Quants & Wealth

Performance, Risk & Optimization Through the Wealth Lifecycle

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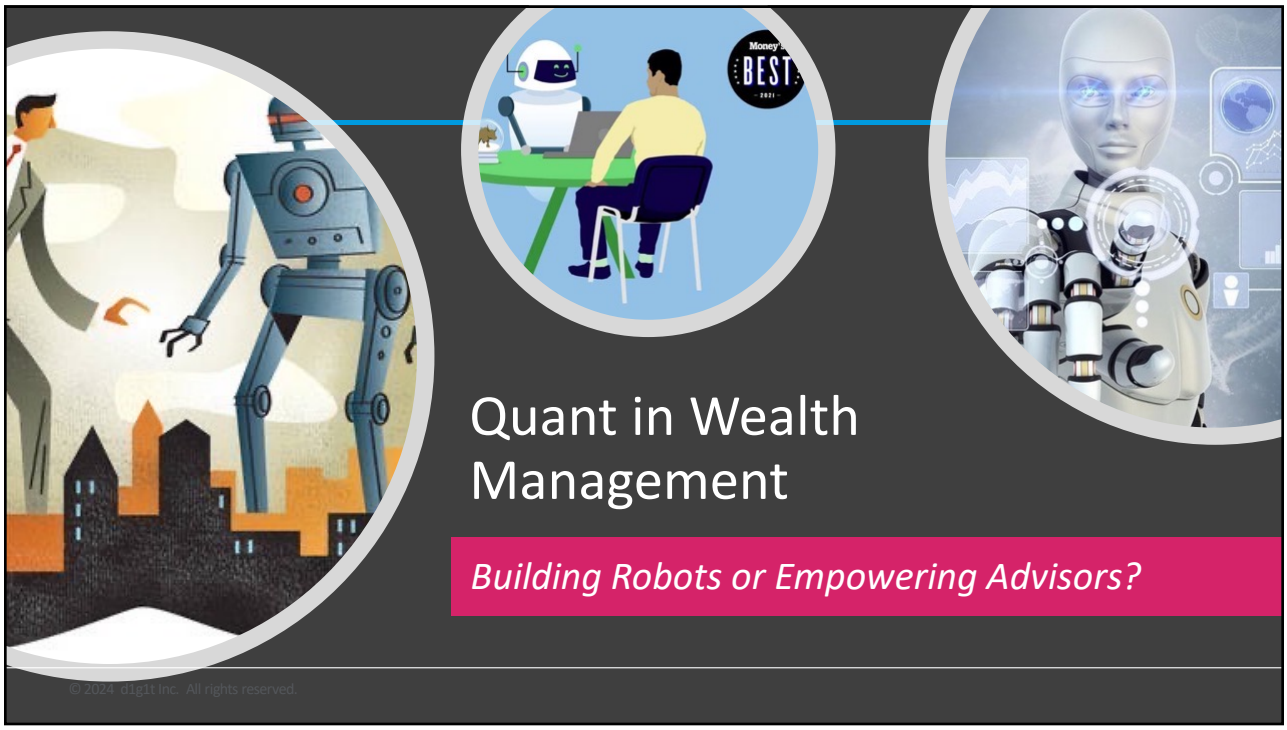
Dr. Dan Rosen
CEO, d1g1t

Outline

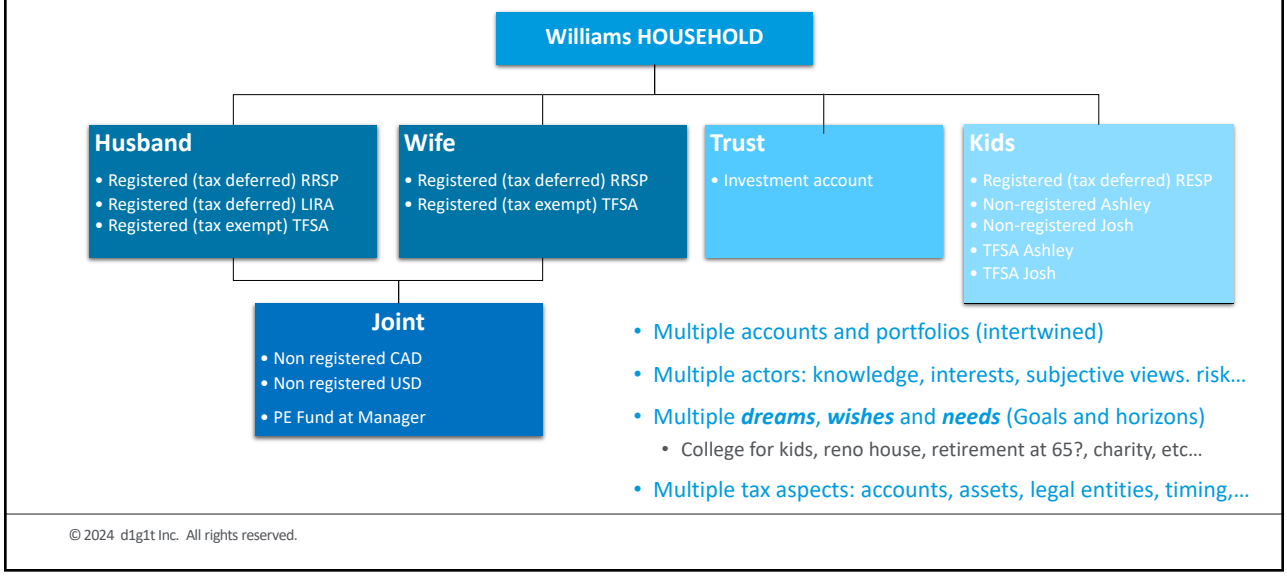
Introduction – Quants and Wealth Management (*The Problem*)

