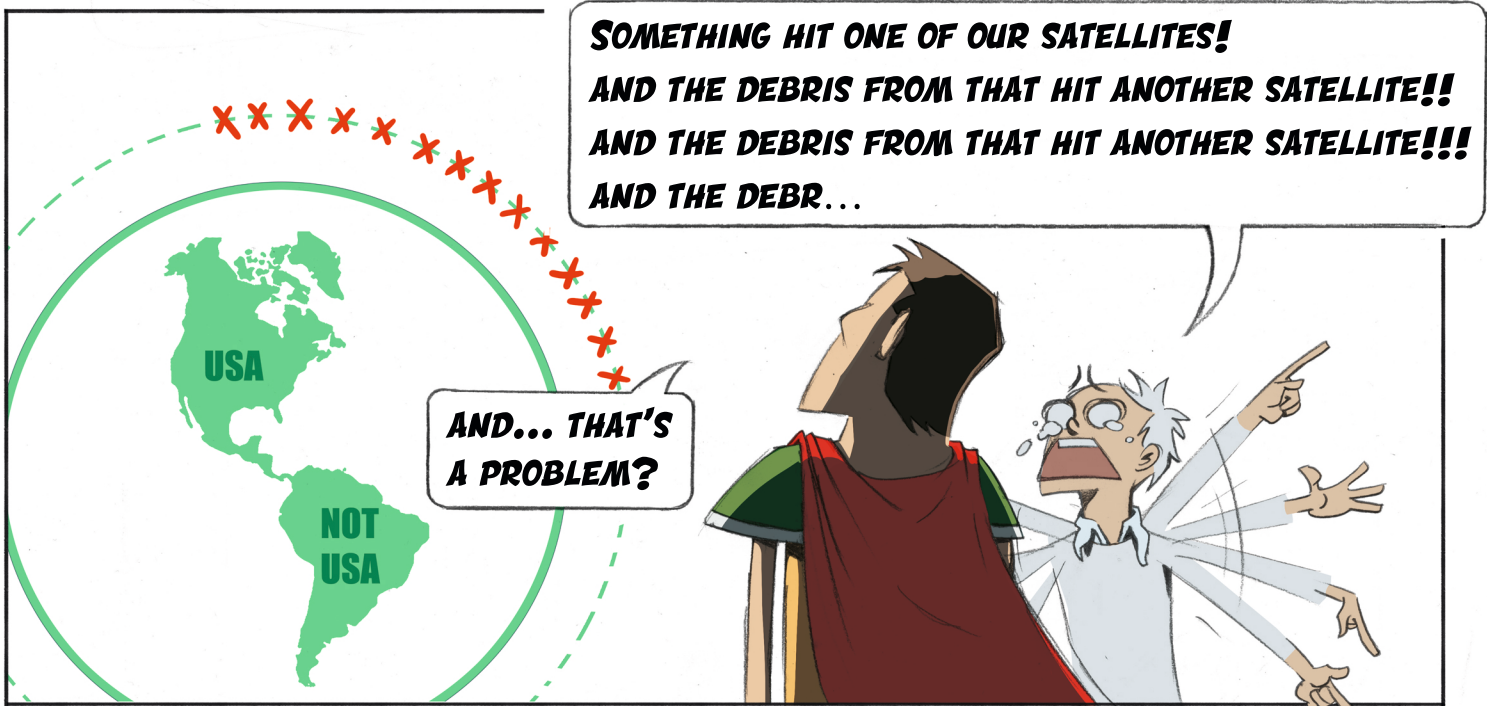
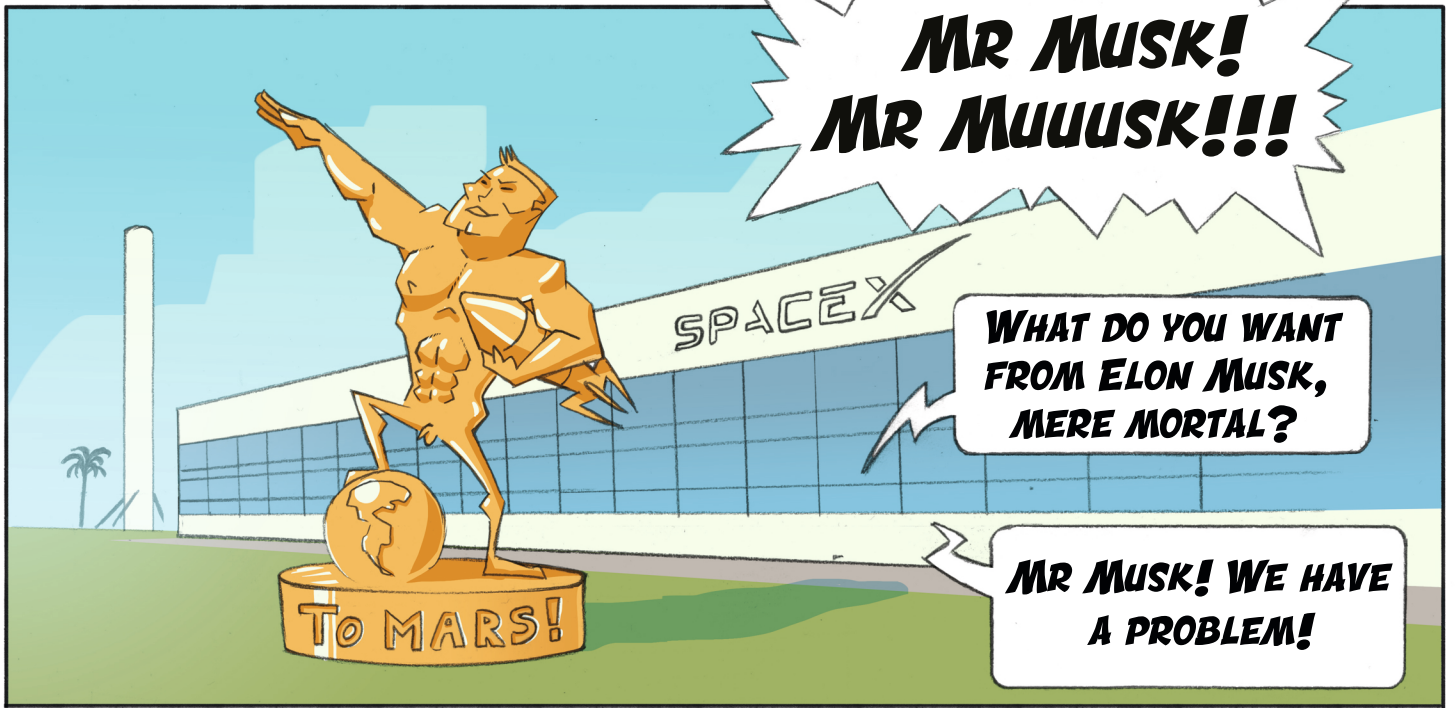
SERIOUSLY?

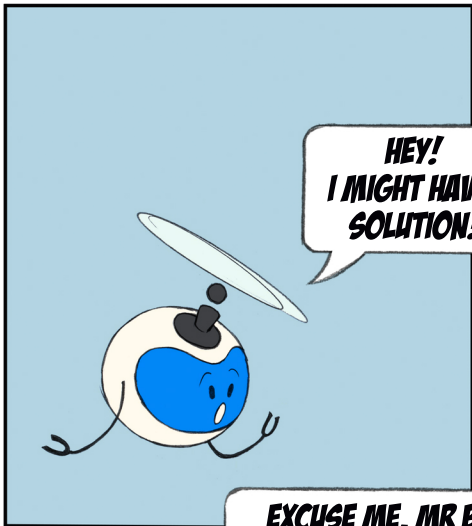
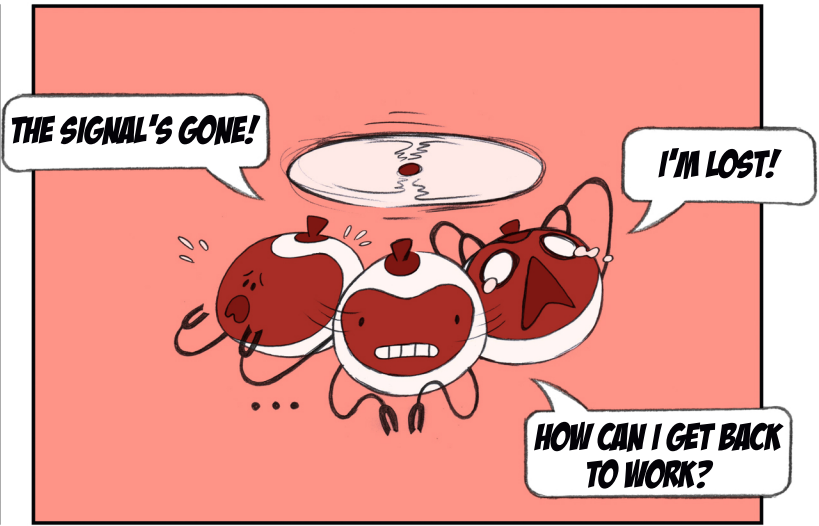
HEY, WHAT'S THAT
COMING AT US?



