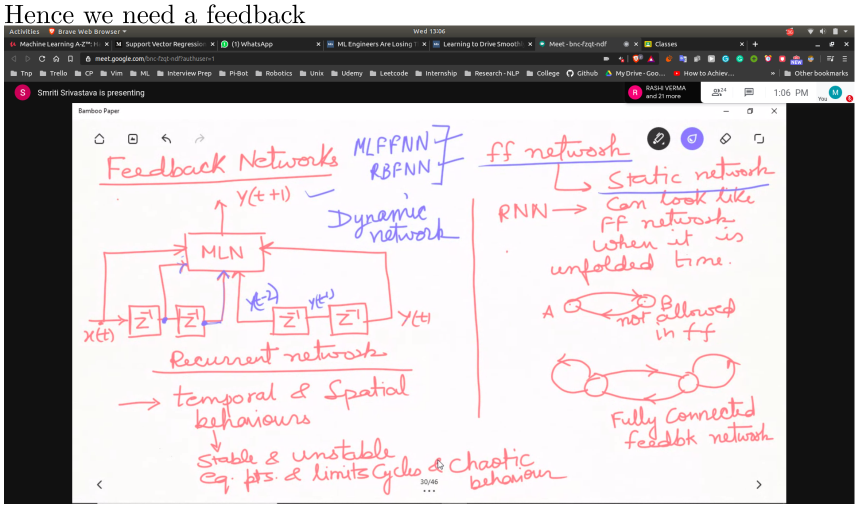
Feedback Networks

- FF network is a static network
- So in order to have dynamic , we need feedback
- Hence we need a feedback
- 

Prop.

- Rich Temporal and spatial behaviours
  - because it's time stamp depends upon t,t-1
- stable and unstable cycles
- mainly used for pattern recogninition

Unfolding in Time

- RNN can look like NN , when they are unfolded in time

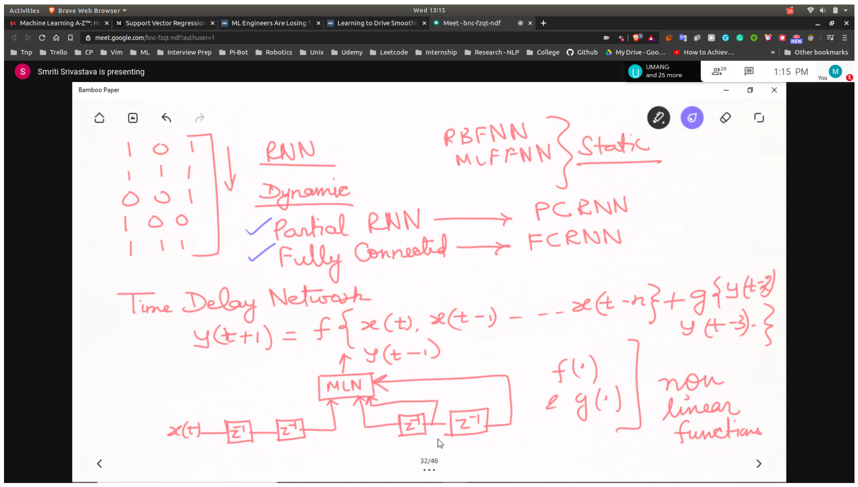
Types

- FCRNN
- Partially Connected(PCRNN)

