WebPPL is a feature-rich probabilistic programming language embedded in Javascript.

Check out some **demos** or try it yourself in the editor below.

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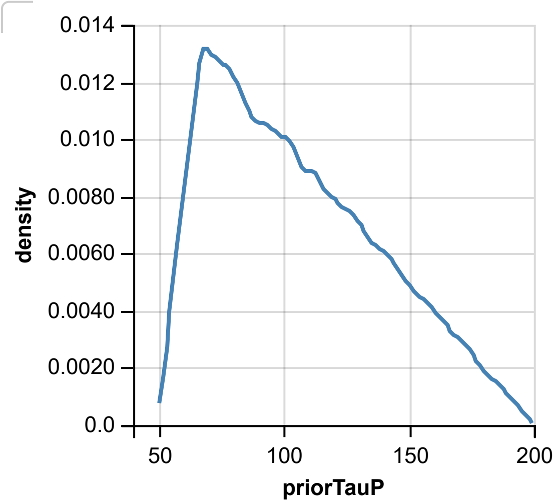
```
print("==============================================================================")
print("PCM20201213_TriangleMedianPrior&RiskCalculation            *** 2020/12/13 *** ")
print("  see also Simple Reaction Time, Example 9, Card, Moran & Newell, 1983, p.66  ")
print("  see also https://www.humanbenchmark.com/tests/reactiontime/statistics       ")
print("  here we use the triangular distribution as a prior distribution             ")
print("  see also https://en.wikipedia.org/wiki/Triangular_distribution              ")
print("  CMN-interval 'typical[fast ~ slow]' is interpreted ...                      ")
print("            as  triangle(fast=a, slow=b, 'typical'=median=c)                  ")
print("==============================================================================")
/**
 * @author - Claus Moebus   <claus.moebus@uol.de>
 */
//------------------------------------------------------------------------------------------
/**
 * @variable {number} startTime - used in method 'runtime' to compute runtime in sec and min
 */
var startTime = Date.now()
//------------------------------------------------------------------------------------------
print("Input parameter:")
/**
 * @variable {integer} nTrials - no of efficient samples (incl. burnout) in MCMC-sampling
 */
var nTrials = 6E4
print("nTrials = " + nTrials)
//------------------------------------------------------------------------------------------
/**
 * @variable {integer} nSigma - no of standard deviations between mean and 'slow', 'fast'
 *                              interval boundaries
 */
var nSigma = 3
print("nSigma = " + nSigma)
//------------------------------------------------------------------------------------------
/**
 * @variable {integer} myBurnPeriod - length of burnin period in MCMC process
 */
var myBurnPeriod = nTrials * 0.10
print("length of burn-in period = " + myBurnPeriod)
//------------------------------------------------------------------------------------------
/**
 * @variable {integer} myLag - only every myLag-th sample will be retained during MCMC
 */
var myLag = 10
print("length of lag = " + myLag)
//------------------------------------------------------------------------------------------
/**
 * @variable {array} data - author's reaction times in an experiment found here
 *                           https://www.humanbenchmark.com/tests/reactiontime/
 *                           visited March 2018
 */
var data =
    [458, 292, 228, 403, 271, 420, 350, 235, 260, 306]
print("response time data = [" + data + "]")
print("mean of data  = " + listMean(data))
print("stdev of data = " + listStdev(data))
print("-----------------------------------------------------------------------------")
/**
 * @function seqOfThresholds - generates an array of thresholds between min and max
 * @property {number}  min - minimum = fastman's value
 * @poperty  {number}  max - maximum = slowman's value
 */
var seqOfThresholds = function(min, max) {
  var range = max - min
  var stepSize =  range/50
  var increment = function(x) {x * stepSize + min}
  mapN(increment, Math.floor(range/stepSize + 1))
}
//------------------------------------------------------------------------------------------
/**
 * @variable {array} tauPCrit   - critical values-at-risk in msec for tauP
 * @variable {array} tauCCrit   - critical values-at-risk in msec for tauC
 * @variable {array} tauMCrit   - critical values-at-risk in msec for tauM
 * @variable {array} tauSumCrit - critical values-at-risk in msec for tauSum
 */
var tauPCrit   = seqOfThresholds(100, 200) // from typical value upto slowmans value
var tauCCrit   = seqOfThresholds( 70, 170) // from typical value upto slowmans value
var tauMCrit   = seqOfThresholds( 70, 100) // from typical value upto slowmans value
var tauSumCrit = seqOfThresholds(240, 470) // from typical value upto slowmans value
print("-----------------------------------------------------------------------------")
/**
 * @description - function hyperParmTauX returns the parameter c=mode fom input parameters
 *                        - 'typical'=median, fast=a, and slow=b are taken from MHP
 *                        -  returns mode=c
 * @ function hyperParmTauX
 * @param   {number} 'typical' - value is the median value of the CMN-interval
 * @param   {number}         a - value is the 'fast' parameter of Triangle(a, b, c)
 * @param   {number}         b - value is the 'slow' parameter of Triangle(a, b, c)
 * @returns {number}         c - value is the mode c parameter of Triangle(a, b, c)
 */
var hyperParmTauX = function(md, a, b) {
  var c1 =   2*Math.pow(md-a, 2)/(b-a) + a
  var c2 = - 2*Math.pow(md-b, 2)/(b-a) + b
  var c  = (c1 >= (a + b)/2) ? c1 : c2
  return{c:c, a:a, b:b}
}
var hyperParmTauP = hyperParmTauX(100.0, 50.0, 200.0)
print("hyperParmTauP = {c: " + hyperParmTauP.c + ", a:" + hyperParmTauP.a +
      ", b:" + hyperParmTauP.b + "}")
var hyperParmTauC = hyperParmTauX(70.0, 25.0, 170.0)
print("hyperParmTauC = {c: " + hyperParmTauC.c + ", a:" + hyperParmTauC.a +
      ", b:" + hyperParmTauC.b + "}")
var hyperParmTauM = hyperParmTauX(70.0, 30.0, 100.0)
print("hyperParmTauM = {c: " + hyperParmTauM.c + ", a:" + hyperParmTauM.a +
      ", b:" + hyperParmTauM.b + "}")
print("-----------------------------------------------------------------------------")
/**
 * @object hyperParmSigmaTauSum - shape=a and scale=b for variance of Gaussian Likelihood
 * @property {number} a - value is the shape parameter of Gamma(a, b)
 * @property {number} b - value is the scale parameter of Gamma(a, b)
 */
var hyperParmSigmaTauSum = {a:4.0, b:20.0}
print("hyperParmSigmaTauSum = {a:" + hyperParmSigmaTauSum.a + ", b:" + hyperParmSigmaTauSum.
print("-----------------------------------------------------------------------------")
//------------------------------------------------------------------------------------------
// function definitions
//------------------------------------------------------------------------------------------
/**
 * @function runtime - method to compute the runtime in seconds and minutes
 */
var runTime = function() {
  var stopTime = Date.now()
  var runSecs = (stopTime - startTime)/1000
  var runMins = runSecs/60
  print("runtime in seconds = " + runSecs)
  print("runtime in minutes = " + runMins)}
//------------------------------------------------------------------------------------------
/**
 * @description - descriptive statistics of a sample-generated distribution
 * @function myTauXDistribution
 * @param {string} id - The identifier of the tauX distribution.
 * @param {distributionObject} tauXDistribution - tauX distribution (X = P, C, M, T)
 * @param {number} modeTauX - mode of tauX as a function of a and b
 *                            mode = (a-1)*b for a >= 1
 * @returns {object} meanSigmaTauObject - object with mean and sigma of TauX
 * @property {number} meanTauX - mean of tauX (X = P, C, M, T) or tau
 * @property {number} sigmaTauX - standard deviation of tauX (X = P, C, M, T) or tau
 */
var myTauXDescription = function(id, tauXDistribution, modeTauX) {
  var myTauXDistribution = { // extraction of probs and support from WebPPL tauX distributio
    probs: map(function(eventTuple){ // object to compute mean and sigma of tauX
      Math.exp(tauXDistribution.score(eventTuple))}, tauXDistribution.support()),
    support: tauXDistribution.support()}
  print(id)
  // mode(tauX), mean(tauX), variance(tauX) and sigma(tauX)
  print("mode = " + modeTauX)
  var meanTauX = sum(map2(function(value, prob) {
    value*prob},myTauXDistribution.support, myTauXDistribution.probs))
  print("mean = " + meanTauX)
  var sigmaTauX = Math.sqrt(sum(map2(function(value, prob) {
    Math.pow((value-meanTauX), 2)*prob},
                                     myTauXDistribution.support,
                                     myTauXDistribution.probs)))
  print("sigma = " + sigmaTauX)
  var tauX_Intval = {fast:meanTauX - nSigma * sigmaTauX, mean:meanTauX,
                     slow:meanTauX + nSigma * sigmaTauX}
  return tauX_Intval}
//------------------------------------------------------------------------------------------
/**
 * @description - cdf computes the cumulative density function P(X <= c)
 * @function cdf
 * @param {distributionObject} distrObject - must be generated by function 'Infer'
 * @param {real} c - function argument of cdf F(c) = P(X <= c)
 * @returns {real} - F(c) = P(X <= c)
 */
var cdf = function(distrObject, c) {
  var support = distrObject.support()
  var probs = map(function(xValue){
    Math.exp(distrObject.score(xValue))
  }, support)
  sum(map2(function(prob, xValue) {
    xValue <= c ? prob : 0
  }, probs, support))
}
//-------------------------------------------------------------
/**
 * @description - probsAtRisk computes the cumulative density function 1-F(c) = P(X > c)
 * @function probsAtRisk
 * @param {distributionObject} distrObject - must be generated by function 'Infer'
 * @param {real} valsAtRisk - function arguments of cdf 1-F(c) = P(X > c)
 * @returns {array} - F(c_i) = P(X <= c_i)  ; i = 1, ...
 */
