Formulas

for Turning Your Passion into a Career

Albion College Gerstacker Institute 50th Anniversary Celebration
November 10, 2023
John W. Pearce, CFA, ‘11

Today, I hope to say…

…something you will ***remember***…

…something you will ***disagree*** with…

…and something that makes you ***think***.

About Me

Albion College

- Mathematics & Economics
- Minor: Management – Gerstacker Institute
- Concentration: Ford Institute for Public Policy
- Honors: Magna Cum Laude, Phi Beta Kappa
- Extracurriculars: Fed Challenge, Sigma Chi Pro Consul (VP), FURSCA, Habitat for Humanity

University of Chicago

- Booth School of Business, MBA
- Concentrations: Analytic Finance, Behavioral Science
- Honors: Wallman Scholar (High Honors), Beta Gamma Sigma
- Extracurriculars: Be a good dad, stay married, keep my full-time job

Career

NorthPointe Capital

- *Intern*
- *Quantitative Analyst*
- *Director of Quantitative Research*

IMRF

- *Portfolio Manager – Internally Managed Equities*

Up next?

Life

Family

- *Tara (Albion '11)*
- *Hank (6½)*
- *Rosie (4½)*

Interests: Reading, Golf, Trout, Grouse

I’ve got good news and bad news…

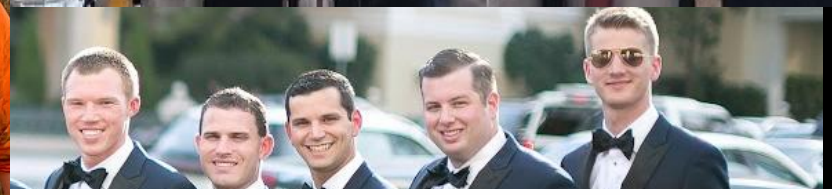
The bad news is there will be math…

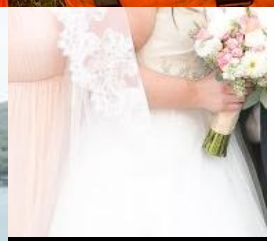
…kind of a lot.

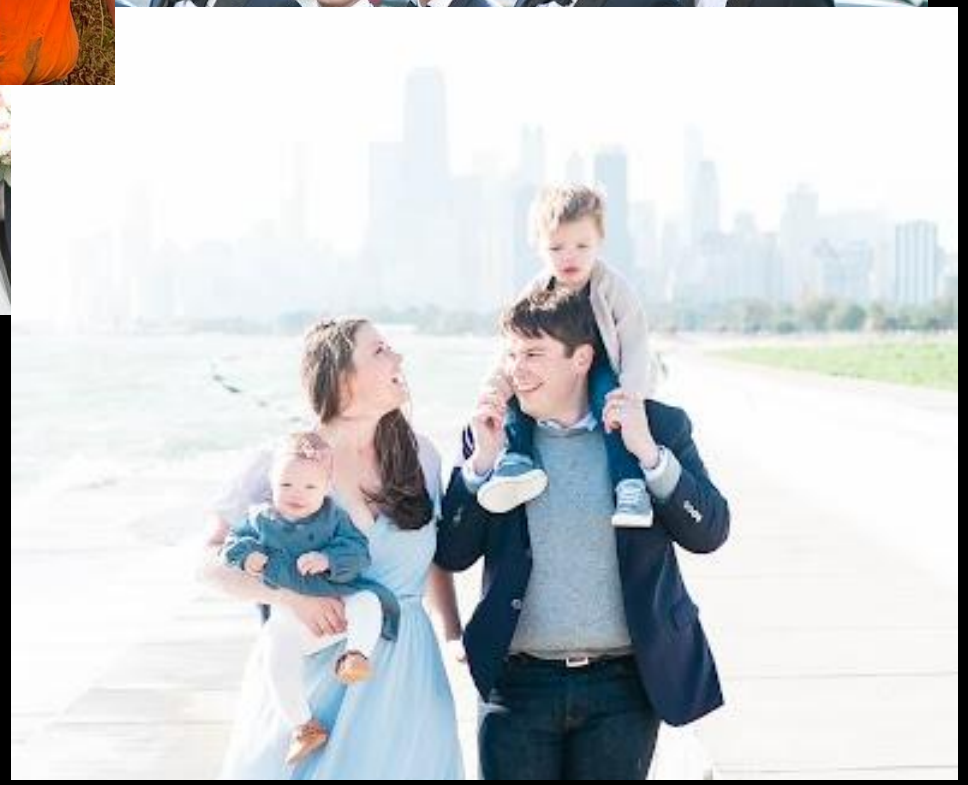
The good news is I’ll try to make it fun…

…hopefully, you’ll see why it matters…

… let’s start with something that’s just pure fun.







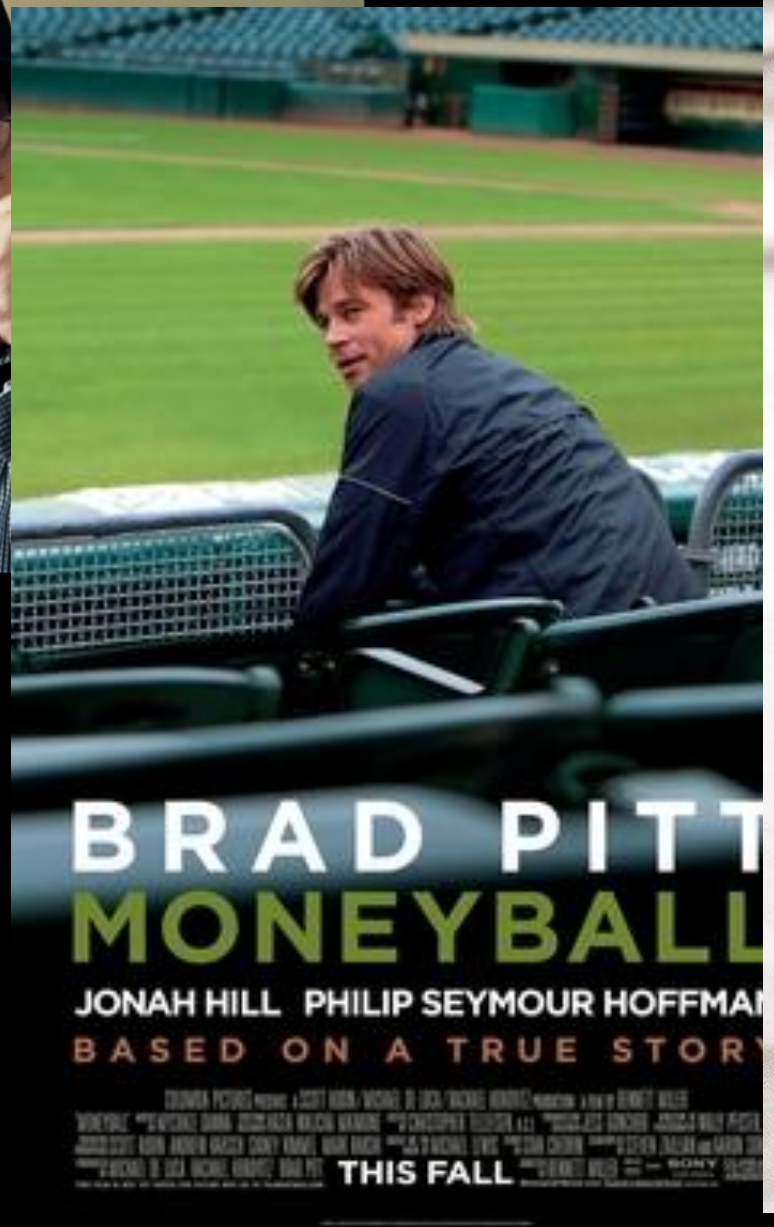
What do you want to be when you grow up?

