### 1NC- Colonization

#### Space colonization coming now

Christiana Reedy, 8/17/**17**, "When Will the First Human Space Colony Be Established?," Futurism, <https://futurism.com/when-will-the-first-human-space-colony-be-established>

Will humanity be ready to colonize space before doomsday? We asked Futurism readers when they thought humans will colonize off-planet, and the results revealed quite a consensus. More than 70 percent of people who took the poll thought a colony will be established during the first half of the 21st century, and the decade with the most votes — a whopping 36 percent of participants — was the 2030s. Satish Varma, a software engineer, explained why he voted for this decade. Varma wrote in his response that our technological advances in spacecraft design, artificial intelligence (AI), and bionics will be the driving forces that finally propel us into space long term. “Currently there are some promising advances in space exploration and artificial intelligence by companies like SpaceX, Google, and Tesla in a short time frame,” Varma wrote. Varma’s observations are right on — both SpaceX and Blue Origin have recently reached significant milestones in developing reusable rockets, which will be key in making space travel economically viable. Google has recently developed an AI that can learn almost as fast as we can, making the technology much more promising for real-world applications, like flying spaceships. What The Experts Have to Say The technologies have enticed governments and companies around the world to take the idea of space colonization seriously. The two most popular targets for human occupation are currently Mars and the Moon. The Moon gets a little less attention these days, but scientists have estimated that we could build a colony there over the pan of six years and for as little as $10 billion. The Chinese and European space agencies are carefully examining the possibility of a Moon base, as such a resource would greatly reduce the cost of traveling to other planets — including Mars. On the Mars front, the United Arab Emirates (UAE) has announced its intention to establish a settlement on the Red Planet by 2117. Other nations are likely to beat the UAE in reaching this goal, however, as the U.S. government has tasked NASA with getting humans on Mars by 2033, and China has set an even more ambitions goal: by the end of the decade. These government efforts align with readers’ predictions. But SpaceX CEO Elon Musk hopes to prove just how much more efficient private companies are than government bureaucracies. His plan, too, is to send humans to Mars by 2020, but that isn’t his only goal. He wants to make travel to the Red Planet affordable, setting the price cap at $200,000 in his new plan that focuses on establishing a self-sustaining space civilization rather than a simple exploratory expedition. Such an establishment will be paramount to the future of the human species, Musk said.

#### Mars colony is feasible, solves a laundry list of extinction scenarios, and ends war on Earth

**Davies 10** – Dirk Schulze-Makuch, Ph.D. and Professor of Earth and Environmental Sciences at Washington State University, and Paul Davies, Ph.D. and Professor in the Beyond Center at Arizona State University, “To Boldly Go: A One-Way Human Mission to Mars”, Journal of Cosmology, 12, October / November, http://journalofcosmology.com/Mars108.html

There are **several reasons** that **motivate** the **establishment of a permanent Mars colony. We are a vulnerable species** living in a part of the galaxy where **cosmic events such as major asteroid and comet impacts and supernova explosions pose a significant threat to life on Earth**, especially to human life. **There are** also **more immediate threats to** our culture, if not our **survival as a species. These include global pandemics, nuclear or biological warfare, runaway global warming, sudden ecological collapse and supervolcanoes** (Rees 2004). **Thus**, the **colonization** of other worlds **is a must if the human species is to survive** for the long term. The first potential colonization targets would be asteroids, the Moon and Mars. The **Moon** is the closest object and does provide some shelter (e.g., lava tube caves), but in all other respects **falls short compared to** the variety of **resources available on Mars. The latter is true for asteroids as well. Mars is by far the most promising for** sustained **colonization** and development, **because it is similar in many respects to Earth and, crucially, possesses a moderate surface gravity, an atmosphere, abundant water and carbon dioxide, together with a range of essential minerals. Mars is** our **second closest planetary neighbor (after Venus)** and a trip to Mars at the most favorable launch option takes about six months with current chemical rocket technology. In addition to **offering humanity a "lifeboat" in the event of a mega-catastrophe, a Mars colony is attractive** for other reasons. Astrobiologists agree that there is a fair probability that Mars hosts, or once hosted, microbial life, perhaps deep beneath the surface (Lederberg and Sagan 1962; Levin 2010; Levin and Straat 1977, 1981; McKay and Stoker 1989; McKay et al. 1996; Baker et al. 2005; Schulze-Makuch et al. 2005, 2008, Darling and Schulze-Makuch 2010; Wierzchos et al. 2010; Mahaney and Dohm 2010). A scientific facility on Mars might therefore be a unique opportunity to study an alien life form and a second evolutionary record, and to develop novel biotechnology therefrom. At the very least, an intensive study of ancient and modern Mars will cast important light on the origin of life on Earth. Mars also conceals a wealth of geological and astronomical data that is almost impossible to access from Earth using robotic probes. A permanent human presence on Mars would open the way to comparative planetology on a scale unimagined by any former generation. In the fullness of time, a Mars base would offer a springboard for human/robotic exploration of the outer solar system and the asteroid belt. Finally, **establishing a permanent multicultural and multinational human presence on another world would have major beneficial political and social implications for Earth, and serve as a strong unifying and uplifting theme for all humanity**.

