2018 marks 200 years of the publication of *Frankenstein: Or the Modern Prometheus* – a book that is today hailed as the first science fiction novel. To celebrate the occasion, this article takes a close look at some landmark works in this genre and traces the inter-dependence of science and science fiction.
It was June 1816. Lord Byron, P.B. Shelley and his wife to be, Mary were confined indoors inside a hotel by Lake Geneva in Switzerland. Outside, it was raining incessantly. To elevate the spirits of his friends, Lord Byron proposed that they entertain each other with ghost stories.

The mysteries of the human body had been unravelled in the 16th Century by Andreas Vesalius. By dissecting numerous human corpses he had understood the functions of the vital organs and dispelled age-old myths about the mechanism that keeps the human body alive. His seminal book De Humani Corporis Fabrica (On the Fabric of the Human Body), is the first modern treatise of human anatomy.

This beautifully illustrated book had caught Mary Shelley’s attention. She spent hours studying the anatomical drawings of human muscles and bones. Mary had a natural interest in science — particularly life science. She attended public lectures on science and took meticulous notes.

That June evening, when Mary looked out of the window of her hotel room and caught a glimpse of Lake Geneva lit up by lightning, she was reminded of an experiment in galvanism she had seen in her childhood in London. Electrical stimulus was applied to the corpse of an executed criminal. The jaws of the deceased began to quiver and the adjoining muscles were horribly contorted. One eye actually opened. It was a ghostly experience that haunted Mary for many years.

In the flickering light of the candle kept on her study table, Mary Shelley penned her first thoughts on the creation of artificial life. Mary imagined the creator to be a young student of natural philosophy, as science was then called. She gave him the name Victor Frankenstein. Mary unleashed her imagination on the process of creating artificial life — what would Frankenstein use as his raw material? Would he work with clay as Prometheus, the mythical Greek hero had done? How would he create flesh and blood and what would Frankenstein’s creation look like?

Eighteen months later, on the 1st of January 1818, Frankenstein: Or the Modern Prometheus was published. Today it is hailed as the first science fiction book to be ever written — science fiction because the central character Victor Frankenstein makes a deliberate decision and turns to modern, systematic experiments in the laboratory.

The “creature” created by Victor Frankenstein is 8 feet tall, proportionately big and hideous to look at, with yellow eyes and a semi-transparent skin that barely concealed the blood vessels and muscles underneath. Frankenstein is so repelled by his own creation that he runs to the next room and goes to sleep. When he wakes up, he finds the creature looming over his bed with a grotesque smile. Victor rushes out of the house, leaving his creation behind. When he returns home with his friend, the “creature” is gone. Years later, when Victor encounters his creation, the creature accuses him, “Accursed creator! Why did you form a monster so hideous that even you turned from me in disgust?”

In the course of the story, the “creature” not only goes on a murderous spree, but also takes complete control of Victor’s life, demanding that Victor create a female companion for the “creature”. Victor resists, having learned the lesson from his earlier creation. The “creature” grows more demanding, taking greater and greater control of Victor’s life. The creature warns Victor, “I have love in me the likes of which you can scarcely imagine and rage, the likes of which you would not believe. If I cannot satisfy one, I will indulge the other.” Eventually, after devouring Victor’s brother, newlywed wife Elizabeth and his friend Henry, the “creature” is the cause of Victor’s death amidst the floating ice sheets in North Pole.

Shelley’s masterwork has been acknowledged by posterity as “a book that can encourage us to be both thoughtful and hopeful”. At Arizona University’s Frankenstein Bicentennial Project, it was said:

“No work of literature has done more to shape the way humans imagine science and its moral consequences than Frankenstein: or The Modern Prometheus, Mary Shelley’s remarkably enduring tale of creation and responsibility... In writing Frankenstein, Mary produced both in the creature and in its creator tropes that continue to resonate deeply with contemporary audiences. Moreover, these tropes and the imaginations they engender actually influence the way we confront emerging science and technology, conceptualise the process of scientific research, imagine the motivations and ethical struggles of scientists, and weigh the benefits of scientific research against its anticipated and unforeseen pitfalls.”
The seeds of a new genre of literature, Science Fiction, were sown. This genre continues to shape our scientific imagination, make prophecies of a dystopic future and imagine gadgets and machines that soon turn into reality.