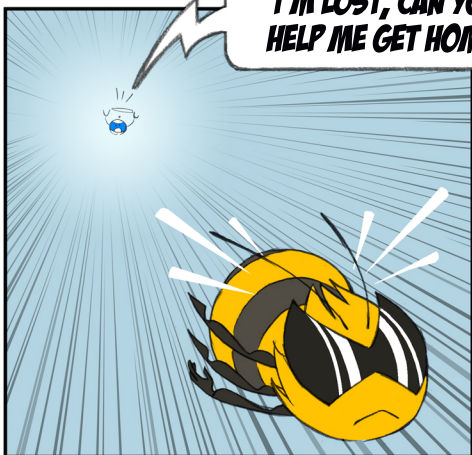
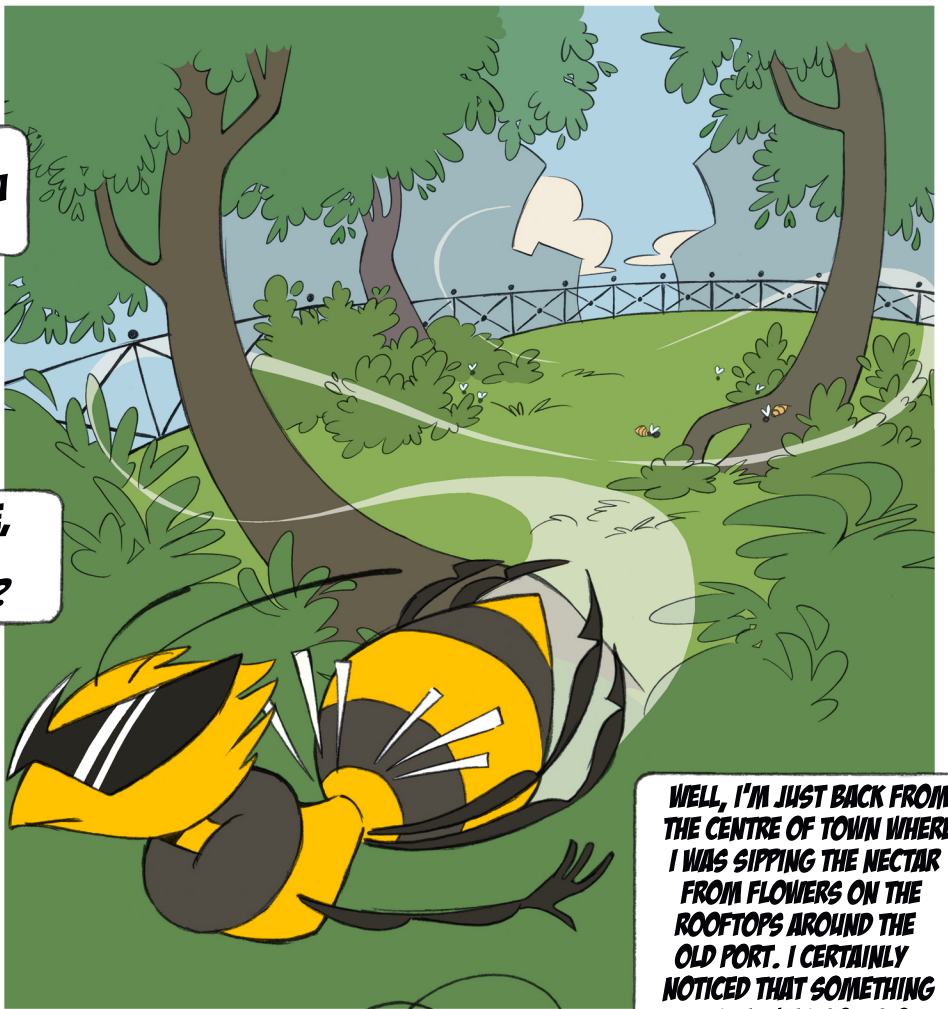
CRACK!

!!!



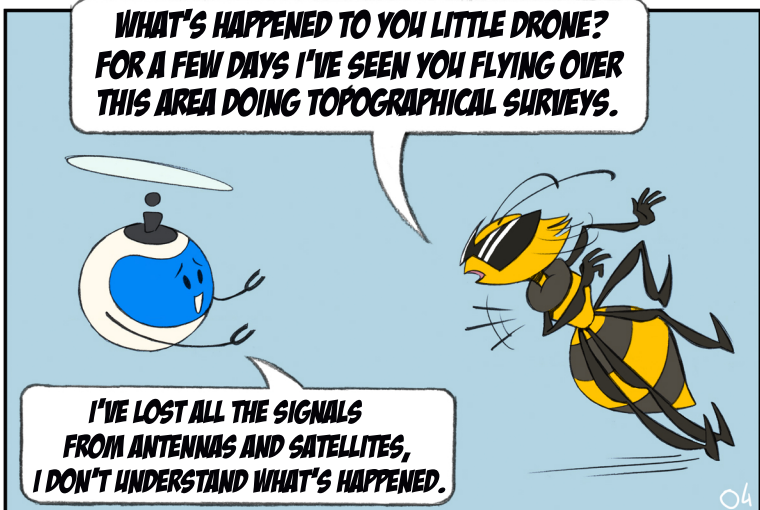


**HEY!
I MIGHT HAVE A
SOLUTION!**



**EXCUSE ME, MR BEE,
I'M LOST, CAN YOU
HELP ME GET HOME?**

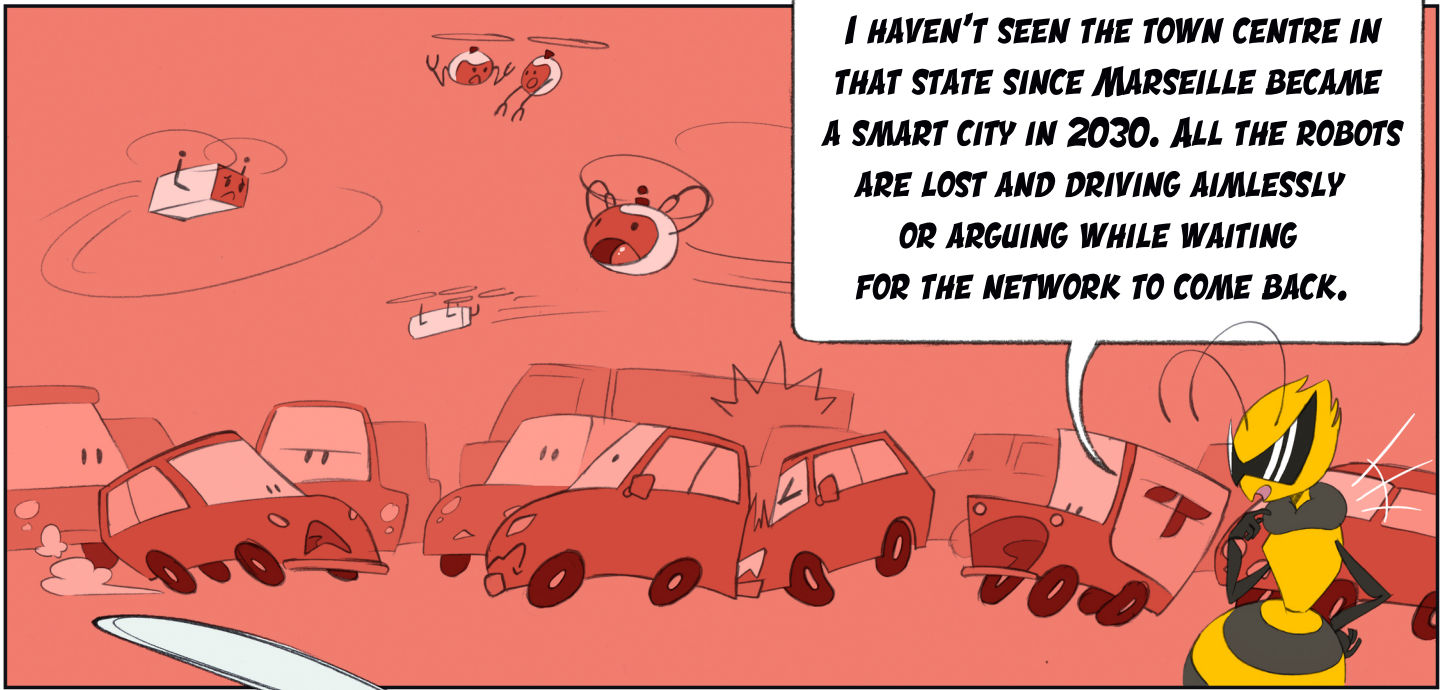
**WELL, I'M JUST BACK FROM
THE CENTRE OF TOWN WHERE
I WAS SIPPING THE NECTAR
FROM FLOWERS ON THE
ROOFTOPS AROUND THE
OLD PORT. I CERTAINLY
NOTICED THAT SOMETHING
UNUSUAL WAS GOING ON.**



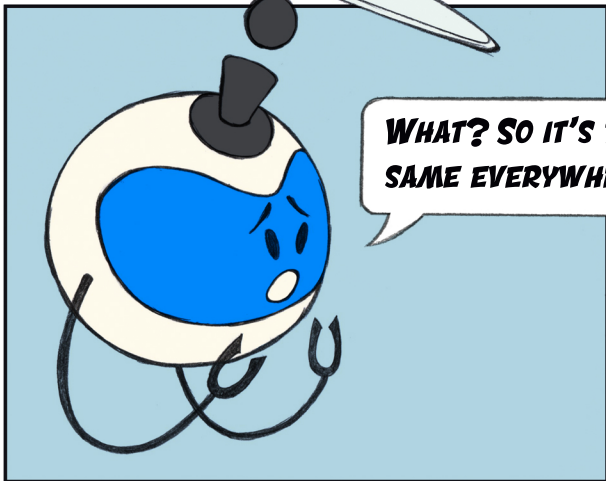
**WHAT'S HAPPENED TO YOU LITTLE DRONE?
FOR A FEW DAYS I'VE SEEN YOU FLYING OVER
THIS AREA DOING TOPOGRAPHICAL SURVEYS.**

**I'VE LOST ALL THE SIGNALS
FROM ANTENNAS AND SATELLITES,
I DON'T UNDERSTAND WHAT'S HAPPENED.**

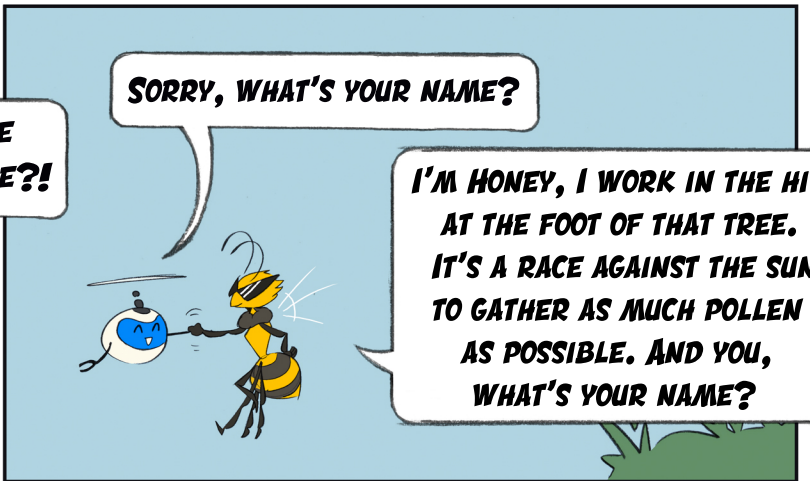




I HAVEN'T SEEN THE TOWN CENTRE IN THAT STATE SINCE MARSEILLE BECAME A SMART CITY IN 2030. ALL THE ROBOTS ARE LOST AND DRIVING AIMLESSLY OR ARGUING WHILE WAITING FOR THE NETWORK TO COME BACK.