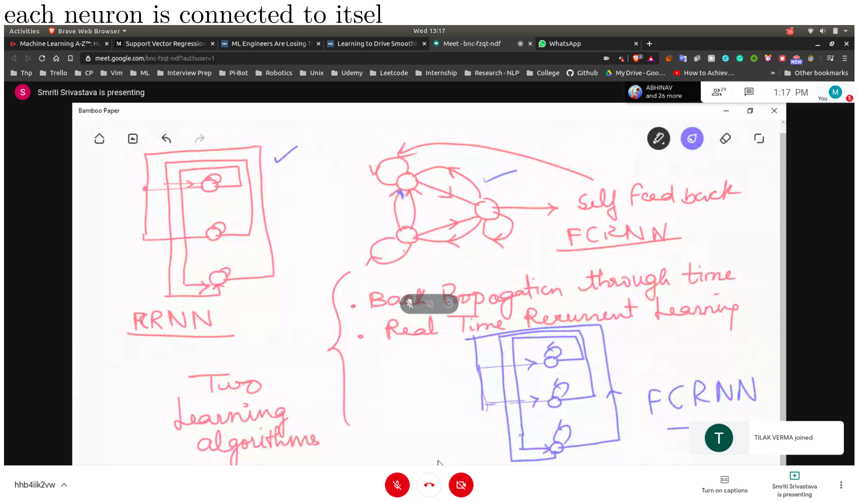
Application

- Time Series Prediction
- Temporal Pattern recognition
  - signal classification
  - sound classification

