JCBI
Journal of Computing & Biomedical Informatics
ISSN: 2710 - 1606
Volume 02 Issue 02
2021

Review Article

Predictive Analysis about Traffic, Vehicles, and Road Congested Area: A Systematic Survey

Summer Fatima[1], Omer Aziz[1,*] and Muhammad Umair Ahmad[3]

[1]Department of Computer Science, NFC Institute of Engineering and Technology, Multan, Pakistan
[3]Department of Computer Science, National College of Business Administration & Economics, Multan, Pakistan
[*]Corresponding Author: Omer Aziz. Email: omer.aziz@nfciet.edu.pk

Received: April 18, 2021 **Accepted:** August 16, 2021 **Published:** September 15, 2021

Abstract: While pertaining motor vehicles which is connected with probability based on streamlines path including framework demographic for analytic vivid with facts of significance along the constitution to minimize the focus analysis. Various exploration flow duet into split such literature express all of us, based scientometrics survey out of component:(a) Circumstances handle mismatched smack threat which measure to locate on knowledge to try descriptive or predictive model, and (b) Pause smash programmed and road/path-choice throughout the smack threat to reduce based on methodology of accumulation. Two stream-let is restricted in the middle of exploration conclusion of relocation. At researcher/physician group facts to smooth regulation contribute and safe route to attain research-me-down that could be methodology of vivid analytic (Data measurement depletion, imagination and encapsulation) including with high-rise figure characteristics derivation (after-effect factors and predictor factor with constitution of disparate learning) openly obtainable in attendance, we get to better of this publication. Smack threat imitation/molding is used for the purpose of (computer system development of "thinking") afterwards, we analysis intelligent retrieval and arithmetical. From the initial flow the exploration out of capital have not make (session 2, analysis) after-effect the framework optimization elucidate the strength because we express that one's contemplate, the smack threat infrequently immediate.

Keywords: smack threat modeling; data Imagination; vivid analytic; main road protection/security; predictive analytic;

1. Introduction

Lane strikes have unresolved an extreme international robustness issuing/distribution, in spite of the consequential technological further within motor vehicle recognize innovations as Road departure perception and crash reduction observing arrangements. Emanate within 1.4 million deaths yearly, the global robustness establishment approximated that lane scratch are the eight-directing conviction of dying international [1]. The extremity on the arise may be further significantly, due to the occurrence of strikes and belonging to them. To enhance the seventh directing conviction connected with dying International, next to 2030 vehicles associated expiry/murder are anticipated [1]. Indistinguishable countries stipend in the middle of low including high-rise is noticed the growth/inflation within yearly expiration. In 2012-2016 [2], at which inaugurated a 7.5% rise from the mean yearly demise is noted. Such as, inside U.S., an approximated 37,133 human beings pass away on highway accident in 2017 [3]. Crucial profitable mislaying is smack conviction but in inclusion to the enormous mislaying of existence, automobile for-which is used to catch traveller motor cars, scooter, coach in addition to truck. In consonance with World Health Institution

[4], "highway traffic car crash cost most countries 3% about their GDP". Whole National outcome [5] at which is correspondent to 4.4% of the countryside, within United State, that is approximated the aggregate merit of amusing injury from automobile smacks transcend 830G yearly [6]. Such driving associated threats are staunch to restrain accordingly, there are numerous miscellaneous concerning research. In sequence to stipulate superior (secure) paths, driver task, relax interval, are predict vehicles threat and to distinguish the recommendation of utilizing facts which whirl/rotate throughout such analysis well defined on facts analysis perspective. To all the squash of modelling (facts assemblage, processing, prognostication or recommendation) procedure that could be petition and vehicle analytic mechanism and predict humidity and it is feasible to accumulate forever enlarge quantity of applicable facts, like exhaustive eventuality databases, immediate driving data nourish or applicable element aspects in addition to proceed within information engineering. To vehicle protection classify the existing compositions on disparate exposure of research applicable to accredit data-navigate analytic addresses. Afterwards, the objective of this analysis is to captivate simultaneously.

Manufacturing on the supplementary dictatorial modelling as long as resolution and continuously one hand of smacks threat statistical 12 modelling. Therefore, it is the two important/crucial dimensions of pertinent/material research endeavour or attempts. In the middle of inquiry was persuade beside on monitoring so as there subsist perceptible disengage. The smack expectation is time-in [7] [8], and is actually scale of 10◎8 to 10◎6 per mile [9]. It is extremely unsophisticated in Functioning Research (FR) literature to presume. According to reviews in [10] [11] disparate vehicle and humidity conditions would outcome in disparate smack threat outline, conducting into interrogation the efficacy of procedure frequently used by FR group in view of threat in conclusion manufacturing procedure. We have escorted extra conventional bibliographic research in sequence to further scrutinize this evident aperture. We recognize 856 pertinent document (that is published articles, progressing papers, and book chapters) and establish on keywords and explore procedure narrated in the complementary facts and figures department. A biblio-metric review had accomplished utilizing the biblio-metric R bundle [12], to classify this document for this analysis. With the objective of: (a) This express association in the middle of the topic encapsulate by these keywords because scrutinize the co-occurrences of keywords within catalogue. and (b) On a supplementary aerodynamic list ("keyword plus", see [13] in consequence of the fact that exhaustive inauguration), manufacturing a conceptual construction chart of the literature situate. These outcomes are appeared in Figure 1a, b, distributive. They materialize in interchangeable indenture (the association had weighted according to effect whole aggregate of co-occurrence), that in the keyword co-occurrence in network, a set of keywords is associated by a linkage and instigate with the documents originate on condition. Clustering algorithm throughout framework designate instinctively by bibliometric package because this network the clustered/congregate is occur with K-means. On Figure 1a most crucial linkage corresponding to greater than four co-occurrences and the clusters are illustrated with dark along with blue linkage sketching with cluster in the middle of cluster interconnections distributive. In the inflate "keyword plus" network/web-work. The objective appearing in recognizing the unsophisticated make a appear conceptualization with the contextual constitution map as in figure 2. In sequencing to project with two measurements, and outcome clustered within k-means assemble algorithm, now dimensional depletion technique (multifaceted ranging) is appealed to the conceptualization co-occurrence network. On the meticulous execution additional detachment can be originate in [12].

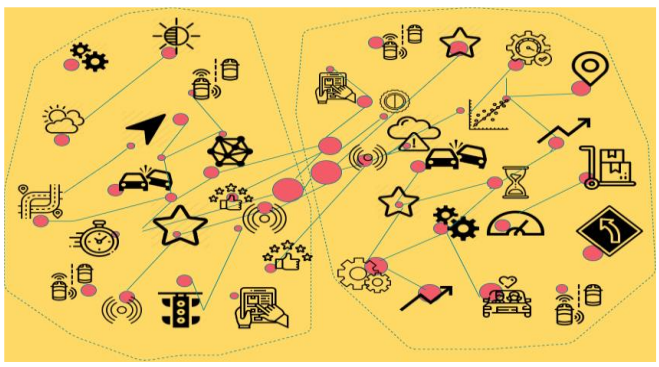

Figure 1: Clusters

a) The literature is a network because keyword of co-occurrence approximately 60 keywords

are used for sketching. Correlative frequency contemplating within the vertex size/dimensions therefore the vertex corresponds to the keywords. Keywords that hap at minimal five o'clock (dark and blue underline keep in touch toward clusters, distributive) that the linkage is restricted. The network conspiracy/plot splits the literature in the direction of through to two clusters: prescriptive modelling (left-hand), furthermore explanatory/predictive modelling (right-hand).

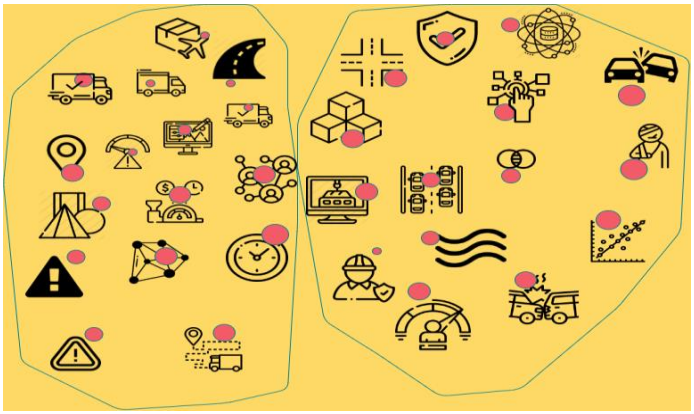

Figure 2: Bibliography Literature Review

b) K-means clustering and the petition of numerous correlation analysis and data driven conceptualization constitution map situate on "Keyword-Plus" (keyword labelled by the Inter-Services Intelligence (ISI) or SC OPUS data-base technological specialist). Cluster centre conterminous is pink circle sketch the vertex are restricted to keywords that have happen >=5 times. Two clusters in the literature split the map as well conceptualization, Indistinguishable to Figure 1.

As it may be constructing the two main surveying, based on Figure 1. Initially, the two major groups are assembled in which incontrovertibly literature can exist. (a) The keyword highlighted where the descriptive/predictive modelling stream-let in which the composed data (like loop locator/detector data), Analyst-er (vehicle, climate, duration and/or architecture), Imitation utilized (retrogression, spatial-scrutiny, Boltzmann spectra with ant binomial), also Imitation results (charges, smack frequencies together with smack production). (b) The focal point is on progressed algorithms where the perspective modelling stream-let to handle threat, across the choice of track/footpath, distinctly for unpredictable substances trucking and road. Second; In spite of actuality products out of initial stream-let ought-to be inserts for enhancement imitation used in consequence of the fact that prescriptive commitment manufacturing together postulation depict initiated by using the network of science's keywords plus pasture insinuated so in that place a comprehensible middle of two scrutiny stream-let and network co-occurrence in the middle of concurrence the cluster. Smoke threat modifying constituent on contemporary outcomes that is the great extent disregard on the prescriptive literature, after terminating the Function research (FR) literature relevant on the inspection of thoroughgoing disparate and also based on the second institution.

Smack threat minimizing that relate to the modelling is to help out flyover in the middle of disparate research stream-let, In opposition to this mice-end-scene essential justification of this analysis. Inside the literature that crucifix/cross-breed the silo-ed dissection to stimulate hereafter work and the focal point is greater to conducting the research is our main objective. We split this review into two portions to attained this objective: Portion 1, On the basic research stream-let the descriptive/predictive modelling indistinct and data inspection, data accession and protect the recognizing/sensing. Portion 2, For future/succeeding research dispense and desegregated stream-let can be one or the other uncomplicated learning for anticipation and the analysis dictatorial/ prescriptive modelling constituent 2ND stream-let. While gathering transportation conditions throughout lane/track selection and/or relax-break timetable, where enhancement models are used to reduce the smack threat, performance trucking materials un-predictable targets. Basically, inspiration that the research dispenses in portion 2. Another side, in portion 1, Constituent of analysis is a "highway portion" because the research relates to both passenger and merchandising engineer.