var probsAtRisk = function (distrObject, valsAtRisk) {
  map(function(valAtRisk) {
    1.0 - cdf(distrObject, valAtRisk)
  }, valsAtRisk)
}
//-------------------------------------------------------------
/**
 * @ description - prints a table of two column vectors:
 *               -  values-at-risk and risk probabilities
 */
var printRiskProbs = function(valsAtRisk, valsAtRiskText, probs) {
  /*
  map2(function(valAtRisk, prob) {
    print(valsAtRiskText + " = " +  valAtRisk + ";  risk probability = " + prob)
  }, valsAtRisk, probs)
  */
}
//-------------------------------------------------------------
/**
 * @description - prints a table of two column vectors:
 *              - values-at-risk and increase of risk probabilities
 * @function printDiffProbs
 */
var displayDiffProbs = function(valsAtRisk, valsAtRiskText, probsPrior, probsPosterior) {
  var probDiffs = map2(function(priorPr, postPr) {
    postPr - priorPr  // change
  }, probsPrior, probsPosterior)
  map2(function(valAtRisk, probDiff) {
    if (probDiff < 0.05) {print(valsAtRiskText + " = " +  valAtRisk
                                + "; increase in risk probs = " + probDiff)}
    else {/* empty */ ;}}
      , valsAtRisk, probDiffs)
  viz.line(valsAtRisk, probDiffs, {xLabel: valsAtRiskText, yLabel: "Risk Excess"})
}
//===========================================================================================
/**
 * @description         - draws one sample from the Triangle(a, b, c)-distribution
 *                      - // https://en.wikipedia.org/wiki/Triangular_distribution
 * @function            - oneSampleOfTriangle
 * @param (number) fast - is the lower bound of the CMN-interval and a of Triangle(a, b, c)
 * @param (number) slow - is the upper bound of the CMN-interval and b of Triangle(a, b, c)
 * @param (number) mode - is the mode of the CMN-interval  and param c of Triangle(a, b, c)
 */
var oneSampleOfTriangle = function(a, b, c) {
  var u  = sample(Uniform({a:0, b:1}))
  var ba = b - a
  var bc = b - c
  var ca = c - a
  var Fc = ca / ba
  var x  = (0 < u) && (u < Fc) ?
      (a + Math.sqrt(u * ba * ca)) :
      (b - Math.sqrt((1 - u) * ba * bc))
  return x
}
//
//------------------------------------------------------------------------------------------
/**
 * @function oneSampleOfPriors      - takes  o n e  sample from all priors tauP, tauC, tauM,
 *                                  -  tauSum = tauP + tauC + tauM, and sigmaTauSum
 * @returns {object} sampleOfPriors - o n e  priors-tuple
 * @returns {object} priorSigmaTauSum - o n e  sample from the Gamma distr
 *                                  - this is prior sigma for the Gaussian likelihood
 */
var oneSampleOfPriors = function () {
  var priorTauP = oneSampleOfTriangle(hyperParmTauP.a,hyperParmTauP.b,hyperParmTauP.c)
  var priorTauC = oneSampleOfTriangle(hyperParmTauC.a,hyperParmTauC.b,hyperParmTauC.c)
  var priorTauM = oneSampleOfTriangle(hyperParmTauM.a,hyperParmTauM.b,hyperParmTauM.c)
  var priorTauSum = priorTauP + priorTauC + priorTauM
  var priorSigmaTauSum =
      sample(Gamma({shape:hyperParmSigmaTauSum.a, scale:hyperParmSigmaTauSum.b}))
  return {priorTauP:priorTauP, priorTauC:priorTauC, priorTauM:priorTauM,
          priorTauSum:priorTauSum, priorSigmaTauSum:priorSigmaTauSum}
}
//-----------------------------------------------------------------------------------
/**
 * @description - Infer generates an multivariate prior distribution for TauX
 * @variable {distribution} priorTauX - value is a WebPPL distribution object
 */
var priorTauX = Infer({model:oneSampleOfPriors, method: 'forward', samples: nTrials})
print('Univariate Priors TauX (X=P, C, M, Sum, SigmaTauSum) ~ Gamma(???, ???)')
viz.marginals(priorTauX)
print("-----------------------------------------------------------------------------")
print("model-generated "+ nSigma + "*sigma tau-interval: ")
var priorTauPIntval =
    myTauXDescription("priorTauP", marginalize(priorTauX,'priorTauP'), "unknown")
print("{fast:" + priorTauPIntval.fast + "  mean:" + priorTauPIntval.mean + "  slow:" + prior
var tauPProbsPrior = probsAtRisk(marginalize(priorTauX,'priorTauP'), tauPCrit)
printRiskProbs(tauPCrit, 'tauPCrit', tauPProbsPrior)
print("-----------------------------------------------------------------------------")
var priorTauCIntval =
    myTauXDescription("priorTauC", marginalize(priorTauX,'priorTauC'), "unknown")
print("{fast:" + priorTauCIntval.fast + "  mean:" + priorTauCIntval.mean + "  slow:" + prior
var tauCProbsPrior = probsAtRisk(marginalize(priorTauX,'priorTauC'), tauCCrit)
printRiskProbs(tauCCrit, 'tauCCrit', tauCProbsPrior)
print("-----------------------------------------------------------------------------")
var priorTauMIntval =
    myTauXDescription("priorTauM", marginalize(priorTauX,'priorTauM'), "unknown")
print("{fast:" + priorTauMIntval.fast + "  mean:" + priorTauMIntval.mean + "  slow:" + prior
var tauMProbsPrior = probsAtRisk(marginalize(priorTauX,'priorTauM'), tauMCrit)
printRiskProbs(tauMCrit, 'tauMCrit', tauMProbsPrior)
print("-----------------------------------------------------------------------------")
var priorTauSumIntval =
    myTauXDescription("priorTauSum", marginalize(priorTauX,'priorTauSum'), "unknown")
print("{fast:" + priorTauSumIntval.fast + "  mean:" + priorTauSumIntval.mean + "  slow:" + p
var tauSumProbsPrior = probsAtRisk(marginalize(priorTauX,'priorTauSum'), tauSumCrit)
printRiskProbs(tauSumCrit, 'tauSumCrit', tauSumProbsPrior)
print("-----------------------------------------------------------------------------")
var priorSigmaTauSum_Intval =
    myTauXDescription("priorSigmaTauSum", marginalize(priorTauX,'priorSigmaTauSum'), "unknow
print("model-generated "+ nSigma + "*sigma tau-interval: ")
print("{fast:" + priorSigmaTauSum_Intval.fast + "  mean:" + priorSigmaTauSum_Intval.mean + "
print("=============================================================================")
/**
 * @function oneSampleOfModel - takes  o n e  sample from the priors
 * @returns {object} posteriorTauSum - returns  o n e  sample of posterior TauSum-tuple
 */
var oneSampleOfModel = function() {
  /**
   * @variable {number} PriorTauSum - a sample from Gamma TauSum-distribution
   */
  var priorTauP = oneSampleOfTriangle(hyperParmTauP.a,hyperParmTauP.b,hyperParmTauP.c)
  var priorTauC = oneSampleOfTriangle(hyperParmTauC.a,hyperParmTauC.b,hyperParmTauC.c)
  var priorTauM = oneSampleOfTriangle(hyperParmTauM.a,hyperParmTauM.b,hyperParmTauM.c)
  var priorTauSum = priorTauP + priorTauC + priorTauM
  /**
   * @variable {number} priorSigmaTauSum - a sample from SigmaTauSum Gamma distribution
   */
  var priorSigmaTauSum =
      sample(Gamma({shape:hyperParmSigmaTauSum.a, scale:hyperParmSigmaTauSum.b}))
  //
  map(function(datum) {
      observe(Gaussian({mu:priorTauSum, sigma:priorSigmaTauSum}),datum)
  }, data)
  return {postTauP: priorTauP, postTauC: priorTauC,  postTauM: priorTauM,
          postTauSum:priorTauSum, postSigmaTauSum:priorSigmaTauSum}
}
//------------------------------------------------------------------------------------
/**
 * @description - Infer generates the posterior distribution 'posteriorTauT'
 * @variable {distributionObject} posteriorTauT - univariate posterior distribution
 */
print('Univariate Posteriors TauX (X=P, C, M, Sum) Gamma(???, ???) and SigmaTauSum Gamma(???,
var posterior = Infer({model:oneSampleOfModel, method:'MCMC', samples: nTrials,
                           burn:myBurnPeriod, lag:myLag})
viz.marginals(posterior)
print("-----------------------------------------------------------------------------")
print("model-generated "+ nSigma + "*sigma tau-interval: ")
var postTauPIntval =
    myTauXDescription("postTauP", marginalize(posterior,'postTauP'), "unknown")
print("{fast:" + postTauPIntval.fast + "  mean:" + postTauPIntval.mean + "  slow:" + postTau
var tauPProbsPosterior = probsAtRisk(marginalize(posterior,'postTauP'), tauPCrit)
printRiskProbs(tauPCrit, 'tauPCrit', tauPProbsPosterior)
print("----------------------------------------------------------")
displayDiffProbs(tauPCrit, 'tauPCrit', tauPProbsPrior, tauPProbsPosterior)
print("-----------------------------------------------------------------------------")
var postTauCIntval =
    myTauXDescription("postTauC", marginalize(posterior,'postTauC'), "unknown")
print("{fast:" + postTauCIntval.fast + "  mean:" + postTauCIntval.mean + "  slow:" + postTau
var tauCProbsPosterior = probsAtRisk(marginalize(posterior,'postTauC'), tauCCrit)
printRiskProbs(tauCCrit, 'tauCCrit', tauCProbsPosterior)
print("----------------------------------------------------------")
displayDiffProbs(tauCCrit, 'tauCCrit', tauCProbsPrior, tauCProbsPosterior)
print("-----------------------------------------------------------------------------")
var postTauMIntval =
    myTauXDescription("postTauM", marginalize(posterior,'postTauM'), "unknown")
print("{fast:" + postTauMIntval.fast + "  mean:" + postTauMIntval.mean + "  slow:" + postTau
var tauMProbsPosterior = probsAtRisk(marginalize(posterior,'postTauM'), tauMCrit)
printRiskProbs(tauMCrit, 'tauMCrit', tauMProbsPosterior)
print("----------------------------------------------------------")
displayDiffProbs(tauMCrit, 'tauMCrit', tauMProbsPrior, tauMProbsPosterior)
print("-----------------------------------------------------------------------------")
```

