

Appendix C:

Important Mathematical Definitions

Convolution. The convolution $f(x, y) = g(x, y) * h(x, y)$ of two 2-dimensional functions $g(x, y)$ and $h(x, y)$ is defined as:

$$f(x, y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} g(u, v) h(x - u, y - v) du dv$$

Correlation. The cross-correlation function $c(x, y) = g(x, y) \star h(x, y)$ of two 2-dimensional functions $g(x, y)$ and $h(x, y)$ is defined as:

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$$c(x, y) = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} g^*(u, v) h(x + u, y + v) du dv$$

Corresponding relations. Relation of correlation $c(x, y)$ and convolution $*$:

$$c(x, y) = g^*(x, y) * h(-x, -y).$$

If F denotes Fourier transform, and G and H denote Fourier-transformations of g and h , then:

$$\int_{-\infty}^{\infty} \int_{-\infty}^{\infty} |g(x, y)|^2 dx dy = \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} |G(k_x, k_y)|^2 dk_x dk_y \quad (\text{Plancherel or Rayleigh theorem}),$$

$$F[g(x, y) \star g(x, y)] = |G(k_x, k_y)|^2 \quad (\text{Wiener-Khinchin theorem}),$$

$$F[g(x, y) * h(x, y)] = G(k_x, k_y) H(k_x, k_y) \quad (\text{See also MacLennan, 1990.})$$

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