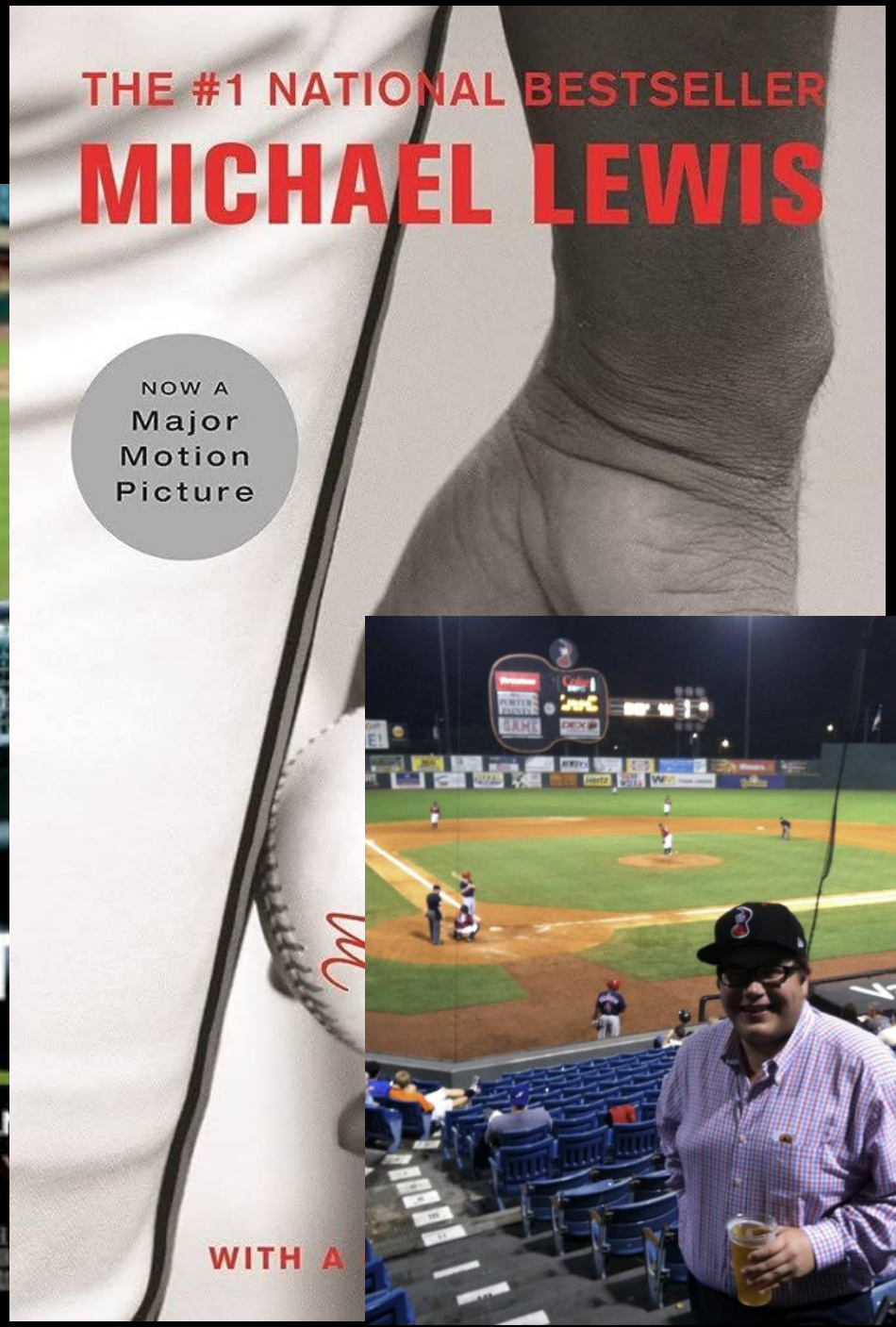
I didn’t know when I was your age and…

…I’ll let you in on a little secret:

I still don’t really know.

A's


BRAD PITT
MONEYBALL
JONAH HILL PHILIP SEYMOUR HOFFMAN
BASED ON A TRUE STORY
THIS FALL


THE #1 NATIONAL BESTSELLER
MICHAEL LEWIS
NOW A
Major
Motion
Picture
WITH A

A's

(A) Moneyball Formula

$$RPS_{it} = \beta_{it,\,OBP} OBP_{it} + \beta_{it,\,SLG} SLG + \beta_{i,\,NL} NL + \cdots + \epsilon$$

Where:

- RPS = number of runs scored by team
- OBP = on-base percentage of that team
- SLG = slugging percentage of that team
- NL = binary indicator variable for National League
- … = other factors
- ϵ = error term

You can cost-efficiently field a good team of baseball players by paying attention to factors that are overlooked (or undervalued) by traditional scouting approaches.

$$y_i = \beta_0 + \beta_1 x_{i,1} + \cdots + \beta_n, x_{i,n} + \epsilon$$

$$\boldsymbol{y} = \boldsymbol{X\beta} + \boldsymbol{\epsilon}$$

The behavior of a dependent variable can be described by observing other independent variables and used to make (hopefully accurate!) forecasts.

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$$r_i - r_f = \beta_{i,MKT}(r_m - r_f) + \beta_{i,\,SMB} SMB + \beta_{i,\,HML} HML + \beta_{i,\,RMW} RMW + \beta_{i,\,CMA} CMA + \alpha$$

Where:

- MKT = return of the market in excess of the risk-free rate (r_m – r_f)
- SMB = size (small minus big)
- HML = value (high book to market minus low book to market)
- RMW = profitability (robust minus weak)
- CMA = investment policy (conservative minus aggressive)
- α = alpha (or maybe also just error)

Fama-French Five Factor Asset Pricing Model (2014): The cross-section of expected returns for stocks and bonds can be described by common risk factors (or behavioral anomalies).

My Moneyball Formula

At NorthPointe Capital I led quantitative research efforts to *identify sources of alpha* to apply in our portfolios to attempt to outperform our benchmarks and earn management fees from institutional investing clients and retail mutual funds.

$$r_i - r_f =$$
$$\beta_{i,MKT}(r_m - r_f)$$
$$+ \beta_{i,\,SMB} SMB$$
$$+ \beta_{i,\,HML} HML$$
$$+ \beta_{i,\,RMW} RMW$$
$$+ \beta_{i,\,CMA} CMA$$
$$+ \beta_{i,\,MOM} MOM$$
$$+ etc.$$
$$+ \alpha$$

At IMRF I manage $5.5 billion of assets (11% of the Fund) in three quantitative equity strategies to achieve *cost-efficient exposure to long-term rewarded factor premia* for the exclusive benefit of the Fund's stakeholders…

…and I contribute to overall asset allocation strategy and ongoing Fund management.

The Pension Equation

You can pay out future benefits if you save money prudently and invest it wisely.

$$C + I = B + E$$

Contributions
How much do Employers and Employees pay in?

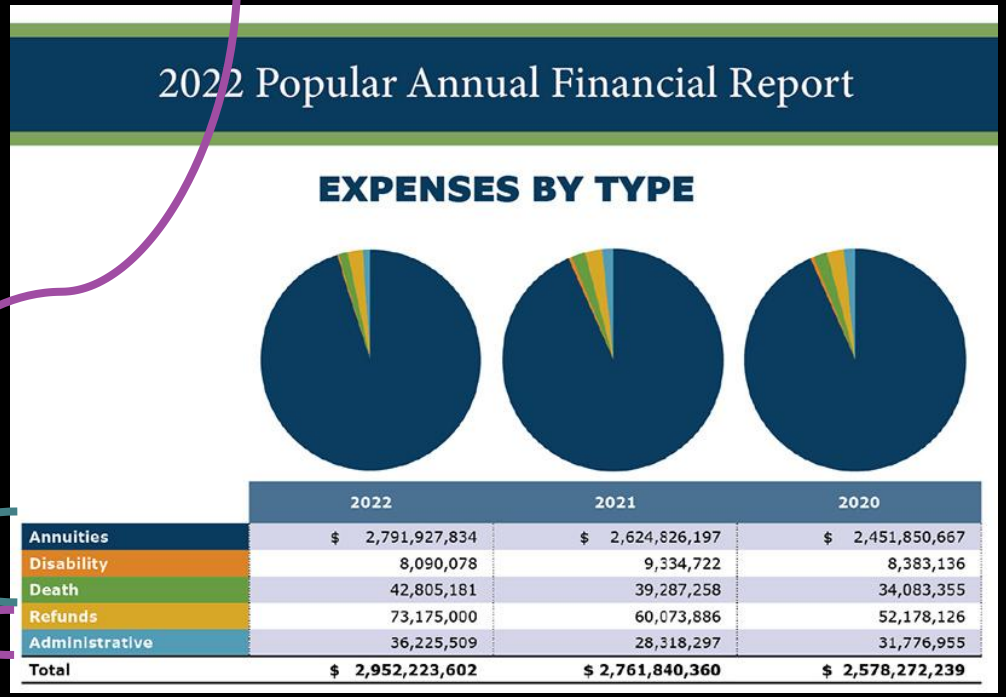
Investment Returns
How much did your investments return?

Benefits
What is your benefit liability?

Expenses
What are the expenses of managing the Fund?

The Pension Equation at IMRF

$$C + I = B + E$$



2022 Popular Annual Financial Report

EXPENSES BY TYPE

	2022	2021	2020
Annuities	$ 2,791,927,834	$ 2,624,826,197	$ 2,451,850,667
Disability	8,090,078	9,334,722	8,383,136
Death	42,805,181	39,287,258	34,083,355
Refunds	73,175,000	60,073,886	52,178,126
Administrative	36,225,509	28,318,297	31,776,955
Total	$ 2,952,223,602	$ 2,761,840,360	$ 2,578,272,239

The Pension Equation in Practice

$$C + I = B + E$$

$$PV(C + I) = PV(B + E)$$

$$\frac{PV(C + I)}{PV(B + E)} =$$

The Pension Equation in Practice

$$C + I = B + E$$

$$PV(C + I) = PV(B + E)$$

$$\frac{PV(C + I)}{PV(B + E)} = 98.2\%$$

Many Formulas with Important Lessons

The Fundamental Law of Active Management:

$$IR = IC \times \sqrt{Breadth} + TC$$

Outcome depends on skill and number of bets.

Variance of n-Asset Portfolio:

$$var(r_P) = \boldsymbol{w'\Sigma w}$$

Diversification is the only free lunch there is in investing.

Optimal Risky Asset Portfolio:

$$\boldsymbol{\omega^* = \frac{1}{\iota'\Sigma^{-1}\mu}\Sigma^{-1}\mu}$$

Optimal weights are not dependent on risk-aversion.

Black-Scholes Equation:

$$\frac{\delta V}{\delta t} + \frac{1}{2}\sigma^2 S^2 \frac{\delta^2 V}{\delta S^2} = rV - rS\frac{\delta V}{\delta S}$$

alternatively

$$C = N(d_1)S_t - N(d_2)Ke^{-rt}$$

where

$$d_1 = \frac{\ln\left(\frac{S_t}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

and

$$d_2 = d_1 - \sigma\sqrt{t}$$

Options are valuable.

Bayes Theorem:

$$P(A|\mathrm{B}) = \frac{P(B|A)P(A)}{P(B)}$$

When you get new information, update your beliefs.

Modigliani-Miller Theorem:

Proposition I

$$V_L = V_U + T_C D$$

Proposition II

$$r_e = r_0 + \frac{D}{E}(r_0 - r_D)(1 - T_C)$$

*Capital structure is irrelevant.**

**Under certain strict assumptions.*

Kelly Criterion:

$$f^* = \frac{p}{a} - \frac{q}{b}$$

Bet sizing matters.

Nash Equilibrium:

$$u_i(s_i^*, s_{-i}^*) \geq u_i(s_i\ , s_{-i}^*)$$

for all

$$s_i \in S_i$$

Understanding strategy can predict equilibrium solutions.

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$\delta V \quad 1 \quad \delta^2 V \quad \delta V$

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$= V_U + T_C D$

$(r_0 - r_D)(1 - T_C)$

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$u_i(s_i^*, s_{-i}^*) \geq u_i(s_i\ , s_{-i}^*)$

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Understanding strategy can predict equilibrium solutions.

Enough with the formulas.

For now.

Three Frameworks

Life on a Galton Board

How do you deal with getting bumped around?