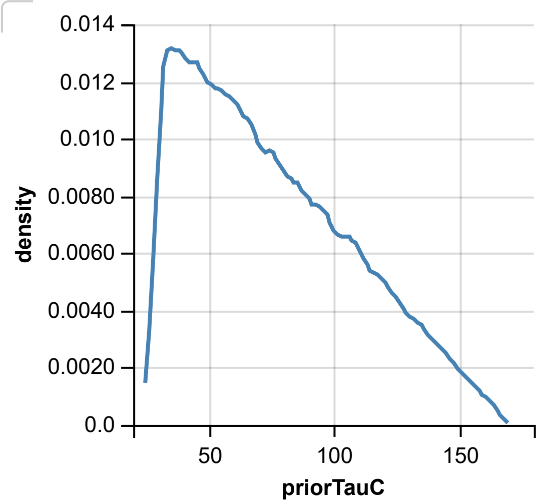
```
var postTauSumIntval =
    myTauXDescription("postTauSum", marginalize(posterior,'postTauSum'), "unknown")
print("{fast:" + postTauSumIntval.fast + "  mean:" + postTauSumIntval.mean + "  slow:" + pos
var tauSumProbsPosterior = probsAtRisk(marginalize(posterior,'postTauSum'), tauSumCrit)
printRiskProbs(tauSumCrit, 'tauSumCrit', tauSumProbsPosterior)
print("----------------------------------------------------------")
displayDiffProbs(tauSumCrit, 'tauSumCrit', tauSumProbsPrior, tauSumProbsPosterior)
print("-----------------------------------------------------------------------------")
var postSigmaTauSumIntval =
    myTauXDescription("postSigmaTauSum", marginalize(posterior,'postSigmaTauSum'), "unknown"
print("{fast:" + postSigmaTauSumIntval.fast + "  mean:" + postSigmaTauSumIntval.mean + "  sl
print("=============================================================================")
runTime()
print("====================================================================================
```

