Commented Summary of a Year of Work in Covid-19 Statistical Modeling

Jorge Luis Romeu, Ph.D.
https://www.researchgate.net/profile/Jorge_Romeu
http://web.cortland.edu/romeu/; Email: romeu@cortland.edu

1.0 Introduction

In this article we summarize ten months of pro-bono work on statistical modeling of Covid-19 topics. It all started on March 4th, when we wrote a communication to the Grand Lodge of New York, raising our concerns about continuing Lodge meetings, given the speed with which the Coronavirus was spreading from China, to Europe, to New York, California, Washington, etc.

We stated how, in Washington State, 10 deaths were attributed to the virus. Assuming that, if as in China, the death rate were 2%, there could be up to 10/0.02 = 500+ infections. Authorities had identified only 100+. Thence, there existed the possibility of having 400+ cases, still remaining undetected, potentially infecting others. In addition, we provided a numerical example describing how the infection process worked, that made its way to the media and became a video tutorial.

Shortly after, we proposed to the American Statistical Assoc. and American Society for Quality[1] to organize a group of retired members to volunteer with Covid-19 statistical efforts. In April, we wrote the proposal https://web.cortland.edu/matresearch/Covid-19Proposal2020.pdf and started distributing and hanging in ResearchGate, LinkedIn and other Internet forums, our papers.

We started developing statistical models and applications of methods that could illustrate stats; and persuade researchers and practitioners from other professions to include stats in their work, and to invite more statisticians to collaborate with them. These tutorials would also help educate (https://web.cortland.edu/matresearch/CORONAVARUSListEngNov2020.pdf) our leaders and the general public. The material was well-received, according to LinkedIn and ResearchGate hits https://web.cortland.edu/matresearch/SELECTEDREADINGSRESEARCHGATE.pdf

In the rest of this article we summarize the contents and uses of the statistics papers written. In Section 2 we describe the web page we created, and its introductory section. In Section 3 we deal with papers on Design of Experiments and Quality Control Applications. In Section 4, we deal with Reliability and Logistics Applications. In Section 5 we summarize papers in Multivariate Analysis (Principal Components and Discriminant). In Section 6 we overview Stochastic Process papers that implement Markov Chain models. In Section 7, we present Socio-economic analyses of some problems derived from Covid-19. In Section 8, we conclude.

[1] GLNY, the ASA, and ASQ are the three Civil Society organizations we belong to, and work with.

2.0 Introduction, history and basic information:

In this section we present some Basic Information for the Study of the Coronavirus Pandemic and its outbreak, from both historical and sociological, and numerical and medical perspectives.

Regrettably, this Pandemic has been as ill-named as the 1918 Pandemic. Some are labeling it the *Chinese or Kung-Fu virus*, with similar objective as when *1918 Pandemic was* named *Spanish Flu*: https://web.cortland.edu/matresearch/HISTORY%201918%20FLU%20PANDEMIC.pdf

Then, read *The Economist*: https://web.cortland.edu/matresearch/CoronavarusEconomist.pdf
Said article, appearing at the beginning of the Pandemic, analyzes its origin and implications.

We developed an illustrative Numerical Example of the transmission process of the virus:

https://www.researchgate.net/publication/339936386_A_simple_numerical_example_that_illustrates_the_dangesrs_of_the_Coronavarus_epidemic

Said numerical example made its way to the Syracuse newspapers, which adapted it into a U-Tube video for educational use: https://www.syracuse.com/coronavirus/2020/03/how-fast-can-coronavirus-spread-statistics-professor-explains-why-we-need-to-act-now-video.html

My Formal Proposal, asking the retired community of statisticians, academics and researchers, to contribute their time and experience, pro-bono, to help fight the Covid-19 Pandemic is found in: https://www.researchgate.net/publication/341282217_A_Proposal_for_Fighting_Covid-19_and_its_Economic_Fallout

Johns Hopkins University global map, illustrating the world-wide expansion of the Coronavirus https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf6 was included in the web page, for general information.

