Analysis of the Burgers equation by LSUN

First run TanSacNet/code/setpath

Requirements: MATLAB R2022b

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```
clc, clear
close all
```

Setting the conditions for the Burgers equation

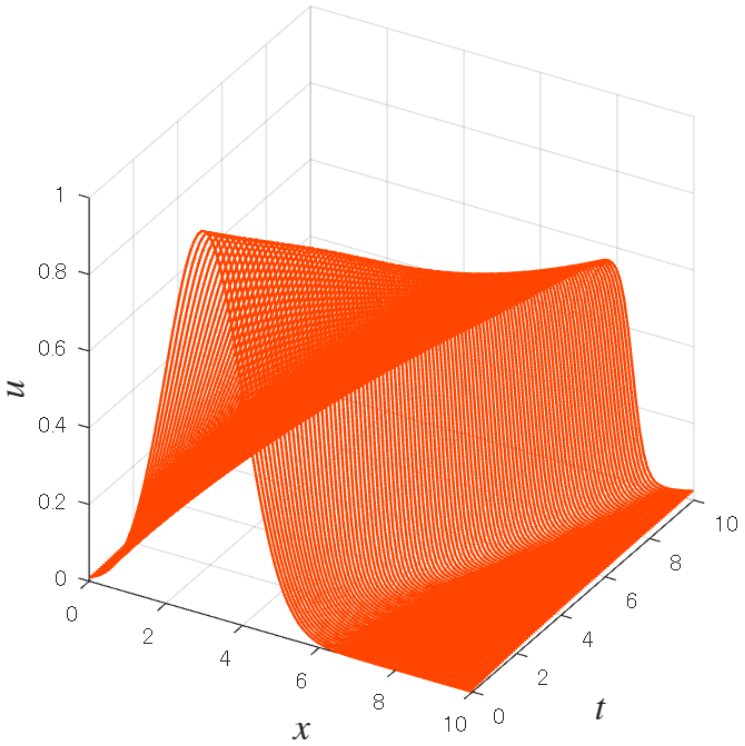
```
mu = 1;                 % advection coefficient (fixed at 1)
nu = 0.05;              % Viscosity coefficient (corresponding to v in the
differential equation)
% Spatial Mesh
L_x = 10;               % Maximum value in space direction
dx = 0.1;
N_x = floor(L_x/dx);    % Total number of meshes in spatial direction
X = linspace(0,L_x,N_x);% Coordinates
% Temporal Mesh
L_t = 10;               % Maximum value in time direction
dt = 0.1;
N_t = floor(L_t/dt);    % Total number of meshes in time direction
T = linspace(0,L_t,N_t);% Coordinates
% Wave number discretization
k = 2*pi*fftfreq(N_x, dx);
% initial condition
u0 = exp(-(X-3).^2/2);
%u0 = np.sin(2*np.pi*X/L_x)
ndim = 100;
```

Data preparation

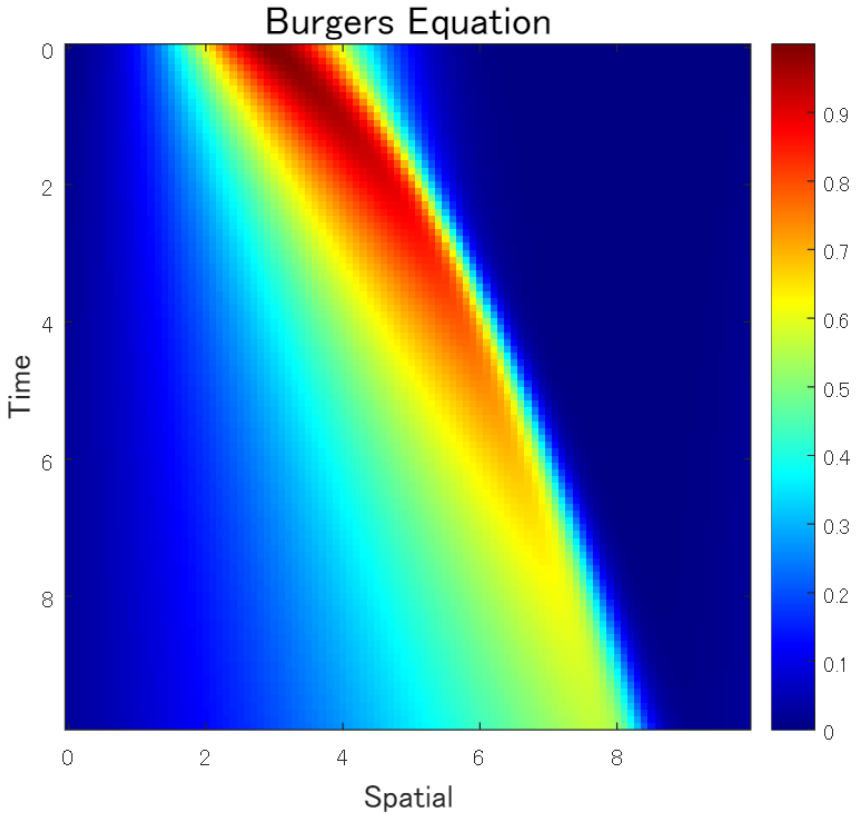
```
%PDE resolution (ODE system resolution)
opt = odeset('MaxStep',5000);
[~,DataT] = ode45(@(t,u) burg_system(u,t,k,mu,nu),T,u0,opt);
```

Data visualisation

```
figure
orangered = [255 69 0]/255;
disp_plot3_(T,X,DataT,orangered)
```




```
figure
disp_imagesc_(T,X,DataT)
```



Configuration

Data size

```
nT = size(DataT,1);
nX = size(DataT,2);
```

Stride (block size)

```
pt = 2;
stride = 2*pt; % Stride (even)
assert(mod(nX,stride)==0,'stride must be a divisor of nX.');
```

Output dimension (per block)

```
nCoefs = 2;
assert(nCoefs<=stride,'nCoefs must be less than or equal to stride.')
```

Number of overlapping blocks (number of shifts)

```
nof = 1;
kx = 2*nof+1; % Number of overlapping blocks (odd)
```

Setting display

```
strbuf = "-- Settings --" + newline;
```

```
strbuf = strbuf.append("Data size (space): " + num2str(nX) + newline);
strbuf = strbuf.append("Data size (time): " + num2str(nT) + newline);
strbuf = strbuf.append("Block size: " + num2str(stride) + newline);
strbuf = strbuf.append("Output dimension (per block): " + num2str(nCoefs) +
newline);
strbuf = strbuf.append("Number of overlapping blocks: " + num2str(kx) + newline);
disp(strbuf)
```

```
-- Settings --
Data size (space): 100
Data size (time): 100
Block size: 4
Output dimension (per block): 2
Number of overlapping blocks: 3
```

One-dimensional locally structured unitary networks (1-D LSUNs)

References.

- Lu Gan and Kai-Kuang Ma, "On simplified order-one factorizations of paraunitary filterbanks," in IEEE Transactions on Signal Processing, vol. 52, no. 3, pp. 674-686, March 2004, doi: 10.1109/TSP.2003.822356.

Original PUFB configuration

Even-channel real coefficient symmetric delay decomposition (Real SDF) configuration [Fig. 7 (b), Gan et al,. IEEE T-SP, 2004]

- Number of channels M = 2m
- r_k = m

Number of stages (k-1) (polyphase order N) set to even 2n, allowing for spatial non-causality

Modified non-causal PUFB

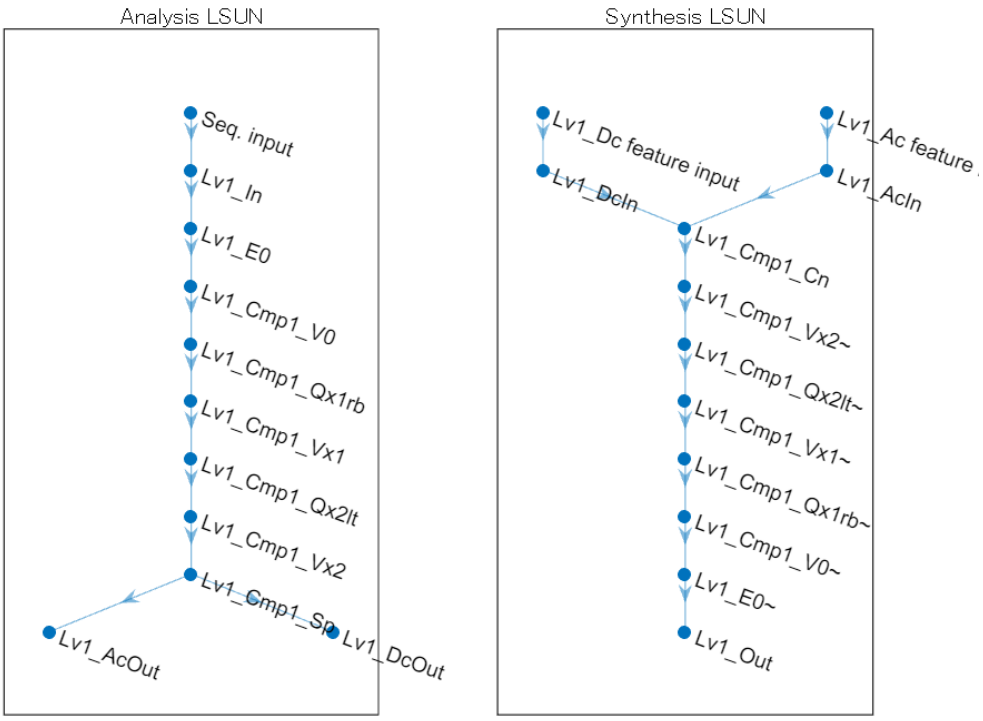
LSUN extension of modified non-causal PUFB

Custom network construction

- Defining custom deep learning layers - MATLAB & Simulink - MathWorks United Kingdom

```
import tansacnet.lsun.*
analysislgraph = fcn_createcslsunlgraph1d([],...
 'InputSize',nX,...
 'Stride',stride,...
 'OverlappingFactor',kx,...
 'Mode','Analyzer');
synthesislgraph = fcn_createcslsunlgraph1d([],...
 'InputSize',nX,...
 'Stride',stride,...
 'OverlappingFactor',kx,...
 'Mode','Synthesizer');
figure
```

```
subplot(1,2,1)
plot(analysislgraph)
title('Analysis LSUN')
subplot(1,2,2)
plot(synthesislgraph)
title('Synthesis LSUN')
```



Initialisation of design parameters

```
% Standard deviation of initial angles
stdInitAng = 1e-9;
% Construction of synthesis network.
analysisnet = dlnetwork(analysislgraph);
% Initialize
nLearnables = height(analysisnet.Learnables);
expanalyzer = '^Lv\d+_Cmp\d+_Q(\w\d|0)+(\w)+$';
nLayers = height(analysislgraph.Layers);
for iLearnable = 1:nLearnables
     if analysisnet.Learnables.Parameter(iLearnable)=="Angles"
         alayerName = analysisnet.Learnables.Layer(iLearnable);
         if ~isempty(regexp(alayerName,expanalyzer,'once'))
         disp("Angles in " + alayerName + " are set to N(-pi/
2,"+num2str(stdInitAng^2)+")")
         analysisnet.Learnables.Value(iLearnable) = ...
         cellfun(@(x) x+stdInitAng*randn(size(x))-pi/2, ...
```

```
            analysisnet.Learnables.Value(iLearnable),'UniformOutput',false);
            else
            disp("Angles in " + alayerName + " are set to
N(0,"+num2str(stdInitAng^2)+")")
            analysisnet.Learnables.Value(iLearnable) = ...
            cellfun(@(x) x+stdInitAng*randn(size(x)), ...
            analysisnet.Learnables.Value(iLearnable),'UniformOutput',false);
            end
        end
end
```

```
Angles in Lv1_Cmp1_V0 are set to N(0,1e-18)
Angles in Lv1_Cmp1_Qx1rb are set to N(-pi/2,1e-18)
Angles in Lv1_Cmp1_Vx1 are set to N(0,1e-18)
Angles in Lv1_Cmp1_Qx2lt are set to N(-pi/2,1e-18)
Angles in Lv1_Cmp1_Vx2 are set to N(0,1e-18)
```

Establishment of concomitant relationships

Copying design parameters

```
import tansacnet.lsun.*
% Construction of analysis network
analysislgraph = layerGraph(analysisnet);
synthesislgraph = fcn_cpparamsana2syn(synthesislgraph,analysislgraph);
```

```
Copy angles from Lv1_Cmp1_V0 to Lv1_Cmp1_V0~
Copy angles from Lv1_Cmp1_Vx1 to Lv1_Cmp1_Vx1~
Copy angles from Lv1_Cmp1_Vx2 to Lv1_Cmp1_Vx2~
```

```
synthesislgraph = fcn_cpparamsana2syn_csax_(synthesislgraph,analysislgraph);
```

```
Copy angles from Lv1_Cmp1_Qx1rb to Lv1_Cmp1_Qx1rb~
Copy angles from Lv1_Cmp1_Qx2lt to Lv1_Cmp1_Qx2lt~
```

```
synthesisnet = dlnetwork(synthesislgraph);
```

Confirmation of the adjoint relationship (complete reconstruction).

