

## CRIME ANALYSIS USING QUANTITATIVE METRICS

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### Abstract

Based on statistical report on crime database of a country, most of the crime occurrence and proliferation evaluation methods developed so far are not reliable enough to make firm conclusions about the crimes that are likely to occur in near future. The reason for this is that there are no quantifiable measures for crimes, which could be used for analyzing them in the framework of mathematics and logic. The main objective of this paper is to evolve certain metrics for crimes and study various crime databases in terms of these metrics. The Indian crime database due to National Crime Record Bureau and American crime database due to the Federal Bureau of Investigation are considered for the intended study.

**Keywords:** Crimes, Crime Metrics, Crime Databases

### 1. Introduction

Any activity that causes mental, intellectual, psychological, physical harm to self or other individual or a group of individuals or societies is called CRIME. Such an activity by defying the conscientious and geopolitical rules and laws is punishable if the gravity of the activity exceeds a threshold set by laws. The causes of crime are complex. Most people today agree that poverty, parental neglect, low self-esteem, alcohol and drug abuse are all connected in explaining why people commit crimes. Some people are simply at greater risk of becoming offenders because of the circumstances into which they are born. To certain extent, genetic makeup of people contributes to intolerance and violent thought processes which lead to criminal activities. Is it the responsibility of an individual's genetic makeup that makes them a criminal or is it the environment in which they are raised that determines their outcome? Many scientists have been attempting to determine the role of neurochemicals in influencing criminal or antisocial behavior. Included in the list of neurochemicals already cited by researchers are monoamine oxidase (MOA), epinephrine, norepinephrine, serotonin, and dopamine.

At present human beings suffer from "Tolerance Deficiency Syndrome (TDS)". TDS of an individual may be due to his/her genetic makeup called "Latent Tolerance Deficiency Syndrome (LTDS)" or it may be an acquired one called "Acquired Tolerance Deficiency Syndrome (ATDS)". All said and done, crime is a subjective spatiotemporal activity. Basically, crime is denoted by an ordered couple <Predator, Prey>. Predator may be an individual or a group. Prey may also be an individual or a group. Crime report is usually presented in a tabular form. The entries of the table would be categorized under (i) place (province/state/district/village), (ii) type of crime and (iii) number of crimes committed over a finite period of time (week/month/year). Crime statistics is computed using common tools of analysis. Based on the statistics, probability of occurrence of a particular crime over a period of time is evaluated. This is called 'Prediction of Crime' based on statistics. The prediction process is governed by canonical rules of probability and detection estimation theory. Prediction is fundamentally based on crime statistical data. Hence, it is clear that crime data collected by security personnel has to be genuine in order to predict future crimes reliably.

Basically, crime is denoted by an ordered couple <Predator, Prey>. Predator may be an individual or a group. Prey may also be an individual or a group. Crime report is usually presented in a tabular form. The entries of the table would be categorized under (i) place (province/state/district/village), (ii) type of crime and (iii) number of crimes committed over a finite period of time (week/month/year). Crime statistics is computed using common tools of analysis. Consider ten types of crimes: (i) murder, (ii) terrorists attack, (iii) racists attack, (iv) Incidental robbery, (v) planned robbery, (vi) alcoholics attack, (vii) rape, (viii) political unrest, (ix) civil unrest and (x) teasing. Each crime type is viewed as a 7-tuple as shown below. Each item in the 7-tuple is represented by a finite alphanumeric code.

| Crime ID | Crime Type | GPS Coordinates | Time/Date/Month/Year | Predator ID<br>Individual/Group | Prey ID<br>Individual/Group | Status |
|----------|------------|-----------------|----------------------|---------------------------------|-----------------------------|--------|
|----------|------------|-----------------|----------------------|---------------------------------|-----------------------------|--------|

Each crime type is treated as a 'state' with a state variable  $\xi$ . The linear array of ten state variables corresponding to the ten crime types is called 'crime vector'.

