Connected

The Surprising Power of Our Social Networks and How They Shape Our Lives

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For Erika, Sebastian, Lysander, and Eleni

and

for Harla, Lucas, and Jay

to whom our connection is aeonian

Contents

CHAPTER 1

In the Thick of It

In the mountain village of Levie, Corsica, during the 1840s, Anton-Claudio Peretti became convinced that his wife, Maria-Angelina, was having an affair with another man and that, even worse, their daughter was not his child. Maria told Anton that she was going to leave him, and she made preparations to do so with her brother, Corto. That very evening, Anton shot his wife and daughter to death and fled to the mountains. The bereft Corto sorely wanted to kill Anton, but he could not find him. In a bit of violent symmetry that seemed sensible to residents of the area, Corto instead killed Anton's brother, Francesco, and nephew, Aristotelo.

It did not end there. Five years later, Giacomo, brother of the deceased Aristotelo, avenged the deaths of his brother and father by killing Corto's brother. Giacomo wanted to kill Corto's father too, but he had already died of natural causes, denying Giacomo the satisfaction.[1] In this cascade of death, Giacomo and Corto's brother were connected by quite a path: Giacomo was the son of Francesco, who was the brother of Anton, who was married to Maria, who was the

sister of Corto, whose brother was the target of Giacomo's murderous wrath.

Such behavior is not restricted to historically or geographically distant places. Here is another example, closer to home: Not long before the summer of 2002 in St. Louis, Missouri, Kimmy, an exotic dancer, left a purse containing $900 in earnings with a friend while she was busy. When she came back to reclaim it, her friend and the purse were gone. But a week later, Kimmy's cousin spotted the purse thief's partner at a local shop, and she called Kimmy. Kimmy raced over with a metal pole. She viciously attacked this friend of her erstwhile friend. Later she observed with pride that she had "beat her [friend's] partner's ass.... I know I did something...[to get even] that's the closest thing I could [do]."[2]

Cases like these are puzzling. After all, what did Anton's brother and nephew and Kimmy's friend's friend have to do with anything? What possible sense is there in injuring or killing the innocent? Even by the incomprehensible standards of murderous violence, what is the point of these actions, taken one week or five years later? What explains them?

We tend to think of such cases as quaint curiosities, like Appalachian feuds, or as backward practices, like the internecine violence between Shiite and Sunni tribesmen or the cycle of killings in Northern Ireland or the reciprocating gang violence in American cities. But this grim logic has ancient roots. It is not just that the impetus to revenge is ancient, nor even that such violence can express group solidarity ("we are Hatfields, and we hate McCoys"), but that violence—in both its minor and extreme forms—can spread through social ties and has done so since humans emerged from the African savanna. It can spread either in a directed fashion (retaliating against the perpetrators) or in a generalized fashion (harming nondisputants nearby). Either way, however, a single murder can set off a cascade of killings. Acts of aggression typically diffuse outward from a starting point—like a bar fight that begins when one man swings at another

who ducks, resulting in a third man getting hit, and soon (in what has become a cliché precisely because it evokes deep-seated notions of unleashed aggression) punches are flying everywhere. Sometimes these epidemics of violence, whether in Mediterranean villages or urban gangs, can persist for decades.[3]

Notions of collective guilt and collective revenge that underlie cascades of violence seem strange only when we regard responsibility as a personal attribute. Yet in many settings, morality resides in groups rather than in individuals. And a further clue to the collective nature of violence is that it tends to be a public, not a private, phenomenon. Two-thirds of the acts of interpersonal violence in the United States are witnessed by third parties, and this fraction approaches three-fourths among young people.[4]

Given these observations, perhaps the person-to-person spread of violence should not surprise us. Just as it is often said that "the friend of my friend is my friend" and "the enemy of my enemy is my friend," so too the friend of my enemy is my enemy. These aphorisms encapsulate certain truths about animosity and affection, but they also convey a fundamental aspect of our humanity: our connection. While Giacomo and Kimmy acted alone, their actions show just how easily responsibility and retaliation can diffuse from person to person to person across social ties.

In fact, we do not even have to search for complicated paths across which violence spreads, because the initial step, from the very first person to the next, accounts for most of the violence in our society. In trying to explain violence, it is myopic to focus solely on the perpetrator—his frame of mind, his finger on the trigger—because murder is rarely a random act between strangers. In the United States, 75 percent of all homicides involve people who knew each other, often intimately, prior to the murder. If you want to know who might take your life, just look at the people around you.

But your social network also includes those who might save your life. "On March 14, 2002, I gave my right kidney to my best friend's

husband," Cathy would later note in an online forum that chronicles the experiences of people who become "living donors" of organs. The summer before, during a heartfelt chat, Cathy had learned that her friend's husband's renal failure had worsened and that he needed a kidney transplant in order to survive. Overcome with the desire to help, Cathy underwent a series of medical and psychological evaluations, getting more and more excited as she passed each one and moved closer to her goal of donating one of her kidneys. "The experience has been the most rewarding of my life," she wrote. "I am so grateful that I was able to help my best friend's husband. His wife has her husband back. His sons have their dad back.... It's a win-win situation. We all win. I gave the gift of life."[5]

Similar stories abound, and such "directed donations" of organs can even come to involve people who have rather tenuous connections, a Starbucks clerk and his longtime customer, for example. There can even be organ-donation cascades that loosely resemble the Perettis' murder cascade. John Lavis, a sixty-two-year-old resident of the town of Mississauga, Ontario, father of four and grandfather of three, was dying of heart failure in 1995. His heart had failed during triple-bypass surgery, and he was placed on a temporary artificial heart. In a stroke of unbelievable good fortune, a donor heart was transplanted into him just eight days later when he was on the brink of death. His daughter recalled: "We were a family of immense gratitude.... [My father] received the biggest gift he will ever receive—his life was given back to him." Motivated by this experience, Lavis's children all signed organ-donor cards, thinking that this symmetrical act was the least they could do. Then in 2007, Lavis's son Dan died in a work-related accident. Eight people benefited from Dan's decision to donate his organs. The woman who received his heart later wrote to the Lavis family, thanking them for "giving her a new life."[6] The same year in the United States, a similar cascade an amazing ten links long took place between unrelated living kidney donors (albeit with explicit medical coordination), saving many lives along the way.[7]

