

Appendix A: Source Codes of Proposed CA Models

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fid=fopen('3m131272.txt','w');
X=struct('p',{[0 0]});
V=struct('p',{[0 0]});
dXf=struct('p',{[0 0]});
dx=struct('s',0);
dy=struct('s',0);
DL=[16 0];
time=1200;
A1=[1 0];
Motor=[2 1];
Car=[6 2];
veh=150;
back=10;
nocell=5;
veh1=veh+2;
for i=1:nocell
    V.no(i).time(1).p=[1 0];
    v1(i)=1;
    Vmax(i)=13;
end;
V.no(veh1).time(1).p=[1 0];
v1(veh1)=0;
Vmax(veh1)=13;
for i=nocell:veh
    k=i+1;
    v1(k)=binornd(1,0.72);
    V.no(k).time(1).p=[1 0];
end;
% set veh and initial value
for i=1:veh1
    IT=10*(veh1-i);
    if i<=nocell
        IT1=10*(veh1-nocell);
        X.no(i).time(1).p=[IT1 i];
    else
        if v1(i)==1
            p1=unidrnd(nocell);
            X.no(i).time(1).p=[IT p1];
        else
            p2=unidrnd(nocell-1)+1;
            X.no(i).time(1).p=[IT p2];
        end;
    end;
end;
end;
for k=(nocell+1):(veh+1)
    if v1(k)==1
        Vmax(k)=fix(normrnd(13,0));
    else
        Vmax(k)=fix(normrnd(12,0));
    end;
end;
end;
for t=1:time
%set the analysis time
    T1=t+1;
    %define the next period
    for n=1:veh1
        A3=Vmax(n);
    end;
end;

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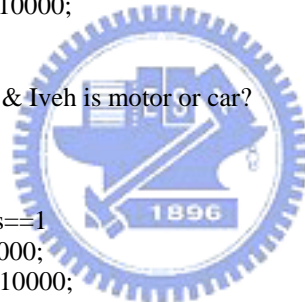
if n<=nocell
    A12=V.no(n).time(t).p(1);
    if (t>=50) & (t<=250)
        V.no(n).time(T1).p=max(0,V.no(n).time(t).p-A1);
    else
        if (A12<A3)
            V.no(n).time(T1).p=V.no(n).time(t).p+A1;
        else
            V.no(n).time(T1).p=V.no(n).time(t).p;
        end;
    end;
    X.no(n).time(T1).p=X.no(n).time(t).p+V.no(n).time(T1).p;
end;
if n>nocell
    A32=V.no(n).time(t).p(1);
    for I=1:veh1
        % chcek gaps from all infront veh on time t
        dx.n(I).t(t).s=X.no(I).time(t).p(1)-X.no(n).time(t).p(1);
        dy.n(I).t(t).s=X.no(I).time(t).p(2)-X.no(n).time(t).p(2);
    end;
    %define the y difference
    for I=1:veh1
        if v1(n)==1
            %nveh is motor
            if v1(I)==1
                %infront Iveh is motor
                if dy.n(I).t(t).s==0
                    %infront Iveh infront
                    FD(I)=dx.n(I).t(t).s-Motor(1);
                    FCR1(I)=10000;
                    FCL1(I)=10000;
                    FCR2(I)=10000;
                    FCL2(I)=10000;
                elseif dy.n(I).t(t).s== -1
                    %infront Iveh in right 1
                    FD(I)=10000;
                    FCR1(I)=dx.n(I).t(t).s-Motor(1);
                    FCL1(I)=10000;
                    FCR2(I)=10000;
                    FCL2(I)=10000;
                elseif dy.n(I).t(t).s==1
                    %infront Iveh in left 1
                    FD(I)=10000;
                    FCR1(I)=10000;
                    FCL1(I)=dx.n(I).t(t).s-Motor(1);
                    FCR2(I)=10000;
                    FCL2(I)=10000;
                else
                    FD(I)=10000;
                    FCR1(I)=10000;
                    FCL1(I)=10000;
                    FCR2(I)=10000;
                    FCL2(I)=10000;
                end;
            end;
        else
            %infront Iveh is car, if motor no lane 2 could change
            if dy.n(I).t(t).s==2
                FD(I)=10000;
                FCR1(I)=10000;
                FCL1(I)=dx.n(I).t(t).s-Car(1);
            end;
        end;
    end;
end;

