Part 1A: Select your topic
Quantum Physics

Part 1B: Outline the current state of your topical area
The leading edge topics in quantum physics are numerous and diverse. Some of the most notable are quantum computing and the development of a theory of quantum gravity.

Quantum Computing - The key problems to overcome in this field are error correction and scaling. Error correction is required because the qubits—the information carriers of a quantum computer—are notoriously difficult to measure and stabilize due to their probabilistic nature. The problem of scaling is prevalent because we cannot do anything practical with our quantum computers with the number of qubits we're using now—the largest of them, Google's Bristlecone, has only 72 qubits. Improvements to error correction are required if we want to scale up, as more qubits means more error propagation through the system.

Quantum Gravity - The theories of quantum gravity are interesting because, if one is accepted, it would mean that we could create a Theory of Everything—all the fields of physics would be unified under a single base of equations. There are serious scientific barriers to this. For example, one proposed unifier, string theory, is solvable, but only in spaces with more dimensions than our own. In addition, this field has little conceived commercial value at this time, so funding is a problem.

In the next 10 to 20 years, quantum computing will likely resolve some of its error correction issues and move on to larger systems capable of performing optimization and simulation on scales that can supplement our ubiquitous classical computers to perform useful tasks much faster and more efficiently than ever before. Quantum gravity will likely see expansions on the theorems currently under study, though a unified theory will most likely not yet be discovered.

Part 1C: Map the collaborations and camps within your topical area
• Map the intellectual camps within your area of expertise. What are the

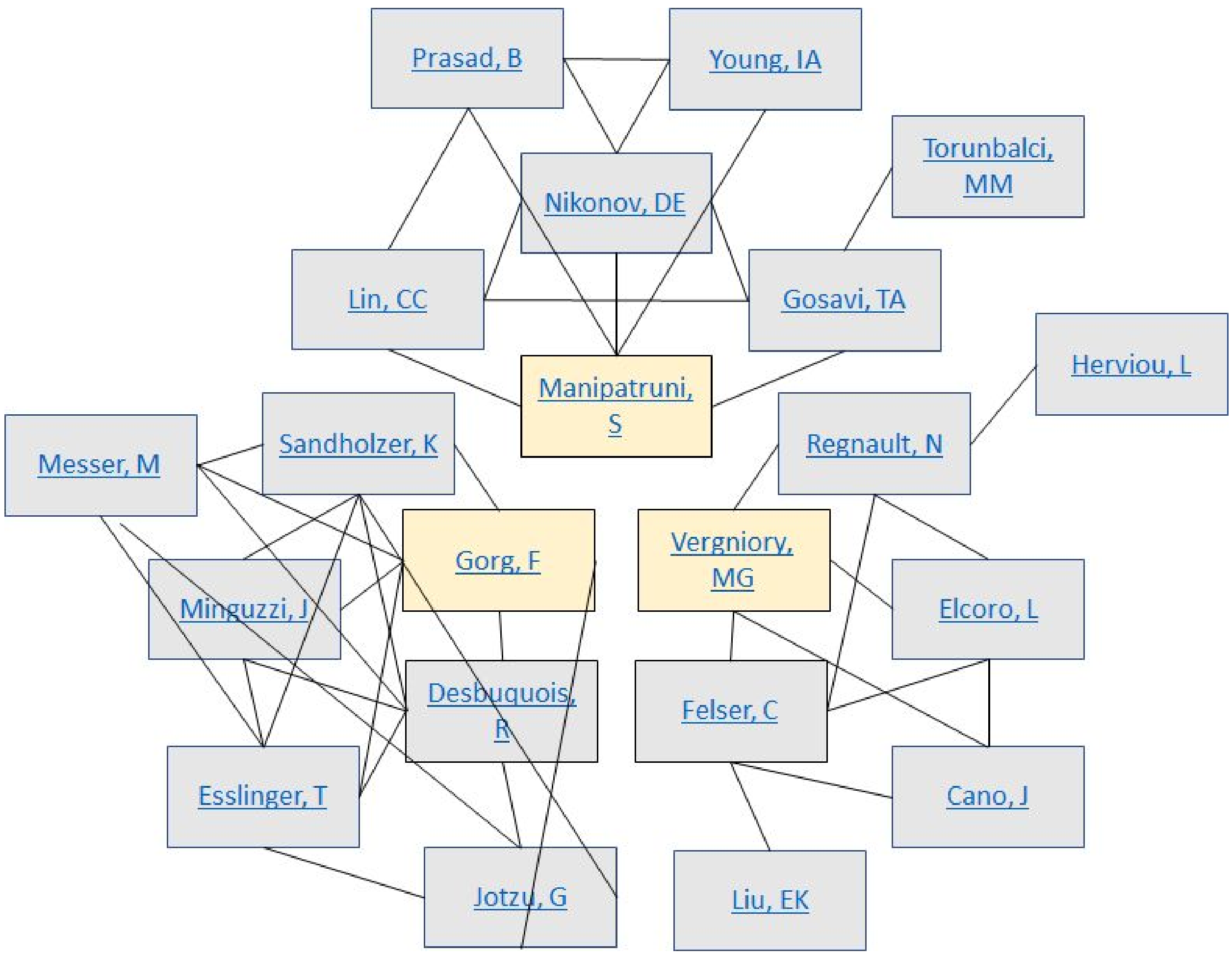
dominant ideas within your topical area, and who bears the flag for each?