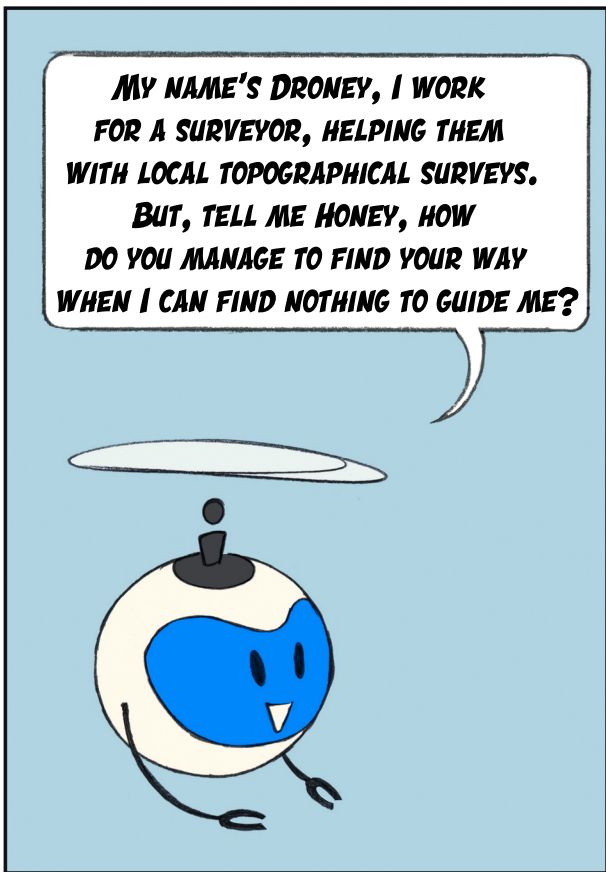


WHAT? SO IT'S THE SAME EVERYWHERE?!

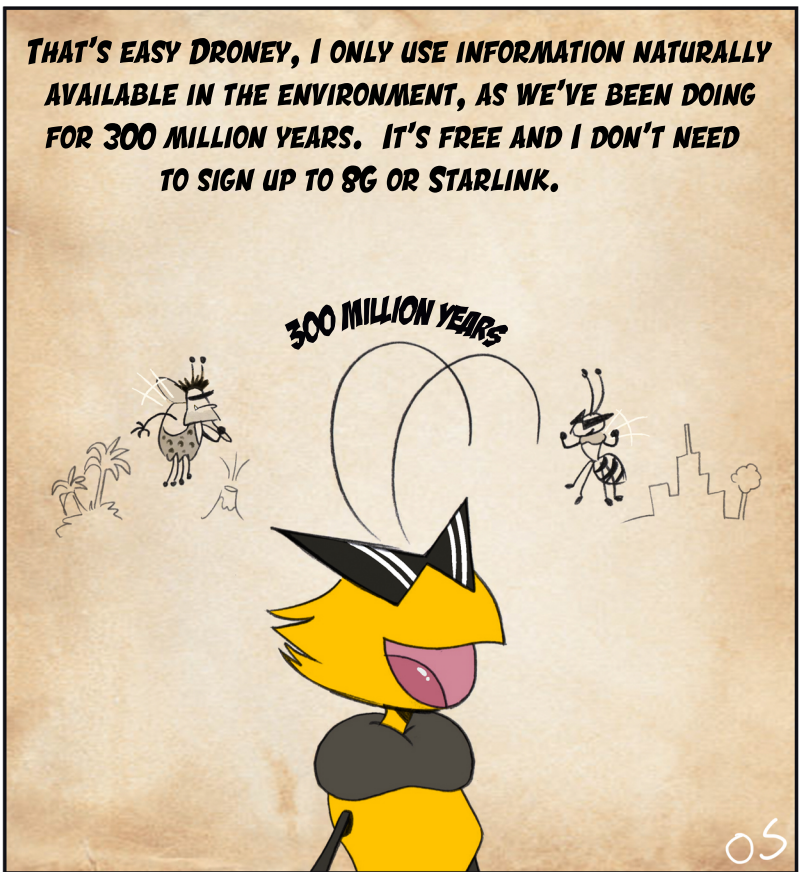


SORRY, WHAT'S YOUR NAME?

I'M HONEY, I WORK IN THE HIVE AT THE FOOT OF THAT TREE. IT'S A RACE AGAINST THE SUN TO GATHER AS MUCH POLLEN AS POSSIBLE. AND YOU, WHAT'S YOUR NAME?



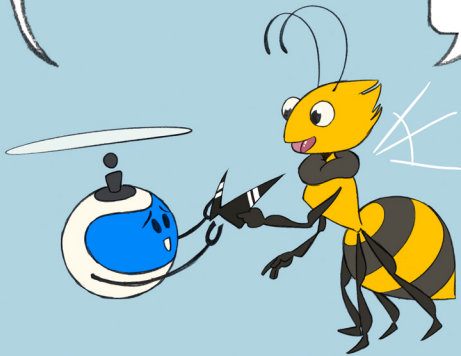
MY NAME'S DRONEY, I WORK FOR A SURVEYOR, HELPING THEM WITH LOCAL TOPOGRAPHICAL SURVEYS. BUT, TELL ME HONEY, HOW DO YOU MANAGE TO FIND YOUR WAY WHEN I CAN FIND NOTHING TO GUIDE ME?



THAT'S EASY DRONEY, I ONLY USE INFORMATION NATURALLY AVAILABLE IN THE ENVIRONMENT, AS WE'VE BEEN DOING FOR 300 MILLION YEARS. IT'S FREE AND I DON'T NEED TO SIGN UP TO 8G OR STARLINK.

**BUT HOW?
IF I CAN'T RETURN TO BASE,
I MIGHT LOSE ALL THE DATA
I'VE COLLECTED TODAY
FROM THIS VAST AREA.**

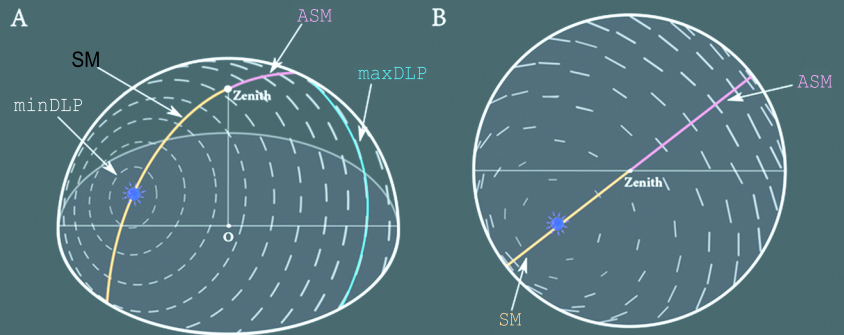
**WELL, FIRST YOU NEED
TO BORROW MY SPECIAL
SUNGLASSES.**



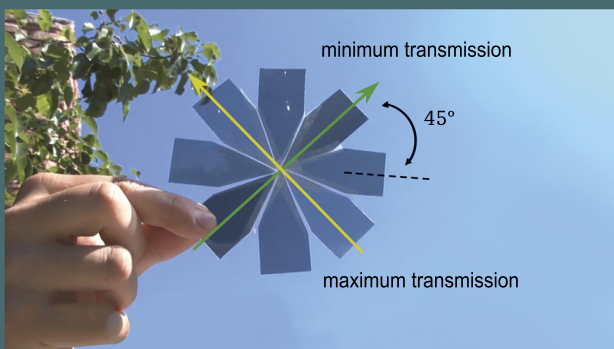
**WOW! THANKS,
DON'T YOU THINK THEY
SUIT ME? CLASSY!**



**WITH MY SUNGLASSES YOU'LL BE ABLE
TO SEE THE POLARISED LIGHT.
IT'S A NICE DAY AND YOU NEED TO SELECT
YOUR BLUE COLOUR CHANNEL BECAUSE,
UNLIKE ME, YOU CAN'T SEE ULTRAVIOLET
LIGHT WHICH ALLOWS ME TO FIND MY WAY
WHEN THE WEATHER IS NOT GOOD.**



EXPLANATION OF THE DIAGRAM. THE SOLAR MERIDIAN (SM) AND THE ANTISOLAR MERIDIAN (ASM) FORM AN AXIS OF SYMMETRY IN THE POLARISATION PATTERN. THIS POLARISATION PATTERN IS IN THE FORM OF CONCENTRIC CIRCLES AROUND THE SUN. THE LEVEL OF POLARISATION (DOP FOR DEGREE OF POLARISATION) IS LOW AROUND THE SUN BUT REACHES A MAXIMUM AT 90° FROM IT, WHICH IS WHY YOU NEED TO HAVE A PANORAMIC VIEW OF THE SKY TO SEE THE POLARISATION CLEARLY, AS SOMETIMES THE SUN IS OBSCURED BY THE ENVIRONMENT, CLOUDS, OR IS BELOW THE HORIZON. THE FIGURE ON THE LEFT SHOWS THE POLARISATION PATTERN OF THE SKY AS A FUNCTION OF THE POSITION OF THE SUN (S) RELATIVE TO AN OBSERVER (O). THE DISC ON THE GROUND IS CONSIDERED TO BE TANGENT TO THE EARTH'S SURFACE; THE AXIS (OZ) IS DEFINED AS THE NORMAL TO THE GROUND. THE ORIENTATION OF THE WHITE DASHES GIVES THE POLARISATION ANGLE (PA), WHILE THEIR LENGTH DESCRIBES THE DEGREE OF LINEAR POLARISATION (DLP). THE PA IS ORTHOGONAL TO THE SOLAR MERIDIAN (SM) AND ANTISOLAR MERIDIAN (ASM). THE FIGURE ON THE RIGHT SHOWS THE PROJECTION OF THE POLARISATION PATTERN ONTO THE GROUND. ALONG THE MERIDIANS, ALL PA ORIENTATIONS ARE PARALLEL TO EACH OTHER AND PERPENDICULAR TO THE MERIDIANS.