Performance & Risk Through the Wealth Lifecycle

Wealth Portfolio Optimization Process



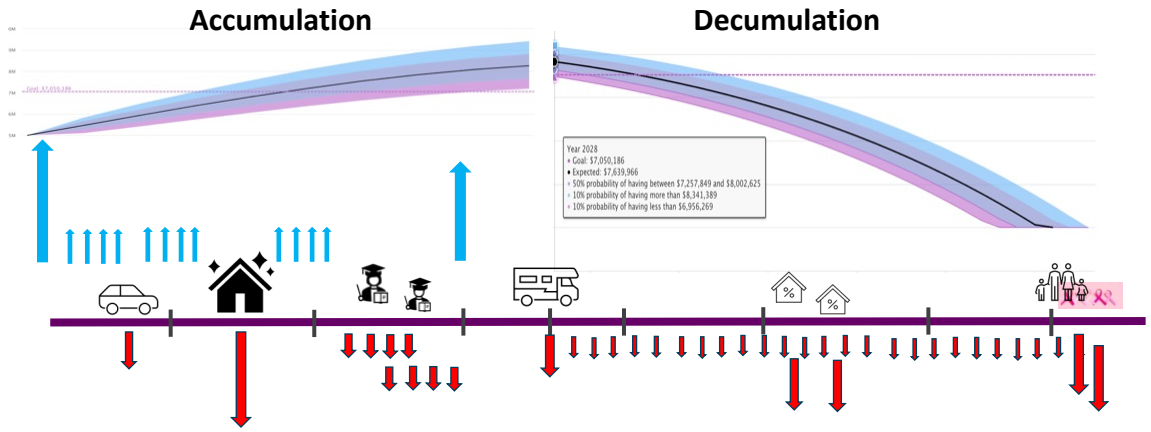
It All Starts with a Client/Family



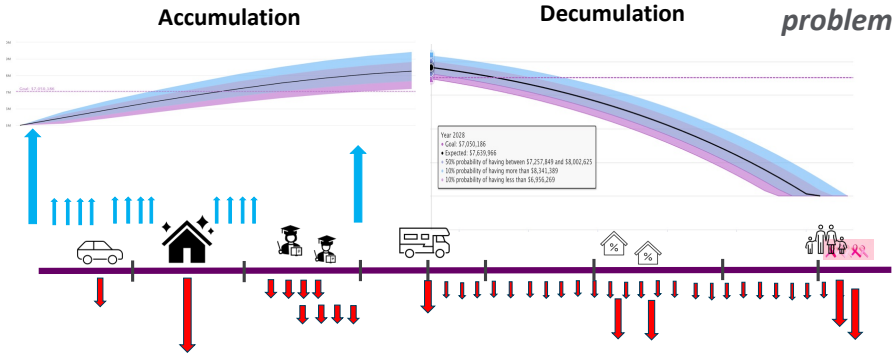
- Multiple accounts and portfolios (intertwined)
- Multiple actors: knowledge, interests, subjective views. risk…
- Multiple ***dreams***, ***wishes*** and ***needs*** (Goals and horizons)
  - College for kids, reno house, retirement at 65?, charity, etc…
- Multiple tax aspects: accounts, assets, legal entities, timing,…

Goals-Based Wealth Management

The General Problem



Goals-Based Wealth Management – The Problem

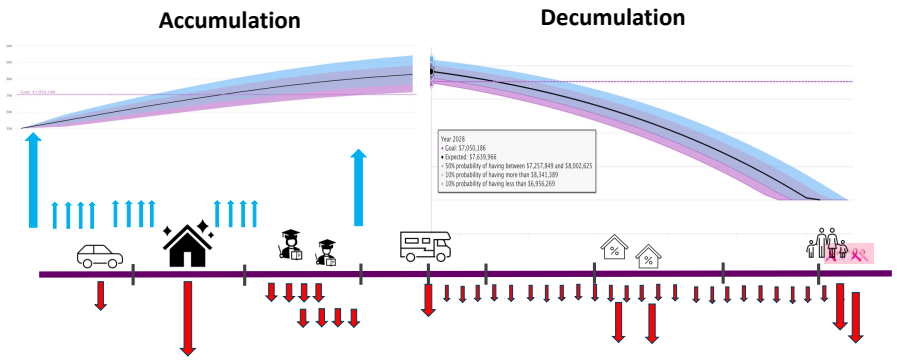


William Sharpe famously coined **decumulation** to be

"the nastiest, hardest problem in finance"

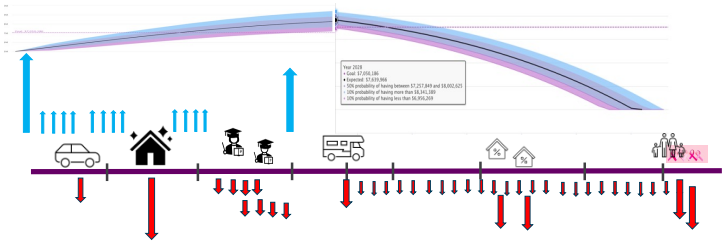
(Ritholz 2017)

Goals Based WM: Household Asset-Liability Management

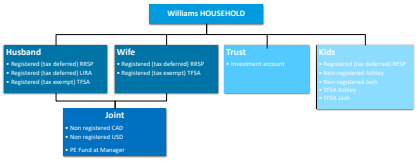


- Additional liquidity requirements and cash-flows
  e.g. private equity investments: funds capital calls, lock-up periods, etc…

Goals Based WM: Household Asset-Liability Management



Find the "Optimal" overall portfolio strategy for the Household



- Asset (risk-factor) allocation now
  - Across all members (legal-entities) and accounts (location)
- Dynamic allocation over time (long horizon)
- Dynamic decision making on funding or fulfilling goals (accumulation and decumulation)
- Alignment with clients' risk profiles… over lifecycle

In Practice… Financial Advice… for *Humans*

The actual problem is very complex!

Financial Advisors work with ***people*** (individuals, families) with human goals, feeling, fears, and (*not so rational*) reactions… and in the real (complex financial) world

- Truly hard to define precisely the problem to optimize (goals, tolerance, trade-offs, reactions)
- Multiple stakeholders, goals, times, levels (utility)
- Constantly changing over time
- Very sensitive to changing individual life circumstances, unexpected life events, markets (ups-downs)
- The "subject/client" itself is changing as well: Individuals' tolerance, appetite and understanding of risk change constantly (education, experience, life events, a financial crisis,…)
- Model assumptions… over long horizons
- The advice itself may create an important feedback loop!
- Difficult to capture complete picture – optimization is very sensitive to these assumptions and definitions

Adoption of Risk-Based Toolkit…

Must be careful on borrowing from banking and institutional applications

- For market risk, typically, short term
  - Banking: 1 day (trading) or 1-2 weeks (regulation)
  - Asset Management: longer, e.g. 1 month
- Used for controls/limits, trading, hedging, optimization
- Objective related to maximize risk adjusted returns
  (perhaps relative to a benchmark
  for Asset Management)

For wealth management… this is different…

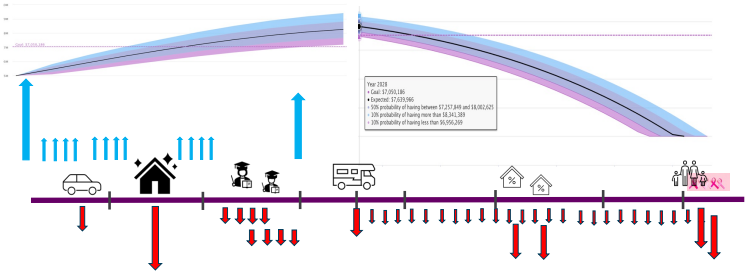
It's all About Risk… … but Risk is Not a Number….