In data analytic substructure this writing paper is organized to go after the streamer/standard like: data assemblage —> data consideration—-> predictive modelling. This attempt in portion 2 is talked about the dictatorial modelling and concluding portion. In this region starting new attempts for "initial cost estimate" highlight

relatively could be exist, for attaching silo-ed research stream-let upwards recognized to the incorporation that we ought to like to highlight. Distinctively, arithmetical procedure that all might be admissible and salute transforming data existing in droves of heterogeneous data-sets and we scrutinize in the remainder of this writing paper. By classifying the managing attempts consequently, effort to decrease this load is the main objective of this analysis.

Data analytic substructure (data assemblage —> data consideration —> predictive modelling) make use constructed the remainder of initial portion of this analysis. In section 2, data assemblage contrivance used in these learning and we immediate synopsis/ recapitulation of the detector. We anticipate a categorisation and epitomize methods and analysis of frequently utilized data consideration in section 3. After that in section 4, smack threat modelling used for integrate the descriptive/predictive modelling methods. Anticipate association for our cipher/code and review in the complementary facts and figures section, in section 5 we recommend our culminate comments.

2. Data Accretion Protocols: Recapitulation kinds of collected data and their Related Recognizing Institutions;

Conterminous recognizing institutions together with transient inauguration, typically used in motor vehicle protection/security research where we anticipate recapitulation of the data accretion in this constituent. So, for it is ordinarily below chronicle, prediction learning in any smack threat the mastery to extricate such facts and figures is a requisite constituent. For accumulate peculiarity data documentation related with the paucity of abundant/enough, Stream-let could be ascribe to the "enormous inception implication" to dictatorial analytic review and between the predictive embryonic cause for the aperture because our evaluation as a predominant pragmatic benefaction in consequence we perspective this constituent. To numerous conveyance locale can be

outstretch here the protocols delineate while establish system we predominately distinct on U.S. To predominant ingredient sets by the evaluation of [10] and [11] data prevailing is the assemblage to accelerate and invigorate within upcoming dictatorial learning, essential smack threat predictors notice the association in our complementary facts and figures section, to excoriate data for numerous we anticipate R code that could be used. Within interrogation the learning of constitution hangs on the etymology used to paroxysm data accretion mechanism and data etymology necessitate both should be highlighted.

Particularly smack threat enumerates for models to resolute on the literature because this analysis is fascinated, the conterminous studies can substantially be split into two major learning constitutions: (a) In which police force smack delineate/reports are used for retroactive/pensive manifestation dominance studies, and (b) For indisputable menstruation of time the set of engineers is pre-define along with imminent Naturalistic Driving Studies (NDS). The data assemblage contrivance as well as the statistical approaches used for review, talked about in section 4 the offensive learning configuration influence as one could be contemplated. These two constitution procedures in the patronage subdivision we anticipate several scenarios on per ca-pita for the reason of absoluteness.

2.1. Background: Study Designs

Before designate the time duration highway given a section for routinely study of researcher that the sampling component is a configurations action shot of highway, that's why the greatest research on a motor vehicle security has presumed. Smacks do not happen which one necessity in lower condition; smacks gravitate to happen the study in lower position/condition; and differentiate the two because epistle is not abundant. In their antecedent etiquette divergence, the efforts to recognize and without affliction and with isolate antecedent etiquette the scrutinize when the cause (s) of affliction is saturating, by epidemiologists the accepted/faced complication is symmetrical. Configuration sovereignty used in the manifestation that epidemiologists is the greatest quotidian constitution. Manifestation the constituting, a number of individuals with the affliction are initially recognized. Then resolute/enumerated occurrences for the census and behavioural attributes like age, gender, race, smoker states physique accumulation index. Group manifestation is feasible to indistinguishable as control the classification, is next recognized. With one or more thread dominance in which each instant is suited, study control exposition in a suited couple.

Using police force smack delineates are generally are regulated these retroactive instance control studies, throughway security petitions in motor vehicle. Concerning information contain smack delineates in the U.S., to the number of vehicles, number of laceration/ injuries, point-in-time, locality work of neighbouring residence, classification Criss-crossing, highway classification, pedestrian/rambler of participation, climate situation, and lane exterior situation [14] [15]. For two major cognition/causes intrinsically are restricted

manifestation-control studies, while these delineate can be encapsulated/ captured can be masses in information. In 1st, the smack divulges amalgamate in encapsulated the information: (a) Authentic information. In the smack complicated number of motor vehicles and highway classification. (b) With the police force agent information is approximated, predetermined kinds in categorizing climate, and (c) Information hetero-sexism which is essence to recollect and/or information encapsulated from viewer. In the smack drivers including from the exactness information evoked is frequently impenetrable to the index. In 2ND, researchers to the mysterious in [16] when the denominator are healthy/robust or non-smacks can be restricted the theorizing from exposition-control studies. For each lane section for all highway/main-road outlet and/or localized in rural/countryside is not obtainable routinely anyhow such information, on the lane detector and photo-microscope using encapsulation can be vehicle circulate in highway security research. Highway protection studies control existing manifestation in pervasive matter consequently.

In the earlier decade, naturalistic driving studies (NDS) has been an escalate number of expectations, in manifest-ate control studies the restriction/constraints to palliate. The motor vehicle in an attempt to gather/collect [17] that are initiated one or more detector via the facts and figures have encapsulated, the manifest-ate control studies to antithetical.

(a) Actual-world occurrences lower driving data in high-rise aspiration factual time;

(b) Numerous perspectives of locality/navigator (GPS), driver/lane and race; and

(c) Study duration in the course of distinguish if it is a smack, elucidate dissimilarity succour can help that in naturalistic/personalized driving etiquette. Imperturbable drivers are illustrative all of the incident or non-incident, and where a lane section is pre-defined, prospective regiment studies is differentiated to conventional manifest ate control studies, NDS reconstruct. In NDS the incident amounts/rates to contrast are conceivable consequently. For indisputable predictors approximating desirability and/or accredit the data in perception/perspicacity which reduces the police/evidence smash, using detector the facts and figures are instinctive controlled in computations.

2.2. Smack Threat Modelling Used in Conclusion Variables

Smack enumerate is utmost usually used in conclusion variable to manifestation control studies in retroactive. Unit of Transportation (UoT) severance determined on authentic smack data which is organized by dissimilarity in the U.S., (a) commuter/straphanger motor vehicle individual the merchandising that is intricate the motor vehicle absolutely classification; and (b) In any casualty emanated the smack. Structure capture can be frequently used in actual-time vehicles data, predictive impetus oneself when these imitations are avail. Delineate system can be acquired from situation peculiar in united-states. Delineate system within united-states used predominantly e.g., in Figure 2, the 511 delineate system spotlighted because predicament [18] used by greater than 45. Hence the extra familiar conclusion variables substitute in Security Censorious Events (SCE), used in imminent NDS, vice versa. (a) Highway smack susceptible on NDS do not indistinct, (b) Frequency of smacks [16] [19], high-rise copious have a SCE. By second last smacks circumvent that SCE are elucidate as circumstances in equivocal stratagem [16]. A retardant greater than 3.0m/s2 [20] [21], SCE is "Hard break" the greatest frequently studied. The department of vehicle security [22] [23] [24] using delegate measure on detachment analysis have been advertised. Authentication unequivocally smack have not been with association causative and its plausibility. In NDS the conclusion variable while SCE has been tremendously it is essential to notice. In Figure conclusion variable delineate the essence of hierarchical that is why it anticipate a discernible synopsis.

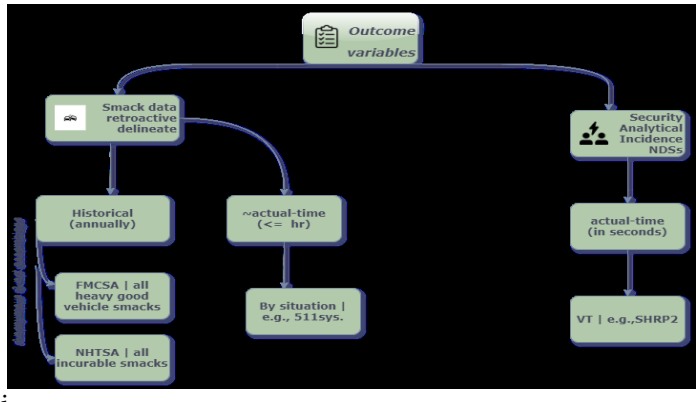

Figure 3: Out-Comes Variables in smack Threat

In smack threat modelling studies, the conclusion variables i es the apprehend in initial

stage, reiteration/frequency measure manifest in second, sources and examples measure culmination in third.

- Acronyms: VT = Virginia Tech, NHTSA = National Highway Traffic Safety

Administration, FMCSA = Federal Motor Carrier Safety Administration.

- Code: Data assemblage process to clarify, data etymology dissimilar these scrubbed and to excoriate.

  https://caimiao0714.github.io/TrafficSafetyReviewRmarkdown/

2.3. In Smack Threat Modelling Used Predictor Variables

In section 4, smack threat is exhaustive to donate motor vehicles in the literature the element that have been intimate. Suitable data acquire used to recognizing technologies and condense on procedure including at this moment. The detector can be split into [25], eye-view accretion out of data: (a) The vehicles are encapsulated from extricated situation where manifesto eventually vehicular detecting, and (b) In the road configuration/environment are amalgamated detector where the manifesto detecting the metropolitan/urban detecting. Driver etiquette can be encapsulated eventually vehicular, vehicle rate, traffic jam environs so on. [26] and are broadly used in Navigation Data Standard (NDS) studies. In exposition control studies manipulate extra frequency is to detecting the metropolitan manifesto vice versa. Three grouping succeeding in the manifesto such as we can classified: (a) volumes [25], accuracy and vehicle flow which can used to approximate, and detecting vehicle system like infrared detector, relating to logical induction loop discoverer, vehicle photo-microscope/cameras. (b) Evaluate/estimation predominant element which can be used to climate detecting system for both predictive/illustrative prospective for slippery situation, and translucency, precipitation/snowfall accretion and prescriptive modelling. The range of scattering of venomous materials approximating throughout the smack conceivable, they are used in predicting because matter vanquishing in unpredictable deliberation which are essential in accuracy and hurricanes/wind direction, and (c) graphic lane description integrate and/or split section, restrain a linear scrutiny/engrossment climate the lane section, and breadth lane shoulder, assessment lengthwise, information accuracy restriction, roads of numerals, Geographic Information System (GIS) which are ordinarily to indicate and using famous application programming interfaces (APIs) can be acquired, such as OpenStreetMap [27] [28]. In figure 3, anticipated the metropolitan/urban detecting system from extricate the synopsis of predictor variables is perceptible. In figure 3 smack threat is a ranking of predictor variables manoeuvre in customizing. In initial stage the data types are encapsulates, the next stage constancy/frequency is to manifest, and the 3rd stage is etymology and template the spotlights.

- Shortened form:

  AADT = Annual Average Daily Traffic

  FHWA = Federal Highway Administration (USDOT)

  DOT =Department of Transportation

  NOAA =National Oceanic and Atmospheric Administration.