run

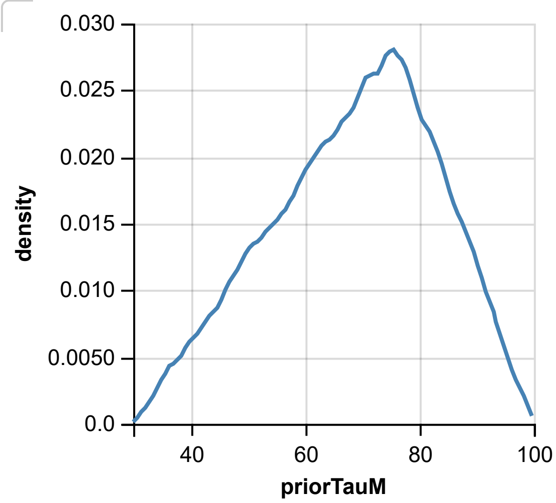
```
==============================================================================
PCM20201213_TriangleMedianPrior&RiskCalculation           *** 2020/12/13 ***
  see also Simple Reaction Time, Example 9, Card, Moran & Newell, 1983, p.66
  see also https://www.humanbenchmark.com/tests/reactiontime/statistics
  here we use the triangular distribution as a prior distribution
  see also https://en.wikipedia.org/wiki/Triangular_distribution
  CMN-interval 'typical[fast ~ slow]' is interpreted ...
            as  triangle(fast=a, slow=b, 'typical'=median=c)
==============================================================================
Input parameter:
nTrials = 60000
nSigma = 3
length of burn-in period = 6000
length of lag = 10
response time data = [458,292,228,403,271,420,350,235,260,306]
mean of data  = 322.3
stdev of data = 77.10389095240265
-----------------------------------------------------------------------------
-----------------------------------------------------------------------------
hyperParmTauP = {c: 66.66666666666666, a:50, b:200}
hyperParmTauC = {c: 32.06896551724137, a:25, b:170}
hyperParmTauM = {c: 75.71428571428572, a:30, b:100}
-----------------------------------------------------------------------------
hyperParmSigmaTauSum = {a:4, b:20}
-----------------------------------------------------------------------------
Univariate Priors TauX (X=P, C, M, Sum, SigmaTauSum) ~ Gamma(???, ???)
priorTauP:
```