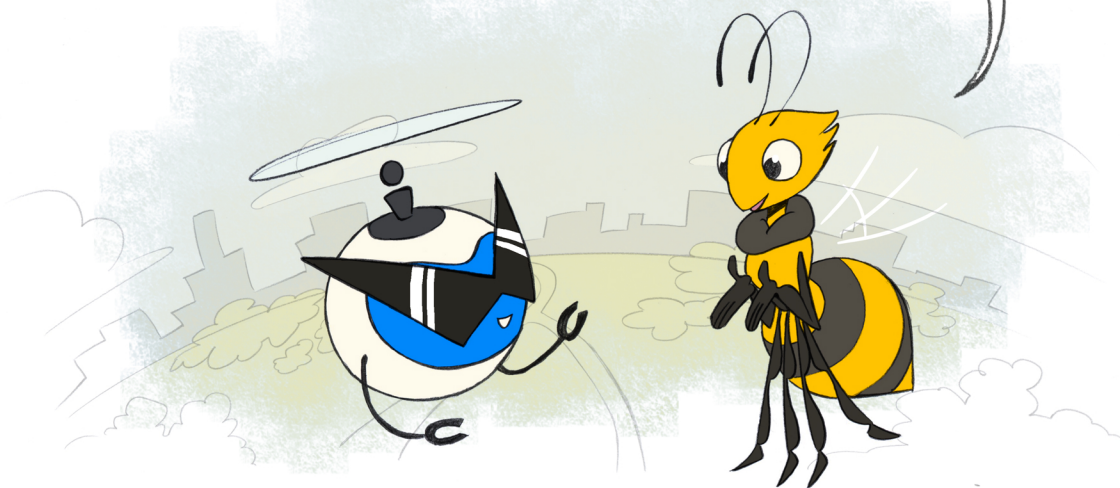
**WOW! INSTEAD OF SEEING
A BLUE SKY WITH A FEW CLOUDS
I CAN NOW SEE LOTS OF CONCENTRIC
CIRCLES AROUND THE SUN.
YOUR SUNGLASSES ARE MAGIC.**



THAT'S THE SKY'S POLARIZATION PATTERN; IT'S AN OPTICAL INTERACTION BETWEEN SUNLIGHT AND THE MOLECULES THAT MAKE UP THE ATMOSPHERE. IT FORMS CONCENTRIC CIRCLES AROUND THE SUN; YOU ONLY NEED TO FIND THE AXES OF SYMMETRY OF THE POLARISATION PATTERN TO DETERMINE YOUR HEADING OR THE SUN'S POSITION TO GEOLOCATE YOURSELF.

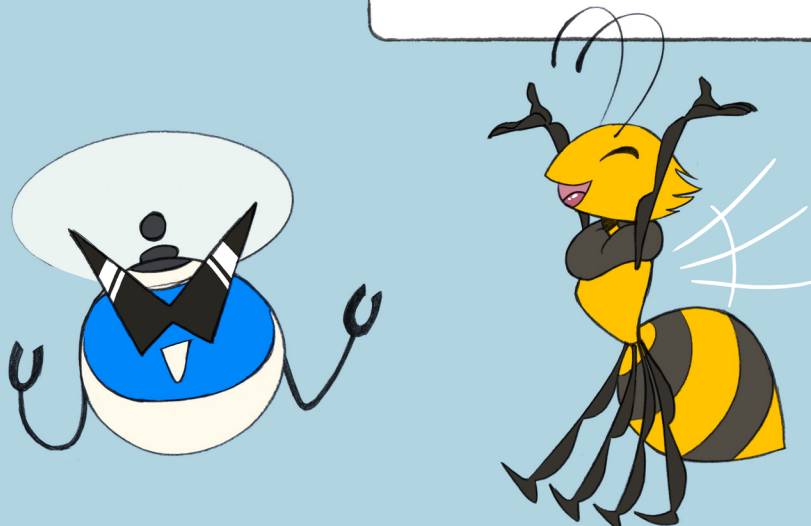
INCREDIBLE, I HAD NEVER HEARD THAT SUNLIGHT IS POLARISED

I KNOW WHERE AND AT WHAT TIME THE SUN RISES AND SETS EVERY DAY, SO I CAN ESTIMATE THE SUN'S PATH THROUGH THE SKY. IT'S EASY, THERE ARE ONLY 365 DAYS IN A YEAR AND IN THE SUMMER, I ONLY WORK FOR 6 WEEKS SO I'VE ONLY GOT ABOUT 40 OF THE SUN'S TRAJECTORIES TO MEMORISE, GIVEN THAT I DON'T GO MORE THAN 8 MILES (13 KM) FROM MY HIVE. SO, I CAN USE THE SUN'S TRAJECTORY TO ESTIMATE MY DISTANCE AND DIRECTION FROM MY HIVE.

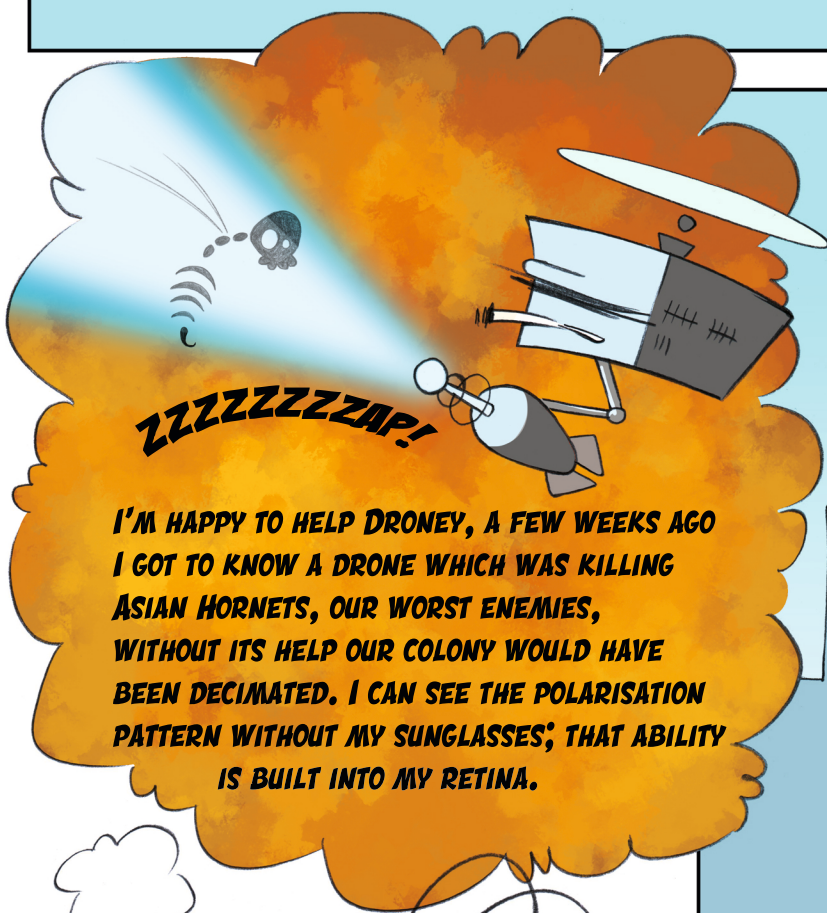
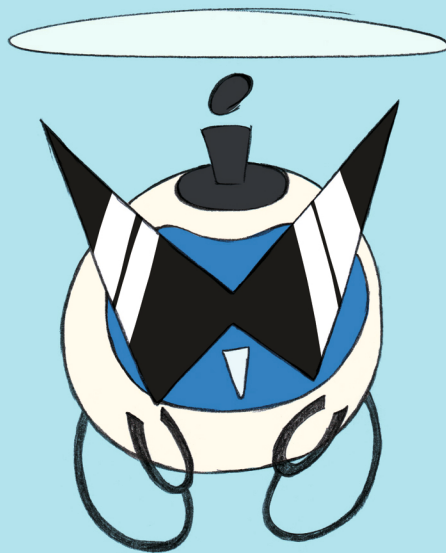


HOW PRECISE IS THIS "OPTICAL COMPASS"?