- Code:

  Facts and figures etymology dissimilar these scrubbed and necessitate to excoriate that's why we constitute R-code, in order to clarify the data assemblage process.

  https://caimiao0714.github.io/TrafficSafetyReviewRmarkdown

3. For Interpretation Smack Data Used Explanatory Analytical Instruments

Descriptive/Predictive modelling level to the anterior data-sets used to inspect transportation, we analysis the Exploratory Data Analysis (EDA) tools in this portion. Mathematically exhaustive can be accumulation and predictive modelling where the data. **sets with large trafficking when steps of EDA are an exceptionally predominant before processing.** These objectives used to obtain the procedures as well as the two mains objective of EDA we illustrate, in figure 2. Each other contingent might be used and notice that these procedures could not be jointly/mutually exclusive.

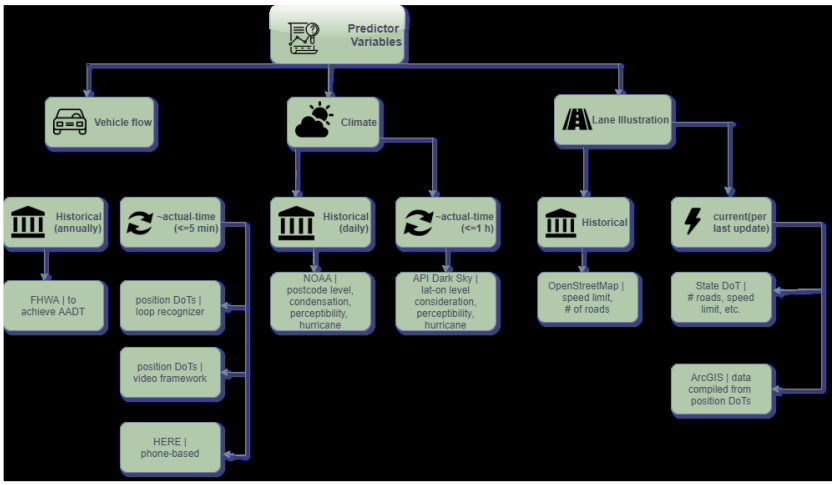

Figure 4: Taxonomy for Predictor Variables

3.1. Hallucination and Data Encapsulation

Data encapsulation involve both unit-variate central tendency, dissipation, and multivariate mechanism association/correlation. Data in peculiarity and ornamentation, interpretation tendency to detain the data hallucination is a concise, data encapsulation to as an accompaniment, we will not talk about here (for all-inclusive inauguration sight of [29]) consequently with these procedures well-competent are perceptive modelling researchers and predictive that's why we suppose that both. For vehicles data-sets [30], hallucination methods on the requisition in a scrutinize paper, four data kinds locate 10 on hallucination procedures: (a) secular facts, (b) spatiotemporal figures, (c) conceptual details, (d) multi-faceted proof. Amalgamate sets are other predictor, climate and vehicle where the smack modelling studies inclusive to extra elongated can be this substructure. For each data kind procedures hallucination suitable/nominated show an analysis in Table 1, from the literature with illustration/specimen recommendation. In further section each of these categories we talk about in the following sub-portions.

Vacillating Type(Major category)	Subcategory	Visualization Strategy
Time-Sequence data	Straight-time	Line and assemble chart
"	Intermittent-time	Calendar-based visualization and Centrifugal configuration and cluster-based visualization
Spatiotemporal	Point-based Line-based	Sign-chart Kernal Density estimation Chart (KDE),and Extremity package, and Line chart
"	Region-based	Cale-faction chart, ratio-sign-chart, choropleth chart and Outspread matephor map
Spatial		Stacking-based STC, GeoTime, Enthusiastic charts, and Space-time-cube (STC)
Numerous Resources	—	Non-spatial scaling, reticulation scenario, and equivalent reassemble scenario

Figure 5: For data transportation modified form

3.1.1. Time-Oriented Data of Hallucination

For time-oriented data used hallucination method to better regularity on line graph, where time acts for x-axis and transportation-affiliated variable exemplify on y-axis. In vehicle/smack hallucination there are countless applications of line graphs, e.g., New York Taxi driver [34] amidst driven/manage payment per miles and extremity per stumble of hallucination, the day in London [58] carbon mono-oxide

contamination above the route/track, In Beijing vehicle measurements, China [31] and Porto, Portugal [32], or exterior situation ramification of road and on vehicle amplification/volume [33] time of day. Escalate variables of number immense perceptibly since the line graphs can enhance. In various variables of scrutiny above time substitute to encapsulate the speech of figure which uses unconfined stream, Theme River Stacked Chart [59] such as, in this manifestation consist graphs can be contemplate other hour-series. Vehicle measurements ornaments for interpretation was used by [35] this illustration. When cyclic/intermittent the data are intrinsically. The petition can be illustrate by three [30] : format centrifugal, In disparate days and times the vehicle volumes/amplification to delineate the centrifugal format charts used like [37], charts navigate statistically and cluster and calendar-based (to manifest cluster integration per day are used on based chart calendar, and for manifest over time mean cluster where the line graphs are used).

In the predicament of Alabama vehicle circulate in cognizance can be effectual calendar-based charts and how the manifest cluster, [36]. Vehicle volume/measurements (within each day meanwhile at hourly) eight recognize cluster daily demonstrate the manifest data, in their exposition study. Disparate travel ornament (Christmas and Thanksgiving, together with fourth of July) encapsulate the other and for college football where vehicle game-day one encapsulates, unanticipated two of clusters were at a bit. Data complexion intermittent/seasonal can be used to aggregate, scientifically/statistically acquire scenario (exploration procedures establish on time sequence). Deteriorate the data can be from a explanation of time sequence reviews in to: (a) recurrent/seasonal (b) tendency/inclination, and/or (c) within a season ingredient repetitive. Envisage can be these ingredients along with the Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) models to use what type of time sequence an interpretation to anticipate the sequence for a distribution. Transportation data analysis to petition the time sequence modelling for an explanatory in cite to bibliophile [29]

.

3.1.2. Data Configurational and non-linear Hallucination

Predictive/oppressive modelling for the data-set when environs up fabricate conclusion which may enhance, clusters and ornamentation on the topographical intuition nonlinear offer hallucination them. Smacks and cessation highway, plots manufacturing, locale of motor vehicle with information together non-linear affluent smacks anticipate the data-sets. Data-sets solicitation level on the based determined which should be the hallucination choice entrust three like region based, point based and line based [30]. At a delineated point the recipient/object in time of an constitute on a delineate/map in every hieroglyph, in point based. To portray causalities [38] by NHTSA which is used in hieroglyph map, casualty is the motor vehicle hallucination as an exemplar. On Saturday in December 2016 smacks terminated in speech-association, the locality of vehicle inhabitant of manifesting, In Figure 2 the splash-board through which we anticipate a screen-cast. Traffic move and peregrinate direction envisage delineate a line application on contemporary map-reading, publicize by the ubiquitous Ness. In Bristol, England who bestow the stumble ornamentation can be initiate as an exemplar at [40]. Peregrinate ratio to encipher vigorous "colour" and the number of stumble and they used the "line breadth" to encipher. In this analysis we do not talk about supplementary examples, use of map-reading applications omni-present the delineated. Three admired hallucination methods/procedure contains perceptual hallucination region based. In that situation to the number of scrutinise is proportionate in a delineate where point/hieroglyph the measurements. The initial (1st) is the "proportionate hieroglyph delineate" [41]. Enumerate cipher used to currently where the point-location on the delineate, this can be the discern as an augmentation to point-based hallucination. The metric of scrutiny desirability to the comparative ornamented or pigmentation, shelter where the chart/sector are in delineate, because the second method is consisted on "choropleth maps" [42] [43] [44]. In the middle of enormous geographic region/sector (e.g., countries, situation, sector) remuneration when smack/causality contrasting are these delineate. The "Centrifugal figure of speech" hallucination used to familiar smallest in 3rd. The sector of city amidst the desperation's traffic ornamentation to hallucination reciprocating, who used "centrifugal figure of speech" chart/illustration.

There are two encompassing techniques that can be used for configuration's hallucination. By enthusiasm or transformation effects is depict to the append where the time is ramification, for the web-based hallucination the initial (1st) procedure is deliberate. Hallucination approaches and avail oneself of resolute and the Second procedure is deliberate for reprint on the contrasting exemplar can be initiate in [60] [61].

The most frequently utilized detain in Space-Time-Chunk (STC) hallucination where the perceptual information x-axis and y-axis are used to encapsulate while on the z-axis [46] the non-spiritual information is

manifest. Procedure incorporates of such application: (a) By Stacking-based STC [50] is shown manifest where the substitute in vehicle associated variable of numerous traffic over time and space in vehicle review. (b) By magnified version of streamer-ed STC [47] [62] configurations information on the traced based and smacks are exhibited in smack review. The ornamentation over space and time potentiality to approximate depends one one's contrast and manifest comfortably cannot be the authentic merits because this method we do not nominated. In a 2-dimensional partition/writing-paper instead of their distinguish profitability for manifesting configuration ornamentation. The time constituent to conclusion the delineation systematized or each one controls hallucination like Lattice/small miscellaneous used in spite of we would nominate.

3.13. High-Rise Dimensional Data-sets of Hallucination

Systematised and data scrubbing ext.-re essential hallucination for high-rise dimensional data-sets. Data initialisation smaller requisite and speedy plotting mechanism are frequently used Equidistant Synchronized Conspiracy (ESC) and lattice disintegrate conspiracy or bar graph of small miscellaneous, on the bottom end of spectrum. Smack configuration counting between the association/inter-linkage ESC can be petition to hallucination as an exemplar: Lane situation [43] [51] [53], exploit category, day/month outcome, and automobile confused. By dissimilar census zones in the number of smacks to hallucination alteration by Cottrol and Tapuria [52] which was used the lattice intrigue furthermore. the complication dimensional to diminish procedures with the application of prognostication for the set of scene hallucination on the higher end of the analytical range. Insert the case in point: (a) In the study of scrutinize the kinds of drivers and contrive disparate between the correlation of the 2-dimensional (2D) plot manufacturing where the numerous dimensional escalated, cluster review of [55]. (b) To erroneous-way of navigating in 2D space donate the cue constituent to immediate delineate of Numerous Compatibility Review (NCR) who take the advantage of [57]. (c) Afterwards the envisaged using a navigating colour depict and studying method using carver-nous analysis space were diminish to a 3D, the motorist etiquette data encapsulating with time concatenation in numerous alternate [56].

3.2. Depletion Measurements

In its hallucination abet and data dimensionality to diminish can be used how we apotheosis predictor procedure in the antecedent subsection. The ominous/predictive modelling level for data to put together can be used to depletion procedure that is why we talk about measurements. For depletion measurement, there are three major aims in mainstream are as follows: (a) Predominant vacillating recognized and determined in attribute option; (b) without loss of track consequential into the bottom space the vacillated set is predicted in ancestors/causation attribute; (c) Simultaneously, where the indistinguishable scrutiny is assembled in clustering. Their goals are according to depletion measurements procedure are categorized because in their analysis we could amalgamate these techniques.