```
x = rand([1 nX 1 nT],'double');
dlx = dlarray(x,"SSCB"); % Deep learning array (SSCB)
[dls{1:2}] = analysisnet.predict(dlx);
dly = synthesisnet.predict(dls{:});
mse_ = mse(dlx,dly);
display("MSE: " + num2str(mse_))
```

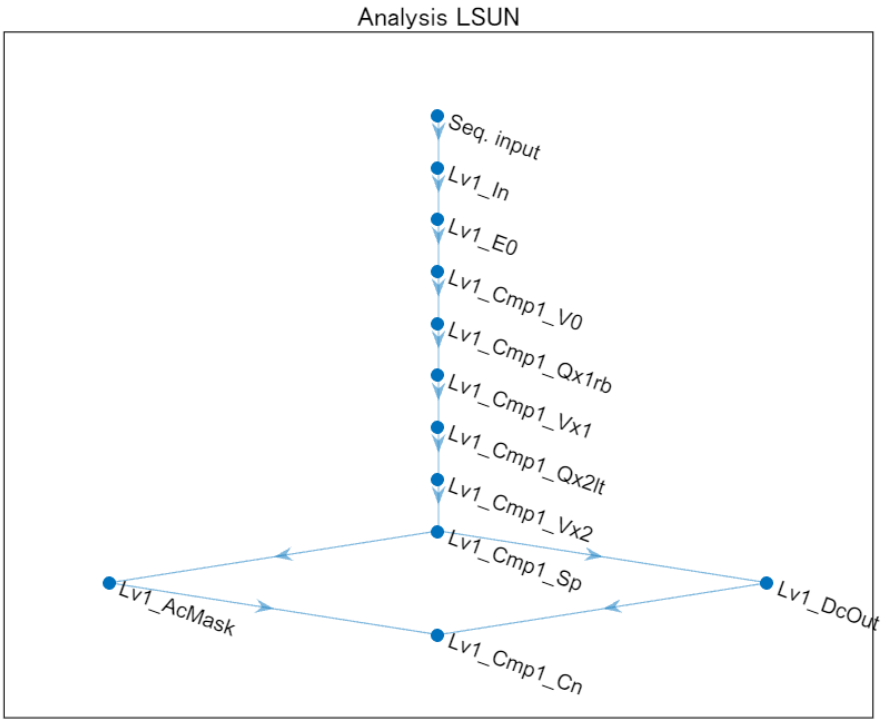
```
    "MSE: 4.1777e-14"
```

```
assert(mse_<1e-6)
```

Design parameter optimisation and signal approximation.

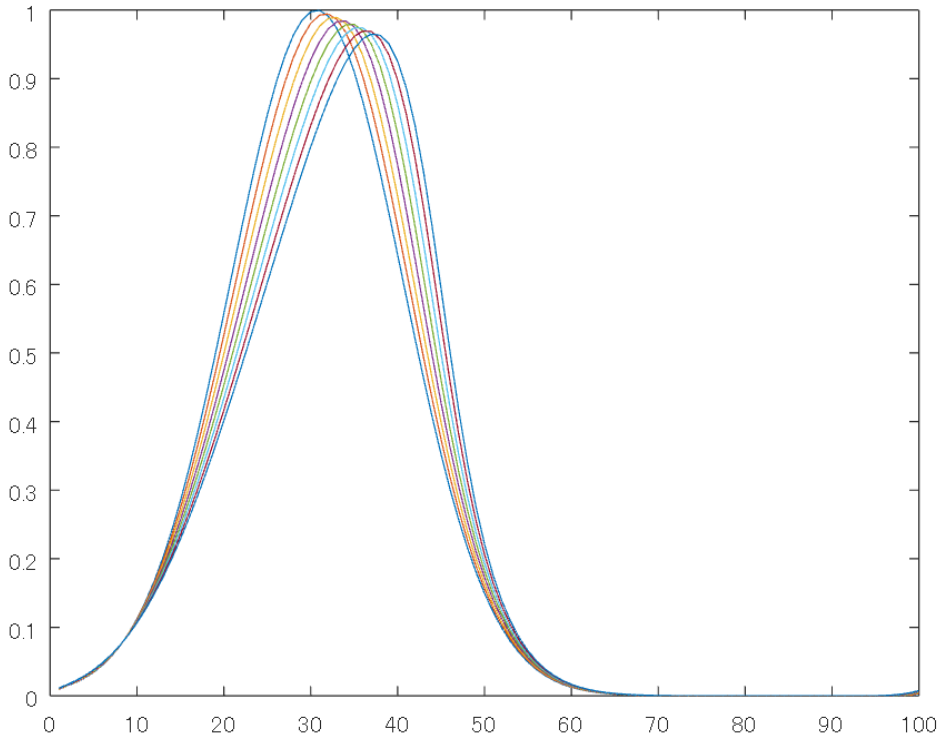
```
import tansacnet.lsun.*
analysislgraph = layerGraph(analysisnet);
```

```
% Coefficient masking
nChsTotal = prod(stride);
coefMask = reshape([ones(nCoefs,1); zeros(nChsTotal-nCoefs,1)],2,[]).';
coefMask = coefMask(:);
%nLevels = 1;
%for iLv = nLevels:-1:1
iLv = 1;
strLv = sprintf('Lv%0d_',iLv);
% For AC
analysislgraph = analysislgraph.replaceLayer([strLv 'AcOut'],...
 mask1dLayer('Name',[strLv 'AcMask'],'Mask',coefMask(2:end),...
 'NumberOfChannels',nChsTotal-1));
%strLvPre = strLv;
%end
% Output layer
iCmp = 1;
strCmp = sprintf('Cmp%0d_',iCmp);
%analysislgraph = analysislgraph.addLayers([...
% lsunChannelConcatenation1dLayer('Name',[strLv strCmp 'Cn']) ...
% lsunRegressionLayer('Coefficient output')
% ]);
analysislgraph = analysislgraph.addLayers(...
 lsunChannelConcatenation1dLayer('Name',[strLv strCmp 'Cn']));
analysislgraph = analysislgraph.connectLayers(...
 [strLv 'AcMask' ], [strLv strCmp 'Cn/ac']);
analysislgraph = analysislgraph.connectLayers(...
 [strLv 'DcOut' ], [strLv strCmp 'Cn/dc']);
figure
plot(analysislgraph)
title('Analysis LSUN')
```



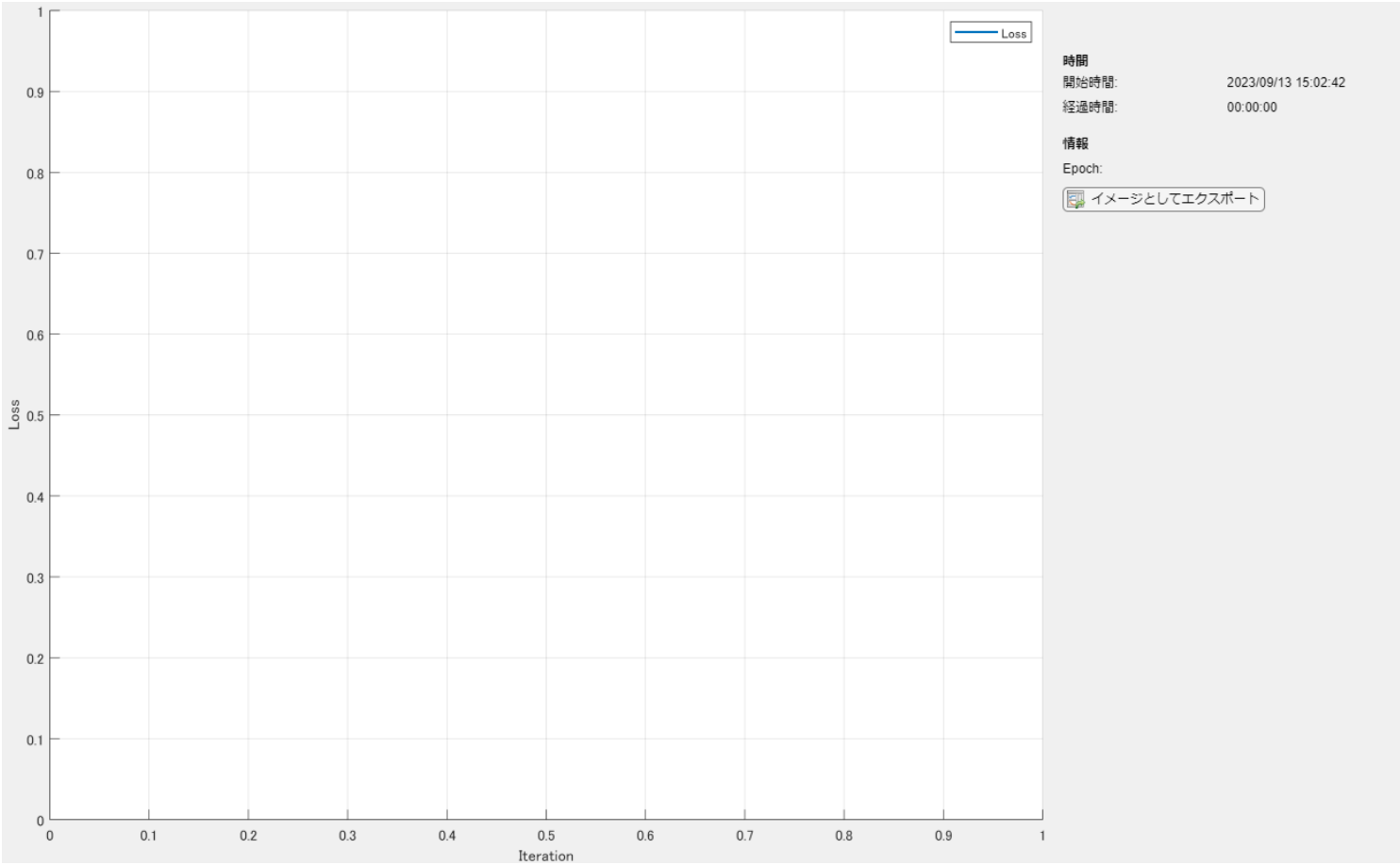
Reads numerical sequence data as 1-D images from a datastore.

```
% Load sequences
arrds = arrayDatastore(DataT,"ReadSize",1,"IterationDimension",1);
%arrds = transform(arrds,@(x) cell2mat(x));
figure
arr = cell2mat(preview(arrds));
for idx = 1:height(arr)
 plot(arr(idx,:))
 hold on
end
hold off
```



Design preparation

```
dlX = dlarray(gpuArray(arr(1,:)),"SSCB");
trainnet = dlnetwork(analysislgraph,dlX);
assert(trainnet.Initialized)
figure
monitor = trainingProgressMonitor(Metrics="Loss",Info="Epoch",XLabel="Iteration");
```



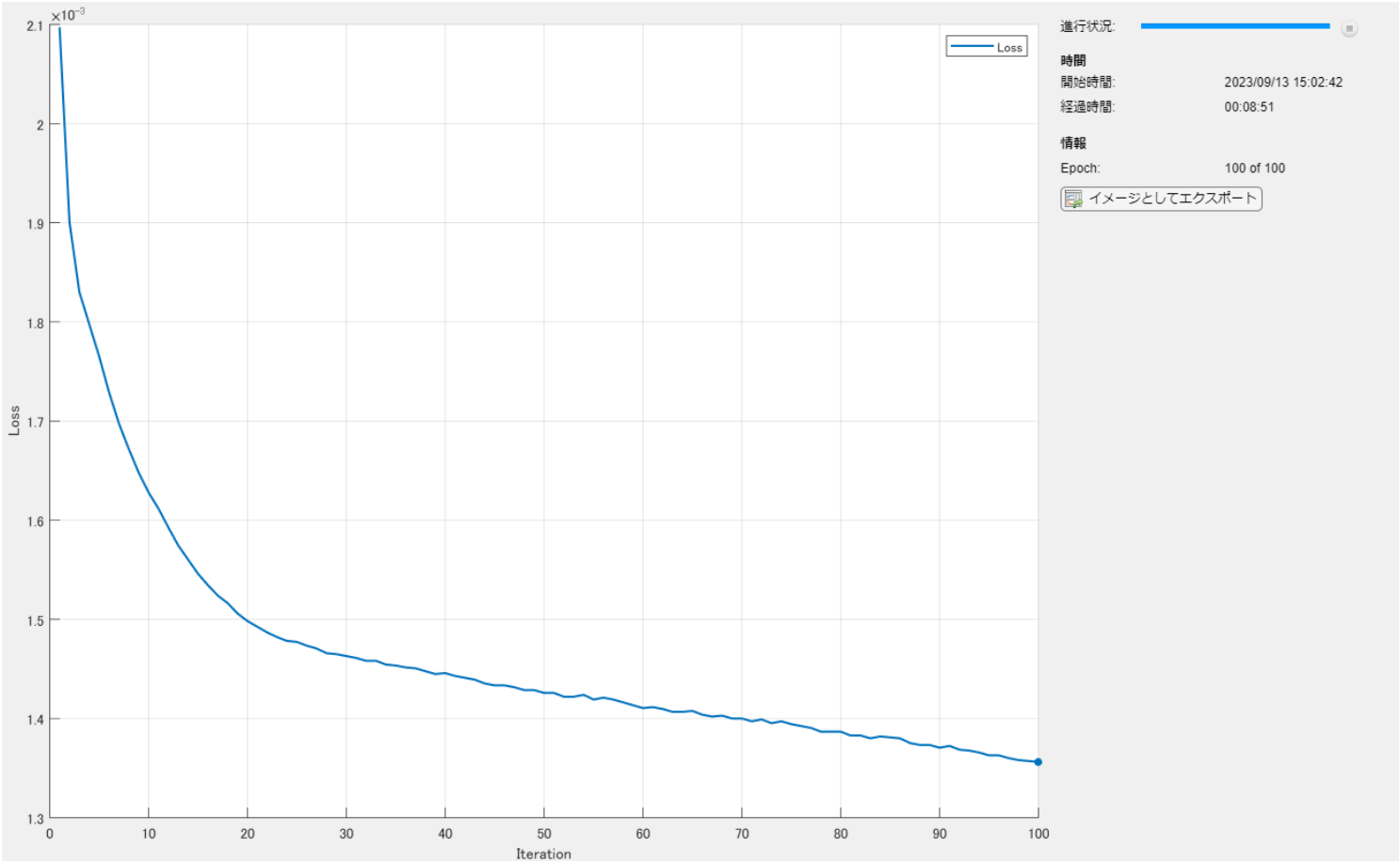
Optimisation design

Parameters for learning

- Creating mini-batches for deep learning - MATLAB - MathWorks United Kingdom

```
numEpochs = 100;
miniBatchSize = nT;
numObservationsTrain = nT;
numIterationsPerEpoch = ceil(numObservationsTrain / miniBatchSize);
numIterations = numEpochs * numIterationsPerEpoch;
% Minibatch
mbq = minibatchqueue(arrds,...
 "MinibatchSize",miniBatchSize,...
 "MiniBatchFcn",@(x) permute(cell2mat(x),[3 2 4 1]),...
 "OutputAsDlarray",1,...
 ..."OutputCast","double",...
 "MiniBatchFormat", "SSCB",...
 "OutputEnvironment", "gpu",...
 "PartialMiniBatch","discard");
% Training
averageGrad = [];
averageSqGrad = [];
iteration = 0;
```

```
epoch = 0;
start = tic;
% Loop over epochs.
while epoch < numEpochs && ~monitor.Stop
     epoch = epoch + 1;
     % Shuffle data.
     shuffle(mbq);
     % Loop over mini-batches.
     while hasdata(mbq) && ~monitor.Stop
     iteration = iteration + 1;
     % Read mini-batch of data.
     dlX = next(mbq);
     % Evaluate the model gradients, state, and loss using dlfeval and the
     % modelGradients function and update the network state.
    [loss,grad] = dlfeval(@modelLoss,trainnet,dlX);
     %Update the network parameters using the Adam optimizer.
     [trainnet,averageGrad,averageSqGrad] = ...
     adamupdate(trainnet,grad,averageGrad,averageSqGrad,iteration);
     % Display the training progress.
     recordMetrics(monitor,iteration,Loss=loss);
     updateInfo(monitor,Epoch=epoch + " of " + numEpochs);
     monitor.Progress = 100 * iteration/numIterations;
     end
end
```



Trained Analysis LSUN

