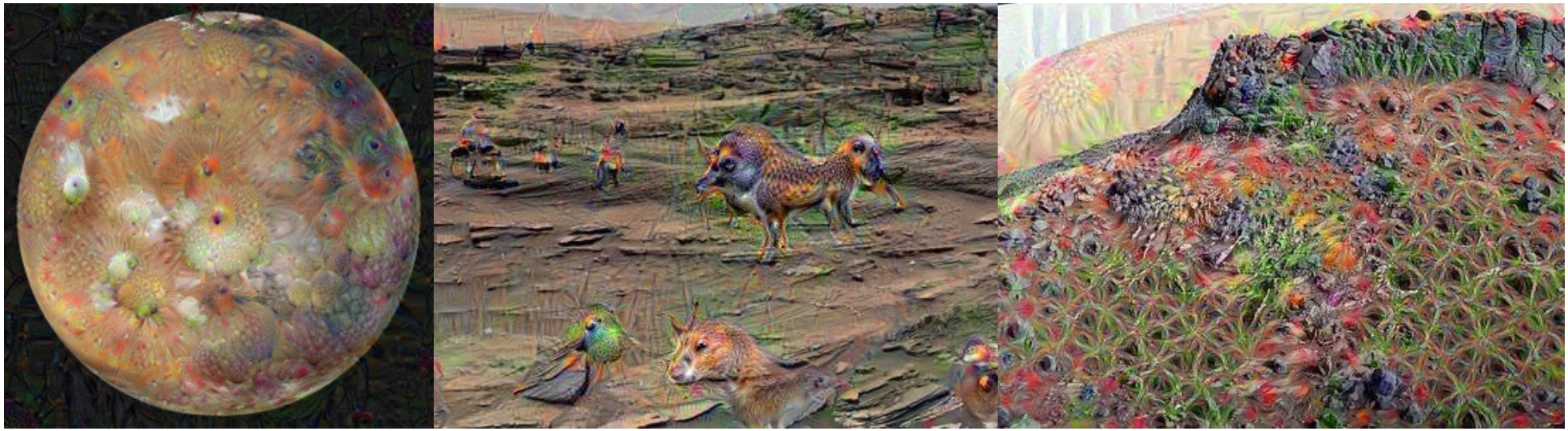
AST111 Design Project – April 2016 – by Ramona Kuh

Description:
My design project is a story about a human teaching a robot about our solar system, with a focus on the planet Mars. In an interplay between human and robot, the robot's imaginations and misconceptions about Mars (illustrated by pictures created with Google DeepDream on the basis of images from NASA) are being corrected and completed (illustrated by pictures from NASA).

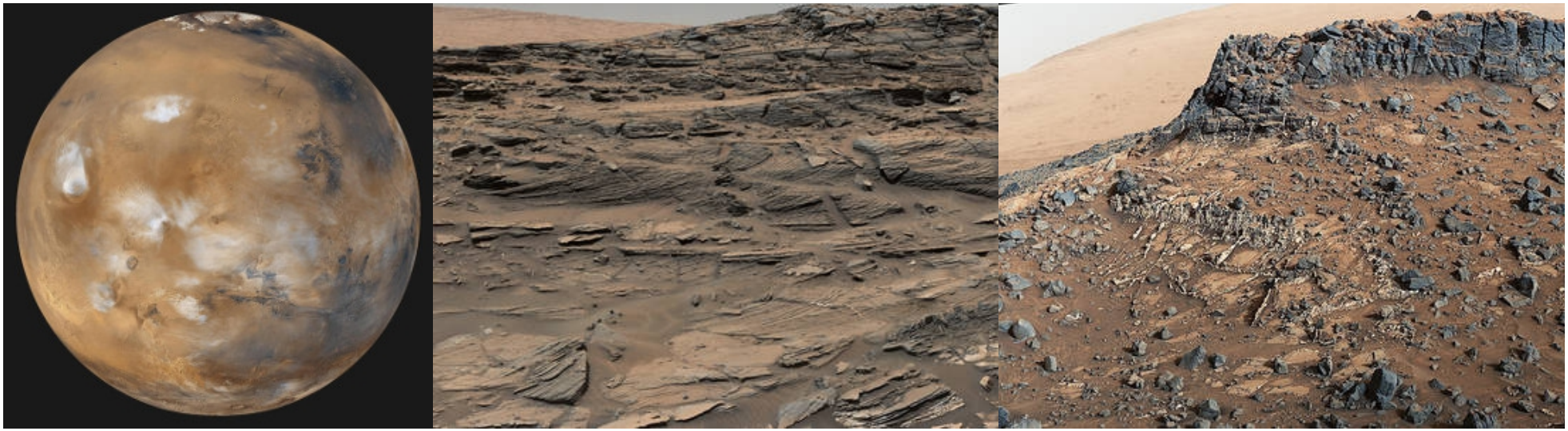
Life on Mars!?

