Validation-SimpleSupportBeam-CustomerLikelihood

This example is on Bayesian inversion - Simple beam | Examples | UQLab with known forward model. This document is a test to see how Uqlab customerLikelihood works.

1 - INITIALIZE UQLAB

```
clearvars
rng(100,'twister')
uqlab
```

```
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C:\NY2023\D_document\UQLab_Rel2.0.0\LICENSE.

To request special permissions, please contact:
  - Stefano Marelli (marelli@ibk.baug.ethz.ch).

Useful commands to get started with UQLab:
uqlab -doc           - Access the available documentation
uqlab -help          - Additional help on how to get started with UQLab
uq_citation help   - Information on how to cite UQLab in publications
uqlab -license       - Display UQLab license information
```
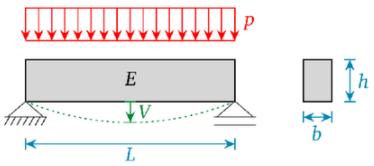

2 - PRIOR DISTRIBUTION



The forward model $V = \frac{5pL^4}{32Ebh^3}$ in inbuilt in the logLikelihood function, b,h,L are constants are not shown in the prior

```
%Priors on E and p
PriorOpts.Marginals(1).Name = 'E';                % Young's modulus
PriorOpts.Marginals(1).Type = 'LogNormal';
PriorOpts.Marginals(1).Moments = [30 4.5]*1e9;    % (N/m^2)

PriorOpts.Marginals(2).Name = 'p';                % uniform load
PriorOpts.Marginals(2).Type = 'Gaussian';
PriorOpts.Marginals(2).Moments = [12000 600]; % (N/m)

% Discrepancy parameters
```

```
PriorOpts.Marginals(3).Name = 'sigma2'; % variance
PriorOpts.Marginals(3).Type = 'Uniform';
PriorOpts.Marginals(3).Parameters = [0 0.01259^2]; % (m^2) Consistent with given
example
myPriorDist = uq_createInput(PriorOpts);
```

3 - Define the custom-loglikelihood

$$\mathcal{L}(\boldsymbol{x};\mathcal{Y}) = \prod_{i=1}^{N} \mathcal{N}(\boldsymbol{y}_i|\mathcal{M}(\boldsymbol{x}),\boldsymbol{\Sigma})$$
$$= \prod_{i=1}^{N} \frac{1}{\sqrt{(2\pi)^{N_{\text{out}}}\det(\boldsymbol{\Sigma})}} \exp\left(-\frac{1}{2}\left(\boldsymbol{y}_i - \mathcal{M}(\boldsymbol{x})\right)^{\intercal}\boldsymbol{\Sigma}^{-1}\left(\boldsymbol{y}_i - \mathcal{M}(\boldsymbol{x})\right)\right)$$

```
myLogLikeli = @(params,y) myLOGlikeli(params,y);
```

4 - MEASUREMENT DATA

```
%Consistent with given example
myData.y = [12.84; 13.12; 12.13; 12.19; 12.67]/1000; % (m)
myData.Name = 'Mid-span deflection';
```

5 - Bayes Analysis

Consistent with example

```
BayesOpts.Data = myData;
BayesOpts.LogLikelihood = myLogLikeli;
BayesOpts.Type = 'inversion';
BayesAnalysis = uq_createAnalysis(BayesOpts);
```

```
The solver was not specified, using MCMC
The sampler was not specified, using affine invariant ensemble sampler
Starting AIES...

|##############################| 100.00%

Finished AIES!
```

6 - Postprocess results

Ground truth should be:

