The Large Area Telescope (LAT) on board the Fermi Gamma-ray Space Telescope, has now been continuously surveying the high-energy (>100 MeV) gamma-ray sky for over 3 years. Amongst the large number of LAT detected sources, several first new examples of different types of Gamma-ray binary systems in our Galaxy have been revealed. One new member of this diverse Gamma-ray binary population is the detection of a nova -- a thermonuclear explosion on a white dwarf surface fueled by mass accreted from a companion star -- a source type previously unexpected as a high-energy gamma-ray emitter. Other Gamma-ray binary discoveries, containing either a neutron star or black hole, have been revealed through discoveries of orbital modulation in their gamma-ray, X-ray, optical, and/or radio emissions. The systematic studies leading to these discoveries, along with a discussion of the future prospects for identifying the increasing population of unidentified gamma-ray sources, will be presented.