Social-network ties can—and, as we will see, usually do—convey benefits that are the very opposite of violence. They can be conduits for altruistic acts in which individuals pay back a debt of gratitude by paying it forward. The role that social connections can play in the spread of both good and bad deeds has even prompted the creation of novel strategies to address social problems. For example, programs in several U.S. metropolitan areas involve teams of "violence interrupters." These streetwise individuals, often former gang members, try to stop the killing by attempting to break the cycle of transmission. They rush to the bedsides of victims or to the homes of victims' families and friends, encouraging them not to seek revenge. If they can persuade just one person not to be violent, quite a few lives can be saved.

Our connections affect every aspect of our daily lives. Rare events such as murder and organ donation are just the tip of the iceberg. How we feel, what we know, whom we marry, whether we fall ill, how much money we make, and whether we vote all depend on the ties that bind us. Social networks spread happiness, generosity, and love. They are always there, exerting both subtle and dramatic influence over our choices, actions, thoughts, feelings, even our desires. And our connections do not end with the people we know. Beyond our own social horizons, friends of friends of friends can start chain reactions that eventually reach us, like waves from distant lands that wash up on our shores.

Bucket Brigades and Telephone Trees

Imagine your house is on fire. Luckily, a cool river runs nearby. But you are all alone. You run back and forth to the river, bucket in hand, toting gallon after gallon of water to splash on your burning home. Unfortunately, your efforts are useless. Without some help, you will not be able to carry water fast enough to outpace the inferno.

Now suppose that you are not alone. You have one hundred neighbors, and, lucky for you, they all feel motivated to help. And

each one just happens to have a bucket. If your neighbors are sufficiently strong, they can run back and forth to the river, haphazardly dumping buckets of water on the fire. A hundred people tossing water on your burning house is clearly better than you doing it by yourself. The problem is that once they get started your neighbors waste a lot of time running back and forth. Some of them tire easily; others are uncoordinated and spill a lot of water; one guy gets lost on his way back to your house. If each person acts independently, then your house will surely be destroyed.

Fortunately, this does not happen because a peculiar form of social organization is deployed: the bucket brigade. Your hundred neighbors form a line from the river to your house, passing full buckets of water toward your house and empty buckets toward the river. Not only does the bucket brigade arrangement mean that people do not have to spend time and energy walking back and forth to the river; it also means that weaker people who might not be able to walk or carry a heavy bucket long distances now have something to offer. A hundred people taking part in a bucket brigade might do the work of two hundred people running haphazardly.

But why exactly is a group of people arranged this way more effective than the same group of people—or even a larger group—working independently? If the whole is greater than the sum of its parts, how exactly does the whole come to be greater? Where does the "greater" part come from? It's amazing to be able to increase the effectiveness of human beings by as much as an order of magnitude simply by arranging them differently. But what is it about combining people into groups with *particular configurations* that makes them able to do more things and different things than the individuals themselves?

To answer these questions, and before we get to the fun stuff, we first need to explain a few basic terms and ideas of network theory. These basic concepts set the stage for the individual stories and the more complicated ideas we will soon explore as we investigate the

surprising power of social networks to affect the full spectrum of human experience.

We should first clarify what we mean by a group of people. A *group* can be defined by an attribute (for example, women, Democrats, lawyers, long-distance runners) or as a specific collection of individuals to whom we can literally point ("those people, right over there, waiting to get into the concert"). A social network is altogether different. While a network, like a group, is a collection of people, it includes something more: a specific set of connections between people in the group. These ties, and the particular pattern of these ties, are often more important than the individual people themselves. They allow groups to do things that a disconnected collection of individuals cannot. The ties explain why the whole is greater than the sum of its parts. And the specific pattern of the ties is crucial to understanding how networks function.

The bucket brigade that saves a house is a very simple social network. It is linear and has no branches: each person (except the first and last) is connected to two other people, the one in front and the one behind. For moving something like water long distances, this is a good way to be organized. But the optimal organization of one hundred people into a network depends very much on the task at hand. The best pattern of connections between a hundred people to put out a fire is different from the best pattern for, say, achieving a military objective. A company of one hundred soldiers is typically organized into ten tightly interconnected squads of ten. This allows each soldier to know all of his squad mates rather than just the grunt in front of him and the grunt behind him. The military goes to great lengths to help squad members know each other very well, so well in fact that they are willing to give their lives for one another.

Consider still another social network: the telephone tree. Suppose you need to contact a hundred people quickly to let them know that school is canceled. Before modern communications and the Internet, this was a challenge because there was no public source of up-to-the-minute information that everyone could access from their homes

(though the ringing of church bells in the town square comes to mind). Instead, each person needed to be contacted directly. The telephone made this task much easier, but it was still a burden for one person to make all one hundred calls. And even if someone set out to do this, it might take quite a while to get to the people at the end of the list, by which time they may have already left home for school. Having a single person make all the calls is both inefficient and burdensome.