Quantum Physics is a broad area of expertise, so I chose to narrow my field of search to Quantum Computing. I used this field of search in Web of Science, narrowing it to the Hot Papers of this year and last year. This classification is defined as those papers which received enough citations in the November and December of last year—positioning them in the top 0.1 percent of papers in their field. I then sorted by Relevance, and took the first author of each of the top three papers to be one of the three top researchers and developers in the field of quantum computing.

Top three researchers/developers: Manipatruni, Sasikanth (Manipatruni, S); Goerg, Frederik (Gorg, F); Vergniory, M.G. (Vergniory, MG)

To construct a collaboration map, I first inserted the names of my selected three most prominent researchers/developers in the field of quantum computing; then connected them each to the three next-most prominent researchers in the Hot Paper I used to select them in the first place. I then found each of the newly added researchers and connected them to the most prominent researcher in their next-most cited paper (after their shared Hot Paper) since 2018.

Collaboration Map:



According to this map (though its methods are limited) most of those I categorized as top researchers in the field of quantum computing are entrenched in their own scientific sub-communities—collaborating fairly often with others in them—but are unlikely to branch out to other such sub-communities. This can be attributed to the nature of their field—quantum computing is seeing an explosion of new research and interest as of late. As such, various researchers are going in very different directions, and the three categorized the top researchers in the manner I used above just so happen to be working in different directions, and thus lack shared collaborators or papers with shared authorship.

As for different camps, one of the primary subjects of contention at this point in quantum computing research is how to build a useful quantum computer. Most of this comes down to finding the right kind of qubit for the job. There are many camps, including the original formulation for qubits, topological qubits, and the newly realized silicon qubits. The Sycamore processor at Google used the original qubit type, and the advantage in using those so far is that they have been created, and used successfully to demonstrate quantum supremacy by a team led by Dr. John Martinis.

The topological qubit, undergoing development in Microsoft's Station Q, is a more stable qubit, theoretically more error-resistant than its predecessor. This project, led by Dr. Michael Manfra, is at a disadvantage in that the topological qubit has not been finished, at least not officially. The silicon qubit has thus far proven more unstable than the original qubit type, but its material means that if it is created the cost to build a quantum computer will go down drastically. Silicon is a fair amount cheaper than the other materials being used to make qubits at this time. This approach doesn't have quite the momentum of others at the moment, and is being pursued by a variety of researchers without a clear leader yet apparent.