Time Delay Network

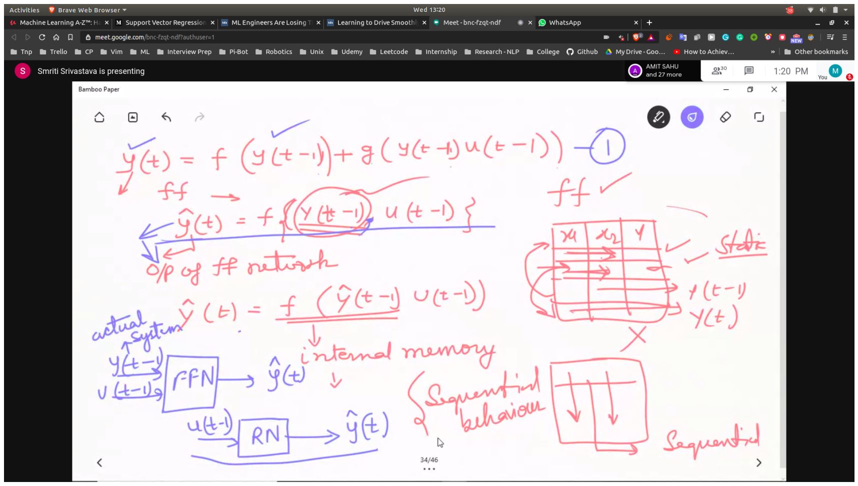
- 

Formation of full conncected neural networks

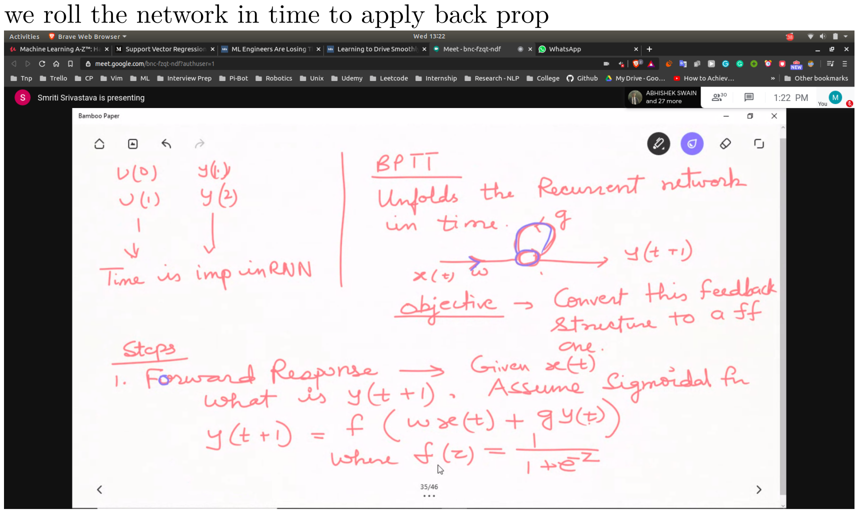
- each neuron is connected to itsel
- 

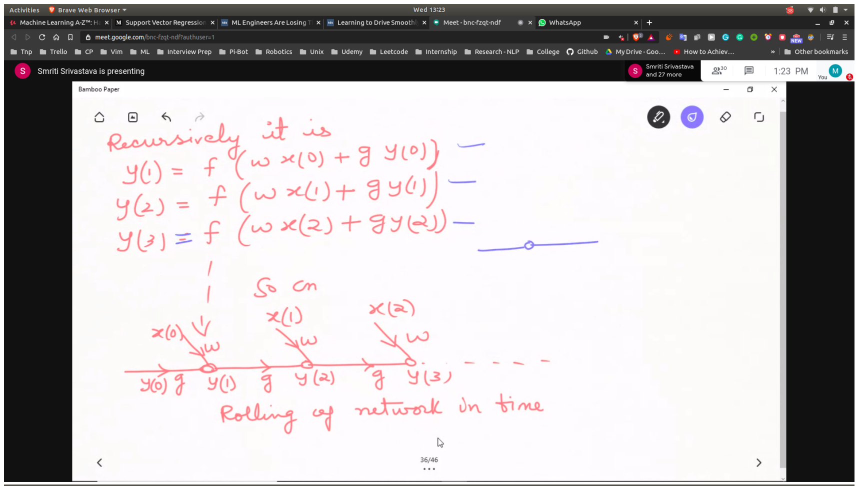
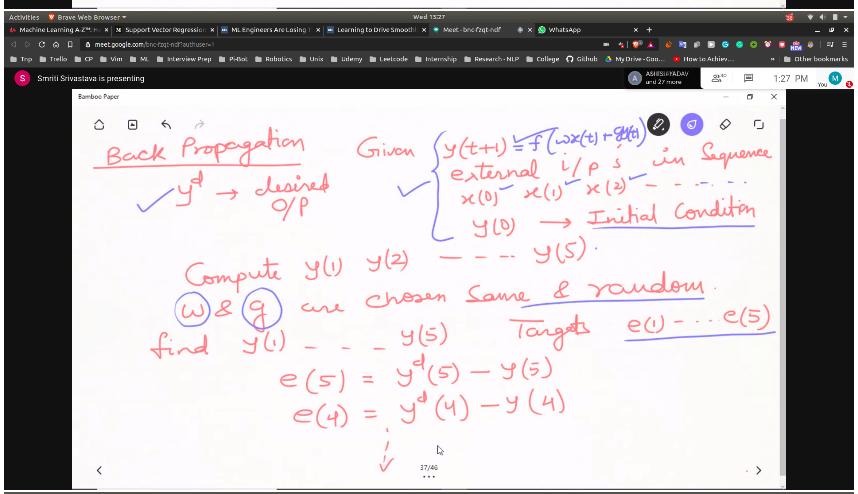
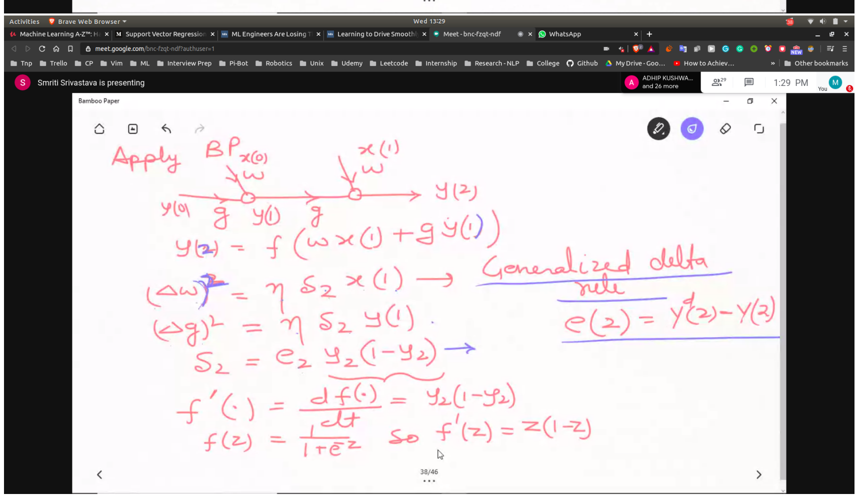
Comp