```
import tansacnet.lsun.*
analsunlgraph = fcn_createcslsunlgraph1d([],...
    'InputSize',nX,...
    'Stride',stride,...
    'OverlappingFactor',kx,...
    ...'NumberOfVanishingMoments',noDcLeakage,...
    'Mode','Analyzer');
synlsunlgraph = fcn_createcslsunlgraph1d([],...
    'InputSize',nX,...
    'Stride',stride,...
    'OverlappingFactor',kx,...
    ...'NumberOfVanishingMoments',noDcLeakage,...
    'Mode','Synthesizer');
trainlgraph = layerGraph(trainnet);
% Trained net -> Analyzer
synlsunlgraph = fcn_cpparamsana2syn(synlsunlgraph,trainlgraph);
```

```
Copy angles from Lv1_Cmp1_V0 to Lv1_Cmp1_V0~
Copy angles from Lv1_Cmp1_Vx1 to Lv1_Cmp1_Vx1~
Copy angles from Lv1_Cmp1_Vx2 to Lv1_Cmp1_Vx2~
```

```
synlsunlgraph = fcn_cpparamsana2syn_csax_(synlsunlgraph,trainlgraph);
```

```
Copy angles from Lv1_Cmp1_Qx1rb to Lv1_Cmp1_Qx1rb~
Copy angles from Lv1_Cmp1_Qx2lt to Lv1_Cmp1_Qx2lt~
```

```
% Analyzer -> Synthesizer
analsunlgraph = fcn_cpparamssyn2ana(analsunlgraph,synlsunlgraph);
```

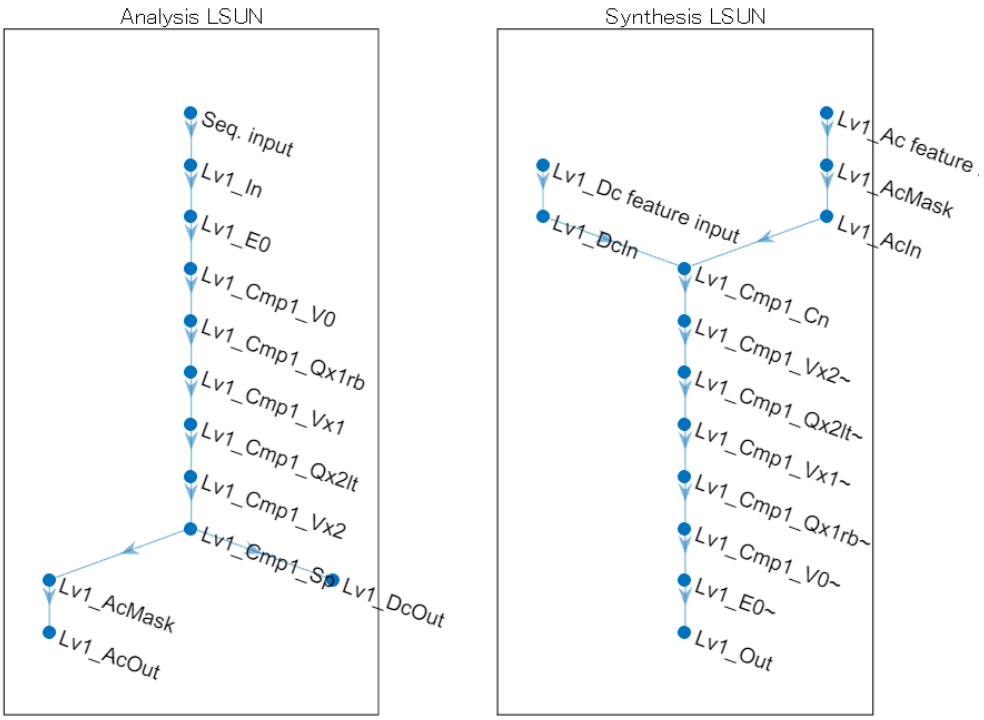
```
Copy angles from Lv1_Cmp1_V0~ to Lv1_Cmp1_V0
Copy angles from Lv1_Cmp1_Vx1~ to Lv1_Cmp1_Vx1
Copy angles from Lv1_Cmp1_Vx2~ to Lv1_Cmp1_Vx2
```

```
analsunlgraph = fcn_cpparamssyn2ana_csax_(analsunlgraph,synlsunlgraph);
```

```
Copy angles from Lv1_Cmp1_Qx1rb~ to Lv1_Cmp1_Qx1rb
Copy angles from Lv1_Cmp1_Qx2lt~ to Lv1_Cmp1_Qx2lt
```

```
nLevels = 1;
%for iLv = nLevels:-1:1S
iLv = 1;

% !!! 完全再構成を確認するためマスク処理を無効化
% coefMask = ones(nChsTotal,1);

strLv = sprintf('Lv%0d_',iLv);
% For analyzer
analsunlgraph = analsunlgraph.replaceLayer([strLv 'DcOut'],...
    regressionLayer('Name',[strLv 'DcOut']));
```

```
%analsunlgraph = analsunlgraph.addLayers(...
%    mask1dLayer('Name',[strLv 'AcMask'],'Mask',coefMask(2:end),...
%    'NumberOfChannels',nChsTotal-1));
%analsunlgraph = analsunlgraph.connectLayers([strLv 'AcOut'],[strLv 'AcMask']);
analsunlgraph = analsunlgraph.replaceLayer([strLv 'AcOut'], ...
        mask1dLayer('Name',[strLv 'AcMask'],'Mask',coefMask(2:end),...
    'NumberOfChannels',nChsTotal-1));
analsunlgraph = analsunlgraph.addLayers(regressionLayer('Name',[strLv 'AcOut']));
analsunlgraph = analsunlgraph.connectLayers([strLv 'AcMask'],[strLv 'AcOut']);

% For synthesizer
synlsunlgraph = synlsunlgraph.replaceLayer([strLv 'Out'],...
    regressionLayer('Name',[strLv 'Out']));
%
synlsunlgraph = synlsunlgraph.disconnectLayers([strLv 'Ac feature input'],[strLv
'AcIn']);
synlsunlgraph = synlsunlgraph.addLayers(...
    mask1dLayer('Name',[strLv 'AcMask'],'Mask',coefMask(2:end),...
    'NumberOfChannels',nChsTotal-1));
synlsunlgraph = synlsunlgraph.connectLayers([strLv 'Ac feature input'],[strLv
'AcMask']);
synlsunlgraph = synlsunlgraph.connectLayers([strLv 'AcMask'],[strLv 'AcIn']);

%strLvPre = strLv;
%end

%
figure
subplot(1,2,1)
plot(analsunlgraph)
title('Analysis LSUN')
subplot(1,2,2)
plot(synlsunlgraph)
title('Synthesis LSUN')
```




```
% Replace invalid linear layers with empty lattice parameters
fcn_replace_emptyangles_(analsunlgraph)
fcn_replace_emptyangles_(synlsunlgraph)
```

```
analsunlgraph.Layers
```

```
ans =
  次の層をもつ 12×1 の Layer 配列:

     1   'Seq. input'       イメージの入力                                          1×100×1 イメージ
     2   'Lv1_In'           tansacnet.lsun.lsunIdentityLayer                    Identity
     3   'Lv1_E0'           tansacnet.lsun.lsunBlockDct1dLayer                  Block DCT of size 4
     4   'Lv1_Cmp1_V0'      tansacnet.lsun.lsunInitialFullRotation1dLayer       LSUN initial full rotation (pt,pb)
     5   'Lv1_Cmp1_Qx1rb'   tansacnet.lsun.lsunCSAtomExtension1dLayer           Analysis LSUN C-S transform w/ Righ
     6   'Lv1_Cmp1_Vx1'     tansacnet.lsun.lsunIntermediateFullRotation1dLayer  Analysis LSUN intermediate full rot
     7   'Lv1_Cmp1_Qx2lt'   tansacnet.lsun.lsunCSAtomExtension1dLayer           Analysis LSUN C-S transform w/ Left
     8   'Lv1_Cmp1_Vx2'     tansacnet.lsun.lsunIntermediateFullRotation1dLayer  Analysis LSUN intermediate full rot
     9   'Lv1_Cmp1_Sp'      tansacnet.lsun.lsunChannelSeparation1dLayer         Channel separation
    10   'Lv1_AcMask'       mask1dLayer                                         MASK for 3 channels
    11   'Lv1_DcOut'        回帰出力                                             mean-squared-error
    12   'Lv1_AcOut'        回帰出力                                             mean-squared-error
```

```
synlsunlgraph.Layers
```

```
ans =
  次の層をもつ 13×1 の Layer 配列:

     1   'Lv1_DcIn'              tansacnet.lsun.lsunComponentSeparation1dLayer       tansacnet.lsun.lsunComponentS
     2   'Lv1_AcIn'              tansacnet.lsun.lsunComponentSeparation1dLayer       tansacnet.lsun.lsunComponentS
```

```
     3   'Lv1_Cmp1_Cn'            tansacnet.lsun.lsunChannelConcatenation1dLayer       Channel concatenation
     4   'Lv1_Cmp1_Vx2~'          tansacnet.lsun.lsunIntermediateFullRotation1dLayer   Synthesis LSUN intermediate t
     5   'Lv1_Cmp1_Qx2lt~'        tansacnet.lsun.lsunCSAtomExtension1dLayer            Synthesis LSUN C-S transform
     6   'Lv1_Cmp1_Vx1~'          tansacnet.lsun.lsunIntermediateFullRotation1dLayer   Synthesis LSUN intermediate t
     7   'Lv1_Cmp1_Qx1rb~'        tansacnet.lsun.lsunCSAtomExtension1dLayer            Synthesis LSUN C-S transform
     8   'Lv1_Cmp1_V0~'           tansacnet.lsun.lsunFinalFullRotation1dLayer          LSUN final full rotation (pt
     9   'Lv1_E0~'                tansacnet.lsun.lsunBlockIdct1dLayer                 Block IDCT of size 4
    10   'Lv1_Out'                回帰出力                                             mean-squared-error
    11   'Lv1_Ac feature input'   イメージの入力                                       3×1×25 イメージ
    12   'Lv1_Dc feature input'   イメージの入力                                       1×1×25 イメージ
    13   'Lv1_AcMask'             mask1dLayer                                         MASK for 3 channels
```

```
analsunnet = assembleNetwork(analsunlgraph)
```

```
analsunnet =
  DAGNetwork のプロパティ:

         Layers: [12×1 nnet.cnn.layer.Layer]
    Connections: [11×2 table]
     InputNames: {'Seq. input'}
    OutputNames: {'Lv1_DcOut'  'Lv1_AcOut'}
```

```
synlsunnet = assembleNetwork(synlsunlgraph)
```

```
synlsunnet =
  DAGNetwork のプロパティ:

         Layers: [13×1 nnet.cnn.layer.Layer]
    Connections: [12×2 table]
     InputNames: {'Lv1_Ac feature input'  'Lv1_Dc feature input'}
    OutputNames: {'Lv1_Out'}
```

Analysis process

```
analsunseq = zeros(nT,stride,ndim/stride,'like',DataT);
for iT = 1:nT
    [dc,ac] = analsunnet.predict(gpuArray(DataT(iT,:))); % dc: 1 x Pos., ac: Ch. x
1 x Pos
    analsunseq(iT,:,:) = cat(2,permute(dc,[3 1 2]),permute(ac,[2 1 3]));
end
% 3-D array w/ Time x Ch. x Pos.
analsunseq
```

```
analsunseq =
analsunseq(:,:,1) =

    0.0365         0   -0.0108         0
    0.0362         0   -0.0126         0
    0.0367         0   -0.0130         0
    0.0374         0   -0.0131         0
    0.0382         0   -0.0130         0
    0.0390         0   -0.0130         0
    0.0398         0   -0.0129         0
    0.0407         0   -0.0129         0
    0.0415         0   -0.0128         0
    0.0424         0   -0.0128         0
```

0.0432	0	-0.0127	0
0.0440	0	-0.0126	0
0.0448	0	-0.0126	0
0.0456	0	-0.0125	0
0.0463	0	-0.0124	0
0.0470	0	-0.0123	0
0.0477	0	-0.0123	0
0.0484	0	-0.0122	0
0.0491	0	-0.0121	0
0.0497	0	-0.0120	0
0.0503	0	-0.0119	0
0.0509	0	-0.0118	0
0.0515	0	-0.0118	0
0.0520	0	-0.0117	0
0.0525	0	-0.0116	0
0.0530	0	-0.0115	0
0.0535	0	-0.0114	0
0.0540	0	-0.0113	0
0.0544	0	-0.0112	0
0.0549	0	-0.0111	0
0.0553	0	-0.0110	0
0.0557	0	-0.0109	0
0.0560	0	-0.0108	0
0.0564	0	-0.0107	0
0.0568	0	-0.0106	0
0.0571	0	-0.0105	0
0.0574	0	-0.0104	0
0.0577	0	-0.0104	0
0.0580	0	-0.0103	0
0.0583	0	-0.0102	0
0.0586	0	-0.0101	0
0.0589	0	-0.0100	0
0.0591	0	-0.0099	0
0.0594	0	-0.0098	0
0.0596	0	-0.0097	0
0.0598	0	-0.0096	0
0.0600	0	-0.0095	0
0.0602	0	-0.0095	0
0.0604	0	-0.0094	0
0.0606	0	-0.0093	0
0.0608	0	-0.0092	0
0.0610	0	-0.0091	0
0.0611	0	-0.0090	0
0.0613	0	-0.0090	0
0.0614	0	-0.0089	0
0.0616	0	-0.0088	0
0.0617	0	-0.0087	0
0.0619	0	-0.0087	0
0.0620	0	-0.0086	0
0.0621	0	-0.0085	0
0.0622	0	-0.0084	0
0.0623	0	-0.0084	0
0.0624	0	-0.0083	0
0.0625	0	-0.0082	0
0.0626	0	-0.0081	0
0.0627	0	-0.0081	0
0.0628	0	-0.0080	0
0.0629	0	-0.0079	0
0.0630	0	-0.0079	0
0.0630	0	-0.0078	0
0.0631	0	-0.0077	0
0.0632	0	-0.0077	0
0.0632	0	-0.0076	0
0.0633	0	-0.0076	0