Through much of the 19th Century, humankind’s understanding of electricity and magnetism widened through the experiments conducted by Michael Faraday, Hans Christian Oersted and others and the theoretical predictions made by James Clerk Maxwell. In 1830, steam locomotives were introduced for public use. In 1844 Samuel Morse applied the principles of electromagnetism to send his first telegraphic message from Washington to Maryland. Around 1880, the first electric bulbs lit up the homes of the well to do Europeans and Americans. The world became a brighter and smaller place.

Jules Verne, a French writer, imagined going round the earth in 80 days. His novel Around the World in 80 Days begins with an article in The Daily Telegraph, stating that with the opening of a new railway service in India, it is now possible to travel around the world in 80 days. Verne’s protagonist Phileas Fogg accepts a 20,000 Pound challenge from a fellow member of Reform Club and sets off by train from London. The technological innovations of the 19th century had opened the possibility of rapid circumnavigation. The prospect fascinated Verne and his readership.

In his other books, Verne has taken his readers to the centre of the earth (Journey to the Centre of the Earth), deep under the sea (20,000 Leagues Under the Sea) and hovering over Africa on a balloon (Five Weeks on a Balloon). His books are filled with technical details that students of science will find interesting, but the lay readers may find somewhat laborious to read. In Verne’s own words, “even before I began writing stories, I always took numerous notes out of every book, newspaper, magazine, or scientific report that I came across”.

He spent hours at the Bibliotheque Nationale de France, conducting research for his stories and feeding his passion for science and recent discoveries. Verne extrapolated the future applications of the science of the day and guessed at the marvels that might be produced from the scientific knowledge of his times. Verne is credited for being a prophet of technological progress.

He imagined machines that could transmit information over long distances, the carriages in his stories were pulled not by horses, but by engines relying on combustion. Captain Nemo’s vehicle in 20,000 Leagues Under the Sea is a prototype of a submarine. However, Verne himself denied any claim of being a futuristic prophet. He said that when he wrote Five Weeks on a Balloon, he had no faith in the possibility of steering balloons and taking them to desired destinations.

Verne’s imagination took him everywhere. When he wrote From Earth to the Moon, nobody was thinking of space travel. Verne’s descriptions of space travel take into account the effects of acceleration on the traveller and how he would cope with the new environment on the Moon. Interestingly, Verne wrote in this book that the best place to launch rockets would be from the coast of Florida and he named his space vehicle the Columbiad. Decades later, NASA named their space shuttle, Columbia. All the books written by Verne were immensely popular. Inventors like Marconi and the first space traveller Yuri Gagarin have acknowledged the inspiration they have derived from Verne’s books.

If Jules Verne travelled to the moon in his imagination, H.G. Wells’s imagination took him to Mars. Mars had been discovered as the planet nearest to the earth. An astronomer Giovanni Schiaparelli even reported seeing canals on Mars. Wells’s imagination was ignited by the idea of life on the Red Planet. One day he was having a discussion with his elder brother about how the British colonizers had gone on a genocidal rampage in Africa. His brother commented, “What if troops from outer space land on the earth and start annihilating us as we have been annihilating the Africans”.

From these thoughts was born the best seller War of the Worlds, one of the earliest stories that detail a conflict between mankind and an extra-terrestrial race. Here Martians land in London and its outskirts and start indiscriminately killing humans with their deadly weapons. Wells unleashes his imagination on the destructive power of scientific advancement. His description of the Martian weapons foreshadows chemical warfare and laser war. The Martians are armed with rotating lenses on their heads. These lenses can focus a beam of light on the target and set it alight.