Similar Information about the spread of Coronavirus infection in the State of New York is in: https://www.syracuse.com/coronavirus-ny/

Covid-19 topics were included in my MFE634 MS Engineering course. Students applied Quality tools to analyze Covid-19 issues: https://web.cortland.edu/matresearch/Covid-19COPQGrp1.pdf and https://web.cortland.edu/matresearch/Coronavirus_Assess_Grp2.pdf and https://web.cortland.edu/matresearch/Covid-19FTAGrp5.pdf

Previous Quality Engineering students also had Experiences with Epidemiology (Ebola & Zika):
https://web.cortland.edu/matresearch/EbolaGageR&R2016.pdf
https://web.cortland.edu/matresearch/2017ZikaVirusFinPres.pdf

Section ends with an Index of our Covid-19 papers, with hits from LinkedIn and ResearchGate:
https://web.cortland.edu/matresearch/SELECTEDREADINGSRESEARCHGATE.pdf

3.0 Design of Experiments (DOE) and Quality Control (SPC) Applications:

In this section we present tutorials on specialized statistical methods such as DOE and SPC that can be successfully applied to the Study of the Coronavirus Pandemic issues.

*This short paper illustrates some practical aspects in the implementation of *Control Charts* for proportions and mean/range, *to assess and monitor* community infection levels of Covid-19.

Monitoring Community Infection Levels of Covid-19 Virus using Quality Control Techniques

https://web.cortland.edu/matresearch/AplicatSPCtoCovid19MFE2020.pdf

*This paper walks the reader through the *detailed implementation of a DOE, to assess* the Effect on *Community Infection Spread*, of Factors Social Distancing, Face Masks and Day Schedule. The data set used was created by the author, using his experience and readings of Covid-19.

Design of Experiments in Identification of Factors impacting Community Spread of Covid-19

https://www.researchgate.net/publication/341532612_Example_of_a_DOE_Application_to_Coronavarius_Data_Analysis

*This paper is *a tutorial on Fractional Factorial DOEs* used *to screen and identify* experimental treatments and characteristics that may affect Covid-19 patients. Designs used include *Plackett-Burnam*, which helps to *reduce the number of experiments* done, saving valuable researcher time and effort. The Covid-19 data was also created by the author, using his experience and readings.

Fractional Factorial DOEs in Identification of medical treatments that reduce Covid19 infection

https://www.researchgate.net/publication/344924536_Design_of_Experiments_DOE_in_Covid-19_Factor_Screening_and_Assessment

4.0 Reliability and Logistics Applications:

In this section we present tutorials on some specialized statistical methods such as *Reliability and Logistics*, which can be successfully applied to *Triage, and to ICU* overcapacity problems.

*Health care facilities require implementing *efficient and effective Logistics* (e.g. ensuring PPEs, support equipment and workers are available). *Failure Modes and Effects Analysis* (FMEAs) and *Fault Tree Analysis* (FTAs) are two valuable *reliability techniques*. Finally, a reliability analysis example illustrates how to establish *efficient replacement schedules* for key ICU equipment.

Design and performance evaluation of ICU units, using Reliability

https://www.researchgate.net/publication/342449617_Example_of_the_Design_and_Operation_of_an_ICU_using_Reliability_Principles

*This *Power Point presentation* provides a quick and simple *introduction to* the techniques of *Fault Tree Analysis* (FTA) and *Failure Mode and Effect Analyses* (FMEA). It includes real examples and the corresponding icons used to build FTAs.

A summary of Fault Tree Analysis (FTA) and Failure Mode and Effects Analysis (FMEA)

https://web.cortland.edu/matresearch/FMEA&FTASumaryS2017.pdf

*We analyze a data set of patients in ICU Ventilators, created to illustrate this *non-parametric survival analysis*. First, we consider patient Ventilator *Time to Death or to Recovery*. We then include patient *covariate information* (e.g. age, number of *Comorbidities*, and if termination was due to death, or to recovery). We analyze the probability of Patient survival, given Ventilator Time, age, Co-morbidities; and strength and direction of covariates effects in patient's Ventilator sojourn. We also implement *Discriminant and Regression Analyses* between recovering and dying Patients, *to assess* which *factors* impact them. The purpose of these procedures is *to help evaluate Triage* in the unfortunate case its application is required, *due to ICU overcapacity*.