Risk in wealth management involves more than just analyzing a portfolio

- Entire view of a family's wealth… not only a single investment portfolio
- Multiple portfolios and accounts… and tax implications…
- A client's (family's) risk capacity/tolerance/appetite
- Multiple goals and timelines… over long horizons (5, 10, 20, 50 years)
  - Accumulation (pre-retirement) and decumulation (post-retirement) periods
- Scale… if you are a successful advisor, you likely have a large number of clients that you want to manage efficiently…

Risk in The Wealth Management Problem

- Investment and Portfolio risk (long investment horizon)
  - Market risk (mostly)
    - Multi-asset: equities, FI, commodities, private equity/credit,…
    - Inflation risk (long investment horizon)
- Goals-based risk
- Liquidity risk
- Longevity risk
  - LTC Risk (Long Term Care)
- Client's "Behavioural" Risk



The Wealth Management Risk Cycle

It All Starts with a Client/Family

Investor's Risk Profile

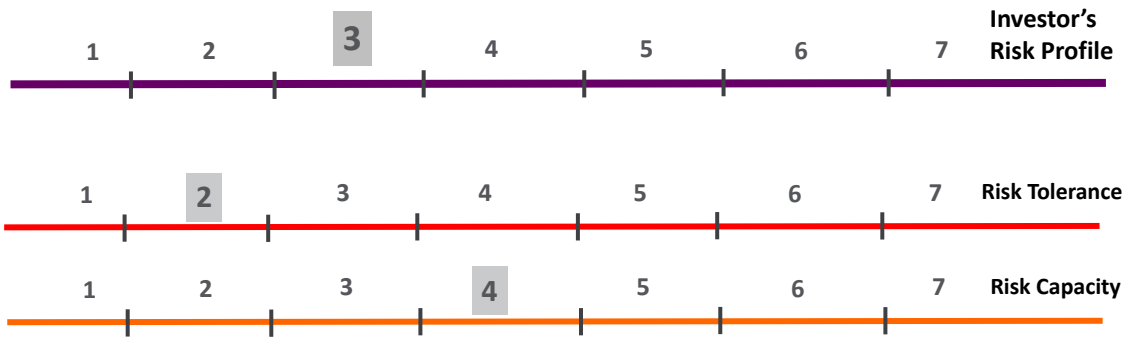
Multiple metrics are needed to characterize an "Investor's Risk"

- **Risk Capacity** – how much risk you can handle financially
- **Risk Tolerance** – how much risk you can withstand emotionally
- **Risk Appetite** – willingness to bear financial risk (with expectation of generating a potential profit)
- Financial knowledge
- Information appetite

Risk return trade-off / risk aversion

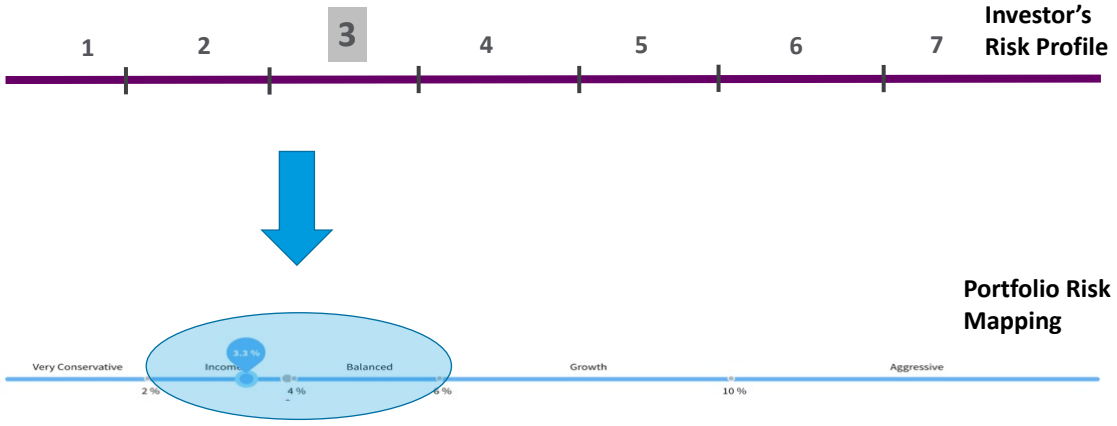
Tools include: Behavioural Finance and Psychometrics

Investor's Risk Profile



Household/Family: risks profiles defined for the entire household and members

Aligning Risks across the Cycle



The Wealth Management Risk Cycle

Goals reflect an investor's (individual or household)

- Needs
- Wants
- Wishes
- Dreams

Goals & Risk

Goals reflect an investor's (individual or household) needs, wants, wishes and dreams

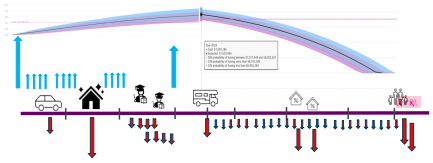
Typical risk measures reflecting future short-term portfolios losses do not relate directly to goals

- e.g. VaR, expected shortfall, volatility, drawdown…

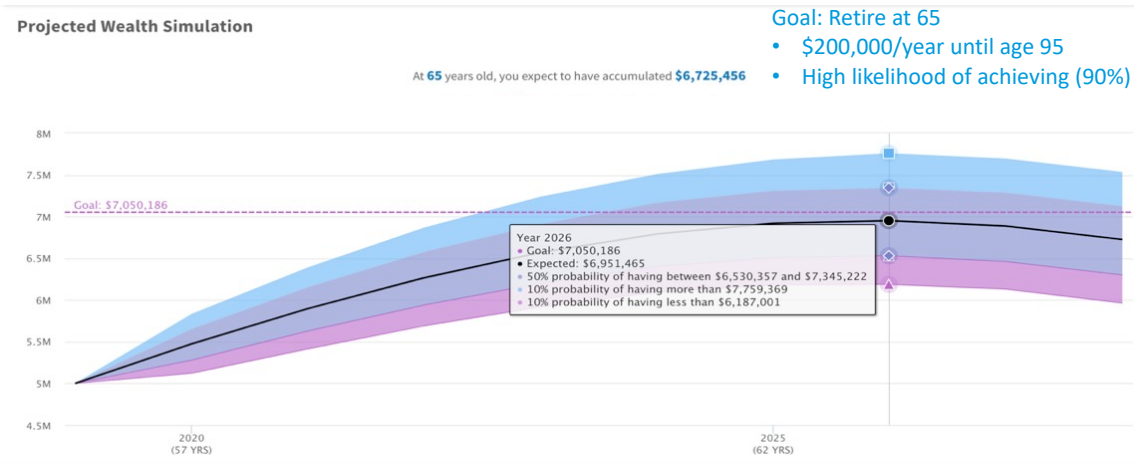
Goal-based Risk → the possibility of not achieving goal(s) in the future, how far we will be, and the severity/consequences (for an investment strategy over time)

Relevant metrics

- Probability of meeting goal(s)
- Distance to meet goal (for a given strategy and scenarios)
- Expected shortfall (conditional on not meeting goal)
- Trade-offs between competing goals (of different importance)