| murder  | terrorists attack | Racists attack | Incidental robbery | planned robbery | alcoholics attack | rape    | political unrest | civil unrest | Teasing    |
|---------|-------------------|----------------|--------------------|-----------------|-------------------|---------|------------------|--------------|------------|
| $\xi_1$ | $\xi_2$           | $\xi_3$        | $\xi_4$            | $\xi_5$         | $\xi_6$           | $\xi_7$ | $\xi_8$          | $\xi_9$      | $\xi_{10}$ |

### Concept of Crime Vector and Crime Vector Space

#### Crime analytics using Crime Vectors with binary valued parametric variables

Every Crime Vector  $\psi = \langle \xi_1, \xi_2, \xi_3, \xi_4, \xi_5, \xi_6, \xi_7, \xi_8, \xi_9, \xi_{10} \rangle$  is a binary vector of length 10 and one can construct 1024 crime vectors. Based on the axioms of Boolean algebra, one can construct  $2^{1024}$  linear Boolean functions  $\phi_0, \phi_1, \phi_2, \dots, \phi_{2^{1024}-1}$ , which form the sequence space called **Crime Vector Space  $\Phi_2$** .

#### Crime analytics using Crime Vectors with N-ary valued parametric variables

In this case, every Crime Vector  $\psi = \langle \xi_1, \xi_2, \xi_3, \xi_4, \xi_5, \xi_6, \xi_7, \xi_8, \xi_9, \xi_{10} \rangle$  is a N-ary valued vector of length 10 and one can construct  $N^{10}$  crime vectors. Based on the axioms of discrete algebra, one can construct  $N^{N^{10}}$  discrete algebraic functions  $\phi_0, \phi_1, \phi_2, \dots, \phi_{N^{N^{10}}-1}$ , which form the **Crime Vector Space  $\Phi_N$** .

All the above crime vector modelling would work only when the crimes are quantified by means of some metrics.

## 2. Crime Metrics

**Crime Density (CD):** This is a measure of ratio of number of times that an independent crime occurred over a period of time in an area referred by zip code to actual area in square miles.

**Crime Rate (CR):** This is a measure of the ratio of number of times that an independent crime occurred over a period of time in an area referred by zip code to the population (as defined in standard literature). This definition does not appear to be correct because the term ‘rate’ always refers to number of occurrences over a period of time.

**Crime Velocity (CV):** ‘Crime velocity’ is viewed as a crime metric because crime is a spatio-temporal entity and of course, time is a vector.

**Crime Acceleration (CA):** This measure could be viewed as a crime metric because crime acceleration is a time rate of change of crime velocity.

System theoretic point of view, a finite ensemble of crimes is a spatio-temporal dynamical nonstationary random process and so every crime is modeled as a non-uniform sampled deterministic signal. In this context, compressive sensing and sparsing techniques are advocated and the notion of ‘**Uniform Crime Velocity (UCV)**’ introduced. **The total number of occurrences of a particular crime over a period of seven days (a week) is considered here as the UCV of that crime.** This amounts to saying that one has 52 UCV’s of a particular crime over a period of one year. Hence, the 52 UCV’s could be treated as discrete time signal which refers to what we call as ‘**Crime Velocity (CV)**’. One such hypothetical CV is shown in figure 1. In short, the discrete signal shown in figure 1 over the **364 ordered days (one left out based on sparsing)** of a year is the CV to be considered for analysis purposes. The flat portions in the discrete signal over a period of seven days is the UCV of a crime.

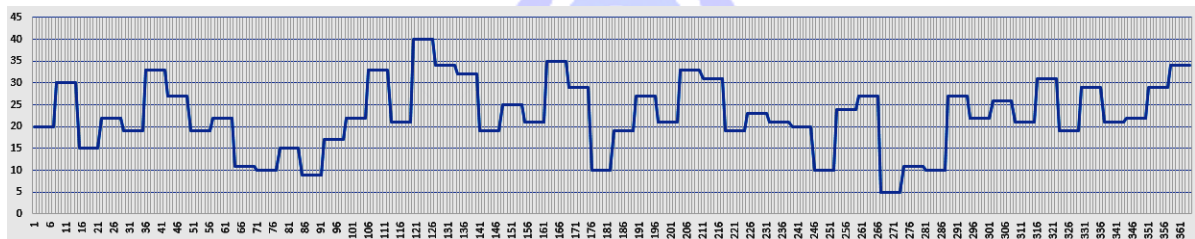


Fig. 1: Hypothetical CV of a crime over 364 ordered days

We consider here the case of New Jersey of the USA Zip code 11358, for the entire year 2016, and view the concatenation of 52 weeks and the number of, say, shooting crime occurred during these 52 weeks, which is extracted from the UCV data base. Fig. 2 shows the map of all zip codes of the state of New York (New Jersey).