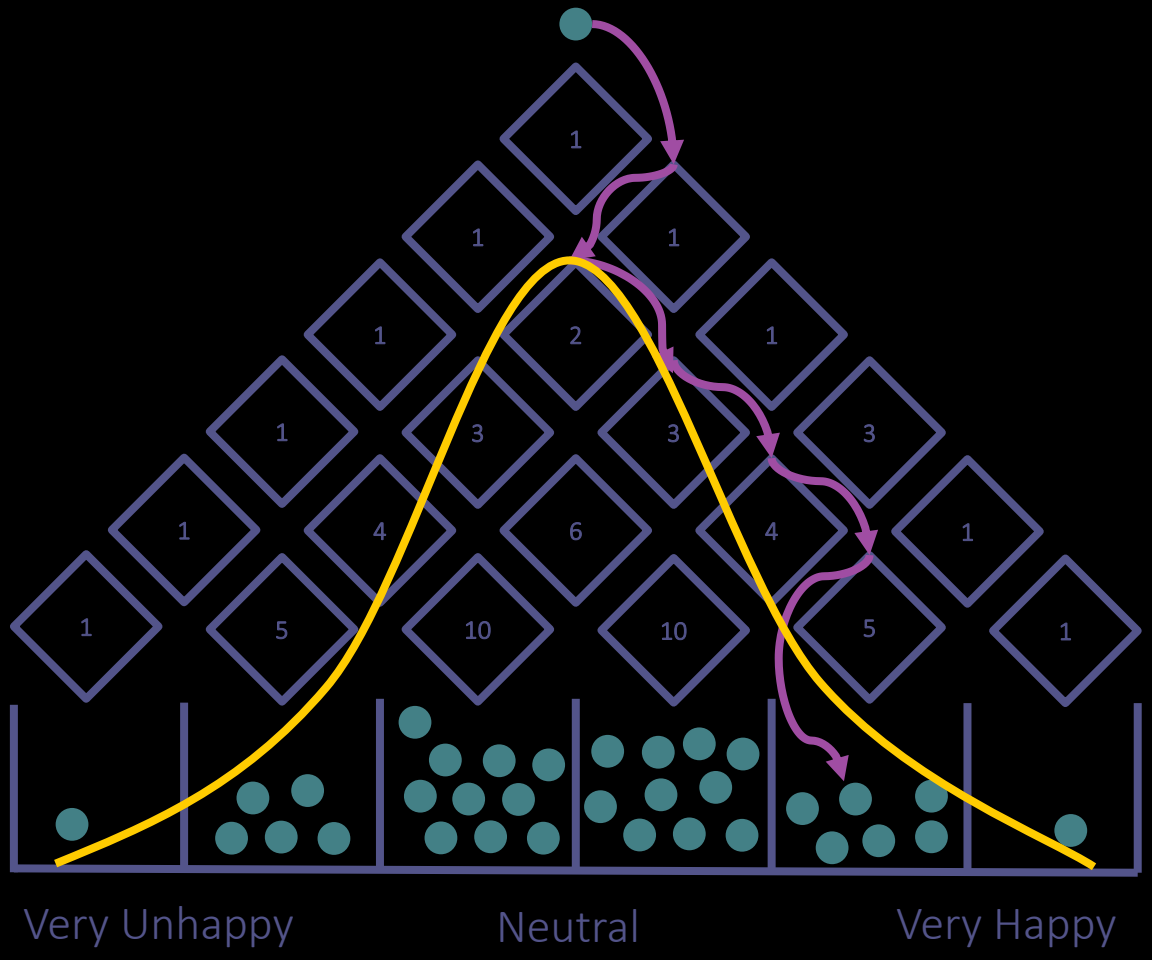
Quantum Theory of Wealth

What leap do you want to make?

The Shape of [Risk] Stories

Are you the author or the audience?

Life on a Galton Board



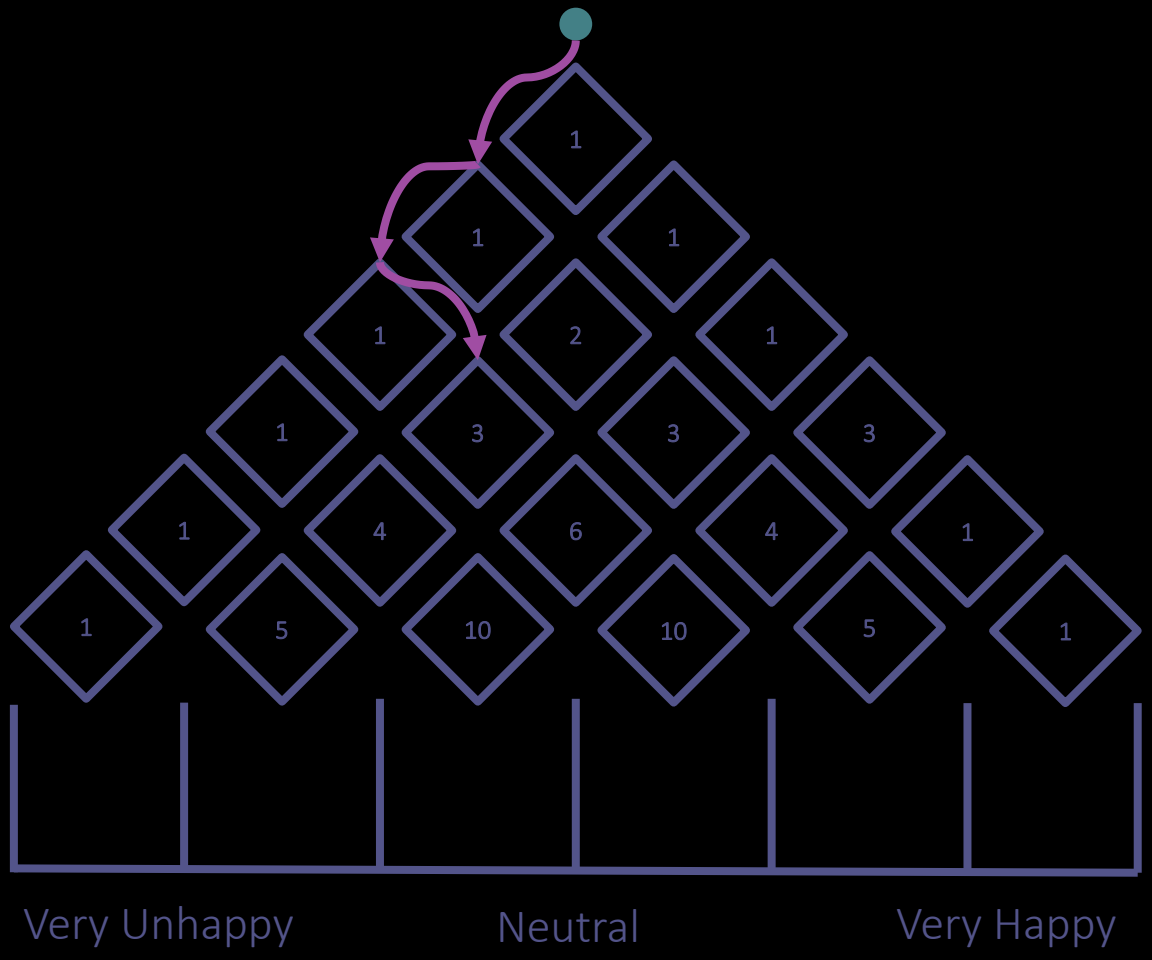
"And you may find yourself living in a shotgun shack/
And you may find yourself in another part of the world/
And you may find yourself behind the wheel of a large automobile/
And you may find yourself in a beautiful house, with a beautiful wife/
And you may ask yourself, ***'Well, how did I get here?'***"

–"Once in a Lifetime" | Talking Heads

Decisions and ***chance*** contribute to the ***distribution of outcomes***.