An Example of Survival Analysis of Covid-19 using ICU & Patients Ventilator data

https://www.researchgate.net/publication/342583500_An_Example_of_Survival_Analysis_Data_Applied_to_Covid-19

**Clinical Trials* are about assessing the success or failure *of a treatment or vaccine*. In this paper, *industrial sampling plans* are used to help shorten Clinical Trials. We discuss *testing methods* and their *sample size requirements*, then, sampling *plans for attributes* (pass or fail) that follow the Binomial Distribution. We then explore *double and sequential sampling plans*, the Expected *Sample Number (ASN*), that assesses the efficiency of multi-stage sampling plans. We conclude with a *detailed tutorial on sequential probability ratio tests* (SPRTs). We illustrate these plan discussions via *numerical and practical examples*. All these methods can *help accelerate clinical trials* without affecting their quality or reliability.

Statistical Methods to Accelerate Covid-19 Vaccine Clinical Trials using sequential analysis

https://www.researchgate.net/publication/344193195_Some_Statistical_Methods_to_Accelerate_Covid-19_Vaccine_Testing

*This paper provides a *detailed three-step tutorial on Survival Analysis*, applied to the study and assessment of *Life Length of Covid-19 Vaccines*. First, survival analysis was implemented to assess *rate of decay of Vaccine Life Length*, in time, to establish its *Useful Life*. Secondly, we studied how Life may be modified by *population factors* such as *age, socioeconomic conditions, gender,* number of *co-morbidities*, etc. Then, *Discriminant Analysis* between the two vaccinated groups (those later infected with Covid-19, and those that were not) was implemented *to identify* which *factors impacted Vaccine Life and Efficacy*. Finally, a *multiple regression* analysis was implemented *to quantify* such impact. It was determined that, as patient Age and Number of Co-morbidities increases, the length of time (Life Length) and efficacy of the Vaccine diminishes. Such *results* are used to *determine* the *number of Vaccine doses* required *for immunization*.

Survival Methods to Establish Covid-19 Vaccine Life (Length of its Effectiveness)

https://www.researchgate.net/publication/344495955_Survival_Analysis_Methods_Applied_to_Establishing_Covid-19_Vaccine_Life

*In this article we *estimate a health care system* (e.g. hospital, ward, ICU) *load and operating requirements* (number of beds, of doctors, nurses, ventilators, etc.) to successfully cope with a possible system overload, during a given Covid-19 wave. We implement *Poisson and Negative Binomial Distributions* to assess *ICU overflow*, and estimate *Staff and Equipment requirements*. We *simulate patient admissions* using these distribution parameters, obtaining *average, best or worst cases*, evaluating these results using *survival analysis*. We *compare* and discuss *ICU staff and equipment requirements*, estimated under patient overflows, obtaining *Confidence Intervals* with different probabilities of admission. *Probabilities of survival on an ICU*, given patient age and co-morbidities, are estimated, including *expected times to death*. All this *information* may be *used to determine patient allocation* to an ICU and ventilator facility, *in case of Triage*.

Covid-19 ICU Staff and Equipment Requirements using the Negative Binomial

https://www.researchgate.net/publication/345914205_Covid-19_ICU_Staff_and_Equipment_Requirements_using_the_Negative_Binomial

5.0 Multivariate Analysis (Principal Components; Discriminant Analysis):

In this section we present *Principal Components and Discriminant Analysis* statistical *tutorials*, These method can be successfully *applied to Triage, and ICU overcapacity* problems.