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        FCR2(I)=10000;
        FCL2(I)=dx.n(I).t(t).s-Car(1);
    elseif dy.n(I).t(t).s==1
        FD(I)=dx.n(I).t(t).s-Car(1);
        FCR1(I)=10000;
        FCL1(I)=dx.n(I).t(t).s-Car(1);
        FCR2(I)=10000;
        FCL2(I)=10000;
    elseif dy.n(I).t(t).s==0
        FD(I)=dx.n(I).t(t).s-Car(1);
        FCR1(I)=dx.n(I).t(t).s-Car(1);
        FCL1(I)=10000;
        FCR2(I)=10000;
        FCL2(I)=10000;
    elseif dy.n(I).t(t).s==-1
        FD(I)=10000;
        FCR1(I)=dx.n(I).t(t).s-Car(1);
        FCL1(I)=10000;
        FCR2(I)=dx.n(I).t(t).s-Car(1);
        FCL2(I)=10000;
    else
        FD(I)=10000;
        FCR1(I)=10000;
        FCL1(I)=10000;
        FCR2(I)=10000;
        FCL2(I)=10000;
    end;
end;
% nveh is motor & Iveh is motor or car?
else
% nveh is car
if v1(I)==1
    if dy.n(I).t(t).s==1
        FD(I)=10000;
        FCR1(I)=10000;
        FCL1(I)=dx.n(I).t(t).s-Motor(1);
        FCR2(I)=10000;
        FCL2(I)=dx.n(I).t(t).s-Motor(1);
    elseif dy.n(I).t(t).s==0
        FD(I)=dx.n(I).t(t).s-Motor(1);
        FCR1(I)=10000;
        FCL1(I)=dx.n(I).t(t).s-Motor(1);
        FCR2(I)=10000;
        FCL2(I)=10000;
    elseif dy.n(I).t(t).s==-1
        FD(I)=dx.n(I).t(t).s-Motor(1);
        FCR1(I)=dx.n(I).t(t).s-Motor(1);
        FCL1(I)=10000;
        FCR2(I)=10000;
        FCL2(I)=dx.n(I).t(t).s-Motor(1);
    elseif dy.n(I).t(t).s==-2
        FD(I)=10000;
        FCR1(I)=dx.n(I).t(t).s-Motor(1);
        FCL1(I)=10000;
        FCR2(I)=dx.n(I).t(t).s-Motor(1);
        FCL2(I)=10000;
    else
        FD(I)=10000;
        FCR1(I)=10000;
        FCL1(I)=10000;
    end;
end;

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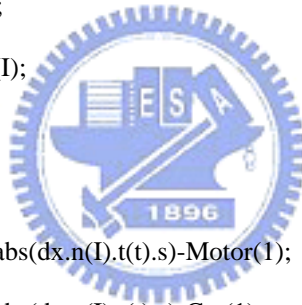
        FCR2(I)=10000;
        FCL2(I)=10000;
    end;
else
    if dy.n(I).t(t).s==2
        FD(I)=10000;
        FCR1(I)=10000;
        FCR2(I)=10000;
        FCL1(I)=dx.n(I).t(t).s-Car(1);
        FCL2(I)=dx.n(I).t(t).s-Car(1);
    elseif dy.n(I).t(t).s==1
        FD(I)=dx.n(I).t(t).s-Car(1);
        FCR1(I)=10000;
        FCR2(I)=10000;
        FCL1(I)=dx.n(I).t(t).s-Car(1);
        FCL2(I)=dx.n(I).t(t).s-Car(1);
    elseif dy.n(I).t(t).s==0
        FD(I)=dx.n(I).t(t).s-Car(1);
        FCR1(I)=dx.n(I).t(t).s-Car(1);
        FCR2(I)=dx.n(I).t(t).s-Car(1);
        FCL1(I)=dx.n(I).t(t).s-Car(1);
        FCL2(I)=10000;
    elseif dy.n(I).t(t).s==-1
        FD(I)=dx.n(I).t(t).s-Car(1);
        FCR1(I)=dx.n(I).t(t).s-Car(1);
        FCR2(I)=dx.n(I).t(t).s-Car(1);
        FCL1(I)=10000;
        FCL2(I)=10000;
    elseif dy.n(I).t(t).s==-2
        FD(I)=10000;
        FCR1(I)=dx.n(I).t(t).s-Car(1);
        FCR2(I)=dx.n(I).t(t).s-Car(1);
        FCL1(I)=10000;
        FCL2(I)=10000;
    else
        FD(I)=10000;
        FCR1(I)=10000;
        FCR2(I)=10000;
        FCL1(I)=10000;
        FCL2(I)=10000;
    end;
end;
    %nveh is car, Iveh is motor or car?
end;
    %find all possible neighbor lane distance
if FD(I)<0
    FD(I)=10000;
else
    FD(I)=FD(I);
end;
if FCR1(I)<0
    if I~=n
        if v1(n)==1
            BR1(I)=abs(dx.n(I).t(t).s)-Motor(1);
        else
            BR1(I)=abs(dx.n(I).t(t).s)-Car(1);
        end;
    if BR1(I)<0
        BR1(I)=0;
    else