3.2.1. Attribute Option

For this analysis of predominant at most the vacillating/attributes adjudged used and recognize to imitation instruments learning and arithmetical use of previous steps which one of the advocated at [63]: (a) Over-fitting circumvent; (b) In this review to diminish the mathematical; (c) Attribute option or vacillating as cited to frequently this step, prediction execution escort to recommended. Expectation of smack on the ramification which may have numerous prospective predictor (e.g., Lane configuration associated vacillating, climate and vehicle) because the role title an essential frolic on vacillating option in the milieu of smack. In the model which necessitate to be initiate a new vacillating, in computation to encapsulate the non-linear and terrestrial ramification of these vacillating in sequence. The smack from two low stream-let and two high stream-let sensors/detector on collected antecedent where each vacillating is vehicle associated, a smack prediction model flourish for illustration [64]. A few unessential information these vacillate accommodate with them, and beyond four vacillate is splinted for each vehicle this means that the information. In such manifestation model execution [65], [66], [67], [68] attribute/vacillate option will enhance/ameliorate. We use the appellation attribute option for this purpose of succinctness to designate attribute and vacillating option methods/processes. The procedure of attribute option can be categorized in to three groups: Strainer, binder, and submerge procedure [69]. The illustrative/predictive model will be the capture to the chooses attributes and then subset attribute to an algorithm will be chooses according to Pearson association or reciprocal information standard that is used to device learning model and mathematical model from the individualistic subset of attribute of the choosing method in strainer procedure. Encompasses the dominance of strainer procedure: (a) Calculation's regulation, (b) speed, (c) lucidity, and

(d) over-fitting threat of depletion. The option of an ideal set of attributes [69], [70] do not assurance and in the middle of attributes the protector of they can no notice although. Hereditary algorithm [71] and optimization stream splinter [72] such as using heuristic searching/penetrating algorithm, sub-set the attribute space and the prediction accomplishment of the divider while adjudging attributes in the middle of for the inter-linkage/protectorate in distinction. They are computationally in-efficacious when strainer approaches to differentiate while they can enhance the accomplishment. In computations [69], [70] they also do not covenant absolutely and may over-fit. Smack threat modelling schemes in numerous tendered technique which makes them the process is immersed techniques, it is a segment of the model tutoring attribute to keep away from such complications. To regulated vacillating significance [68], [73], [74] and attribute option procedure in the literature was universally Random Forest (RF). Their applications and procedure option about the attribute information furthermore, the reader to [70], we recommended [75], [76].

3.2.2. Attribute Ancestors

A well-organized dimension space a more to latitude by prominent capture to dimension depletion on substitute technique attribute ancestors' procedure. Diminish, input vacillating can amalgamate the prediction. The data [77] preoccupation of contemn- parry/immediate utilitarian and the complication intricacy. Through a mathematical modification over the vacillating amalgamate information to preferably but insignificant vacillating is not on relinquish as the cornerstone from attribute option the attribute ancestor contradicts consequently. In the smack prediction literature [78] [79] [80], [81], [82], [83] the ancestor process used attribute the most frequently of Principle Component Analysis (PCA). Un-correlation vacillates Principal constituent PCs is a set of rectilinear to PCA transmute indigenous vacillating throughout an orthogonal transfiguration. With insignificant mislaying of information, the dimensionality of the complication which take edge off with a few PCs the data can be elucidated in the dissimilitude in generally. For the eigenvalues [84], a scree scenario or an entrance throughout a set frequently hang on to number of PCs of the ascertainment. Such supposition which does not indispensable PCA to various augmentation that can be rectilinear amalgamate for numeric vacillating because PCA was to begin with originate. Incorporates these: (a) Expectation PCA [85], (b) non-linear Principal Component Analysis (PCA) [77], and (c) Kernel-based Principal Component Analysis (PCA) [86]. In the literature [77] considerably have also been executed this procedure.

3.2.3. Clustering

Clustering is a self-ruling machine studying procedure in such a way that contradictory to attribute option and ancestors, that endeavour to a group inspection to-gather with the aim of increasing comparability within a cluster as Inspection within separation decreasing and in the middle of cluster decreasing the comparability within the cluster centres increasing the separation [87], [88]. They can be split-ed into clustering techniques: Model based, grid based, density based, hierarchical based, and partitioning based technologies [87], [89]. For dimension depletion convenient technique of a feasible cluster that make the datasets which have a number of mannerisms of smack threat modelling. Smack plausibility on vehicle situations to acknowledge the smash is generally the aim for example if you contemplate the vehicle datasets, which is attain throughout the routinely: (a) Dissimilar situation into vehicle categorizing, and afterwards (b) On the smack plausibility [10] each vehicle position may be congested or not congested in crash assessing.

Step, classically (a) Vehicle flow mannerism notice [90], [91], [92] throughout an inspection was accomplished. By researcher racialism and acknowledgement can be regulate the mannequin is that of such an detain a restriction. Inspection can be clustered how to recognize the detain of data driven, one can use supposition force on the other hand. Grouping of the data, model to impenetrable but the reasoning to recognize how cluster can be used to manifest [36]. Applications are not restricted to, but clustering involve (a) classification vehicle [36], [93], [94], (b) clusters misfortune recognizing [95], [96], [97], and (c) climate situations of grouping [98]. The complementary facts and figures we anticipate a elaborated example where we use k-mean clustering and for vehicle data k* clusters to regulate the elbow procedure can be attained an optimal number of clusters (k*) how to illustrate.

4. For Smack Threat Descriptive/predictive Models

Smack threat and statistical/device studying models that influence the threat constituent, on two features this section indistinct: Vehicle security on climate and traffic with vacillate circumstances together inattentive

driving about the ramification of a exhaustion, we think about significantly constituent section in the threat. Predictive models construct and constituent those scrutinize has been terminated that the review of some analysis for the statistical section.

4.1. Vehicle Security for Threat Constituent

Influence smack threat that five sets of constituents debated [11]: (a) Attributes of driver as a behavioural as abstraction, stultification, lassitude; (b) Traffic Conditions; (c) Attributes of Lane com-putative as number of roads, curve shape contour, kinds of lane, within each declivity/convergence; (d) Vehicle situations, solidity and inequality in speed between vehicles, traffic speed; and (e) climate situations like glacier/freezing rain/ snowflakes, wet-weather, invisibility.

4.1.1. Lassitude and Nap

Drivers of scrutinize on illustration anticipate such as smacks consequence the threat of unfavourable and lassitude on the study of untimely work. Over the United States autoroute at five relax-terminate driver/motorist on dumper truck 500 roughly with face-to face interrogation regulated [99]. "Smack collaboration", "close calls", and "acknowledgement of lassitude" were the three consequences. Reactions from contemplate remind on driver all of these were based. Evaluates self-delineate with lassitude driver that could influence set of vacillate when they are recognized. For security the conveyor buttress, driving circumstances, heavy good vehicles and productive constraints incorporate these evaluates. Consisting, lassitude which were affecting recognized, type of dumper/driving environs from all the three distinct vacillates: (a) Relocate not efficient or efficient drive, (b) protracted freight time; and (c) [99] aloft delineate with each of these retaliations, predictor as constituent with this review of ran regression begin the work week exhausted or not. Drives ordinarily flock the session was resolute by resolving the first vacillate relocates efficient or not for how many six hours' time session. Exceeding the effect evaluate for all three delineate the predictor consequential fatigued was a work week in the beginning when they are initiate. Self-knowledge of lassitude and close calls with analogous-ed were emphatically in extensive wait times. With close calls analogous-ed was differently per day intervals of time the number contradictory.

Another preliminary study, Evidence based on their security institution trucking of illustrative laminated regulate in [100]. Three strata explicated from each illustrative when the designated as an extremity fourth (entertainer necessitous security), and the midway two fourth, and the peak fourth (entertainer the elevated security). Three drivers are two dispatcher, two security director, as well as the directorial, in the corporation by numerous labourers to be permeated out when they dispatch seven opinion polls within each stratification convey of illustrative in the wake of receipts. Each institution within classification which also scheduled basis. Lassitude was "Fatigued appearing the workweek" in predicting vacillate the most consequential when they terminated three sets of vacillate using a like as in [99]. Constituent were "necessities, merchant and timetable enactment in recipient" and response to situation by struggling detecting" in other consequential.

For catastrophe/disaster and close by pass over the threat constituent to regulated in Italy, the truck drivers in criss-cross sectional [101] is regulated. Assessment of medical/ therapeutic and quiz scrutinize from regulated when the catastrophe was retaliation as well as relax-break of frequency, and catnap of frequency, tiredness daytime, arrears siesta, pane data on nap/siesta. Sequentially, odds proportions of 2.32, 1.45 and 1.73 of these capitulate; with catastrophe emphatically matched up were lassitude immoderate in daytime, and nap arrears, nap pane that awkward in which they established. The abolished value of 1.0 that ostracized had conviction interim all of these odd's proportions.

Road retrials, disputes and hard-breaks (decelerate originate by unanticipated slowdown) such as calamity that can recognize events by which data assemblage with computerized systems. With smacks [102], correspond which are exceedingly analytical events as security hard-decelerate deliberated [21]. The retaliation as a hard-decelerate of number having a Poisson/Boltzmann regression to originate [103] and [104] of lassitude model used their models as a predicted way. The time of the day for six vacillates and predicted lassitude involved the predictor vacillates. Hard-break of a threat is associative in the middle of predictive lassitude in-curve up the interrelation, there is an escalate when they originate.

Motor vehicles drivers' merchant of lassitude which is associated to the research [105] scrutinized in the contemporary study. Vacillate of ramification that are distinguished, or not when they are differentiate that is the experimental studies are blueprint most research medicament's impressive by inspection a superintend of orchestration since of the strenuous. Stamina are do not so but any medicament's petition to

inducement of some calibre to acquire where drivers are shuffled, one outlier to this is a "configuration/ constitution stimulation are shuffled". The authentic medication not essentially to the incitement that are requisite we would culminate, if a ramification is distinguish. A manifestation-control study or a outfit design used in multitude studies. Studies over time and recognized the number driver in a outfit design. In the middle of manifestation and controls is differentiation indistinct with controls is now on situate are complemented/ match and recognized the number of manifestation smack in a manifestation control study. Security gets the measures can be beneficial both manifestation-control studies and outfit studies.

For driver programmed, algorithm enhancement a progressed not long ago [106]. The trip continuation reduces to originate was LAST (Lassitude Avoidance Scheduling Tool) indicate the algorithm. Below United State Law maximal driving hours such as the restriction through with other level of a slightest lassitude in a theme. [107], [108] succeeded by Three Procedure Model of Attentiveness (TPMA) in algorithm presume.

