Mathematics, physics, computer science, game theory – Jasmine revolution, Anna protest, terror strikes, food riots. Elegant scientific theories and techniques are being increasingly used to predict and analyse large and messy social conflicts. The 'new social science' can be surprisingly accurate and useful. India is taking baby steps in a field that can revolutionise public policy.

The Mathematics of Anger & Hope

:: Hari Pulakkat

Media reports are superficial sources of information for scholarly pursuits, but only when seen through human eyes. Kalev Leetaru, a text analytics specialist at the University of Illinois, put a set of media reports under the penetrating gaze of Nautilus, a supercomputer based at the University of Tennessee. The computer analysed 30 years of data from around the world, containing 100 million news reports, 10 billion names and activities and 100 trillion relationships.

Leetaru was looking for a method to forecast large-scale human behaviour, and he thought he found it at the end of his analysis. He had looked deeply at the tone and frequency of words used in news reports. He was particularly interested in spikes of negative sentiment, which he closely associated with an imminent revolution. He found such sentiments in the days leading up to the recent revolutions in Tunisia, Egypt and Libya. They were no coincidence, according to him. Several other major events – the 1990s ethnic conflict in the Balkans, for example – were also associated with spikes in negative sentiment.

Half a Million DVDs

"People do not wake up on a Friday morning and decide to start a riot," says Leetaru, who is assistant director for text and digital media analytics at the Institute for Computing in the Humanities, Arts, and Social Science at the University of Illinois. “There is a long slide towards such events.” The fate of Hosni Mubarak is one of Leetaru’s prime exhibits. “Everyone said he would last the revolution because he had lasted 30 years. But analysis showed that this revolution was different.”

Leetaru had measured the density of emotional language. Algorithms helped him score words for their emotional weight and then classify them as positive or negative. He also analysed the results in statistical terms and threw up results that looked like a stock price graph. Leetaru could then easily spot the spikes in collective national emotion, which are usually evident before an extreme event takes place.

Leetaru now applies his textual mining skills to understand global social problems. Social science did not have such specialists till recently because the world had no data to analyse. The advent of digitised text and then the social media and Twitter has put in front of computer scientists an enormous amount of information to analyse. And advances in computing technology have given them the ability to analyse this information quickly.

Thirty years worth of media coverage consisted of 2.4 petabytes of data, roughly equal to half a million DVDs or 20 billion

TOMORROW'S HEADLINES, MODELLLED TODAY
pictures, but modern computers can cut through this mountain easily. And such data analysis is now throwing up surprising facts about human behaviour. “Collective human behaviour is more predictable than we thought,” says Aaron Clauset, assistant professor of computer science at the University of Colorado in Boulder.

Probability of Another 9/11
Clauset is a computational scientist. Computation is a step ahead of data mining, in that it simulates events and gives predictions and forecasts. Clauset has been analysing a problem that is now on top of everyone’s minds: global terrorism. Specifically, he has been using contemporary statistical methods to investigate the probability of big terrorist attacks.

A terrorist attack is as random an event as you can get, and yet Clauset has found patterns over the years that can be used to forecast big ones. “Forecasting is different from prediction,” says Clauset. “You can’t predict the next earthquake but you can predict it.” Geophysicists forecast earthquakes in terms of probabilities within a specific time window. They can never say that an earthquake will strike a specific place at a specific time, but the forecast can give enough data to prepare a response when it finally strikes. Similarly, Clauset thinks that global terrorism forecasts can help governments to prepare responses for big terrorist attacks.

In the year 2000, Mitre Corporation in the US finished a study on rare events commissioned by the US Department of Defence. Mitre undertakes public-interest sponsored research. It found that an event like 9/11 has a 7% probability of occurring, and a 30% probability over the next 10 years. Computation developed by Clauset to calculate these probabilities, but India still lags behind in the field. Mitre plans to study complex social behaviour.

Computational methods are providing surprising insights about social outcomes.