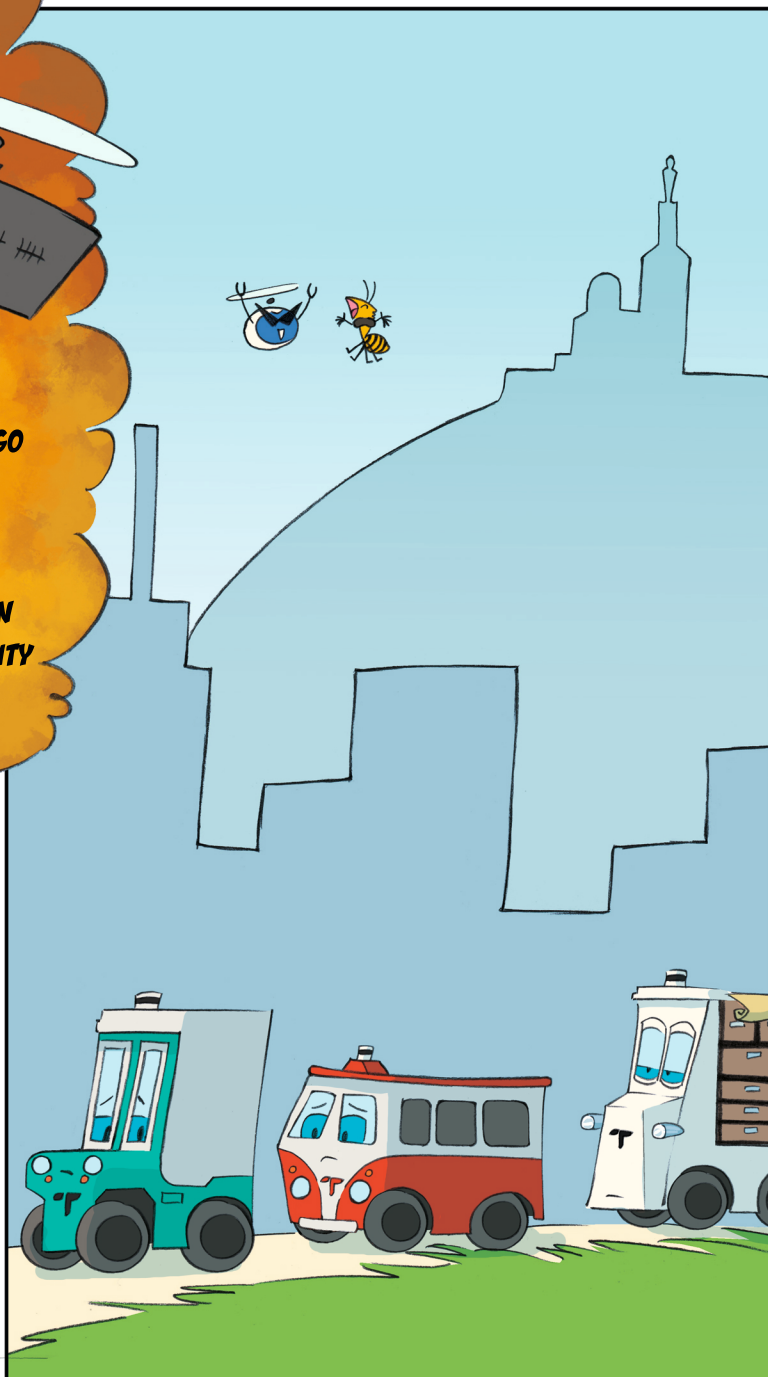
AS PRECISE AS A MAGNETIC COMPASS, PRECISE TO ABOUT 0.2° , I DON'T EVER LOSE MY WAY, OR NOT KNOW WHERE NORTH IS, UNLIKE YOU WHEN YOU FLY OVER METAL STRUCTURES WHICH INTERFERE WITH THE EARTH'S MAGNETIC FIELD. IF YOU GET COMPLETELY LOST, WATCH HOW THE POLARISATION PATTERN CHANGES OVER TIME. BUT, YOU DO NEED TO WAIT A FEW MINUTES WHILE THE EARTH ROTATES AS THIS MOVES THE POLARISATION PATTERN AROUND THE EARTH'S AXIS. THIS AXIS INDICATES TRUE GEOGRAPHIC NORTH. SO, YOU WILL SEE THE POLARISATION PATTERN MOVE AROUND A FIXED POINT IN THE SKY WHERE, AT NIGHT, YOU WILL ALSO SEE POLARIS, THE NORTH STAR.

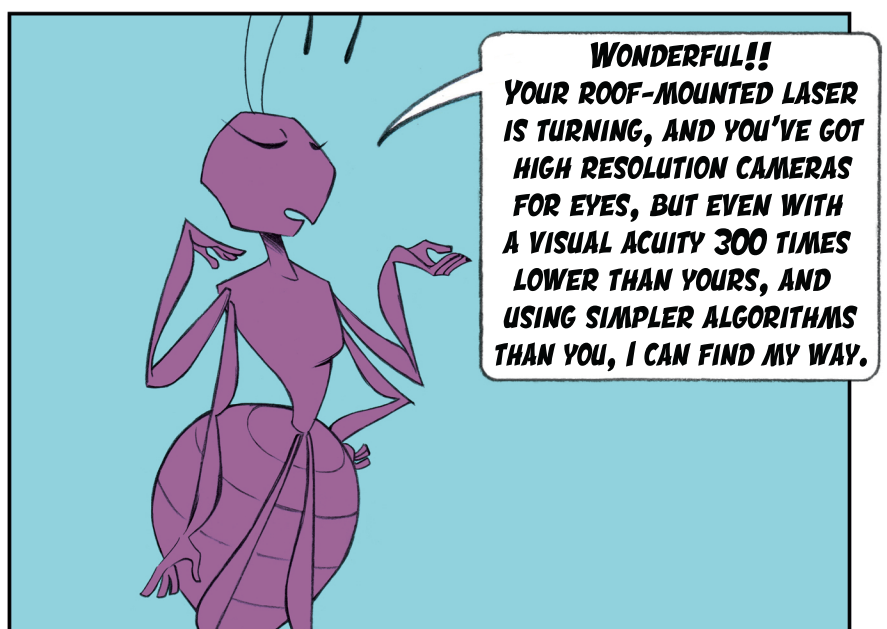
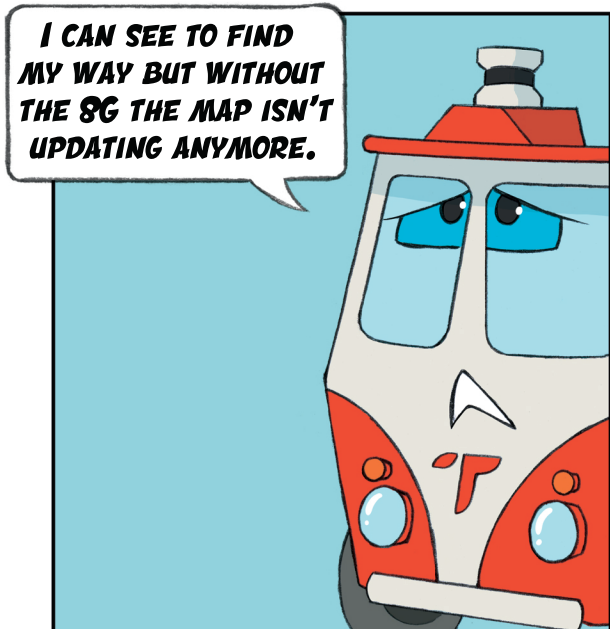
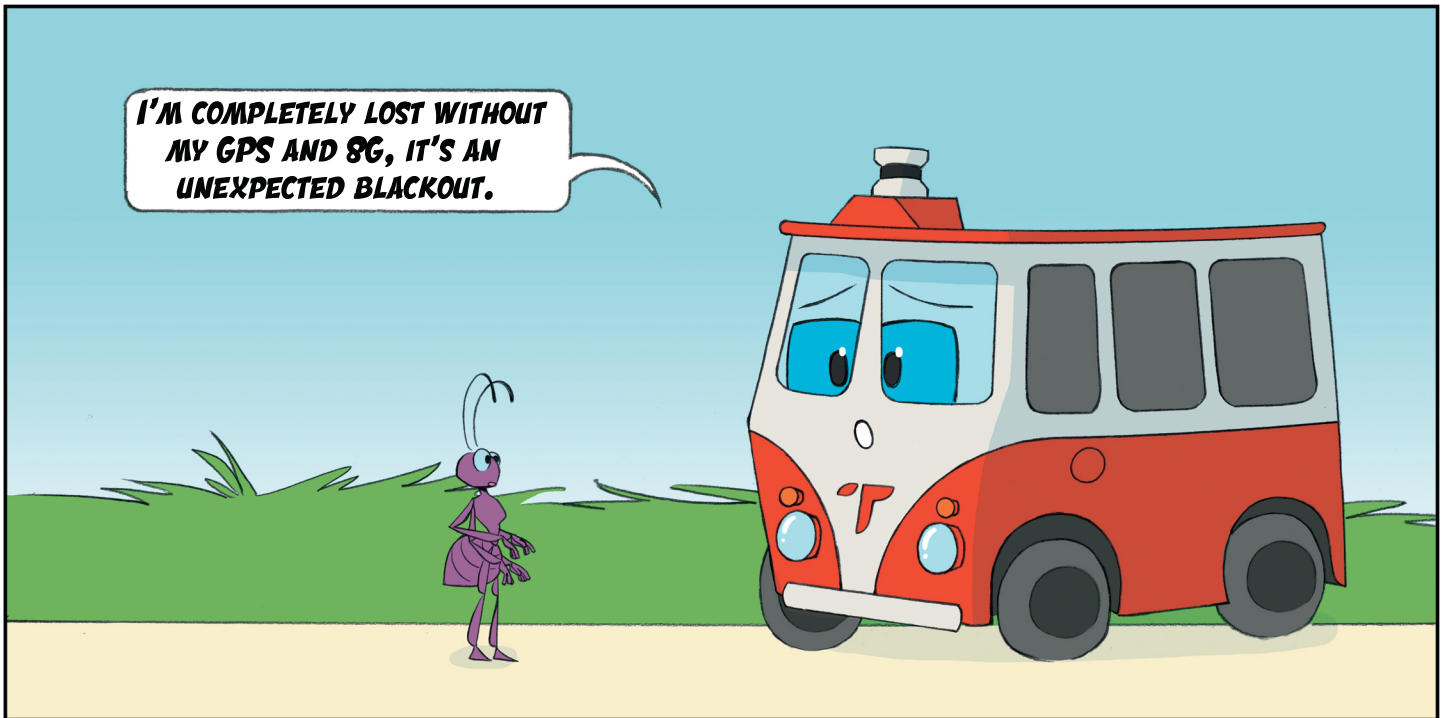
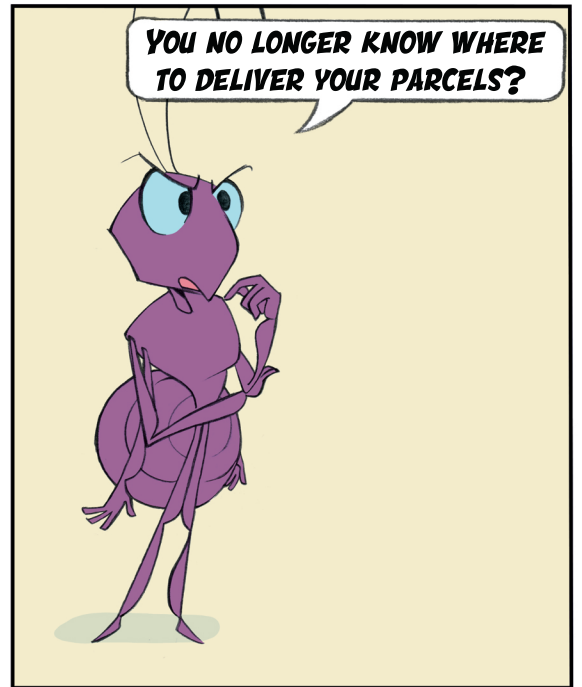
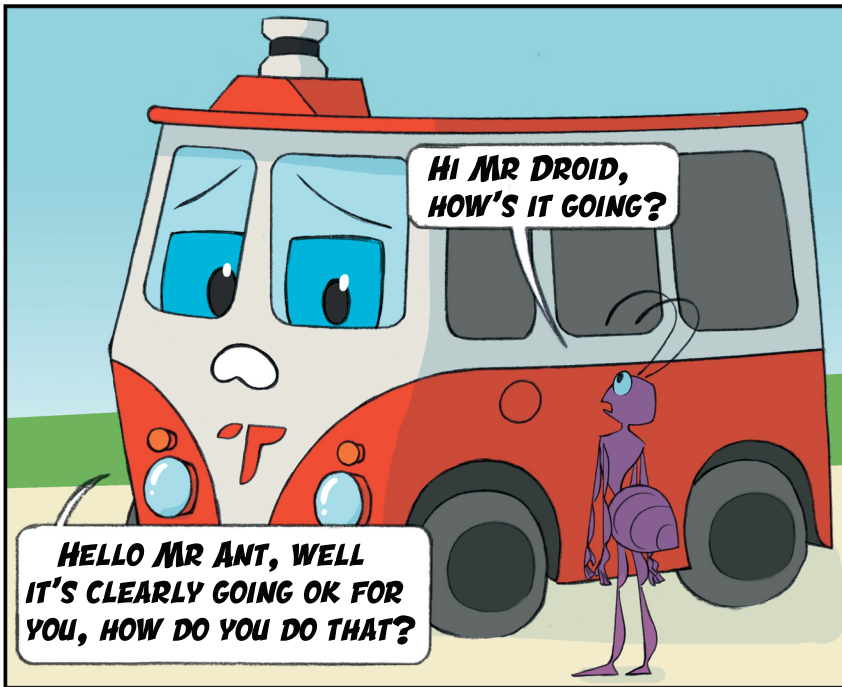


