**Variability in response to piecewise-constant inputs with arbitrarily (random and deterministic) distributed amplitudes**

**Reference set (for each parameter set):** Response to a piecewise constant input with increasing amplitudes with the same size-step. They are calculated from a randomly distributed sample of amplitudes by using the first and last amplitudes of this set and computed the intermediate amplitudes (constant step-size).

**Code:** Response\_LinearWhiteNoiseInputs.m

PeaksOsc.m

TroughsOsc

**Parameter Sets**:

**Parameter Set XX=01 (node)**

C = 1;

gL = 0.25;

g1 = 0.25;

tau1 = 100;

taumrse = 3.5

**Parameter Set XX=02 (focus)**

C = 1;

gL = 0.05;

g1 = 0.3;

tau1 = 100;

taumrse = 8.5

**Parameter Set XX=03 (passive)**

C = 1;

gL = 0.25;

g1 = 0;

% tau1 = 100;

taumrse = 4

**Parameter Set XX=04 (passive)**

C = 1;

gL = 0.05;

g1 = 0;

% tau1 = 100;

taumrse = 19.9

**Parameter Set XX=05 (node)**

C = 1;

gL = 0.1;

g1 = 0.2;

tau1 = 100;

taumrse = 6.8

fnat = 0

fres = 7

**Parameter Set XX=06 (focus)**

C = 1;

gL = 0.1;

g1 = 0.8;

tau1 = 100;

Tdur = 5

taumrse = 4.8

fnat = 12.3

fres = 14

**Parameter Set XX=07 (passive)**

C = 1;

gL = 0.1;

g1 = 0;

tau1 = 100;

taumrse = 10

fnat = 0

fres = 0

**Parameter Set XX=08 (node)**

C = 1;

gL = 0.1;

g1 = 0.1;

tau1 = 100;

fnat = 0

fres = 6

**Parameter Set XX=09 (node)**

C = 1;

gL = 0.2;

g1 = 0.1;

tau1 = 100;

fnat = 0

fres = 6

**Parameter Set XX=10 (focus)**

C = 1;

gL = 0.1;

g1 = 5;

tau1 = 100;

Tdur = 5

fnat = 34.8

fres = 35

**Parameter Set XX=11 (focus)**

C = 1;

gL = 0.1;

g1 = 5;

tau1 = 100;

fnat = 32.2

fres = 35

**Parameter Set XX=12 (focus)**

C = 1;

gL = 0.1;

g1 = 5;

tau1 = 100;

fnat = 0

fres = 0

**Parameter Set XX=13 (focus)**

C = 1;

gL = 0.2;

g1 = 5;

tau1 = 100;

fnat = 0

fres = 0

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**Parameter Set XX=14**

C = 1;

gL = 0.1;

g1 = 0;

tau1 = 100;

**Parameter Set XX=15**

C = 1;

gL = 0.1;

g1 = 2.5;

tau1 = 100;

**Parameter Set XX=16**

C = 1;

gL = 0.1;

g1 = 5;

tau1 = 100;

**Parameter Set XX=17**

C = 1;

gL = 0.2;

g1 = 0;

tau1 = 100;

**Parameter Set XX=18**

C = 1;

gL = 0.2;

g1 = 2.5;

tau1 = 100;

**Parameter Set XX=19**

C = 1;

gL = 0.2;

g1 = 5;

tau1 = 100;

**Parameter Set XX=20**

C = 1;

gL = 0.1;

g1 = 2;

tau1 = 100;

**Parameter Set XX=21**

C = 1;

gL = 0.1;

g1 = 2;

tau1 = 50;

**Parameter Set XX=22**

C = 1;

gL = 0.1;

g1 = 2;

tau1 = 25;

**Parameter Set XX=23**

PWL

pwlv=@(v,gL,gc,alpha) v.\*(v<alpha)+(alpha+gc/gL\*(v-alpha)).\*(v>=alpha);

alpha = 0.5;

gc = 0.1;

gL = 0.5;

g1 = 0;

I = 0.5;

**Parameter Set XX=24**

PWL

pwlv=@(v,gL,gc,alpha) v.\*(v<alpha)+(alpha+gc/gL\*(v-alpha)).\*(v>=alpha);

alpha = 100;

gc = 0.1;

gL = 0.5;

g1 = 0;

I = 0.5;