Table 1 provides the weekly UCV’s of shooting crime, say for the hypothetical zip code 11358. Figure 1 shows the crime pattern in terms of UCV’s over 364 ordered days. With reference to the notion of compressive sensing and sparsing it is sufficient to consider a 52-point x-scale for the year 2016.

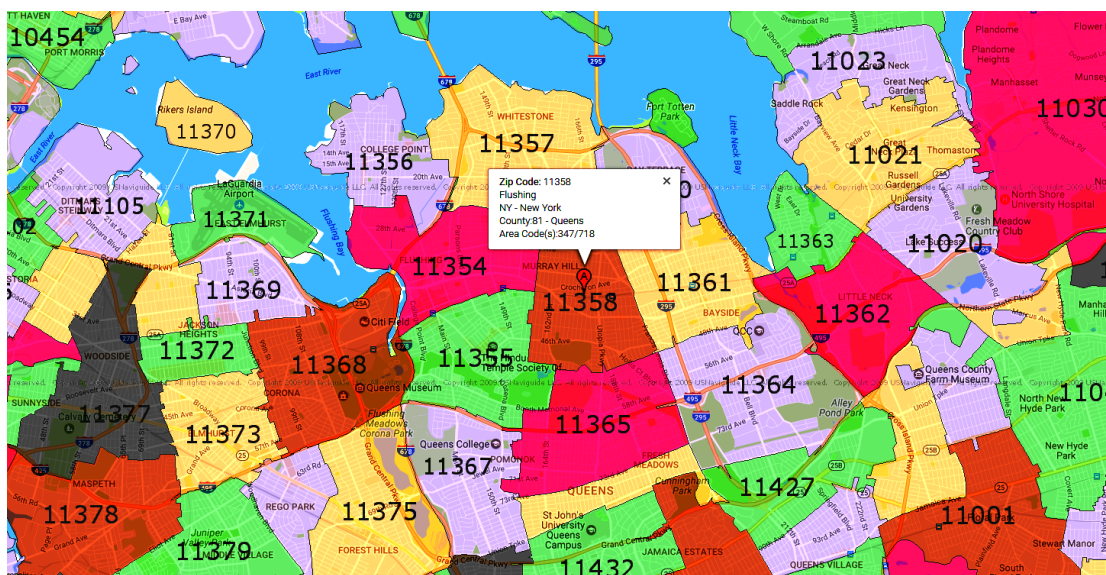


Fig. 2: Zip codes of the state of New York

Table 1: Weekly UCV's of shooting crime for the year 2016 for the zip code 11358

| Weeks of the year 2016 | Day 1 UCV | Day 2 UCV | Day 3 UCV | Day 4 UCV | Day 5 UCV | Day 6 UCV | Day 7 UCV |
|------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| Week 01                | 20        | 20        | 20        | 20        | 20        | 20        | 20        |
| Week 02                | 30        | 30        | 30        | 30        | 30        | 30        | 30        |
| Week 03                | 15        | 15        | 15        | 15        | 15        | 15        | 15        |
| Week 04                | 22        | 22        | 22        | 22        | 22        | 22        | 22        |
| Week 05                | 19        | 19        | 19        | 19        | 19        | 19        | 19        |
| Week 06                | 33        | 33        | 33        | 33        | 33        | 33        | 33        |
| Week 07                | 27        | 27        | 27        | 27        | 27        | 27        | 27        |
| Week 08                | 19        | 19        | 19        | 19        | 19        | 19        | 19        |
| Week 09                | 22        | 22        | 22        | 22        | 22        | 22        | 22        |
| Week 10                | 11        | 11        | 11        | 11        | 11        | 11        | 11        |
| Week 11                | 10        | 10        | 10        | 10        | 10        | 10        | 10        |
| Week 12                | 15        | 15        | 15        | 15        | 15        | 15        | 15        |
| Week 13                | 9         | 9         | 9         | 9         | 9         | 9         | 9         |
| Week 14                | 17        | 17        | 17        | 17        | 17        | 17        | 17        |
| Week 15                | 22        | 22        | 22        | 22        | 22        | 22        | 22        |
| Week 16                | 33        | 33        | 33        | 33        | 33        | 33        | 33        |
| Week 17                | 21        | 21        | 21        | 21        | 21        | 21        | 21        |
| Week 18                | 40        | 40        | 40        | 40        | 40        | 40        | 40        |
| Week 19                | 34        | 34        | 34        | 34        | 34        | 34        | 34        |
| Week 20                | 32        | 32        | 32        | 32        | 32        | 32        | 32        |
| Week 21                | 19        | 19        | 19        | 19        | 19        | 19        | 19        |