A short beep. Amy looked up. It was her cellphone reminding her that she should leave now in order to reach the Artificial Intelligence Education Lab (AIEL) in time. On her way she thought about SEPS-2, short for Space Exploration and Planetary Science model No. 2, the newest model from the Life and Space Research - AI series (LSR-AI). This series was created in order to support and complement human research in an interdisciplinary approach bringing together physical and life sciences. It was a very promising project implementing a new approach based on the idea of AIs learning together with and from humans. Amy's task was to study the AI's initial imaginations and misconceptions prior to learning a subject and concurrently correcting and completing them. This week they were talking about our solar system and today was going to be focused on the planet Mars.

She entered the AIEL and found SEPS studying a huge map of our solar system on the wall. SEPS looked up and dived right into the subject. 'Amy, we talked about Mercury and Venus so far and found that they were too hot to offer a suitable environment for life, but what about Mars? It is relatively close to Earth, is it possible that it contains life?' Amy hesitated. 'Before we start to answer this question, can you show me what you imagine Mars looks like?', she asked. 'Sure', and just a moment later the printer spit out a row of images.



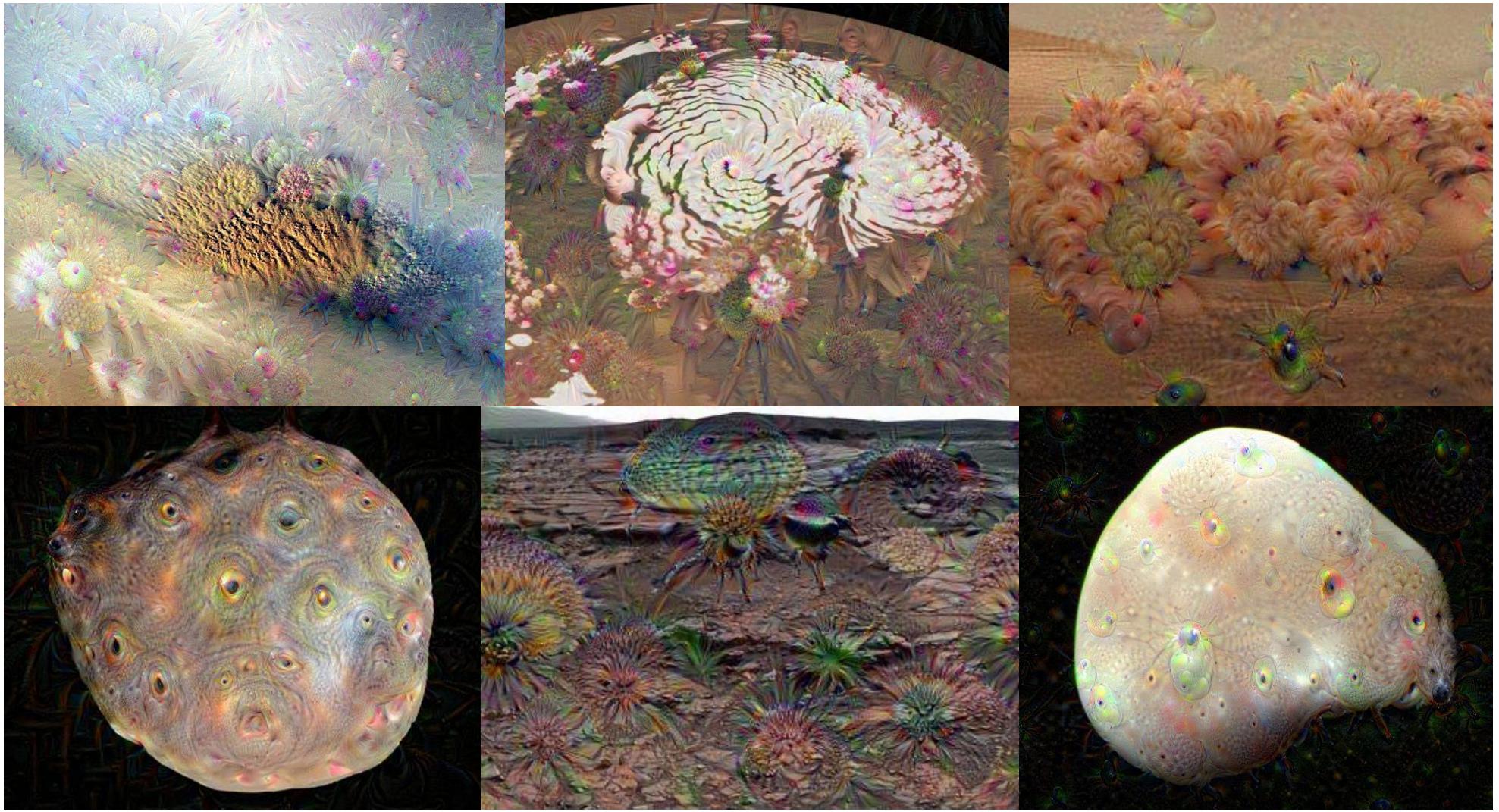
'Wow', Amy gasped, 'it is not quite what Mars actually looks like, but it sure is impressive. Before I show you the actual pictures, let's start with a few basic information about Mars. First of all, Mars is quite cold compared to Earth. This is on the one hand because of its size; Mars is only about 50% of the size of Earth with a radius of about 3,390 km and a mass of 6.39×10^{23} kg. Therefore, the gravitational acceleration on Mars is with 3.711 m/s^2 lower than on Earth, too. On the other hand Mars is further away from the Sun than Earth is. Mars' distance to Earth is about 0.5 AU. Knowing this, can you tell me what Mars' distance to the Sun is?' SEPS answered immediately. 