Simple example of Rock Paper Scissors optimization (using softmax)

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Unconstrained parameters

```
a_theta = sym('a_theta',[3 1]);
b_theta = sym('b_theta',[3 1]);
```

Softmax so probabilities sum to 1 and are > 0

```
a = exp(a_theta)/sum(exp(a_theta));
b = exp(b_theta)/sum(exp(b_theta));
```

Rock > Scissors > Paper > Rock

Rock=1, Paper=2, Scissors=3

```
a_{loss} = -(a(1)*b(3)+a(2)*b(1)+a(3)*b(2));

b_{loss} = -(b(1)*a(3)+b(2)*a(1)+b(3)*a(2));
```

Regularization

Set to 0 to disable regularization

```
reg = 0.03;
if reg>0
    a_loss = a_loss + reg*sum(a_theta.^2);
    b_loss = b_loss + reg*sum(b_theta.^2);
end
```

Gradient descent updates

```
lr=0.1;
a_diff = [diff(a_loss, a_theta(1)); ...
```

```
diff(a_loss, a_theta(2)); ...
  diff(a_loss, a_theta(3))];
b_diff = [diff(b_loss, b_theta(1)); ...
  diff(b_loss, b_theta(2)); ...
  diff(b_loss, b_theta(3))];
a_theta_update = a_theta - lr*a_diff;
b_theta_update = b_theta - lr*b_diff;
% Print equations
% disp(a_theta_update);
% disp(b_theta_update);
```

Random initial parameters

```
a_theta_t = rand(3,1);
b_theta_t = rand(3,1);
```

Train model

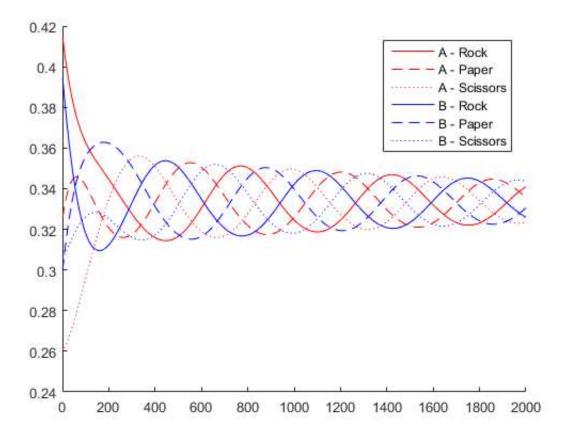
```
nb epoch = 2000;
nb batches = 1;
logs = zeros(nb epoch, 6);
for epoch=1:nb_epoch
   % Retrieve current parameters
   a_t = vpa(subs(a, a_theta, a_theta_t));
   b t = vpa(subs(b, b theta, b theta t));
   % Save parameters to log
   logs(epoch,:) = [a_t.' b_t.'];
   % Display parameters in terminal
   % disp([a t b t]);
   % Perform nb batches steps of updates
   for batch=1:nb batches
       % Calculate next theta
        a theta next = vpa(subs(subs(a theta update, a theta, a theta t), b theta, b theta t))
       b theta next = vpa(subs(subs(b theta update, a theta, a theta t), b theta, b theta t))
        % Store next theta
        a theta t = a theta next;
        b theta t = b theta next;
   end
end
```

Write results

```
csvwrite('RockPaperScissors.csv',logs);
```

Graph results

```
figure;
hold on;
plot(logs(:,1), '-r');
```



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