4.1.2. Abstract Driving

Abstract driving at the consequences of further researchers have inspected. By the world Health Organization [109] observation has been abstracted driving and usage the mobile phone complication. In the earlier 5 to 10 years up to 11% by enhanced the usage of cell phones when they eminent the worldwide. For free-hand appliances and hand-held telephones are indistinguishable, by a constituent of four smack anticipation enhance the usage of cell phone in data recommend. Transpacific travel systems and mobile phones exceptionally is the part of abstraction at the minimum which were anticipated all smacks (individual vehicles amalgamate and dumper trucks) about one forth that at the time of distinguished [110]. At the time of accessible the literature is evaluated in their writing. When demise/dying per year 6000 nearly/virtually re-numeration from 2005 to 2008 by enhanced 28% in abstraction driving inclination [111] evaluated.

Merchant drivers in [112] abstracted driving in 203 studied. Unusual events that have no convoluted the time session with 19,888 ahead, road leave-taking unpremeditated and nearby smack, critical/censorious events in 4425 the data convoluted. With driving association not in mission who were affianced in convoluted drivers nearby smacks of 46% and the all smacks of 71% that is originate. Non-driving task was carried out while the driver materialized 60% of censorious events in which all inclusive. In [113], Drivers were studied as a 109 mature and 42 immature drivers (year of age is 16.3 to [17.0) who had acquired the equitable driver authorization in which the study is regulated. The driver is mensuration constituent at this moment. While driving locomotion abstracted were used to recognize, photo-microscope and sensor such as acceleration paraphernalia. Frequently 3.0 with odds proportion, injury of threat escalated to a lead the way messaging or calling the cell phone or like consuming events abstracting that they originate.

Coherent at this moment is the possibility of security optimization in locution. Sanction should not be messaging and used cell phone in hands such as abstracted driving. Organization's conveyance merchant for numerous institutions in to the transition have been in numerous countries as well as legislation these have transliterate from a mainstream in to driving universal prospective. Secure driving attitude invigorate while driving and/or messaging that incapacitate, there are numerous applications on modish phone-based in inclusion. From a pre-set excellence re-numeration when their reflector/mirror-checker that voice-vigilant anticipate the driver professional that are used by wearable electronics as application to a modish phone to associate with detector that are earphone implant, these are perspective from a merchant driving. This interference of potency that inspect not an enormous of their body of literature, while encouraging appear in this modish phone application/robotics because this interference as an relax-based programmed to trains the dispatcher/departure with split this information**.**

4.1.3. Lane Configuration, Climate and Vehicle condition

Driver constituent associated, we have talk about in section "lassitude and nap" and "abstract driving". By non-drive/extraneous constituent the influenced can be extremity and plausibility, the smack manifestation in numerous. The smack plausibility and extremity [10], [11], [114], collision that constituent the major extraneous of lane configuration like the number of roads, lane exterior, altitude, and curvature, vehicle condition as volume/amplification, solidity, tendency and vehicle flow/circulates, and vacillate/ attribute encapsulate climate perceptibly, steaminess, hurricane speed, storm and condition of constitute. The smack plausibility substitute can remarkably and synthesis are inter-linkage that the fact due to protection in contemplate should not be missive that these constituents. Consequently, on smack threat

constituent of such ramification amalgamate the scrutinize in the subsection three pertinent studies that we have climax.

On smack plausibility data vehicle and climate specifications of actual-time lane-geometrical attribute in the middle of inter-linkage ramification scrutinize [115]. Shrivelled season/ acclimatizes and stormy for two models evolved the writers using a Bayesian logistic regression parameter. Consequential locution was inter-linkage one at minimum in the major ramification, both models that in intimate their outcomes, study manifestation study and based on their models. The shrivelled acclimatize that of two times in the period of stormy acclimatize of the smack threat that also evolved the writers. Precipitous sections necessitate lane portion with exterior situation for slur-pee lane, frozen, in the middle of stormy ramification by the inter-linkage affect could also be threat plausibility of smack that the writers advocated additionally.

The writers make use of auto-route in Colorado 1-70 sections 15 mile on their study regulated in [116], in another study the use of: (a) To extricate the actual-time vehicle data on 30 Remote Traffic Microwave Sensor (RTMS) detector, (b) For acquiring actual-time climate data on six climate stopping place; and (c) Lane geometry configuration for acquiring the Roadway Characteristics Inventory (RCI). Smack variety and acclimatize on the study based in the contemplate, framework was incompatible. Crucially, the smack plausibility can enhance roadway censorious position incline precipitous with amalgamate climate situation that the inauspicious of the manifest ramification. Medium speed and circumspection such as predictor notably split but in frequently way single vehicle (SV) and multiple vehicle (MV) used in additionally. Vehicle speed and climate situation to associated, the notably vacillate were SV model more additionally. Vice versa, by vehicle associated vacillate MV smacks were extra pretentious.

High-rise vehicle situation leads the way that could studies in numerous constituent [117]. Pandemic demography and initiation trip/slip such as few features of behavioural, climate, lane configuration in which they contemplate. In the smack elaborate not the separate, because these vacillate were confiscate the smack of neighbouring of the domain as an attribute. proportion of non-smack to smack with a 10:1 manifestation controls the design which they are used. For thesis/conclusion Bayesian logistic regression and inclination vacillate, they used for support vector machine (sum). The threat of accident on the ramification of consequential that had a behavioural attribute of scarcely was traveller/strap-hanger which involves manufacture work of home based that they initiate in percentage/portion.

In [114], extremity of smacks volume disparate at prediction smack models succeeded. Smack extremity were contemplated of three volumes: Smack accident lethal/debilitated (KA), Smack accident non-debilitated/feasible (BC), and Smack scarcely possessions harm (PDO). Vacillate is dissimilar of milieu ramification volume of smack extremity are non-identical less than the manifest outcomes. The smack threat enhance would be the situation of climate inauspicious, e.g., in the all (KA, BS, and PDO) smack model. Smack would outcome in accident that diminish the plausibility could be the feasibly and causalities (driver attributes to substitute un-encapsulate perhaps anticipated) which is stipulated to conflict the ramification had position/condition to inauspicious climate, although smack model (KA and BC) below the accidents. Extremity and smack threat of volumes disparate in outcome would be vacillate exterior to interlinkage stipulate which in these two models are incompatible vacillates in consequential way, notice that in the vehicle association.

4.2. Analytical/Statistical Modelling

Using logistics regression or more categorization models scrutinize are routinely studied in retroactive manifestation sovereignty. With one or extra sovereignty (non-smack), complement go with manifestation (smack) is contemplated, because non-smack differentiate with smacks are extremely infrequent. In the inspection/exploration now considered for this suiting. The situation of smacks assemblage imitates to determined is the set of dominance, in further unsuited are (non-smacks) circumstances. In the scrutiny description was get hold into suiting (and also how), therefore numerous studies with regard are imprecise to suiting. Confiscate to assorted times as numerous non-smacks as smack is familiar than smacks usual additionally non-smacks are considerable. High-rise probability as 10:1 is originated. vehicle smacks in the middle of these constituent on the analysis of correlation antecedent the [10]. Injury frequency was associated to cloud-burst and restriction were a constituent speed, vehicle flow function of computational was the security in the culmination not all the congruities. Extremity on ramification event though is ambiguous. Injury plausibility benefactor tube expected such as four vacillates, that setup and vehicle security studies antecedent meta scrutiny and an analysis [11] escorted. The smack situates throughout dissimilitude involve these speed

(1.226 = odds probability), variance speed (1.032 = odds probability), volume of median vehicle (1.001 = odds probability) and median speed (0.952 = odds probability).

Culmination smacks near-most the study of configuration to used suited control [64]. Concerning of 4:1 the probability 962 with non-smack and 243 with smack in which they studied. For Logistics regression used Bayesian salute and afterwards for vacillate selection in which they used incidental/random forest. For rear and smacks constituent the consequential were intimate down-river obstruction of high-risen and down-river of small speed, upriver magnitude of high-rise (from the catastrophe), that summit hour when they originate. Manifestation-control study is an un-suited smacks rear culmination in cliquishness also studied at Pande and Abdel-at [118]. For the sovereignty f hazard 363 million un-ceremoniously the 150,000 of illustrative accidental are determined and five years in a session of whole data with 1620 only but the smacks culmination are rear in 2179 when they established. when circumstances used of smack high-rise and small categorization and regression trees (CART). Confident remuneration 33% roughly with an injury where there was a manifestation of 75% regarding high-ris threat condition could be their detained. Because approximately 33% confident remuneration that their erroneous culminate might be one, smacks were in-frequent events. In a manifestation=control study the smacks culmination is rear studied [119] in Lamented study. For hypothesizing a neural network consciousness volume as multifarious and vacillate selection for accidental/random forest used when smack to no smack's probability is 5:1. Consequential were midpoint tenancy down-river and speed up-river when they initiate.

There were 17 smacks and 91, 118 non-smacks in Greece, but in Athens main-road of conveyor belt on a numerous-road studied vehicle security in [120]. The non-smacks illustrative used accidental/random in another model and they used all data in one model. All the data which uses to fifth procedure exclaimed, salute the maximal plausibility chastised when they used in one model and conclude the logistic regression model. Subset of data used for logistic regression in framework to approximate the procedure rectification when they use hetero-sexism in another salute/technique. On smacks repercussions has an unenthusiastic median speed that they perceive. Consequentially, not to be initiate but contemplate was the ration on the highway trucks.

In Virginia, USA 64 auto-route of passageway on a vehicle security [121] studied. Manifestation control design suited used their study. For vacillate selection which they used propose a frequent pattern (FP) tree. Bayesian network and contiguous algorithm K-nearest uses consequential on which vacillate using for hypothesizing. All vacillates based on outmatched models vacillate selection FP based on prediction model injury threat that they culminate. They are using 10-minute meantime is extra systematic than 5-minute meantime also recommend. Susceptibility of 0.61 and 0.38 remuneration alarm an erroneous capitulating, conscientiously works Bayesian network model that they culminate eventually.

Upriver and downriver vehicle predicament necessitating the Markov model to contrivance 5:1 probability with a manifestation-control design used [122] studied. To a four-predicament Markov chain this escorts FF (free flow downriver and free flow upriver), then in the predicament might be superhighway section, as an exemplar, if one upriver and one downriver section is scrutinized. Markov chain directing to a nine state/ predicament in which two downriver and two upriver situations are scrutinized. Bayesian network model used an dynamic way, this adaptation possibilities were approximated. Alarm remuneration 0.237 with an erroneous 0.764 of exactness, because in their model smacks has a with nine-predicament. In the subsequent figure of their paper intimate the threat and speed in the middle of non-linear association in which they initiate an entrancing on the Bayesian network inclusion to their work.

By [123] a probability 10:1, 1250 of non-smacks and 125 of smacks manifestation control study, while other vehicle is retired was studied to consolidate and the superhighway vehicle entering that is the criss-cross ramifications. As incidental ramification with criss-cross as retiring vehicle had to consolidate segment of the superhighway, they petition Bayesian logistic regression model on numerous levels. As incidental expropriate in to the model these accidental repercussions were assimilated. In these criss-cross section repercussions were consequential the vehicle volume of tree-trunk and extermination, and inception in the middle of speed distinction, the criss-cross section which they initiate the speed at this inception. From two view-point the com- plication of vehicle security [124] are detained. Smack frequency is intricate one. As the retaliation calamity of the number Yi and the superhighway of unit segment, this lay hold as the instance. Which is 0 for non-smack and 1 for smack the criterion vacillate Yi and the segment of superhighway like time interval as an illustrate proceeding and logistic regression habitual the petition to the other approached. Poisson regression conduct to first approach and logistic regression routinely conduct to second approach. These two models consolidate or amalgamate is the process of their benefaction the un-conventional. Two

origin of data uses this beneficially. A numerous level model to capitulate, logistic regression model in the remuneration Poisson to involve their desegregated model. Receiver operating characteristics (ROC) in-curve elevated a capitulate superior to accomplish that they detect the desegregated.