```
    0.0633         0   -0.0075         0
    0.0634         0   -0.0074         0
    0.0634         0   -0.0074         0
    0.0635         0   -0.0073         0
    0.0635         0   -0.0073         0
    0.0636         0   -0.0072         0
    0.0636         0   -0.0071         0
    0.0636         0   -0.0071         0
    0.0637         0   -0.0070         0
    0.0637         0   -0.0070         0
    0.0637         0   -0.0069         0
    0.0637         0   -0.0069         0
    0.0638         0   -0.0068         0
    0.0638         0   -0.0068         0
    0.0638         0   -0.0067         0
    0.0638         0   -0.0067         0
    0.0638         0   -0.0066         0
    0.0638         0   -0.0065         0
    0.0638         0   -0.0065         0
    0.0639         0   -0.0065         0
    0.0639         0   -0.0064         0
    0.0639         0   -0.0063         0
    0.0639         0   -0.0063         0
    0.0639         0   -0.0063         0
    0.0639         0   -0.0062         0
    0.0639         0   -0.0062         0


analsunseq(:,:,2) =

    0.1047         0   -0.0263         0
    0.1058         0   -0.0260         0
    0.1068         0   -0.0256         0
    0.1077         0   -0.0253         0
    0.1085         0   -0.0250         0
    0.1091         0   -0.0246         0
    0.1097         0   -0.0243         0
    0.1102         0   -0.0240         0
    0.1106         0   -0.0236         0
    0.1109         0   -0.0233         0
    0.1112         0   -0.0229         0
    0.1115         0   -0.0225         0
    0.1116         0   -0.0222         0
    0.1118         0   -0.0218         0
    0.1119         0   -0.0215         0
    0.1120         0   -0.0211         0
    0.1120         0   -0.0207         0
    0.1120         0   -0.0204         0
    0.1120         0   -0.0201         0
    0.1120         0   -0.0197         0
    0.1119         0   -0.0194         0
    0.1119         0   -0.0191         0
    0.1118         0   -0.0188         0
    0.1117         0   -0.0184         0
    0.1116         0   -0.0181         0
    0.1114         0   -0.0178         0
    0.1113         0   -0.0176         0
    0.1111         0   -0.0173         0
    0.1110         0   -0.0170         0
    0.1108         0   -0.0167         0
    0.1106         0   -0.0165         0
    0.1104         0   -0.0162         0
    0.1102         0   -0.0160         0
    0.1100         0   -0.0157         0
```

0.1098	0	-0.0155	0
0.1096	0	-0.0153	0
0.1094	0	-0.0150	0
0.1092	0	-0.0148	0
0.1089	0	-0.0146	0
0.1087	0	-0.0144	0
0.1085	0	-0.0142	0
0.1082	0	-0.0140	0
0.1080	0	-0.0138	0
0.1077	0	-0.0136	0
0.1075	0	-0.0134	0
0.1073	0	-0.0133	0
0.1070	0	-0.0131	0
0.1068	0	-0.0129	0
0.1065	0	-0.0127	0
0.1063	0	-0.0126	0
0.1060	0	-0.0124	0
0.1058	0	-0.0122	0
0.1055	0	-0.0121	0
0.1053	0	-0.0119	0
0.1050	0	-0.0118	0
0.1048	0	-0.0117	0
0.1045	0	-0.0115	0
0.1043	0	-0.0114	0
0.1040	0	-0.0112	0
0.1038	0	-0.0111	0
0.1035	0	-0.0110	0
0.1033	0	-0.0108	0
0.1030	0	-0.0107	0
0.1028	0	-0.0106	0
0.1026	0	-0.0105	0
0.1023	0	-0.0104	0
0.1021	0	-0.0102	0
0.1018	0	-0.0101	0
0.1016	0	-0.0100	0
0.1013	0	-0.0099	0
0.1011	0	-0.0098	0
0.1009	0	-0.0097	0
0.1006	0	-0.0096	0
0.1004	0	-0.0095	0
0.1001	0	-0.0094	0
0.0999	0	-0.0093	0
0.0997	0	-0.0092	0
0.0994	0	-0.0091	0
0.0992	0	-0.0090	0
0.0990	0	-0.0089	0
0.0988	0	-0.0088	0
0.0985	0	-0.0087	0
0.0983	0	-0.0087	0
0.0981	0	-0.0086	0
0.0979	0	-0.0085	0
0.0976	0	-0.0084	0
0.0974	0	-0.0083	0
0.0972	0	-0.0083	0
0.0970	0	-0.0082	0
0.0967	0	-0.0081	0
0.0965	0	-0.0080	0
0.0963	0	-0.0079	0
0.0961	0	-0.0079	0
0.0959	0	-0.0078	0
0.0957	0	-0.0077	0
0.0955	0	-0.0077	0
0.0953	0	-0.0076	0
0.0950	0	-0.0075	0

```
    0.0948         0   -0.0075         0
    0.0946         0   -0.0074         0


analsunseq(:,:,3) =

    0.2558         0   -0.0523         0
    0.2528         0   -0.0500         0
    0.2499         0   -0.0479         0
    0.2470         0   -0.0460         0
    0.2442         0   -0.0442         0
    0.2414         0   -0.0425         0
    0.2387         0   -0.0409         0
    0.2360         0   -0.0395         0
    0.2334         0   -0.0381         0
    0.2309         0   -0.0368         0
    0.2284         0   -0.0356         0
    0.2260         0   -0.0345         0
    0.2237         0   -0.0334         0
    0.2214         0   -0.0324         0
    0.2192         0   -0.0314         0
    0.2170         0   -0.0305         0
    0.2149         0   -0.0297         0
    0.2128         0   -0.0289         0
    0.2108         0   -0.0281         0
    0.2088         0   -0.0274         0
    0.2069         0   -0.0267         0
    0.2050         0   -0.0260         0
    0.2032         0   -0.0254         0
    0.2014         0   -0.0248         0
    0.1997         0   -0.0242         0
    0.1980         0   -0.0237         0
    0.1964         0   -0.0231         0
    0.1947         0   -0.0226         0
    0.1932         0   -0.0221         0
    0.1916         0   -0.0217         0
    0.1901         0   -0.0212         0
    0.1886         0   -0.0208         0
    0.1872         0   -0.0204         0
    0.1858         0   -0.0200         0
    0.1844         0   -0.0196         0
    0.1831         0   -0.0192         0
    0.1818         0   -0.0188         0
    0.1805         0   -0.0185         0
    0.1792         0   -0.0182         0
    0.1780         0   -0.0178         0
    0.1768         0   -0.0175         0
    0.1756         0   -0.0172         0
    0.1744         0   -0.0169         0
    0.1733         0   -0.0166         0
    0.1721         0   -0.0164         0
    0.1710         0   -0.0161         0
    0.1700         0   -0.0158         0
    0.1689         0   -0.0156         0
    0.1679         0   -0.0153         0
    0.1668         0   -0.0151         0
    0.1658         0   -0.0148         0
    0.1649         0   -0.0146         0
    0.1639         0   -0.0144         0
    0.1629         0   -0.0142         0
    0.1620         0   -0.0140         0
    0.1611         0   -0.0138         0
    0.1602         0   -0.0136         0
    0.1593         0   -0.0134         0
```

```
    0.1584         0   -0.0132         0
    0.1576         0   -0.0130         0
    0.1567         0   -0.0128         0
    0.1559         0   -0.0127         0
    0.1551         0   -0.0125         0
    0.1543         0   -0.0123         0
    0.1535         0   -0.0122         0
    0.1527         0   -0.0120         0
    0.1520         0   -0.0118         0
    0.1512         0   -0.0117         0
    0.1505         0   -0.0115         0
    0.1497         0   -0.0114         0
    0.1490         0   -0.0113         0
    0.1483         0   -0.0111         0
    0.1476         0   -0.0110         0
    0.1469         0   -0.0108         0
    0.1462         0   -0.0107         0
    0.1456         0   -0.0106         0
    0.1449         0   -0.0105         0
    0.1442         0   -0.0103         0
    0.1436         0   -0.0102         0
    0.1430         0   -0.0101         0
    0.1423         0   -0.0100         0
    0.1417         0   -0.0099         0
    0.1411         0   -0.0098         0
    0.1405         0   -0.0097         0
    0.1399         0   -0.0096         0
    0.1393         0   -0.0095         0
    0.1387         0   -0.0094         0
    0.1382         0   -0.0093         0
    0.1376         0   -0.0092         0
    0.1370         0   -0.0091         0
    0.1365         0   -0.0090         0
    0.1359         0   -0.0089         0
    0.1354         0   -0.0088         0
    0.1349         0   -0.0087         0
    0.1344         0   -0.0086         0
    0.1338         0   -0.0085         0
    0.1333         0   -0.0084         0
    0.1328         0   -0.0083         0
    0.1323         0   -0.0083         0
    0.1318         0   -0.0082         0


analsunseq(:,:,4) =

    0.5318         0   -0.0842         0
    0.5134         0   -0.0781         0
    0.4968         0   -0.0728         0
    0.4816         0   -0.0682         0
    0.4676         0   -0.0641         0
    0.4548         0   -0.0605         0
    0.4429         0   -0.0573         0
    0.4319         0   -0.0544         0
    0.4216         0   -0.0517         0
    0.4120         0   -0.0493         0
    0.4030         0   -0.0471         0
    0.3945         0   -0.0451         0
    0.3865         0   -0.0433         0
    0.3790         0   -0.0416         0
    0.3718         0   -0.0400         0
    0.3650         0   -0.0385         0
    0.3586         0   -0.0372         0
    0.3524         0   -0.0359         0
```

0.3466	0	-0.0347	0
0.3410	0	-0.0336	0
0.3356	0	-0.0325	0
0.3305	0	-0.0315	0
0.3256	0	-0.0306	0
0.3209	0	-0.0297	0
0.3164	0	-0.0289	0
0.3120	0	-0.0281	0
0.3078	0	-0.0273	0
0.3038	0	-0.0266	0
0.2999	0	-0.0259	0
0.2961	0	-0.0253	0
0.2925	0	-0.0247	0
0.2890	0	-0.0241	0
0.2856	0	-0.0235	0
0.2823	0	-0.0230	0
0.2791	0	-0.0225	0
0.2760	0	-0.0220	0
0.2730	0	-0.0215	0
0.2701	0	-0.0211	0
0.2673	0	-0.0206	0
0.2645	0	-0.0202	0
0.2619	0	-0.0198	0
0.2593	0	-0.0194	0
0.2568	0	-0.0190	0
0.2543	0	-0.0187	0
0.2519	0	-0.0183	0
0.2496	0	-0.0180	0
0.2473	0	-0.0176	0
0.2451	0	-0.0173	0
0.2429	0	-0.0170	0
0.2408	0	-0.0167	0
0.2387	0	-0.0164	0
0.2367	0	-0.0162	0
0.2348	0	-0.0159	0
0.2328	0	-0.0156	0
0.2310	0	-0.0154	0
0.2291	0	-0.0151	0
0.2273	0	-0.0149	0
0.2256	0	-0.0146	0
0.2238	0	-0.0144	0
0.2221	0	-0.0142	0
0.2205	0	-0.0140	0
0.2189	0	-0.0138	0
0.2173	0	-0.0136	0
0.2157	0	-0.0134	0
0.2142	0	-0.0132	0
0.2127	0	-0.0130	0
0.2113	0	-0.0128	0
0.2098	0	-0.0126	0
0.2084	0	-0.0125	0
0.2070	0	-0.0123	0
0.2057	0	-0.0121	0
0.2043	0	-0.0120	0
0.2030	0	-0.0118	0
0.2017	0	-0.0117	0
0.2005	0	-0.0115	0
0.1992	0	-0.0114	0
0.1980	0	-0.0112	0
0.1968	0	-0.0111	0
0.1956	0	-0.0109	0
0.1945	0	-0.0108	0
0.1933	0	-0.0107	0
0.1922	0	-0.0105	0

```
    0.1911         0   -0.0104         0
    0.1900         0   -0.0103         0
    0.1889         0   -0.0102         0
    0.1879         0   -0.0100         0
    0.1868         0   -0.0099         0
    0.1858         0   -0.0098         0
    0.1848         0   -0.0097         0
    0.1838         0   -0.0096         0
    0.1828         0   -0.0095         0
    0.1819         0   -0.0094         0
    0.1809         0   -0.0093         0
    0.1800         0   -0.0092         0
    0.1791         0   -0.0091         0
    0.1782         0   -0.0090         0
    0.1773         0   -0.0089         0
    0.1764         0   -0.0088         0
    0.1755         0   -0.0087         0
    0.1747         0   -0.0086         0


analsunseq(:,:,5) =

    0.9413         0   -0.1067         0
    0.8920         0   -0.0978         0
    0.8489         0   -0.0901         0
    0.8107         0   -0.0835         0
    0.7768         0   -0.0777         0
    0.7463         0   -0.0727         0
    0.7187         0   -0.0682         0
    0.6936         0   -0.0642         0
    0.6706         0   -0.0607         0
    0.6495         0   -0.0575         0
    0.6301         0   -0.0546         0
    0.6121         0   -0.0520         0
    0.5953         0   -0.0496         0
    0.5797         0   -0.0474         0
    0.5651         0   -0.0454         0
    0.5515         0   -0.0436         0
    0.5386         0   -0.0418         0
    0.5265         0   -0.0402         0
    0.5151         0   -0.0388         0
    0.5042         0   -0.0374         0
    0.4940         0   -0.0361         0
    0.4842         0   -0.0349         0
    0.4750         0   -0.0337         0
    0.4662         0   -0.0327         0
    0.4578         0   -0.0317         0
    0.4498         0   -0.0307         0
    0.4421         0   -0.0298         0
    0.4347         0   -0.0290         0
    0.4277         0   -0.0282         0
    0.4209         0   -0.0274         0
    0.4145         0   -0.0267         0
    0.4082         0   -0.0260         0
    0.4022         0   -0.0253         0
    0.3964         0   -0.0247         0
    0.3909         0   -0.0241         0
    0.3855         0   -0.0235         0
    0.3803         0   -0.0230         0
    0.3753         0   -0.0224         0
    0.3705         0   -0.0219         0
    0.3658         0   -0.0215         0
    0.3612         0   -0.0210         0
    0.3568         0   -0.0206         0
```

