

# The Complex Theory of Relationships

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## Abstract

A slightly tongue-in-cheek attempt to apply complex number theory to understand human relationships.

## 1 Introduction

Now, everyone would agree that relationships are *complex*. This can be interpreted to mean that any given relationship can be represented by a point in the complex plane. Complex numbers can in turn be represented in two different ways:

- Cartesian coordinates ( $x$  and  $y$ )
- Polar coordinates ( $r$  and  $\theta$ )

Mathematically, this means they have a real part and an imaginary part, or alternatively a magnitude and an angle. These are related by the expressions:

$$z = x + iy = re^{i\theta} = r \cos \theta + i r \sin \theta \quad (1)$$

Which of course is Euler's Formula, where  $i$  is the imaginary number.

## 2 Definitions

### 2.1 $\Re$ : Real

The real part of the relationship is those things that are objectively true. It is the shared experiences, knowledge of the other person, and other things which provide strength and durability to a relationship. By its very nature, the real part of a relationship must be the same for both participants. It generally must vary continuously and monotonically (always increasing), due to actual events or information. It is generally greater than zero, limiting us to quadrants I and IV. A negative real part can be thought of as a bad action that undermines a relationship.

### 2.2 $\Im$ : Imaginary

The imaginary part is all those intangible, subjective things like trust, affection, and expectations. Loosely speaking, it is the level of 'intentionality' in the relationship: how much thought goes into the relationship, even when the participants are not together. Due to its subjective nature, it is quite possible - even likely - for participants to have differing imaginary parts in their view of the relationship. The imaginary part, since it is tied to mental states, is susceptible to fluctuations and rapid changes. It can even be less than zero, for the case of active dislike.

### 2.3 $\|Magnitude\|$ and $\angle Angle$

The magnitude  $r = \sqrt{x^2 + y^2}$  corresponds to the "depth" of the relationship. The angle, therefore, is the relative contributions of the 'real' and 'imaginary' parts. A low-theta relationship is tied closely to reality, while a high-theta relationship exists primarily in the minds of the participants (or possibly just one of them).

Most friendships are low-theta relationships, except during times of crises. Parenthood (and similar activities, like mentoring) tend to have  $\theta \approx 45^\circ$ , combining equal parts of knowledge and concern. High-theta relationships are most often found in romance (positive theta) or enmity (negative theta). The apparent depth of the relationship might be the same in both cases, but the causes of that depth are quite different. The impact of this can be seen in the next sections.

## 3 Time Evolution

The evolution of the relationship is governed by the equation:

$$\frac{dr}{dt} = \frac{y}{\tau[R]} \quad (2)$$

Where  $\tau[R]$  is the time constant of the relationship, equal to the sum of the characteristic time of each participant:

$$\tau[R] = \tau[1] + \tau[2] \quad (3)$$

Thus, the time constant is dominated by the larger of the two.

The key feature to note is that the change in magnitude is tied to the imaginary part. Thus, a relationship with a high-theta angle might grow extremely quickly, but most of that growth is imaginary (infatuation being the classic example). Conversely, a low-theta relationship is quite stable, but can take a while to develop.

When the imaginary part goes to zero, the relationship can be said to be dead, or at least asleep. The real part may not actually diminish, but it will gradually be lost in the background as other relationships increase in depth.

When the imaginary part goes negative, the relationship will actively decay. What is happening is that the common ground of the relationship is actually being lost: information is forgotten, and experiences are denied. Sometimes the real things get replaced by imaginary things, as described in the next section, transformations.

## 4 Transformations

Since relationships can be represented by points in the complex plane, they can also be represented as two-component vectors. As such, they are amenable to general transformations, namely rotations and reflections.