**Parameter Set XX=25**

PWL

pwlv=@(v,gL,gc,alpha) v.\*(v<alpha)+(alpha+gc/gL\*(v-alpha)).\*(v>=alpha);

alpha = 0.5;

gc = 0.1;

gL = 0.5;

g1 = 1;

I = 0.5;

**Parameter Set XX=26**

PWL

pwlv=@(v,gL,gc,alpha) v.\*(v<alpha)+(alpha+gc/gL\*(v-alpha)).\*(v>=alpha);

alpha = 100;

gc = 0.1;

gL = 0.5;

g1 = 1;

I = 0.5;

**Parameter Set XX=27**

Uniformly distributed amplitudes and random order (but not randomly distributed amplitudes)

etamax = 2;

etamin = -2;

etaord = -etamin:4/Npieces:(Npieces-1)\*etamax/Npieces;

C = 1;

gL = 0.1;

g1 = 0;

tau1 = 100;

Tmax = 1000000

ImpPsdVtraceSamplePerm\_pwcwn\_27\_02

Tmax = 10000

ImpPsdVtraceSamplePerm\_pwcwn\_27\_02b

See note after XX=29

Tmax = 1000000

ImpPsdVtraceOrderedUniformPerm\_pwcwn\_27\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedUniformPerm\_pwcwn\_27\_02b.eps

**Parameter Set XX=28**

Uniformly distributed amplitudes and random order (but not randomly distributed amplitudes). Same amplitude difference between adjacent pieces in the ordered input signal.

etamax = 2;

etamin = -2;

etaord = -etamin:4/Npieces:(Npieces-1)\*etamax/Npieces;

C = 1;

gL = 0.1;

g1 = 0.2;

tau1 = 100;

Tmax = 1000000

ImpPsdVtraceSamplePerm\_pwcwn\_28\_02

Tmax = 10000

ImpPsdVtraceSamplePerm\_pwcwn\_28\_02b

See note after XX=29

Tmax = 1000000

ImpPsdVtraceOrderedUniformPerm\_pwcwn\_28\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedUniformPerm\_pwcwn\_28\_02b.eps

**Parameter Set XX=29**

Uniformly distributed amplitudes and random order (but not randomly distributed amplitudes)

etamax = 2;

etamin = -2;

etaord = -etamin:4/Npieces:(Npieces-1)\*etamax/Npieces;

C = 1;

gL = 0.1;

g1 = 1;

tau1 = 100;

Tmax = 1000000

ImpPsdVtraceSamplePerm\_pwcwn\_29\_02

Tmax = 10000

ImpPsdVtraceSamplePerm\_pwcwn\_29\_02b

See note after XX=29

Tmax = 1000000

ImpPsdVtraceOrderedUniformPerm\_pwcwn\_29\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedUniformPerm\_pwcwn\_29\_02b.eps

For some reason, the graphs for ParameterSet\_27, ParameterSet\_28 and ParameterSet\_29 were later found to produce different results for the ordered data, probably due to differences in initial conditions. They were redone.

**Parameter Set XX=30 to XX=32**

Randomly distributed amplitudes and random order. The random distribution of amplitudes mimics a normal distribution (deterministic Gaussian-like amplitudes)

etamax = 2;

etamin = -2;

etaaux = etamin:(etamax etamin)/(Npieces):(Npieces)\*etamax/Npieces;

pd = makedist('Normal','mu',0,'sigma',1.5);

eta\_cdf = cdf(pd,etaaux);

AmpInt = 2\*flip(eta\_cdf(1:Npieces/2));

AmpInt = AmpInt\*(etamax-etamin)/(2\*sum(AmpInt));

eta(1) = etamin;

for j=2:Npieces/2

eta(j) = eta(j-1)+AmpInt(j-1);

end

for j=1:Npieces/2

eta(Npieces/2+j) = -eta(Npieces/2-j+1);

end

etaord = eta;

Ietaord = zeros(1,length(t));

for l=1:length(ton)-1

Ietaord(floor(ton(l)/dt):floor((ton(l)+Tdur)/dt)) = etaord(l);

end

Ietaord(end) = Ietaord(end-1);

v = zeros(1,length(t));

w = zeros(1,length(t));

v(1) = Ietaord(1)/(gL+g1);

w(1) = Ietaord(1)/(gL+g1);

**Parameter Set XX=30**

C = 1;

gL = 0.1;

g1 = 0;

tau1 = 100;

mu = 0

sigma = 1.5

Tmax = 1000000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_30\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_30\_02b.eps