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        BR1(I)=BR1(I);
    end;
else
    BR1(I)=10000;
end;
FCR1(I)=10000;
else
    FCR1(I)=FCR1(I);
    BR1(I)=10000;
end;
if FCR2(I)<0
    if I~=n
        if v1(n)==1
            BR2(I)=abs(dx.n(I).t(t).s)-Motor(1);
        else
            BR2(I)=abs(dx.n(I).t(t).s)-Car(1);
        end;
        if BR2(I)<0
            BR2(I)=0;
        else
            BR2(I)=BR2(I);
        end;
    else
        BR2(I)=10000;
    end;
    FCR2(I)=10000;
else
    FCR2(I)=FCR2(I);
    BR2(I)=10000;
end;
if FCL1(I)<0
    if I~=n
        if v1(n)==1
            BL1(I)=abs(dx.n(I).t(t).s)-Motor(1);
        else
            BL1(I)=abs(dx.n(I).t(t).s)-Car(1);
        end;
        if BL1(I)<0
            BL1(I)=0;
        else
            BL1(I)=BL1(I);
        end;
    else
        BL1(I)=10000;
    end;
    FCL1(I)=10000;
else
    FCL1(I)=FCL1(I);
    BL1(I)=10000;
end;
if FCL2(I)<0
    if I~=n
        if v1(n)==1
            BL2(I)=abs(dx.n(I).t(t).s)-Motor(1);
        else
            BL2(I)=abs(dx.n(I).t(t).s)-Car(1);
        end;
        if BL2(I)<0
            BL2(I)=0;
        else

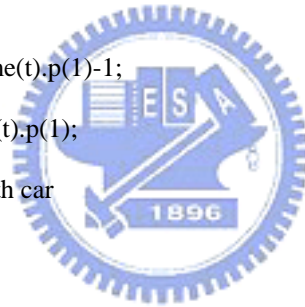
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        BL2(I)=BL2(I);
    end;
    else
        BL2(I)=10000;
    end;
    FCL2(I)=10000;
    else
        FCL2(I)=FCL2(I);
        BL2(I)=10000;
    end;
    %out the veh in back
end;
%for I=1:veh
a2=FD(veh1);
I1=veh1;
for I=1:(veh1-1)
    if a2<FD(I)
        a2=a2;
    else
        a2=FD(I);
        I1=I;
    end;
end;
%find the nearest front veh
dXf.no(n).time(t).p(1)=a2;
%define a veh in front
%if A32>=13
    %A37=dXf.no(n).time(t).p(1)-1;
    %else
    A37=dXf.no(n).time(t).p(1);
    %end;
%the gap in front of the nth car
C12=FCR1(veh1);
I2=veh1;
for I=1:(veh1-1)
    if C12<FCR1(I)
        C12=C12;
    else
        C12=FCR1(I);
        I2=I;
    end;
end;
% find the nearest gap on right 1
C122=FCR2(veh1);
I22=veh1;
for I=1:(veh1-1)
    if C122<FCR2(I)
        C122=C122;
    else
        C122=FCR2(I);
        I22=I;
    end;
end;
% find the nearest gap on right 2
C13=FCL1(veh1);
I3=veh1;
for I=1:(veh1-1)
    if C13<FCL1(I)
        C13=C13;
    else

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        C13=FCL1(I);
        I3=I;
    end;
end;
% find the nearest gap on left 1
C132=FCL2(veh1);
I32=veh1;
for I=1:(veh1-1)
    if C132<FCL2(I)
        C132=C132;
    else
        C132=FCL2(I);
        I32=I;
    end;
end;
% find the nearest gap on left 2
BCR11=BR1(veh1);
IB1=veh1;
for I=1:(veh1-1)
    if BCR11<BR1(I)
        BCR11=BCR11;
    else
        BCR11=BR1(I);
        IB1=I;
    end;
end;
% find the nearest right behind gap
BCR22=BR2(veh1);
IB3=veh1;
for I=1:(veh1-1)
    if BCR22<BR2(I)
        BCR22=BCR22;
    else
        BCR22=BR2(I);
        IB3=I;
    end;
end;
% find the next 2 right behind gap
BCL11=BL1(veh1);
IB2=veh1;
for I=1:(veh1-1)
    if BCL11<BL1(I)
        BCL11=BCL11;
    else
        BCL11=BL1(I);
        IB2=I;
    end;
end;
% find the nearest left behind gap
BCL22=BL2(veh1);
IB4=veh1;
for I=1:(veh1-1)
    if BCL22<BL2(I)
        BCL22=BCL22;
    else
        BCL22=BL2(I);
        IB4=I;
    end;
end;
% find the next 2 left behind gap

