Love in the Time of Dynamics

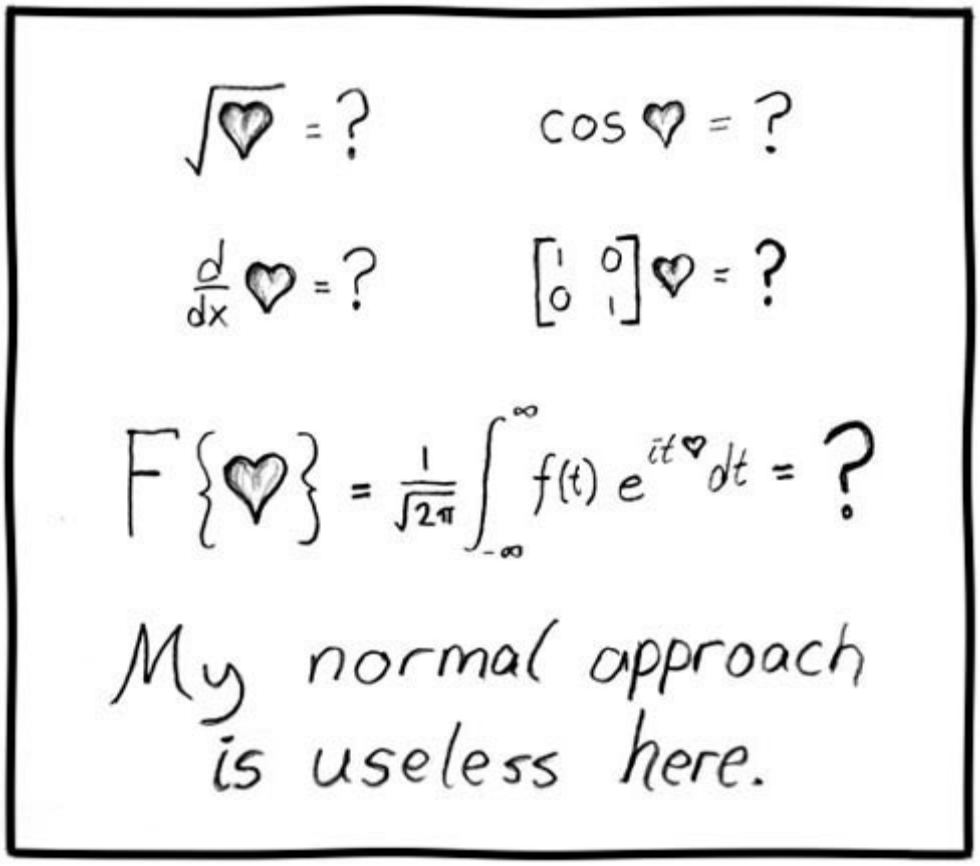

Figure 1 - XKCD Comic 'Useless' <http://xkcd.com/55/>

Introduction

I would like to model human romantic relationships as an LTI system. It has been claimed in the past that this is a fruitless endeavor (1), but it is something that I have approached several times with varying success though I have never gone so in depth. I will draw all the appropriate analogies to effort, flow, capacitive, inductive, and resistive elements and provide some interpretation of frequency plots and the behavior of the system for various constants.

System Description

In this application problem I will develop a model for human romantic relationships based on LTI first and second order systems. This is a direct extension of the LTI models of effort and flow we have developed in class for mechanical/electrical/hydraulic/thermal systems and we will be able to see many parallels between them.

The first analogy we must develop is to effort and flow. Fortunately there is a very simple analogy that lends itself well to effort and flow:

Effort - ♡

The effort in a relationship is the emotional connection between the people. This is the abstract 'force' that drives them to be together. It is completely contained in each person's mind and has no relationship to their situation.

Flow - Ψ

The flow in a relationship is the physical connection between the two people. This does not necessarily have to be of a sexual nature; it can simply be spending time together or talking on the phone. Any physical interaction is flow.

