Key points from Lecture 11 of ASTR 350

1. Pulsars were discovered in 1967 and the community rapidly realized that these can only be rotating neutron stars.
2. Pulsars are known with spin periods from a bit over a millisecond to (possibly) days.
3. Neutron stars are born in the death of massive stars, i.e., in core-collapse supernovae. More specifically, the cores of massive stars (birth mass above 8 times the mass of the Sun) collapse and form either neutron stars or black holes.
4. Neutron stars have extraordinarily large magnetic fields: from $\sim 10^8$ times Earth's to possibly $\sim 10^{16}$ time's Earths. Atoms are strongly distorted in such fields, which are the strongest known fields in astronomy.
5. Neutron stars are, by astronomical standards, small and dense. At ~ 1.5 times the mass of the Sun, the radius is probably around ~ 12 km. The radius is tough to measure, but NASA's NICER mission has done a great job (and, ahem, I lead one of the two groups within NICER to make such estimates...). Because the matter in neutron star cores can't be created in laboratories, the study and measurement of neutron stars provides a key look at an exotic realm of physics.
6. Neutron stars need to be described using general relativity. They are the second-most compact objects in the universe, after black holes, and they warp spacetime and deflect light rays very strongly.
7. Over the population of neutron stars we see all bands of the electromagnetic spectrum, from radio to gamma rays, although most individual neutron stars aren't seen in all of them. Gravitational waves have also been seen from a merging neutron star binary.
8. Neutron stars can be powered by rotation, accretion, residual heat, magnetic fields, and nuclear reactions.