Table of Contents

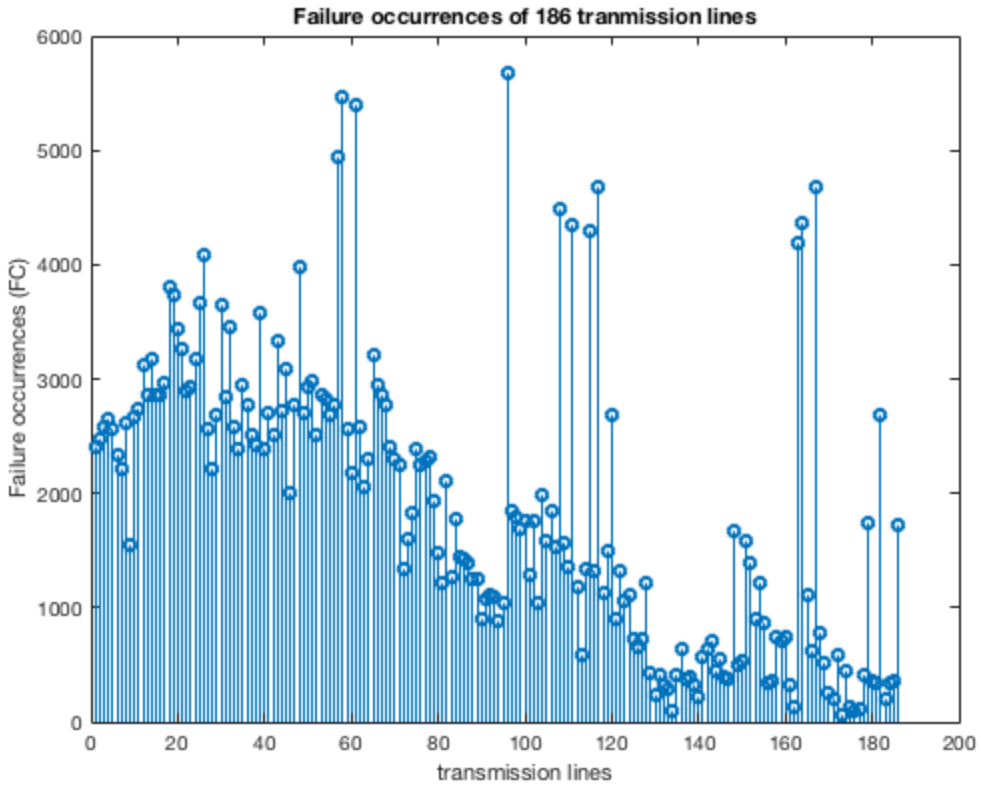
Causal network analysis using Markov Chain

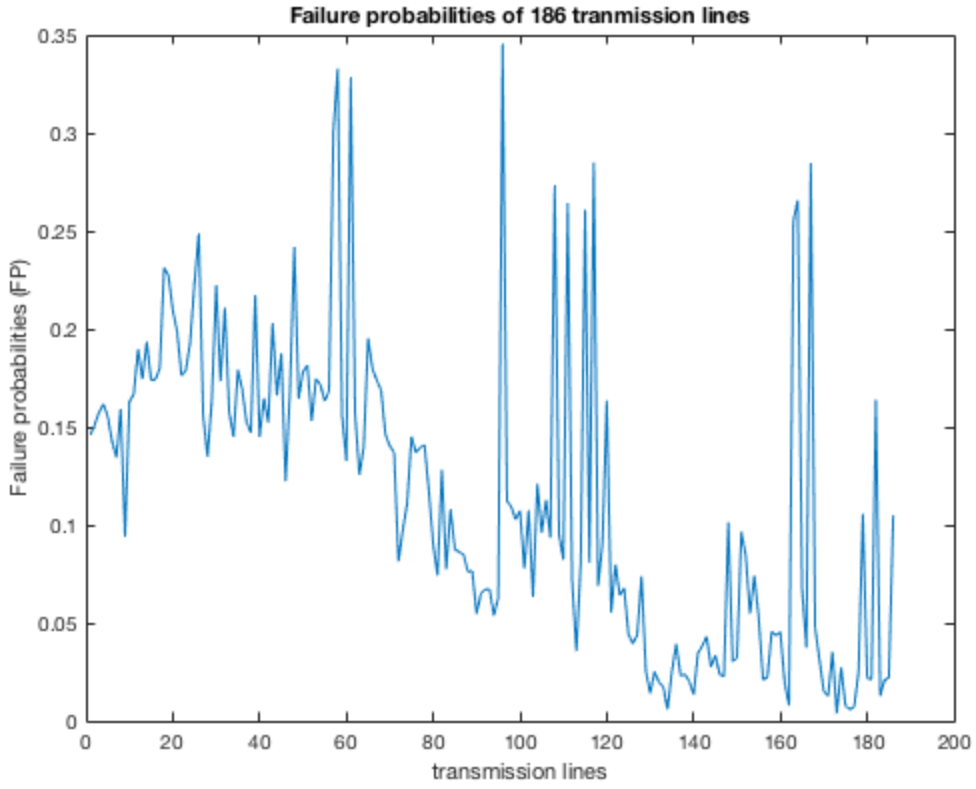
```
clc;

load cascade;
load index;

a = [cascade index];
X = diff([0;find(a(:,1)==-1)]);
C = mat2cell(a(:,2),X,1);
C{:};
```