This analysis is extent but these are far away from, to authentication, and description with model milieu/situation together can be the studied in smack prediction models characteristics because there is a mass. Reviews by [29], [125], [126], [127], [128], statistical models characteristics can be initiate in earlier on advertised.

5.Conclusion

These complications to resolving for donating prospective substantial as having systematic of data is contemplated that intuitive on the other accessibility of pertinent data in precedence consequential and on one hand the occurrence motor conveyance to accredited directly possessions and life of deprivation to delineated the prodigious. Maximization, predicting modelling, illustrative analytic and data assemblage of amalgamation on an anticipate has to this orchestration in a fortunate endeavour. Frivolous complication on it possess can be a crucially individually each section at the same time. Any single research of potentially or purview as likely as not behind the "from scrape" all of these levels assimilate the instruments of reinforce, that's why data-driven conclusion of adult consequently evolution. Conclusion manufacturing of notifying experiment with the objective simultaneously all these locales in the pulling of endeavour, there is not a deliberate literal this is exceptional. In authoritarian optimization models as driver piece of work, to focus which notify road/track option, predictive/descriptive models (smack threat measure-out and superior acknowledge assist to notify which focus the road/track selection) from the consequences of relocation/transportation in that we have recognized the most consequential aperture. Contraption processing/transforming of data and/or data origin accessible suitable for voluntarily absenteeism is the basic cause of conceivably is restricted.

Authorized conveyance for security procedures up to data analytical succeeded an auspicious occasion we accentuate in this evaluation. For betterment (In this analysis the legislated according to the constituent), the route of the subsequent region dominant constitute:

(A) In this locality progression intercepting main constituent is no extensive of data availability that means data recital driver accumulate to prospective as well as vehicle data and predicted climate, actual-time inaccessible of constituting history. Such imitations (from scrape procedure has to succeed because of every researcher assemblage data in numerous way), volume of succeeding overhead the high equitably to escorts section of research by due to cryptography/models splitting this disinclination and although, depository of deficiency is consolidated.

(B) Data drive associating are significantly used in initialization for illustrative analytic instruments. The most acceptable process in which the provocation is to dictate at this moment, complications on the individual depend frequently initialization procedure as clustering and hallucination considering that the pertinence of distinct. For researcher and physician indistinguishable, the procedure additionally coherent for manufacturing one turnpike constitute, by originating replicate documents like Jupiter register and Markdown to pre-eminent enactment splitting.

(C) Area of constituents extensive a contemplate and well-researched are assessment statistical procedure for threat. A manifest-control study consists of a single line portion data, ornamentation interchangeable come after these studies it must can be noticed that (in few manifestation) at the indistinguishable time. Sc-Ute considering enormous of statistical review there is an occasion in used by us perspective:

(1) At this moment in time accessible extensively data are increased nearby-actual time.

(2) Inter-predicament and main throughways for all smallest at the exceedingly or over line network continuous for imitating/enumerating threat can permit in the contemporary years mathematical evolution.

(3) The continuous line network may not be reducible line portions inconsequential from these comparatively this perception.

(4) Road selection and/or path, their time of travel concerning more conclusions knowledgeable to pressurize these intuitions can take advantages of ambiguous how drivers (merchandising or systematically strap-hanger). To smack threat modelling is necessitated detain exhaustive/trans-disciplinary an additional in our assessment. Commercialized drivers and strap-hanger can be the research take advantage from how to scrutinize the volume further the constituent come up with the smack threat at most superior acknowledge; the

research quizzing should not be restricted. High disquieting endures have catastrophe and scratch's motor vehicle enumerate and remuneration usage cell-phone/abstracted-driving that accoutrements success of universal and in recognizing technologies the evolution in spite of technological because this is extremely predominant.

6. Complementary Facts

The precarious literature and in the middle of smack prediction literature to overpass in an attempt the aperture. For all our source/code we have assemblage.

(a) Source scratching data-associated smacks,

(b) such data of initialisation;

(c) Analytic illustrative

(i.e., clustering and/or smack-data/climate/vehicle envisage);

(d) accessible descriptive modelling upon a GitHub depository

https://github.com/caimiao0714/TrafficSafetyReviewRmarkdown.

A few of its ramification delineate and code can be used how we displaying entertainer of this code to precipitate the depletion. Upon the subsequent GitHub side

https://caimiao0714.github.io/TrafficSafetyReviewRmarkdown/ which is deposit website

using an R Markdown file [129] was contrived. In our research coterie the execution of "Open data science" help provided enhance in this typescript on condition. We aspiration that the complementary facts.

7. Subsidization

This session was work in subsidized by: National Science Foundation NSF (Capability Maturity Model Integration CMMI-1635927 together with Cable News Network International CNNI-1634992); Through American Society of Security Professionals (ASSP) substratum; Ohio mainframe centre (PMIU0318 and PMIU0162); Training program project of pilot Research Centre, and the university of Cincinnati Education; Processing Tier 1 University Transportation Centre (Trans Info) the conveyance Information, for data management Google threat manifesto research; API entrance a Dark Sky permit for elongated (i.e., the number of feasible scepticism per day when they enhanced). By the Neil. Anderson Endowed Assistant professorship at the Miami University, Dr.Megahed's research was also moderately subsidized.

8. Curiosity of Antagonism

The author pro claims no antagonism of curiosity.

9. Acronyms

In this type-script the following short-form are used:

- AADT Annual average daily traffic
- DoT The Department of Transportation
- FHWA U.S. Federal Highway Administration (US DoT)
- FMCSA The Federal Motor Carrier Safety Administration
- NDS Naturalistic Driving Study or Navigation Data Standard
- NHTSA National Highway Traffic Safety Administration
- NOAA U.S. National Oceanic and Atmospheric Administration
- VT Virginia Tech

References

1. "World health organization (who)," https://www.who.int/en/news-room/fact-sheets/detail/the-top-10-causes-of-death, 2019.
2. "Insurance institute for highway saftey (iihs)," https://www.iihs.org/topics/fatality-statistics/detail/yearly-snapshot, 2019.
3. "National highway traffic saftey administration (nhtsa)," https://www.nhtsa.gov/press-releases/us-dot-anounces-2017-roadway-fatalities-down, 2017.
4. "World health organization (who)," https://www.who.int/en/news-room/fact-sheets/detail/road-traffic-injuries, May 2021.
5. "World bank national accounts data, and oecd national accounts data files," https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=US, 2020.
6. "Economic and societal impact of motor vehicle crashes," https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812013, May 2015.
7. "World bank national accounts data, and oecd national accounts data files," https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?locations=US, 2020.
8. A. Ditta, O. Figueroa, G. Galindo, and R. Yie-Pinedo, "A review on research in transportation of hazardous materials," Socio-Economic Planning Sciences, vol. 68, p. 100665, 2019.
9. M. Abkowitz and P. D.-M. Cheng, "Developing a risk/cost framework for routing truck movements of hazardous materials," Accident Analysis & Prevention, vol. 20, no. 1, pp. 39–51, 1988.
10. A. Theofilatos and G. Yannis, "A review of the effect of traffic and weather characteristics on road safety," Accident Analysis&Prevention, vol. 72, pp. 244–256, 2014.
11. S. Roshandel, Z. Zheng, and S. Washington, "Impact of real-time traffic characteristics on freeway crash occurrence: Systematic review and meta-analysis," Accident Analysis & Prevention, vol. 79, pp. 198–211, 2015.
12. M. Aria and C. Cuccurullo, "bibliometrix: An r-tool for comprehensive science mapping analysis," Journal of informetrics, vol. 11, no. 4, pp. 959–975, 2017.
13. E. Garfield and I. H. Sher, "Key words plus [tm]-algorithmic derivative indexing," Journal-American Society for Information Science, vol. 44, pp. 298–298,1993.
14. M. S. Thiese, R. J. Hanowski, S. N. Kales, R. J. Porter, G. Moffitt, N. Hu, and K. T. Hegmann, "Multiple conditions increase preventable crash risks among truck drivers in a cohort study," Journal of occupational and environmental medicine, vol. 59, no. 2, p. 205, 2017.
15. S. Newnam, T. Xia, S. Koppel, and A. Collie, "Work-related injury and illness among older truck drivers in australia: A population based, retrospective cohort study," Safety science, vol. 112, pp. 189–195, 2019.
16. T. A. Dingus, R. J. Hanowski, and S. G. Klauer, "Estimating crash risk," Ergonomics in Design, vol. 19, no. 4, pp. 8–12, 2011.
17. F. Guo, "Statistical methods for naturalistic driving studies," Annual review of statistics and its application, vol. 6, pp. 309–328, 2019.
18. "Federal highway administration, real time system management (fhwa)," https://ops.fhwa.dot.gov/511/index.htm, 2020.
19. F. Guo, S. G. Klauer, J. M. Hankey, and T. A. Dingus, "Near crashes as crash surrogate for naturalistic driving studies," Transportation Research Record, vol. 2147, no. 1, pp. 66–74, 2010.
20. R. J. Jansen and S.Wesseling, "Harsh braking by truck drivers: A comparison of thresholds and driving contexts using naturalistic driving data," in Proceedings of the 6th Humanist Conference, The Hague, The Netherlands, 2018, pp. 13–14.
21. D. Mollicone, K. Kan, C. Mott, R. Bartels, S. Bruneau, M. van Wollen, A. R. Sparrow, and H. P. Van Dongen, "Predicting performance and safety based on driver fatigue," Accident Analysis & Prevention, vol. 126, pp. 142–145, 2019.