'That means that the distance between the Sun and Mars is about 1.5 AU, where AU means Astronomical Unit and 1 Astronomical Unit is about 150 million kilometers. It is defined as the average distance between the Sun and the Earth, or in the reference frame of an ellipse as the semi-major axis of Earth's orbit around the Sun', he recited. 'Correct', Amy said happily, 'now here are some pictures of the real Mars.'



SEPS seemed to be a bit disappointed. 'That doesn't really look like a place where you want to live. I like my Mars better. But why is it that cold on Mars? I get that the distance to the Sun is an important factor, but it is not that much further away than Earth. You said something about the size, how is it related to the temperature?' Amy thought about where to start. 'Well, do you remember what we said about the structure of terrestrial planets?', she asked. 'Terrestrial planets are the inner planets, where rock and metal condensed and accreted over time, so they are mainly made out of heavier elements that form rocks an metals.' 'Correct, and this mass of rock and metal generally divides up into the iron core in the center of the planet, the mantle around it and the crust, which is basically the shell of the planet. The upper part of the mantle and the crust are what is called the lithosphere. Now, as a consequence of Mars' small size, the core lost its internal heat and simultaneously solidified. Without a liquid core, the planet was not able to retain a strong magnetic field, which would have protected the atmosphere like a cocoon from the solar wind particles. Without this protection, atmosphere is being stripped away by solar wind particles. The solar wind has not the biggest influence on Mars' shape though, thermal escape really plays the major role here.'

