We compare three methods used in stochastic geometry in order to investigate asymptotic behaviour of random geometrical structures in large domains or in a large intensity regime. Namely, we describe in detail the Malliavin–Stein method, the method of stabilization and the method of cumulants. Then, we discuss some of its possible variants, combinations or extensions. Each method is supplemented with numerous examples concerning limit behaviour of different kinds of point processes, random tessellations and graphs or particle processes. Specially, for a geometric characteristic of the typical cell in a weighted Voronoi tessellation, we use the minus-sampling technique to construct an unbiased estimator of the average value of this characteristic and using the method of stabilization, we establish variance asymptotic and the asymptotic normality of such estimator. Next, we study asymptotic properties of a cylinder process in the plane derived by a Brillinger-type mixing point process. We prove a weak law of large numbers as well as a formula of the asymptotic variance for the area of the process. Under comparatively stronger assumptions, we also derive a central limit theorem for the cylinder process using the method of cumulants.