*The *analysis* below *uses real data taken from New York State Regions*, released on V/13/20 by NYS authorities. It illustrates the power of *multivariate analysis* in the Coronavirus Pandemic struggle. *A Principal Components* analysis was implemented *to assess* variable *impact* on each Region's infection rate. Principal Components *reduces the number of analysis variables* to a *smaller set of highly significant* ones. A *Discriminant Analysis* was then used to assess which of these variables does a better job of *separating* the *Regions into* those that can *safely open* their economy, and *those that should wait*. Using such variables within *Fisher Discriminant equation*, NYS *regions* can be *periodically re-evaluated*, using subsequently obtained NYS data. This is a preliminary study, subject to further data validation and verification.

Principal Components and Discriminant Analysis of Covid-19 data: Part I

https://www.researchgate.net/publication/341385856_Multivariate_Stats_PC_Discrimination_in_the_Analysis_of_Covid-19

* This *paper is a continuation of* the above *Multivariate Statistics in the Analysis of Covid19.* We use the 62 NYS counties to (1) assess *which metrics* better *separate* them, and (2) obtain an *equation to classify* regions into *high and low risk* groups, according to said metrics. *We use* as *variables* (1) *percent positives* per 10K (of county population) and (2) *deaths* per 10K. We also use, since we don't' have county *population density*, (3) subjective *Urban v. Rural* status. We

implement *Principal Components* to see (1) which *variables* most significantly help *differentiate* between *high and low infection counties*. Then, using such variables, develop (2) *Discrimination Functions to classify NYS counties* into high and low risk groups, according to their Covid-19 metrics. We *use the Principal component scores to* plot the different counties and *evaluate how* counties are *similar* (*clustered*), or *different, according to* variables *Positives and Deaths*.

More on Principal Components and Discriminant Analysis of Covid-19 data: Part II

https://www.researchgate.net/publication/342154667_More_on_Applying_Principal_Components_Discrimination_Analysis_to_Covid-19

*This *Power Point* was used *to present* the two above *Multivariate Analysis papers* to the *Data Science Conference on COVID-19* August 28, 2020. It will help better understand their content.

Principal Components and Discriminant Analysis of Covid-19 data: Power Point

https://web.cortland.edu/matresearch/ApplyPrincCompDSCC-Cov19.pdf

*A *tutorial on* the use *of Logistic Regression* to *identify key factors* in Covid-19 *Clinical Trials*. The data analyzed was produced by this researcher using his experience and information. *We compare Logistics Regression with Discriminant Analysis methods* by analyzing same clinical trial data to identify Covid-19 factors that affect vaccine effects. By either method *we detect the same factors* that differentiate between both infected groups (vaccinated and placebo). This *approach* can be *reproduced by substituting, as responses*, placebo v. vaccinated; by infected v. not infected; by deceased v. surviving; by Vaccine A v. Vaccine B, etc. Researchers *may also use, as factors, other patient characteristics* such as weight, age, gender, occupation, number (or types) of co-morbidities and levels of interaction. We conclude that both Logistics Regression and Discriminant Analysis *results are equivalent*. *Logistics provides* the *probability of* a data *element belonging to* one or the other *group under consideration*. Statistically significant factors identify the *key model components* on which researchers should undertake further research.

Logistic Regression/Discriminant Analysis Identifying key Covid Vaccine Clinical Trial Factors

https://www.researchgate.net/publication/346956247_Logistic_Regression_in_Factor_Identification_of_Covid-19_Vaccine_Clinical_Trials

6.0 Stochastic Processes Applications (Markov Chains):

In this section we present *tutorials on modeling* Covid-19 processes as *Markov Chains*.