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for j=1:n-1
    if v1(j)==1
        pd1(j)=X.no(j).time(T1).p(1)-X.no(n).time(t).p(1)-Motor(1);
    else
        pd1(j)=X.no(j).time(T1).p(1)-X.no(n).time(t).p(1)-Car(1);
    end;
    pd2=X.no(j).time(T1).p(2)-X.no(n).time(t).p(2);
    if pd1(j)>=0
        pdf1(j)=pd1(j)-V.no(n).time(t).p(1);
        pdb1(j)=10000;
    else
        pdf1(j)=10000;
        pdb1(j)=pd1(j)+V.no(n).time(t).p(1);
    end;
    if pd2== -1
        pfR1(j)=pdf1(j);
        pbR1(j)=pdb1(j);
        pfL1(j)=10000;
        pbL1(j)=10000;
    elseif pd2==1
        pfL1(j)=pdf1(j);
        pbL1(j)=pdb1(j);
        pfR1(j)=10000;
        pbR1(j)=10000;
    else
        pfR1(j)=10000;
        pbR1(j)=10000;
        pfL1(j)=10000;
        pbL1(j)=10000;
    end;
end;
fR=pfR1(n-1);
fRn=n-1;
for I=1:(n-2)
    if fR<pfR1(I)
        fR=fR;
    else
        fR=pfR1(I);
        fRn=I;
    end;
end;
bR=pbR1(n-1);
bRn=n-1;
for I=1:(n-2)
    if bR<pbR1(I)
        bR=bR;
    else
        bR=pbR1(I);
        bRn=I;
    end;
end;
fL=pfL1(n-1);
fLn=n-1;
for I=1:(n-2)
    if fL<pfL1(I)
        fL=fL;
    else
        fL=pfL1(I);
        fLn=I;
    end;
end;

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end;
bL=pbL1(n-1);
bLn=n-1;
for I=1:(n-2)
    if bL<pbL1(I)
        bL=bL;
    else
        bL=pbL1(I);
        bLn=I;
    end;
end;
if FCL1(I3)<=fL
    FCL1(I3)=FCL1(I3);
else
    FCL1(I3)=fL;
end;
if FCR1(I2)<=fR
    FCR1(I2)=FCR1(I2);
else
    FCR1(I2)=fR;
end;
if A32<A37
    if A32<A3
        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+A1(1);
        V.no(n).time(T1).p(2)=0;
    else
        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
        V.no(n).time(T1).p(2)=0;
    end;
else
    if v1(n)==1
        if X.no(n).time(t).p(2)==1
            % left lane speace > right
            if FCL1(I3)>A37 & BCL11>Motor(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 &
fL>0 & bL>0
                % if left>front & behind gap is enough it is ready for turn
                if FCL1(I3)>V.no(n).time(t).p(1)
                    % when left gap>speed, then turn to left and same speed
                    if FCL1(I3)<A3
                        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                        V.no(n).time(T1).p(2)=1;
                    else
                        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                        V.no(n).time(T1).p(2)=1;
                    end;
                end;
            else
                % when left<speed, then trun to left and dec=>left gap
                V.no(n).time(T1).p(1)=FCL1(I3);
                V.no(n).time(T1).p(2)=1;
            end;
            % lane left1 is enough to turn with the same V
        else
            % left gap<front, then do not trun, only dec=>front gap
            V.no(n).time(T1).p(1)=A37;
            V.no(n).time(T1).p(2)=0;
            % no change, only dec.
        end;
        % for left 1
    elseif X.no(n).time(t).p(2)==nocell
        if FCR1(I2)>A37 & BCR11>Motor(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 &