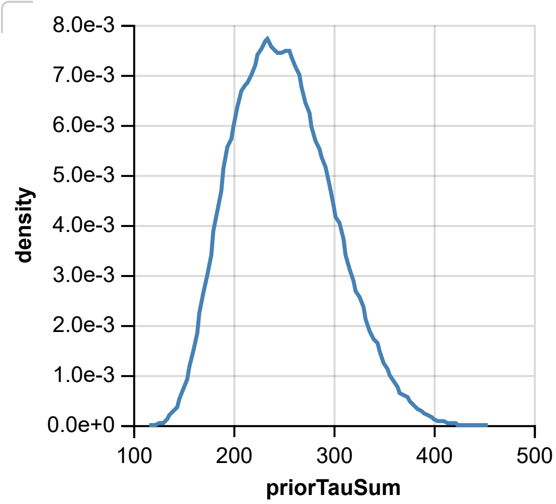
priorTauC:



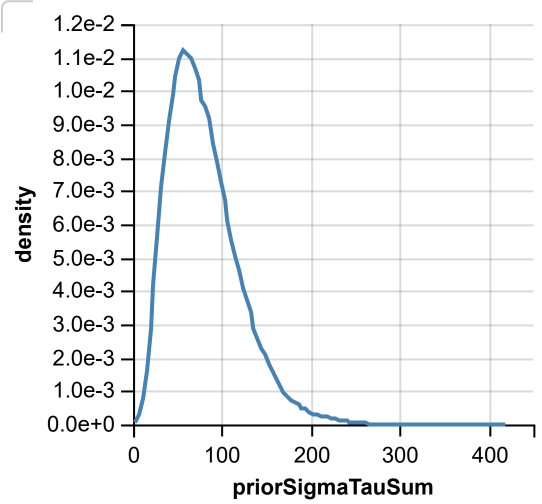
priorTauM:



priorTauSum:

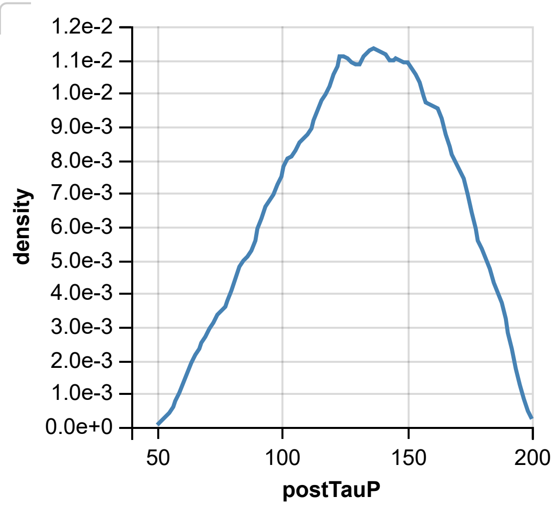


```
priorSigmaTauSum:
```

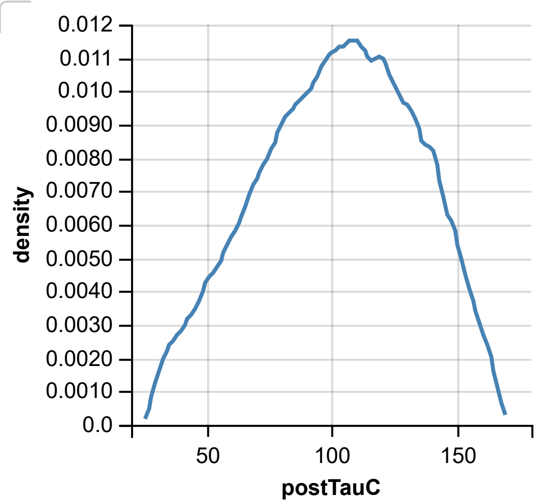


```
----------------------------------------------------------------------------
model-generated 3*sigma tau-interval:
priorTauP
mode = unknown
mean = 105.49703383831006
sigma = 33.662537576075124
{fast:4.509421110084688  mean:105.49703383831006  slow:206.48464656653545}
----------------------------------------------------------------------------
priorTauC
mode = unknown
mean = 75.57508900054202
sigma = 33.28693027934047
{fast:-24.28570183747938  mean:75.57508900054202  slow:175.43587983856344}
----------------------------------------------------------------------------
priorTauM
mode = unknown
mean = 68.61442288076236
sigma = 14.494180237059137
{fast:25.131882169584955  mean:68.61442288076236  slow:112.09696359193977}
----------------------------------------------------------------------------
priorTauSum
mode = unknown
```

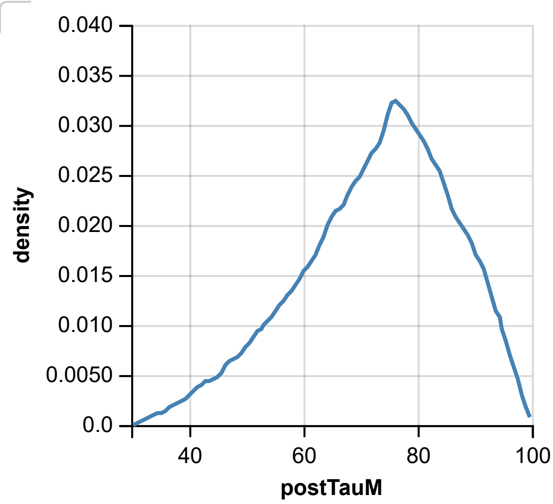
```
mean = 249.68654571961216
sigma = 49.51308114228122
{fast:101.1473022927685  mean:249.68654571961216  slow:398.2257891464558}
----------------------------------------------------------------------------
priorSigmaTauSum
mode = unknown
mean = 79.70825619508916
sigma = 39.86131045641639
model-generated 3*sigma tau-interval:
{fast:-39.87567517416001  mean:79.70825619508916  slow:199.29218756433835}
============================================================================
Univariate Posteriors TauX (X=P, C, M, Sum) Gamma(???, ???) and SigmaTauSum Gamma
(???, ???)
postTauP:
```



