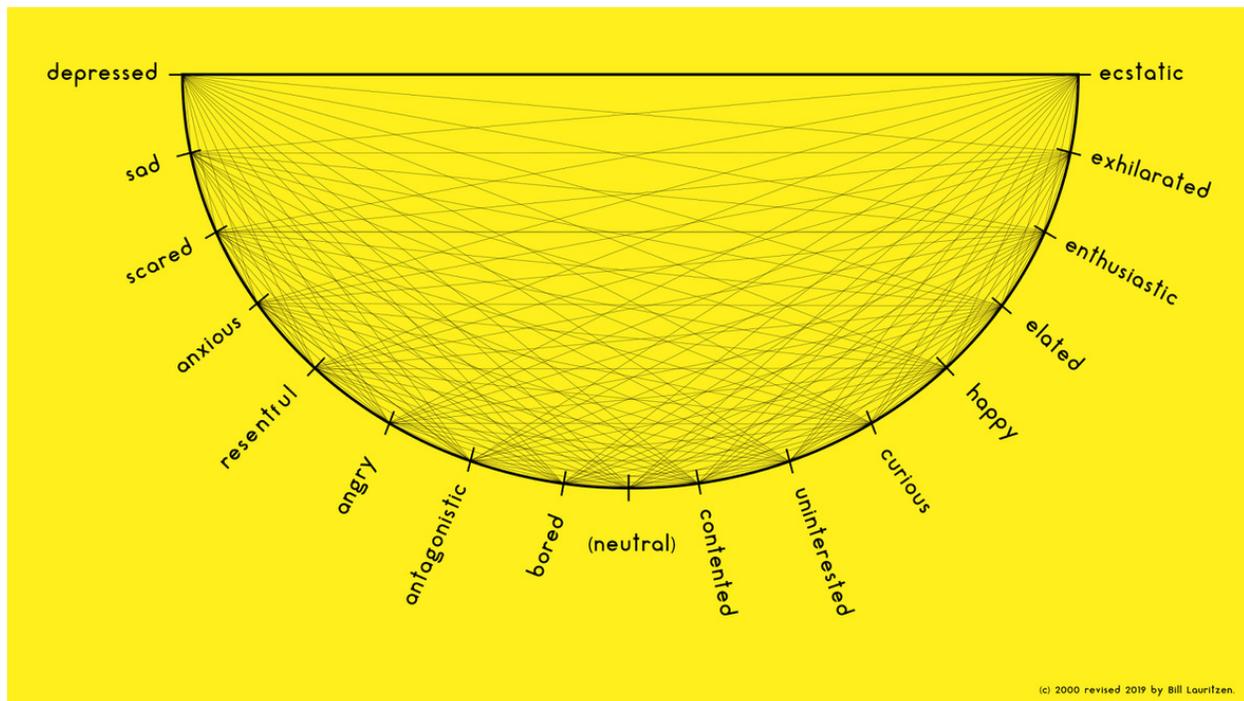


Emotional Homeostatic Curve with Applications for Artificial Intelligence

by Bill Lauritzen



Although researchers have classified emotions in various ways, I present the propositions that:

- 1) certain personal emotions can be ordered along a curved continuum from the most positive to the most negative, tending toward the neutral bottom of the curve,*
- 2) this order can be empirically tested, and*
- 3) this order has predictive value. These propositions have important implications for AI, game designers, robot designers, and affective computing.*

Darwin wrote that there are six basic emotions: happiness, surprise, fear, disgust, anger and sadness. However, research has suggested that disgust is related to anger and surprise is related to fear, leaving only four basic emotions: happiness, fear, anger, and sadness. (Dynamic facial expressions of emotion transmit an evolving hierarchy of signals over time, Jack, Rachael E., Garrod, Oliver G.B., and Schyns, Philippe G. (2014) [Current Biology](#), 24 (2). pp. 187-192.)

If we had to *order* these four, I would suggest that, in a goal-frustration situation, we would start with the positive emotion of happiness and then progress through anger to fear to sadness. We would not usually jump immediately from happiness to sadness (although that is possible).

For example, if I want to get a snack out of a vending machine, I might start in a happy mood, then, upon finding that the machine was not working properly, I might angrily bang or

kick the machine. Then, I might fear that I had lost my money, and finally, after confirming this, I might feel sad about it and leave.

Of course there are also social emotions and there are amplitudes of emotions. We can add some other emotions to these basic four. Let's start with what are considered the most positive, or desirable emotions, and work toward the more least desirable emotions. We might get something like these 17 as shown in the Emotional Curve above: *ecstatic, exhilarated, enthusiastic, elated, happy, curious, uninterested, contented, neutral, bored, antagonistic, angry, resentful, anxious, scared, sad, depressed*. I hypothesize that our general emotional state will tend toward the neutral bottom of the curve. Also, I will provide an example below of how these emotions might progress from one to the other.