| Week 22                | 25        | 25        | 25        | 25        | 25        | 25        | 25        |
| Week 23                | 21        | 21        | 21        | 21        | 21        | 21        | 21        |
| Week 24                | 35        | 35        | 35        | 35        | 35        | 35        | 35        |
| Week 25                | 29        | 29        | 29        | 29        | 29        | 29        | 29        |
| Week 26                | 10        | 10        | 10        | 10        | 10        | 10        | 10        |
| Week 27                | 19        | 19        | 19        | 19        | 19        | 19        | 19        |
| Week 28                | 27        | 27        | 27        | 27        | 27        | 27        | 27        |
| Week 29                | 21        | 21        | 21        | 21        | 21        | 21        | 21        |
| Week 30                | 33        | 33        | 33        | 33        | 33        | 33        | 33        |
| Week 31                | 31        | 31        | 31        | 31        | 31        | 31        | 31        |
| Week 32                | 19        | 19        | 19        | 19        | 19        | 19        | 19        |
| Week 33                | 23        | 23        | 23        | 23        | 23        | 23        | 23        |
| Week 34                | 21        | 21        | 21        | 21        | 21        | 21        | 21        |
| Week 35                | 20        | 20        | 20        | 20        | 20        | 20        | 20        |
| Week 36                | 10        | 10        | 10        | 10        | 10        | 10        | 10        |
| Week 37                | 24        | 24        | 24        | 24        | 24        | 24        | 24        |
| Week 38                | 27        | 27        | 27        | 27        | 27        | 27        | 27        |
| Week 39                | 5         | 5         | 5         | 5         | 5         | 5         | 5         |

|         |    |    |    |    |    |    |    |
|---------|----|----|----|----|----|----|----|
| Week 40 | 11 | 11 | 11 | 11 | 11 | 11 | 11 |
| Week 41 | 10 | 10 | 10 | 10 | 10 | 10 | 10 |
| Week 42 | 27 | 27 | 27 | 27 | 27 | 27 | 27 |
| Week 43 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Week 44 | 26 | 26 | 26 | 26 | 26 | 26 | 26 |
| Week 45 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Week 46 | 31 | 31 | 31 | 31 | 31 | 31 | 31 |
| Week 47 | 19 | 19 | 19 | 19 | 19 | 19 | 19 |
| Week 48 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| Week 49 | 21 | 21 | 21 | 21 | 21 | 21 | 21 |
| Week 50 | 22 | 22 | 22 | 22 | 22 | 22 | 22 |
| Week 51 | 29 | 29 | 29 | 29 | 29 | 29 | 29 |
| Week 52 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

Table 2 provides week wise sparsed data of CV. Figure 3 shows the sparsed CV signal of shooting crime over 52 weeks of the year 2016.