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fR>0 & bR>0

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% if right>front & behind gap is enough it is ready for turn
if FCR1(I2)>V.no(n).time(t).p(1)
    % when right gap>speed, then turn to right and same speed
    if FCR1(I2)<A3
        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
        V.no(n).time(T1).p(2)=-1;
    else
        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
        V.no(n).time(T1).p(2)=-1;
    end;
end;
else
    % when right<speed, then trun to right and dec=>right gap
    V.no(n).time(T1).p(1)=FCR1(I2);
    V.no(n).time(T1).p(2)=-1;
end;
else
    % right gap<front, then do not trun, only dec=>front gap
    V.no(n).time(T1).p(1)=A37;
    V.no(n).time(T1).p(2)=0;
    %no change, must dec
end;
% for right 1
else
    if FCL1(I3)>FCR1(I2) & FCR1(I2)>A37
        if BCL11>Motor(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 & bL>0
            % left>front & behind gap is enough it is ready for turn
            if FCL1(I3)>V.no(n).time(t).p(1)
                % when left gap>speed, then turn to left and same speed
                if FCL1(I3)<A3
                    V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                    V.no(n).time(T1).p(2)=1;
                else
                    V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                    V.no(n).time(T1).p(2)=1;
                end;
            end;
        else
            % when left<speed, then trun to left and dec=>left gap
            V.no(n).time(T1).p(1)=FCL1(I3);
            V.no(n).time(T1).p(2)=1;
        end;
    elseif BCR11>Motor(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fR>0 &
bR>0
        if FCR1(I2)>V.no(n).time(t).p(1)
            % when left gap>speed, then turn to left and same speed
            if FCR1(I2)<A3
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                V.no(n).time(T1).p(2)=-1;
            else
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                V.no(n).time(T1).p(2)=-1;
            end;
        end;
    else
        % when left<speed, then trun to left and dec=>left gap
        V.no(n).time(T1).p(1)=FCR1(I2);
        V.no(n).time(T1).p(2)=-1;
    end;
    % lane left1 is enough to turn with the same V
else
    V.no(n).time(T1).p(1)=A37;
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        V.no(n).time(T1).p(2)=0;
    end;
    % lane left1 is enough to turn with the same V
elseif FCR1(I2)>FCL1(I3) & FCL1(I3)>A37
    if BCR11>Motor(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fL>0 & bL>0
        % if left>front & behind gap is enough it is ready for turn
        if FCR1(I2)>V.no(n).time(t).p(1)
            % when left gap>speed, then turn to left and same speed
            if FCR1(I2)<A3
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                V.no(n).time(T1).p(2)=-1;
            else
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                V.no(n).time(T1).p(2)=-1;
            end;
        else
            % when left<speed, then trun to left and dec=>left gap
            V.no(n).time(T1).p(1)=FCR1(I2);
            V.no(n).time(T1).p(2)=-1;
        end;
    elseif BCL11>Motor(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 &
bL>0
        if FCL1(I3)>V.no(n).time(t).p(1)
            % when left gap>speed, then turn to left and same speed
            if FCL1(I3)<A3
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                V.no(n).time(T1).p(2)=1;
            else
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                V.no(n).time(T1).p(2)=1;
            end;
        else
            V.no(n).time(T1).p(1)=FCL1(I3);
            V.no(n).time(T1).p(2)=1;
        end;
        % lane left1 is enough to turn with the same V
    else
        V.no(n).time(T1).p(1)=A37;
        V.no(n).time(T1).p(2)=0;
    end;
    % lane left1 is enough to turn with the same V
elseif FCL1(I3)>A37 & A37>=FCR1(I2)
    if BCL11>Motor(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 & bL>0
        % if left>front & behind gap is enough it is ready for turn
        if FCL1(I3)>V.no(n).time(t).p(1)
            % when left gap>speed, then turn to left and same speed
            if FCL1(I3)<A3
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                V.no(n).time(T1).p(2)=1;
            else
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                V.no(n).time(T1).p(2)=1;
            end;
        else
            % when left<speed, then trun to left and dec=>left gap
            V.no(n).time(T1).p(1)=FCL1(I3);
            V.no(n).time(T1).p(2)=1;
        end;
    else
        V.no(n).time(T1).p(1)=A37;
    end;

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        V.no(n).time(T1).p(2)=0;
    end;
elseif FCR1(I2)>A37 & A37>=FCL1(I3)
    if BCR11>Motor(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fR>0 & bR>0
        % if left>front & behind gap is enough it is ready for turn
        if FCR1(I2)>V.no(n).time(t).p(1)
            % when left gap>speed, then turn to left and same speed
            if FCR1(I2)<A3
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                V.no(n).time(T1).p(2)=-1;
            else
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                V.no(n).time(T1).p(2)=-1;
            end;
        else
            % when left<speed, then trun to left and dec=>left gap
            V.no(n).time(T1).p(1)=FCR1(I2);
            V.no(n).time(T1).p(2)=-1;
        end;
    else
        V.no(n).time(T1).p(1)=A37;
        V.no(n).time(T1).p(2)=0;
    end;
else
    V.no(n).time(T1).p(1)=A37;
    V.no(n).time(T1).p(2)=0;
end;
end;
%for left 1 or right 1
else
    %nveh is car
    if nocell==2 & X.no(n).time(t).p(2)==2
        V.no(n).time(T1).p(1)=A37;
        V.no(n).time(T1).p(2)=0;
    elseif X.no(n).time(t).p(2)==2
        % the rightest
        if FCL1(I3)>A37 & BCL11>Car(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 &
fL>0 & bL>0
            % if left>front & behind gap is enough it is ready for turn
            if FCL1(I3)>V.no(n).time(t).p(1)
                % when left gap>speed, then turn to left and same speed
                if FCL1(I3)<A3
                    V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                    V.no(n).time(T1).p(2)=1;
                else
                    V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                    V.no(n).time(T1).p(2)=1;
                end;
            else
                % when left<speed, then trun to left and dec=>left gap
                V.no(n).time(T1).p(1)=FCL1(I3);
                V.no(n).time(T1).p(2)=1;
            end;
        % lane left1 is enough to turn with the same V
    elseif FCL1(I3)==A37 & BCL11>Car(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100
& fL>0 & bL>0 & FCL2(I32)>A37
        V.no(n).time(T1).p(1)=FCL1(I3);
        V.no(n).time(T1).p(2)=1;
    else
        %left gap<front, then do not trun, only dec=>front gap