```
    0.3526         0   -0.0201         0
    0.3484         0   -0.0197         0
    0.3444         0   -0.0193         0
    0.3405         0   -0.0189         0
    0.3367         0   -0.0186         0
    0.3331         0   -0.0182         0
    0.3295         0   -0.0179         0
    0.3260         0   -0.0175         0
    0.3226         0   -0.0172         0
    0.3193         0   -0.0169         0
    0.3161         0   -0.0166         0
    0.3130         0   -0.0163         0
    0.3099         0   -0.0160         0
    0.3069         0   -0.0158         0
    0.3040         0   -0.0155         0
    0.3012         0   -0.0152         0
    0.2984         0   -0.0150         0
    0.2957         0   -0.0147         0
    0.2931         0   -0.0145         0
    0.2905         0   -0.0143         0
    0.2880         0   -0.0141         0
    0.2855         0   -0.0138         0
    0.2831         0   -0.0136         0
    0.2807         0   -0.0134         0
    0.2784         0   -0.0132         0
    0.2762         0   -0.0130         0
    0.2740         0   -0.0128         0
    0.2718         0   -0.0127         0
    0.2697         0   -0.0125         0
    0.2676         0   -0.0123         0
    0.2655         0   -0.0121         0
    0.2635         0   -0.0120         0
    0.2616         0   -0.0118         0
    0.2596         0   -0.0117         0
    0.2577         0   -0.0115         0
    0.2559         0   -0.0113         0
    0.2541         0   -0.0112         0
    0.2523         0   -0.0111         0
    0.2505         0   -0.0109         0
    0.2488         0   -0.0108         0
    0.2471         0   -0.0106         0
    0.2454         0   -0.0105         0
    0.2438         0   -0.0104         0
    0.2422         0   -0.0103         0
    0.2406         0   -0.0101         0
    0.2391         0   -0.0100         0
    0.2375         0   -0.0099         0
    0.2360         0   -0.0098         0
    0.2346         0   -0.0097         0
    0.2331         0   -0.0095         0
    0.2317         0   -0.0094         0
    0.2303         0   -0.0093         0
    0.2289         0   -0.0092         0
    0.2275         0   -0.0091         0
    0.2262         0   -0.0090         0
    0.2249         0   -0.0089         0
    0.2236         0   -0.0088         0
    0.2223         0   -0.0087         0


analsunseq(:,:,6) =

    1.4187         0   -0.0974         0
    1.3376         0   -0.0931         0
```

1.2653	0	-0.0882	0
1.2009	0	-0.0833	0
1.1432	0	-0.0785	0
1.0914	0	-0.0740	0
1.0446	0	-0.0698	0
1.0023	0	-0.0660	0
0.9637	0	-0.0625	0
0.9284	0	-0.0593	0
0.8961	0	-0.0564	0
0.8662	0	-0.0536	0
0.8387	0	-0.0512	0
0.8131	0	-0.0489	0
0.7894	0	-0.0468	0
0.7672	0	-0.0448	0
0.7464	0	-0.0430	0
0.7270	0	-0.0413	0
0.7087	0	-0.0397	0
0.6915	0	-0.0383	0
0.6753	0	-0.0369	0
0.6600	0	-0.0356	0
0.6455	0	-0.0344	0
0.6317	0	-0.0333	0
0.6186	0	-0.0322	0
0.6061	0	-0.0312	0
0.5943	0	-0.0302	0
0.5830	0	-0.0293	0
0.5722	0	-0.0285	0
0.5618	0	-0.0277	0
0.5519	0	-0.0269	0
0.5425	0	-0.0262	0
0.5334	0	-0.0255	0
0.5246	0	-0.0248	0
0.5162	0	-0.0242	0
0.5082	0	-0.0236	0
0.5004	0	-0.0230	0
0.4929	0	-0.0225	0
0.4857	0	-0.0220	0
0.4787	0	-0.0215	0
0.4720	0	-0.0210	0
0.4654	0	-0.0205	0
0.4592	0	-0.0201	0
0.4531	0	-0.0196	0
0.4472	0	-0.0192	0
0.4414	0	-0.0188	0
0.4359	0	-0.0184	0
0.4305	0	-0.0181	0
0.4253	0	-0.0177	0
0.4203	0	-0.0174	0
0.4153	0	-0.0170	0
0.4106	0	-0.0167	0
0.4059	0	-0.0164	0
0.4014	0	-0.0161	0
0.3970	0	-0.0158	0
0.3927	0	-0.0155	0
0.3885	0	-0.0153	0
0.3845	0	-0.0150	0
0.3805	0	-0.0148	0
0.3766	0	-0.0145	0
0.3728	0	-0.0143	0
0.3692	0	-0.0140	0
0.3656	0	-0.0138	0
0.3621	0	-0.0136	0
0.3586	0	-0.0134	0
0.3553	0	-0.0132	0

```
    0.3520         0   -0.0130         0
    0.3488         0   -0.0128         0
    0.3457         0   -0.0126         0
    0.3426         0   -0.0124         0
    0.3396         0   -0.0122         0
    0.3367         0   -0.0120         0
    0.3338         0   -0.0119         0
    0.3310         0   -0.0117         0
    0.3283         0   -0.0115         0
    0.3256         0   -0.0114         0
    0.3229         0   -0.0112         0
    0.3203         0   -0.0110         0
    0.3178         0   -0.0109         0
    0.3153         0   -0.0108         0
    0.3128         0   -0.0106         0
    0.3104         0   -0.0105         0
    0.3081         0   -0.0103         0
    0.3058         0   -0.0102         0
    0.3035         0   -0.0101         0
    0.3013         0   -0.0099         0
    0.2991         0   -0.0098         0
    0.2969         0   -0.0097         0
    0.2948         0   -0.0096         0
    0.2928         0   -0.0095         0
    0.2907         0   -0.0093         0
    0.2887         0   -0.0092         0
    0.2867         0   -0.0091         0
    0.2848         0   -0.0090         0
    0.2829         0   -0.0089         0
    0.2810         0   -0.0088         0
    0.2792         0   -0.0087         0
    0.2774         0   -0.0086         0
    0.2756         0   -0.0085         0
    0.2738         0   -0.0084         0


analsunseq(:,:,7) =

    1.8201         0   -0.0443         0
    1.7415         0   -0.0540         0
    1.6629         0   -0.0595         0
    1.5871         0   -0.0620         0
    1.5155         0   -0.0626         0
    1.4486         0   -0.0619         0
    1.3867         0   -0.0605         0
    1.3294         0   -0.0587         0
    1.2766         0   -0.0567         0
    1.2278         0   -0.0546         0
    1.1827         0   -0.0524         0
    1.1410         0   -0.0504         0
    1.1024         0   -0.0484         0
    1.0664         0   -0.0464         0
    1.0330         0   -0.0446         0
    1.0018         0   -0.0429         0
    0.9726         0   -0.0413         0
    0.9452         0   -0.0397         0
    0.9196         0   -0.0383         0
    0.8954         0   -0.0369         0
    0.8727         0   -0.0356         0
    0.8512         0   -0.0344         0
    0.8309         0   -0.0332         0
    0.8117         0   -0.0322         0
    0.7934         0   -0.0311         0
    0.7761         0   -0.0302         0
```

0.7596	0	-0.0292	0
0.7439	0	-0.0284	0
0.7290	0	-0.0275	0
0.7147	0	-0.0268	0
0.7010	0	-0.0260	0
0.6879	0	-0.0253	0
0.6754	0	-0.0246	0
0.6634	0	-0.0240	0
0.6519	0	-0.0233	0
0.6409	0	-0.0228	0
0.6302	0	-0.0222	0
0.6200	0	-0.0216	0
0.6101	0	-0.0211	0
0.6006	0	-0.0206	0
0.5915	0	-0.0202	0
0.5826	0	-0.0197	0
0.5741	0	-0.0193	0
0.5659	0	-0.0188	0
0.5579	0	-0.0184	0
0.5502	0	-0.0180	0
0.5427	0	-0.0177	0
0.5354	0	-0.0173	0
0.5284	0	-0.0170	0
0.5216	0	-0.0166	0
0.5150	0	-0.0163	0
0.5086	0	-0.0160	0
0.5024	0	-0.0157	0
0.4963	0	-0.0154	0
0.4904	0	-0.0151	0
0.4847	0	-0.0148	0
0.4791	0	-0.0146	0
0.4737	0	-0.0143	0
0.4684	0	-0.0140	0
0.4633	0	-0.0138	0
0.4583	0	-0.0136	0
0.4534	0	-0.0133	0
0.4486	0	-0.0131	0
0.4440	0	-0.0129	0
0.4395	0	-0.0127	0
0.4350	0	-0.0125	0
0.4307	0	-0.0123	0
0.4265	0	-0.0121	0
0.4224	0	-0.0119	0
0.4183	0	-0.0117	0
0.4144	0	-0.0115	0
0.4105	0	-0.0114	0
0.4067	0	-0.0112	0
0.4031	0	-0.0110	0
0.3994	0	-0.0109	0
0.3959	0	-0.0107	0
0.3924	0	-0.0106	0
0.3890	0	-0.0104	0
0.3857	0	-0.0103	0
0.3825	0	-0.0101	0
0.3793	0	-0.0100	0
0.3761	0	-0.0099	0
0.3731	0	-0.0097	0
0.3700	0	-0.0096	0
0.3671	0	-0.0095	0
0.3642	0	-0.0093	0
0.3613	0	-0.0092	0
0.3585	0	-0.0091	0
0.3558	0	-0.0090	0
0.3531	0	-0.0089	0

```
    0.3505         0   -0.0088         0
    0.3479         0   -0.0087         0
    0.3453         0   -0.0086         0
    0.3428         0   -0.0085         0
    0.3403         0   -0.0084         0
    0.3379         0   -0.0082         0
    0.3355         0   -0.0081         0
    0.3332         0   -0.0081         0
    0.3309         0   -0.0080         0
    0.3286         0   -0.0079         0


analsunseq(:,:,8) =

    1.9869         0    0.0398         0
    1.9643         0    0.0178         0
    1.9258         0   -0.0010         0
    1.8760         0   -0.0159         0
    1.8190         0   -0.0269         0
    1.7584         0   -0.0346         0
    1.6969         0   -0.0396         0
    1.6363         0   -0.0427         0
    1.5775         0   -0.0443         0
    1.5213         0   -0.0450         0
    1.4680         0   -0.0450         0
    1.4177         0   -0.0446         0
    1.3702         0   -0.0438         0
    1.3257         0   -0.0429         0
    1.2838         0   -0.0418         0
    1.2444         0   -0.0407         0
    1.2073         0   -0.0395         0
    1.1725         0   -0.0383         0
    1.1397         0   -0.0372         0
    1.1087         0   -0.0361         0
    1.0795         0   -0.0350         0
    1.0519         0   -0.0339         0
    1.0257         0   -0.0329         0
    1.0010         0   -0.0319         0
    0.9774         0   -0.0309         0
    0.9551         0   -0.0300         0
    0.9339         0   -0.0292         0
    0.9136         0   -0.0284         0
    0.8943         0   -0.0276         0
    0.8759         0   -0.0268         0
    0.8583         0   -0.0261         0
    0.8415         0   -0.0254         0
    0.8254         0   -0.0247         0
    0.8100         0   -0.0241         0
    0.7952         0   -0.0235         0
    0.7810         0   -0.0229         0
    0.7673         0   -0.0224         0
    0.7542         0   -0.0218         0
    0.7415         0   -0.0213         0
    0.7294         0   -0.0208         0
    0.7176         0   -0.0203         0
    0.7063         0   -0.0199         0
    0.6954         0   -0.0194         0
    0.6849         0   -0.0190         0
    0.6747         0   -0.0186         0
    0.6649         0   -0.0182         0
    0.6553         0   -0.0178         0
    0.6461         0   -0.0175         0
    0.6372         0   -0.0171         0
    0.6285         0   -0.0168         0
```

```
    0.6201         0   -0.0165         0
    0.6120         0   -0.0161         0
    0.6041         0   -0.0158         0
    0.5964         0   -0.0155         0
    0.5889         0   -0.0153         0
    0.5817         0   -0.0150         0
    0.5746         0   -0.0147         0
    0.5678         0   -0.0144         0
    0.5611         0   -0.0142         0
    0.5546         0   -0.0139         0
    0.5483         0   -0.0137         0
    0.5421         0   -0.0135         0
    0.5361         0   -0.0133         0
    0.5302         0   -0.0130         0
    0.5245         0   -0.0128         0
    0.5190         0   -0.0126         0
    0.5135         0   -0.0124         0
    0.5082         0   -0.0122         0
    0.5030         0   -0.0120         0
    0.4979         0   -0.0118         0
    0.4930         0   -0.0117         0
    0.4882         0   -0.0115         0
    0.4834         0   -0.0113         0
    0.4788         0   -0.0112         0
    0.4743         0   -0.0110         0
    0.4698         0   -0.0108         0
    0.4655         0   -0.0107         0
    0.4612         0   -0.0105         0
    0.4571         0   -0.0104         0
    0.4530         0   -0.0102         0
    0.4490         0   -0.0101         0
    0.4451         0   -0.0100         0
    0.4413         0   -0.0098         0
    0.4375         0   -0.0097         0
    0.4338         0   -0.0096         0
    0.4302         0   -0.0094         0
    0.4267         0   -0.0093         0
    0.4232         0   -0.0092         0
    0.4198         0   -0.0091         0
    0.4164         0   -0.0090         0
    0.4132         0   -0.0089         0
    0.4099         0   -0.0087         0
    0.4067         0   -0.0086         0
    0.4036         0   -0.0085         0
    0.4006         0   -0.0084         0
    0.3976         0   -0.0083         0
    0.3946         0   -0.0082         0
    0.3917         0   -0.0081         0
    0.3888         0   -0.0080         0
    0.3860         0   -0.0079         0


analsunseq(:,:,9) =

    1.8471         0    0.0948         0
    1.8978         0    0.0780         0
    1.9325         0    0.0576         0
    1.9492         0    0.0358         0
    1.9479         0    0.0148         0
    1.9307         0   -0.0036         0
    1.9009         0   -0.0187         0
    1.8620         0   -0.0303         0
    1.8170         0   -0.0387         0
    1.7686         0   -0.0447         0
```

1.7186	0	-0.0487	0
1.6685	0	-0.0512	0
1.6191	0	-0.0526	0
1.5711	0	-0.0532	0
1.5247	0	-0.0533	0
1.4803	0	-0.0529	0
1.4378	0	-0.0523	0
1.3974	0	-0.0515	0
1.3589	0	-0.0505	0
1.3223	0	-0.0495	0
1.2875	0	-0.0484	0
1.2544	0	-0.0473	0
1.2230	0	-0.0462	0
1.1931	0	-0.0451	0
1.1646	0	-0.0440	0
1.1376	0	-0.0430	0
1.1117	0	-0.0419	0
1.0871	0	-0.0409	0
1.0636	0	-0.0400	0
1.0412	0	-0.0390	0
1.0197	0	-0.0381	0
0.9991	0	-0.0372	0
0.9795	0	-0.0364	0
0.9606	0	-0.0356	0
0.9425	0	-0.0348	0
0.9251	0	-0.0340	0
0.9084	0	-0.0333	0
0.8924	0	-0.0326	0
0.8769	0	-0.0319	0
0.8620	0	-0.0313	0
0.8477	0	-0.0307	0
0.8339	0	-0.0300	0
0.8205	0	-0.0295	0
0.8076	0	-0.0289	0
0.7952	0	-0.0284	0
0.7832	0	-0.0278	0
0.7715	0	-0.0273	0
0.7603	0	-0.0268	0
0.7494	0	-0.0263	0
0.7388	0	-0.0259	0
0.7286	0	-0.0254	0
0.7187	0	-0.0250	0
0.7090	0	-0.0246	0
0.6997	0	-0.0242	0
0.6906	0	-0.0238	0
0.6818	0	-0.0234	0
0.6732	0	-0.0230	0
0.6648	0	-0.0227	0
0.6567	0	-0.0223	0
0.6488	0	-0.0220	0
0.6412	0	-0.0217	0
0.6337	0	-0.0213	0
0.6264	0	-0.0210	0
0.6193	0	-0.0207	0
0.6123	0	-0.0204	0
0.6056	0	-0.0201	0
0.5990	0	-0.0199	0
0.5925	0	-0.0196	0
0.5863	0	-0.0193	0
0.5801	0	-0.0191	0
0.5741	0	-0.0188	0
0.5683	0	-0.0186	0
0.5625	0	-0.0183	0
0.5569	0	-0.0181	0

