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Physical Analytics: An emerging field with real-world applications and impact

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In the past most information on the internet has been originated by humans or computers. However with the emergence of cyber-physical systems, vast amount of data is now being created by sensors from devices, machines etc digitizing the physical world. While cyber-physical systems are subject to active research around the world, the vast amount of actual data generated from the physical world has attracted so far little attention from the engineering and physics community. In this presentation we use examples to highlight the opportunities in this new subject of "Physical Analytics" for highly inter-disciplinary research (including physics, engineering and computer science), which aims understanding real-world physical systems by leveraging cyber-physical technologies. More specifically, the convergence of the physical world with the digital domain allows applying physical principles to everyday problems in a much more effective and informed way than what was possible in the past. Very much like traditional applied physics and engineering has made enormous advances and changed our lives by making detailed measurements to understand the physics of an engineered device, we can now apply the same rigor and principles to understand large-scale physical systems. In the talk we first present a set of "configurable" enabling technologies for Physical Analytics including ultralow power sensing and communication technologies, physical big data management technologies, numerical modeling for physical systems, machine learning based physical model blending, and physical analytics based automation and control. Then we discuss in detail several concrete applications of Physical Analytics ranging from energy management in buildings and data centers, environmental sensing and controls, precision agriculture to renewable energy forecasting and management.