#### A million humans could live on Mars in 40-100 years, preventing human extinction, but this is only fundable by private companies.

Drake 16 (“Elon Musk: A Million Humans Could Live on Mars By the 2060s,” BY NADIA DRAKE, SEPTEMBER 27, 2016, National Geographic https://www.nationalgeographic.com/science/article/elon-musk-spacex-exploring-mars-planets-space-science)

In perhaps the most eagerly anticipated aerospace announcement of the year, [SpaceX](http://www.spacex.com/) founder Elon Musk has revealed his grand plan for establishing a human settlement on Mars. In short, Musk thinks it’s possible to begin shuttling thousands of people between Earth and our smaller, redder neighbor sometime within the next decade or so. And not too long after that—perhaps 40 or a hundred years later, Mars could be home to a self-sustaining colony of a million people. “This is not about everyone moving to Mars, this is about becoming multiplanetary,” he said on September 27 at the [International Astronautical Congress](https://www.iac2016.org/) in Guadalajara, Mexico. “This is really about minimizing existential risk and having a tremendous sense of adventure.” Musk’s timeline sounds ambitious, and that's something he readily acknowledges. “I think the technical outline of the plan is about right. He also didn’t pretend that it was going to be easy and that they were going to do it in ten years,” says [Bobby Braun](http://braun.gatech.edu/), NASA’s former chief technologist who’s now at Georgia Tech University. “I mean, who’s to say what’s possible in a hundred years?” National Geographic Channel is currently in production on MARS, a global event series set to premiere November 14. Join the journey at [MakeMarsHome.com](http://liveonmars.nationalgeographic.com/landing/countdown). #CountdownToMars And for those wondering whether we should go at all, the reason for Musk making Mars an imperative is simple. “The future of humanity is fundamentally going to bifurcate along one of two directions: Either we’re going to become a multiplanet species and a spacefaring civilization, or we’re going be stuck on one planet until some eventual extinction event,” Musk told Ron Howard during an interview [for National Geographic Channel’s MARS](http://www.makemarshome.com/), a global event series that premieres worldwide on November 14. “For me to be excited and inspired about the future, it’s got to be the first option. It’s got to be: We’re going to be a spacefaring civilization.” Mars Fleet Though he admitted his exact timeline is fuzzy, Musk thinks it’s possible humans could begin flying to Mars by the mid-2020s. And he thinks the plan for getting there will go something like this: It starts with a really big rocket, something at least 200 feet tall when fully assembled. In a simulation of what SpaceX calls its Interplanetary Transport System, a spacecraft loaded with astronauts will launch on top of a 39-foot-wide booster that produces a whopping 28 million pounds of thrust. Using [42 Raptor engines](https://twitter.com/elonmusk/status/780275236922994688), the booster will accelerate the assemblage to 5,374 miles an hour. Overall, the whole thing is 3.5 times more powerful than NASA’s [Saturn V](http://www.nasa.gov/audience/forstudents/5-8/features/nasa-knows/what-was-the-saturn-v-58.html), the biggest rocket built to date, which carried the Apollo missions to the moon. Perhaps not coincidentally, the SpaceX rocket would launch from the same pad, 39A, at Kennedy Space Center in Cape Canaveral, Florida. The rocket would deliver the crew capsule to orbit around Earth, then the booster would steer itself toward a soft landing back at the launch pad, a feat that SpaceX rocket boosters have been doing for almost a year now. Next, the booster would pick up a fuel tanker and carry that into orbit, where it would fuel the spaceship for its journey to Mars. Once en route, that spaceship would deploy solar panels to harvest energy from the sun and conserve valuable propellant for what promises to be an exciting landing on the Red Planet. As Musk envisions it, fleets of these crew-carrying capsules will remain in Earth orbit until a favorable planetary alignment brings the two planets close together—something that happens every 26 months. “We’d ultimately have upward of a thousand or more spaceships waiting in orbit. And so the Mars colonial fleet would depart en masse,” Musk says. The key to his plan is reusing the various spaceships as much as possible. “I just don’t think there’s any way to have a self-sustaining Mars base without reusability. I think this is really fundamental,” Musk says. “If wooden sailing ships in the old days were not reusable, I don’t think the United States would exist.” Musk anticipates being able to use each rocket booster a thousand times, each tanker a hundred times, and each spaceship 12 times. At the beginning, he imagines that maybe a hundred humans would be hitching a ride on each ship, with that number gradually increasing to more than 200. By his calculations, then, putting a million people on Mars could take anywhere from 40 to a hundred years after the first ship launches. And, no, it would not necessarily be a one-way trip: “I think it’s very important to give people the option of returning,” Musk says. Colonizing Mars After landing a few cargo-carrying spacecraft without people on Mars, starting with the Red Dragon capsule in 2018, Musk says the human phase of colonization could begin. For sure, landing a heavy craft on a planet with a thin atmosphere will be difficult. It was tough enough to gently lower NASA’s Curiosity rover to the surface, and at 2,000 pounds, that payload weighed just a fraction of Musk’s proposed vessels. For now, Musk plans to continue developing supersonic retrorockets that can gradually and gently lower a much heavier spacecraft to the Martian surface, using his reusable Falcon 9 boosters as a model. And that’s not all these spacecraft will need: Hurtling through the Martian atmosphere at supersonic speeds will test even the most heat-tolerant materials on Earth, so it’s no small task to design a spacecraft that can withstand a heated entry and propulsive landing—and then be refueled and sent back to Earth so it can start over again. The first journeys would primarily serve the purpose of delivering