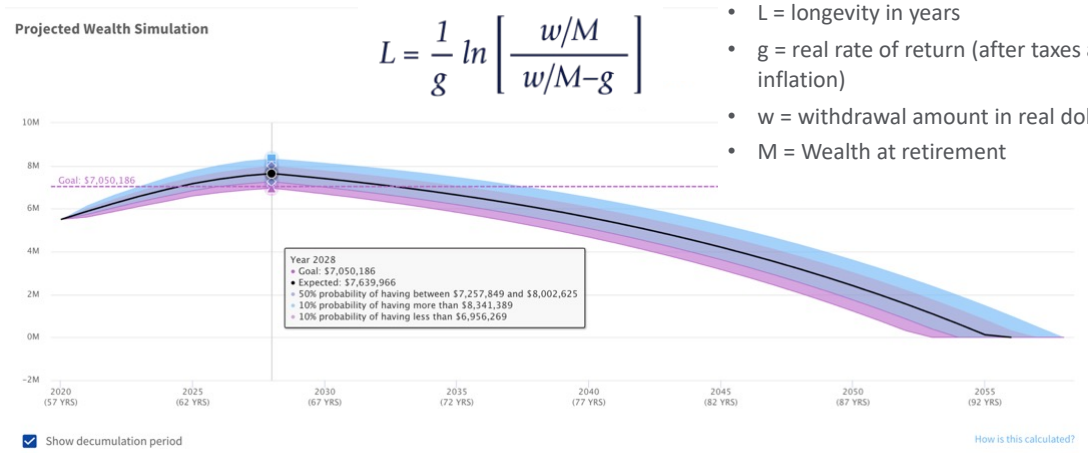
Long-Term Wealth Simulation – Example



Goal: Retire at 65

- $200,000/year until age 95
- High likelihood of achieving (90%)

Long-Term Wealth Simulation (Retirement Income & Decumulation)



$$L = \frac{1}{g} \ln\left[\frac{w/M}{w/M - g}\right]$$

Simple Longevity formula (Fibonacci)

- L = longevity in years
- g = real rate of return (after taxes and inflation)
- w = withdrawal amount in real dollars
- M = Wealth at retirement

The Wealth Management Risk Cycle

Investment Plans, Mandates, IPSs

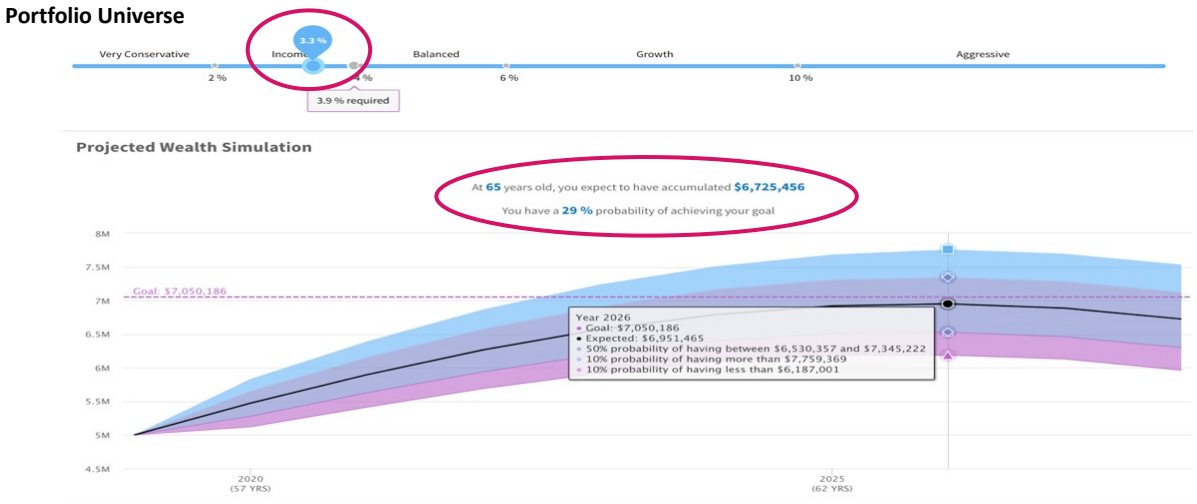
In practice, this needs to be realistic

- Multiple goals and timelines
- Multiple actors: different risk profiles and timelines
- Multiple sources of funding (different rules, taxes)

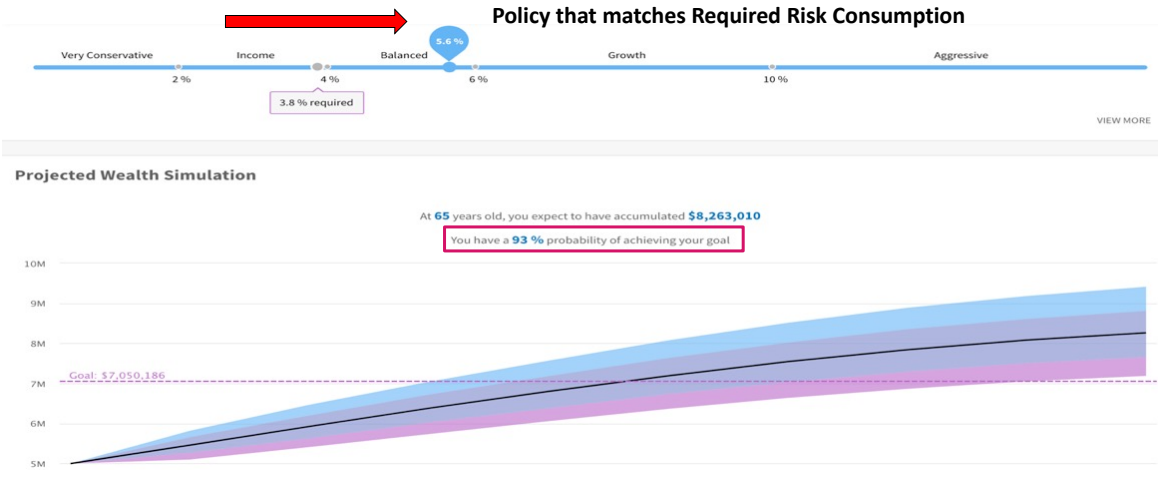
Solution must be actionable: easy to execute, track, and communicate

- Multiple mandates/sub-mandates acting together
- Funded through multiple accounts and financial vehicles (e.g. trusts and insurance)