HONEY, THANK YOU FOR ALL THESE EXPLANATIONS, MAY I BORROW YOUR POLARISED SUNGLASSES FOR A FEW DAYS UNTIL THE PROBLEMS ARE SOLVED?



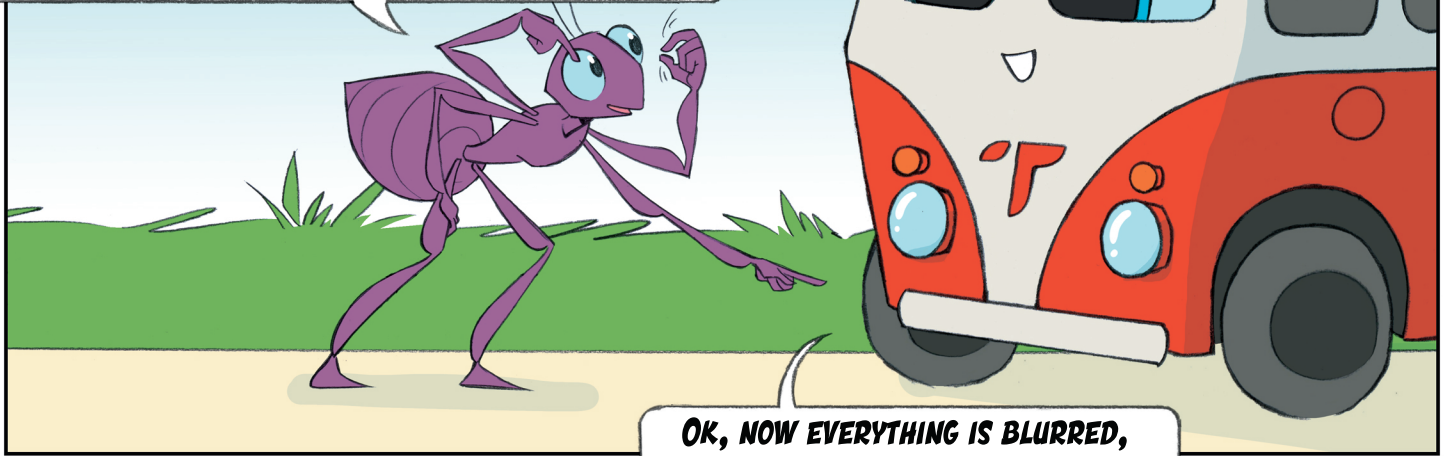
I'M HAPPY TO HELP DRONEY, A FEW WEEKS AGO I GOT TO KNOW A DRONE WHICH WAS KILLING ASIAN HORNETS, OUR WORST ENEMIES, WITHOUT ITS HELP OUR COLONY WOULD HAVE BEEN DECIMATED. I CAN SEE THE POLARISATION PATTERN WITHOUT MY SUNGLASSES; THAT ABILITY IS BUILT INTO MY RETINA.





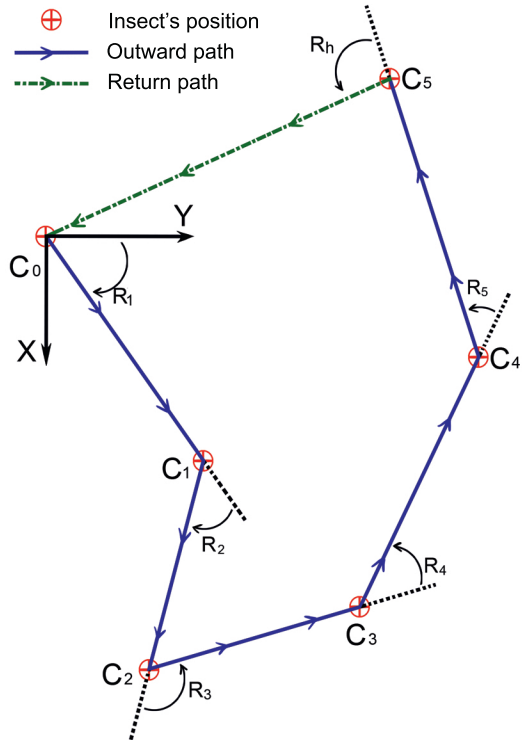
PLEASE, TELL ME MORE.
 COULD YOU SHOW ME WHAT YOU
 WOULD DO TO GET ME HOME?

START BY COUNTING YOUR WHEEL ROTATIONS, BECAUSE
 I COUNT MY STEPS. THEN, REDUCE YOUR OPTICAL
 RESOLUTION, THAT WILL CONSIDERABLY REDUCE THE ENERGY
 COST OF YOUR CALCULATIONS AND SO SAVE YOUR BATTERY.

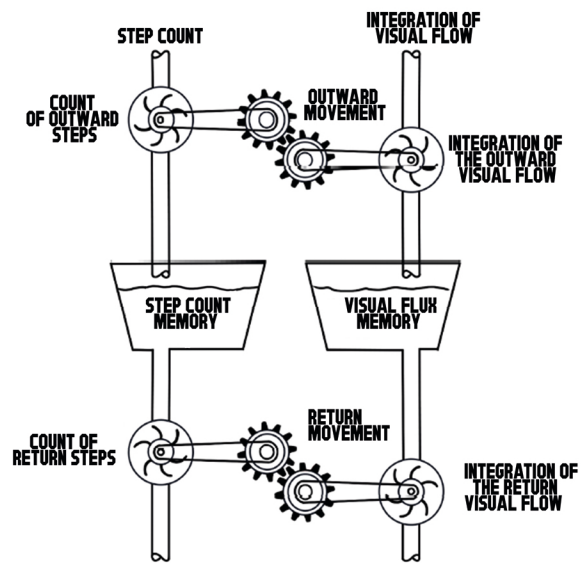
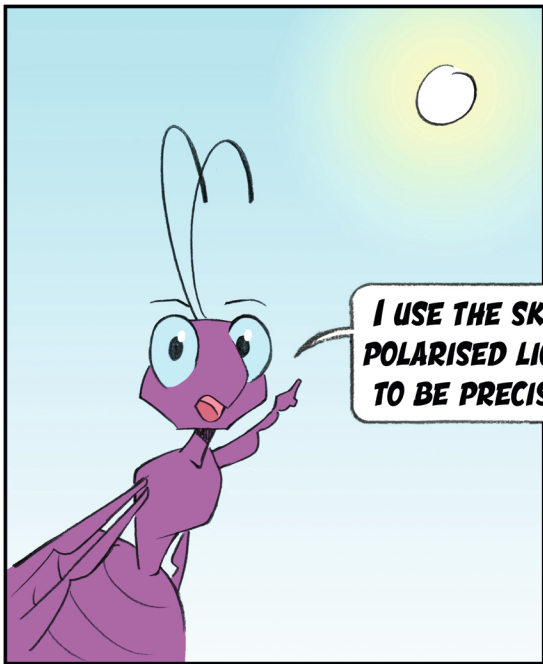
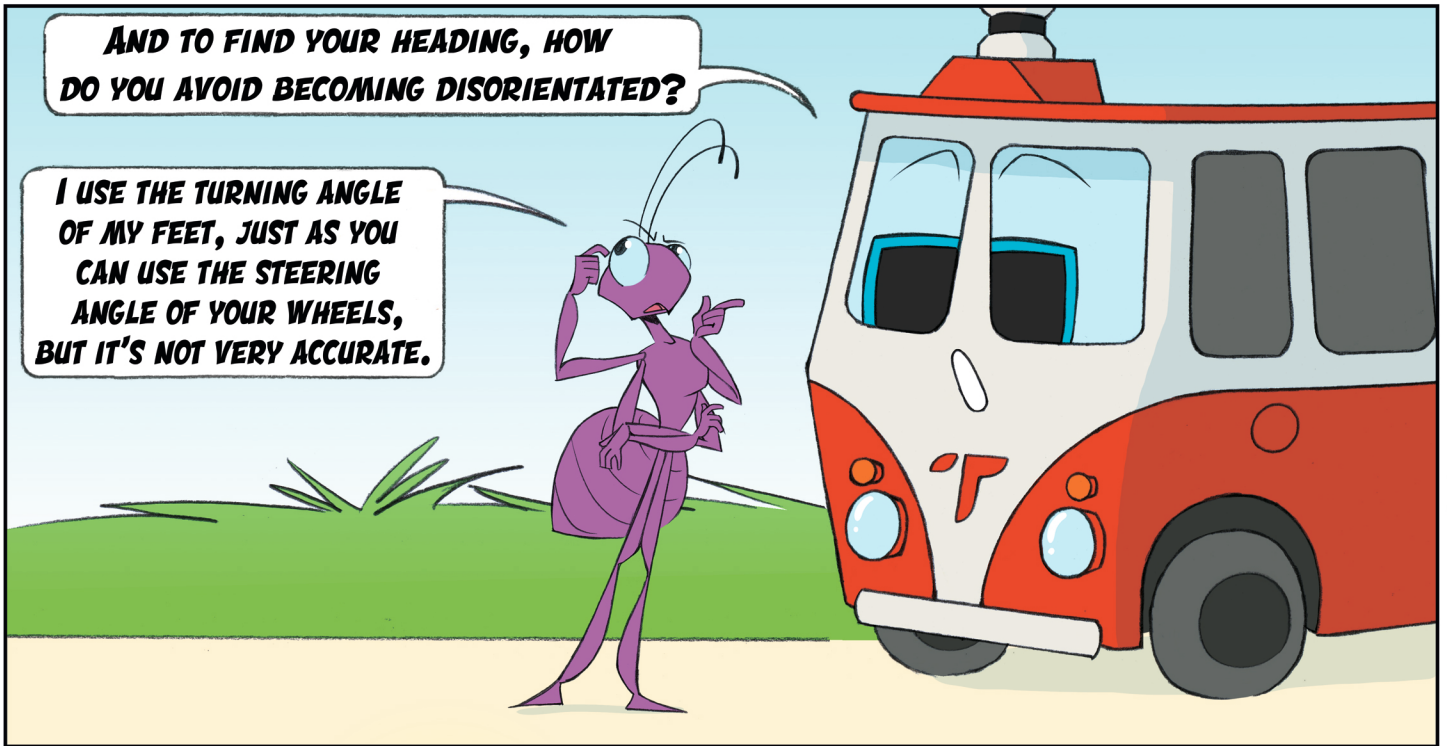