supplies and establishing a propellant depot on the Martian surface, a fuel reservoir that could be tapped into for return trips to Earth. After that depot is set up and cargo delivered to the surface, the fun can (sort of) begin. Early human settlers will need to be good at digging beneath the surface and dredging up buried ice, which will supply precious water and be used to make the cryo-methane propellant that will power the whole enterprise. As such, the earliest interplanetary spaceships would probably stay on Mars, and they would be carrying mostly cargo, fuel, and a small crew: “builders and fixers” who are “the hearty explorer type,” Musk said to Howard. “Are you prepared to die? If that’s OK, then you’re a candidate for going.” While there will undoubtedly be intense competition and lots of fanfare over the first few seats on a Mars-bound mission, Musk worries that too much emphasis will be placed on those early bootprints. “In the sort of grander historical context, what really matters is being able to send a large number of people, like tens of thousands if not hundreds of thousands of people, and ultimately millions of tons of cargo,” he says. “I actually care much more about that than, say, the first few trips.” In short, his vision for establishing a settlement on Mars is more an endurance sport than a sprint. Rocket Man But Musk is used to that. In 2001, he founded SpaceX with one goal in mind: put humans on Mars. At the time, he recalls, he found himself thinking about why, after the successful Apollo missions to the moon, humans hadn’t visited Mars—or reached very far into space at all. “It always seemed like we should have gone there by now, and we should have had a base on the moon, and we should have had space hotels and all these things,” he said to Howard. “I’d assumed that it was a lack of will … it was not a lack of will.” Instead, resources devoted to space exploration were scarce, and government spaceflight programs couldn’t assume the kind of risk that a private endeavor could tolerate. With an accumulated fortune from his time at Paypal, Musk founded a company dedicated to building rockets and vastly improving the vehicles that form the foundation of an interplanetary journey. Contracts with private clients and the U.S. government followed, and now SpaceX is working on a version of its Dragon capsule that can send humans to the International Space Station. Over the years, the company has had many high-profile successes—including landing the first suborbital reusable rocket stages on land and at sea—and its share of failures, with rockets exploding on the launch pad or en route to orbit. That’s no surprise for any big technology development. But putting humans on Mars is a completely different challenge from sending humans into orbit, or even to the moon, especially when the goal isn’t just a few casual trips. “I think what we want to avoid is a replay of Apollo,” Musk says. “We don’t want to send a few people, a few missions to Mars and then never go there again. That that will not accomplish the multiplanetary goal.” Funding Muskville Musk’s ultimate vision of a second, self-sustaining habitat for humans in the solar system is grand and lofty, but by no means unique. What makes Musk’s plan stand out from centuries of science fiction is that he might actually be able to make it happen—if he can bring costs down to his ideal levels. “Entrepreneurs are able to look at questions that we think about, but we’re not quite ready to go there yet, things like supersonic retrograde propulsion,” said NASA administrator [Charlie Bolden](https://www.nasa.gov/about/highlights/bolden_bio.html) during a panel at the IAC. "I think we can quibble over the numbers and the dollars and the timeframes and all, but we shouldn’t lose the fact that this guy went out on the international stage today and just laid it all out on the line," Braun adds. "I found it refreshing." But for Mars to be a viable destination, Musk says the cost of the trip needs to come down to about $200,000, or the average price of a house in the United States. Trouble is, that’s a significant decrease from current cost estimates. Musk doesn’t anticipate being able to do all of this on his own and said to Howard that some sort of synergistic relationship between governments and private industry will be crucial. “I think we want to try to get as much in the way of private resources dedicated to the cause, and then get as much as possible in the way of government resources, so that if one of those funding sources disappears, things continue.” But combining different management styles, abilities to assume risk, sources of funding, and working with old institutional road maps will be a challenge, to say the least. How might that all work? “With difficulty,” says space policy expert [John Logsdon](https://elliott.gwu.edu/emeritus-faculty#logsdon), professor emeritus at The George Washington University. “It will involve breaking things.” For instance, reaching Mars in the 2020s will require a bit of a kick in the pants for SpaceX on the technology front. The massive rocket featured in the simulation is much more powerful than anything in the company’s current arsenal. The first iteration of that futuristic rocket, a gargantuan stepping stone known as the Falcon Heavy, has already been delayed for years. These types of delays are one of the reasons why space policy experts are skeptical about the timing of Musk’s plan, which he acknowledges is murky at best. “Based on past performance, I don’t know how you could say, well, yeah he’s missed all these other deadlines, but this time he’s gonna do it,” Logsdon says. “So I think the reasonable posture is that I’ll believe it when he does it.” If humans do manage to touch down on Mars, Musk thinks the momentum from such an achievement will propel additional developments, just as early explorers searching for glory, gold, and spices drove improvements in ship technology and global industry. Ultimately, Musk believes this kind of endeavor will bring Mars out of the realm of science fiction and transform it from a world fraught with difficulty and danger to one that humans might actually enjoy living on—including Musk. “I think that Mars is gonna be a great place to go,” he says. “It will be the planet of opportunity.”