Table 2: Week wise sparsed data of the one presented in table 1

|         |         |         |         |         |         |         |         |         |         |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 20      | 30      | 15      | 22      | 19      | 33      | 27      | 19      | 22      | 11      |
| Week 1  | Week 2  | Week 3  | Week 4  | Week 5  | Week 6  | Week 7  | Week 8  | Week 9  | Week 10 |
| 10      | 15      | 9       | 17      | 22      | 33      | 21      | 40      | 34      | 32      |
| Week 11 | Week 12 | Week 13 | Week 14 | Week 15 | Week 16 | Week 17 | Week 18 | Week 19 | Week 20 |
| 19      | 25      | 21      | 35      | 29      | 10      | 19      | 27      | 21      | 33      |
| Week 21 | Week 22 | Week 23 | Week 24 | Week 25 | Week 26 | Week 27 | Week 28 | Week 29 | Week 30 |
| 31      | 19      | 23      | 21      | 20      | 10      | 24      | 27      | 5       | 11      |
| Week 31 | Week 32 | Week 33 | Week 34 | Week 35 | Week 36 | Week 37 | Week 38 | Week 39 | Week 40 |
| 10      | 27      | 22      | 26      | 21      | 31      | 19      | 29      | 21      | 22      |
| Week 41 | Week 42 | Week 43 | Week 44 | Week 45 | Week 46 | Week 47 | Week 48 | Week 49 | Week 50 |
| 29      | 34      |         |         |         |         |         |         |         |         |
| Week 51 | Week 52 |         |         |         |         |         |         |         |         |

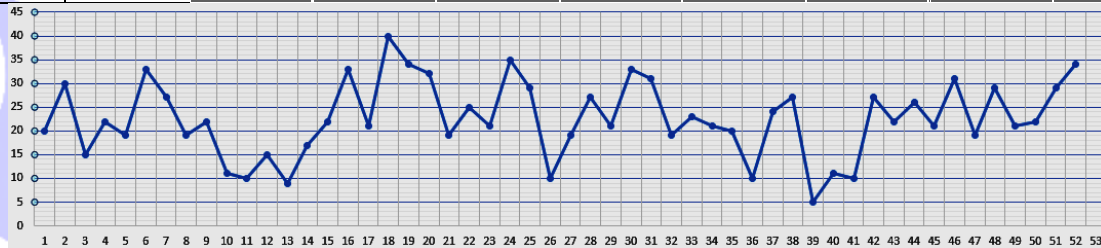


Fig. 3: Hypothetical CV of shooting crime over 52 weeks of the year 2016

The CV signal shown above is a discrete signal denoted by  $x(n)$ ;  $1 \leq n \leq 52$ . The time rate of change of velocity is known as 'acceleration'. In the generic sense, change in velocity  $\Delta v$  over a small period of time  $\Delta t$  is defined as acceleration. In the limiting case of  $\Delta t \rightarrow 0$ , the ratio of  $\Delta v$  to  $\Delta t$  becomes the differential denoted as  $dv/dt$ . In the case of CV over 52 weeks, one can calculate the discrete **Crime Acceleration (CA)** sample points. The following formulas are used to calculate crime acceleration.  $a_i = 0$ ;  $i = 1$ ;  $a_i = 0$ ;  $i = 52$ ;  $a_{i+1} = v_{i+1} - v_i$ ;  $1 < i < 52$ . Note that the end point crime acceleration values are forced to 0.

Table 3: Week wise CA data calculated from of the one presented in table 2.

