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: Izhikevich artificial neuron model from
: EM Izhikevich "Simple Model of Spiking Neurons"
: IEEE Transactions On Neural Networks, Vol. 14, No. 6, November 2003 pp 1569-1572
: V is the voltage analog, u controls
: see COMMENT below or izh.hoc for typical parameter values
: uncomment lines with dvv,du to graph derivatives

NEURON {
  POINT_PROCESS Izhi2003a
  RANGE a,b,c,d,f,g,Iin,fflag,thresh,erev,taug
}

INITIAL {
  V=-65
  u=0.0
  gsyn=0
  net_send(0,1)
}

PARAMETER {
  a = 0.02
  b = 0.2
  c = -65
  d = 2
  f = 5
  g = 140
  Iin = 10
  taug = 1
  thresh=30
  erev = 0
  fflag = 1
}

STATE { u V gsyn } : use V for voltage so don't interfere with built-in v of cell
ASSIGNED {
}
BREAKPOINT {
  SOLVE states METHOD derivimplicit
}
DERIVATIVE states {
  V' = 0.04*V*V + f*V + g - u + Iin - gsyn*(V-erev)
  u' = a*(b*V-u)
  gsyn' = -gsyn/taug
}

NET_RECEIVE (w) {
  if (flag == 1) {
    WATCH (V>thresh) 2
  } else if (flag == 2) {
    net_event(t)
    V = c
    u = u+d
  } else { : synaptic activation
    gsyn = gsyn+w
  }
}
```

```
:** vers gives version
PROCEDURE version () {

}

COMMENT
        a           b           c           d           Iin
============================================================================
       0.02        0.2        -65         6           14          % tonic spiking
       0.02        0.25       -65         6            0.5        % phasic spiking
       0.02        0.2        -50         2           15          % tonic bursting
       0.02        0.25       -55         0.05         0.6        % phasic bursting
       0.02        0.2        -55         4           10          % mixed mode
       0.01        0.2        -65         8           30          % spike frequency adaptation
       0.02       -0.1        -55         6            0          % Class 1
       0.2         0.26       -65         0            0          % Class 2
       0.02        0.2        -65         6            7          % spike latency
       0.05        0.26       -60         0            0          % subthreshold oscillations
       0.1         0.26       -60        -1            0          % resonator
       0.02       -0.1        -55         6            0          % integrator
       0.03        0.25       -60         4            0          % rebound spike
       0.03        0.25       -52         0            0          % rebound burst
       0.03        0.25       -60         4            0          % threshold variability
       1           1.5        -60         0          -65          % bistability
       1           0.2        -60       -21            0          % DAP
       0.02        1          -55         4            0          % accomodation
      -0.02       -1          -60         8           80          % inhibition-induced spiking
      -0.026      -1          -45         0           80          % inhibition-induced bursting
ENDCOMMENT
```