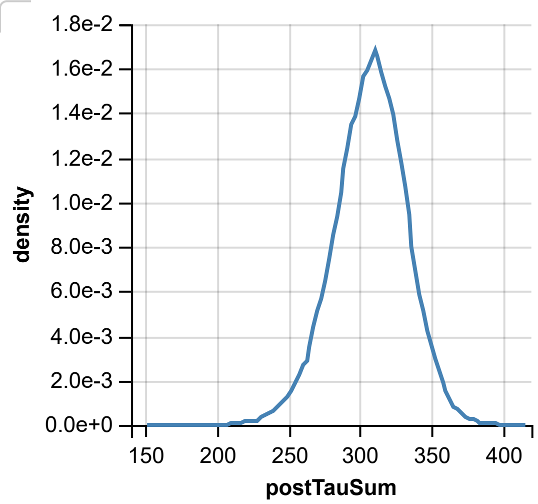
```
postTauC:
```



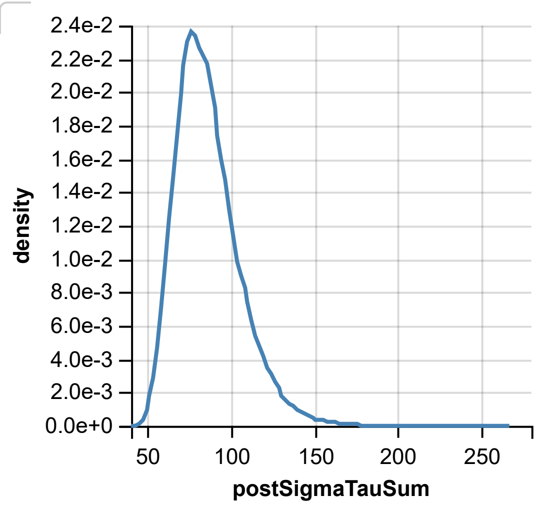
```
postTauM:
```



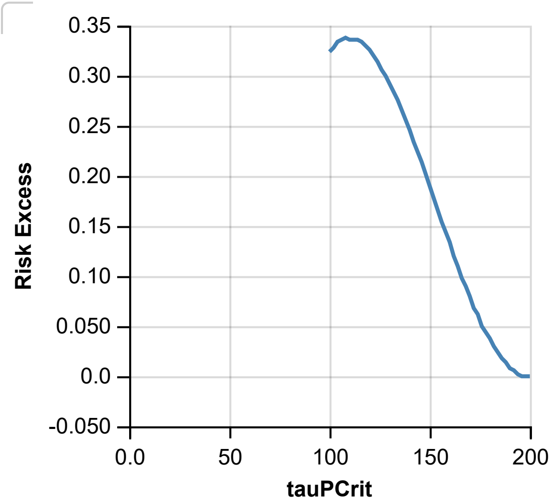
```
postTauSum:
```



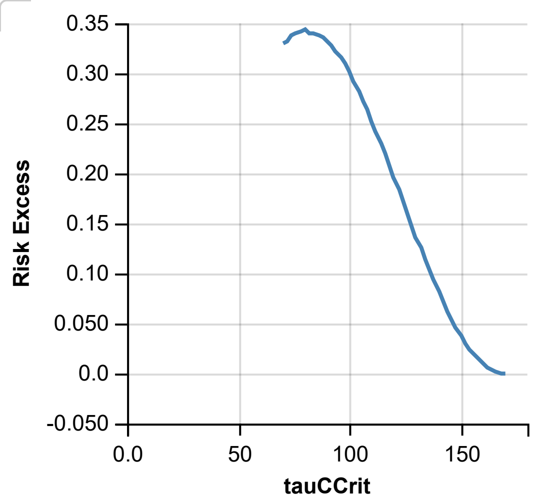
```
postSigmaTauSum:
```



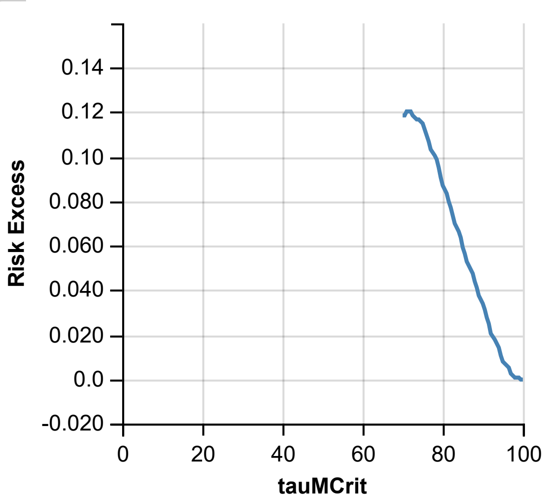
```
----------------------------------------------------------------------------
model-generated 3*sigma tau-interval:
postTauP
mode = unknown
mean = 132.02119543365575
sigma = 31.393728132921876
{fast:37.840011034890125  mean:132.02119543365575  slow:226.20237983242137}
----------------------------------------------------------
tauPCrit = 178; increase in risk probs = 0.044366666666657895
tauPCrit = 180; increase in risk probs = 0.037466666666658766
tauPCrit = 182; increase in risk probs = 0.029783333333326056
tauPCrit = 184; increase in risk probs = 0.024149999999993343
tauPCrit = 186; increase in risk probs = 0.018766666666660492
tauPCrit = 188; increase in risk probs = 0.013066666666661009
tauPCrit = 190; increase in risk probs = 0.008183333333328102
tauPCrit = 192; increase in risk probs = 0.005599999999994942
tauPCrit = 194; increase in risk probs = 0.0026166666666618266
tauPCrit = 196; increase in risk probs = 0.000999999999995338
tauPCrit = 198; increase in risk probs = 0.0002833333333287502
tauPCrit = 200; increase in risk probs = -4.551914400963142e-15
```