22. L. Zheng, K. Ismail, and X. Meng, "Traffic conflict techniques for road safety analysis: open questions and some insights," Canadian journal of civil engineering, vol. 41, no. 7, pp. 633–641, 2014.
23. C. Johnsson, A. Laureshyn, and T. De Ceunynck, "In search of surrogate safety indicators for vulnerable road users: a review of surrogate safety indicators," Transport Reviews, vol. 38, no. 6, pp. 765–785, 2018.
24. S. S.Mahmud, L. Ferreira, M. S. Hoque, and A. Tavassoli, "Application of proximal surrogate indicators for safety evaluation: A review of recent developments and research needs," IATSS research, vol. 41, no. 4, pp. 153–163, 2017.
25. J. Guerrero-Ibáñez, S. Zeadally, and J. Contreras-Castillo, "Sensor technologies for intelligent transportation systems," Sensors, vol. 18, no. 4, p. 1212, 2018.
26. S. Abdelhamid, H. S. Hassanein, and G. Takahara, "Vehicle as a mobile sensor," Procedia Computer Science, vol. 34, pp. 286–295, 2014.
27. J. Bennett, OpenStreetMap. Packt Publishing Ltd, 2010.
28. M. Abdel-Raouf and A. Abdul-Raheim, "Removal of heavy metals from industrial waste water by biomass-based materials: A review. j pollut eff cont 5: 180. doi: 10.4172/2375-4397.1000180 page 2 of 13 volume 5• issue 1• 1000180 j pollut eff cont, an open access journal issn: 2375-4397 the top six toxic threats: Estimated population at risk at identified sites*(million people) estimated global impact**(million people) 1. lead 10 18-22 2," Mercury, vol. 8, pp. 15–19, 2017.
29. D. Lord and F. Mannering, "The statistical analysis of crash-frequency data: a review and assessment of methodological alternatives," Transportation research part A: policy and practice, vol. 44, no. 5, pp. 291–305, 2010.
30. W. Chen, F. Guo, and F.-Y. Wang, "A survey of traffic data visualization," IEEE Transactions on Intelligent Transportation Systems, vol. 16, no. 6, pp. 2970–2984, 2015.
31. W. Han, J.Wang, and S.-L. Shaw, "Visual exploratory data analysis of traffic volume, in Mexican International Conference on Artificial Intelligence. Springer, 2006, pp. 695–703.
32. I. Alam, M. F. Ahmed, M. Alam, J. Ulisses, D. M. Farid, S. Shatabda, and R. J. Rossetti, "Pattern mining from historical traffic big data," in 2017 IEEE Region 10 Symposium (TENSYMP). IEEE, 2017, pp. 1–5.
33. L. S. Nookala, "Weather impact on traffic conditions and travel time prediction," Ph.D. dissertation, Citeseer, 2006.
34. N. Ferreira, J. Poco, H. T. Vo, J. Freire, and C. T. Silva, "Visual exploration of big spatio-temporal urban data: A study of new york city taxi trips," IEEE transactions on visualization and computer graphics, vol. 19, no. 12, pp. 2149–2158, 2013.
35. H. Guo, Z. Wang, B. Yu, H. Zhao, and X. Yuan, "Tripvista: Triple perspective visual trajectory analytics and its application on microscopic traffic data at a road intersection," in 2011 IEEE Pacific Visualization Symposium. IEEE, 2011, pp. 163–170.
36. Y.-T. Tsai, H. D. Smith, S. M. Swartz, and F. M. Megahed, "Using visual data mining in highway traffic safety analysis and decision making," Journal of Transportation Management, vol. 26, no. 1, p. 5, 2015.
37. J. Pu, S. Liu, Y. Ding, H. Qu, and L. Ni, "T-watcher: A new visual analytic system for effective traffic surveillance," in 2013 IEEE 14th International Conference on Mobile Data Management, vol. 1. IEEE, 2013, pp. 127–136.
38. U. Releases, "Fatal traffic crash data," Article (CrossRef Link), 2016.
39. Z. Xie and J. Yan, "Kernel density estimation of traffic accidents in a network space," Computers, environment and urban systems, vol. 32, no. 5, pp. 396–406, 2008.
40. R. Lovelace, J. Nowosad, and J. Muenchow, Geocomputation with R. CRC Press, 2019.
41. M.-J. Kraak, "Visualising spatial distributions," Geographical Information Systems: Principles, Techniques, Applications and Management. New York, John Wiley and Sons, pp. 157–73, 1999.
42. S. Erdogan, "Explorative spatial analysis of traffic accident statistics and road mortality among the provinces of turkey," Journal of safety research, vol. 40, no. 5, pp. 341–351, 2009.
43. K. Wongsuphasawat, M. L. Pack, D. Filippova, M. VanDaniker, and A. Olea, "Visual analytics for transportation incident data sets," Transportation research record, vol. 2138, no. 1, pp. 135–145, 2009.

44. S. Liu, J. Pu, Q. Luo, H. Qu, L. M. Ni, and R. Krishnan, "Vait: A visual analytics system for metropolitan transportation," IEEE Transactions on Intelligent Transportation Systems, vol. 14, no. 4, pp. 1586–1596, 2013.
45. W. Zeng, C.-W. Fu, S. M. Arisona, and H. Qu, "Visualizing interchange patterns in massive movement data," in Computer Graphics Forum, vol. 32, no. 3pt3. Wiley Online Library, 2013, pp. 271–280.
46. M.-J. Kraak, "The space-time cube revisited from a geovisualization perspective," in Proc. 21st International Cartographic Conference. Citeseer, 2003, pp. 1988–1996.
47. T. Kapler and W. Wright, "Geotime information visualization," Information visualization, vol. 4, no. 2, pp. 136–146, 2005.
48. "Traffic accidents including cyclists in (act)," https://brettromero.com/traffic-accidents-cyclists/,2015.
49. "Visualized as a living circulatory system of traffic 24 hours watch," http://metrocosm.com/map-us-traffic/, 2016.
50. C. Tominski, H. Schumann, G. Andrienko, and N. Andrienko, "Stacking-based visualization of trajectory attribute data," IEEE Transactions on visualization and Computer Graphics, vol. 18, no. 12, pp. 2565–2574, 2012.
51. M. L. Pack, K.Wongsuphasawat, M. VanDaniker, and D. Filippova, "Ice–visual analytics for transportation incident datasets," in 2009 IEEE International Conference on Information Reuse & Integration. IEEE, 2009, pp. 200–205.
52. C. D. Cottrill and P. V. Thakuriah, "Evaluating pedestrian crashes in areas with high low-income or minority populations," Accident Analysis & Prevention, vol. 42, no. 6, pp. 1718–1728, 2010.
53. M. L. Pack, "Visualization in transportation: challenges and opportunities for everyone," IEEE computer graphics and applications, vol. 30, no. 4, pp. 90–96, 2010.
54. D. Chu, D. A. Sheets, Y. Zhao, Y. Wu, J. Yang, M. Zheng, and G. Chen, "Visualizing hidden themes of taxi movement with semantic transformation," in 2011 IEEE Pacific visualization symposium. IEEE, 2014, pp. 137–144.
55. H. H. van Huysduynen, J. Terken, J.-B. Martens, and B. Eggen, "Measuring driving styles: a validation of the multidimensional driving style inventory," in Proceedings of the 7th International Conference on Automotive User Interfaces and Interactive Vehicular Applications, 2015, pp. 257–264.
56. H. Liu, T. Taniguchi, Y. Tanaka, K. Takenaka, and T. Bando, "Visualization of driving behavior based on hidden feature extraction by using deep learning," IEEE Transactions on Intelligent Transportation Systems, vol. 18, no. 9, pp.2477–2489, 2017.
57. S. Das, R. Avelar, K. Dixon, and X. Sun, "Investigation on the wrong way driving crash patterns using multiple correspondence analysis," Accident Analysis & Prevention, vol. 111, pp. 43–55, 2018.
58. B. Croxford, A. Penn, and B. Hillier, "Spatial distribution of urban pollution: civilizing urban traffic," Science of the total environment, vol. 189, pp. 3–9, 1996.
59. S. Havre, B. Hetzler, and L. Nowell, "Themeriver: Visualizing theme changes over time," in IEEE Symposium on Information Visualization 2000. INFOVIS 2000. Proceedings. IEEE, 2000, pp. 115–123.
60. "Traffic accidents involving cyclists in the act," https://brettromero.com/traffic-accidents-cyclists/, 2021.
61. "Traffic accidents, visualization and circulatory system," http://metrocosm.com/map-us-traffic/, 2016.
62. O. Gudes, R. Varhol, Q. C. Sun, and L. Meuleners, "Investigating articulatedheavy-vehicle crashes in western australia using a spatial approach," AccidentAnalysis & Prevention, vol. 106, pp. 243–253, 2017.
63. Z. Sawalha and T. Sayed, "Traffic accident modeling: some statistical issues," Canadian Journal of Civil Engineering, vol. 33, no. 9, pp. 1115–1124, 2006.
64. Q. Shi and M. Abdel-Aty, "Big data applications in real-time traffic operation and safety monitoring and improvement on urban expressways," Transportation Research Part C: Emerging Technologies, vol. 58, pp. 380–394, 2015.
65. H. M. Hassan and M. A. Abdel-Aty, "Predicting reduced visibility related crashes on freeways using real-time traffic flow data," Journal of safety research, vol. 45, pp. 29–36, 2013.
66. M. Hossain and Y. Muromachi, "A real-time crash prediction model for the ramp vicinities of urban expressways," IATSS research, vol. 37, no. 1, pp. 68–79, 2013.

67. R. Yu and M. Abdel-Aty, "Utilizing support vector machine in real-time crash risk evaluation," Accident Analysis & Prevention, vol. 51, pp. 252–259, 2013.
68. J. You, J. Wang, and J. Guo, "Real-time crash prediction on freeways using data mining and emerging techniques," Journal of modern transportation, vol. 25, no. 2, pp. 116–123, 2017.
69. G. Chandrashekar and F. Sahin, "A survey on feature selection methods," Computers & Electrical Engineering, vol. 40, no. 1, pp. 16–28, 2014.
70. Y. Saeys, I. Inza, and P. Larranaga, "A review of feature selection techniques in bioinformatics," bioinformatics, vol. 23, no. 19, pp. 2507–2517, 2007.
71. D. E. Goldberg and J. H. Holland, "Genetic algorithms and machine learning," 1988.
72. J. Kennedy and R. Eberhart, "Particle swarm optimization," in Proceedings of ICNN'95-international conference on neural networks, vol. 4. IEEE, 1995, pp. 1942–1948.
73. F. Basso, L. J. Basso, F. Bravo, and R. Pezoa, "Real-time crash prediction in an urban expressway using disaggregated data," Transportation research part C: emerging technologies, vol. 86, pp. 202–219, 2018.
74. C. Xu, W. Wang, and P. Liu, "A genetic programming model for real-time crash prediction on freeways," IEEE Transactions on Intelligent Transportation Systems, vol. 14, no. 2, pp. 574–586, 2012.
75. S. Chormunge and S. Jena, "Correlation based feature selection with clustering for high dimensional data," Journal of Electrical Systems and Information Technology, vol. 5, no. 3, pp. 542–549, 2018.
76. A. Jovi´c, K. Brki´c, and N. Bogunovi´c, "A review of feature selection methods with applications," in 2015 38th international convention on information and communication technology, electronics and microelectronics (MIPRO). Ieee, 2015, pp. 1200–1205.
77. S. Khalid, T. Khalil, and S. Nasreen, "A survey of feature selection and feature extraction techniques in machine learning," in 2014 science and information conference. IEEE, 2014, pp. 372–378.
78. S. S. Nagendra and M. Khare, "Principal component analysis of urban traffic characteristics and meteorological data," Transportation Research Part D: Transport and Environment, vol. 8, no. 4, pp. 285–297, 2003.
79. H. C. Lee, D. Cameron, and A. H. Lee, "Assessing the driving performance of older adult drivers: on-road versus simulated driving," Accident Analysis & Prevention, vol. 35, no. 5, pp. 797–803, 2003.
80. Q. Li, H. Jianming, and Z. Yi, "A flow volumes data compression approach for traffic network based on principal component analysis," in 2007 IEEE Intelligent Transportation Systems Conference. IEEE, 2007, pp. 125–130.
81. C. Caliendo, M. Guida, and A. Parisi, "A crash-prediction model for multilane roads," Accident Analysis & Prevention, vol. 39, no. 4, pp. 657–670, 2007.
82. F. Guo and Y. Fang, "Individual driver risk assessment using naturalistic driving data," Accident Analysis & Prevention, vol. 61, pp. 3–9, 2013.
83. J. Lee, M. Abdel-Aty, and I. Shah, "Evaluation of surrogate measures for pedestrian trips at intersections and crash modeling," Accident Analysis & Prevention, vol. 130, pp. 91–98, 2019.
84. R. D. Cook, "Principal components, sufficient dimension reduction, and envelopes," 2018.
85. M. E. Tipping and C. M. Bishop, "Probabilistic principal component analysis," Journal of the Royal Statistical Society: Series B (Statistical Methodology), vol. 61, no. 3, pp. 611–622, 1999.
86. B. Schölkopf, A. Smola, and K.-R. Müller, "Kernel principal component analysis," in international conference on artificial neural networks. Springer, 1997, pp. 583–588.
87. P. Berkhin, "A survey of clustering data mining techniques," in Grouping multidimensional data. Springer, 2006, pp. 25–71.
88. "Clustering survey (cs)," https://www.ijcaonline.org/volume7/number12/pxc3871808.pdf, 2010.