```
    0.5515         0   -0.0179         0
    0.5461         0   -0.0176         0
    0.5409         0   -0.0174         0
    0.5358         0   -0.0172         0
    0.5307         0   -0.0170         0
    0.5258         0   -0.0168         0
    0.5210         0   -0.0166         0
    0.5163         0   -0.0164         0
    0.5117         0   -0.0162         0
    0.5071         0   -0.0160         0
    0.5027         0   -0.0159         0
    0.4983         0   -0.0157         0
    0.4941         0   -0.0155         0
    0.4899         0   -0.0153         0
    0.4858         0   -0.0152         0
    0.4818         0   -0.0150         0
    0.4778         0   -0.0148         0
    0.4739         0   -0.0147         0
    0.4701         0   -0.0145         0
    0.4664         0   -0.0144         0
    0.4627         0   -0.0142         0
    0.4591         0   -0.0141         0
    0.4555         0   -0.0139         0
    0.4520         0   -0.0138         0
    0.4486         0   -0.0137         0
    0.4452         0   -0.0135         0


analsunseq(:,:,10) =

    1.4621         0    0.1311         0
    1.5451         0    0.1307         0
    1.6287         0    0.1258         0
    1.7086         0    0.1152         0
    1.7799         0    0.0987         0
    1.8378         0    0.0774         0
    1.8790         0    0.0536         0
    1.9021         0    0.0298         0
    1.9080         0    0.0082         0
    1.8992         0   -0.0100         0
    1.8787         0   -0.0246         0
    1.8494         0   -0.0357         0
    1.8143         0   -0.0438         0
    1.7753         0   -0.0496         0
    1.7342         0   -0.0536         0
    1.6921         0   -0.0561         0
    1.6500         0   -0.0577         0
    1.6085         0   -0.0585         0
    1.5678         0   -0.0587         0
    1.5284         0   -0.0585         0
    1.4902         0   -0.0581         0
    1.4535         0   -0.0574         0
    1.4182         0   -0.0566         0
    1.3843         0   -0.0557         0
    1.3518         0   -0.0548         0
    1.3207         0   -0.0537         0
    1.2909         0   -0.0527         0
    1.2624         0   -0.0517         0
    1.2351         0   -0.0506         0
    1.2089         0   -0.0496         0
    1.1838         0   -0.0486         0
    1.1597         0   -0.0476         0
    1.1366         0   -0.0467         0
    1.1144         0   -0.0457         0
```

1.0931	0	-0.0448	0
1.0727	0	-0.0439	0
1.0530	0	-0.0431	0
1.0340	0	-0.0422	0
1.0158	0	-0.0414	0
0.9982	0	-0.0406	0
0.9813	0	-0.0399	0
0.9649	0	-0.0392	0
0.9491	0	-0.0384	0
0.9339	0	-0.0378	0
0.9192	0	-0.0371	0
0.9050	0	-0.0364	0
0.8912	0	-0.0358	0
0.8779	0	-0.0352	0
0.8650	0	-0.0346	0
0.8525	0	-0.0340	0
0.8404	0	-0.0335	0
0.8286	0	-0.0329	0
0.8172	0	-0.0324	0
0.8062	0	-0.0319	0
0.7954	0	-0.0314	0
0.7850	0	-0.0310	0
0.7748	0	-0.0305	0
0.7650	0	-0.0300	0
0.7554	0	-0.0296	0
0.7461	0	-0.0292	0
0.7370	0	-0.0288	0
0.7281	0	-0.0284	0
0.7195	0	-0.0280	0
0.7111	0	-0.0276	0
0.7029	0	-0.0272	0
0.6950	0	-0.0268	0
0.6872	0	-0.0265	0
0.6796	0	-0.0261	0
0.6722	0	-0.0258	0
0.6649	0	-0.0255	0
0.6579	0	-0.0252	0
0.6510	0	-0.0248	0
0.6442	0	-0.0245	0
0.6376	0	-0.0242	0
0.6312	0	-0.0240	0
0.6249	0	-0.0237	0
0.6187	0	-0.0234	0
0.6127	0	-0.0231	0
0.6067	0	-0.0229	0
0.6010	0	-0.0226	0
0.5953	0	-0.0223	0
0.5898	0	-0.0221	0
0.5843	0	-0.0218	0
0.5790	0	-0.0216	0
0.5738	0	-0.0214	0
0.5687	0	-0.0211	0
0.5636	0	-0.0209	0
0.5587	0	-0.0207	0
0.5539	0	-0.0205	0
0.5492	0	-0.0203	0
0.5445	0	-0.0201	0
0.5400	0	-0.0199	0
0.5355	0	-0.0197	0
0.5311	0	-0.0195	0
0.5268	0	-0.0193	0
0.5226	0	-0.0191	0
0.5184	0	-0.0189	0
0.5143	0	-0.0188	0

```
    0.5103         0   -0.0186         0
    0.5064         0   -0.0184         0


analsunseq(:,:,11) =

    0.9846         0    0.1374         0
    1.0489         0    0.1471         0
    1.1212         0    0.1570         0
    1.2019         0    0.1663         0
    1.2906         0    0.1736         0
    1.3857         0    0.1768         0
    1.4838         0    0.1735         0
    1.5798         0    0.1622         0
    1.6679         0    0.1426         0
    1.7424         0    0.1167         0
    1.7995         0    0.0877         0
    1.8374         0    0.0589         0
    1.8571         0    0.0330         0
    1.8608         0    0.0112         0
    1.8517         0   -0.0062         0
    1.8330         0   -0.0196         0
    1.8073         0   -0.0295         0
    1.7770         0   -0.0367         0
    1.7436         0   -0.0418         0
    1.7086         0   -0.0454         0
    1.6727         0   -0.0477         0
    1.6367         0   -0.0493         0
    1.6009         0   -0.0501         0
    1.5658         0   -0.0505         0
    1.5315         0   -0.0506         0
    1.4981         0   -0.0504         0
    1.4658         0   -0.0500         0
    1.4345         0   -0.0495         0
    1.4043         0   -0.0489         0
    1.3751         0   -0.0482         0
    1.3470         0   -0.0475         0
    1.3200         0   -0.0468         0
    1.2939         0   -0.0460         0
    1.2688         0   -0.0452         0
    1.2446         0   -0.0445         0
    1.2213         0   -0.0437         0
    1.1988         0   -0.0429         0
    1.1771         0   -0.0422         0
    1.1562         0   -0.0414         0
    1.1361         0   -0.0407         0
    1.1166         0   -0.0400         0
    1.0979         0   -0.0393         0
    1.0797         0   -0.0386         0
    1.0622         0   -0.0380         0
    1.0452         0   -0.0373         0
    1.0288         0   -0.0367         0
    1.0130         0   -0.0361         0
    0.9976         0   -0.0355         0
    0.9827         0   -0.0349         0
    0.9683         0   -0.0344         0
    0.9543         0   -0.0338         0
    0.9408         0   -0.0333         0
    0.9276         0   -0.0328         0
    0.9148         0   -0.0323         0
    0.9024         0   -0.0318         0
    0.8904         0   -0.0313         0
    0.8786         0   -0.0308         0
    0.8673         0   -0.0304         0
```

```
    0.8562         0   -0.0300         0
    0.8454         0   -0.0295         0
    0.8349         0   -0.0291         0
    0.8247         0   -0.0287         0
    0.8147         0   -0.0283         0
    0.8050         0   -0.0279         0
    0.7956         0   -0.0276         0
    0.7864         0   -0.0272         0
    0.7774         0   -0.0268         0
    0.7686         0   -0.0265         0
    0.7600         0   -0.0261         0
    0.7517         0   -0.0258         0
    0.7435         0   -0.0255         0
    0.7356         0   -0.0252         0
    0.7278         0   -0.0249         0
    0.7202         0   -0.0246         0
    0.7127         0   -0.0243         0
    0.7054         0   -0.0240         0
    0.6983         0   -0.0237         0
    0.6914         0   -0.0234         0
    0.6846         0   -0.0232         0
    0.6779         0   -0.0229         0
    0.6714         0   -0.0226         0
    0.6650         0   -0.0224         0
    0.6587         0   -0.0221         0
    0.6526         0   -0.0219         0
    0.6466         0   -0.0217         0
    0.6407         0   -0.0214         0
    0.6349         0   -0.0212         0
    0.6292         0   -0.0210         0
    0.6237         0   -0.0208         0
    0.6182         0   -0.0206         0
    0.6129         0   -0.0203         0
    0.6076         0   -0.0201         0
    0.6025         0   -0.0199         0
    0.5974         0   -0.0197         0
    0.5925         0   -0.0196         0
    0.5876         0   -0.0194         0
    0.5828         0   -0.0192         0
    0.5781         0   -0.0190         0
    0.5735         0   -0.0188         0
    0.5689         0   -0.0186         0


analsunseq(:,:,12) =

    0.5618         0    0.1220         0
    0.5940         0    0.1309         0
    0.6307         0    0.1413         0
    0.6729         0    0.1535         0
    0.7217         0    0.1676         0
    0.7785         0    0.1841         0
    0.8450         0    0.2029         0
    0.9226         0    0.2233         0
    1.0123         0    0.2440         0
    1.1137         0    0.2620         0
    1.2245         0    0.2734         0
    1.3401         0    0.2742         0
    1.4540         0    0.2622         0
    1.5587         0    0.2380         0
    1.6478         0    0.2053         0
    1.7169         0    0.1690         0
    1.7647         0    0.1338         0
    1.7925         0    0.1028         0
```

1.8034	0	0.0771	0
1.8008	0	0.0568	0
1.7883	0	0.0411	0
1.7687	0	0.0292	0
1.7443	0	0.0204	0
1.7167	0	0.0138	0
1.6872	0	0.0089	0
1.6566	0	0.0052	0
1.6257	0	0.0025	0
1.5947	0	0.0005	0
1.5640	0	-0.0011	0
1.5338	0	-0.0022	0
1.5043	0	-0.0031	0
1.4754	0	-0.0037	0
1.4474	0	-0.0042	0
1.4202	0	-0.0046	0
1.3938	0	-0.0049	0
1.3682	0	-0.0051	0
1.3435	0	-0.0052	0
1.3195	0	-0.0053	0
1.2963	0	-0.0053	0
1.2739	0	-0.0054	0
1.2522	0	-0.0053	0
1.2312	0	-0.0053	0
1.2108	0	-0.0053	0
1.1912	0	-0.0052	0
1.1721	0	-0.0052	0
1.1536	0	-0.0051	0
1.1358	0	-0.0050	0
1.1184	0	-0.0049	0
1.1016	0	-0.0048	0
1.0854	0	-0.0048	0
1.0695	0	-0.0047	0
1.0542	0	-0.0046	0
1.0393	0	-0.0045	0
1.0249	0	-0.0044	0
1.0108	0	-0.0043	0
0.9972	0	-0.0042	0
0.9839	0	-0.0041	0
0.9710	0	-0.0040	0
0.9584	0	-0.0040	0
0.9462	0	-0.0039	0
0.9343	0	-0.0038	0
0.9227	0	-0.0037	0
0.9114	0	-0.0036	0
0.9004	0	-0.0035	0
0.8897	0	-0.0035	0
0.8792	0	-0.0034	0
0.8690	0	-0.0033	0
0.8591	0	-0.0032	0
0.8494	0	-0.0032	0
0.8399	0	-0.0031	0
0.8306	0	-0.0030	0
0.8216	0	-0.0030	0
0.8128	0	-0.0029	0
0.8041	0	-0.0028	0
0.7957	0	-0.0028	0
0.7874	0	-0.0027	0
0.7794	0	-0.0026	0
0.7715	0	-0.0026	0
0.7637	0	-0.0025	0
0.7562	0	-0.0025	0
0.7488	0	-0.0024	0
0.7415	0	-0.0023	0

```
    0.7344         0   -0.0023         0
    0.7274         0   -0.0022         0
    0.7206         0   -0.0022         0
    0.7139         0   -0.0021         0
    0.7074         0   -0.0021         0
    0.7010         0   -0.0020         0
    0.6947         0   -0.0020         0
    0.6885         0   -0.0020         0
    0.6824         0   -0.0019         0
    0.6765         0   -0.0019         0
    0.6707         0   -0.0018         0
    0.6649         0   -0.0018         0
    0.6593         0   -0.0017         0
    0.6538         0   -0.0017         0
    0.6484         0   -0.0017         0
    0.6430         0   -0.0016         0
    0.6378         0   -0.0016         0
    0.6327         0   -0.0015         0


analsunseq(:,:,13) =

    0.2738         0    0.0743         0
    0.2865         0    0.0785         0
    0.3004         0    0.0832         0
    0.3160         0    0.0887         0
    0.3335         0    0.0951         0
    0.3535         0    0.1025         0
    0.3764         0    0.1115         0
    0.4032         0    0.1224         0
    0.4347         0    0.1357         0
    0.4726         0    0.1523         0
    0.5185         0    0.1729         0
    0.5748         0    0.1984         0
    0.6439         0    0.2290         0
    0.7281         0    0.2636         0
    0.8286         0    0.2989         0
    0.9442         0    0.3297         0
    1.0713         0    0.3490         0
    1.2033         0    0.3514         0
    1.3325         0    0.3348         0
    1.4503         0    0.3016         0
    1.5501         0    0.2581         0
    1.6275         0    0.2115         0
    1.6817         0    0.1675         0
    1.7147         0    0.1295         0
    1.7301         0    0.0985         0
    1.7319         0    0.0740         0
    1.7237         0    0.0551         0
    1.7086         0    0.0407         0
    1.6887         0    0.0298         0
    1.6657         0    0.0218         0
    1.6409         0    0.0158         0
    1.6149         0    0.0113         0
    1.5883         0    0.0081         0
    1.5617         0    0.0057         0
    1.5351         0    0.0038         0
    1.5089         0    0.0025         0
    1.4831         0    0.0014         0
    1.4579         0    0.0007         0
    1.4332         0    0.0001         0
    1.4092         0   -0.0004         0
    1.3858         0   -0.0008         0
    1.3630         0   -0.0011         0
```