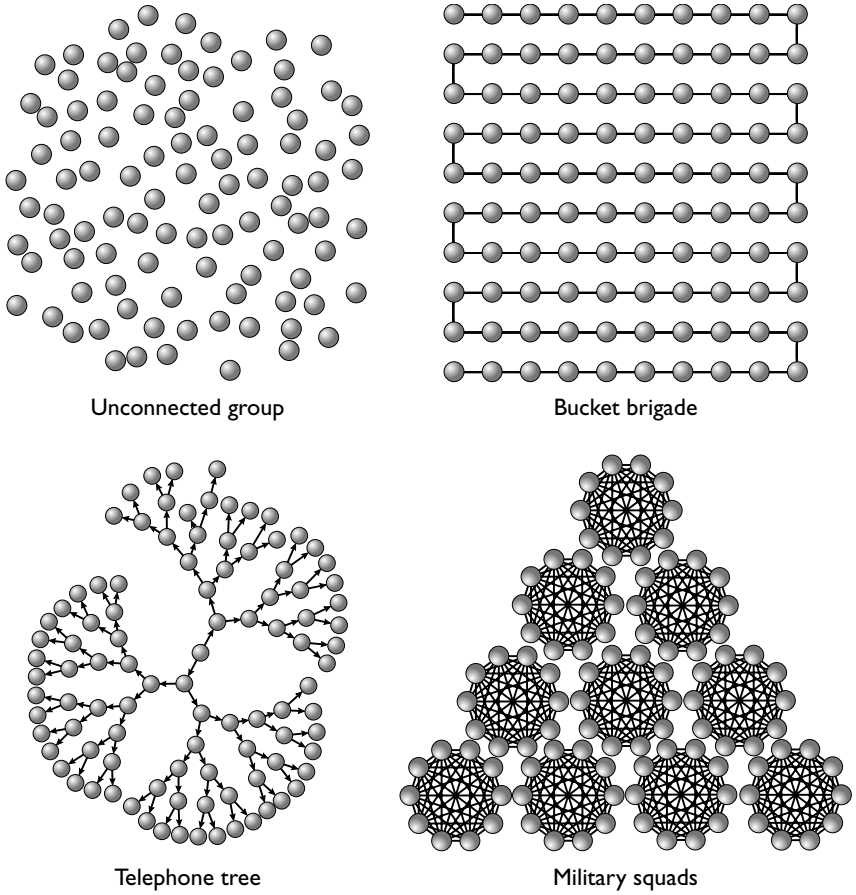
Ideally, one person would set off a chain reaction so that everyone could be reached as quickly as possible and with the least burden on any particular individual. One option is to create a list and have the person at the top of the list call the next person, the second person call the third, and so on until everyone gets the message, as in a bucket brigade. This would distribute the burden evenly, but it would still take a really long time for the hundredth person to be reached. Moreover, if someone in the sequence was not home when called, everyone later in the list would be left in the dark.

An alternative pattern of connections is a telephone tree. The first person calls two people, who each call two people, and so on until everyone is contacted. Unlike the bucket brigade, the telephone tree is designed to spread information to many people simultaneously, creating a cascade. The workload is distributed evenly among all group members, and the problem caused by one person not being home is limited. Moreover, with a single call, one person can set off a chain of events that could influence hundreds or thousands of other people—just as the person who donated the heart that was transplanted into John Lavis prompted another donation that saved eight more lives. The telephone tree also vastly reduces the number of steps it takes for information to flow among people in the group, minimizing the chance that the message will be degraded. This particular network structure thus helps to both amplify and preserve the message. In fact, within a few decades of the widespread deployment of home-based phones in the United States, telephone trees were used for all sorts of purposes. An article in the *Los Angeles Times* from 1957, for example,

describes the use of a phone tree to mobilize amateur astronomers, as part of the "Moonwatch System" of the Smithsonian Astrophysical Observatory, to track American and Russian satellites.[8]

Alas, this same network structure also allows a single swindler to cheat thousands of people. In Ponzi schemes, money flows "up" a structure like a telephone tree. As new people are added to the network, they send money to the people "above" them and then new members are recruited "below" them to provide more money. As time passes, money is collected from more and more people. In what might be the biggest Ponzi scheme of all time, federal investigators discovered in 2008 that during the previous thirty years Bernie Madoff had swindled $50 billion from thousands of investors. Like the Corsican vendetta network we described earlier, Madoff's investment network is the kind most of us would like to avoid.

The four different types of networks we have considered so far are shown in the illustration. First is a group of one hundred people (each represented by a circle, or *node*) among whom there are no ties. Next is a bucket brigade. Here, in addition to the one hundred people, there are a total of ninety-nine ties between the members of the group; every person (except the first and last) is connected to two other people by a *mutual tie* (meaning that full and empty buckets pass in both directions). In the telephone tree, there are one hundred people and again ninety-nine ties. But here, everyone, with the exception of the first and last people in the tree, is connected to three other people, with one inbound tie (the person they get the call from) and two outbound ties (the people they make calls to). There are no mutual ties; the flow of information is directional and so are the ties between people. In a company of one hundred soldiers, each member of each squad knows every other member of the squad very well; and each person has exactly nine ties. Here, there are one hundred people and 450 ties connecting them. (The reason there are not nine hundred ties is that each tie counts once for the two people it connects.) In the drawing, we imagine that there are no ties between



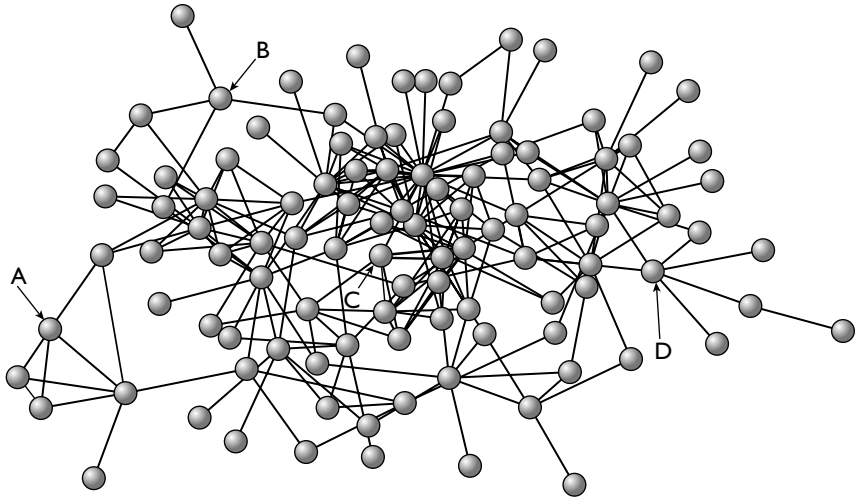
Four different ways to connect one hundred people. Each circle ("node") represents a person, and each line ("tie") a relationship between two people. Lines with arrows indicate a directed relationship; in the telephone tree, one person calls another. Otherwise, ties are mutual: in the bucket brigade, full and empty buckets travel in both directions; in military squads, the connections between the soldiers are all two-way.

squads or, at least, that the ties within squads are much tighter than the ties between squads. This is clearly an oversimplification, but it illustrates still another point about communities in social networks. A *network community* can be defined as a group of people who are

much more connected to one another than they are to other groups of connected people found in other parts of the network. The communities are defined by structural connections, not necessarily by any particular shared traits.