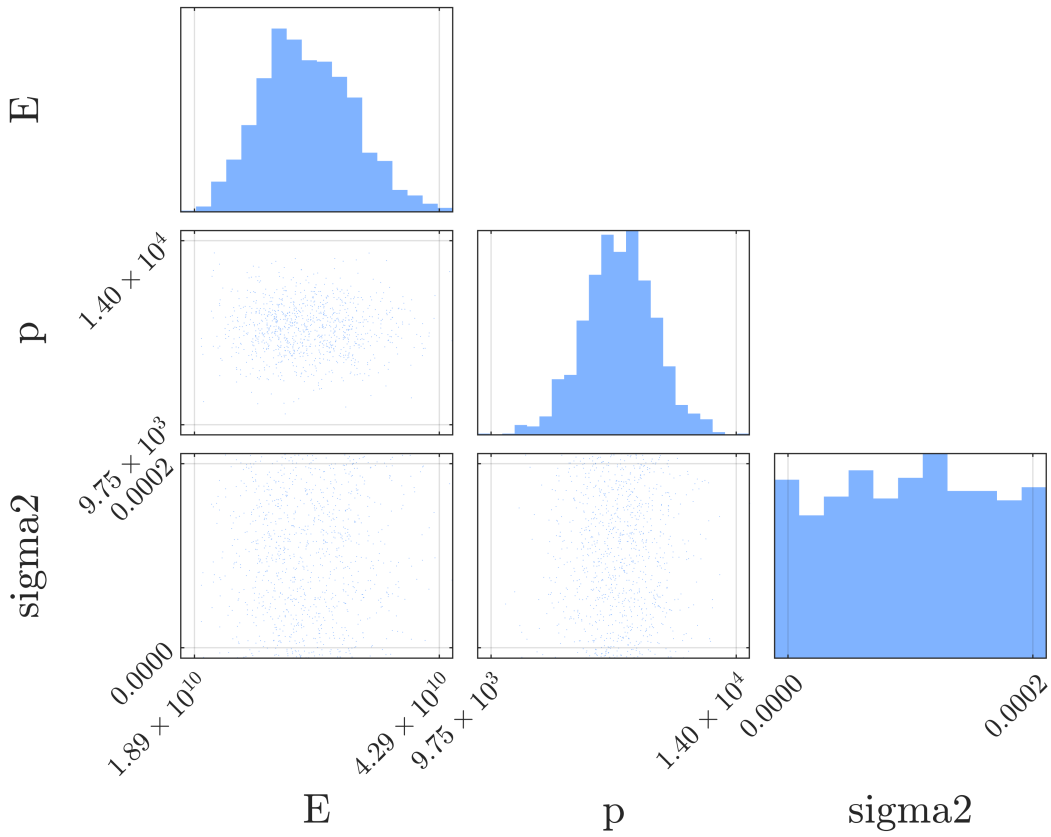
```
%------------------ Posterior Marginals
------------------------------------------------------------------------
| Parameter | Mean     | Std      | (0.025-0.97) Quant. | Type        |
------------------------------------------------------------------------
| E         | 2.4e+10 | 2.1e+09 | (2.1e+10 - 3e+10)    | Model       |
| p         | 1.2e+04 | 5.9e+02 | (1.1e+04 - 1.3e+04) | Model       |
| Sigma2    | 4.2e-06 | 1.3e-05 | (1e-07 - 3.8e-05)    | Discrepancy |
------------------------------------------------------------------------

%------------------ Point estimate
----------------------------------------
| Parameter | Mean     | Parameter Type |
----------------------------------------
| E         | 2.4e+10 | Model          |
| p         | 1.2e+04 | Model          |
| Sigma2    | 4.2e-06 | Discrepancy    |
```

```
uq_print(BayesAnalysis)
```

```
%----------------------- Inversion output -----------------------%
   User-specified likelihood used
%------------------- Solver
   Solution method:                                MCMC

   Algorithm:                                      AIES
   Duration (HH:MM:SS):                            00:00:28
   Number of sample points:                        3.00e+04

%------------------- Posterior Marginals
------------------------------------------------------------------
| Parameter | Mean    | Std     | (0.025-0.97) Quant. | Type  |
------------------------------------------------------------------
| E         | 2.4e+10 | 2.1e+09 | (2.1e+10 - 3e+10)   | Model |
| p         | 1.2e+04 | 5.9e+02 | (1.1e+04 - 1.3e+04) | Model |
| sigma2    | 4.2e-06 | 1.3e-05 | (1e-07 - 3.8e-05)   | Model |
------------------------------------------------------------------

%------------------- Point estimate
----------------------------------------
| Parameter | Mean    | Parameter Type |
----------------------------------------
| E         | 2.4e+10 | Model          |
| p         | 1.2e+04 | Model          |
| sigma2    | 4.2e-06 | Model          |
----------------------------------------

%------------------- Correlation matrix (model parameters)
--------------------------------------
|        |  E       p        sigma2  |
--------------------------------------
| E      |  1       0.46     0.51    |
| p      |  0.46    1        -0.11   |
| sigma2 |  0.51    -0.11    1       |
--------------------------------------
```

```
uq_display(BayesAnalysis);
```

Prior Sample



Posterior Sample