Index

1/f noise, 59
1/f process, 30–32
   Barnes-Allan model, 37, 42
correlation function, 45
Corsini-Saletti synthesis, 46
Cramér-Rao bounds, 69
distribution of time-constants model, 43
definition, 41
examples, 33
fractal dimension, 33
fractal dimension estimation, 64
frequency-domain characterization, 41
Karhunen-Loève-type expansions, 46, 50
Keshner model, 44
mathematical definition, 41
maximum likelihood parameter estimation, 63
measured power spectra, 32
parameter estimation, 120
pole-zero behavior, 45
RC transmission line model, 44
sample paths, 32
smoothing (noise reduction), 72
spectrum, 41
spectrum estimation, 64
state variables, 45
synthesis filter, 62
Van der Ziel model, 43
wavelet coefficient correlation, 50–51
wavelet coefficient stationarity properties, 50
wavelet coefficient variances, 51
wavelet coefficients, ideal band-pass basis, 52
wavelet-based analysis, 50
wavelet-based models, 46
wavelet-based synthesis, 47
wavelet-based synthesis, regularity issues, 49
whitening filter, 61–62

A
autoregressive moving-average (ARMA) models, 35, 43

B
bandpass filter
   ideal, continuous-time, 11
Barnes-Allan process, 37, 42, 45
bihomogeneous signal, 95
Index

Brownian motion, 31, 36, 38

C
characteristic sequence, 108
synthesis, 110
communication channel models, 113
conjugate quadrature filter (CQF), 25–27

D
differentiation in scale, 135
discrete wavelet transform, 21
analysis algorithm, 22
complexity, 22
data length and resolution effects, 23
synthesis algorithm, 22

E
Euler-Cauchy equations, 136

F
filter bank
octave band, 13
Fourier transform
definition, continuous-time, 10
definition, discrete-time, 21
fractal dimension, 33
estimation, 64
estimator performance, 71
estimator performance bounds, 69
fractal modulation
analog data, 124
choice of fractal dimension, 118
digital data, 121
discrete-time implementation, 117, 122–124
finite-length messages, 118
performance, 122, 126
power efficiency, 123
receiver, 120
requirements, 114
spectral efficiency, 116
spectral matching, 120
transmitter, 115
fractional Brownian motion, 30, 36
correlation function, 38
definition, 38
derivative, 39
increments, 38
limitations, 40
self-similarity parameter, 38
synthesis, 39, 139
uniqueness, 40
variance, 40
fractional calculus, 45
fractional Gaussian noise, 36
correlation structure, 39

G
generating sequence, 99

H
highpass filter
ideal, discrete-time, 22
homogeneous signal, 95
bihomogeneous signal, 95
characteristic sequence, 108
discrete-time, 109
energy-dominated, 96, 97
equivalence class, 98
examples, 97, 105
Fourier transform, 97, 103
fractal dimension, 104
generating sequence, 99
Hilbert space, 100
input to LTI($\lambda$) system, 138
periodicity-dominated, 107, 118
power spectrum, 103–105
power-dominated, 96, 103
randomly-generated, 105
regularity, 104
time-frequency portrait, 107
wavelet expansion, 98

I
infrared catastrophe, 35
iterated function system, 110
J
Johnson noise, 60

L
Laplace transform, 130–132
linear scale-invariant system, 132
convolution property, 133
eigenfunctions, 133
generalized class, 136
lagged-impulse response, 132
system function, 134
linear system, 131
linear time- and scale-invariant system, 137
dyadic approximation, 143
wavelet representation, 140
linear time-invariant system, 131
impulse response, 131
long-term dependence, 39
Lorenzian spectra, 43
lowpass filter
  ideal, continuous-time, 19
  ideal, discrete-time, 22

M
Mellin transform, 130, 134
inverse formula, 134
multiresolution signal analysis, 16
characterization, 17
detail signal, 20
perfectly bandlimited, 19

N
nearly-1/f process
  spectrum, 47
  wavelet-based synthesis, 47
nearly-1/f processes, 30, 43

P
Poisson formula, 12

R
regularity, 12

S
scale-differential equations, 135
scaling function, 18
  ideal lowpass, 19
self-similar basis, 96, 99
  example, 101
self-similar system, 130
shot noise, 60
spectral efficiency, 114
stable distributions, 35
statistical self-similarity, 31

T
thermal noise, 60
time-frequency analysis, 14

U
ultraviolet catastrophe, 35

W
wavelet
  basic, 11
  basic (or “mother”), 20
  Battle-Lemarie, 27
  Daubechies, 27
  father, 18
  frame, 10
  Haar, 26
  ideal bandpass, 11, 13, 15, 20, 26, 28
  mother, 11
  scaling function, 18
wavelet bases, 9
  Battle-Lemarie, 27
construction of, 25
dyadic, 11
example lacking multiresolution analysis, 12
examples, 26
  filter bank interpretation, 13
  multiresolution analysis interpretation, 16
  nondyadic, 27
  orthonormal, 11
synthesis/analysis equations, 11
useful identity, 15
vanishing moments, 26–27
wavelet, 11
wavelet-based modeling
  Dow Jones Industrial Average, 54
  heartbeat interarrival data, 55
white Gaussian noise, 31, 35
Wiener process, 31, 35, 38