**This Markov Chain* is intended to illustrate the power that Markov modeling offers to Covid-19 studies. This article *models the trajectory of Covid-19 infected patients into an ICU*, and up to their death through a Markov Chain. We *first* consider a *simple three-state, recurrent model*. Its *steady state probabilities* are obtained *for an efficient and an inefficient system* and we compare. We *then include* additional *absorbing states*, to account for more complex situations. Using TPM we obtain the (1) *probability of death* of a Patient; and using their sojourns in the different states, (2) their *expected time to death*. The results are useful in establishing (1) *logistic requirements* of health care units, to provide excellent patient care, and (2) some *objective Triage procedures*, if ever such extremes are required. *This Markov Chain* tutorial has been, *by far* (i.e. by the number of hits in its LinkedIn and ResearchGate web pages) *our most read Covid-19 stats report*.

A Markov Chain model to study the spread of the Covid-19 virus

https://www.researchgate.net/publication/343021113_A_Markov_Chain_Model_for_Covid-19_Survival_Analysis

*This *second Markov model* assumes that the *virus will infect* a large part of the *population*, thus preventing further community spread and *yielding Herd Immunization*. Our *previous Markov Chain assumed* there was *neither a vaccine nor a treatment* for Covid-19. Also that, if current infection rates remained unchecked, everyone would eventually die. *This paper assumes* that Covid-19 *survivors become immune*, thence, cannot become re-infected. There is much debate about employing *Herd Immunity* as an alternative *solution for combating Covid-19*. Our *Markov Chain* quantitatively *analyzes such situation*. The model obtains (1) the *probability of* a Patient *death or immunization*. Also, the (2) *expected times to death* (or to immunization) when starting *from different states* in the Space (which can be *used in Triage* situations). Transition rates can help *compare efficient and inefficient strategies*, as well as help *establish* an *acceptable infection rate*. Times spent in a State (Sojourn) help *estimate the required size of health care facilities* that will treat patients. *Statistics* models *help answer* many *health questions*, as well as *compare the performance* of different public health strategies, in a *more objective, non-partisan way*. As George Box, a well known statistician, once said: *all models are wrong; some models are useful*.

A Two-Absorbing-States Markov Chain to study the problem of Covid-19 Herd Immunization

https://www.researchgate.net/publication/343345908_A_Markov_Model_to_Study_Covid-19_Herd_Immunization

*This *Markov Model* studies the dilemma of *Re-opening Colleges under Covid-19*. We analyze the situation using a Markov Chain defined over *a nine element state space* that moves through a set of Transient states, eventually leading *to two Absorbing States*: *Expulsion or Coursework Completion*. The *model*, due to its specific State Spaces and transition probabilities is very *useful to compare reopening plans*. Through the infection (transition) rates we study their impact on the *probabilities of Expulsion and Course Completion*. Differing infection rates depend on student *compliance with community public health measures* such as face covering, social distancing, etc. By assigning different values to these rates, *their impact can be assessed and compared*. Once updated and fine tuned (or rebuilt) Markov *models can be used by college authorities* to re-assess and improve their reopening plans, *by faculty and students*, to assess their risks in such openings, *and by government authorities*, to assess the validity and safety of such plans, thus allowing or proscribing them. This *model* can *also* be *modified to assess* re-opening the *public school system*.

A Markov Chain to study the problem of Re-opening Colleges under Covid-19

https://www.researchgate.net/publication/343825461_A_Markov_Model_to_Study_College_Re-opening_Under_Covid-19

**U-Tube* recording of the *Applications in Using Blended Data Workshop*, sponsored by the *ASA Government and Social Statistics Sections*. Our *Markov Chain presentation* is the last one.

GSS/ASA Workshop (U-Tube) on Covid-19 (our Markov Chain presentation is *the last one)*

https://www.youtube.com/watch?v=ByGEUGbU_JU&feature=youtu.be

*This *Markov model* assesses different *patterns of vaccination*, which may *affect* achieving (or not) *Herd Immunity*. The urgency of this paper stems *from polls suggesting* a significant number of *people are not willing to become vaccinated*. Herd Immunity can be acquired by (a) letting the virus infect most of the population. Weaker ones (the elderly, those with co-morbidities etc.) will die) and those surviving will become immunized; alternatively, (b) by vaccinating a large part of the general population. In either case, *the majority of the population must be actively involved*. Vaccination carries two aspects: one is individual and the other social. First, the *vaccine protects the individua*l. Secondly, if enough individuals in the general population are vaccinated, the *activity has an effect over the Pandemic*. With few new customers to infect, the virus starves and disappears. If not enough people become vaccinated, this latter benefit is lost. By *changing* the *vaccination parameters* (e.g. infection rates, participation and immunization percentages), model results will differ, allowing the *comparison of different public health strategies*.