$$f(x|\mu,\sigma^2) = \frac{1}{\sigma}\phi\left(\frac{x-\mu}{\sigma}\right)$$

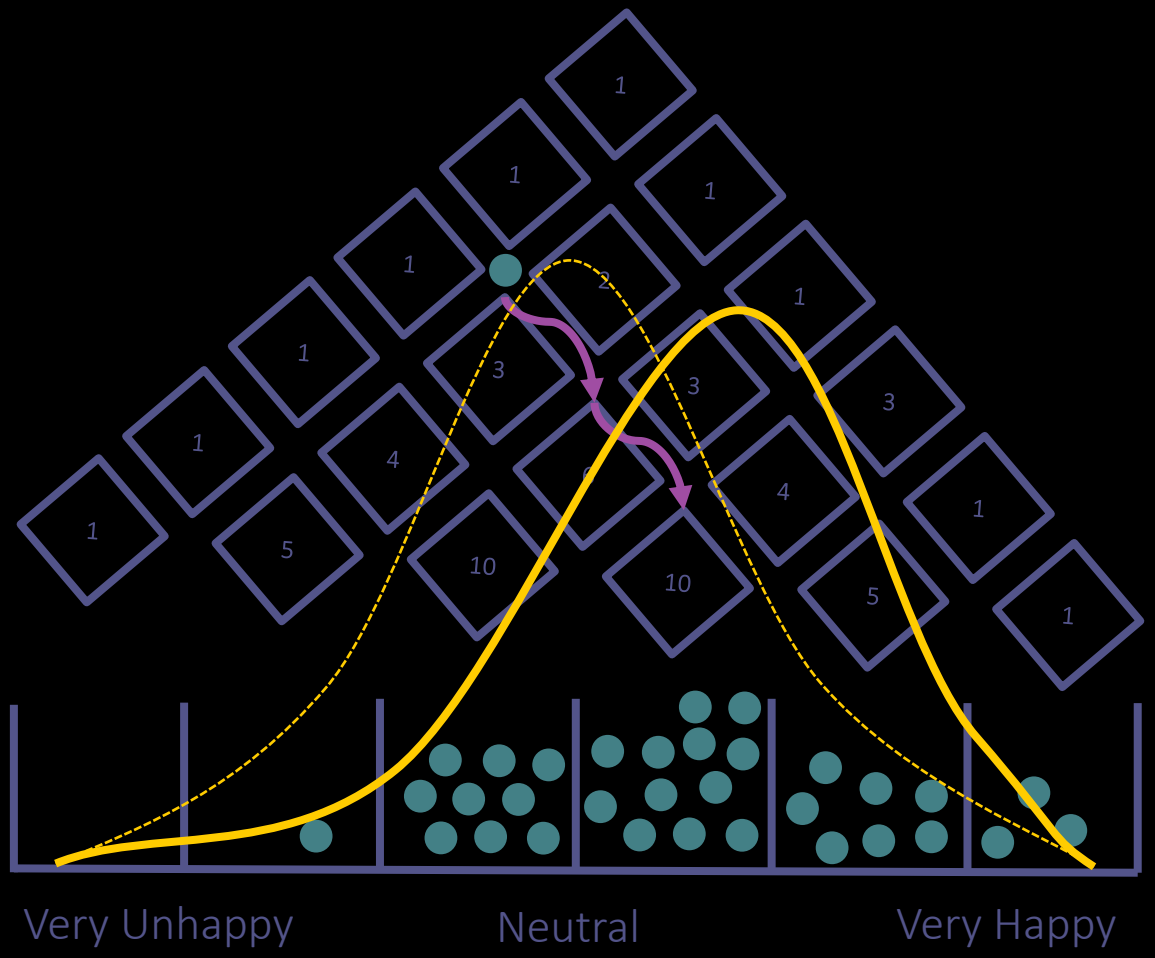
Life on a Galton Board



"And you may ask yourself, 'How do I work this?'
And you may ask yourself, 'Where is that large automobile?'/
And you may tell yourself, ***'This is not my beautiful house'***/
And you may tell yourself, ***'This is not my beautiful wife'"***
–"Once in a Lifetime" | Talking Heads

If you don't like the path you're on…

Life on a Galton Board



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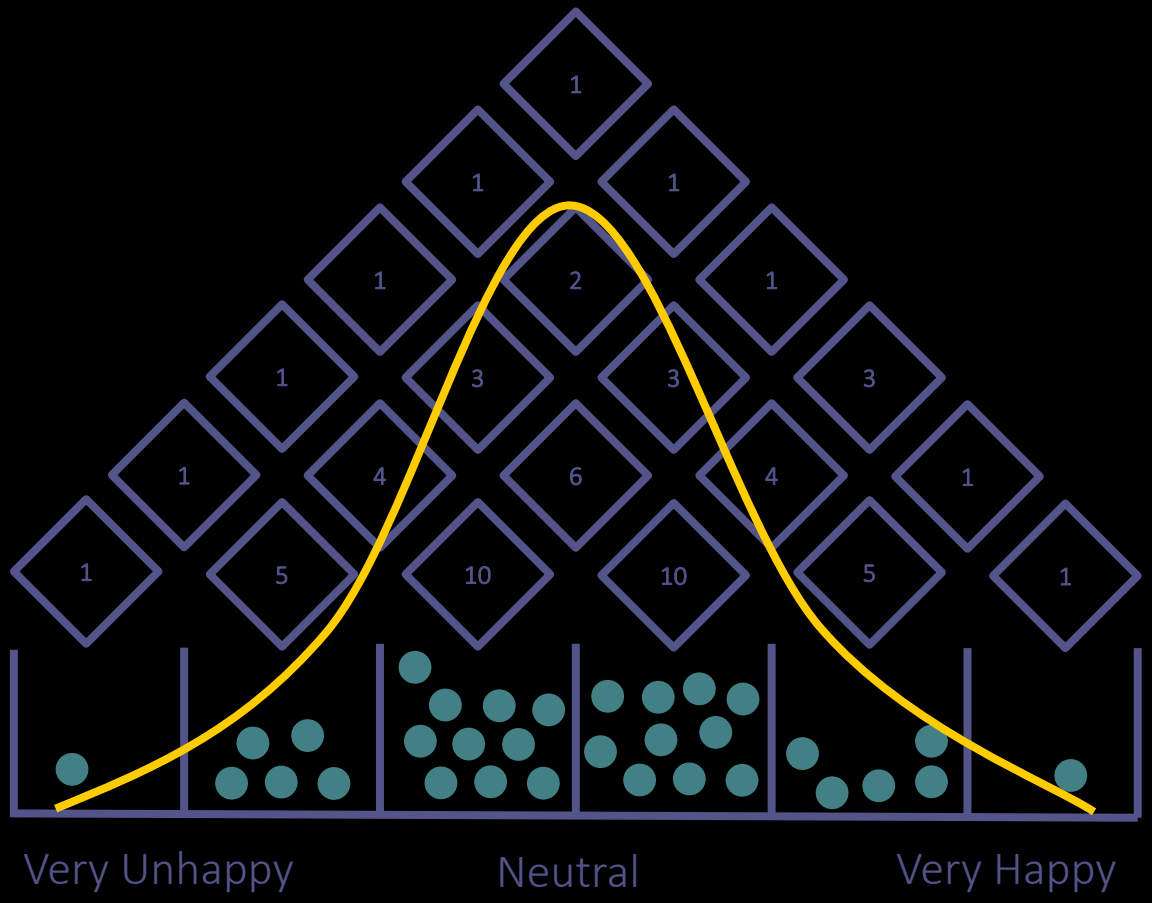
If you don't like the path you're on…
…do something to change it.

The further down you go…
…the harder it is to change.

Life on a Galton Board



"You may ask yourself, 'What is that beautiful house?'/
You may ask yourself, ***'Where does that highway go to?'"***
–"Once in a Lifetime" | Talking Heads

The more you know is out there…

Life on a Galton Board

"You may ask yourself, 'What is that beautiful house?'/
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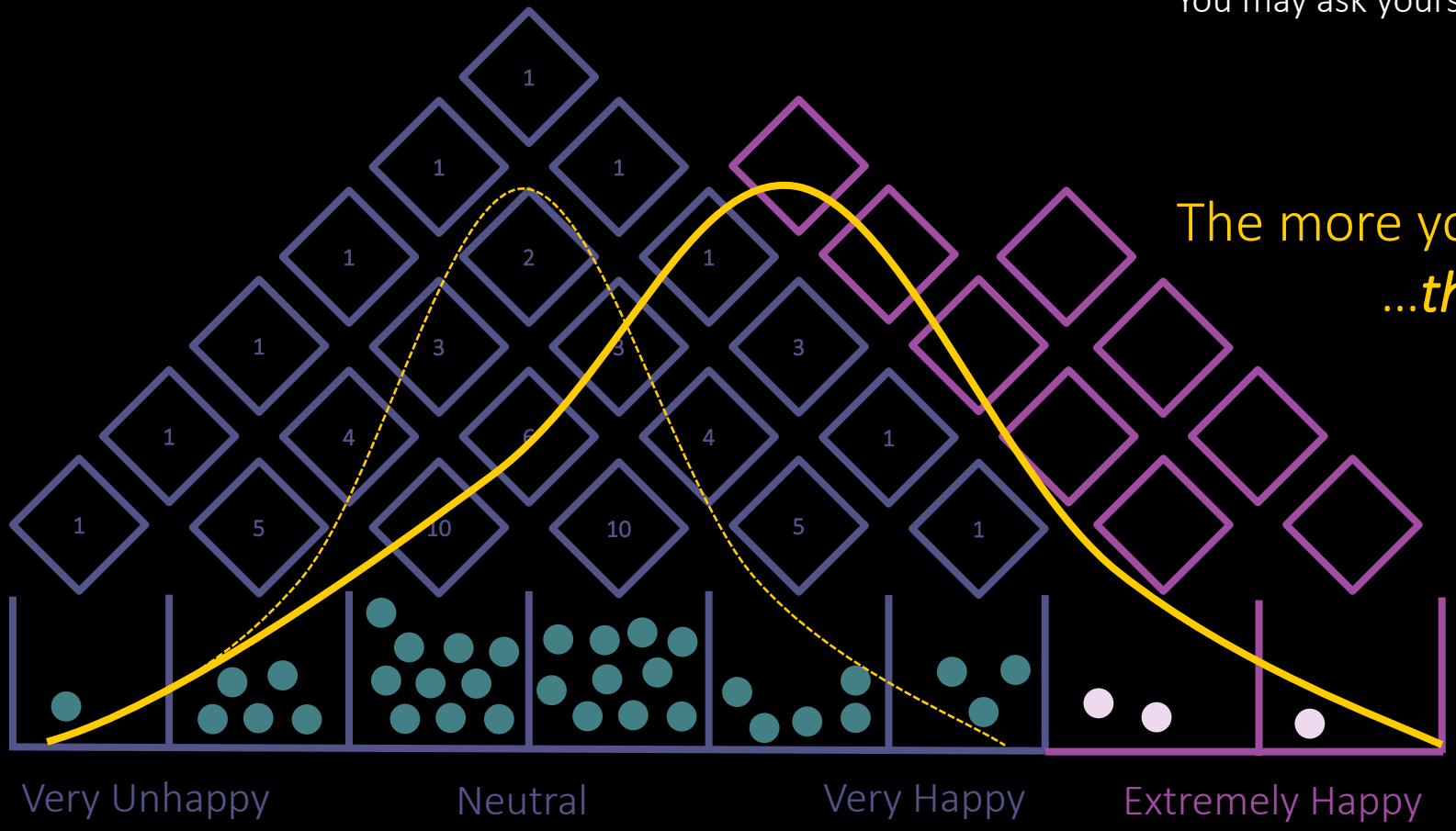
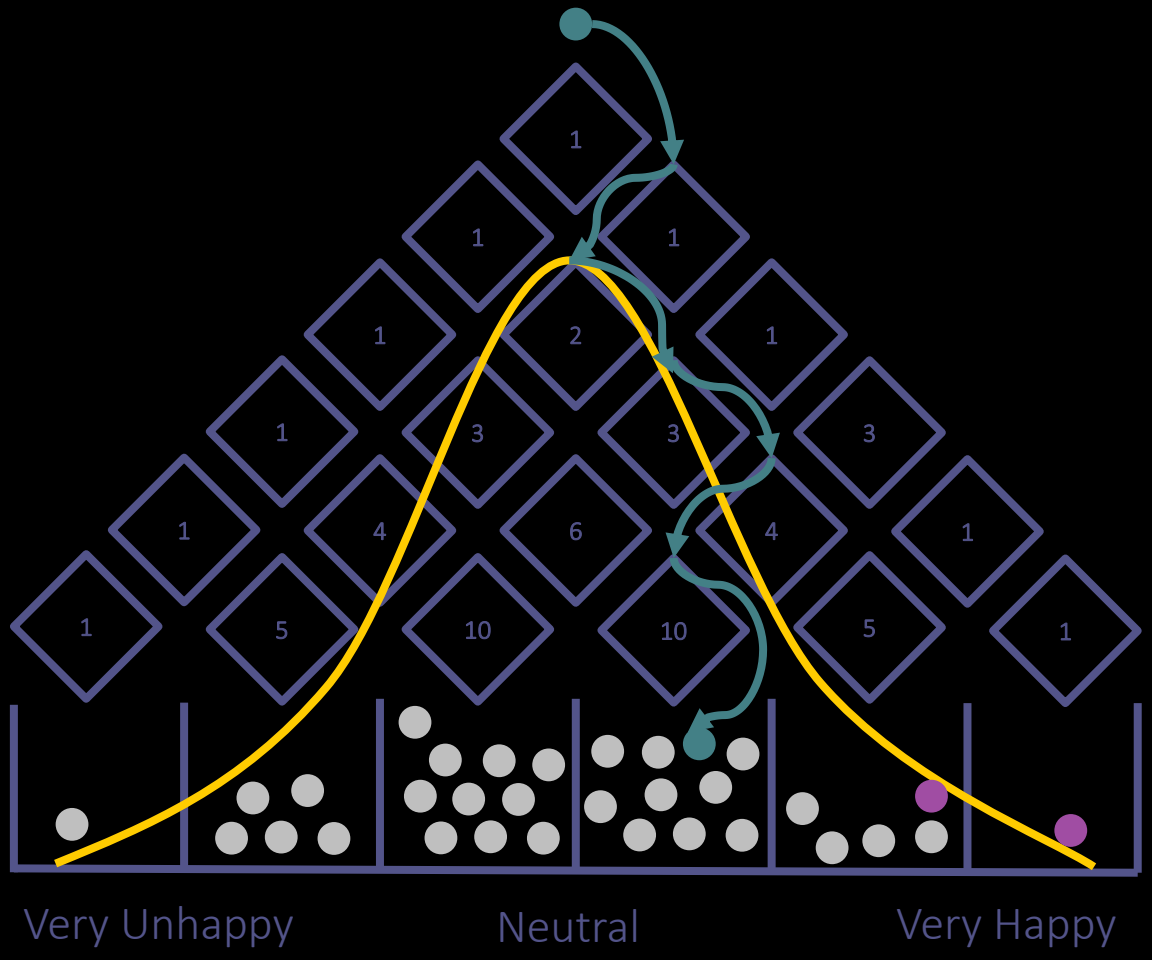
The more you know is out there…
…***the more you can plan for***.