#### Multiple extinction threats within the next century – try or die to get off the rock –multiple scientists agree

Smith and Davies 12 (Cameron M., Anthropology Professor, Evan T., Writer; "A Choice of Catastrophes: Common Arguments for Space Colonization", Emigrating Beyond Earth: Human Adaptation and Space Colonization, http://link.springer.com/chapter/10.1007/978-1-4614-1165-9\_4)

These limits are not entirely mythological. Even if humanity were to end war,¶ overpopulation, disease and pollution, ensure global justice and build a network¶ of defenses against such cosmic dangers as solar eruptions and wandering comets¶ and asteroids, the Sun cannot be prevented burning out, at which time its plasma¶ shell will expand and incinerate the Earth and all human works. The Sun's¶ expansion is not expected to occur for another five billion years, and may be¶ thought of in a somewhat mythical way. But there are certainly serious and¶ immediate threats to the human species that, we argue, make a compelling case¶ for beginning the migration from Earth sooner rather than later.¶ We are not the first to point these out, of course; in his 1979 book A Choice of¶ Catllstrophes3 Isaac Asimov discussed a variety of plausible natural and culturally caused¶ events that could cause the extinction of humanity, or at least collapse¶ global civilization. While humanity has taken action on some of these threats -¶ for example, an international effort now scans the sky for 'civilization-killer'¶ comets and asteroids4 - many of Asimov's proposed calamities could still occur¶ today. Unfortunately, some are more likely today than in the past, such as the¶ use of nuclear, chemical or biological weapons by individuals or small¶ organizations, and the already-apparent effects of global over-consumption of¶ natural resources, which defense organizations worldwide already recognize as¶ likely leading to resource wars in the relatively short term.¶ Asimov made many of these points nearly 40 years ago, but more recent¶ surveys of the possibility of relatively near-term human catastrophe have been¶ published, and they are not encouraging. A context for these projections has¶ been forwarded by philosopher Robert Heilbroner, who has argued in the book¶ Visions of the Future that from the time of early humans to the 17th century AD,¶ most of humanity saw its future as essentially changeless in its material and¶ economic conditions, a position that paints with quite a broad brush. Perhaps¶ more perceptively, he also argues that from the 18th century AD to the mid-¶ 1900s, Western civilization (at least) saw its future as essentially bright and¶ positive, to be achieved through the application of science, whereas since the¶ mid-1900s (significantly, after two World Wars and the invention of nuclear¶ weapons) there has been a more varied conception involving negatives resulting¶ from "impersonal, disruptive, hazardous and foreboding" factors,' though¶ including some positive hope.¶ Technology figures large in these conceptions, and it is clear that science and¶ the technologies that derive from it can yield great opportunities as well as¶ terrible risks. These were important issues to Asimov, and are more important¶ today. A recent review by Oxford University philosopher and futurist Nick¶ Bostrom points out that three recent discussions of the near human future by¶ prominent thinkers have highlighted significant threats to human existence within the next 1-5 centuries; john Leslie gives humanity a 30% chance of¶ becoming extinct in the next five centuries, Astronomer Royal Martin Rees has¶ weighed in with a figure of a 50% chance of extinction within the next 90 years,¶ and Bostrom himself giving humanity a greater than 25% chance of extinction¶ in the next century. Of course, these are speculations, but they are informed¶ speculations and they reflect technological and other realities that could not¶ have informed earlier, mythical doomsday concepts we discussed above.