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V.no(n).time(T1).p(1)=A37;
V.no(n).time(T1).p(2)=0;
%no change, only dec.
end;
% for left 1
elseif X.no(n).time(t).p(2)==nocell
if FCR1(I2)>A37 & BCR11>Car(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 &
fR>0 & bR>0
% if right>front & behind gap is enough it is ready for turn
if FCR1(I2)>V.no(n).time(t).p(1)
% when right gap>speed, then turn to right and same speed
if FCR1(I2)<A3
V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
V.no(n).time(T1).p(2)=-1;
else
V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
V.no(n).time(T1).p(2)=-1;
end;
else
% when right<speed, then trun to right and dec=>right gap
V.no(n).time(T1).p(1)=FCR1(I2);
V.no(n).time(T1).p(2)=-1;
end;
elseif FCR1(I2)==A37 & BCR11>Car(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100
& fR>0 & bR>0 & FCR2(I22)>A37
V.no(n).time(T1).p(1)=FCR1(I2);
V.no(n).time(T1).p(2)=-1;
else
% right gap<front, then do not trun, only dec=>front gap
V.no(n).time(T1).p(1)=A37;
V.no(n).time(T1).p(2)=0;
%no change, must dec
end;
% for right 1
else
if FCL1(I3)>FCR1(I2) & FCR1(I2)>A37
if BCL11>Car(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 & bL>0
% left>front & behind gap is enough it is ready for turn
if FCL1(I3)>V.no(n).time(t).p(1)
% when left gap>speed, then turn to left and same speed
if FCL1(I3)<A3
V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
V.no(n).time(T1).p(2)=1;
else
V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
V.no(n).time(T1).p(2)=1;
end;
else
% when left<speed, then trun to left and dec=>left gap
V.no(n).time(T1).p(1)=FCL1(I3);
V.no(n).time(T1).p(2)=1;
end;
elseif BCR11>Car(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fR>0 & bR>0
if FCR1(I2)>V.no(n).time(t).p(1)
% when left gap>speed, then turn to left and same speed
if FCR1(I2)<A3
V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
V.no(n).time(T1).p(2)=-1;
else
V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);

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        V.no(n).time(T1).p(2)=-1;
    end;
else
    % when left<speed, then trun to left and dec=>left gap
    V.no(n).time(T1).p(1)=FCR1(I2);
    V.no(n).time(T1).p(2)=-1;
end;
else
    V.no(n).time(T1).p(1)=A37;
    V.no(n).time(T1).p(2)=0;
end;
elseif FCR1(I2)>FCL1(I3) & FCL1(I3)>A37
if BCR11>Car(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fR>0 & bR>0
    % if left>front & behind gap is enough it is ready for turn
    if FCR1(I2)>V.no(n).time(t).p(1)
        % when left gap>speed, then turn to left and same speed
        if FCR1(I2)<A3
            V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
            V.no(n).time(T1).p(2)=-1;
        else
            V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
            V.no(n).time(T1).p(2)=-1;
        end;
    else
        % when left<speed, then trun to left and dec=>left gap
        V.no(n).time(T1).p(1)=FCR1(I2);
        V.no(n).time(T1).p(2)=-1;
    end;
elseif BCL11>Car(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 & bL>0
if FCL1(I3)>V.no(n).time(t).p(1)
    % when left gap>speed, then turn to left and same speed
    if FCL1(I3)<A3
        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
        V.no(n).time(T1).p(2)=1;
    else
        V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
        V.no(n).time(T1).p(2)=1;
    end;
end;
else
    % when left<speed, then trun to left and dec=>left gap
    V.no(n).time(T1).p(1)=FCL1(I3);
    V.no(n).time(T1).p(2)=1;
end;
else
    V.no(n).time(T1).p(1)=A37;
    V.no(n).time(T1).p(2)=0;
end;
elseif FCL1(I3)>A37 & A37>=FCR1(I2)
if BCL11>Car(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 & bL>0
    % if left>front & behind gap is enough it is ready for turn
    if FCL1(I3)>V.no(n).time(t).p(1)
        % when left gap>speed, then turn to left and same speed
        if FCL1(I3)<A3
            V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
            V.no(n).time(T1).p(2)=1;
        else
            V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
            V.no(n).time(T1).p(2)=1;
        end;
    end;
else