```
    1.3409         0   -0.0013         0
    1.3194         0   -0.0014         0
    1.2985         0   -0.0016         0
    1.2783         0   -0.0016         0
    1.2586         0   -0.0017         0
    1.2395         0   -0.0018         0
    1.2209         0   -0.0018         0
    1.2029         0   -0.0018         0
    1.1854         0   -0.0018         0
    1.1683         0   -0.0018         0
    1.1518         0   -0.0018         0
    1.1357         0   -0.0018         0
    1.1201         0   -0.0018         0
    1.1049         0   -0.0017         0
    1.0901         0   -0.0017         0
    1.0757         0   -0.0017         0
    1.0617         0   -0.0016         0
    1.0481         0   -0.0016         0
    1.0348         0   -0.0016         0
    1.0219         0   -0.0015         0
    1.0093         0   -0.0015         0
    0.9970         0   -0.0014         0
    0.9850         0   -0.0014         0
    0.9733         0   -0.0013         0
    0.9619         0   -0.0013         0
    0.9508         0   -0.0013         0
    0.9399         0   -0.0012         0
    0.9293         0   -0.0012         0
    0.9190         0   -0.0011         0
    0.9089         0   -0.0011         0
    0.8990         0   -0.0011         0
    0.8893         0   -0.0010         0
    0.8799         0   -0.0010         0
    0.8706         0   -0.0009         0
    0.8616         0   -0.0009         0
    0.8528         0   -0.0009         0
    0.8441         0   -0.0008         0
    0.8357         0   -0.0008         0
    0.8274         0   -0.0008         0
    0.8193         0   -0.0007         0
    0.8113         0   -0.0007         0
    0.8035         0   -0.0007         0
    0.7959         0   -0.0006         0
    0.7884         0   -0.0006         0
    0.7811         0   -0.0006         0
    0.7739         0   -0.0005         0
    0.7669         0   -0.0005         0
    0.7599         0   -0.0005         0
    0.7532         0   -0.0004         0
    0.7465         0   -0.0004         0
    0.7400         0   -0.0004         0
    0.7336         0   -0.0004         0
    0.7273         0   -0.0003         0
    0.7211         0   -0.0003         0
    0.7151         0   -0.0003         0
    0.7091         0   -0.0003         0
    0.7033         0   -0.0002         0
    0.6975         0   -0.0002         0


analsunseq(:,:,14) =

    0.1142         0    0.0367         0
    0.1188         0    0.0382         0
```

```
0.1237        0    0.0399        0
0.1290        0    0.0417        0
0.1347        0    0.0437        0
0.1409        0    0.0460        0
0.1478        0    0.0486        0
0.1553        0    0.0515        0
0.1637        0    0.0549        0
0.1732        0    0.0589        0
0.1840        0    0.0637        0
0.1966        0    0.0695        0
0.2115        0    0.0767        0
0.2293        0    0.0859        0
0.2510        0    0.0978        0
0.2779        0    0.1137        0
0.3119        0    0.1348        0
0.3557        0    0.1627        0
0.4121        0    0.1987        0
0.4845        0    0.2426        0
0.5750        0    0.2920        0
0.6839        0    0.3410        0
0.8084        0    0.3816        0
0.9434        0    0.4056        0
1.0817        0    0.4076        0
1.2153        0    0.3868        0
1.3365        0    0.3478        0
1.4392        0    0.2978        0
1.5199        0    0.2448        0
1.5779        0    0.1948        0
1.6152        0    0.1511        0
1.6354        0    0.1148        0
1.6422        0    0.0854        0
1.6391        0    0.0621        0
1.6291        0    0.0437        0
1.6142        0    0.0294        0
1.5961        0    0.0185        0
1.5760        0    0.0102        0
1.5545        0    0.0039        0
1.5324        0   -0.0007        0
1.5099        0   -0.0040        0
1.4874        0   -0.0065        0
1.4650        0   -0.0082        0
1.4429        0   -0.0095        0
1.4211        0   -0.0104        0
1.3998        0   -0.0111        0
1.3789        0   -0.0115        0
1.3585        0   -0.0118        0
1.3386        0   -0.0120        0
1.3192        0   -0.0121        0
1.3002        0   -0.0122        0
1.2818        0   -0.0122        0
1.2638        0   -0.0122        0
1.2463        0   -0.0121        0
1.2292        0   -0.0120        0
1.2126        0   -0.0119        0
1.1964        0   -0.0118        0
1.1806        0   -0.0117        0
1.1653        0   -0.0116        0
1.1503        0   -0.0115        0
1.1357        0   -0.0113        0
1.1215        0   -0.0112        0
1.1076        0   -0.0111        0
1.0941        0   -0.0109        0
1.0809        0   -0.0108        0
1.0680        0   -0.0107        0
```

```
    1.0554         0   -0.0105         0
    1.0431         0   -0.0104         0
    1.0311         0   -0.0103         0
    1.0194         0   -0.0101         0
    1.0080         0   -0.0100         0
    0.9968         0   -0.0099         0
    0.9859         0   -0.0097         0
    0.9752         0   -0.0096         0
    0.9648         0   -0.0095         0
    0.9546         0   -0.0094         0
    0.9446         0   -0.0093         0
    0.9348         0   -0.0091         0
    0.9253         0   -0.0090         0
    0.9159         0   -0.0089         0
    0.9068         0   -0.0088         0
    0.8978         0   -0.0087         0
    0.8890         0   -0.0086         0
    0.8804         0   -0.0085         0
    0.8719         0   -0.0084         0
    0.8637         0   -0.0083         0
    0.8556         0   -0.0082         0
    0.8476         0   -0.0081         0
    0.8398         0   -0.0080         0
    0.8322         0   -0.0079         0
    0.8247         0   -0.0078         0
    0.8173         0   -0.0077         0
    0.8101         0   -0.0076         0
    0.8030         0   -0.0075         0
    0.7960         0   -0.0074         0
    0.7892         0   -0.0073         0
    0.7825         0   -0.0073         0
    0.7759         0   -0.0072         0
    0.7694         0   -0.0071         0
    0.7631         0   -0.0070         0


analsunseq(:,:,15) =

    0.0410         0    0.0155         0
    0.0427         0    0.0160         0
    0.0445         0    0.0167         0
    0.0464         0    0.0173         0
    0.0483         0    0.0180         0
    0.0504         0    0.0187         0
    0.0526         0    0.0195         0
    0.0550         0    0.0204         0
    0.0575         0    0.0213         0
    0.0602         0    0.0223         0
    0.0631         0    0.0234         0
    0.0662         0    0.0247         0
    0.0697         0    0.0261         0
    0.0736         0    0.0276         0
    0.0780         0    0.0295         0
    0.0830         0    0.0317         0
    0.0890         0    0.0343         0
    0.0960         0    0.0376         0
    0.1045         0    0.0417         0
    0.1150         0    0.0472         0
    0.1279         0    0.0546         0
    0.1439         0    0.0647         0
    0.1641         0    0.0789         0
    0.1900         0    0.0987         0
    0.2240         0    0.1260         0
    0.2690         0    0.1623         0
```

```
    0.3283         0    0.2082         0
    0.4046         0    0.2620         0
    0.4987         0    0.3189         0
    0.6091         0    0.3716         0
    0.7321         0    0.4119         0
    0.8621         0    0.4332         0
    0.9927         0    0.4324         0
    1.1173         0    0.4107         0
    1.2300         0    0.3730         0
    1.3261         0    0.3259         0
    1.4030         0    0.2761         0
    1.4605         0    0.2284         0
    1.4999         0    0.1860         0
    1.5239         0    0.1497         0
    1.5357         0    0.1195         0
    1.5381         0    0.0948         0
    1.5337         0    0.0747         0
    1.5243         0    0.0586         0
    1.5115         0    0.0456         0
    1.4964         0    0.0354         0
    1.4797         0    0.0274         0
    1.4620         0    0.0212         0
    1.4438         0    0.0164         0
    1.4253         0    0.0128         0
    1.4067         0    0.0100         0
    1.3881         0    0.0079         0
    1.3698         0    0.0064         0
    1.3517         0    0.0051         0
     ⋮
     ⋮
```

Synthesis process

```
synlsunnet.Layers(11).InputSize
```

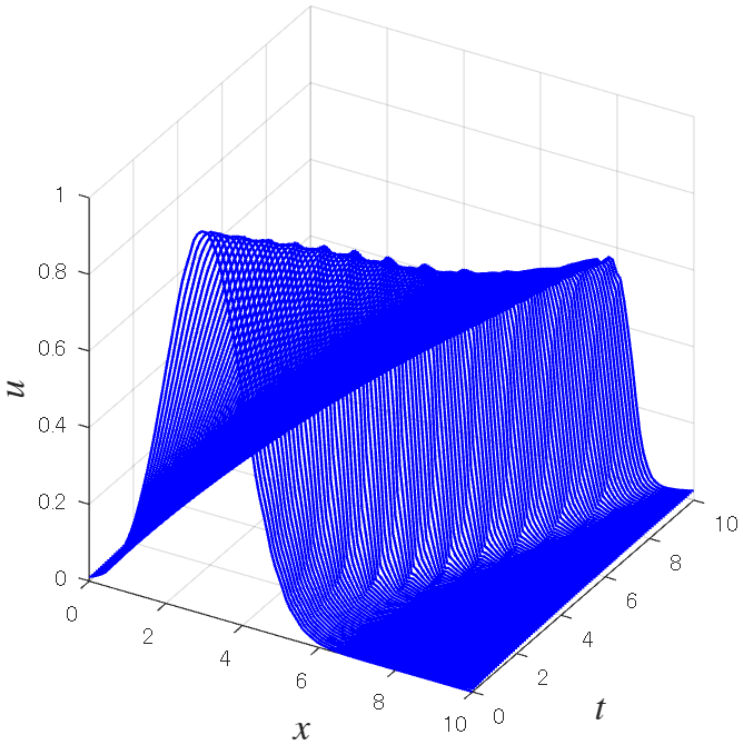
```
ans = 1×3
     3     1    25
```

```
synlsunnet.Layers(12).InputSize
```

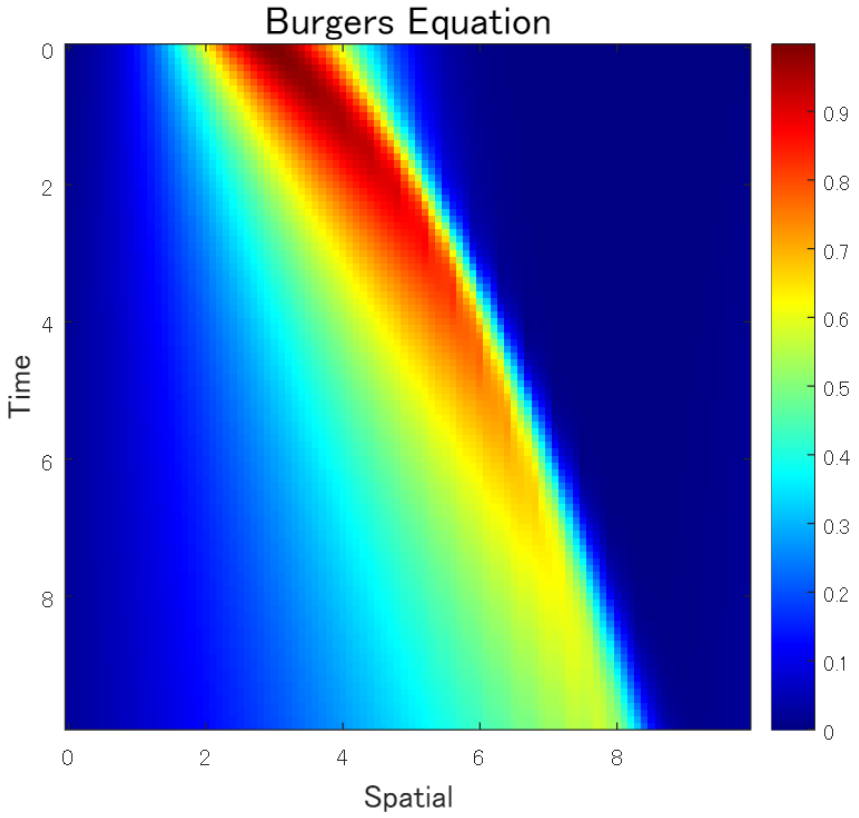
```
ans = 1×3
     1     1    25
```

```
synlsunseq = analsunseq;
DataTaprx = zeros(size(DataT),'like',DataT);
for iT = 1:nT
    ac = permute(synlsunseq(iT,2:end,:),[2 1 3]);
    dc = synlsunseq(iT,1,:);
    DataTaprx(iT,:) = synlsunnet.predict(ac,dc);
end
```

```
figure
disp_plot3_(T,X,DataTaprx)
```




```
figure
disp_imagesc_(T,X,DataTaprx)
```



```
% MSE 評価
mse(DataT,DataTaprx)
```

```
ans = 1.3529e-05
```

```
% !!! By YASAS
%{
% Ananalyzer
dlY = forward(trainnet,dlX);

%DC and 1 AC channel
dcac = squeeze(gather(extractdata(dlY)));
dcac_ = zeros(1,size(dcac,2)*2,100)
for i = 0:size(dcac,2)-1
    dcac_(1,(i*2)+1,:) = dcac(1,i+1,:);
    dcac_(1,(i*2)+2,:) = dcac(2,i+1,:);
end
dtaa = reshape(dcac_,[size(dcac,2)*2,100]);
%}
```

```
% Construction of Hankel matrix
%x = dtaa.';
nDelay = 10
ts = [];
H = [];
nRange = size(x,1)-1;
for k = 0:nRange-nDelay
    xkT = [];
    for iDelay = 0:nDelay
        xkT = cat(2,xkT,x(k+iDelay+1,:));
    end
    H = cat(2,H,xkT.');
end
H
```

Step 2 SVD of H