In a very basic sense, then, a social network is an organized set of people that consists of two kinds of elements: human beings and the connections between them. Unlike the bucket brigade, telephone tree, and military company, however, the organization of natural social networks is typically not imposed from the top. Real, everyday social networks evolve organically from the natural tendency of each person to seek out and make many or few friends, to have large or small families, to work in personable or anonymous workplaces.

For example, in the next illustration, we show a network of 105 students in a single dormitory at an American university and the friendship ties between them. On average, each student is connected to six other close friends, but some students have only one friend, and others have many. Moreover, some students are more embedded than others, meaning they have more connections to other people in the network via friends or friends of friends. In fact, network visualization software is designed to place those who are more interconnected in the center and those who are less interconnected at the periphery, helping us to see each person's location in the network. When your friends and family become better connected, it increases your level of connection to the whole social network. We say it makes you more *central* because having better-connected friends literally moves you away from the edges and toward the center of a social network. And we can measure your centrality by counting not just the number of your friends and other contacts but also by counting your friends' friends, and their friends, and so on. Unlike the bucket brigade where everyone feels his position to be the same ("there's a guy on my left passing me buckets and a guy on my right to whom I give them—it doesn't matter where in the line I am"), here, people are located in distinctly different kinds of places within the network.



In this natural network of close friendships among 105 college students living in the same dormitory, each circle represents a student, and each line a mutual friendship. Even though A and B both have four friends, A's four friends are more likely to know one another (there are ties between them), whereas none of B's friends know each other. A has greater transitivity than B. Also, even though C and D both have six friends, they have very different locations in the social network. C is much more central, and D is more peripheral; C's friends have many friends themselves, whereas D's friends tend to have few or no friends.

A network's *shape*, also known as its structure or topology, is a basic property of the network. While the shape can be visualized, or represented, in different ways, the actual pattern of connections that determines the shape remains the same regardless of how the network is visualized. Imagine a set of five hundred buttons strewn on the floor. And imagine that there are two thousand strings we can use to connect the buttons. Next, imagine that we randomly select two buttons and connect them with a string, knotting each button at the end. Then we repeat this procedure, connecting random pairs of

buttons one after another, until all the strings are used up. In the end, some buttons will have many strings attached to them, and others, by chance, will never have been picked and so will not be connected to another button. Perhaps some groups of buttons will be connected to each other but separated from other groups. These groups—even those that consist of a single unconnected button—are called *components* of the network; when we illustrate networks, we frequently represent only the largest component (in this case, the one with the most buttons).

If we were to select one button from one component and pick it up off the floor, all other buttons attached to it, directly or indirectly, would also be lifted into the air. And if we were to drop this mass of buttons onto another spot on the floor, it would look different than it did when we first picked it up. But the topology—which is a fundamental and intrinsic property of the network of buttons—would be exactly the same, no matter how many times we picked up and dropped the mass of connected buttons. Each button has the same relational position to other particular buttons that it had before; its *location* in the network has not changed. Visualization software tries to show this in two dimensions and to reveal the underlying topology by putting the most tangled buttons in the center and the least connected ones on the edges. It's as if you were trying to untangle a gnarled set of Christmas-tree lights, and there were tendrils of the gnarled mess that you could pull out, and also a thicket of interknotted lights that remained in the center no matter how often you turned the tangle over on the floor.

For numerous reasons we will explore, people come to occupy particular spots in the naturally occurring and continuously evolving social networks that surround us. Organic networks have a structure, complexity, function, spontaneity, and sheer beauty not found in organized networks, and their existence provokes questions about how they arise, what rules they obey, and what purpose they serve.

Rules of Life in the Network

There are two fundamental aspects of social networks, whether they are as simple as a bucket brigade or as complex as a large multigenerational family, a college dormitory, an entire community, or the worldwide network that links us all. First, there is *connection,* which has to do with who is connected to whom. When a group is constituted as a network, there is a particular pattern of ties that connects the people involved, the topology. Moreover, ties are complicated. They can be ephemeral or lifelong; they can be casual or intense; they can be personal or anonymous. How we construct or visualize a network depends on how we define the ties of interest. Most analyses emphasize ties to family, friends, coworkers, and neighbors. But there are all sorts of social ties and, thus, all sorts of social networks. In fact, when things such as sexually transmitted diseases or dollar bills flow through a network, this flow itself can define the ties and hence the structure of a particular set of network connections.

Second, there is *contagion,* which pertains to what, if anything, flows across the ties. It could be buckets of water, of course, but it also could be germs, money, violence, fashions, kidneys, happiness, or obesity. Each of these flows might behave according to its own rules. For example, fire cannot be transported in buckets toward the river; germs cannot affect someone who is immune; and obesity, which we will discuss in chapter 4, tends to spread faster between people of the same sex.

Understanding why social networks exist and how they work requires that we understand certain rules regarding connection and contagion—the structure and function—of social networks. These principles explain how ties can cause the whole to be greater than the sum of the parts.

RULE 1: WE SHAPE OUR NETWORK

Humans deliberately make and remake their social networks all the time. The primary example of this is *homophily,* the conscious or unconscious tendency to associate with people who resemble us (the word literally means "love of being alike"). Whether it's Hells Angels or Jehovah's Witnesses, drug addicts or coffee drinkers, Democrats or Republicans, stamp collectors or bungee jumpers, the truth is that we seek out those people who share our interests, histories, and dreams. Birds of a feather flock together.