Nineteen years later Albert Einstein identified the theoretical basis of laser technology. The first laser was created in 1960 using synthetic ruby, by physicist Theodore Maiman. Today lasers are used in eye surgery, welding, communication, remote sensing, in the super-market and to create holograms. The US Navy tested a deadly laser gun in 2014.

H.G. Wells drew on a lifelong interest in science to fuel his fiction. He began his career as a science teacher, but gave up teaching when his books started bringing him fame and fortune. He took Victorian science of his day, the science of automatons and steam locomotives and propelled it into space age. He envisioned mind-blowing advances in science and technology in terrifying details and became haunted by one question — will mankind annihilate itself.
War of the Worlds was not only a new kind of fiction, but it also envisioned a new kind of warfare, where an entire urban population is under threat of annihilation. It was a prophecy of what was soon to follow — civilians under attack in a global warfare, bombs dropping on innocent humans, tanks taking over cities, civilian life curtailed by curfew — Wells had lived to see his unfortunate prophecy come true. Apocalyptic destruction was brought about during the two world wars through abusive use of advanced science. All Wells’s novels are a prophecy of an advanced human race or predictions of its extinction.

However, the prospect of time travel captured the imagination of the reading public. Einstein’s equations had given firm scientific foundation to time as a fourth dimension. In H.G. Wells’s Time Machine the time traveller moves into the future on his time machine. He goes to AD 802701, where he encounters Eloi, a society of small, elegant, childish adults. Later in the dark, he is approached menacingly by the Morlocks, ape-like creatures who live underground and surface only at night. Exploring one of many “wells” that lead to the Morlocks’ dwellings, he discovers the machinery and industry that makes the above-ground paradise of the Eloi possible. So the time traveller discovers that the human race has evolved into two species: the leisured classes have become the ineffectual Eloi, and the downtrodden working classes have become the brutal light-fearing Morlocks.

Well’s Time Machine becomes a social commentary on the class division that he witnessed in his own time. He predicted that the leisurely upper class would ultimately evolve into the ineffectual Eloi and the exploited working class would evolve into the savage underground creatures Morlocks.

Wells’s book was based on the premise that if time is a dimension like those of space, then the past, present and future are all part of the same unified entity and potentially accessible. If someone could somehow step out of space and time, he would see each person’s life as a complete, immutable thread, something like a film reel. This idea came to be known as the block universe. Wells explained the idea with this example:

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“Here is a portrait of a man at eight years old, another at fifteen, another at twenty-three, and so on. All are evidently sections, as it were, Three-Dimensional representations of his Four-Dimensional being, which is a fixed and unalterable thing.”

Wells is even credited with coinage of the term ‘atom bomb’, which he used in one of his later novels The World Set Free published in 1914. The radioactive decay of uranium and radium had been discovered at the turn of the 20th Century. The tiny nucleus of the atom was discovered to be a storehouse of energy. Wells imagined that mankind would eventually unlock this energy and deploy it on unsuspecting multitudes. The first atom bomb was dropped on Hiroshima on 6 August 1945. H.G. Wells died on August 13, 1946.

In 1891, when Wells was only 26 years old, he had written an essay titled “The Universe Revisited”. He conceptualised a four-dimensional time-space continuum, where time is the fourth dimension. This means, in order to locate something in space, three spatial coordinates and one temporal coordinate would be necessary. Wells submitted his essay in the Fortnightly Review, but the editor Frank Harris rejected it.

Wells took recourse to fiction to air his radical thoughts. His debut novel The Time Machine was published in 1895. Ten years later, when Albert Einstein was 26 years old, his paper on special relativity was published in the scientific journal Nature. Special relativity brought the edifice of Newtonian science crumbling down. But the new concepts were common sense defying. The common man had difficulty in understanding how a metre rod can shrink in size if it begins to move with extraordinary speed or why a clock would tick slowly if it travelled at a speed close to the speed of light.
Although *The Time Machine* was widely read, there is no evidence that Einstein and Wells ever discussed the fourth dimension, though it was integral to the former’s theories and the latter’s stories. Einstein was well-read, but not particularly a fan of speculative fiction. Wells probably was unfamiliar with Einstein’s work. He was not a well-known name outside the scientific circle till measurements taken during the 1919 solar eclipse helped confirm the general relativistic prediction that the path of starlight would be bent by massive objects such as the Sun. This confirmation of Einstein’s theory made him world-famous. In later years, both Einstein and Wells were horrified by 20th century warfare, and came to advocate world government as a means of preventing further calamities.

