"The CAS Class of 2011 Network: NYU’s leading edge"

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THE NYU CAS CLASS OF 2011 NETWORK

Edges/Links = CAS students
Nodes = Major and Minor disciplines of each student
Node color = Blue (Science), Yellow = (Social Science), Red = (Humanities), Other (Interdisciplinary)

[First, I would like to thank President Sexton, Dean Santirocco and Dean Benhabib for making NYU what it is today, a place where we all want to be. I thank Ken Kidd and Ryan Pointer for providing me with data on the CAS graduates. I also note that some of the remarks I will make today are based on writings by Albert Barabasi\(^1\) and Duncan Watts\(^2\).]

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In this, the year of the Social Network, you are graduating from the hub of NYU’s Global Network University. And today, I christen you the NYU CAS Class of 2011 Network, a network that you formed during these past four years through the connections that you made with each other and between the wonderful array of disciplines that NYU scholars and students pursue.
As it turns out, the formation of networks is itself a discipline that is applied to social, financial, and even biological situations. At NYU’s Center for Genomics and Systems Biology, we genome scientists analyze gene networks in order to decipher the extremely complex ways in which genes interact, not only in the functioning of an organism, but also in the creation of biological diversity.

In our studies of gene interactions, we have found that diversity among species or individuals, or even susceptibility to disease, is not the result of a simple difference in a single gene - a mutation, for example --, but rather due to the changes caused by altered or missing interactions between that gene product and the rest of its interacting partners in the genome.

In anticipation of today, I had the idea of applying what we have learned about networks in biological systems to reveal the intricacies of interactions in another complex organism, New York University.

Importantly, the network programs\(^3\) that I used to create and analyze the NYU CAS Class of 2011 Network are exactly the same ones that we genome scientists use to analyze genetic regulatory networks at NYU’s Center for Genomics and Systems Biology, which – thanks to leaders like John Sexton – will celebrate its opening on June 1st.

“But first, what are networks, and how is it that assembling a large collection of components into a complex system such as a network results in something more than, and altogether different from, its components? What makes networks so complex is that the parts making up the whole don’t sum up in any simple fashion. Rather, they interact with each other, and in interacting, even quite simple components can generate complex behavior.”\(^2\)

“A perfect example, close to our hearts is the sequence of the human genome. This DNA sequence revealed that the basic code of all of human life consists of only about 30,000 genes. So, where does all the complexity of human biology come from? Clearly, it is not from the total number of genes, which is barely greater in humans than in the simplest of organisms. Nor does it come from the complexity of the individual components of the genes, which could scarcely be simpler: four chemical DNA bases - G, A, T, and C. Rather, it derives from the simple fact that individual genes, like people, function by interacting, and that the patterns of interactions can display almost unlimited complexity.”\(^2\)

The way that scientists study the interactions of genes in a genome, is exactly the way we can approach understanding the role of people in a social network, workers in an organization, or the network of students in the CAS graduating class.

But first, let’s look at how to construct a network. Networks are made up of nodes and the connections between them are called links or edges.

“In all networks, when you add enough links so that each node has an at least one link, a miracle happens -- a unique giant cluster emerges, such that starting from any node, one can get to any other node by navigating along the links between the nodes. Mathematicians call this phenomenon the “emergence” of a network and physicists call it a “percolation.” It is equivalent to a phase transition, similar to the moment when water freezes. So, we can think of network formation as a crystallization. Sociologists will tell you that when this crystallization happens, the subjects of their study just formed a community. And that is when the network drastically changes. Before, we had a bunch of tiny isolated clusters of nodes, disparate groups of people who communicated only within their isolated clusters. After achieving the critical one link per node, we now have a giant cluster formed by almost everybody.”\(^1\)
“However, real-world networks are connected well beyond the minimum of one link per node. Nature plays it smart by going way past the minimum, and so, the natural networks around us are not just webs, they are densely connected networks within which every node is navigable – and every node in the network is connected either directly or indirectly by a short path length. That is why all the molecules in the human body are integrated into a single complex cellular network, whose components and structure we - in the field of Systems Biology- aim to reveal.”

So, now that you have had a mini-class in network analysis – let’s learn about the properties of the NYU CAS Class of 2011 Network. In constructing this network, I made each of you CAS students the “edges” or the “links” that connect the disciplines of your majors and minors.

The analysis of this network shows that although you arrived at NYU in 2007 as 1,657 individuals from 50 states and 35 different countries, that during these past four short years, you formed a dense, small-world, highly-connected network composed of 1,374 links or ‘edges” connecting a whopping 102 disciplines across all departments and divisions of CAS.

In a nutshell, your graduating class created a dense network in which all disciplines and all departments have achieved that complete connectivity, so that the whole of CAS is much more than the sum of its parts. Surprisingly, the large majority of you formed links that crossed the fundamental academic divisions: Science, Social Science, and Humanities.

Two other related aspects of the dense CAS network you formed are particularly notable. First, within every division there is at least one department that forms a hub, with large numbers of student “edges” spanning network connections across all of the three academic divisions. These hubs not only make the network resilient, but they are also largely responsible for the extremely short path length (or distance) between any two random nodes in the CAS network.

In fact, the resulting CAS network is so highly connected –more highly connected than any network I have yet studied in nature--- that it has an extremely small path length--- that is, any two disciplines are connected either directly by at least one student “edge,” or indirectly by an average of 2.4 student “edge” connections.

Second, I would like to highlight the CAS 2011 graduating students that I call the “edges of one”. This relates to 264 of you who forged a unique and singular link between new and emerging disciplines. These new links that you created between new emerging nodes are critical to the evolution and future growth of the network that we call a university.

Finally, as you graduate today, you now become part of a larger network, one in which your NYU experience makes you a leading edge in forging new connections across a global network that will help transform the world.

Congratulations to you all.

Citations:
1. Adapted from Albert-Lazlo Barabasi, “Linked”, Published by Plume (a Penguin Group)
2. Adapted from Duncan Watts, “Six Degrees”, Published by Norton.
3. CAS Network created using “Cytoscape” software.