Life on a Galton Board



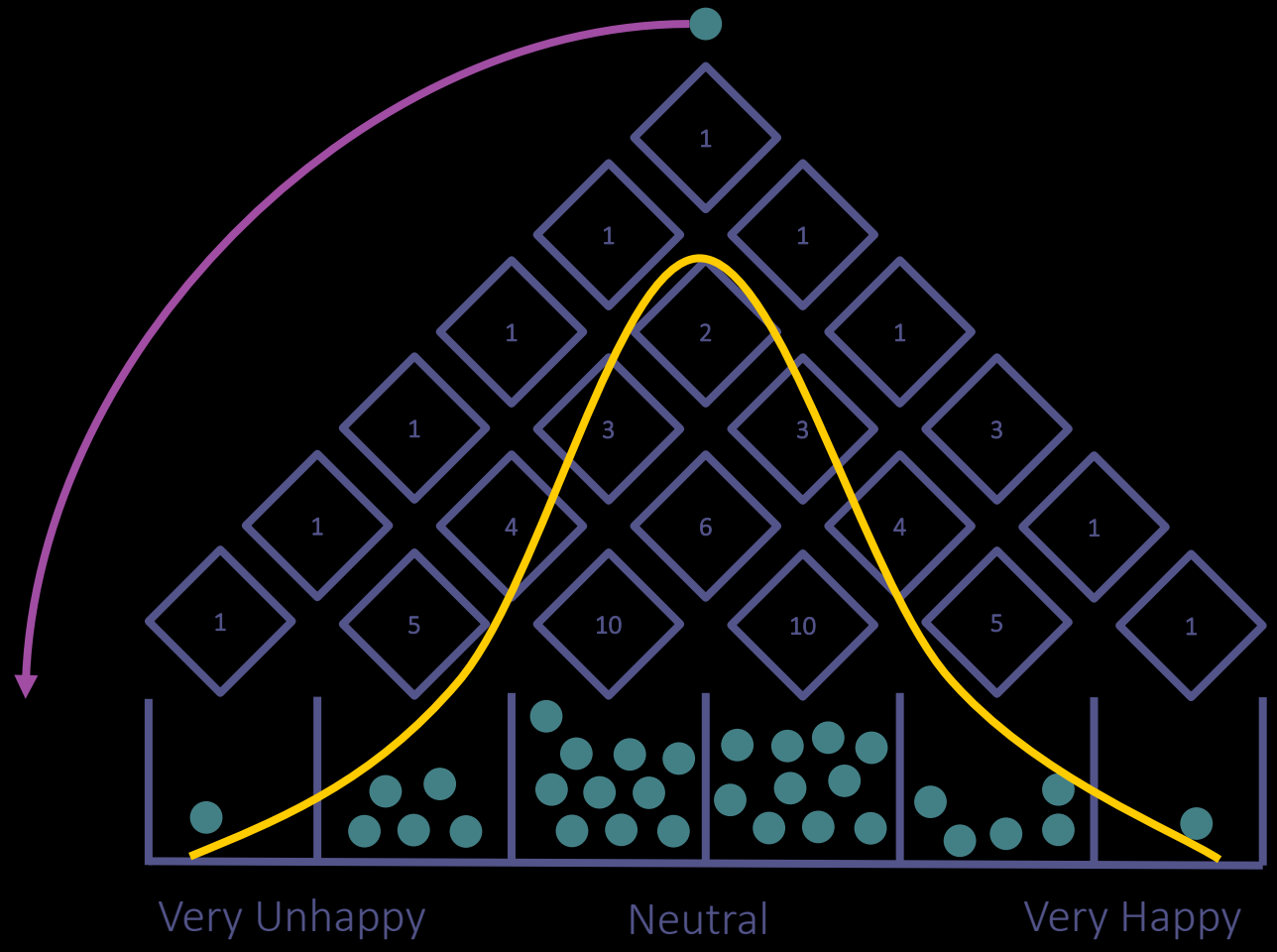
"And you may ask yourself, ***'Am I right? Am I wrong?'*** And you may say to yourself, 'My God! What have I done?'"

–"Once in a Lifetime" | Talking Heads

In comparing yourself to others…

…don't be fooled by randomness.

Life on a Galton Board



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A word of warning…

…it's easier to move left than right.

Quantum Theory of Wealth

Wealth Quantum	Wealth Level	Life State	Description	How do you get here?
1				
2				
3				
4				
5				
6				

Quantum Theory of Wealth

Wealth Quantum	Wealth Level	Life State	Description	How do you get here?
1	$100,000			
2	$1 Million			
3	$5 Million			
4	$25 Million			
5	$100 Million			
6	$1 Billion			

Quantum Theory of Wealth

Wealth Quantum	Wealth Level	Life State	Description	How do you get here?
1	$100,000	Subsistence	Life is a grind	
2	$1 Million	Stable	Ballin' on a budget	
3	$5 Million	Comfortable	Treat yo' self (but don't quit your day job)	
4	$25 Million	Independent	GTH money	
5	$100 Million	Controlling	Big fish in most ponds	
6	$1 Billion	Global	Bezos, Musk, Gates, etc.	

Quantum Theory of Wealth

Wealth Quantum	Wealth Level	Life State	Description	How do you get here?
1	$100,000	Subsistence	Life is a grind	Unstable career or failure after taking a big risk
2	$1 Million	Stable	Ballin' on a budget	Stable career in low paying field
3	$5 Million	Comfortable	Treat yo' self (but don't quit your day job)	Stable career in high paying field or some windfall income
4	$25 Million	Independent	GTH money	Extremely high performer in lucrative field (e.g., CEO of large company) or big windfall
5	$100 Million	Controlling	Big fish in most ponds	Take a risk and it pays off
6	$1 Billion	Global	Bezos, Musk, Gates, etc.	Take a risk and it *really* pays off

Your Theory of Wealth

It isn't important which wealth quantum you pick as a goal…

…instead, it's important that you think about your goals…

…and align your actions with them.

Your Theory of Wealth

–Kurt Vonnegut

The New Yorker, May 16, 2005

Your Theory of Wealth

"I've got something he can never have."

–Kurt Vonnegut

The New Yorker, May 16, 2005

Your Theory of Wealth

"I've got something he can never have."

"The knowledge that I've got ***enough***."

