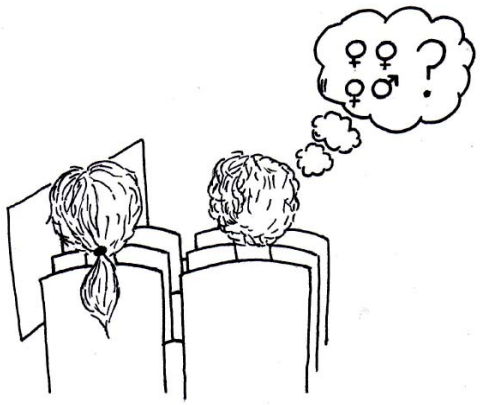
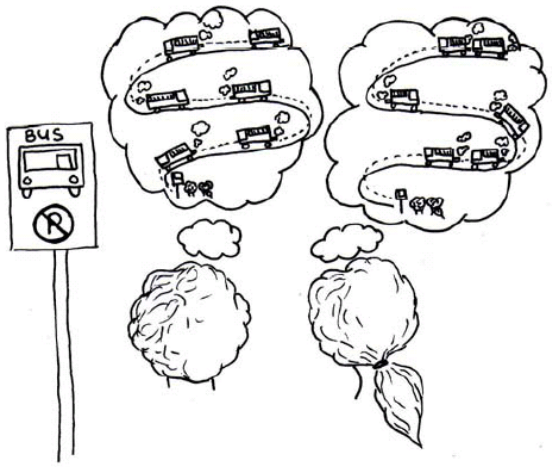
My friend and I catch a bus…

…on the way to the movies I spot an old school mate I haven't seen in years – he tells me he now has two kids. "Any daughters?" I ask "Yes," he says, as he steps off the bus. Hmm, I wonder if both his kids are girls? I guess it's 50/50 – all I know is that one of the kids is a girl, there's an even chance the other one is too. My friend is not impressed; "It's one chance in three," she says.[1]



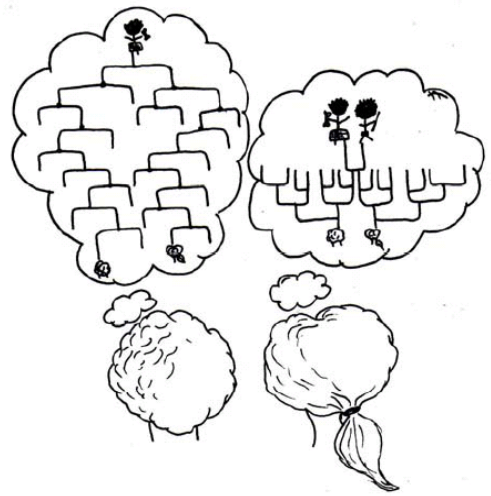
We get off the bus and go to the movies. Afterwards we go to catch a bus home. There's no timetable, but a guy tells us the buses arrive randomly, and the average time between them is twenty minutes. Fine, but how long should we expect to wait? Well, we could have arrived near the start, middle or near the end of that 'average' twenty minutes, so let's say it balances out at ten minutes. My friend says it's closer to twenty. After twenty minutes I decide she might be right…[2]



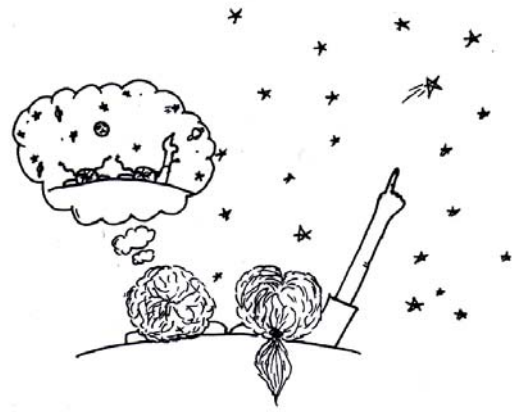
[1] Three quarters of all fathers with two children have at least one girl, and one quarter have two girls. So amongst those fathers that have two children of which at least one is a girl, the proportion that have two girls is ¼ divided by ¾, which is one third.

*[2] The average time between arrivals is 20 minutes, but if they arrive randomly you're more likely to arrive at the bus stop during a long gap between buses (e.g. 30 mins) than a during a short one (e.g. 5 mins) so your expected wait will be more than 10 minutes. Under a simple 'exponential' model for random arrival times the expected wait is **exactly** 20 minutes.*

To kill time, we discuss how we might be related - we're from different parts of the planet, and different races, so it's not easy. "But we must have had a common ancestor at some time in the past" I say. "Yep, there was probably someone in 300BC that was a great-great-… grandparent to you and me – and to virtually everyone alive today", she replies. "How do you know that?" I ask. "Because around 3000BC, everyone alive back then either has no descendants alive today, or almost everyone is their descendant." Huh?[3]



The bus still hasn't arrived, it's dark, and I gaze up at the stars. "You know the universe must be teeming with other beings who are also staring right now into space", I tell my friend. "How come?" she asks. "Well we evolved here, and there are a zillion planets probably just like ours so there must be plenty that also have beings like us". "Nah", she replies, "we're probably all alone"[4].



Text: Mike Steel

Illustration: Emma Steel

[3] Joseph Chang (Yale) and colleagues discovered this – not with genetics or studying detailed family records – but by clever use of probability. They studied how ancestries get entwined as you go back in time from child to parents, grandparents etc. Before long there will be an ancestor of nearly everyone. And around twice as many generations earlier than this a miracle happens – it's highly probable that each person alive back then either has no survivors today, or almost everyone today can claim that person as an ancestor. These findings, based on rough estimates of population sizes around the planet and their inter-connectedness in the past, were published in the journal ***Nature*** *in 2004.*

[4] If p is the probability that intelligent life evolved on any given earth-like planet then we might assume that p can't be very tiny since life ***did*** *evolve here. Yet which of the N = zillions of actual earth-like planets we happen to find ourselves on to be asking this question is irrelevant - all that we can claim evidence for is that Np isn't too small – for instance it might equal 1. If so, the probability of intelligent life elsewhere in the Universe is the conditional Poisson probability:* $(1-e^{-Np}-(Np)\cdot e^{-Np})/(1-e^{-Np})$. *That's 42 per cent. Maybe Douglas Adams was onto something…*