Getting Inside Your Head

A mind is not only a terrible thing to waste but also an extremely difficult thing to understand. New imaging techniques that rely on vectors, generalizations of vectors (known as tensors), and matrices provide much more information about communication pathways in the brain than earlier methods did. This gives doctors the ability to better diagnose many diseases and disorders—including Alzheimer's and stroke—as well as concussions. Standard imaging techniques gather only one dimension of information, but vectors and matrices can represent the three-dimensional movement of molecules in the brain, which makes it possible to see the routes taken by communication signals.

In addition to aiding diagnosis, the new imaging methods are allowing a better understanding of the overall structure of the brain's communication pathways. Researchers had expected to see a tangled mess but instead used partial differential equations and differential geometry to discover that the fiber pathways have a very precise structure organized along three specific, but curved, directions. Furthermore, and potentially even more surprising, each of the directions corresponds with a direction of brain development.

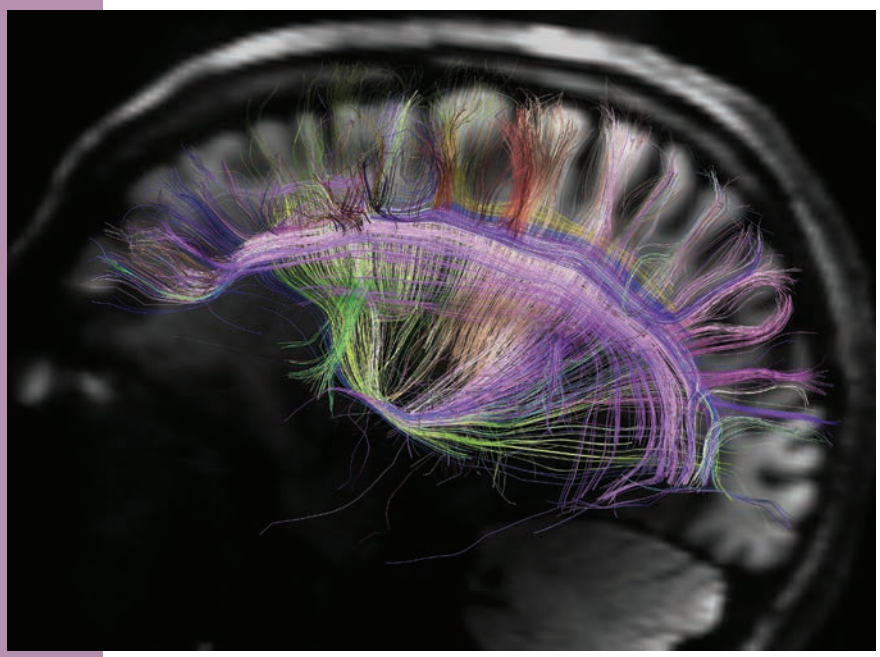

Image: L.L. Wald and V.J. Wedeen, Martinos Center for Biomedical Imaging and the Human Connectome Project.

For More Information:
"Diffusion Tensor Imaging: A New View of the Brain," Dana Mackenzie, *Fueling Innovation and Discovery: The Mathematical Sciences in the 21st Century*, 2012.

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