But we also choose the *structure* of our networks in three important ways. First, we decide how many people we are connected to. Do you want one partner for a game of checkers or many partners for a game of hide-and-seek? Do you want to stay in touch with your crazy uncle? Do you want to get married, or would you rather play the field? Second, we influence how densely interconnected our friends and family are. Should you seat the groom's college roommate next to your bridesmaid at the wedding? Should you throw a party so all your friends can meet each other? Should you introduce your business partners? And third, we control how central we are to the social network. Are you the life of the party, mingling with everyone at the center of the room, or do you stay on the sidelines?

Diversity in these choices yields an astonishing variety of structures for the whole network in which we come to be embedded. And it is diversity in these choices—a diversity that has both social and genetic origins as we will see in chapter 7—that places each of us in a unique location in our own social network. Of course, sometimes these structural features are not a matter of choice; we may live in places that are more or less conducive to friendship, or we may be born into large or small families. But even when these social-network structures are thrust upon us, they still rule our lives.

We actually know quite a bit about how people vary in terms of how many friends and social contacts they have and in how

interconnected they are. Yet, identifying who a person's social contacts are can be a tricky business since people have many interactions of varying intensities with all sorts of people. While a person may know a few hundred people by sight and name, he will typically be truly close to only a few. One way social scientists identify such close individuals is to ask questions like, who do you discuss important matters with? Or, who do you spend your free time with? When answering such questions, people will identify a heterogeneous mix of friends, relatives, coworkers, schoolmates, neighbors, and others.

We recently put these questions to a sample of more than three thousand randomly chosen Americans. And we found that the average American has just four close social contacts, with most having between two and six. Sadly, 12 percent of Americans listed no one with whom they could discuss important matters or spend free time. At the other extreme, 5 percent of Americans had eight such people. About half of the people listed as members of Americans' intimate groups were said to be friends, but the other half included a wide variety of different kinds of relationships, including spouses, partners, parents, siblings, children, coworkers, fellow members of clubs, neighbors, and professional advisers and consultants. Sociologist Peter Marsden has called this group of people that we all have a "core discussion network." In a national sample of 1,531 Americans studied in the 1980s, he found that core-discussion-network size decreases as we age, that there is no overall difference between men and women in core-network size, and that those with a college degree have core networks that are nearly twice as large as those who did not finish high school.[9]

Next, in our own work, we asked the respondents to tell us how interconnected their social contacts were to each other. So if a person said that Tom, Dick, Harry, and Sue were his friends, we asked him if Tom knew Dick, if Tom knew Harry, if Tom knew Sue, if Dick knew Harry, and so on. We then used these answers to calculate the probability that any two of a person's friends were also friends with

each other. This probability is an important property that we use to measure how tightly interwoven a network is.

If you know Alexi, and Alexi knows Lucas, and Lucas knows you, we say this relationship is *transitive*—the three people involved form a triangle. Some people live in the thick of many transitive relationships (like person A in the illustration on page 14), while others have friends who do not know each other (like person B). Those with high transitivity are usually deeply embedded within a single group, while those with low transitivity tend to make contact with people from several different groups who do not know one another, making them more likely to act as a bridge between different groups. Overall, we found that if you are a typical American, the probability that any two of your social contacts know each other is about 52 percent.

Although these measures characterize the networks we can see, they also tell us something about the networks we cannot see. In the vast fabric of humanity, each person is connected to his friends, family, coworkers, and neighbors, but these people are in turn connected to their friends, family, coworkers, and neighbors, and so on endlessly into the distance, until everyone on earth is connected (pretty much) to everyone else, one way or another. So whereas we think of our own network as having a more limited social and geographic reach, the networks that surround each of us are actually very widely interconnected.

It is this structural feature of networks that underlies the common expression "it's a small world." It is often possible, through a few connections from person to person, for an individual to discover a connection to someone else. A famous example (at least among social scientists) was described in a paper first drafted in the 1950s by two early figures in the study of social networks, Ithiel de Sola Pool and Manfred Kochen. One of the authors overheard a patient in a hospital in a small town in Illinois say to a Chinese patient in the adjoining bed: "You know, I've only known one Chinese before in

my life. He was——from Shanghai." Whereupon the response came back, "Why, that's my uncle."[10] In fact, the authors did not tell us his name, perhaps because they were worried that the reader, in a further illustration of the small-world effect, would know him.

RULE 2: OUR NETWORK SHAPES US

Our place in the network affects us in turn. A person who has no friends has a very different life than one who has many. For example, we will see in chapter 4 that having an extra friend may create all kinds of benefits for your health, even if this other person doesn't actually do anything in particular for you.

One study of hundreds of thousands of Norwegian military conscripts provides a simple example of how the mere number of social contacts (here, siblings) can affect you.[11] It has been known for some time that first-born children score a few points higher in terms of intelligence than second-born children, who in turn score a bit higher than third-born children. One of the outstanding questions in this area of investigation, however, has been whether these differences are due to biological factors fixed at birth or to social factors that come later. The study of Norwegian soldiers showed that simple features of social networks, such as family size and structure, are responsible for the differences. If you are a second-born son whose older sibling died while you were a child, your IQ increases and resembles the IQ of a first-born child. If you are a third-born child and one of your older siblings died, your IQ resembles that of a second-born child; and if both of your older siblings died, then your IQ resembles that of a first-born child.

Whether your friends and other social contacts are friends with one another is also crucial to your experience of life. Transitivity can affect everything from whether you find a sexual partner to whether you commit suicide. The effect of transitivity is easily appreciated by the example of how divorce affects a child. If a child's parents are married (connected) then they probably talk to each other, but

if they get divorced (disconnected) they probably do not. Divorce means that communication often has to pass through the child ("Tell your father not to bother picking you up next Saturday!"), and it is much harder to coordinate raising the child ("You mean your mother bought you ice cream too?"). What is remarkable is that even though the child is still deeply connected to both parents, her relationship with each of them changes as a consequence of the divorce. Yet these changes result from the loss of a connection between the parents—a connection the child has little to do with. The child still has two parents, but her life is different depending on whether or not they are connected.