Now that we have the effort and flow of relationships, we can begin to establish constitutive relationships between the emotion and the physicality. Below we see the three basic equations for emotion and physical connection along with their mechanical and electrical analogies. The constants L, R, and P may also change over long periods of time.

$\heartsuit = L \int \Psi \, dt$	[Love]	$F = k \int v \, dt$	[Spring]	$V = C \int i \, dt$	[Capacitor]
$\heartsuit = R \, \Psi$	[Romance]	$F = c \, v$	[Damper]	$V = R \, i$	[Resistor]
$\heartsuit = P \frac{d\Psi}{dt}$	[Passion]	$F = m \frac{dv}{dt}$	[Mass]	$V = L \frac{di}{dt}$	[Inductor]

Table 1 - The basic constitutive equations of emotional and physical connection and their mechanical and electrical analogs.

Love – The love equation is a direct parallel to the spring relationship in the mechanical realm and the capacitive relationship in the electrical realm. Love operates on the slowest time scale of any romantic feeling—it can take people months or even years to fall into or out of love. Falling in love can be thought of as a slow build-up of all the positive interactions with someone, i.e. integration with respect to time of physical interactions. Positive L indicates a loving relationship and negative L indicates hate.

Romance – The romance equation is similar to the damper or resistor equations but it can be positive or negative. It operates on a medium timescale, typically representing interactions between week-long honeymoons and going out to lunch. While the interaction is going on there is emotional connection because of it, but the romantic emotional connection doesn't last, only the loving connection. The Romance equation also controls the difference between love and friendship. Positive R means romantic interactions increase the emotional connection so that the system is unstable and will either end in undying love

or undying hate. Negative R means romantic interactions decrease the emotional connection (as is true between friends) so that the system is stable and will eventually reach a constant value.

Passion – The passion equation is similar to the mass or induction equations. It operates on the shortest time scale, being merely that rush of excitement as physical interactions first begin or jump up to a new level of intimacy. Negative passion means that increases in physical interactions reduce emotional connection—meaning that stable oscillations will occur. Positive passion is what lovers feel, causing a strong positive feedback cycle and creating an unstable system.

System Response

For any given system, there will also be some "friendship level" that is the total amount of emotional connection possible between the two people. We can thus write an equation relating emotional connection and physical connection and the total friendship level.

$$P\frac{d\Psi}{dt} + R\,\Psi + L\int \Psi\, dt = F(t)$$

We can see from this equation that human romantic relationships are merely a standard second order system that we can analyze using our basic engineering tools.

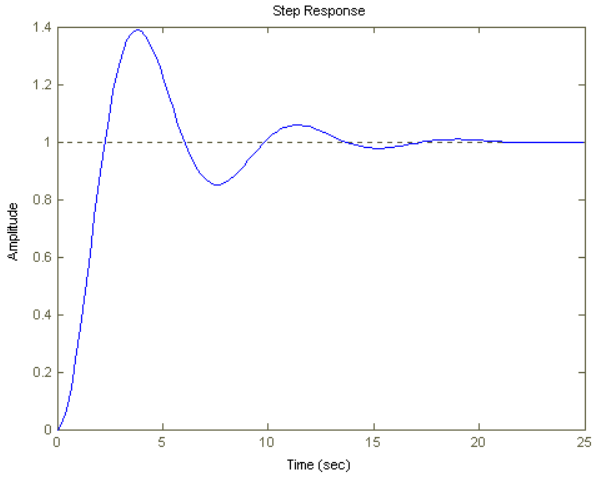

Figure 2 - Second order response of romantic relationships for L > 0, R < 0, P < 0. The oscillation eventually vanishes and the people become friends.

In this plot, we can see all the major features of people becoming friends. There is an initial overshoot when the people question whether they will be more than friends and a dip when they both back off a little too much. This oscillation continues, but eventually damps out and the two people finally reach their friendship level.