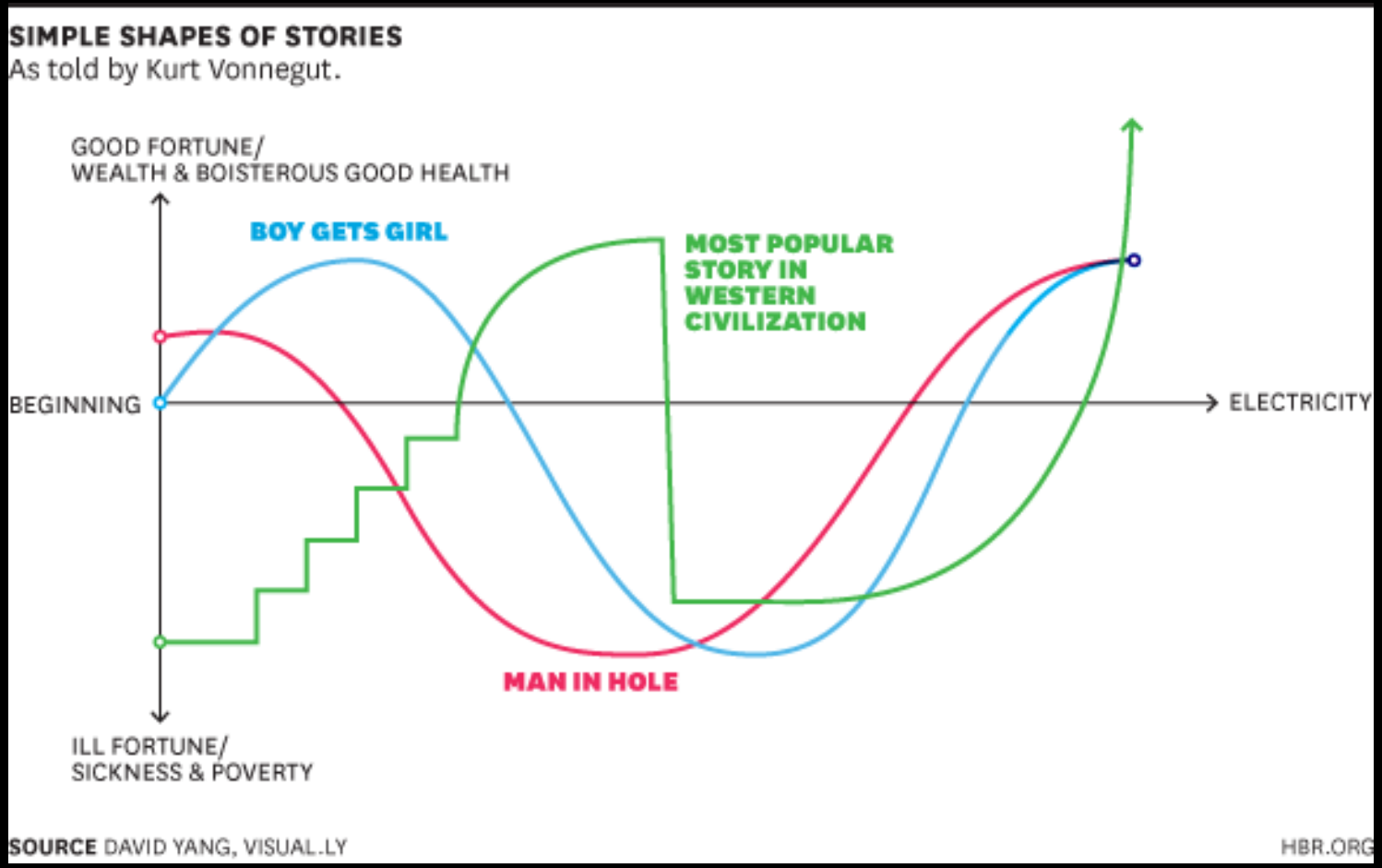
–Kurt Vonnegut

The New Yorker, May 16, 2005

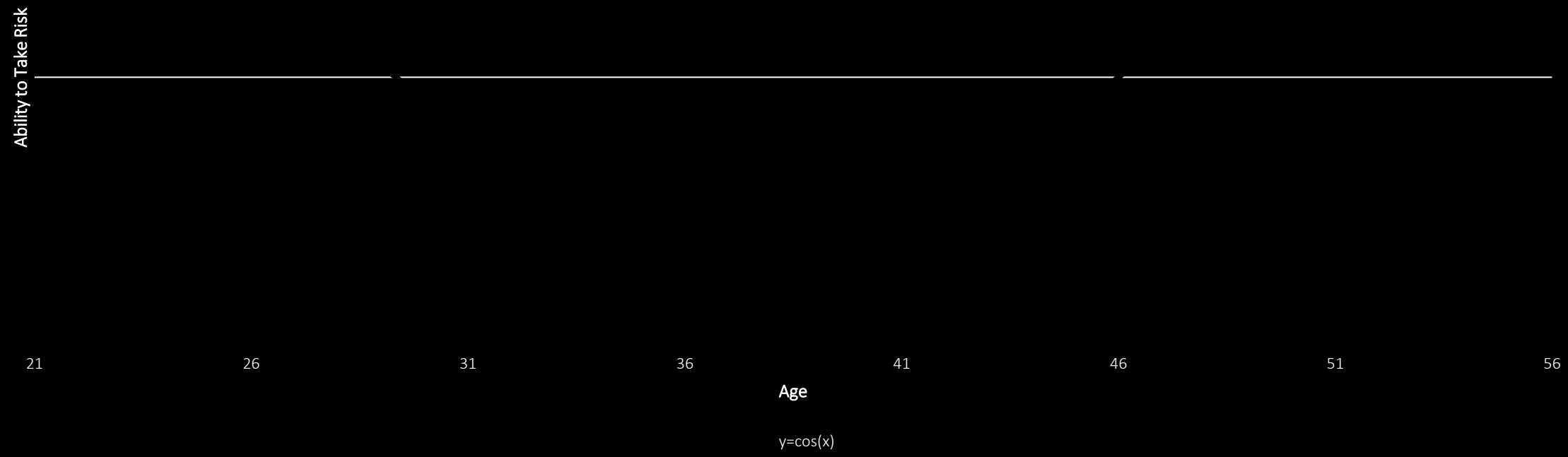
The Shape of Stories

"I wrote *another* thesis, about the *mathematical* shapes of stories. That one was rejected too."

The Shape of Stories



The Shape of [Risk] Stories



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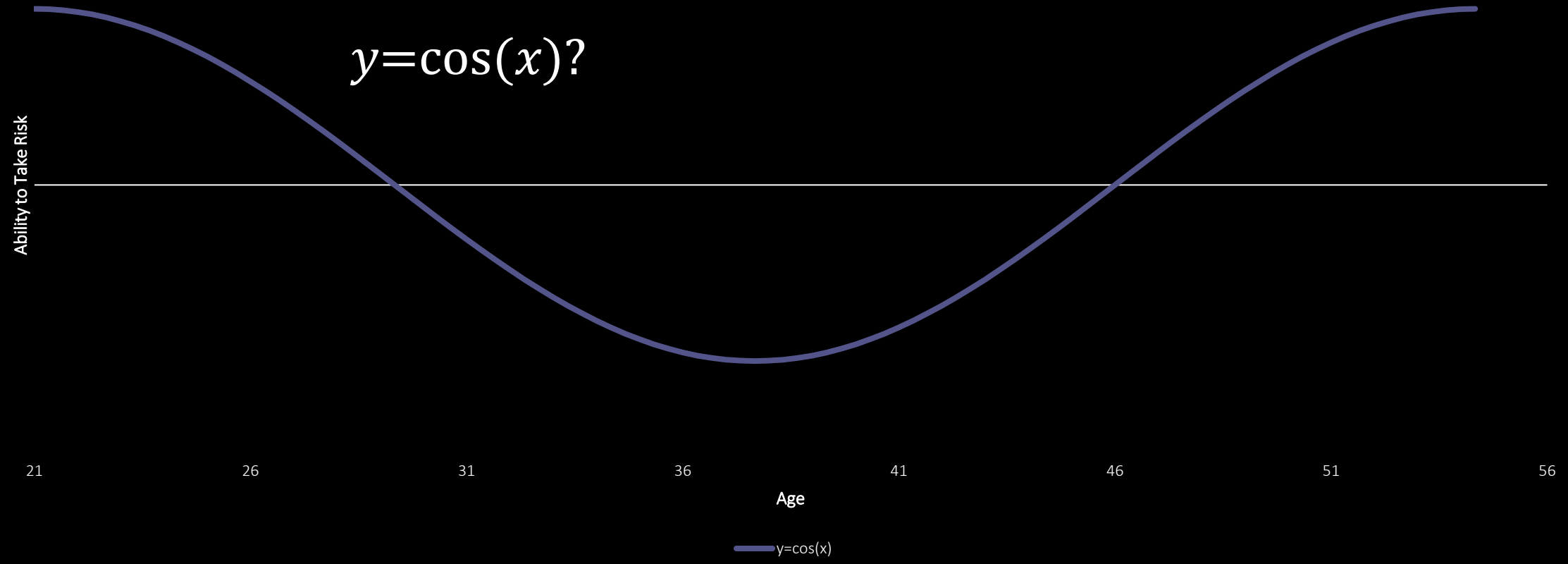