And how many contacts your friends and family have is also relevant. When the people you are connected to become better connected, it reduces the number of hops you have to take from person to person to reach everyone else in the network. You become more central. Being more central makes you more susceptible to whatever is flowing within the network. For example, person C in the figure on page 14 is more central than person D. Ask yourself which person you would rather be if a hot piece of gossip were spreading; you should be person C. Now ask yourself which person you would rather be if a deadly germ were spreading in the network; you should be person D. And this is the case even though persons C and D each have the same number of social ties: they are each directly connected to just six people. In later chapters, we will show how your centrality affects everything from how much money you make to whether you will be happy.

RULE 3: OUR FRIENDS AFFECT US

The mere shape of the network around us is not all that matters, of course. What actually flows across the connections is also crucial. A bucket brigade is formed not to make a pretty line for you to look at while your house is burning but so that people can pass water to each other to douse the flames. And social networks are not

just for water—they transport all kinds of things from one person to another.

As we will discuss in chapter 2, one fundamental determinant of flow is the tendency of human beings to influence and copy one another. People typically have many direct ties to a wide variety of people, including parents and children, brothers and sisters, spouses (and nice ex-spouses), bosses and coworkers, and neighbors and friends. And each and every one of these ties offers opportunities to influence and be influenced. Students with studious roommates become more studious. Diners sitting next to heavy eaters eat more food. Homeowners with neighbors who garden wind up with manicured lawns. And this simple tendency for one person to influence another has tremendous consequences when we look beyond our immediate connections.

RULE 4: OUR FRIENDS' FRIENDS' FRIENDS AFFECT US

It turns out that people do not copy only their friends. They also copy their friends' friends, and their friends' friends' friends. In the children's game telephone, a message is passed along a line by each child whispering into the next child's ear. The message each child receives contains all the errors introduced by the child sharing it as well as those introduced by prior children to whom the child is not directly connected. In this way, children can come to copy others to whom they are not directly tied. Similarly, every parent warns children not to put money in their mouths: the money, we think, contains germs from numerous people whose hands it has passed through, and not just from the most recent pair of hands. Analogously, our friends and family can influence us to do things, like gain weight or show up at the polls. But their friends and family can influence us too. This is an illustration of *hyperdyadic spread*, or the tendency of effects to spread from person to person to person, beyond an individual's direct social ties. Corto's brother lost his life because of such spread.

It is easy to think about hyperdyadic effects when the network is

a straight line—("that guy three people down the line better pass the bucket, or we're all going to be in big trouble"). But how on earth can they be understood in a natural social network such as the college students in the illustration on page 14, or complex networks of thousands of people with all kinds of crosscutting paths stretching far beyond the social horizon (as we will consider later)? To decipher what is going on, we need two kinds of information. First, we must look beyond simple, sequential dyads: we need to know about individuals and their friends, their friends' friends, their friends' friends' friends, and so on. And we can only get this information by observing the whole network at once. It has just recently become possible to do this on a large scale. Second, if we want to observe how things flow from person to person to person, then we need information about the ties and the people they connect at more than one point in time, otherwise we have no hope of understanding the dynamic properties of the network. It would be like trying to learn the rules of an unfamiliar sport by looking at a single snapshot of a game.

We will consider many examples and varieties of hyperdyadic spread, but we can set the stage with a simple one. The usual way we think about contagion is that if one person has something and comes into contact with another person, that contact is enough for the second person to get it. You can become infected with a germ (the most straightforward example) or with a piece of gossip or information (a less obvious example). Once you get infected by a single person, additional contact with others is generally redundant. For example, if you have been told accurately that stock XYZ closed at $50, another person telling you the same thing does not add much. And you can pass this information on to someone else all by yourself.

But some things—like norms and behaviors—might not spread this way. They might require a more complex process that involves reinforcement by multiple social contacts. If so, then a network arranged as a simple line, like a bucket brigade, might not support transmission of more complicated phenomena. If we wanted to get

people to quit smoking, we would not arrange them in a line and get the first one to quit and tell him to pass it on. Rather, we would surround a smoker with multiple nonsmokers, perhaps in a squad.

Psychologist Stanley Milgram's famous sidewalk experiment illustrates the importance of reinforcement from multiple people.[12] On two cold winter afternoons in New York City in 1968, Milgram observed the behavior of 1,424 pedestrians as they walked along a fifty-foot length of street. He positioned "stimulus crowds," ranging in size from one to fifteen research assistants, on the sidewalk. On cue, these artificial crowds would stop and look up at a window on the sixth floor of a nearby building for precisely one minute. There was nothing interesting in the window, just another guy working for Milgram. The results were filmed, and assistants later counted the number of people who stopped or looked where the stimulus crowd was looking. While 4 percent of the pedestrians stopped alongside a "crowd" composed of a single individual looking up, 40 percent stopped when there were fifteen people in the stimulus crowd. Evidently, the decisions of passersby to copy a behavior were influenced by the size of the crowd exhibiting it.

An even larger percentage of pedestrians copied the behavior incompletely: they looked up in the direction of the stimulus crowd's gaze but did not stop. While one person influenced 42 percent of passersby to look up, 86 percent of the passersby looked up if fifteen people were looking up. More interesting than this difference, however, was that a stimulus crowd of five people was able to induce almost as many passersby to look up as fifteen people did. That is, in this setting, crowds larger than five did not have much more of an effect on the actions of passing individuals.

RULE 5: THE NETWORK HAS A LIFE OF ITS OWN

Social networks can have properties and functions that are neither controlled nor even perceived by the people within them. These properties can be understood only by studying the whole

group and its structure, not by studying isolated individuals. Simple examples include traffic jams and stampedes. You cannot understand a traffic jam by interrogating one person fuming at the wheel of his car, even though his immobile automobile contributes to the problem. Complex examples include the notion of culture, or, as we shall see, the fact that groups of interconnected people can exhibit complicated, shared behaviors without explicit coordination or awareness.