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```

        % when left<speed, then turn to left and dec=>left gap
        V.no(n).time(T1).p(1)=FCL1(I3);
        V.no(n).time(T1).p(2)=1;
    end;
else
    V.no(n).time(T1).p(1)=A37;
    V.no(n).time(T1).p(2)=0;
end;
elseif FCR1(I2)>A37 & A37>=FCL1(I3)
    if BCR11>Car(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fR>0 & bR>0
        % if left>front & behind gap is enough it is ready for turn
        if FCR1(I2)>V.no(n).time(t).p(1)
            % when left gap>speed, then turn to left and same speed
            if FCR1(I2)<A3
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)+1;
                V.no(n).time(T1).p(2)=-1;
            else
                V.no(n).time(T1).p(1)=V.no(n).time(t).p(1);
                V.no(n).time(T1).p(2)=-1;
            end;
        else
            % when left<speed, then turn to left and dec=>left gap
            V.no(n).time(T1).p(1)=FCR1(I2);
            V.no(n).time(T1).p(2)=-1;
        end;
    else
        V.no(n).time(T1).p(1)=A37;
        V.no(n).time(T1).p(2)=0;
    end;
elseif FCR1(I2)==A37 & A37>FCL1(I3)
    if BCR11>Car(1)+V.no(IB1).time(t).p(1) & FCR1(I2)<100 & fR>0 & bR>0 &
FCR2(I22)>A37
        % if left>front & behind gap is enough it is ready for turn
        V.no(n).time(T1).p(1)=FCR1(I2);
        V.no(n).time(T1).p(2)=-1;
    else
        V.no(n).time(T1).p(1)=A37;
        V.no(n).time(T1).p(2)=0;
    end;
elseif FCL1(I3)>=A37 & A37>=FCR1(I2)
    if BCL11>Car(1)+V.no(IB2).time(t).p(1) & FCL1(I3)<100 & fL>0 & bL>0
&FCL2(I32)>A37
        % if left>front & behind gap is enough it is ready for turn
        V.no(n).time(T1).p(1)=FCL1(I3);
        V.no(n).time(T1).p(2)=1;
    else
        V.no(n).time(T1).p(1)=A37;
        V.no(n).time(T1).p(2)=0;
    end;
else
    V.no(n).time(T1).p(1)=A37;
    V.no(n).time(T1).p(2)=0;
end;
end;
% for position
end;
% nveh is motor or car?
end;
% determine speed of the nth car in new period T1
if t>(time-350) & (n==veh1)

```

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        if V.no(n).time(t).p(1)>2
            V.no(n).time(T1).p(1)=V.no(n).time(t).p(1)-3;
            V.no(n).time(T1).p(2)=V.no(n).time(t).p(2);
        else
            V.no(n).time(T1).p(1)=0;
            V.no(n).time(T1).p(2)=V.no(n).time(t).p(2);
        end;
    end;
    %new poision of the nth car
    X.no(n).time(T1).p=V.no(n).time(T1).p+X.no(n).time(t).p;
    V.no(n).time(T1).p(2)=0;
end;
% n>=nocell
end;
% for n=veh1
end;
%for j=time
for t=1:3:350
    OC=0;
    V0=0;
    nocu=0;
    tn=nocell+1;
    for n=1:veh1
        p(n)=X.no(n).time(t).p(1);
    end;
    for n=1:veh1
        if v1(n)==0
            if X.no(n).time(t).p(1)-6>=min(p)+back
                ocu=6*2;
            elseif min(p)+back>X.no(n).time(t).p(1)-6 & X.no(n).time(t).p(1)-min(p)-back>0
                ocu=(X.no(n).time(t).p(1)-min(p)-back)*2;
            else
                ocu=0;
            end;
        else
            if X.no(n).time(t).p(1)-2>=min(p)+back
                ocu=2*1;
            elseif min(p)+back>X.no(n).time(t).p(1)-2 & X.no(n).time(t).p(1)-min(p)-back>0
                ocu=(X.no(n).time(t).p(1)-min(p)-back);
            else
                ocu=0;
            end;
        end;
        if ocu>0
            nocu=nocu+1;
            V1=V.no(n).time(t).p(1);
        else
            nocu=nocu;
            V1=0;
        end;
        V0=V0+V1;
        OC=OC+ocu;
    end;
    distance(t)=max(p)-min(p)-back;
    density(t)=(nocu-nocell)/distance(t);
    occupy(t)=(OC)/distance(t)/nocell;
    speed(t)=V0/nocu;
    fprintf(fid,'speed(%3.0f)=[%7.4f]\n',t,speed(t));
    fprintf(fid,'density(%3.0f)=[%7.4f]\n',t,density(t));
    fprintf(fid,'occupy(%3.0f)=[%7.4f]\n',t,occupy(t));
end;

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end;
for t=350:30:time
    OC=0;
    V0=0;
    nocu=0;
    tn=nocell+1;
    for n=1:veh1
        p(n)=X.no(n).time(t).p(1);
    end;
    for n=1:veh1
        if v1(n)==0
            if X.no(n).time(t).p(1)-6>=min(p)+back
                ocu=6*2;
            elseif min(p)+back>X.no(n).time(t).p(1)-6 & X.no(n).time(t).p(1)-min(p)-back>0
                ocu=(X.no(n).time(t).p(1)-min(p)-back)*2;
            else
                ocu=0;
            end;
        else
            if X.no(n).time(t).p(1)-2>=min(p)+back
                ocu=2*1;
            elseif min(p)+back>X.no(n).time(t).p(1)-2 & X.no(n).time(t).p(1)-min(p)-back>0
                ocu=(X.no(n).time(t).p(1)-min(p)-back);
            else
                ocu=0;
            end;
        end;
    end;
    if ocu>0
        nocu=nocu+1;
        V1=V.no(n).time(t).p(1);
    else
        nocu=nocu;
        V1=0;
    end;
    V0=V0+V1;
    OC=OC+ocu;
end;
distance(t)=max(p)-min(p)-back;
density(t)=(nocu-nocell)/distance(t);
occupy(t)=(OC)/distance(t)/nocell;
speed(t)=V0/nocu;
fprintf(fid,'speed(%3.0f)=[%7.4f]\n',t,speed(t));
fprintf(fid,'density(%3.0f)=[%7.4f]\n',t,density(t));
fprintf(fid,'occupy(%3.0f)=[%7.4f]\n',t,occupy(t));
end;