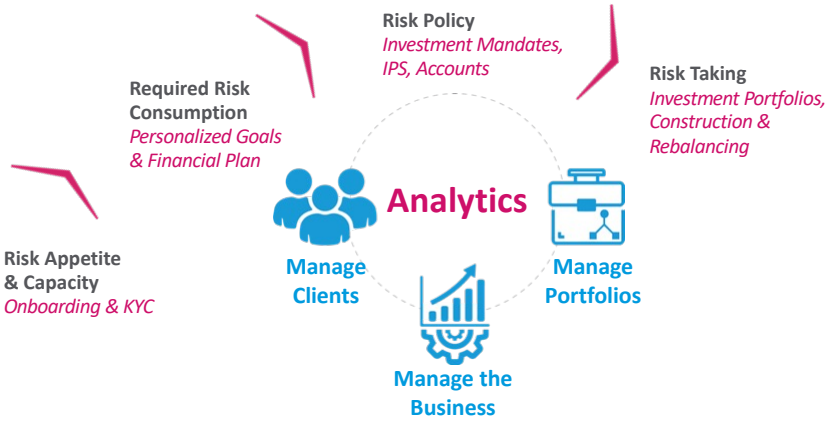
Risk & Goal Based Wealth Management



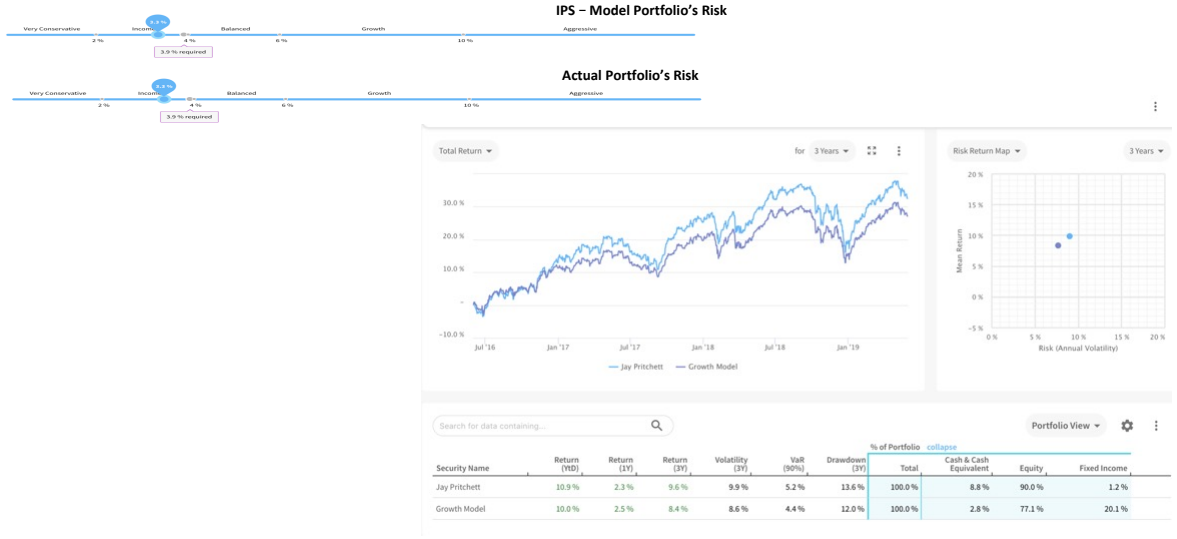
Risk & Goal Based Wealth Management



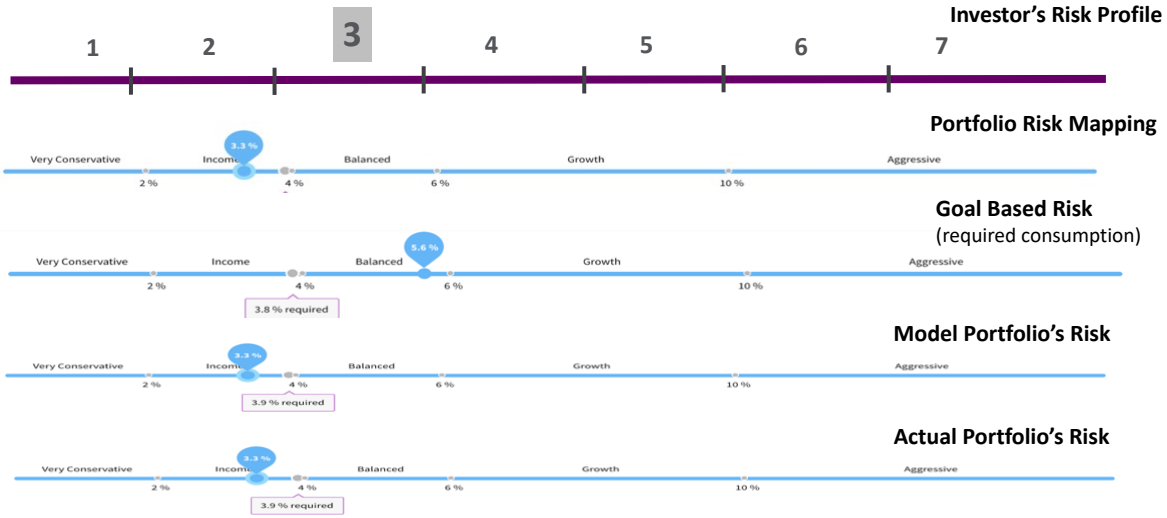
The Wealth Management Risk Cycle



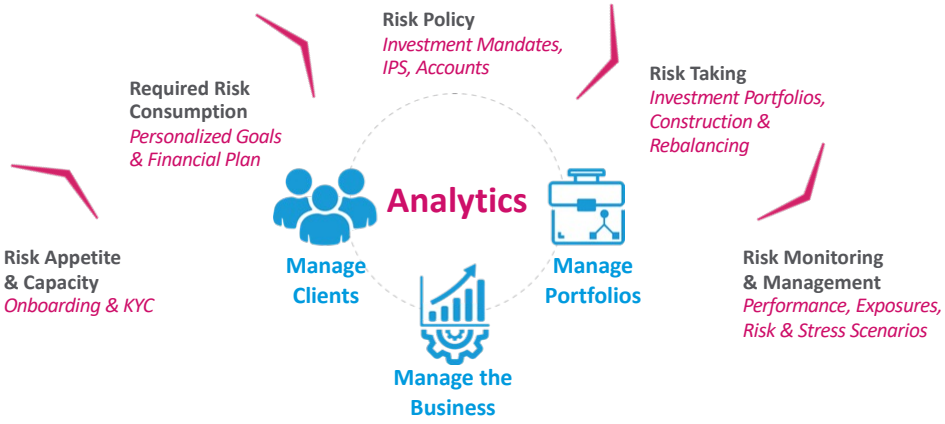
Constructing & Rebalancing Portfolios



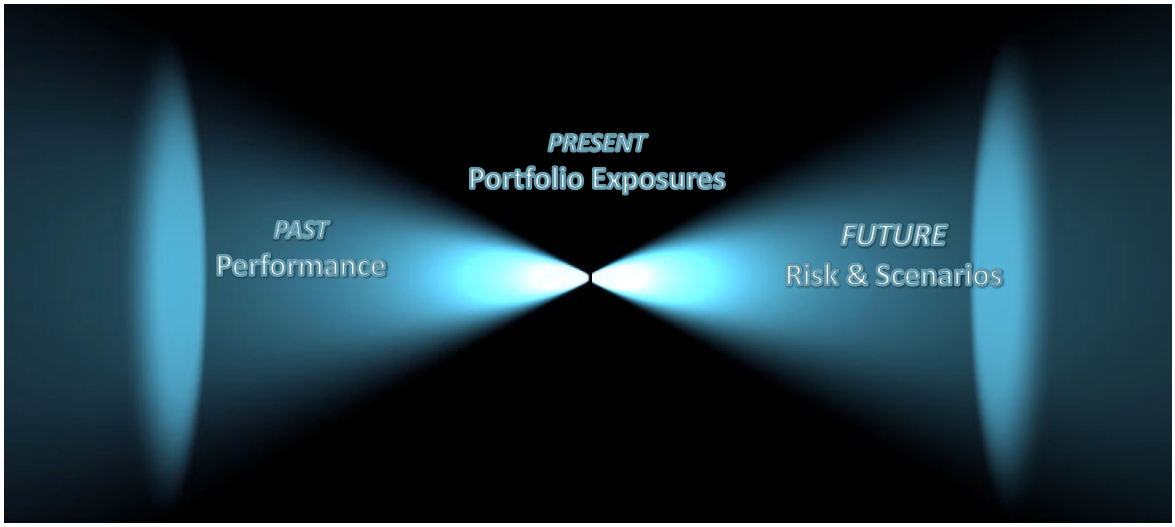
Aligning Risks across the Cycle – Tracking Mandates & Portfolios