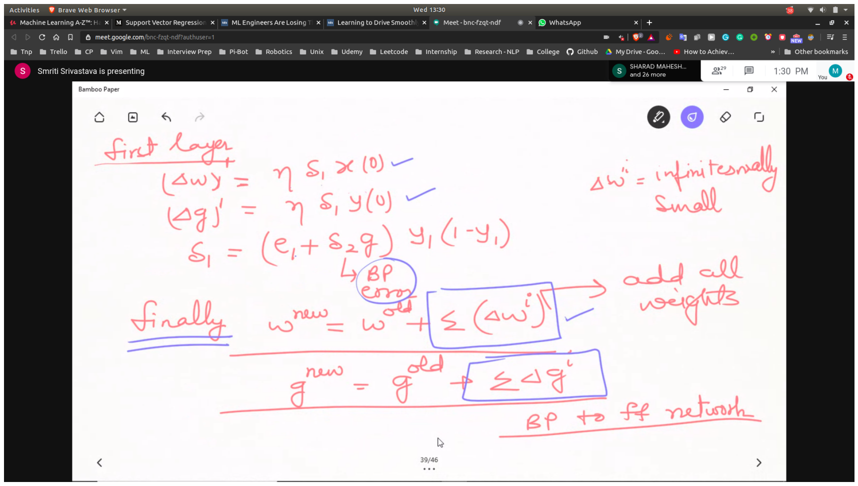
- comparision of the NN

- 

Applying Back Propagation

- we roll the network in time to apply back prop
- 

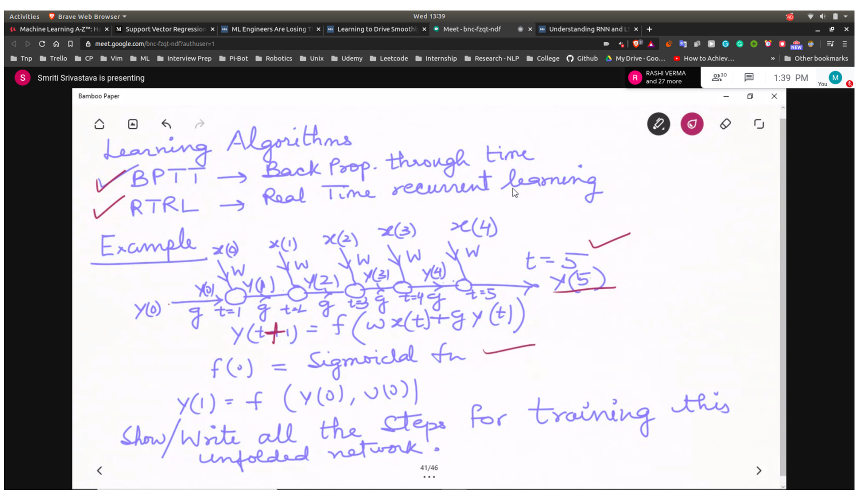
- 
Smriti Srivastava is presenting
Recursively it is
y(1) = f(w x(0) + g y(0))
y(2) = f(w x(1) + g y(1))
y(3) = f(w x(2) + g y(2))
So on
x(0) w x(1) w x(2) w
y(0) g y(1) g y(2) g y(3)
Rolling of network in time
36/46
- 
Smriti Srivastava is presenting
Back Propagation
y^d → desired O/P
Given y(t+1) = f(wx(t) + gy(t))
external i/p s in Sequence
x(0) x(1) x(2) - - - - -
y(0) → Initial Condition
Compute y(1) y(2) - - - y(5).
w & g are chosen same & random.
find y(1) - - - y(5)
Targets e(1) - - - e(5)
e(5) = y^d(5) − y(5)
e(4) = y^d(4) − y(4)
37/46
- 
Smriti Srivastava is presenting
Apply BP
x(0) w x(1) w
y(0) g y(1) g y(2)
y(2) = f(w x(1) + g y(1))
(Δw)^2 = η δ2 x(1) →
Generalized delta rule
(Δg)^2 = η δ2 y(1)
e(2) = y^d(2) − y(2)
δ2 = e2 y2(1 − y2) →
f'(·) = df(·)/dt = y2(1 − y2)
f(z) = 1/(1+e^-z) so f'(z) = z(1 − z)
38/46