Reflections can only be around the x-axis, that is:

$$y \Rightarrow -y \quad (4)$$

This corresponds to a radical shift in attitude - a conversion, if you will. This is generally a response to a traumatic event, and is more likely (and devastating) in high-theta relationships. Such a transformation is quite common among adolescents, who can switch "best-friendships" with alarming frequency. Similar behavior can be seen in the relationship between politicians and special interest groups.

Rotations can take place in two different ways, and are the only way the real part can change discontinuously. The healthiest kind are rotations which collapse a vector onto the real axis. This is generally a 'resolution' - where unrealistic ideas are exchanged for truth. It is the one of the most common endings for a one-side infatuation. However, it works best for relationships

with relatively small imaginary parts; otherwise, the acceleration is too great and it overshoots into a reflection.

What that happens, the imaginary part becomes negative, and the relationship decays. The positive shared experiences are slowly eaten away and replaced by negative misconceptions, which feed the process and eventually result in hurtful acts (i.e., a negative real part). The only cure for this is forgiveness, where the negative imaginary part is set to zero. For reconciliation to occur at least one participant must set their imaginary part to high and positive. The negative real part must usually be set aside until the new relationship has gained enough strength to absorb it.

## 5 Applications

### 5.1 Romance

The most interesting applications are for the high-theta cases, namely romantic relationships. Useful questions are:

- what is the current growth rate?
- how much depth is due to reality
- how much to imagination?

As a rule of thumb, healthy romantic relationships should rarely go over 30 degrees (two parts reality to one part imagination). When they do, it is important to rotate back down periodically, otherwise the imaginary part will start shooting towards infinity. If that happens, the real part can no longer stabilize the relationship and fluctuations will lead to a reflection. The unrealistic positive emotions turn negative, and there is a nasty divorce or breakup, ultimately destroying the relationship.

To preserve a healthy relationship, all those positive emotions need to be channelled into real growth, rather than imaginary growth. Participants should select activities that will help them to actually know one another better, rather than compounding their already distorted perceptions with further fantasies. It may also be necessary to 'synchronize' the imaginary parts, to make sure both participants have the same expectations regarding the relationship. This is sometimes known as a Relationship Definition Talk, or RDT.

Another useful fact to remember is that complex numbers add linearly. Thus, it may be fruitful to break a relationship down into its various components. An otherwise healthy relationship may have one or two areas where there exists negative imaginary parts that, if left unchecked, could spell serious trouble further down the road.

### 5.2 The Grief Cycle

The most dramatic example of the value of the Complex Theory of Relationships can be seen in what is commonly known as the grief cycle. As mentioned above, normal relationships live in the upper right Quadrant I, where both real and imaginary components are negative. When relationships enter into a time of difficulty, the resulting process of grief can be visualized as a counter-clockwise rotation through the complex plane:

**Denial** This corresponds to a pure positive imaginary component, with no reality.

**Bargaining** Here reality goes negative, while the imagination is still positive (Upper Left Quadrant II).

**Anger** Now both reality and imagination goes negative (Lower Left Quadrant III).

**Sadness** Finally positive reality is restored, at the price of negative imagination (Lower Right Quadrant IV).

This concept of grief as a rotation provides some interesting insights. For example, the cycle can be pictured as a complex vector rotating through a viscous fluid. When the relationship breaks, the vector bounces in a counter-clockwise direction through the cycle. If the person involved fails to accept or process their anger, the vector becomes stalled. If the vector is stuck in Anger, we call it Bitterness. If stuck in Sadness, we call it Depression. The solution is to recognize the need to keep the vector moving. This involves embracing and accepting Anger, but only as transitional stage leading towards acceptance.

## 6 Conclusions

The marriage of number theory and relationship theory - like all marriages - is rather a difficult one at times. This first order theory obviously ignores many higher-order corrections. In particular, much work remains to be done on the correlations between two participants different views of the same relationship. However, recognizing these basic elements - real, imaginary, magnitude, and angle - and their relationship to one another, can help us to identify the causes and cures of relationship problems with greater speed, accuracy, and efficacy.