Question 1:

Dear Cheap Astronomy – What is the role of AI in space

AI simulates human decision-making and finds most practical usage in the sorting and analysing of various kinds of data. So. you can feed an AI program pictures of galaxies and the classifications they fit into and then the AI can then identify and classify new ones that you feed it. It's kind of like how Galaxy Zoo used to work, except with Galaxy Zoo it was actual crowd-sourced people that did the work.

These days you can also chat to an AI entity, which will consider what you say and provide an appropriate response. From its perspective whatever you say is just data, since talking is just a method of data transfer. And you can tell AI platforms to draw pictures and play music – although here you are engaging with an AI platform with pre-programmed drawing and composing capabilities and you just provide it with parameters against which to produce an output.

In any of these contexts a degree of machine learning is possible – meaning the more the AI does, the better it gets at what it does. And if you give it feedback on what it did well versus what it didn't do so well, it will get a lot better at what it does.

That's not the end of the story, but it does give some scope to what's possible. A range of applications for AI in space exploration are available – pretty much wherever data analysis and a protocol set of responses to that data might be required. One can get philosophical here and question how much intelligence there really is in following a set of pre-programmed protocol responses but then much of astronaut training involves developing protocol responses – if there's an air-leak, immediately do these things in step-wise order unless the yellow light starts blinking in which case do step 3 before step 2 – and so on. And on the bright side an AI won't panic, get overwhelmed or tired. You can question their capacity for creative thought, but again even where senior command decisions may not be entirely protocol driven, they still mostly involve weighing the balance of probabilities of going one way or the other, based on the data available and your own experience.

All that said, AI isn't ready to take over command of a spacecraft just yet. AIs are developed for particular contexts and it can be challenging to build in capacity to responded to unanticipated scenarios, particularly where those scenarios may be unanticipated by an AI's human programmer. There's a role for machine learning here, although learning by trial and error isn't what you really want in a spacecraft operating system. Nonetheless, AI is improving iteratively – which is not to suggest there is infinite possibility, but we are perhaps yet to see just how effective it might become.

Hello Steve

Oh hi Bridget

Have you talking to chatbots?

Oh, ah well it's for the podcast Bridget. I've been researching AI in space

Really. What did you discover?

Well, it's out there Bridget

You do realise Steve that AI. is not a new thing. Any form of autonomous navigation is essentially AI. The Mars rovers launched in 2003 had AI to help them move around on Mars. AI has also been used to analyse astronomical data, for example to identify exoplanets.

Gosh Bridget you seem to be suggesting the whole AI breakthrough thing has been hyped up a bit.

There has been iterative development in AI for more than two decades now.

So there go folks – AI is in space and will very continue to be so for perpetuity, we may just rebrand it a few times so that it keeps looking like it's something new.

Question 2:

Dear Cheap Astronomy – What will space warfare look like?

We've previously discussed on this podcast that fighting a war from space is probably a bad idea. You might conceivably drop a bomb from orbit, but once you've identified yourself as an enemy it's pretty easy to take you out from the ground. You may be able to dodge a few missiles at the start, but once you're out of maneuvering fuel you'll be stuck in a straight-line orbit and hence a sitting duck.

Ship to ship warfare in space also seems a bit impractical. In orbit, if you make an aggressive move towards another ship, it would see you coming long before you were in firing range and it would probably be easier to let ground forces take you out rather than bothering to engage you itself. You could try a Star Trek *We Are One Big Happy Fleet* attack – but that only really works once and ground forces will take you out shortly afterwards anyway. There's all kinds of robot attacks to imagine, where being taken out by ground forces afterwards might be less of an issue – but there's really no practical difference between that and just firing a missile from the ground.

Once you are far away from Earth that ground forces become less relevant – you are then in the utter vastness of space. We can imagine that long-term there might be space lanes that are used by purpose-built passenger and cargo craft and there will be additional armed and more maneuverable spacecraft whose purpose it will be to defend such vessels. On top of that would be pirates and other aggressor spacecraft – essentially the bad guys.

But whether such scenarios will really happen comes down to economics. What makes space travel different from ocean travel is that in space all you have to do is get up to speed, after which you will maintain that speed indefinitely in a vacuum. In ocean travel you have to keep expending fuel just to maintain a constant speed and pushing against resisting ocean and air means smaller streamlined craft are faster and more maneuverable than large lumbering cargo ships.

In space travel you expend most of your fuel at the start and then coast the distance you have to travel with just enough leftover fuel for a few maneuvers at the other end. So, if a pirate wants to chase down such a ship it's going to have to deal with the rocket equation – meaning it will have to carry more maneuvering fuel and if it's carrying more maneuvering fuel, it will have to carry more fuel to maneuver that maneuvering fuel and so on. So, in space, rather than a big cargo ship being overtaken smaller, faster attack vessels, the attack spacecraft will have to be bigger than the spacecraft they are attacking. Cost-benefit wise that arrangement may just not work for pirates, if they have to invest more than they can ever hope to plunder.

Any weaponry attached to spacecraft will mostly likely be for close range attack and defence. While missiles are effective long range remote weapons, they are a lot of mass to carry on board, particularly if you rarely use them, so it probably makes more sense to launch missiles from ground-based or orbiting installations, where maintenance and upgrades are easy to manage. On that basis it would make more sense for spacecraft to invest in short range defence and attack weaponry – which as defence could also be used to take out missiles, since if you're in space you are going to see them coming way ahead of impact and have ample time to prepare. In the unlikely event you ever do have a close-range sortie with another space craft. Lasers and other energy beam weapons could be effective to burn out peripheral infrastructure like heat radiators and solar panels, but they're only really effective up close, since their energy declines fairly quickly over distance. So, for anything more than peripheral surface damage, what you need is good old guns and bullets to achieve any kind of armour piercing effect. Who knows though, perhaps we'll be too busy exploring the vast wonders of the Universe to worry about old territorial squabbles – nah, just kidding.