```
[U,Sgm,V] = svd(H,'econ')
```

Step 3 PCT

```
iMode = 1
ui = reshape(U(:,iMode),size(x,2),[]).'
```

Visualize

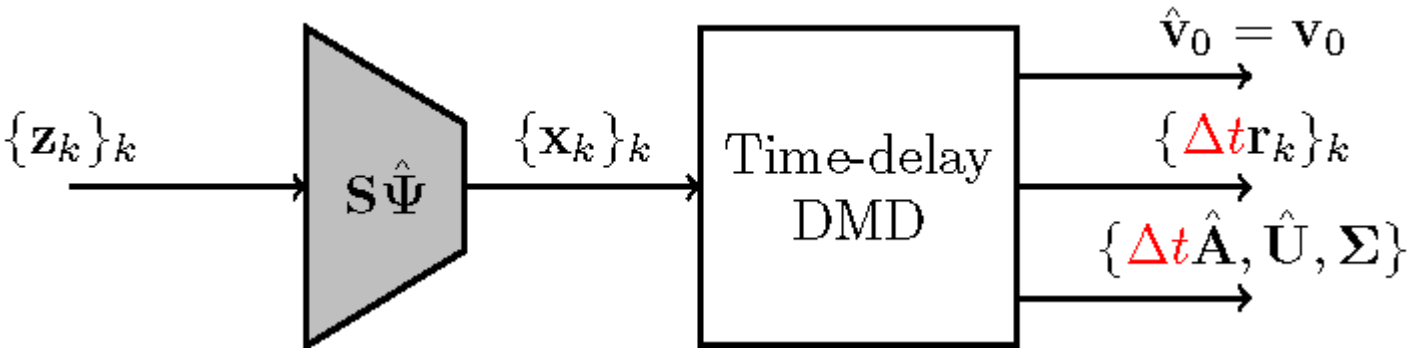
```
%myplot(T(1:size(ui,1)),ui)
```

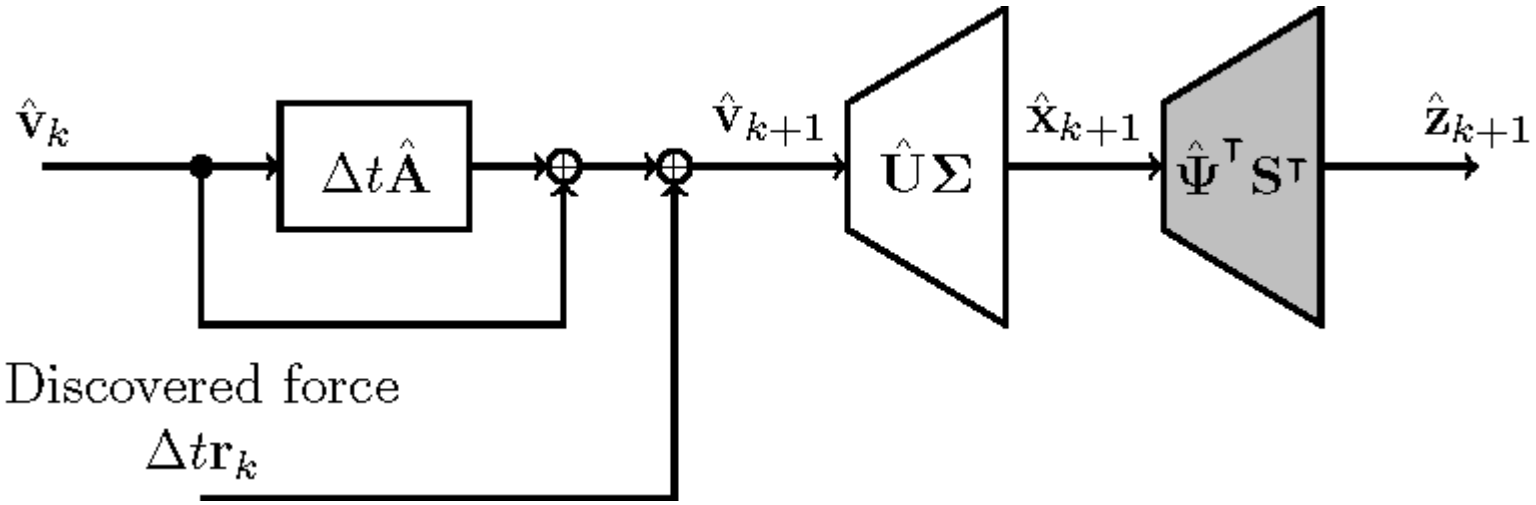
```
V0 = V(1:end-1,:);
V1 = V(2:end,:);
dtAplusI = (V1.')*pinv(V0.')
```

Step 4 Discover forcinge signal

```
v0hat = V(1,:).';
vk = v0hat;
dtrk_ = 0;
dtr = [];
for k = 1:nRange-nDelay
    % True value
    vkp1 = V(k+1,:).';
    % Forcasted value
    vkp1hat = dtAplusI*vk;
    % Forcing signal
    dtrk_ = vkp1 - vkp1hat;
    % Update
    vk = vkp1;
    dtr = cat(2,dtr,dtrk_);
end
```

Learnable parameters





Parameters

$\hat{\mathbf{v}}_0$

```
v0hat
```

$\{\Delta t\mathbf{r}_k\}$

```
dtr
```

$\mathbf{I} + \Delta t\hat{\mathbf{A}}$

```
dtAplusI
```

$\hat{\mathbf{U}}$

```
Uhat = U(1:ndim,:);
Uhat
```

$\boldsymbol{\Sigma}$

```
Sgm
```

Step 5 w/ Discovered forcing signal

```
vkhat = v0hat;
dtrk = dtr(:,1);
Xhat = (Uhat*Sgm*vkhat).';
for k = 1:nRange-nDelay
```

```
    dtrk = dtr(:,k);
    vkp1hat = dtAplusI*vkhat + dtrk;
    Xhat = cat(1,Xhat,(Uhat*Sgm*vkp1hat).');
    % Update
    vkhat = vkp1hat;
end
```

Visualize

```
%myplot(T(1:size(Xhat,1)),Xhat);
```

Step 6 w/o Discorverd forcing signal

```
vkhat = v0hat;
dtrk = dtr(:,1);
Xhat = (Uhat*Sgm*vkhat).';
for k = 1:nRange-nDelay
    dtrk = dtr(:,k);
    vkp1hat = dtAplusI*vkhat; % + dtrk;
    Xhat = cat(1,Xhat,(Uhat*Sgm*vkp1hat).');
    % Update
    vkhat = vkp1hat;
end
```

```
import tansacnet.lsun.*
% Construction of analysis network
trainlgraph = layerGraph(trainnet);
synthesislgraph = fcn_cpparamsana2syn(synthesislgraph,trainlgraph);
synthesislgraph = fcn_cpparamsana2syn_csax_(synthesislgraph,trainlgraph);

% analysislgraph = layerGraph(analysisnet);
% synthesislgraph = fcn_cpparamsana2syn(synthesislgraph,analysislgraph);
% synthesislgraph = fcn_cpparamsana2syn_csax_(synthesislgraph,analysislgraph);
synthesisnet = dlnetwork(synthesislgraph);
```

```
% Reconstruction of output to be sent throughr LSUN synthesizer
Aa = zeros(4,1,size(dcac,2),size(Xhat,1));
for i = 0:size(dcac,2)-1
    Aa(1,1,i+1,:) = Xhat(:,(i*4)+1);
    Aa(2,1,i+1,:) = Xhat(:,(i*4)+2);
    Aa(3,1,i+1,:) = Xhat(:,(i*4)+3);
    Aa(4,1,i+1,:) = Xhat(:,(i*4)+4);
end

%Aa = reshape(Xhat,[4,1,25,size(Xhat,1)]);
Dc = dlarray(Aa(1,1,:,:),"SSCB");
Ac = dlarray(Aa(2:end,1,:,:),"SSCB");
```

```
%Ad = forward(synthesisnet,Ac,Ab);
Ad = synthesisnet.predict(Dc,Ac);
```

```
Ae = reshape(gather(extractdata(Ad)),[100,size(Xhat,1)]);

% Load sequences
arrds = arrayDatastore(Ae.',"ReadSize",1,"IterationDimension",1);
%arrds = transform(arrds,@(x) cell2mat(x));
figure
arr = cell2mat(preview(arrds));
for idx = 1:height(arr)
 plot(arr(idx,:))
 hold on
end
hold off
```

```
figure
orangered = [255 69 0]/255;
disp_plot3_(T(1:90),X(1:90),Ae,orangered)

figure
disp_imagesc_(T(1:90),X(1:90),Ae)
```

Function definition.

Peter Mao (2023). fftfreq(https://www.mathworks.com/matlabcentral/fileexchange/67026-fftfreq), MATLAB Central file exchange. Retrieved, 6 January 2023.

```
function f=fftfreq(npts,dt,alias_dt)
% returns a vector of the frequencies corresponding to the length
% of the signal and the time step.
% specifying alias_dt > dt returns the frequencies that would
% result from subsampling the raw signal at alias_dt rather than
% dt.


 if (nargin < 3)
 alias_dt = dt;
 end
 fmin = -1/(2*dt);
 df = 1/(npts*dt);
 f0 = -fmin;
 alias_fmin = -1/(2*alias_dt);
 f0a = -alias_fmin;

 ff = mod(linspace(0, 2*f0-df, npts)+f0, 2*f0) - f0;
 fa = mod( ff+f0a, 2*f0a) - f0a;
```

```
 % return the aliased frequencies
 f = fa;
end
```

Definition of ODE system (PDE ---(FFT)---> ODE system)

```
%Definition of ODE system (PDE ---(FFT)---> ODE system)
function u_t_real = burg_system(u, t, k,mu,nu)
 %Spatial derivative in the Fourier domain
 u_hat = fft(u);
 u_hat_x = 1j*k(:).*u_hat;
 u_hat_xx = -(k(:).^2).*u_hat;

 %Switching in the spatial domain
 u_x = ifft(u_hat_x);
 u_xx = ifft(u_hat_xx);

 %ODE resolution
 u_t = -mu*u.*u_x + nu*u_xx;
 u_t_real = real(u_t);
end
```

Function to extract a local patch block from a global array

```
function y = fcn_extract_blks_(x,iBlk,blksz,kx)
% Extend array x
padsz = [0 (kx-1)*blksz/2];
xx = padarray(x,padsz,"circular");
%
posx = (iBlk-1)*blksz+1;
y = xx(:,posx:posx+kx*blksz-1);
end
```

Function to place a local patch block to a global array

```
function y = fcn_place_blks_(y,blk,iBlk,blksz)
% Extend array x
posx = (iBlk-1)*blksz+1;
y(:,posx:posx+blksz-1) = blk;
end
```

Loss function

where is a unitaly analyzer with a coefficient mask. is guaranteed.

```
function [loss,gradients] = modelLoss(dlnet, dlX)
% Forward data through the dlnetwork object.
dlY = forward(dlnet,dlX); % F(x)
```

```
% Compute loss.
Nx = size(dlX,4);
Ny = size(dlY,4);
loss = sum(dlX.^2,"all")/Nx-sum(dlY.^2,"all")/Ny;
% Compute gradients.
gradients = dlgradient(loss,dlnet.Learnables);
loss = double(gather(extractdata(loss)));
end
```

```
function disp_plot3_(T,X,DataT,c)
if nargin < 4
 c = 'blue';
end
for idx = 1:length(X)
 plot3(X,T(idx)*ones(size(X)),DataT(idx,:),...
 'Color',c,...
 'LineWidth',1)
 hold on
end
xlabel('$x$', 'FontSize',14,'Interpreter','latex')
ylabel('$t$', 'FontSize',14,'Interpreter','latex')
zlabel('$u$', 'FontSize',14,'Interpreter','latex')
ax = gca;
ax.View = [30 30];
ax.PlotBoxAspectRatio = [ 1 1 1];
grid on
hold off
end
```

```
function disp_imagesc_(T,X,DataT)
imagesc(DataT)
colormap("jet")
colorbar
title('Burgers Equation','FontSize',15)
xlabel('Spatial','FontSize',12)
ylabel('Time','FontSize',12)
ax = gca;
ax.PlotBoxAspectRatio = [1 1 1];
ax.XTick = 1:20:100;
ax.XTickLabel = round(X(ax.XTick));
ax.YTick = 1:20:100;
ax.YTickLabel = round(T(ax.YTick));
end
```

```
function disp_plotmv_(ax,T,X,DataT,AprxT)
     a = DataT(1,:);
     b = AprxT(1,:);
     p = plot(ax,X,a,X,b);
     axis([min(X) max(X) min(DataT(:)) max(DataT(:))])
     xlabel('x')
     grid on
     hold on
     drawnow
     for iT = 2:length(T)
     a = DataT(iT,:);
     b = AprxT(iT,:);
     p(1).YData = a;
     p(2).YData = b;
     drawnow
     end
     hold off
end
```

```
function synthesislgraph = fcn_cpparamsana2syn_csax_(synthesislgraph,analysislgraph)
expanalyzer = '^Lv\d+_Cmp\d+_Q(\w\d|0)+(\w)+$';
nLayers = height(analysislgraph.Layers);
for iLayer = 1:nLayers
     alayer = analysislgraph.Layers(iLayer);
     alayerName = alayer.Name;
         if ~isempty(regexp(alayerName,expanalyzer,'once'))
         slayer = synthesislgraph.Layers({synthesislgraph.Layers.Name} ==
alayerName + "~");
         slayer.Angles = alayer.Angles;
         synthesislgraph = synthesislgraph.replaceLayer(slayer.Name,slayer);
         disp("Copy angles from " + alayerName + " to " + slayer.Name)
         end
end
end
```

```
function analysislgraph = fcn_cpparamssyn2ana_csax_(analysislgraph,synthesislgraph)
expanalyzer = '^Lv\d+_Cmp\d+_Q(\w\d|0)+(\w)+$';
nLayers = height(analysislgraph.Layers);
for iLayer = 1:nLayers
 alayer = analysislgraph.Layers(iLayer);
 alayerName = alayer.Name;
     if ~isempty(regexp(alayerName,expanalyzer,'once'))
     slayer = synthesislgraph.Layers({synthesislgraph.Layers.Name} == alayerName +
"~");
     alayer.Angles = slayer.Angles;
     analysislgraph = analysislgraph.replaceLayer(alayerName,alayer);
```

```
     disp("Copy angles from " + slayer.Name + " to " + alayerName)
     end
end
end
```

```
function myplot(t,x)

subplot(1,2,1)
plot(t,[x(:,1)+15 x(:,2)-5 x(:,3)-45]);
axis([0 30 -80 80])
set(gca,'ytick',[-40 0 40],'yticklabel',{'x3','x2','x1'})
xlabel('t')
title('Burgers Eq')

subplot(1,2,2)
plot3(x(:,1),x(:,2),x(:,3));
xlabel('x1')
ylabel('x2')
zlabel('x3')

end
```

```
function fcn_replace_emptyangles_(lsunlgraph)
explayer = '^Lv\d+_Cmp\d+_V(\w\d|0)+(~|)$';
nLayers = height(lsunlgraph.Layers);
for iLayer = 1:nLayers
    layer_ = lsunlgraph.Layers(iLayer);
    if ~isempty(regexp(layer_.Name,explayer,'once'))
        if isa(layer_,"tansacnet.lsun.lsunIntermediateFullRotation1dLayer") &&
isempty(layer_.Angles)
            newlayer = tansacnet.lsun.lsunSign1dLayer( ...
                'Name',layer_.Name, ...
                'Stride',layer_.Stride, ...
                'Mode',layer_.Mode, ...
                'NumberOfBlocks',layer_.NumberOfBlocks, ...
                'Mus',layer_.Mus);
            lsunlgraph = lsunlgraph.replaceLayer(layer_.Name,newlayer);
            display("Replaced " + layer_.Name + " to " + class(newlayer))
        end
    end
end
end
```