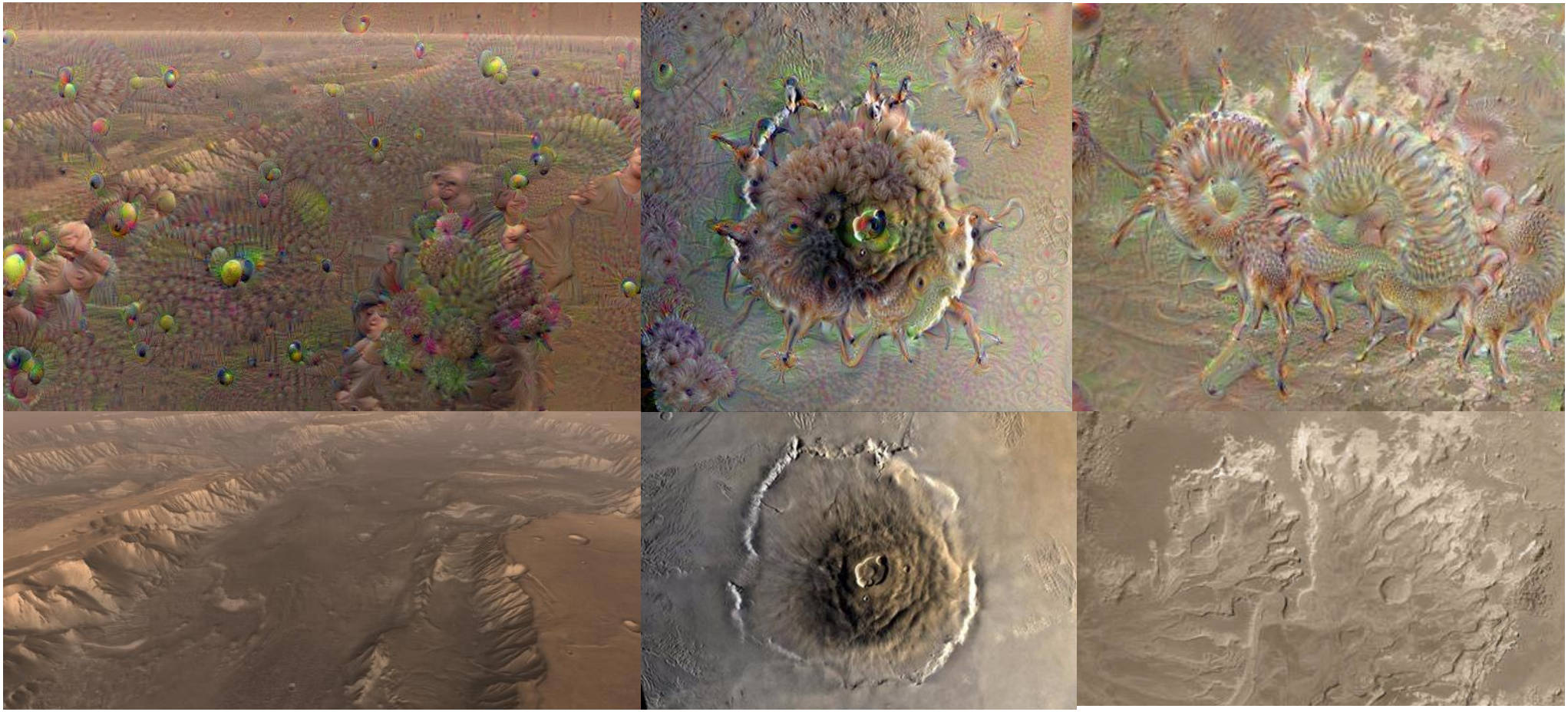
'What is thermal escape?', SEPS asked. 'Let us put this definition aside for a moment and come back to the conditions on the surface of Mars. A day on Mars is pretty much as long as a day on Earth, 1 day and 40 minutes to be exact. Mars has a tilt of 25°, but this angle is not stable. Unlike Earth, where the relatively big moon stabilizes Earth's tilt of 23.5°, Mars only has two small moons, Deimos and Phobos. Nevertheless, Mars has