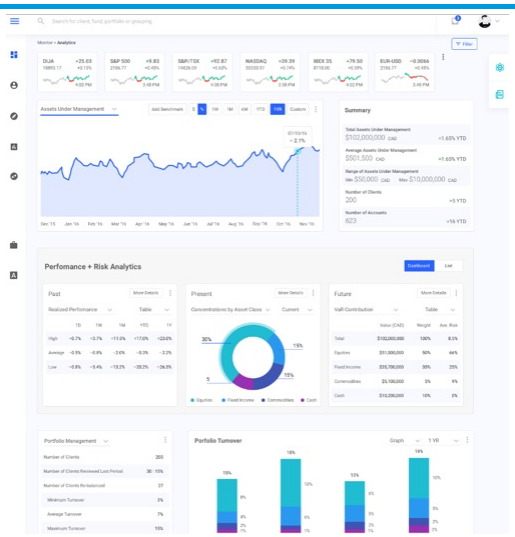
The Wealth Management Risk Cycle



Risk Monitoring – Investment Light Cone Analytics



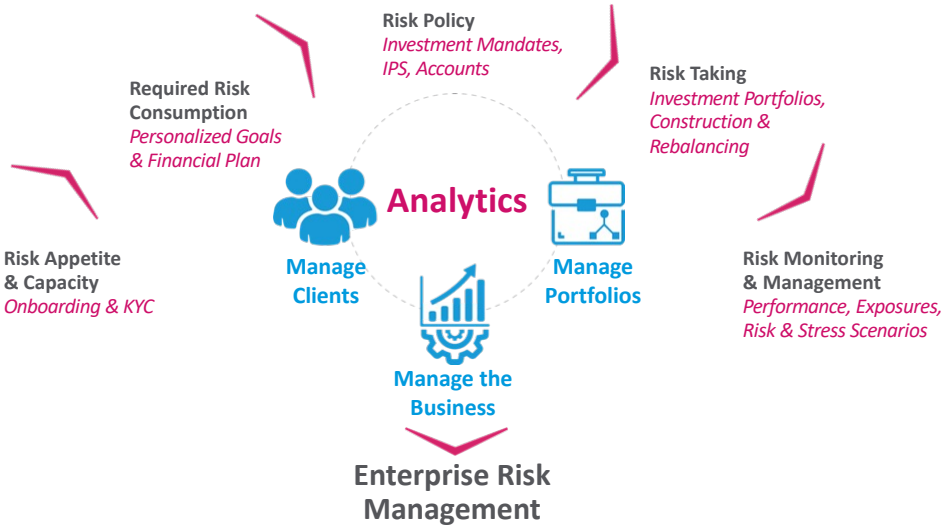
Monitoring Portfolios: Exposures, Performance, Risk



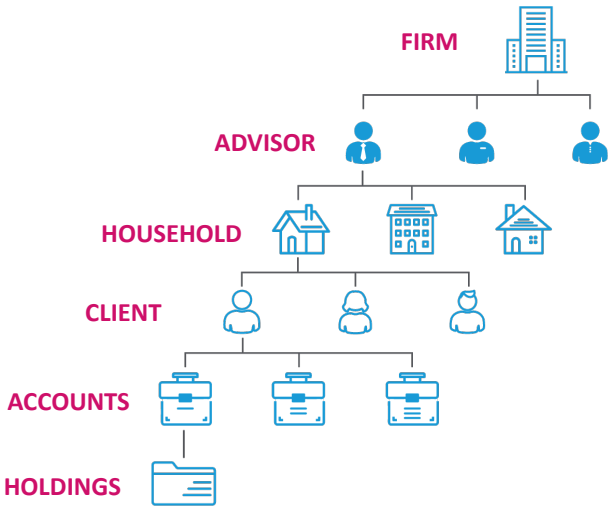
Tracking Portfolios…
and understanding causes:

- Exposures: slice & dice
- Performance attribution
- Risk contributions
- Scenario Analysis
- Risk factor analysis and decomposition
- Cashflow forecasts

The Wealth Management Risk Cycle



Manage the Business – Enterprise Wealth Analytics



- Firm AUM growth, Revenues, Advisor Performance, Key Trends
- Advisor AUM, Inflows/Outflows, # of clients, Largest Clients,
- Household Wealth, Allocation, Overall Exposure, Performance & Risks, Investment Flows
- KYC, Risk Profile – Goals – IPS – Portfolios, Client Stories
- Optimal Tax Allocation, Realized & unrealized gains, Tax Reports
- Security/Fund Performance & Risk, Active Returns (Comparables), PE/Alts Analytics

Wealth Management **Risk** and **Performance** Metrics

Behavioural

- **Risk Tolerance**
- **Risk Capacity**
- **Risk Appetite**

ALM/Household Treasury

- **Gap Risk**
- **Shortfall**
- **Prob of achieving goal (distance to Goal)**
- **Liquidity**

- Exposures

- Performance attribution

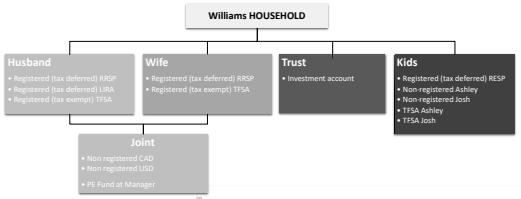
- Portfolio Risk & diversification

- **Market Risk (short & long-horizon)**
- **Credit Risk**
- **Liquidity Risk**

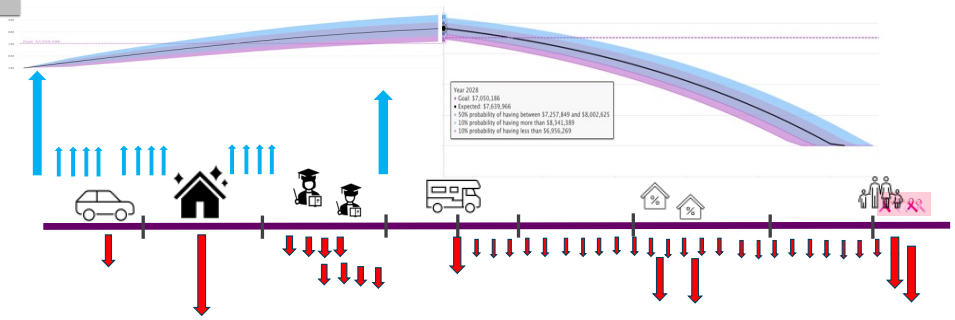
- Stress Scenarios

Wealth Portfolio Optimization …. at Scale

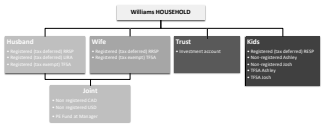
The Mother-of-All Portfolio Optimization in Wealth Management