|                    |     |     |     |    |    |     |     |    |     |     |
|--------------------|-----|-----|-----|----|----|-----|-----|----|-----|-----|
| Weeks              | 1   | 2   | 3   | 4  | 5  | 6   | 7   | 8  | 9   | 10  |
| Crime Velocity     | 20  | 30  | 15  | 22 | 19 | 33  | 27  | 19 | 22  | 11  |
| Crime Acceleration | 0   | 10  | -15 | 7  | -3 | 14  | -6  | -8 | 3   | -11 |
| Weeks              | 11  | 12  | 13  | 14 | 15 | 16  | 17  | 18 | 19  | 20  |
| Crime Velocity     | 10  | 15  | 9   | 17 | 22 | 33  | 21  | 40 | 34  | 32  |
| Crime Acceleration | -1  | 5   | -6  | 8  | 5  | 11  | -12 | 19 | -6  | -2  |
| Weeks              | 21  | 22  | 23  | 24 | 25 | 26  | 27  | 28 | 29  | 30  |
| Crime Velocity     | 19  | 25  | 21  | 35 | 29 | 10  | 19  | 27 | 21  | 33  |
| Crime Acceleration | -13 | 6   | -4  | 14 | -6 | -19 | 9   | 8  | -6  | 12  |
| Weeks              | 31  | 32  | 33  | 34 | 35 | 36  | 37  | 38 | 39  | 40  |
| Crime Velocity     | 31  | 19  | 23  | 21 | 20 | 10  | 24  | 27 | 5   | 11  |
| Crime Acceleration | -2  | -12 | 4   | -2 | -1 | -10 | 14  | 3  | -22 | 6   |
| Weeks              | 41  | 42  | 43  | 44 | 45 | 46  | 47  | 48 | 49  | 50  |
| Crime Velocity     | 10  | 27  | 22  | 26 | 21 | 31  | 19  | 29 | 21  | 22  |
| Crime Acceleration | -1  | 17  | -5  | 4  | -5 | 10  | -12 | 10 | -8  | 1   |
| Weeks              | 51  | 52  |     |    |    |     |     |    |     |     |
| Crime Velocity     | 29  | 34  |     |    |    |     |     |    |     |     |
| Crime Acceleration | 7   | 0   |     |    |    |     |     |    |     |     |

Table 3 provides week wise data of **Crime Acceleration**. Fig. 4 shows the CA signal of shooting crime over 52 weeks of the year 2016.

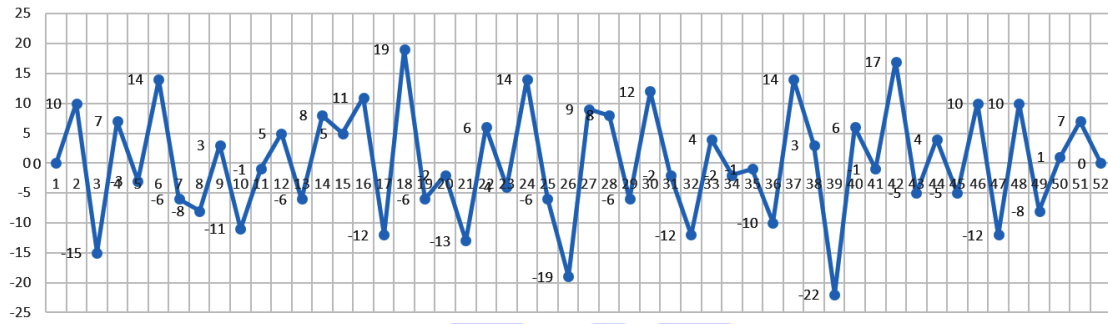


Fig. 4: CA of shooting crime over 52 weeks of the year 2016

Figure 5 shows the joint display of crime velocity over 364 days and crime velocity and acceleration over 52 weeks of the year 2016. The negative crime acceleration (negative number) is called as '**Crime Retardation (CR)**'. The number of CAs (positive numbers) observed over a period of time is called '**Crime Acceleration Index (CAI)**'. The number of CRs observed over a period of time is called '**Crime Retardation Index (CRI)**'. The ratio of CAI to CRI is called as '**Crime Syndrome (CS)**'. **The crime syndrome CS is an advanced crime metric and it is very significant measure in crime analytics because it quantifies the status of a particular crime happening in a zone over a period of time.** If CS is greater than 1 then the crime status is viewed as **BAD**. If it is less than 1, then the crime status is viewed as **GOOD**. If CS is 1, then the crime status is viewed as **critical**. With reference to table 1 and figure 2, end points are forced to 0. Out of the remaining 50 points in the CA data, the CAI is 24 and the CRI is 26. Now the CS is the ratio **24/26** which is **0.9230769230769231**. This CS could be qualified as **NOT BAD**. CS is an indirect feedback measure of what we call as '**Crime Control (CC)**'. CC could be quantified over a period of time in order to evaluate the counter measure steps (performance) undertaken by the security agencies. Figure 5 shows joint display of crime velocity over 364 days and crime velocity and acceleration over 52 weeks of the year 2016. Figure 6 shows monotonically decreasing and increasing crime velocities.