Many of the simple examples can be understood best if we completely ignore the will and cognition of the individuals involved and treat people as if they were "zero-intelligence agents." Consider the human waves at sporting events that first gained worldwide notice during the 1986 World Cup in Mexico. In this phenomenon, originally called *La Ola* ("the wave"), sequential groups of spectators leap to their feet and raise their arms, then quickly drop back to a seated position. The effect is quite dramatic. A group of physicists who usually study waves on the surface of liquids were sufficiently intrigued that they decided to study a collection of filmed examples of *La Ola* in enormous soccer stadiums; they noticed that these waves usually rolled in a clockwise direction and consistently moved at a speed of twenty "seats per second."[13]

To understand how such human waves start and propagate, the scientists employed mathematical models of excitable media that are ordinarily used to understand inanimate phenomena such as the spread of a fire through a forest or the spread of an electrical signal through cardiac muscle. An *excitable medium* is one that flips from one state to another (like a tree that is either on fire or not) depending on what others around it are doing (are nearby trees on fire?). And these models yielded accurate predictions of the social phenomenon, suggesting that *La Ola* could be understood even if we knew nothing about the biology or psychology of humans. Indeed, the wave cannot be understood by studying the actions of a single individual standing up and sitting down. It is not orchestrated by someone with a megaphone atop a cooler. It has a life of its own.

Mathematical models of flocks of birds and schools of fish and swarms of insects that move in unison demonstrate the same point: there is no central control of the movement of the group, but the group manifests a kind of collective intelligence that helps all within it to flee or deter predators. This behavior does not reside within individual creatures but, rather, is a property of groups. Examination of flocks of birds "deciding" where to fly reveals that they move in a way that accounts for the intentions of all the birds, and, even more important, the direction of movement is usually the best choice for the flock. Each bird contributes a bit, and the flock's collective choice is better than an individual bird's would be.[14] Similar to *La Ola* and to flocking birds, social networks obey rules of their own, rules that are distinct from the people who form them. But now, people are not having fun in a stadium: they are donating organs or gaining weight or feeling happy.

In this regard, we say that social networks have emergent properties. *Emergent properties* are new attributes of a whole that arise from the interaction and interconnection of the parts. The idea of emergence can be understood with an analogy: A cake has a taste not found in any one of its ingredients. Nor is its taste simply the average of the ingredients' flavors—something, say, halfway between flour and eggs. It is much more than that. The taste of a cake transcends the simple sum of its ingredients. Likewise, understanding social networks allows us to understand how indeed, in the case of humans, the whole comes to be greater than the sum of its parts.

Six Degrees of Separation and Three Degrees of Influence

Stanley Milgram masterminded another, much more famous experiment showing that people are all connected to one another by an average of "six degrees of separation" (your friend is one degree

from you, your friend's friend is two degrees, and so on). Milgram's experiment, conducted in the 1960s, involved giving a few hundred people who lived in Nebraska a letter addressed to a businessman in Boston, more than a thousand miles away.[15] They were asked to send the letter to somebody they knew personally. The goal was to get it to someone they thought would be more likely than they to have a personal relationship with the Boston businessman. And the number of hops from person to person that the letter took to reach the target was tracked. On average, six hops were required. This amazing fact initiated a whole set of investigations into the small-world effect originally characterized by de Sola Pool and Kochen, and it entered popular culture too, with John Guare's play *Six Degrees of Separation* and even the trivia game Six Degrees of Kevin Bacon.

But some academics were skeptical. For instance, as far apart as Nebraska and Boston might be (both geographically and culturally), they were both inside the United States. So in 2002, physicist-turned-sociologist Duncan Watts and his colleagues Peter Dodds and Roby Muhamad decided to replicate Milgram's experiment on a global scale using e-mail as the mode by which people communicated.[16] They recruited more than ninety-eight thousand subjects (mostly from the United States) to send a message to "targets" around the world by forwarding the e-mail to someone each subject knew who might in turn know the targeted person. Each subject was randomly assigned one target from a list of eighteen possible targets in thirteen countries. The targets included a professor at an Ivy League university, an archival inspector in Estonia, a technology consultant in India, a policeman in Australia, and a veterinarian in the Norwegian army—quite a motley crew. Once again—astonishingly—it took roughly six steps (on average) to get the e-mail to each targeted person, replicating Milgram's original estimate of just how small the world is.

However, just because we are connected to everyone else by six degrees of separation does not mean that we hold sway over all of these people at any social distance away from us. Our own research

has shown that the spread of influence in social networks obeys what we call the Three Degrees of Influence Rule. Everything we do or say tends to ripple through our network, having an impact on our friends (one degree), our friends' friends (two degrees), and even our friends' friends' friends (three degrees). Our influence gradually dissipates and ceases to have a noticeable effect on people beyond the social frontier that lies at three degrees of separation. Likewise, we are influenced by friends within three degrees but generally not by those beyond.

The Three Degrees Rule applies to a broad range of attitudes, feelings, and behaviors, and it applies to the spread of phenomena as diverse as political views, weight gain, and happiness. Other scholars have documented that among networks of inventors, innovative ideas seem to diffuse to three degrees, so that an inventor's creativity influences his colleagues, his colleagues' colleagues, and his colleagues' colleagues' colleagues. And word-of-mouth recommendations for everyday concerns (like how to find a good piano teacher or how to find a home for a pet) tend to spread three degrees too.

