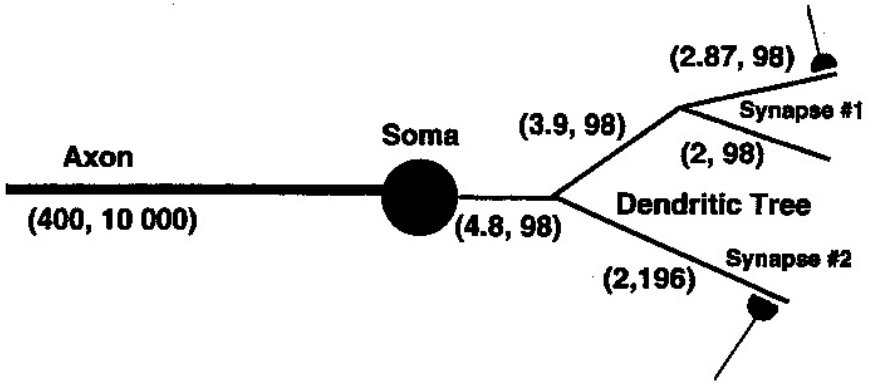
EE 445F — 98 Finals - Gudaljan

Question #3

Describe the *correction learning* in an artificial neural network represented by a *fully connected feed forward* network with two hidden neural units, and one output neural unit. How can such learning be accelerated? Give mathematical expressions. **[15 Marks]**

Question #4

For the shown neuron, the branches are specified in terms of (diameter in μm, length in μm) and the axon is located along the x-axis with its terminus at the origin ($x = 0$). For the two synapses, presynaptic action potentials give rise to constant synaptic conductances ($g_{s1} = g_{s2} = 0.55\ mS/cm^2$), and reversal potentials ($E_{s1} = -50\ mV$, $E_{s2} = -90\ mV$). The post-synaptic dendritic membrane has conductances ($g_{Na} = 0.01\ mS/cm^2$, $g_K = 0.367\ mS/cm^2$) and Nernst potentials ($E_{Na} = 54.2\ mV$, $E_K = -74.7\ mV$) for sodium and potassium, respectively. The dendritic intracellular resistance per unit length is $r_{id} = 8\ M\Omega/cm$. The soma does not fire an action potential in response to such presynaptic action potentials.



When *Ouabain* (whose effect is to block the sodium-potassium pump in the cell membrane) is administered to this neuron, then the soma fires an action potential which propagates on the axon with a uniform velocity of 1 $mm/msec$, and it is described at the soma by $v_m(t) = 20\ e^{-\frac{t^2}{T}}$ where v_m is the transmembrane voltage in mV and t is time in $msec$. The intracellular and extracellular conductivities of the axon are 0.01 & 0.05 S/cm, respectively.

Compute the following:
(a) The effect of *Ouabain* on the post synaptic potentials, the synaptic currents, and the dendritic space constant.
(b) The firing threshold of the soma.
(c) The axonal maximum longitudinal intracellular current, maximum transmembrane current per unit length, and the maximum extracellular potential 5 mm above the axon, at $t = 5\ msec$. **[35 Marks]**

Question #1

Describe the following *(in point form and/or diagrams)*:
(a) The main anatomical features of the cardiovascular system, the central nervous system, and the gastrointestinal system.
(b) The governing mechanisms of frequency *coding* and *decoding* for information transmission in neurons.
(c) The *myogenic* and *neuronal* control systems in the canine small intestine, and their contributions to the control of intestinal motility. **[30 Marks]**

Question #2

Derive two expressions for the resting membrane voltage in terms of (i) ionic permeabilities, and (ii) ionic conductances. *Start from first principles.* **[20 Marks]**