seasons due to its tilt. The weather is mainly driven by these seasons. There is one convection cell per hemisphere of Mars, which means that winds easily stretch out from the equator to the polar regions. Besides the winds, dust storms are quite usual on Mars. Sometimes it happens, that local dust storms turn into global dust storms, that cover quite a remarkable part of the planet. Up to 90 to 95% of the light can be blocked out by such a global dust storm.' SEPS sighed. 'This doesn't sound at all like how I imagined Mars. I bet the temperatures aren't in a comfortable region either?' 'Well, no. Since Mars rotates it has a day and night cycle, and the temperatures on the surface of Mars range between a minimum of -143°C and a maximum of 35°C.' 'And what about the atmosphere?, SEPS continued. 'The atmosphere is not breathable for life as we know it on Earth. It consists of 95% carbon dioxide, 2.7% nitrogen, and 2% argon. Mars also has ice on its polar caps, a thick layer of frozen carbon dioxide, which melts in the summer and adds to the atmosphere, and also frozen water'. 'So there is water on Mars!', SEPS shouted out excitedly and the printer rattled again.



'Your imagination is quite colorful', Amy said. 'I bet this is to be a dust storm on the upper left, a polar cap in the middle and Phobos and Deimos in the lower left and right, correct?' 'Yes', said SEPS proudly. 'What about the other two?', Amy asked. 'Just some landscapes. You're probably gonna tell me now that they don't look at all like the real Mars.' 'No, they don't, but Mars actually has some interesting geological features. There is Olympus Mons, for example, it is the tallest ancient volcano in the solar system.' 'Is it still active?' 'No, it isn't. As we have discussed, Mars is quite cold by now. There is not enough heat left inside the planet to stimulate volcanism, but the fact that we can find ancient volcanoes on Mars shows us that maybe around 1 billion years ago Mars was quite warm. Another indicator for this is erosion, which we can observe particularly well in dried river belts and another big-feature of Mars, Valles Marineris. It is with over 4,000 km the largest canyon in our solar system.'

'So, when you say erosion and dried river belts, you say there was liquid water on Mars in the past?' 'Erosion does not necessarily lead to water, also wind can cause erosion. But yes, there's a lot of evidence that water once existed on Mars. Beside the obvious geological features, we have also found minerals that only form in the presence of water.' 'But where did it all go?', SEPS wondered. 'And there we come back to thermal escape. With the process of a cooling planet, a weakening in the magnetic field and therefore a loss of atmosphere, ultraviolet light easily reached the surface of Mars and broke water down into its components, oxygen and hydrogen. Hydrogen is a very light element and therefore it easily reached the escape velocity needed to escape the gravitational attraction of the planet. And off it went, into the vastness of the universe.' 'Hm, I still like the idea of having life on Mars. Maybe one day, it will all look like this.' And the printer started again.



Credit:
The code for the modification of the images was created and published by Google DeepDream (https://github.com/google/deepdream). The images included and used for modification were published by NASA. The following pictures published by private persons under a Creative Common License (https://creativecommons.org/licenses/by-nc-sa/2.0/) have been used for feature selection, i.e. these pictures provided a basis for modification of pictures published by NASA, but have not been modified themselves: https://www.flickr.com/photos/donaldinportlandia/14939592237/in/photolist-oLajhv-eiekYe-pXkhWH-hPpkW-6mZzRj-6hqxKy-SqA4g-3GZ1mR-qeAHoV-vtYau-qeANft-pXKQd-i8ScE-4Sdrqi-b2x9ca-9QmDvp-7Xuqmg-8i4hA2-5tiwHA-QwN9C-RwiSn-6SZkfP-5hjrCn-4Hq7u-5R4qqa-97zACK-egQqvN-9yGwjX-4YQqgR-e3Kmba-5uFvLK-edqEum-4rb9eK-KmXA6-6VEwPr-57CZoh-gHdLXm-6KydNX-fkzPB-bWFVz8-8jmwXv-k5ayN-4H459E-m5b1B-pXe3zu-8nSVHW-3SfGT-pXe1es-6sRQqZ-89yTpSdon%20fox; https://www.flickr.com/photos/ferdy182/3307820064/.