¶ 6¶ Natural threats to humanity include impacts on Earth from extraterrestrial¶ objects such as asteroids and comets. Human-caused threats to humanity, or at¶ least civilization (defined and discussed in Chapter 2), include ecological¶ overexploitation and conflicts using nuclear, biological and/or chemical¶ weapons. The magnitude of threats to humanity range widely (e.g. from¶ extinction to substantial reduction of the species population); we focus on the¶ levels of (a) the extinction of Homo sapiens sapiens or (b) the collapse of modem¶ civilization.¶ Extinction¶ Extinct species are those whose members have all died out; they may be known¶ to humanity in the fossil and/or DNA record of ancient life forms, but are no¶ longer living at present. Humanity has only been scientifically aware of the 4.5-¶ billion-year age of the Earth for about 100 years, and for much of humanity's¶ more recent history we have considered Earth to be a relatively safe and benign¶ home, at least between cyclic catastrophes. But palaeoenvironmental and fossil¶ records show that calamities and extinctions have been common through time.¶ In a comprehensive survey of the paleontological record paleontologist David¶ Raup has documented that over 99% of all species that have ever lived on Earth¶ have become extinct, and that most species (e.g. sapiens) have a duration of¶ about four million years, while most genera (e.g. Homo) have a duration of about¶ 20 million years. 7 While these are fascinating figures, we must recall that, as we¶ will see through this book, such figures apply to life forms that do not know they¶ are evolving in the first place, and can therefore do nothing proactively about¶ significant threats to their selective environments- their habitats. Humanity, as¶ we saw in Chapters 2 and 3, however, is unique in its ability to both perceive¶ such changes and, if time allows, adapt to them. We return to this important¶ point at the end of this chapter.¶ Extinction normally takes place over multiple generations; millions of¶ generations for faster-reproducing species, thousands for slower-reproducing¶ species. It often results from changes in selective environments that are too rapid¶ for a given species to adapt biologically. For example, when a comet (or asteroid) struck the Earth around 65 million years ago , selective environments changed¶ due to the cloud of debris that was spewed into the atmosphere; the cloud¶ blocked sunlight, which caused changes in temperature, vegetation regimes and¶ so on. This was a change of selective environment so rapid that dinosaurs were¶ unable to adapt with the biological evolution of novel traits suitable to their new¶ selective pressures. Species can also become extinct if they are out-competed by¶ other life forms that are more proficient at life in a given selective environment,¶ as when North American mammals migrated south and replaced many South¶ American marsupials, starting around 3 million years ago.¶ The history of life on Earth includes several well-documented mass-extinction¶ events in which large percentages of Earth life - or some segment of Earth life -¶ became extinct. These events are so distinctive in the fossil record that the¶ disappearance of an established life form and the appearance of new one in the¶ paleontological record are often used to define the beginnings and ends of the¶ geological periods. Such events could occur again and it is clear that most¶ would either cause human extinction at least the collapse of modern¶ civilization.¶ Some mass extinctions occurred over millions of years due to gradual¶ changes in the environment, and some - as in the well-known comet or¶ asteroid impact that ended the reign of the dinosaurs - occurred, from the¶ perspective of life form adaptation, instantly. In each case, full recovery of the¶ Earth's biodiversity took tens of millions of years. We will examine some such¶ extinction events after considering another possible scenario: not extinction,¶ but civilization collapse. ¶