OK, NOW EVERYTHING IS BLURRED,
 I FEEL AS SHORT-SIGHTED AS A MOLE,
 OR RATHER, AN ANT.

TO CALCULATE HOW FAR I'VE TRAVELLED
 FROM ONE POINT TO ANOTHER, I COUNT MY STEPS
 AND SUM THE VISUAL TRACKING SPEED OF THE GROUND,
 THIS IS CALLED OPTICAL FLOW. THEN I COMPARE
 THE TWO CALCULATIONS TO ESTIMATE THE DISTANCE.



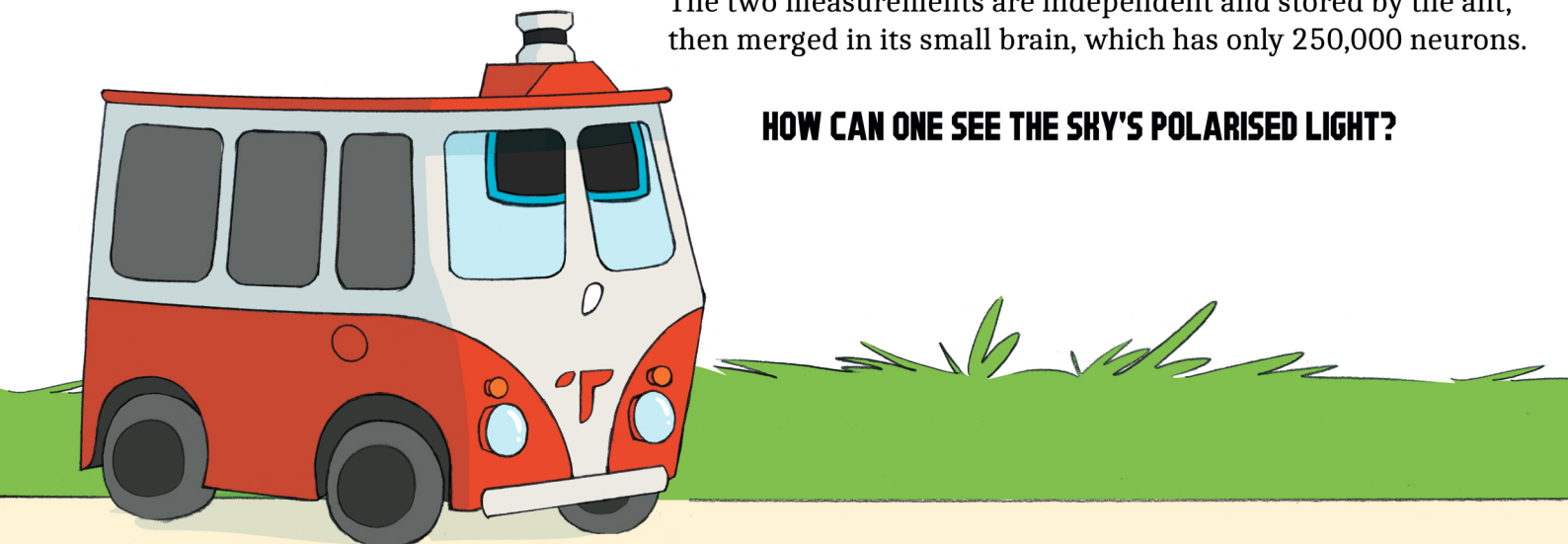
Explanation of the diagram.
 When the ant or bee moves from C0 to C1, then C2, then C3, then C4, then C5. The ant only memorises the distance C0C5 and the angle RH to return to its nest at C0. A bee only needs to memorise the distance and angle between two points. Insects therefore memorise very little information to navigate, unlike AI, which must systematically position itself in a digital twin of the environment to precisely determine its route in that environment.



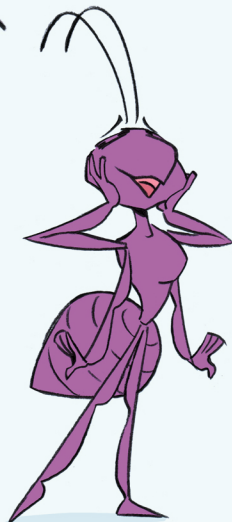
Explanation of the diagram.

On the left, the ant's step counting system, and on the right, the integration of the visual flow coming from the ground. Each provides a measurement of the distance travelled by the ant. The two measurements are independent and stored by the ant, then merged in its small brain, which has only 250,000 neurons.

HOW CAN ONE SEE THE SKY'S POLARISED LIGHT?



I NEED TO FIND A PAIR OF SUNGLASSES WITH POLARISED LENSES FOR YOU, THEY'RE VERY FASHIONABLE WITH BEES.



HEY, HIGH-FLYER, CAN YOU HELP ME?



THOSE SUNGLASSES REALLY SUIT YOU! COULD I BORROW THEM TO DEMONSTRATE SKYLIGHT POLARISATION TO MY FRIEND WHO HAS LOST HIS BEARINGS?



YEAH, NO PROBLEM, I DON'T REALLY NEED THEM.



THAT'S GREAT, I CAN SEE LOTS OF CONCENTRIC CIRCLES IN THE SKY.



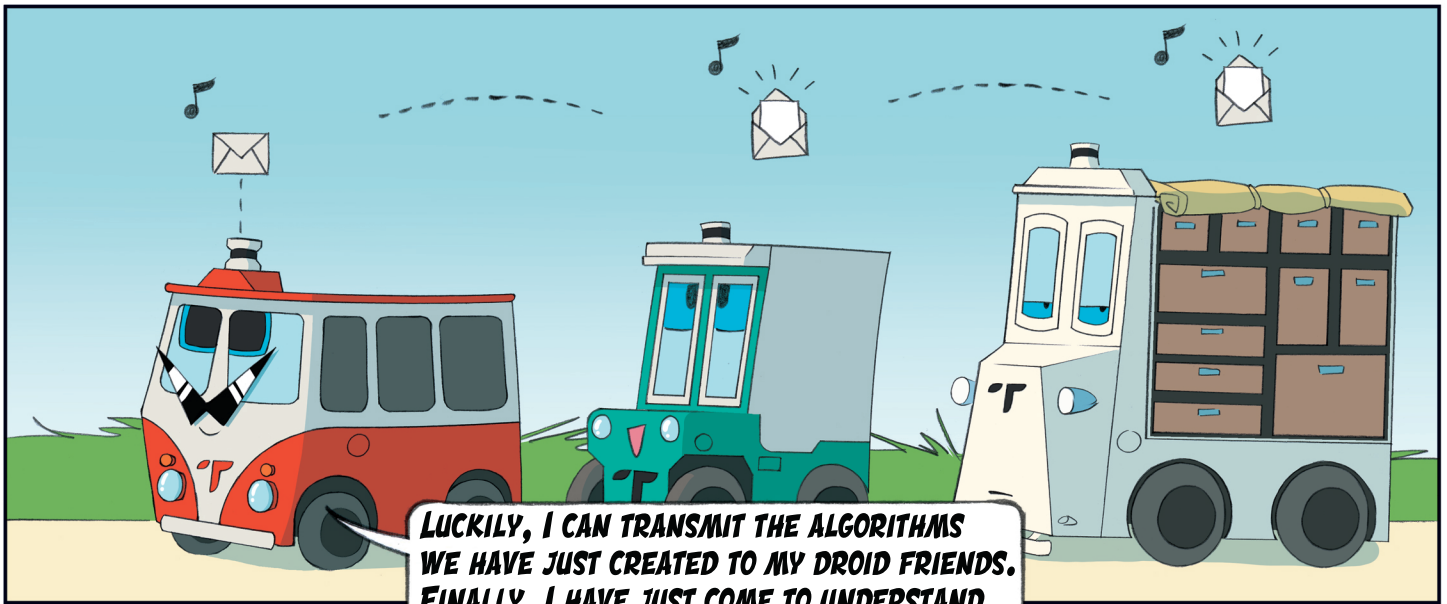
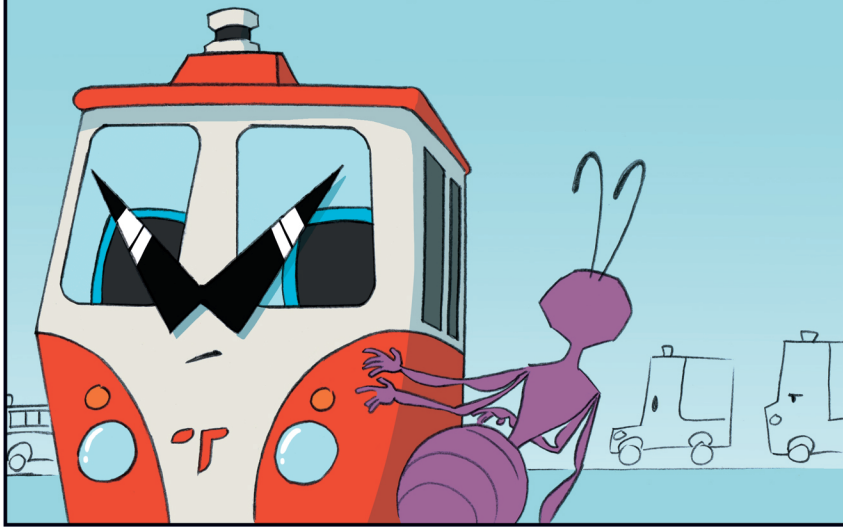
IF YOU FOLLOW THE SYMMETRY AXIS OF THE POLARIZATION PATTERN YOU WILL FIND YOUR HEADING AS EASILY AS WITH GPS, AND TO DO SO YOU ONLY NEED TO BE ABLE TO SEE A PART OF THE SKY.