Finding FC = Failure occurrences of each transmission line

```
 % get the highest digit abd store the count in an array
highestDigit = max(cell2mat(C));
countArray = zeros(2, highestDigit);
 % replace the second row with the digits
countArray(2,:) = 1:highestDigit;
 % then loop over the cell array
for ii = 1:numel(C)
  digits = C{ii}(2:end); % filter out the first digit
  for jj=1:numel(digits)
     countArray(1,digits(jj)) = countArray(1,digits(jj)) + 1; % add
 one every time it occurs
  end
end
% remove the zeros
maskZeros = countArray(1,:)~=0;
countArray = countArray(:,maskZeros);

A = [];
% print the result
%fprintf('Digit  |  Number of occurrenced \n')
for ii = 1:length(countArray)
%fprintf('%d             %d \n',countArray(2, ii), countArray(1,ii));
```

```
N = countArray(1,ii);
A = [A, N];
end

figure (1)
stem(1:186, A)
title('Failure occurrences of 186 tranmission lines');
xlabel('transmission lines');
ylabel('Failure occurrences (FC)');

figure (2)
plot(1:186, A/16430)
title('Failure probabilities of 186 tranmission lines');
xlabel('transmission lines');
ylabel('Failure probabilities (FP)');
```





Calculation of the number of samples in each stage

```
for i = 1:size(C,1);
    lngth(i) = length(C{i}); % Number of elements in each cell
end
for j = 1:max(lngth)
    row(j) = sum(lngth>=j); % Number of elements in each 'row'
end
```

stage 2

```
S = [96]; % initial failure

for mm = 1:length(S)

nn = countArray(1, S(mm)); % number of occurrences of the initially
 failed tx-line
a = [];
b = 0;
for i = S(mm) % initial failure
    for j = 1:186 % searching for the 2nd stage tx-line

            if(j ~= i)
```

```
            sequence_check  = [i; j];
            n = sum(cellfun(@(x)
 ~isempty(strfind(x.',sequence_check.')), C));
            a = [a, n];
            b = b+1;
            q1(b,:)= [i j n];
            temp = q1(:,3);
            ind = find(temp==max(temp));

            end
     end
end

p1 = q1(ind,:);
w12 = (p1(3)/16430)*(nn/(16430)); % weights between initial falure and
 stage2 tx-line
s1 = table(p1(1), p1(2), w12);
```

stage 3

```
a = [];
b = 0;
for i = S(mm) % initial failure
    for j = p1(2) % 2nd stage tx-line
        for k = 1:186 % searching for the 3rd stage tx-line

            if(j ~= i && k ~= i && k ~= j)
            sequence_check  = [i; j; k];
            n = sum(cellfun(@(x)
 ~isempty(strfind(x.',sequence_check.')), C));
            a = [a, n];
            b = b+1;
            q2(b,:)= [i j k n];
            temp = q2(:,4);
            ind = find(temp==max(temp));

            end
        end
    end
end

p2 = q2(ind,:);
w23 = (p2(4)/(16430))*w12; % weights between stage2 and stage3 tx-line
s2 = table(p2(1), p2(2), p2(3), w23);
```