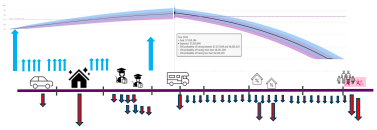


Find the "Optimal" overall portfolio strategy for the Household



The Mother-of-All Portfolio Optimization in Wealth Management

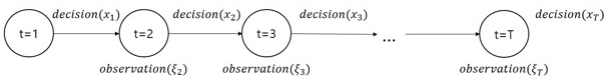




"Optimal" Household portfolio strategy

- Maximize multi-criteria utility function: multiple goals over time
  - Inflows and outflows (consumption), terminal wealth (or at
- Long horizon (covering accumulation and decumulation)
- Accounting for taxes, risk profiles, stochastic markets
- Rich scenario set (multi-factor forecasting model)
- Takes best advantage of investment universe available ("efficient portfolios")
- Complex constraints: consistent with multiple client risk/investment preferences, liquidity, compliance/regulatory (tax)

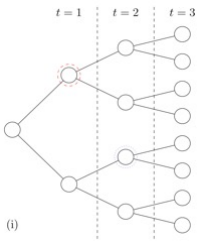
General Formulation: Multistage Stochastic Optimization



Decision Process $\boldsymbol{x}$: allocations, in/out-flows, fulfil goals

Stochastic Process $\boldsymbol{\xi}$: evolution over time of all investments

$$\min_{x_1 \in \mathcal{X}_1} f_1(x_1) + \mathbb{E}_{\xi_2}\left[\inf_{x_2 \in \mathcal{X}_2(x_1,\xi_1)} f_2(x_2,\xi_2) + \mathbb{E}_{\xi_3}\left[\cdots + \mathbb{E}_{\xi_T}\left[\inf_{x_T \in \mathcal{X}_T(x_{T-1},\xi_T)} f_T(x_T,\xi_T)\right]\right]\right].$$



Multi-stage Stochastic Programing approach (e.g. Dempster et al, Mulvey et al)

1. Scenario tree approximates the stochastic process ξ (finite number of realizations)
2. Solve large equivalent deterministic convex optimization problem under realized scenario tree

Curse of dimensionality (may lead to intractable problem)

- Number of scenarios increases exponentially with the number of stages and nodes per stage (dimensionality of process….)

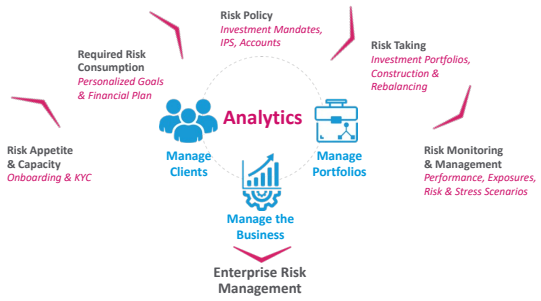
Stochastic Dynamic Programing (e.g Das et al)

- Markov processes, explicit conditional probabilities, low dimensionality

Machine Learning methods: Reinforcement learning, Neural Networks (e.g. Dixon & Halperin, Forsyth et al)

- Applicable to general setting, non-parametric data-driven processes… but may be slow and lack explanation

Wealth Portfolio Optimization
Efficient Portfolio Manufacturing and Client Management at Scale!



Objective: provide **personalized**, and **high-touch** portfolio investment programs for 100s or 1000s of clients in an efficient manner

- Understand the entire book of business
  - Pro-actively (instead of reactively) address which clients
    - Require more attention
    - Can take advantage of an opportunity
    - Are more affected by a given market event…
- Dynamic, interactive engagement with a given client to define what is important and understand trade-offs
- Realistic: account for uncertainties and lack of precise definition and changes over time

Quant Portfolio Manufacturing Process

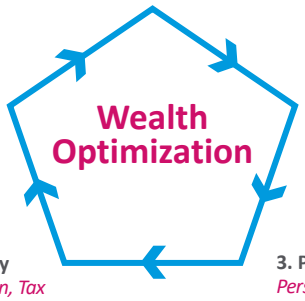
1. Product Manufacturing
Efficient Portfolios/ Model Portfolios

2. Dynamic Risk Allocation
Consumption & Funding: Goals, Liquidity Management

3. Portfolio Customization
Personalized, Client Specific Portfolios

4. Tax efficiency
Account Location, Tax Harvesting, etc…

5. Risk Monitoring & Management
Performance Attribution, Exposures, Risk & Stress Scenarios



Scalable process to construct ***Effective*** Portfolio management strategies for all clients

We achieve this by:

- Breaking the process into a set of steps that are

  Manageable & ***Repeatable***

- Taking advantage of the best financial optimization, risk management and ML tools available

Quantitative Portfolio Manufacturing Process

1. Product Manufacturing
Efficient Portfolios/ Model Portfolios

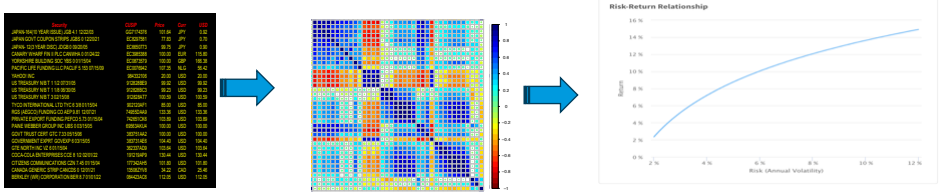
Efficient Portfolios & Model Portfolios

Construct set of optimal model portfolios or investment programs, based on available investment vehicles and expertise (available for all clients… segmented)

- Define *Investment Universe* (opportunities)
- Asset allocation, risk factor allocation, diversification
- Advanced optimization toolkit: e.g. Black-Litterman, Bayesian models, etc…

Output: full set(s) of "efficient" **general Model Portfolios**

Investment Universe



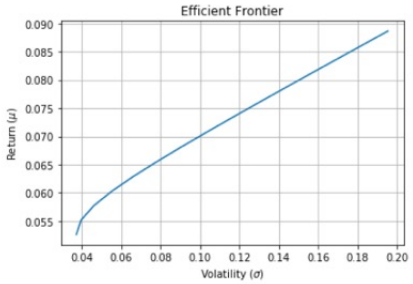
Quantitative Portfolio Manufacturing Process

1. Product Manufacturing
Efficient Portfolios/ Model Portfolios

2. Dynamic Risk Allocation
Consumption & Funding: Goals, Liquidity Management

How do we pick a given Model portfolio? ("what's Lambda")

Which portfolios or asset/risk factor allocations do we invest in now… and over time (rebalancing)



