feather-like structures has tended to ignore pterosaurs. Instead it has focused on non-avian dinosaurs, which couldn't. As a result, the relationship — if any — between pterosaur pycnofibres and dinosaur feathers has been obscure.

No longer. A paper this week in *Nature Ecology and Evolution* shows that some pycnofibres, far from being simple monofilaments, had branching or brush-like structures — just like the feathers found on birds and their closest dinosaur relatives (Z. Yang *et al. Nature Ecol. Evol.* **3**, 24–30; 2019).

The study suggests, therefore, that pycnofibres could share an evolutionary origin with dinosaur and bird feathers. And the common ancestor of birds, dinosaurs and pterosaurs might also have been able to produce such pycnofibre structures.

The study's evidence comes from fossils of two sparrow-sized pterosaurs between 160 million and 165 million years old (a shade earlier than the earliest known bird, *Archaeopteryx*, which is around 150 million years old), from the Jurassic period of China.

The pterosaurs have four distinct kinds of pycnofibre: the regular monofilaments seen in other pterosaurs; a type with a brush at the distal ends; a variety in which brush-like filaments sprout from the middle of the main fibre; and a fourth, in which several fibres meander from a common root. Structures corresponding to all four types of pycnofibre have been found associated with various dinosaurs, underlining the case that pterosaurs are indeed related to dinosaurs.

Importantly, each kind of fibre is not distributed randomly on the bodies of the two pterosaurs. The simple monofilament form is found all over the body; the brush-like form on particular regions of the head, limbs and tail; and the curious form with sprouting filaments is restricted to the head. The fourth form, which closely resembles the down of bird chicks, is found on the wing membranes.

This distinct distribution indicates that each type had a biological function, and that one kind of filament was not simply the decayed product of another.

What were these functions? Pycnofibres of the first and second type might have provided insulation and streamlined the body shape to minimize aerodynamic drag, as feathers do in birds and fur does in bats. The sprouting type on the head might have functioned similarly to the sensory bristles found on the heads of modern birds. The downy, fourth kind of fibre might have helped to keep the wings warm, as it's known that feathers with this structure are much more efficient at trapping warm air than is mammalian hair.

"For the first time, we can visualize pterosaurs with a touch of colour."

Moreover, the pycnofibres contain remnants of melanosomes — organelles that are typically found in feathers, feather-like structures and mammalian hairs, and that help to lend these structures their distinctive colours. When applied to the pterosaur fuzz, a technique called Fourier-transform infrared spectroscopy produces the same spectra as those found in birds both ancient and modern, as well as red (but not black) human hair.

For the first time, we can visualize pterosaurs with a touch of colour, as we can fossil birds, dinosaurs and even dinosaur eggs. Flying alongside the earliest birds and even some very early flying mammals, pterosaurs must have made the skies of the Mesozoic Era a riot of life and colour. ■

Computer games

Classical and quantum machines are battling for computational superiority.

Will 2019 be the year when quantum computers show they have the right stuff? Google says so — one of the company's labs, in Santa Barbara, California, has promised that its state-of-the-art quantum chip will be the first to perform calculations beyond even the best existing supercomputers.

And Google isn't alone. A number of other companies, big and small, are working steadily towards the same symbolic goal. Venture capitalists have poured money into dozens of quantum-computing start-up companies. Excitement and anticipation are mounting.

In a stark reminder of the power of quantum computing, in May, two theoretical computer scientists solved a 25-year-old conjecture (go.nature.com/2eatyco). They confirmed that quantum computers are — in an admittedly abstract setting — vastly more efficient than classical ones at particularly complex tasks, such as testing whether a set of numbers is random.

Still, such work does not justify the expectations that now surround quantum computing. A recent report by the US National Academies of Sciences, Engineering, and Medicine (penned by leading Google and Microsoft researchers, among others) stressed the technical hurdles that lie in the way of building practically useful quantum computers. Creating such machines will take at least a decade, the report says.

Theoretical physicist Seth Lloyd at the Massachusetts Institute of Technology in Cambridge speaks for many when he says the field is in a period of explosive progress — but that the hype is also getting out of control. "The whole quantum-computing field is just going hogwild right now," he says.

Is a quantum computer even needed? High-profile work by an 18-year-old computer scientist earlier this year suggests not, at least for one specific task. Ewin Tang effectively taught an old computer a new trick — one that was previously thought to need a quantum system.

She developed an extremely efficient classical algorithm — that is, one that can run on an ordinary computer — for 'recommendation systems', such as those that certain websites use to try to guess a consumer's tastes (E. Tang Preprint at https://arxiv.org/abs/1807.04271; 2018). Her work produced a much faster version than current, relatively sluggish systems. Tang's algorithm is not necessarily practical to use, so it won't replace current algorithms unless it is substantially improved — in its current form, it would be useful only with data sets of truly gigantic proportions. But a quantum algorithm that was in development for that same task has now been rendered moot, before it ever had a chance to run on an actual machine.

Last month, Tang, who is now at the University of Washington in Seattle, doubled down. She and two colleagues demolished the quantum advantage of another type of algorithm for certain machine-learning tasks (A. Gilyén *et al.* Preprint at https://arxiv.org/abs/1811.04909; 2018). A different team at the University of Texas in Austin reached the same conclusion independently (N.-H. Chia *et al.* Preprint at https://arxiv.org/abs/1811.04852; 2018). Computer scientists responded to the news with memes that, for example, compared Tang to a gladiator slaughtering the hopes and dreams of the quantum community. And it was a bittersweet moment for Tang's co-author, Seth Lloyd — he wrote the quantum algorithm that was trounced.

Some in the field argue that these uses of classical computing are actually successes for quantum computing, because they show how the quantum way of thinking can have an impact, even before quantum computers exist. Specialists also point to problems for which quantum computers have long been known to have a proven advantage, such as web searches. In other cases — such as factoring large integers into primes or simulating the electronic properties of materials — scientists think that quantum computers are still likely to have an advantage, although this has not yet been demonstrated mathematically.

Quantum computers are a not-yet-existent technology in search of problems to solve. Meanwhile, researchers are seeing how far classical strategies can be taken. Both are valid research avenues. A quantum device remains a laudable goal. But it's not the only route to the future. ■