A Markov Model to Assess Covid-19 Vaccine Herd Immunization Patterns

https://www.researchgate.net/publication/347441411_A_Markov_Model_to_Assess_Covid-19_Vacine_Herd_Inmunization_Patterns

7.0 Socio-economic Analyses of Problems derived from Covid-19:

In this section we overview four papers that deal with *conceptual issues that affect* the input or the interpretation of the statistical analysis *of Covid-19 problems*.

*This paper discusses how the *Off-shoring American jobs* during a quarter of a century, was one of the main causes that triggered *the election of President Donald Trump*. His *initial handling* of Coronavirus Pandemic was *not efficient*. In addition, *Off-shoring affected* many industries that could have provided *essential materials* to help in the fight against Covid-19. The *result* was that, the *number of Covid-19 infections and deaths* was *possibly larger* than it should have been.

Fallouts of Off-Shoring (outsourcing) and Tax payers' contributions, to Coronavirus Pandemic

https://www.researchgate.net/publication/341685776_Off-Shoring_Taxpayers_and_the_Coronavarus_Pandemic

*This paper discusses the *implication that if African-Americans and Hispanics* were *impacted by Covid-19 above their population representation* it was *because* something *genetic* was involved. We indicate how *it may not be race or ethnicity but poverty* and other negative social conditions, such as insufficient or no health care, poor living conditions, working in high risk jobs, living in overcrowded quarters, what causes these populations to become infected in larger percentages. Notice and *compare how, middle and upper class African-American and Hispanics* are affected in *equivalent numbers*, as *their middle and upper class peers in mainstream white America*.

A Digression on the Interaction between Race, Ethnicity, Class and Coronavirus.

https://www.researchgate.net/publication/343700072_A_Digression_About_Race_Ethnicity_Class_and_Covid-19

*We digress about *Covid-19 vaccine accelerated Clinical Trials* and the early release by CDC of several candidate vaccines made possible by application of new techniques. Two previous papers https://www.researchgate.net/publication/344495955_Survival_Analysis_Methods_Applied_to_Establishing_Covid-19_Vaccine_Life and statistical methods for more efficient vaccine testing: https://www.researchgate.net/publication/344193195_Some_Statistical_Methods_to_Accelerate_Covid-19_Vaccine_Testing are of interest. *Some drawbacks* on early release stem from limited testing time: failure to identify some *side-effects*, especially long-term ones; failure to determine *the time length* of immunization provided, or the *particular cohorts* (e.g. elderly) that each of the vaccines will benefit (or hurt). The world needs *a working vaccine*, even with potentially minor problems. In a couple of years of world-wide vaccination we *will* all *achieve heard immunity*.

A Digression about Aspects of Clinical Trials for the new Vaccine against Covid-19.

https://www.researchgate.net/publication/346305686_A_Digression_on_Covid-19_Vaccine_Clinical_Trials_and_its_Consequences

*The *search for a Covid-19 vaccine* was a complete *success*! However, the *US rollout* of such vaccines has proven *a failure*. Such poor rollout suggests the *need to re-examine its approach*, and *redefine some of its methods*. For comparison, *in June of 1944* the Allied army successfully landed in *Normandy*. Over 1,200 aircraft and more than 5,000 vessels carrying 160,000 troops, medical supplies, water, food, ammunition, etc. were moved in a few days. *Operations Research, the technique* that made possible the invasion's *essential Logistics, was born*. The *political and military leaders* had the brilliance of *establishing the key goals* of the military operation, while *letting OR people* take care of *the technical details of its logistics implementation*. This article provides *examples of proven OR, logistics and quality engineering techniques* that have been *successfully applied to improve many situations*. Some of the *methodology presented* in this paper, may also *help improve* the current *Vaccine rollout performance*.