There are three possible reasons our influence is limited. First, like little waves spreading out from a stone dropped into a still pond, the influence we have on others may eventually peter out. The stone displaces a certain volume of water as it is dropped, and the energy in the wave dissipates as it spreads out. One way to think about this socially is that there is decay in the fidelity of information as it is transmitted, as in the child's game of telephone. So, if you quit smoking or endorse a particular political candidate, by the time this information reaches your friends' friends' friends' friend, that person may no longer have accurate or reliable information about what you actually did. We call this the *intrinsic-decay explanation.*

Second, influence may decline because of an unavoidable evolution in the network that makes the links beyond three degrees unstable. Ties in networks do not last forever. Friends stop being friends. Neighbors move. Spouses divorce. People die. The only way

to lose a direct connection to someone you know is if the tie between you disappears. But for a person three degrees removed from you, any of three ties could be cut and you would lose at least one pathway between you. Hence, on average, we may not have stable ties to people at four degrees of separation given the constant turnover in ties all along the way. Consequently, we do not influence nor are we influenced by people at four degrees and beyond. We call this the *network-instability explanation.*

Third, evolutionary biology may play a part. As we will discuss in chapter 7, humans appear to have evolved in small groups in which everyone would have been connected to everyone else by three degrees or less. It is indeed useful to know whether anyone in our group has it in for us or is our ally, or whether others need our help or might help us. And it is useful to influence others in our group to do what we do. But we have not lived in large groups long enough for evolution to have favored people who can extend their influence beyond three degrees. Put another way, we may not be able to influence people four degrees removed from us because, in our hominid past, there was no one who was four degrees removed from us. We call this the *evolutionary-purpose explanation.*

It seems likely that all these factors play a role. But no matter the reasons, the Three Degrees Rule appears to be an important part of the way human social networks function, and it may continue to constrain our ability to connect, even though technology gives us access to so many more people.

While this inherent limit may seem, well, limiting (who doesn't want to rule the world?), we should remember how small the world is. If we are connected to everyone else by six degrees and we can influence them up to three degrees, then one way to think about ourselves is that each of us can reach about halfway to everyone else on the planet.

Moreover, even when restricted to three degrees, the extent of our effect on others is extraordinary. The way natural social networks are

structured means that most of us are connected to thousands of people. For example, suppose you have twenty social contacts, including five friends, five coworkers, and ten family members, and each of them in turn has similar numbers of friends and family (to make things simple, let's assume they are not the same contacts as yours). That means you are indirectly connected to four hundred people at two degrees of separation. And your influence doesn't stop there; it goes one more step to the twenty friends and family of each of those people, yielding a total of $20 \times 20 \times 20$ people, or eight thousand people who are three degrees removed from you. That would include every single person in the small Oklahoma town where James grew up.

So while the observation that there are six degrees of separation between any two people applies to how connected we are, the observation that there are three degrees of influence applies to how contagious we are. These properties, connection and contagion, are the structure and function of social networks. They are the anatomy and physiology of the human superorganism.

Connected

Most of us are already aware of the direct effect we have on our friends and family; our actions can make them happy or sad, healthy or sick, even rich or poor. But we rarely consider that everything we think, feel, do, or say can spread far beyond the people we know. Conversely, our friends and family serve as conduits for us to be influenced by hundreds or even thousands of other people. In a kind of social chain reaction, we can be deeply affected by events we do not witness that happen to people we do not know. It is as if we can feel the pulse of the social world around us and respond to its persistent rhythms. As part of a social network, we transcend ourselves, for good or ill, and become a part of something much larger. We are connected.

Our connectedness carries with it radical implications for the way we understand the human condition. Social networks have value precisely because they can help us to achieve what we could not achieve on our own. In the next few chapters, we will show how networks influence the spread of joy, the search for sexual partners, the maintenance of health, the functioning of markets, and the struggle for democracy. Yet, social-network effects are not always positive. Depression, obesity, sexually transmitted diseases, financial panic, violence, and even suicide also spread. Social networks, it turns out, tend to magnify whatever they are seeded with.

Partly for this reason, social networks are creative. And what these networks create does not belong to any one individual—it is shared by all those in the network. In this way, a social network is like a commonly owned forest: we all stand to benefit from it, but we also must work together to ensure it remains healthy and productive. This means that social networks require tending, by individuals, by groups, and by institutions. While social networks are fundamentally and distinctively human, and ubiquitous, they should not be taken for granted.

If you are happier or richer or healthier than others, it may have a lot to do with where you happen to be in the network, even if you cannot discern your own location. And it may have a lot to do with the overall structure of the network, even if you cannot control that structure at all. And in some cases, the process feeds back to the network itself. A person with many friends may become rich and then attract even more friends. This rich-get-richer dynamic means social networks can dramatically reinforce two different kinds of inequality in our society: *situational inequality* (some are better off socioeconomically) and *positional inequality* (some are better off in terms of where they are located in the network).

Lawmakers have not yet considered the consequences of positional inequality. Still, understanding the way we are connected is an essential step in creating a more just society and in implementing

public policies affecting everything from public health to the economy. We might be better off vaccinating centrally located individuals rather than weak individuals. We might be better off persuading friends of smokers of the dangers of smoking rather than targeting smokers. We might be better off helping interconnected groups of people to avoid criminal behavior rather than preventing or punishing crimes one at a time.

The powerful effect of social networks on individual behaviors and outcomes suggests that people do not have complete control over their own choices. Interpersonal influence in social networks therefore raises moral questions. Our connections to others affect our capacity for free will. How much blame does Giacomo in Corsica deserve for his actions, and how much credit does Dan Lavis in Ontario deserve for his? If they acted merely as links in a chain, how can we understand their freedom to choose their actions at all?

Some scholars explain collective human behavior by studying the choices and actions of individuals. Others dispense with individuals and focus exclusively on groups formed by social class, race, or political party affiliation, each with collective identities that cause people in these groups to mysteriously and magically act in concert. The science of social networks provides a distinct way of seeing the world because it is about individuals *and* groups, and about how the former actually become the latter.

If we want to understand how society works, we need to fill in the missing links between individuals. We need to understand how interconnections and interactions between people give rise to wholly new aspects of human experience that are not present in the individuals themselves. If we do not understand social networks, we cannot hope to fully understand either ourselves or the world we inhabit.