Statistical Inception for the MCMC Dream:

The *kick* is in the residual (augmentation)!

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The development of MCMC algorithms via data augmentation (DA) or equivalently auxiliary variables has some resemblance to the theme plot of the recent Hollywood hit *Inception*. We MCMC designers all share essentially the same ``3S" dream, that is, to create algorithms that are simple, stable, and speedy. Within that grand dream, however, we have created a rather complex web of tools, with some of them producing very similar algorithms but for unclear reasons, or others that were thought to be of different origins but actually are layered when viewed from a suitable distance. These include *conditional augmentation, marginal augmentation, PX-DA, partially non-centering parameterization, sandwiched algorithms, interweaving strategies, ASIS*, etc. It turns out that there is a simple statistical insight that can unify essentially all these methods conceptually, and it also provides practical guidelines for their DA constructions. It is the simple concept of regression residuals, which are constructed to be orthogonal to the regression functions. All these methods in one form or another effectively build a *residual augmentation*. Given a DA distribution f(T, A), where T is our targeted variable (i.e., f(T) is our targeted distribution) and A is the augmented variable, there are two broad classes of residuals depending on whether we regress T on A or A on T. In this talk we will demonstrate how methods like conditional augmentation and partially non-centering parameterization build their residual augmentations by regressing A on T, whereas methods such as marginal augmentation and ASIS effectively use residual augmentations from regressing T on A. For either class, the attempted orthogonality helps to reduce the dependence among MCMC draws, and when the orthogonality leads to true independence as occurring in some special cases, we reach the dream of producing i.i.d. draws. (The talk is based on *JCGS*' 20th Anniversary Featured Discussion, Yu and Meng (2011); limited-time free download available at http://pubs.amstat.org/toc/jcgs/20/3 .)