**Parameter Set XX=31**

C = 1;

gL = 0.1;

g1 = 0.2;

tau1 = 100;

mu = 0

sigma = 1.5

Tmax = 1000000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_31\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_31\_02b.eps

**Parameter Set XX=32**

C = 1;

gL = 0.1;

g1 = 1;

tau1 = 100;

mu = 0

sigma = 1.5

Tmax = 1000000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_32\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_32\_02b.eps

**Parameter Set XX=33**

C = 1;

gL = 0.1;

g1 = 0;

tau1 = 100;

mu = 0

sigma = 1

Tmax = 1000000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_33\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_33\_02b.eps

**Parameter Set XX=34**

C = 1;

gL = 0.1;

g1 = 0.2;

tau1 = 100;

mu = 0

sigma = 1

Tmax = 1000000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_34\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_34\_02b.eps

**Parameter Set XX=35**

C = 1;

gL = 0.1;

g1 = 1;

tau1 = 100;

mu = 0

sigma = 1

Tmax = 1000000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_35\_02.eps

Tmax = 10000

ImpPsdVtraceOrderedGaussianlikePerm\_pwcwn\_35\_02b.eps

**Parameter Set XX=36**

PWL

pwlv=@(v,gL,gc,alpha) v.\*(v<alpha)+(alpha+gc/gL\*(v-alpha)).\*(v>=alpha);

alpha = 0.5;

gc = 0.1;

gL = 0.5;

g1 = 1;

tau1 = 10;

I = 0.5;

**Parameter Set XX=37**

PWL

pwlv=@(v,gL,gc,alpha) v.\*(v<alpha)+(alpha+gc/gL\*(v-alpha)).\*(v>=alpha);

alpha = 100;

gc = 0.1;

gL = 0.5;

g1 = 1;

xtau = 10

I = 0.5;

**Parameter Set XX=38**

C = 1;

gL = 0.3;

g1 = 1.3;

tau1 = 60;

Tdur = 1

**Parameter Set XX=39**

C = 1;

gL = 0.2;

g1 = 2;

tau1 = 10;

**Simulation Protocols**

**ZZ\_01:** Tdur=5

**ZZ\_02:** Tdur=1

ZZ\_03: Tdur=25

ZZ\_04: Tdur=50

**Notes.** XX=14 to XX=19: The six sets correspond to the same input sequence (SEQ=02).

DiagramVariability\_pwcwn\_step\_XX.eps

DiagramVariability\_pwcwn\_nostep\_XX.eps

N = 5;

Step: eta\_k = -2, -1, 0, 1 2

NoStep: eta\_k = -2,0,1,-1,2

VtraceSamplePerm\_pwcwn\_XX.eps

VpsdVtraceSamplePerm\_pwcwn\_XX.eps

ImpVtraceSamplePerm\_pwcwn\_XX.eps

PeakTroughs\_Permutations\_pwcwn\_XX.eps

Ntrials = 100;

Delta (Tdur) = 5

N (pieces) = 200 (and 2000 for the PSD)

Ntrials permutations of the same set of values of eta.

Computation of the peak-troughs patterns for each trial.

Computation of the peak-troughs patterns envelope for the Ntrials, the mean and the peak-troughs patterns for the corresponding ordered cell,

VarComparison\_XXYY\_01.eps

VarNormComparison\_XXYY\_01.eps

Comparison of the variance and normalized variance (by the peak of the autonomous response) for the data sets DataVar\_XX\_01.dat/DataVar\_YY\_01.dat and DataVarNorn\_XX\_01.dat/DataVarNorm\_YY\_01.dat using the parameter above and Ntrials=1000

ImpVtraceSample\_OrderedUniformPerm\_pwcwn\_XX\_YY.eps

VpsdVtraceSample\_OrderedUniformPerm\_pwcwn\_XX\_YY.eps

Uniform distribution of PWC input amplitudes

Arbitrary permutation

Tmaxx = 10000;

dt = 0.1;

t = 0:dt:Tmaxx;

Tdur = 5;

Npieces = floor(Tmaxx/Tdur);

ton = 0:Tdur:Tmaxx;

ton(1) = dt;

jon = floor(ton/dt);

etamax = 2;

etamin = -2;

etaord = etamin:4/Npieces:(Npieces-1)\*etamax/Npieces;

etarand = etaord(randperm(length(etaord),length(etaord)));

YY=01 (Tdur=5, Tmaxx=10000)

YY=02 (Tdur=1,Tmaxx = 1000000)

b: Tmaxx = 1000000;