```





APPENDIX B PUBLICATION LIST

A.與論文相關論文 (Refereed papers)

1. Lawrence W. Lan and Chiung-Wen Chang, "Motorcycle's Moving Behavior in Mixed Traffic: Particle-Hopping Model with Cellular Automata," **Journal of the Eastern Asia Society for Transportation Studies**, Vol.5, pp. 23-37, 2003.10.
2. 藍武王、張瓊文, 「GM 與 ANFIS 機車跟車模式之比較」, **運輸計劃季刊**, Vol. 33, No. 3, 2004.09.
3. Lawrence W. Lan and Chiung-Wen Chang, "Inhomogeneous Particles Hopping Models for Mixed Traffic with Motorcycles and Cars," International Conference on Application of ICT in Transport Systems in a Third World Context, Kalutara, Sri Lanka, 2004.08.

B.其他投稿論文 (Other refereed papers)

4. 曾平毅、林豐博、張瓊文、蘇振維, 「高速公路收費站延滯模式之研究」, **運輸計劃季刊**, 第三十一卷第四期, 民國 91 年 12 月, 頁 795-816.
5. Tseng, P. Y., Chang, C. W. and Yang, M. P., "Using the Characteristics of Service Time for Accidents in Police Personnel Allocation," **Journal of the Eastern Asia Society for Transportation Studies**, Vol.4, No.5, Oct. 2001, pp. 251-260.
6. 曾平毅、張瓊文、張建彥, 「我國整體運輸計畫之課題分析」, **都市交通季刊**(專題論著), 第十五卷第四期, 民國 89 年 12 月, 頁 10-25.
7. 張瓊文、曾平毅, 「高速公路收費站服務時間之特性分析」, **中華道路季刊**, 第四十卷第二期, 民國 90 年 4 月, 頁 32-41.
8. 林豐博、曾平毅、張瓊文、蘇振維, 「高速公路出口匝道路段車流特性與容量分析」, **交通學報**, 第一卷第一期, 民國 90 年 12 月, 頁 75-102.
9. 曾平毅、林國顯、張瓊文, 「多車道郊區公路機車流之觀察與模擬分析」, **交通學報**, 第三卷第二期, 民國 92 年 12 月, 頁 55-74.

C.研討會論文

10. 藍武王、張瓊文, 「快慢分隔道路機車行車模式與特性之研究」, 中華民國第三屆機車交通與安全研討會論文集, pp. 1-16, 2001.04.
11. 藍武王、張瓊文, 「適應性類神經模糊推論系統於機車跟車模式之應用」, 第十屆校際運輸學術聯誼研討會, 2002.05.
12. Lawrence W. Lan, Chiung-Wen Chang and April Y. Kuo, "General-Motors (GM) based and Fuzzy-neural based Motorcycle Following Models – A Comparison," 2002 中華民國第十屆模糊理論及其應用會議論文集, 2002.12.