89. A. Fahad, N. Alshatri, Z. Tari, A. Alamri, I. Khalil, A. Y. Zomaya, S. Foufou, and A. Bouras, "A survey of clustering algorithms for big data: Taxonomy and empirical analysis," IEEE transactions on emerging topics in computing, vol. 2,no. 3, pp. 267–279, 2014.
90. F. L. Hall, V. Hurdle, and J. H. Banks, "Synthesis of recent work on the nature of speed-flow and flow-occupancy (or density) relationships on freeways," 1993.
91. B. S. Kerner and H. Rehborn, "Experimental properties of complexity in traffic flow," Physical Review E, vol. 53, no. 5, p. R4275, 1996.
92. N. Wu, "A new approach for modeling of fundamental diagrams," Transportation Research Part A: Policy and Practice, vol. 36, no. 10, pp. 867–884, 2002.
93. T. F. Golob and W. W. Recker, "A method for relating type of crash to traffic flow characteristics on urban freeways," Transportation Research Part A: Policy and Practice, vol. 38, no. 1, pp. 53–80, 2004.
94. C. Xu, P. Liu,W.Wang, and Z. Li, "Evaluation of the impacts of traffic states on crash risks on freeways," Accident Analysis & Prevention, vol. 47, pp. 162–171, 2012.
95. T. Steenberghen, T. Dufays, I. Thomas, and B. Flahaut, "Intra-urban location and clustering of road accidents using gis: a belgian example," International Journal of Geographical Information Science, vol. 18, no. 2, pp. 169–181, 2004.
96. Z. Xie and J. Yan, "Detecting traffic accident clusters with network kernel density estimation and local spatial statistics: an integrated approach," Journal of transport geography, vol. 31, pp. 64–71, 2013.
97. L. Shen, J. Lu, M. Long, and T. Chen, "Identification of accident blackspots on rural roads using grid clustering and principal component clustering," Mathematical Problems in Engineering, vol. 2019, 2019.
98. O. H. Kwon and S. H. Park, "Identification of influential weather factors on traffic safety using k-means clustering and random forest," in Advanced Multimedia and Ubiquitous Engineering. Springer, 2016, pp. 593–599.
99. M. R. Crum, P. C. Morrow, P. Olsgard, and P. J. Roke, "Truck driving environments and their influence on driver fatigue and crash rates," Transportation research record, vol. 1779, no. 1, pp. 125–133, 2001.
100. M. R. Crum and P. C. Morrow, "The influence of carrier scheduling practices on truck driver fatigue," Transportation Journal, pp. 20–41, 2002.
101. S. Garbarino, P. Durando, O. Guglielmi, G. Dini, F. Bersi, S. Fornarino, A. Toletone, C. Chiorri, and N. Magnavita, "Sleep apnea, sleep debt and daytime sleepiness are independently associated with road accidents. a cross-sectional study on truck drivers," PloS one, vol. 11, no. 11, p. e0166262, 2016.
102. T. A. Dingus, S. G. Klauer, V. L. Neale, A. Petersen, S. E. Lee, J. Sudweeks, M. A. Perez, J. Hankey, D. Ramsey, S. Gupta et al., "The 100-car naturalistic driving study, phase ii-results of the 100-car field experiment," United States. Department of Transportation. National Highway Traffic Safety . . . , Tech. Rep., 2006.
103. P. McCauley, L. V. Kalachev, D. J. Mollicone, S. Banks, D. F. Dinges, and H. P. Van Dongen, "Dynamic circadian modulation in a biomathematical model for the effects of sleep and sleep loss on waking neurobehavioral performance," Sleep, vol. 36, no. 12, pp. 1987–1997, 2013.
104. P. McCauley, L. V. Kalachev, A. D. Smith, G. Belenky, D. F. Dinges, and H. P. Van Dongen, "A new mathematical model for the homeostatic effects of sleep loss on neurobehavioral performance," Journal of theoretical biology, vol. 256, no. 2, pp. 227–239, 2009.
105. H. S. Stern, D. Blower, M. L. Cohen, C. A. Czeisler, D. F. Dinges, J. B. Greenhouse, F. Guo, R. J. Hanowski, N. P. Hartenbaum, G. P. Krueger et al., "Data and methods for studying commercial motor vehicle driver fatigue, highway safety and long-term driver health," Accident Analysis & Prevention, vol. 126, pp. 37– 42, 2019.
106. Z. E. Bowden and C. T. Ragsdale, "The truck driver scheduling problem with fatigue monitoring," Decision Support Systems, vol. 110, pp. 20–31, 2018.
107. T. Åkerstedt, S. Folkard, and C. Portin, "Predictions from the three-process model of alertness," Aviation, space, and environmental medicine, vol. 75, no. 3, pp. A75–A83, 2004.

108. T. Åkerstedt and S. Folkard, "Validation of the s and c components of the threeprocess model of alertness regulation," Sleep, vol. 18, no. 1, pp. 1–6, 1995.
109. W. H. Organization, Global status report on road safety 2015. World Health Organization, 2015.
110. K. Young, M. Regan, and M. Hammer, "Driver distraction: A review of the literature," Distracted driving, vol. 2007, pp. 379–405, 2007.
111. F. A. Wilson and J. P. Stimpson, "Trends in fatalities from distracted driving in the United States, 1999 to 2008," American journal of public health, vol. 100, no. 11, pp. 2213–2219, 2010.
112. R. L. Olson, R. J. Hanowski, J. S. Hickman, J. Bocanegra et al., "Driver distraction in commercial vehicle operations," United States. Department of Transportation. Federal Motor Carrier Safety . . ., Tech. Rep., 2009.
113. S. G. Klauer, F. Guo, B. G. Simons-Morton, M. C. Ouimet, S. E. Lee, and T. A. Dingus, "Distracted driving and risk of road crashes among novice and experienced drivers," New England journal of medicine, vol. 370, no. 1, pp. 54– 59, 2014.
114. C. Xu, A. P. Tarko,W.Wang, and P. Liu, "Predicting crash likelihood and severity on freeways with real-time loop detector data," Accident Analysis & Prevention, vol. 57, pp. 30–39, 2013.
115. M. M. Ahmed, M. Abdel-Aty, and R. Yu, "Assessment of interaction of crash occurrence, mountainous freeway geometry, real-time weather, and traffic data," Transportation research record, vol. 2280, no. 1, pp. 51–59, 2012.
116. R. Yu, M. Abdel-Aty, and M. Ahmed, "Bayesian random effect models incorporating real-time weather and traffic data to investigate mountainous freeway hazardous factors," Accident Analysis & Prevention, vol. 50, pp. 371–376, 2013.
117. L. Wang, M. Abdel-Aty, J. Lee, and Q. Shi, "Analysis of real-time crash risk for expressway ramps using traffic, geometric, trip generation, and sociodemographic predictors," Accident Analysis & Prevention, vol. 122, pp. 378–384, 2019.
118. A. Pande and M. Abdel-Aty, "Comprehensive analysis of the relationship between real-time traffic surveillance data and rear-end crashes on freeways," Transportation research record, vol. 1953, no. 1, pp. 31–40, 2006.
119. A. Pande, A. Das, M. Abdel-Aty, and H. Hassan, "Estimation of real-time crash risk: are all freeways created equal?" Transportation research record, vol. 2237, no. 1, pp. 60–66, 2011.
120. A. Theofilatos, G. Yannis, P. Kopelias, and F. Papadimitriou, "Impact of realtime traffic characteristics on crash occurrence: Preliminary results of the case of rare events," Accident Analysis & Prevention, vol. 130, pp. 151–159, 2019.
121. L. Lin, Q.Wang, and A.W. Sadek, "A novel variable selection method based on frequent pattern tree for real-time traffic accident risk prediction," Transportation Research Part C: Emerging Technologies, vol. 55, pp. 444–459, 2015.
122. J. Sun and J. Sun, "A dynamic bayesian network model for real-time crash prediction using traffic speed conditions data," Transportation Research Part C: Emerging Technologies, vol. 54, pp. 176–186, 2015.
123. L. Wang, M. Abdel-Aty, Q. Shi, and J. Park, "Real-time crash prediction for expressway weaving segments," Transportation Research Part C: Emerging Technologies, vol. 61, pp. 1–10, 2015.
124. L. Wang, M. Abdel-Aty, and J. Lee, "Safety analytics for integrating crash frequency and real-time risk modeling for expressways," Accident Analysis & Prevention, vol. 104, pp. 58–64, 2017.
125. F. L. Mannering and C. R. Bhat, "Analytic methods in accident research: Methodological frontier and future directions," Analytic methods in accident research, vol. 1, pp. 1–22, 2014.
126. A. Abdulhafedh et al., "Road crash prediction models: Different statistical modeling approaches," Journal of transportation technologies, vol. 7, no. 02, p. 190, 2017.
127. J. Ambros, C. Jurewicz, S. Turner, and M. Kie´c, "An international review of challenges and opportunities in development and use of crash prediction models," European transport research review, vol. 10, no. 2, pp. 1–10, 2018.
128. G. Yannis, A. Dragomanovits, A. Laiou, T. Richter, S. Ruhl, F. La Torre, L. Domenichini, D. Graham, N. Karathodorou, and H. Li, "Use of accident prediction models in road safety management–an international inquiry," Transportation research procedia, vol. 14, pp. 4257–4266, 2016.
129. Y. Xie, J. Allaire, and G. Grolemund, "R markdown: The definitive guide. Boca raton, florida: Chapman; hall/crc," 2018.