There are many more emotional states than those 17 presented in the emotional curve image, with many possible interactions, as well interactions with social emotions (guilt, pride). There are also cultural “display rules” (such as “men don’t cry” or “women shouldn’t show anger.”) However, I think this simple Emotional Curve could provide a useful framework for programmers. (In the future, social emotions and amplitudes could be added along other dimensions.)

Let's look at an example in a goal-frustration situation of these nine emotions: *enthusiastic, happy, curious, bored, antagonistic, angry, scared, sad, depressed*:

You are on your way to the airport in a taxi, on the expressway. You are going to a conference in which you will give tonight's keynote dinner speech about your latest research. You are *enthusiastic*!

You notice a slight increase in traffic as you are traveling, but it is nothing to be concerned about. You have plenty of time. You are *happy* as you imagine yourself delivering your speech.

However, traffic continues to increase slightly. You become *curious* about this and you mention it to the taxi driver. “I wonder why the slowdown,” you ask. “Hard to say,” he answers. “There could be an accident up ahead.” He asks you the time of your flight, and you tell him, and he says it should be no problem. You feel *contented* as you travel along, still thinking about the speech you are going to deliver.

However, it's a long ride to the airport and you soon get *bored* thinking about your speech, and you think about other things: your family, the next academic year, etc.

Suddenly, there are many cars ahead in all lanes. The taxi is forced to slow to 15 miles an hour. The cars gleaming in the hot sun, and their exhaust pipes emit noxious fumes. You get a little *antagonistic* toward the taxi driver.

You say, “I thought you said it would be no problem.”

He's annoyed too: “Well that's what I thought.”

You say, “Isn't there another way around this traffic?”

He says, “No. I've tried going around this traffic many times. It always took longer.”

Now traffic is barely moving, and you are very *angry*.

You yell, “This fucking traffic is a nightmare! I'm moving out of this damn city!”

“Just relax, buddy,” the driver says. “There's nothing we can do about it.”

Traffic is still not moving at all. “Shit!” you say quietly to yourself, and now you are *scared*, for if the traffic continues like this, you will miss your flight, and your keynote address at the dinner.

Your bad luck continues. Traffic on the expressway completely stops! You might as well get out and walk to the airport. You feel like *crying*. How can this be happening to you? You will never make it to the dinner on time. What have you done to deserve this? Why has the universe turned against you?

No cars move for what seems like a very long time. You check your watch and five minutes have past with no motion. There's probably no way now you can make the flight. You sink into a *depression*, as you think about missing the dinner, and even worse, someone else giving a speech in your place. They will probably even ask your chief rival to give a speech. You eventually sigh and resign yourself to the reality of the situation. Maybe next year you can give the keynote speech.

Suddenly, the taxi jerks forward and starts moving again, although very slowly. You don't want to get your hopes up, but you *sniffle* a little, nursing your wounded and sit up straighter. The cars ahead of you seem to be moving a faster.

You look at your watch. It will be close, but you might get there before the plane leaves if traffic continues to improve. Your hands get sweaty and you gulp. You *fearfully* watch the traffic up ahead. Traffic is definitely getting faster. You fearfully ask the taxi driver, “Can't you go around these cars?!”

“Yeah, if I want to get a ticket,” he answers, pointing out the police car one lane over.

However, as you watch, the police car exits the freeway. “He exited!” you shout *angrily*, “Now Go!” The taxi driver has already speeded up and begun to weave in and out of traffic. You try to direct him when you see an opening, “There! Over there!” you shout with *antagonism*.

He ignores you. He's managing better without your suggestions. Eventually you get *bored* watching him. Traffic is getting faster, and you look at your watch.

“Do you think I can make it in time?” you ask.

“It's looking better,” he answers.

The taxi rounds a bend in the road, and you both see an accident that has been cleared off the road. Just past the accident the road is clear. The driver steps on the accelerator.

You think *happily* to yourself, “Yes!” The taxi is speeding along, and you look at your watch. You already have your boarding pass; it looks like you will get there on time. You wonder why you let a little traffic upset you so much.

Up ahead, you see planes landing and taking off, and you begin to feel a surge of *enthusiasm*. You think to yourself, “They are going to love this speech.”

Obviously, in some situations, people might jump from one emotion to another “distant” emotion based on a rapid removal of all obstacles to achieving their goal. For example, had the traffic jam cleared up instantly rather than gradually, the person in question might have jumped from depressed back to enthusiastic.

Robotic Empathy

A robot or machine that can recognize human emotions, could adopt a similar emotion to be in greater rapport with the human. For example, a robot that was programmed to have a goal state of “wanting to interact with humans verbally,” and whose goal was thwarted by a human who was sad, could respond sadly or with another nearby emotion. I think the human would more likely interact with the robot and this could be tested empirically. The empathetic communication with a robot could help change the human negative emotional state.

Although it's possible that emotions may eventually evolve in machines, at present we can give machines, such as Siri, Alexa, and Google, artificial emotions so that they will be more acceptable to humans.

Of course there is a danger here. If one does not limit robotic *anger to verbal* rather than *physical* responses, it could be disastrous. So robots would need some sort of *emotional governor* to prevent this.