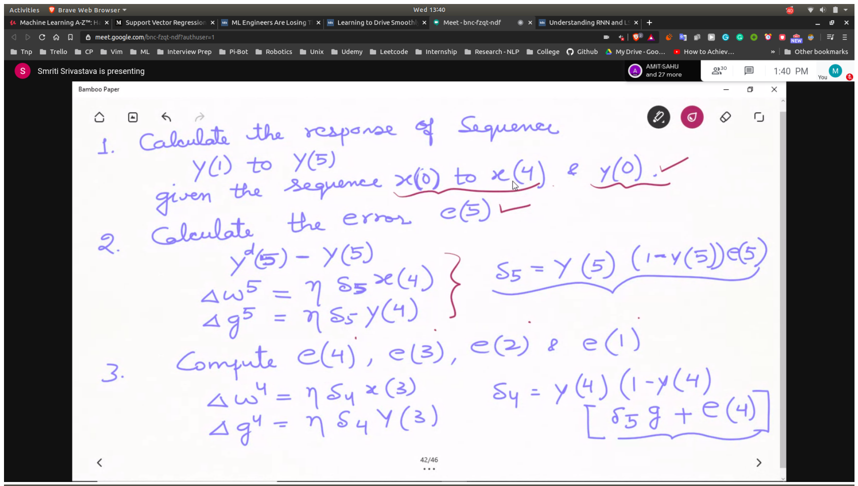
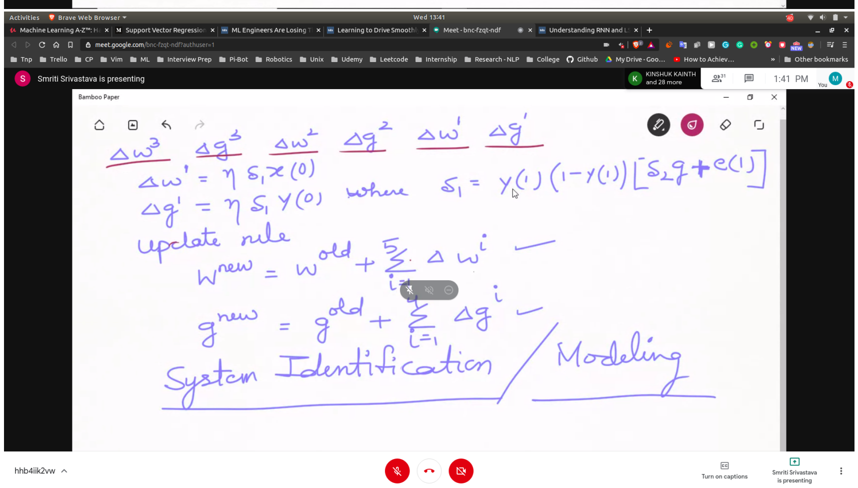
- 

2 Learning Algo

- Back Prop Through time
- Real Time recurrent learning

Example

- 

- 
Smriti Srivastava is presenting
Bamboo Paper
1. Calculate the response of Sequence
y(1) to y(5)
given the sequence x(0) to x(4) & y(0)
2. Calculate the error e(5)
$y^d(5) - y(5)$
$\Delta w^5 = \eta\, \delta_5\, x(4)$
$\Delta g^5 = \eta\, \delta_5\, y(4)$
$\delta_5 = y(5)\,(1-y(5))\,e(5)$
3. Compute e(4), e(3), e(2) & e(1)
$\Delta w^4 = \eta\, \delta_4\, x(3)$
$\Delta g^4 = \eta\, \delta_4\, y(3)$
$\delta_4 = y(4)\,(1-y(4))\,[\delta_5 g + e(4)]$
42/46
1:40 PM
- 
Smriti Srivastava is presenting
Bamboo Paper
$\Delta w^3 \quad \Delta g^3 \quad \Delta w^2 \quad \Delta g^2 \quad \Delta w^1 \quad \Delta g^1$
$\Delta w^1 = \eta\, \delta_1\, x(0)$
$\Delta g^1 = \eta\, \delta_1\, y(0)$ where $\delta_1 = y(1)\,(1-y(1))\,[\delta_2 g + e(1)]$
update rule
$w^{new} = w^{old} + \sum_{i=1}^{5} \Delta w^i$
$g^{new} = g^{old} + \sum_{i=1}^{5} \Delta g^i$
System Identification / Modeling
1:41 PM
Turn on captions