stage 4

```
a = [];
b = 0;
for i = S(mm) % initial failure
    for j = p1(2) % 2nd stage tx-line
        for k = p2(3) % 3rd stage tx-line
            for l = 1:186 % searching for the 4th stage tx-line
```

```
            if(j ~= i && k ~= i && k ~= j && l ~= i && l ~= j && l ~=
 k)
            sequence_check  = [i; j; k; l];
            n = sum(cellfun(@(x)
 ~isempty(strfind(x.',sequence_check.')), C));
            a = [a, n];
            b = b+1;
            q3(b,:)= [i j k l n];
            temp = q3(:,5);
            ind = find(temp==max(temp));
            end

            end
        end
    end
end

p3 = q3(ind,:);
w34 = (p3(5)/(12538))*w23; % weights between stage3 and stage4 tx-line
s3 = table(p3(1), p3(2), p3(3), p3(4), w34);
```

stage 5

```
a = [];
b = 0;
for i = S(mm) % initial failure
    for j = p1(2) % 2nd stage tx-line
        for k = p2(3) % 3rd stage tx-line
            for l = p3(4) % 4th stage tx-line
                for m = 1:186 % searching for the 5th stage tx-line

                    if(j ~= i && k ~= i && k ~= j && l ~= i && l ~= j
 && l ~= k && m ~= i && m ~= j && m ~= k && m ~= l)
                    sequence_check  = [i; j; k; l; m];
                    n = sum(cellfun(@(x)
 ~isempty(strfind(x.',sequence_check.')), C));
                    a = [a, n];
                    b = b+1;
                    q4(b,:)= [i j k l m n];
                    temp = q4(:,6);
                    ind = find(temp==max(temp));
                    end
                end

            end
        end
    end
end

p4 = q4(ind,:);
w45 = (p4(6)/(10308))*w34; % weights between stage4 and stage5 tx-line
s4 = table(p4(1), p4(2), p4(3), p4(4), p4(5), w45);
```

stage 6

```
a = [];
b=0;
for i = S(mm) % initial failure
    for j = p1(2) % 2nd stage tx-line
        for k = p2(3) % 3rd stage tx-line
            for l = p3(4) % 4th stage tx-line
                for m = p4(5) % 5th stage tx-line
                    for o = 1:186 % searching for the 6th stage tx-
line

                        if(j ~= i && k ~= i && k ~= j && l ~= i && l
 ~= j && l ~= k && m ~= i && m ~= j && m ~= k && m ~= l && o ~= i && o
 ~= j && o ~= k && o ~= l && o ~= m)
                        sequence_check  = [i; j; k; l; m; o];
                        n = sum(cellfun(@(x)
 ~isempty(strfind(x.',sequence_check.')), C));
                        a = [a, n];
                        b = b+1;
                        q5(b,:)= [i j k l m o n];
                        temp = q5(:,7);
                        ind = find(temp==max(temp));
                        end

                    end
                end
            end
        end
    end
end
p5 = q5(ind,:);
w56 = (p5(7)/(8870))*w45; % weights between stage5 and stage6 tx-line
s5 = table(p5(1), p5(2), p5(3), p5(4), p5(5), p5(6), w56);

InitialFailure_stage1 = S(mm);
stage2 = p1(2);
stage3 = p2(3);
stage4 = p3(4);
stage5 = p4(5);
stage6 = p5(6);

TopSequence = table(InitialFailure_stage1, stage2, stage3, stage4,
 stage5, stage6)
weights = table(w12, w23, w34, w45, w56)


TopSequence =

  1×6 table

    InitialFailure_stage1    stage2    stage3    stage4    stage5
 stage6
```

```
    ____________________    ______    ______    ______    ______
 ______

    96                      61        58        117       108
 115


weights =

  1×5 table

      w12          w23          w34           w45           w56
    _______    _________    __________    __________    __________

    0.05595    0.0071819    0.00064957    3.4596e-05    1.8605e-06
```

```
end
```

Published with MATLAB® R2017b