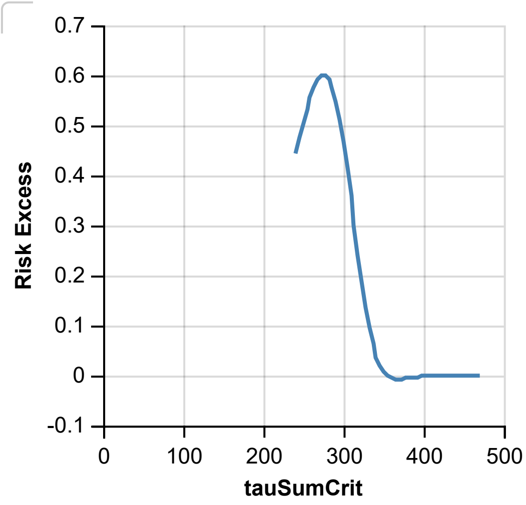
```
-----------------------------------------------------------------------------
postTauC
mode = unknown
mean = 102.33429612824399
sigma = 31.48333332760716
{fast:7.8842961454225104  mean:102.33429612824399  slow:196.7842961110655}
----------------------------------------------------------
tauCCrit = 148; increase in risk probs = 0.046133333333325144
tauCCrit = 150; increase in risk probs = 0.038266666666659344
tauCCrit = 152; increase in risk probs = 0.030516666666660086
tauCCrit = 154; increase in risk probs = 0.02473333333332739
tauCCrit = 156; increase in risk probs = 0.019349999999994538
tauCCrit = 158; increase in risk probs = 0.014266666666661765
tauCCrit = 160; increase in risk probs = 0.010783333333328815
tauCCrit = 162; increase in risk probs = 0.006633333333329161
tauCCrit = 164; increase in risk probs = 0.004199999999996096
tauCCrit = 166; increase in risk probs = 0.0016666666666629304
tauCCrit = 168; increase in risk probs = 0.000116666666631011
tauCCrit = 170; increase in risk probs = -3.552713678800501e-15
```



```
------------------------------------------------------------------------------
postTauM
mode = unknown
mean = 72.81104128540957
sigma = 13.43269209305298
{fast:32.51296500625063  mean:72.81104128540957  slow:113.10911756456852}
-----------------------------------------------------------
tauMCrit = 86.8; increase in risk probs = 0.04956666666666021
tauMCrit = 87.4; increase in risk probs = 0.04708333333332715
tauMCrit = 88; increase in risk probs = 0.04396666666660825
tauMCrit = 88.6; increase in risk probs = 0.04091666666666116
tauMCrit = 89.2; increase in risk probs = 0.03729999999999478
tauMCrit = 89.8; increase in risk probs = 0.03383333333332861
tauMCrit = 90.4; increase in risk probs = 0.03144999999999554
tauMCrit = 91; increase in risk probs = 0.028016666666662582
tauMCrit = 91.6; increase in risk probs = 0.024916666666662923
tauMCrit = 92.2; increase in risk probs = 0.020466666666663413
tauMCrit = 92.8; increase in risk probs = 0.017516666666663627
tauMCrit = 93.4; increase in risk probs = 0.015849999999997144
tauMCrit = 94; increase in risk probs = 0.014099999999997337
tauMCrit = 94.6; increase in risk probs = 0.011016666666664343
tauMCrit = 95.2; increase in risk probs = 0.008033333333331338
tauMCrit = 95.8; increase in risk probs = 0.006249999999982014
tauMCrit = 96.4; increase in risk probs = 0.004916666666664904
tauMCrit = 97; increase in risk probs = 0.002816666666665135
tauMCrit = 97.6; increase in risk probs = 0.0013166666666653004
tauMCrit = 98.2; increase in risk probs = 0.000766666666665361
tauMCrit = 98.8; increase in risk probs = 0.00036666666666540504
tauMCrit = 99.4; increase in risk probs = 0.00019999999999875673
tauMCrit = 100; increase in risk probs = -1.2212453270876722e-15
```



```
-----------------------------------------------------------------------------
postTauSum
mode = unknown
mean = 307.16653284730586
sigma = 25.321458845981024
{fast:231.2021563093628  mean:307.16653284730586  slow:383.1309093852489}
----------------------------------------------------------
tauSumCrit = 341.2; increase in risk probs = 0.037933333333329156
tauSumCrit = 345.8; increase in risk probs = 0.021016666666664352
tauSumCrit = 350.4; increase in risk probs = 0.008599999999999053
tauSumCrit = 355; increase in risk probs = 0.0006666666666665932
tauSumCrit = 359.6; increase in risk probs = -0.003666666666666263
tauSumCrit = 364.2; increase in risk probs = -0.006049999999999334
tauSumCrit = 368.79999999999995; increase in risk probs = -0.006816666666665916
tauSumCrit = 373.4; increase in risk probs = -0.006316666666665971
tauSumCrit = 378; increase in risk probs = -0.005183333333327625
tauSumCrit = 382.6; increase in risk probs = -0.004383333333332851
tauSumCrit = 387.2; increase in risk probs = -0.0034166666666662904
tauSumCrit = 391.79999999999995; increase in risk probs = -0.0024999999999997247
tauSumCrit = 396.4; increase in risk probs = -0.0018499999999997963
tauSumCrit = 401; increase in risk probs = -0.0011999999999998678
tauSumCrit = 405.6; increase in risk probs = -0.0009166666666665657
tauSumCrit = 410.2; increase in risk probs = -0.0005499999999999394
tauSumCrit = 414.79999999999995; increase in risk probs = -0.00034999999999996145
tauSumCrit = 419.4; increase in risk probs = -0.0001666666666666483
tauSumCrit = 424; increase in risk probs = -0.00008333333333332416
tauSumCrit = 428.6; increase in risk probs = -0.00004999999999999449
tauSumCrit = 433.2; increase in risk probs = -0.00001666666666666483
tauSumCrit = 437.79999999999995; increase in risk probs = -0.00001666666666666483
tauSumCrit = 442.4; increase in risk probs = -0.00001666666666666483
tauSumCrit = 447; increase in risk probs = -0.00001666666666666483
tauSumCrit = 451.6; increase in risk probs = -0.00001666666666666483
tauSumCrit = 456.2; increase in risk probs = 0
tauSumCrit = 460.79999999999995; increase in risk probs = 0
tauSumCrit = 465.4; increase in risk probs = 0
tauSumCrit = 470; increase in risk probs = 0
```



```
-----------------------------------------------------------------------------
postSigmaTauSum
mode = unknown
mean = 86.16072090736341
sigma = 19.126797213146563
{fast:28.78032926792372  mean:86.16072090736341  slow:143.5411125468031}
=============================================================================
runtime in seconds = 7542.482
runtime in minutes = 125.70803333333333
=================================================================================
===
```

Features

- Runs on the command line with node.js (http://nodejs.org/) or in the browser (http://docs.webppl.org/en/master/development/workflow.html#browser-version).
- Supports modular and re-usable code using packages (http://docs.webppl.org/en/master/packages.html) built on top of the npm package system, and interoperates with existing Javascript packages in the npm ecosystem.
- Includes a large and expanding library of primitive distributions. (http://docs.webppl.org/en/master/distributions.html)
- Implements a variety of inference algorithms (http://docs.webppl.org/en/master/inference/index.html), including exact inference via enumeration, rejection sampling, Sequential Monte Carlo, Markov Chain Monte Carlo, Hamiltonian Monte Carlo, and inference-as-optimization (e.g. variational inference).
- Provides inference as a first-class operator in the language, allowing for nested inference (‘inference about inference’).
- Supports optimizable models with neural network components using adnn (https://www.npmjs.com/package/adnn).