#### Every second we don’t colonize ends 1029 future human lives – outweighs literally any other impact

Bostrom 3— Nick Bostrom, Nick Bostrom is a Swedish philosopher at the University of Oxford known for his work on existential risk, the anthropic principle, human enhancement ethics, superintelligence risks, the reversal test, and consequentialism. ("Astronomical Waste: The Opportunity Cost of Delayed Technological Development", Utilitas, 2003, Available Online at http://www.nickbostrom.com/astronomical/waste.html, accessed 7-15-2016, JSO)

As I write these words, suns are illuminating and heating empty rooms, unused energy is being flushed down black holes, and our great common endowment of negentropy is being irreversibly degraded into entropy on a cosmic scale. These are resources that an advanced civilization could have used to create value-structures, such as sentient beings living worthwhile lives. The rate of this loss boggles the mind. One recent paper speculates, using loose theoretical considerations based on the rate of increase of entropy, that the loss of potential human lives in our own galactic supercluster is at least ~10^46 per century of delayed colonization.[1] This estimate assumes that all the lost entropy could have been used for productive purposes, although no currently known technological mechanisms are even remotely capable of doing that. Since the estimate is meant to be a lower bound, this radically unconservative assumption is undesirable. We can, however, get a lower bound more straightforwardly by simply counting the number or stars in our galactic supercluster and multiplying this number with the amount of computing power that the resources of each star could be used to generate using technologies for whose feasibility a strong case has already been made. We can then divide this total with the estimated amount of computing power needed to simulate one human life. As a rough approximation, let us say the Virgo Supercluster contains 10^13 stars. One estimate of the computing power extractable from a star and with an associated planet-sized computational structure, using advanced molecular nanotechnology[2], is 10^42 operations per second.[3] A typical estimate of the human brain’s processing power is roughly 10^17 operations per second or less.[4] Not much more seems to be needed to simulate the relevant parts of the environment in sufficient detail to enable the simulated minds to have experiences indistinguishable from typical current human experiences.[5] Given these estimates, it follows that the potential for approximately 10^38 human lives is lost every century that colonization of our local supercluster is delayed; or equivalently, about 10^29 potential human lives per second. While this estimate is conservative in that it assumes only computational mechanisms whose implementation has been at least outlined in the literature, it is useful to have an even more conservative estimate that does not assume a non-biological instantiation of the potential persons. Suppose that about 10^10 biological humans could be sustained around an average star. Then the Virgo Supercluster could contain 10^23 biological humans. This corresponds to a loss of potential equal to about 10^14 potential human lives per second of delayed colonization. What matters for present purposes is not the exact numbers but the fact that they are huge. Even with the most conservative estimate, assuming a biological implementation of all persons, the potential for one hundred trillion potential human beings is lost for every second of postponement of colonization of our supercluster.[6]

**Reject arg’s for why these don’t impede on the public end so the aff doesn’t include them**

**1–Super shifty and proves that it’s impossible to interpret what is good under the PTD**

**2–Colonization is inconsistent with a commons because it claims property over land exclusively–not for public use**

**3–Means you only defend some forms of appropriation are bad–specifying certain types is a voter for limits cuz you can specify infinite combinations**