WHAT IS COMPUTATIONAL SOCIAL SCIENCE?
■ There’s vast data about people & behaviour patterns
■ Modern computers can analyse vast amounts of data
■ Scientists have the tools to study complex systems
■ Some scientists are applying these tools to study complex social behaviour
■ Computational methods are providing surprising insights about social outcomes

HOW CAN YOU FORECAST TERRORIST STRIKES?
■ Terrorist strikes have happened over many decades
■ This history creates a rich database
■ Data analysis shows that they follow maths laws
■ Using these laws, one can calculate the probability of a terrorist strike of specific magnitudes
■ These forecasts, when fully developed, can be useful for preparing responses

ARE FOOD RIOTS RELATED TO US HOUSING BUBBLE?
■ As the bubble bursts, money moves to the stock market
■ As the stock market booms and crashes, money moves to commodities
■ Commodity speculation increases global food prices
■ High food prices add to the vulnerability of populations that are already stressed
■ Such vulnerable populations start rioting

The Economic Times on Sunday
Mishita Mehra, a professor at the University of Southern California, for instance, has written papers on how randomised checkpoints can be set up in Mumbai (or any other city). “Humans tend to fall into predictable patterns and checking in a randomised fashion can be applied to any situation, say, like drug trafficking and this has great potential for controlling corruption and crime,” he says. Tambe has also addressed several police officers and Central Industrial Security Force personnel at a seminar at the Mumbai airport in June 2010.

What makes him an authority on the subject? Tambe developed a model using game theory that is currently deployed at various airports and ports in the US. According to him, policymakers want a security strategy that is unpredictable, yet covers important targets more frequently, and simultaneously takes into account how the adversary will react. “Game theory provides a mathematical solution to this problem. It’s like mathematically solving a problem where they give me the basic parameters, and I just use my computer science expertise to give them an answer based on their own inputs,” he adds.

Push from the West

Given that game theory has been around a lot longer in the West – after all John Nash, slyly played by Russell Crowe in the Hollywood hit, *A Beautiful Mind*, was talking about it back in the 1950s – most of the eyerowiselyaking work is taking place there. Consider Alvin Roth, professor of economics and public administration, Harvard. Roth has helped design a number of market systems and businesses. He has also published several books on game theory. His classic text, *The Economics of Matchmaking*, sold over 65,000 copies and was translated into 20 languages. “The book is in response to a question I was asked in 1994, ‘What’s the right way to allocate medical residency spots?’” Roth explains. “We’ve been using the system for over a decade.”

**WHERE THEORY WORKED**

**US PORTS AND AIRPORTS**

Security checks became smarter

**3G SPECTRUM AUCTION IN INDIA**

Allocation was dispute-free

**SOME SCHOOLS, HOSPITALS IN US**

Supply of doctors was matched to demand. Same for students & schools

**CRIME FIGHTING**

NYPD reduced muggings

**CHICKEN GAME**

Two cars are going to collide unless one driver swerves. The best outcome for each driver is that the other one swerves out. A crash is the worst outcome for both. Game theory predicts either driver will refuse to change course and will both play chicken. Neither driver trusts the other to change course. So, neither can assume the crash won’t happen. The insight here is that in a confrontation, players can use the fact even one of them backing down can mean he and everyone else will be better off. In public policy, this leads to rules that can anticipate if or when bad guys will back down.

**PRISONER’S DILEMMA**

Two murder suspects are told if they both confess, they’ll get a favourable treatment. If one confesses, they’ll spend a short term in jail – as long as it’s not for court to hear the case. The evidence is not strong. However, if both confess, and the other doesn’t, the squealer walks, while the other gets the maximum penalty. The best outcome for them is that both keep mum. But if they don’t trust each other, both will confess. And both will be worse off. That’s what game theory predicts. The actual individuals can try to be better off and end up being worse off. In other terms, this means good guys must learn to trust each other.

**THE WAY FORWARD**

“I think game theory is very useful... but using game theory for policy purposes involves lots of careful modelling and attention to detail,” cautions Harvard’s Roth. All models are simplifications of reality; they can go wrong on occasions if their assumptions fit poorly with real-world conditions or if the data quality is low. But then, as Mishita says, this problem is not so much a game theory problem. “Game theory makes strong but transparent and explicit assumptions while many other means of making forecasts are purely judgemental and not transparent,” he adds.

India may have been slow off the blocks but is trying to catch up. Many organisations have begun research in the field. For instance Tata Consultancy Services’ innovation lab in Delhi is doing game-theoretic research. The company declined to comment on the details of the research. This reticence is fairly common among India’s few practitioners of game theory’s public-policy applications and it is largely informed by the nascent stage of research. But there could be plenty to talk about soon.