The idea of time travel has been taken up time and again in science fiction literature and cinema. The past and the future are bafflingly juxtaposed in films like *Interstellar* and *Arrival*. These works of fiction are firmly rooted in Einstein’s General Theory of Relativity. General Relativity, by treating space and time as an amalgam, naturally matches up with the block universe idea of the past, present and future co-existing in the space time continuum. Einstein believed that fundamentally the future is inalterable and free will non-existent. Nevertheless, we have the perception that we are moving through the one-dimensional arrow of time.

In the 1985 movie *Back to the Future*, the protagonist Marty goes 30 years into the past in a time machine built by the eccentric scientist Doc Brown. Doc’s time machine is powered by plutonium stolen from the terrorists. Back in 1955, Marty has to grapple with what is known as ‘grandfather effect’. He must save his mother Lorraine from the advances of the drunken Biff and ensure that the subdued, gentle George wins the hand of Lorraine. If Marty cannot do that, his own existence will be wiped out. Marty accomplishes his mission and ensures that his ‘present’ takes a turn for the better.

Now he has to return from 1955 to 1985. There isn’t enough plutonium to take him back. 1.21 gigawatts of electricity is necessary to trigger the time machine. Doc and Marty find a way to harness the energy of the lightning that they know would strike the clock tower precisely at 10:04 pm on Saturday night. They connect an electrical cable to the clock tower to transfer the electricity to the flux capacitor of the time machine. Marty presses the accelerator, Doc waits for the precise moment to make the connection. Precisely at 10:04 pm the clock tower is charred by lightning. Marty is transported back to the future. Is time travel really possible? Christopher Nolan’s *Interstellar* would have us believe that passing through the wormhole one can go into the future. A wormhole can be visualized as a tunnel with two ends, each at separate points in spacetime. In the film *Interstellar*, a professor tells the protagonist Cooper that 48 years ago, a wormhole appeared near Saturn, opening the path to a distant galaxy with 12 potentially habitable planets. Some of these planets could be an alternative habitat for humankind. Humanity’s survival on
The horizon of a rotating black hole is called an ergosphere. An object within the ergosphere cannot appear stationary with respect to an outside observer unless that object was to move at faster than the speed of light.

Since the ergosphere is outside the event horizon, it is still possible for objects that enter that region with sufficient velocity to escape from the gravitational pull of the black hole. An object can gain energy by entering the black hole’s rotation and then escaping from it, thus taking some of the black hole’s energy with it. In *Interstellar*, Cooper uses this technique to swing his spaceship out of the field of Gargantua.

It took the animation team more than a year to create an ergosphere around the black hole Gargantua and trace the spaceship’s trajectory through this ergosphere. Some individual frames took up to 100 hours to render, totalling 800 terabytes of data.

Interestingly, the resulting visual effect provided Thorne with new insight into the effects of gravitational lensing and accretion disks surrounding black holes. Thorne published three scientific papers based on his newfound insight. This is a unique example of artistic imagination and scientific insight feeding off each other.

In 2017, Thorne was awarded the Nobel Prize in Physics along with two other scientists, for decisive contributions to the LIGO detector and the observation of gravitational waves. The interdependence between science and science fiction made a complete circle.

The genre of literature initiated by Mary Shelley 200 years ago has grown and flourished in many different directions. It has proved to be a charmed arena where scientific rigour meets fertile imagination to generate a clairvoyant vision of the implications of the principles of science that govern the Universe and our lives. If science helps human beings to pin their position in the Universe, science fiction propels them into the imaginary world of the probable and the plausible.

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