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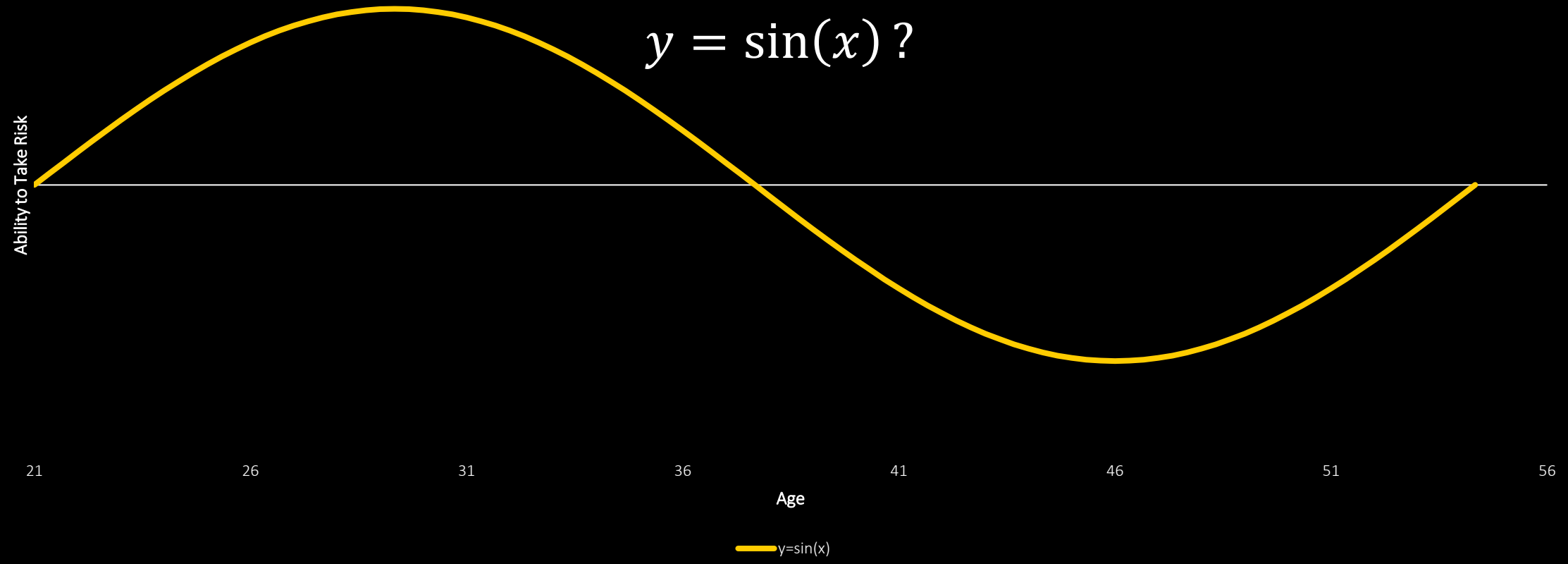
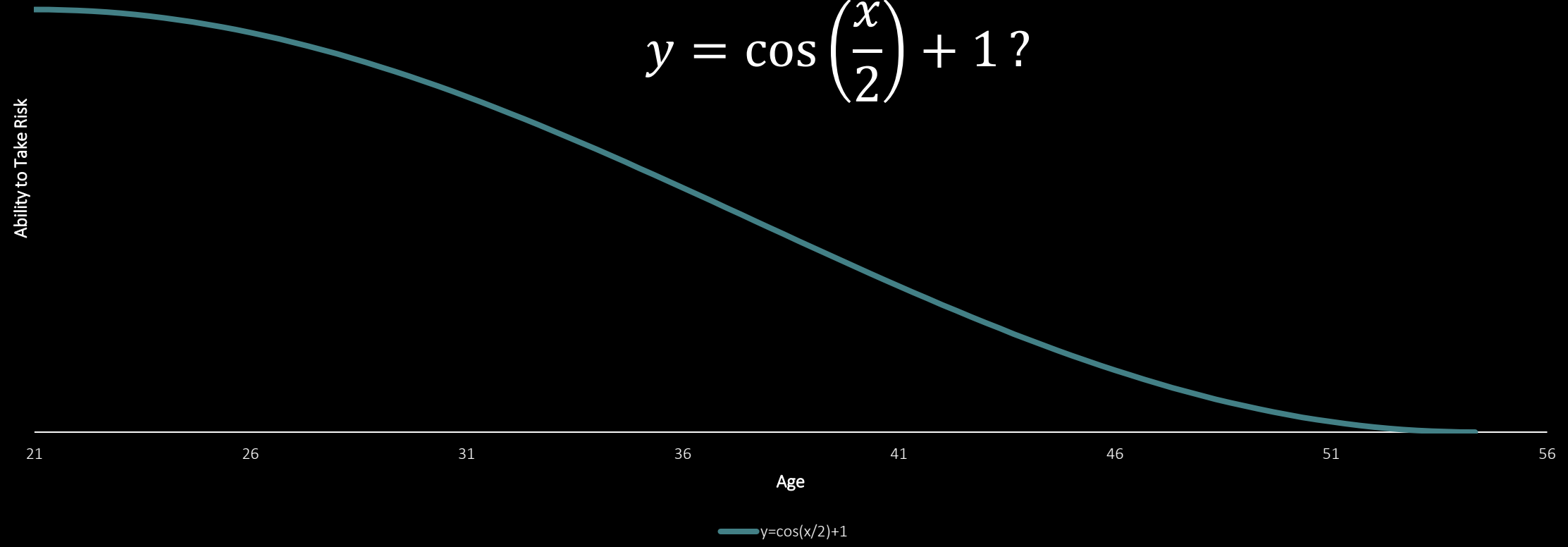


The Shape of [Risk] Stories

$$y = \cos\left(\frac{x}{2}\right) + 1\,?$$



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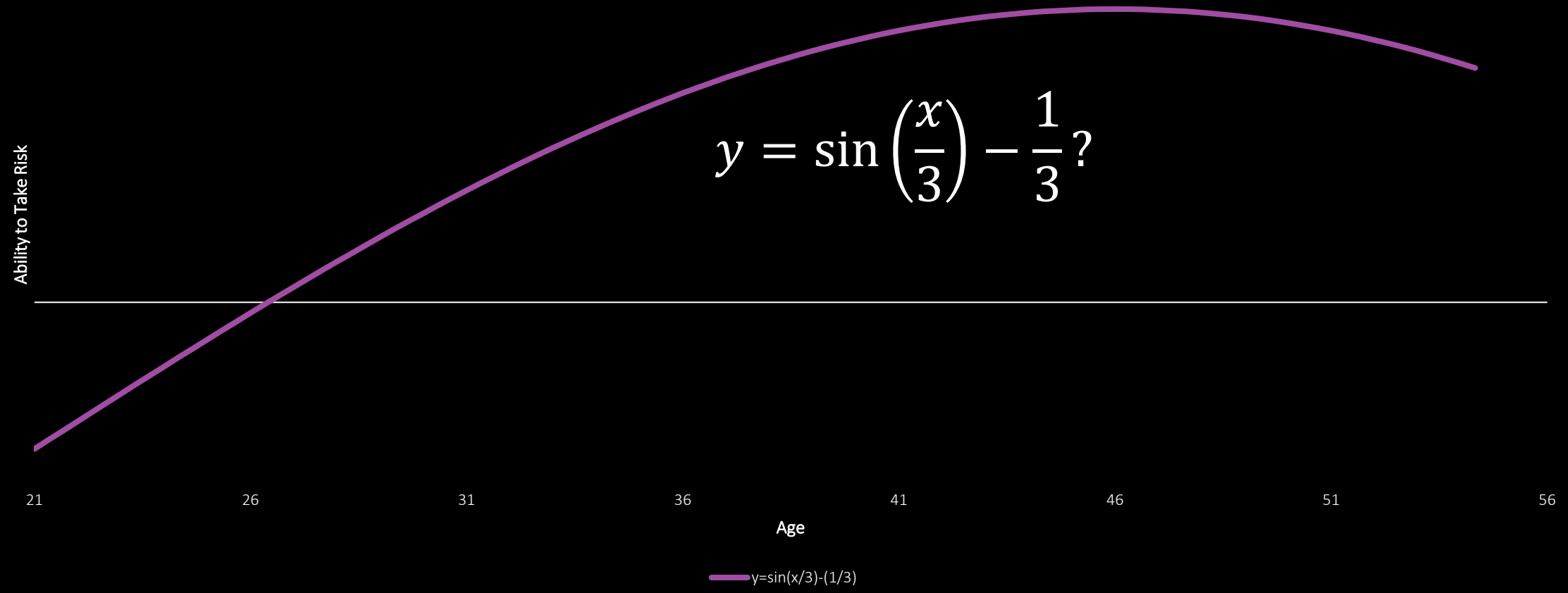
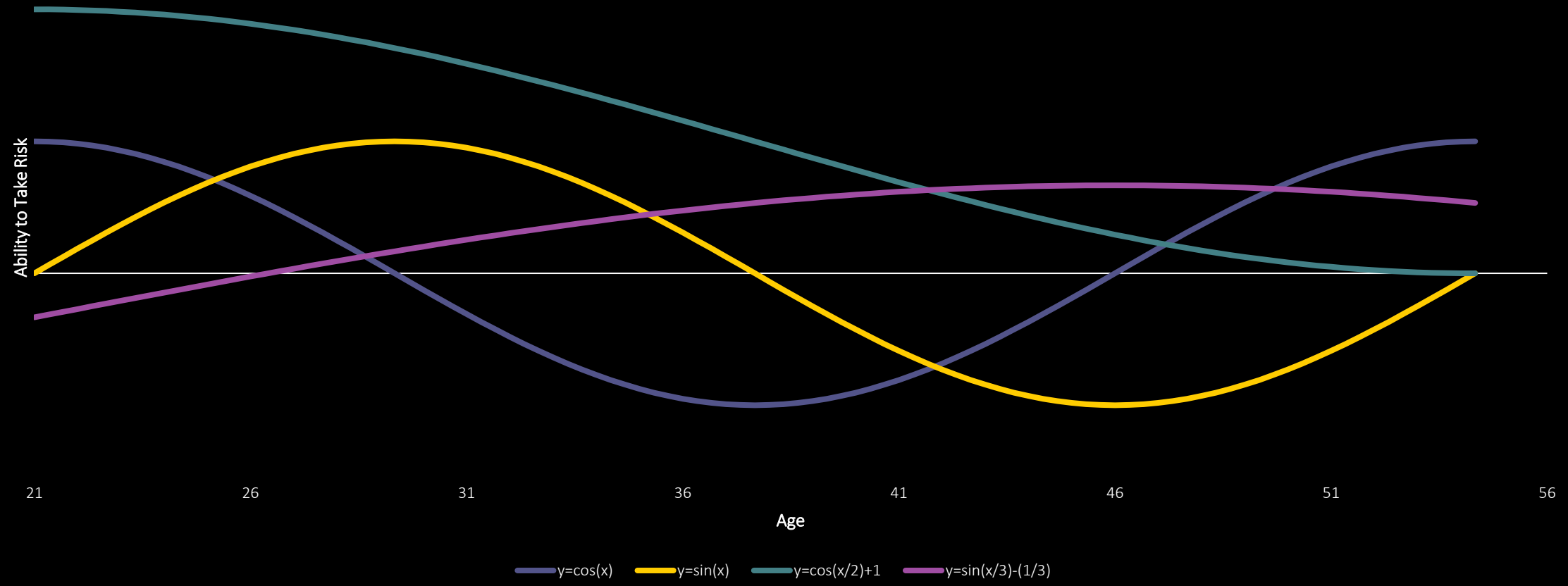
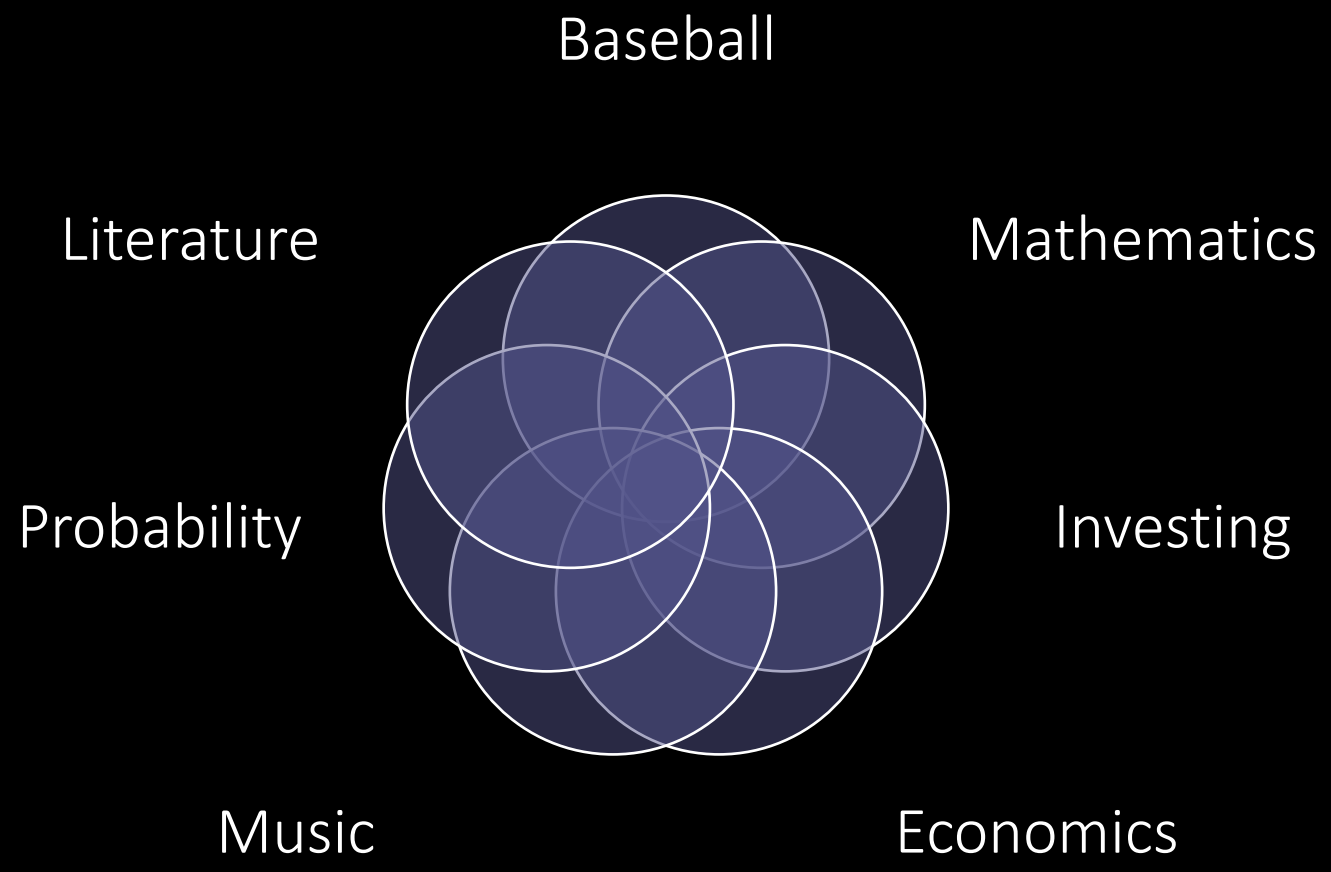