WOW! YOUR OPTICAL COMPASS IS AMAZING. IT'S MUCH BETTER THAN MY GPS WHICH CAN'T SEE THE SATELLITES WHEN I'M IN A NARROW STREET. WITH THIS, IF I CAN SEE THE SKY, I KNOW WHICH WAY TO GO.



I NOTICE THAT ALL OF YOUR DROID FRIENDS ARE LOST. YOU SHOULD FORM A CONVOY, JUST LIKE WE DO TO GET HOME, IT WILL HELP YOU TO GET BACK TO YOUR WAREHOUSE.

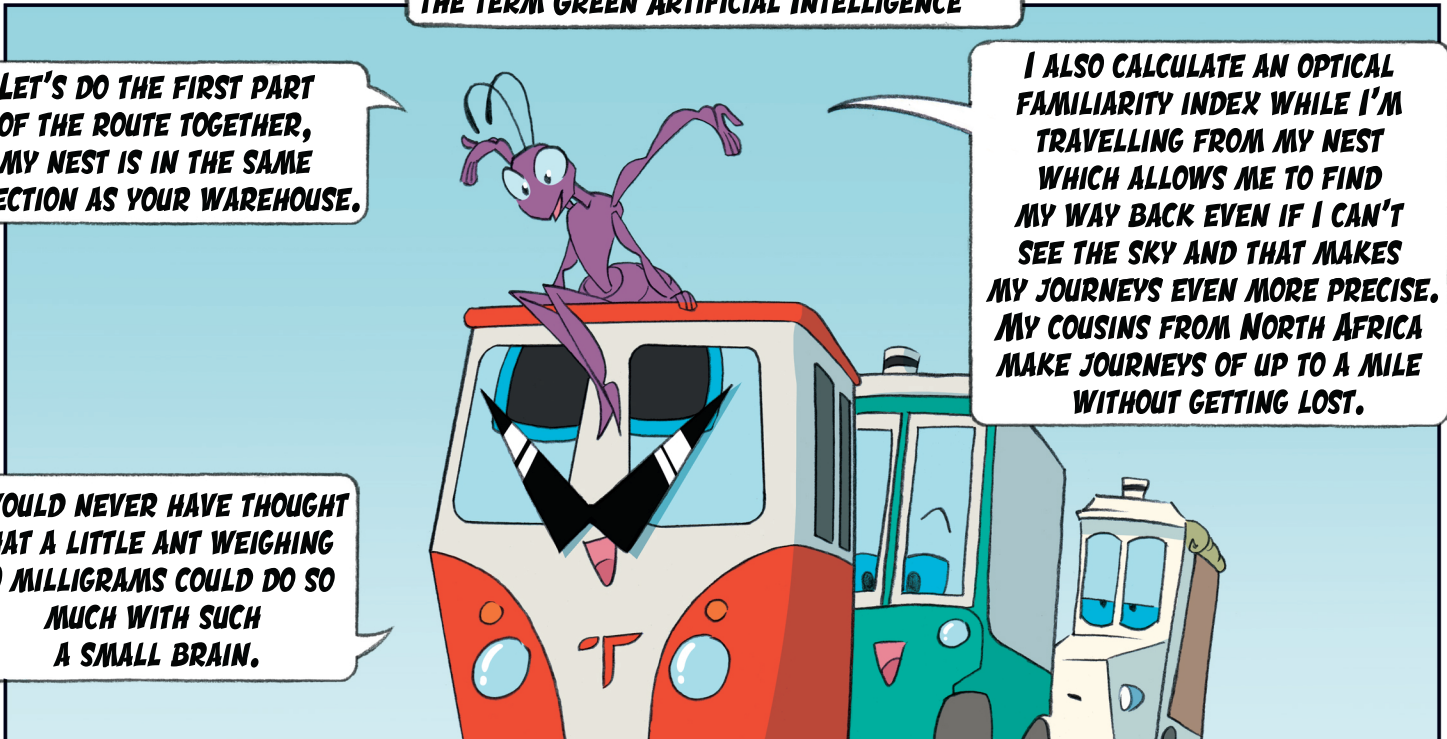


LUCKILY, I CAN TRANSMIT THE ALGORITHMS WE HAVE JUST CREATED TO MY DROID FRIENDS. FINALLY, I HAVE JUST COME TO UNDERSTAND THE TERM GREEN ARTIFICIAL INTELLIGENCE

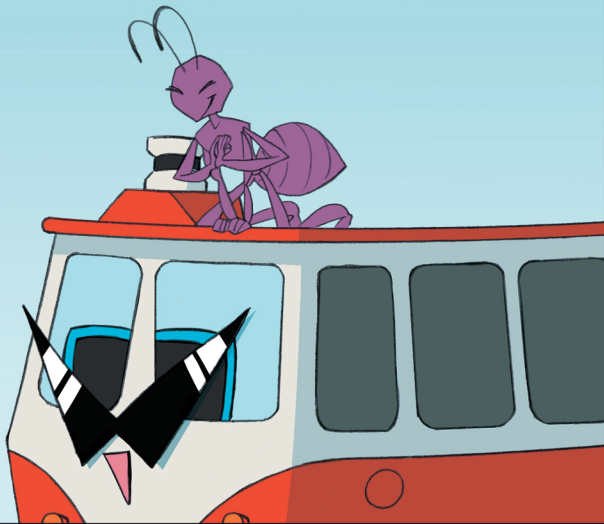
LET'S DO THE FIRST PART OF THE ROUTE TOGETHER, MY NEST IS IN THE SAME DIRECTION AS YOUR WAREHOUSE.

I ALSO CALCULATE AN OPTICAL FAMILIARITY INDEX WHILE I'M TRAVELLING FROM MY NEST WHICH ALLOWS ME TO FIND MY WAY BACK EVEN IF I CAN'T SEE THE SKY AND THAT MAKES MY JOURNEYS EVEN MORE PRECISE. MY COUSINS FROM NORTH AFRICA MAKE JOURNEYS OF UP TO A MILE WITHOUT GETTING LOST.

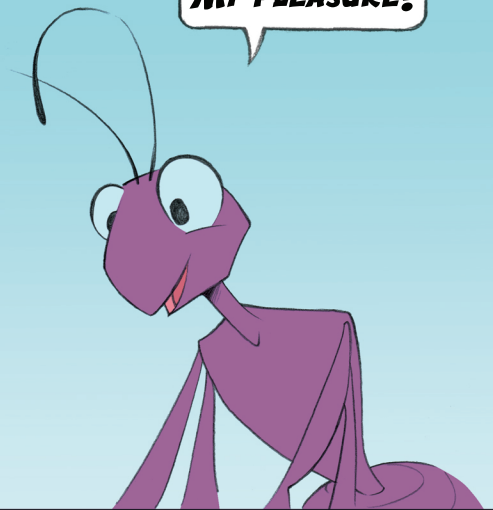
I WOULD NEVER HAVE THOUGHT THAT A LITTLE ANT WEIGHING 10 MILLIGRAMS COULD DO SO MUCH WITH SUCH A SMALL BRAIN.



**THANK YOU FOR ALL THESE EXPLANATIONS
AND FOR THE SUNGLASSES, NOW
I WILL BE ABLE TO FIND MY WAY.**



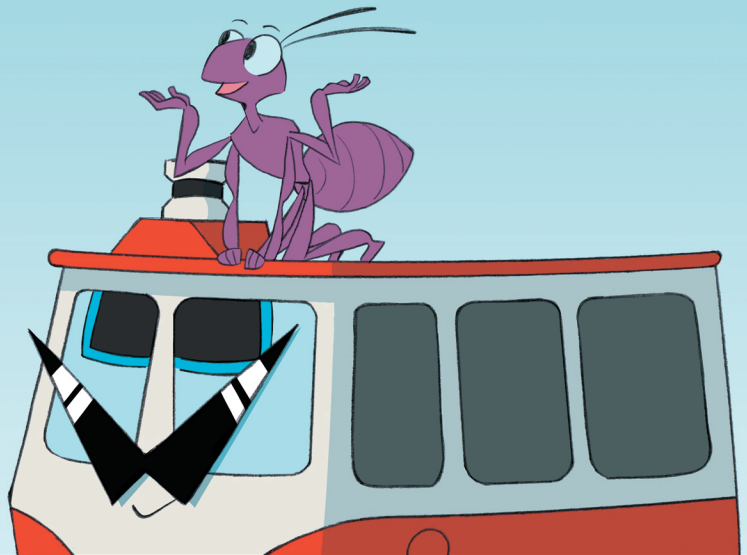
MY PLEASURE!



**LOOK DRONEY,
THE DROIDS ARE
MOVING AGAIN!**



**AND IT LOOKS LIKE THE DRONES
ARE OK TOO.**



**IT'S EASIER WHEN YOU TAKE INSPIRATION
FROM YOUR SURROUNDINGS.**



YOU'RE ABSOLUTELY RIGHT!





**AM I DREAMING OR ARE INSECTS
AND ROBOTS COOPERATING?**