A Digression on Covid-19 Vaccine Rollout.

https://www.researchgate.net/publication/348607971_A_Digression_on_Covid-19_Vaccine_Rollout

8.0 Discussion & Conclusions

The work reported here was done between March 4, 2020 and February 3, 2021. In those eleven months, this researcher wrote *over two dozen papers, reports and tutorials*, on Covid19 issues.

We followed *Eight Steps in developing* each of our Covid-19 oriented, *statistical papers*:

1. Select a current Covid-19 topic of interest
2. Research the topic from a Public Health perspective
3. Select a statistical method to deal with this topic
4. Review the statistical method to be used
5. Find/develop an appropriate data set for analysis
6. Analyze the data with stated method
7. Obtain the Results and Conclude
8. Distribute the information (web, institutions etc)

The reader may estimate the *number of hours invested in this effort*. Certainly, we have put in several hundred hours of pro-bono work to help defeat Covid-19. We hope it has contributed.

Combining the results from the Markov Chains, Survival, and Multivariate Analyses, as well as other methods used in this series, *may provide tools* for public health and other professionals to *help establish rules for Triage* procedures, if such situation ever becomes necessary.

In our work we want to *reach four audiences*: (1) *public health* professionals and researchers, (2) *medical doctors*, (3) *statisticians* and (4) *the public* in general.

We want to *encourage public health and medical professionals to* use more statistical procedures and *do more joint work with statisticians* -not only after data have been collected, but also at the time that the experiments are being designed

We want to encourage statisticians, especially those retired, who have the experience, financial support (their pension), and the time to provide such assistance, *to contribute in helping with the planning, implementation and analysis* of statistical procedures –or with writing about them.

We want to provide illustrative examples to doctors, public health researchers, government, and general public, to help them better understand what others do, *fostering greater collaboration*.

Finally, *this series of papers on statistical analysis of Covid-19* problems can *become part of a biostatistics course* in a public health or medical curriculum, or of an *applied modeling and data analysis graduate course, in a statistics department*.

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Alternative access to these Covid-19 papers:

Quality, Reliability and Continuous Improvement Institute applied statistics web site: QR&CII https://web.cortland.edu/romeu/QR&CII.htm (In English)

Instituto de Estadistica Aplicada y Mejora Continua applied statistics web site: IEA&MC https://web.cortland.edu/matresearch/QR&CIInstPg.htm (In Spanish)

Coronavirus Page: https://web.cortland.edu/matresearch/CORONAVARUSListEngNov2020.pdf

About the Author:

Jorge Luis Romeu retired Emeritus from the State University of New York (SUNY). He was, for sixteen years, a Research Professor at Syracuse University, where he is currently an Adjunct Professor of Statistics. Romeu worked for many years as a Senior Research Engineer with the Reliability Analysis Center (RAC), an Air Force Information and Analysis Center operated by IIT Research Institute (IITRI), and Quanterion Solutions (QSI). Romeu received seven Fulbright assignments: in Mexico (3), the Dominican Republic (2), Ecuador, and Colombia. He holds a doctorate in Statistics/O.R., is a Chartered Stat. Fellow, of the Royal Statistical Society, a Senior Member of the American Society for Quality (ASQ), and a Member of the American Statistical Association. He is a Past ASQ Regional Director (currently a Deputy Regional Director), and holds ASQ Reliability and Quality Professional Certifications. Romeu created and directs the Juarez Lincoln Marti International Ed. Project (JLM, https://web.cortland.edu/matresearch/), which (i) supports higher education in Ibero-America, and (ii) maintains the Quality, Reliability and Continuous Improvement Institute (QR&CII, https://web.cortland.edu/romeu/QR&CII.htm) applied statistics web site.