The Shape of Your Story?



How on earth is he going to tie this all together?

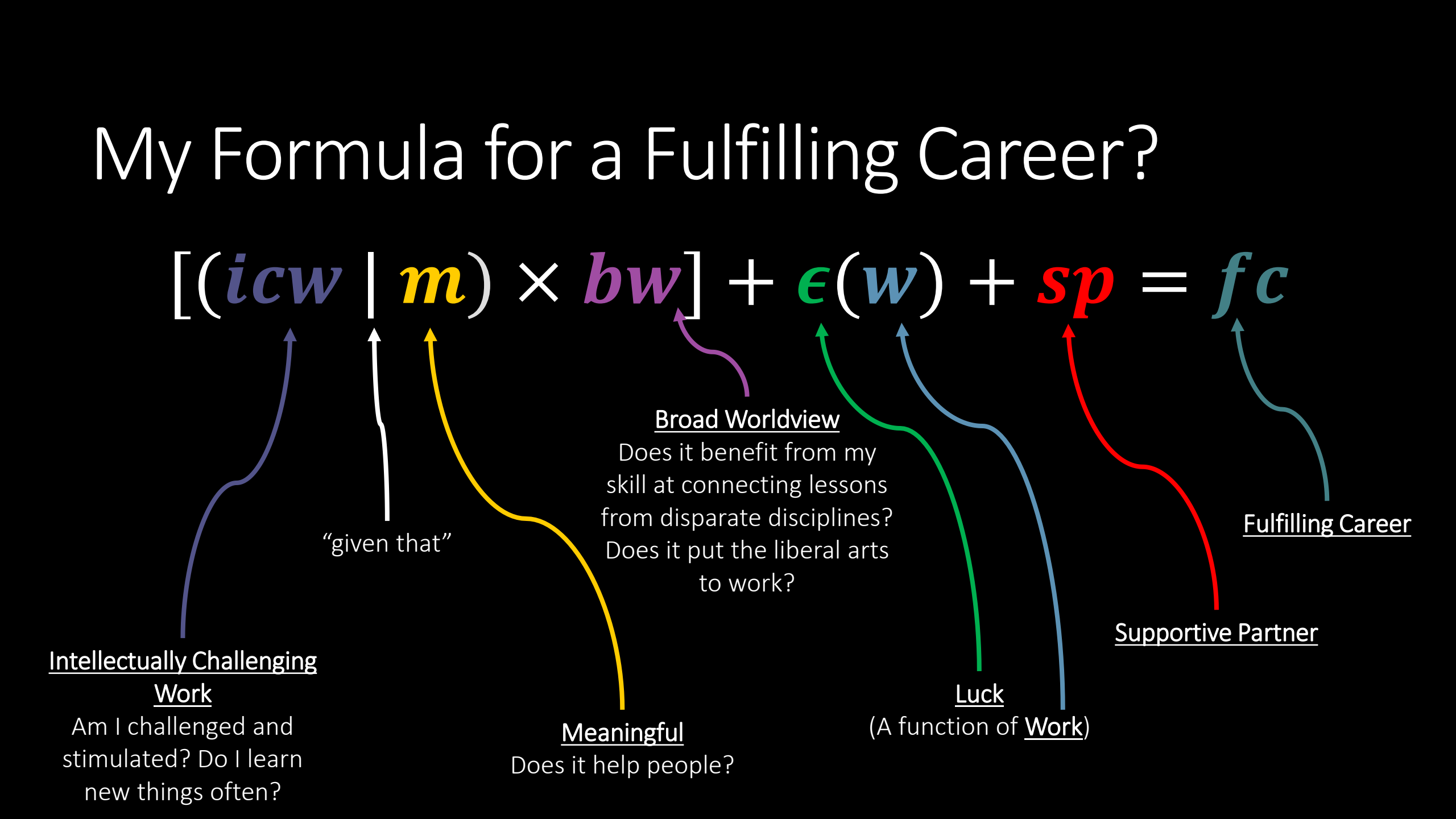
And will he tell us what the formula is for turning your passion into a career?


Baseball
Literature
Mathematics
Probability
Investing
Music
Economics

LIFE

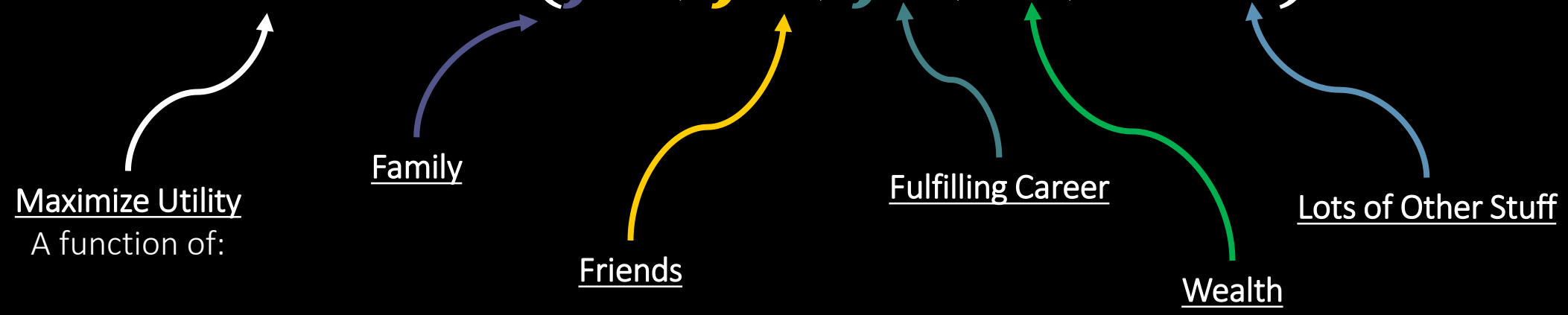
My Formula for a Fulfilling Career?

$$[(icw \mid m) \times bw] + \epsilon(w) + sp = fc$$



My Formula for Life?

$$\max. U(fa, fr, fc, \omega, etc.)$$



$$\text{s.t. } fa, fr, fc > \omega$$

My Formulas?

But the real secret is…

…*there really aren't any formulas*…

…there are lots of ways to get where you want to go…

…so, *get moving* and *don't stop*.

Ask Me (almost) Anything

Thanks for your attention… and sorry for all the formulas!