Fig. 5: Joint display of crime velocity over 364 days and crime velocity and acceleration over 52 weeks of the year 2016

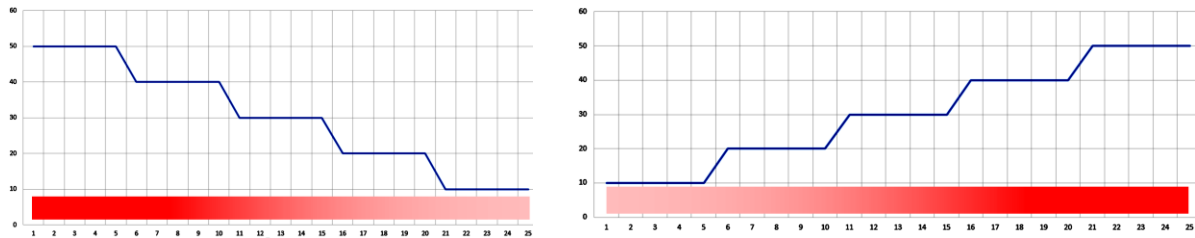


Fig. 6: Monotonically (stepwise) decreasing and increasing crime velocities

### Advanced Crime Metrics

**Crime Syndrome (CS):** The ratio of ‘Crime Acceleration Index (CAI)’ to Crime Retardation Index (CRI)’ is defined as ‘Crime Syndrome (CS)’. CS is a real number and it is a single valued measure of the crime occurrence pattern over a finite duration of time. Each type of crime would exhibit a unique CS. CS could be calculated on quarterly, or half yearly or annual basis. One would come across two trivial cases in this context. The case when CAI is 0 indicates either a red zone (crime zone) or a zone wherein a particular crime velocity monotonically (stepwise) converges to 0 over the duration of time, which means that the zone under observation would turn out to be a green zone (crime free zone). Alternatively, the second case when CRI is 0 indicates either a green zone (crime free zone) or a zone wherein a particular crime velocity monotonically (stepwise) tends to infinity over the duration of time, which means that the zone under observation would turn out to be a red zone (crime zone). Figure 26.4.1.5 shows a hypothetical graphical display of these two trivial cases ‘monotonically (stepwise) decreasing crime velocities’ and ‘monotonically (stepwise) increasing crime velocities’.

**Crime Regulation (CRe):** This is a figure of merit of a particular crime intensity observed over a duration of time. Crime Regulation (CRe) is defined as the ratio of the sum of all velocities of a crime corresponding to CAI to the sum of all velocities of the crime corresponding to CRI. CRe is a real number and it is a single valued measure of the crime regulation pattern over a finite duration of time. Each type of crime would exhibit a unique CRe. CRe could be calculated on quarterly, or half yearly or annual basis. One would come across two cases in this regard. The case when CRe is 1 indicates the fact that the sum of velocities corresponding to all positive peaks is equal to the sum of velocities corresponding to all negative peaks in acceleration signature, which means the particular crime is optimally regulated over the period of time. The second case when CRe is more than 1 indicates the fact that the crime is sub optimally regulated. The case when CRe is less than 1 is unrealistic. It should be noted that crime regulation is either due to some kind of intrinsic social order or due to corrective measures taken by the law and order and police departments. Possibility of intrinsic social order in a crime prone society is very remote. Hence CRe could be treated as an indirect crime control measure of the performance of the law and order and police departments.

**Crime Trend (CT):** This measure CT is variation observed in CRe over a period of time. CT of a particular crime is a deterministic time series and the ensemble of all CTs is a crime process over an observation window which is a month or six months or one year. **This measure is highly user friendly and could be used directly in a mobile application.**

**Crime Flow:** This measure **Crime Flow (CF)** indicates variations in the crime rate with reference to traffic flow. People move from one place to another with predetermined plan. More than 80% of the people who move are office-goers. Spatial distribution of human population is due to two kinds of travelers, one, regular office-goers and the other casual travelers. **It is to be noted that crime flows along with people.** If one is able to locate spatial pockets of human population at a particular instant of time, then one would be able to evaluate distributed crime rates at that instant in a fixed area, say a city. CF is a temporal behavior of Crime Rates at various places with reference to traffic flow and so it is a pseudo random pattern.