Demos

Browser-based applications powered by WebPPL.

- Procedural vines with shape constraints (demos/vines/index.html)
- 3D procedural spaceships with shape constraints (http://dritchie.github.io/web-procmod/) (Note: the code in this demo is written in an older version of WebPPL)

Local install

Install WebPPL in two easy steps:

1. Install node.js (http://nodejs.org)
2. Run `npm install -g webppl`

Now, the `webppl` command is globally available.

To upgrade to the latest version, run `npm update -g webppl` .

Documentation

To learn more about how to set up and use WebPPL, take a look at our documentation (http://docs.webppl.org) and the examples (https://github.com/probmods/webppl/tree/master/examples).

To learn more about how WebPPL works under the hood, check out our web book, The Design and Implementation of Probabilistic Programming Languages (http://dippl.org/).

For probabilistic modeling in general, our other web book, Probabilistic Models of Cognition (https://probmods.org), might be of interest.

License

Contributions

We encourage you to contribute to WebPPL! Check out our guidelines for contributors (https://github.com/probmods/webppl/blob/master/CONTRIBUTING.md) and join the webppl-dev (https://groups.google.com/forum/#!forum/webppl-dev) mailing list.

Pronunciation

Say “web people”.

Citing

If you use WebPPL in academic projects and papers, please cite as:

> *N. D. Goodman and A. Stuhlmüller (electronic). The Design and Implementation of Probabilistic Programming Languages. Retrieved from* `http://dippl.org` *. [bibtex]*

Publications

If you publish a paper using/extending WebPPL, let us know (https://groups.google.com/forum/#!forum/webppl-dev) and we'll add it to this list:

D. Ritchie, P. Horsfall, and N. D. Goodman. Deep Amortized Inference for Probabilistic Programs (https://arxiv.org/abs/1610.05735). arXiv:1610.05735.

L. Ouyang, M. H. Tessler, D. Ly, and N. D. Goodman. Practical optimal experiment design with probabilistic programs (https://arxiv.org/abs/1608.05046). arXiv:1608.05046.

M. H. Tessler and N. D. Goodman. A Pragmatic Theory of Generic Language (https://arxiv.org/abs/1608.02926). arXiv:1608.02926.

D. Ritchie, A. Thomas, P. Hanrahan, and N. D. Goodman. Neurally-Guided Procedural Models: Amortized Inference for Procedural Graphics Programs using Neural Networks (https://arxiv.org/abs/1603.06143). NIPS 2016.

D. Ritchie, A. Stuhlmüller, and N. D. Goodman. C3: Lightweight Incrementalized MCMC for Probabilistic Programs using Continuations and Callsite Caching (https://arxiv.org/abs/1509.02151). AISTATS 2016.

M. H. Tessler and N. D. Goodman. Communicating generalizations about events (http://stanford.edu/~mtessler/papers/Tessler2016-cogsci.pdf). Proceedings of the Thirty-Eighth Annual Conference of the Cognitive Science Society, 2016.

E. J. Yoon, M. H. Tessler, N. D. Goodman, and M. C. Frank. Talking with tact: Polite language as a balance between kindness and informativity (http://stanford.edu/~mtessler/papers/YoonTessler2016-cogsci.pdf). Proceedings of the Thirty-Eighth Annual Conference of the Cognitive Science Society, 2016.

C. Graf, J. Degen, R. X. D. Hawkins, and N. D. Goodman. Animal, dog, or dalmatian? Level of abstraction in nominal referring expressions (https://cocolab.stanford.edu/papers/GrafEtAl2016-Cogsci.pdf). Proceedings of the Thirty-Eighth Annual Conference of the Cognitive Science Society, 2016.

O. Evans, A. Stuhlmüller, and N. D. Goodman. Learning the Preferences of Ignorant, Inconsistent Agents (https://stuhlmueller.org/papers/preferences-aaai2016.pdf). AAAI 2016.

A. Stuhlmüller, R. X. D. Hawkins, N. Siddharth, and N. D. Goodman. Coarse-to-Fine Sequential Monte Carlo for Probabilistic Programs (https://arxiv.org/abs/1509.02962). arXiv:1509.02962.

O. Evans, A. Stuhlmüller, and N. D. Goodman. Learning the Preferences of Bounded Agents (https://stuhlmueller.org/papers/preferences-nipsworkshop2015.pdf). Workshop on Bounded Optimality, NIPS 2015.

R. X. D. Hawkins, A. Stuhlmüller, J. Degen, and N. D. Goodman. Why do you ask? Good questions provoke informative answers (https://stuhlmueller.org/papers/qa-cogsci2015.pdf). Proceedings of the Thirty-Seventh Annual Conference of the Cognitive Science Society, 2015.

G. Scontras and M. H. Tessler (electronic). Composition in Probabilistic Language Understanding (http://gscontras.github.io/ESSLLI-2016/). Retrieved from `http://gscontras.github.io/ESSLLI-2016`.

O. Evans, A. Stuhlmüller, J. Salvatier, and D. Filan (electronic). Modeling Agents with Probabilistic Programs (http://agentmodels.org). Retrieved from `http://agentmodels.org`.

N. D. Goodman and J. B. Tenenbaum (electronic). Probabilistic Models of Cognition (http://probmods.org). Retrieved from `http://probmods.org`.

N. D. Goodman and A. Stuhlmüller (electronic). The Design and Implementation of Probabilistic Programming Languages (http://dippl.org). Retrieved from `http://dippl.org`.

Acknowledgments

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