### Key Factors for Various Crimes

Any activity that causes mental, intellectual, psychological, physical harm to self or other individual or a group of individuals or societies is called CRIME. Such an activity by defying the conscientious and geopolitical rules and laws is punishable if the gravity of the activity exceeds a threshold set by laws. The **causes of crime** are complex. Most people today agree that poverty, parental neglect, low self-esteem, alcohol and drug abuse are all connected in explaining why people commit **crimes**. Some people are simply at greater risk of becoming offenders because of the circumstances into which they are born. To certain extent, genetic makeups of people contribute to intolerance and violent thought processes which lead to criminal activities. At present human beings suffer from “**Tolerance Deficiency Syndrome (TDS)**”. TDS of an individual may be due to his/her genetic makeup called “**Latent Tolerance Deficiency Syndrome (LTDS)**” or it may be an acquired one called “**Acquired Tolerance Deficiency Syndrome (ATDS)**”. Every individual is a biological system whose behavior

is decided by many different sets of genes. One set of genes are called 'Rogue Genes' which are responsible for hyper reactive behavior. As and when rogue genes predominantly express themselves, intolerance level goes high. When this level crosses a threshold then that particular individual tends to think, speak and act violently, which is detrimental to others. All living species have rogue genes with different intensity (expression) levels. These levels are alleviated or aggravated mainly due to the type of food consumed by individuals. All herbivorous species exhibit calm and quiet behavior whereas carnivorous species exhibit violent behavior. This is but natural and there cannot be any contradictory opinion in this regard. Societies constitute heterogeneous human species of both eating habits and hence cultural, civilizational and religious dogmas have been practiced in order to control rogue genes of individuals and to ensure social order. When an individual belonging to a particular society disregards the societal compulsions is likely to lead a turbulent and intolerant life. The purpose of this research is to identify quantifiable parameters under two categories, which form the basic factors of various crimes.

**Economic Crisis Category:** Most of the people suffer from this crisis. Insufficient domestic income, unemployment, disparities in income, inflation, fall in stock trading, money devaluation, incorrect government economic policies, random changes in GDP, deep economic fall in service segments like, IT, entertainment, tourism, hospitality, real estate and many more are the key factors for rising crime trend.

**Median Household Income (MHI):** This is one of the main factors causing rise in crimes. Households in a locality could be divided in three groups based on their *median incomes* (i) Low Income Group (LIG), (ii) Medium Income Group and (iii) High Income Group (HIG). This classification depends on the financial status (living expenses) of a city or a locality.

**Unemployment Fraction (UF):** Unemployment is expected to have a direct bearing on various crimes in a locality. One cannot fit a linear model to this study. However, number of crimes observed in a locality could be seen to be directly proportional to number of unemployed people in that locality. Unemployment Fraction (UF) is the ratio of number of unemployed people to the total population. The term 'total population' refers to employable people, that is, the sum of employed and unemployed people in a locality. UF is an important factor that contributes to rise in crime in a locality.

$$\text{Unemployment Fraction (UF)} = \frac{\text{Number of people unemployed}}{\text{Number of people employed} + \text{Number of people unemployed}}$$

The real number values of UF vary from 0 (where number of people unemployed is 0) to 1 (where number of people unemployed is equal to the total population),

**Employment Regulation (ERe):** The difference between number of people employed and the number of people unemployed could also be viewed as a significant factor causing crimes in a locality. Employment Regulation (ERe) is defined as the ratio of the difference between number of people employed and the number of people unemployed to total population. For better graphical visualization it could also be calculated as this ratio subtracted from 1.

$$\text{Employment Regulation (ERe)} = 1 - \frac{\text{Number of people employed} - \text{Number of people unemployed}}{\text{Number of people employed} + \text{Number of people unemployed}}$$

**Identity Crisis Category:** Most of the crime causing factors under this category are psychological in nature and so cannot be quantified at least as on date.

### 3. Conclusions

This paper advocates the notion of crime analysis using certain basic quantitative metrics such as Crime Density (CD), Crime Rate (CR), Crime Velocity (CV), and Crime Acceleration (CA). A sample area zip code in the state of New York has been considered for analyzing these crime metrics.

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