Quantitative Portfolio Manufacturing Process

1. Product Manufacturing
Efficient Portfolios/ Model Portfolios

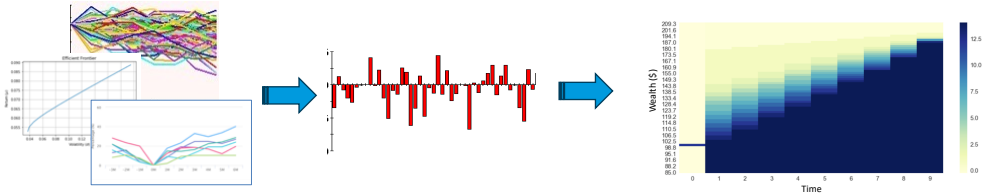
2. Dynamic Risk Allocation
Consumption & Funding: Goals, Liquidity Management

Dynamic Portfolio Investment Strategies: meet goals manage liquidity (long horizons, 10-50 years) and align with clients' behavioural risk profiles

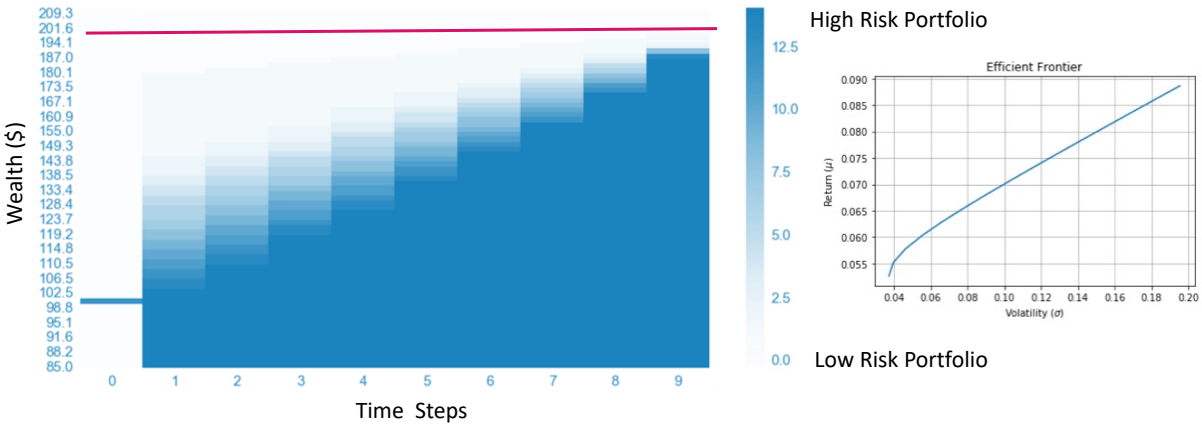
Goal-based Wealth Management (*Household ALM*)

- Includes accumulation, liquidity management (inflows, outflows, capital calls, etc…) and decumulation/wealth transition (post retirement)
- **Stochastic Dynamic Portfolio Optimization**: dynamic programing and machine learning tools (Reinforcement Learning, Neural Networks)

Output: **dynamic allocation** (of efficient portfolios) of over time based on goals, sensitivities and what-if analysis



Goals-Based Dynamic Portfolio Optimization – Example

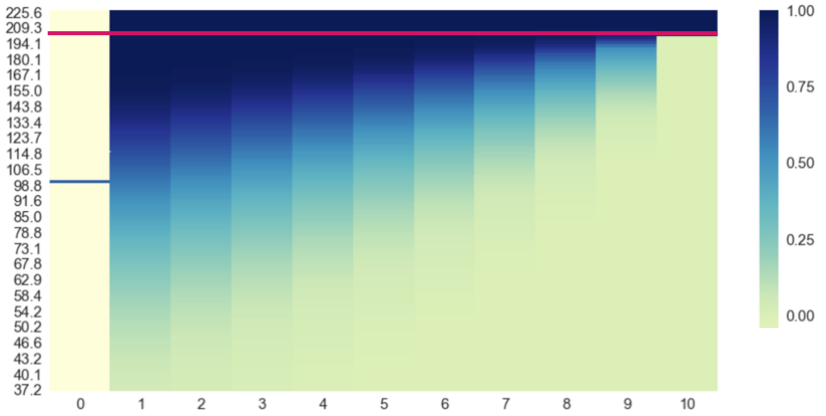


Optimal dynamic portfolio strategy – grid corresponding to each wealth node and time

W_0 = \$100 and Wealth Goal: G = \$200 after 10 periods

Reference: Das et al.

Dynamic Portfolio Optimization – Example



Optimal probability (of reaching the goal), at each wealth node and time

Wealth Goal: G = $200 after 10 periods

Modelling Dynamic GBWM

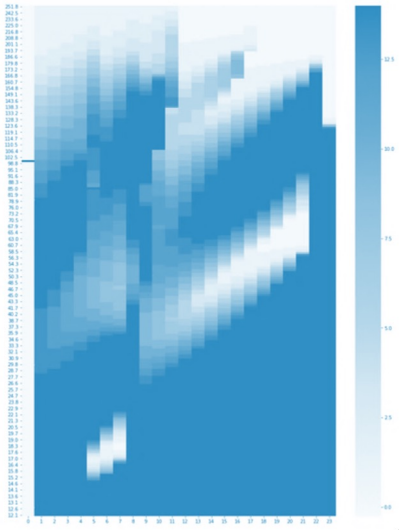
The dynamic setting further allows to make the problem more realistic

- Handle multiple (competing) goals at different points in in time: e.g. buying a cottage in 2 years, vs. retirement vs. leaving inheritance
  - Handling different priorities and level of importance (via utility function)
- Goals at different level of the family hierarchy and multiple ways of funding
- Uncertain cashflows (inflows and outflows)
- Realistic financial details: e.g. tax assumptions
- Realistic economic model and stress scenarios…

The optimization setting also allows us solve for

- Sensitivities, what-if analyses, trade-offs
- Inverse problem: Find most likely scenario(s) or actions that may affect our goals – severity, timing…

Dynamic Portfolio Optimization – Example



Example: Grid of optimal portfolios for multiple goals at different times

- Multi-criteria optimization using a utility function (weighting function for multiple goals)

Quantitative Portfolio Manufacturing Process

1. Product Manufacturing
Efficient Portfolios/ Model Portfolios

2. Dynamic Risk Allocation
Consumption & Funding: Goals, Liquidity Management

Wealth Optimization

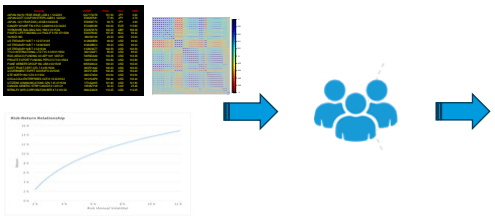
3. Portfolio Customization
Personalized, Client Specific Portfolios

Customized Client Model Portfolios

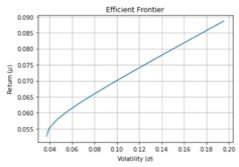
Adjust model portfolios to create a specific personalized strategies for each individual client

- Additional Inputs: client specific constraints, investment preferences
- Use of advanced optimization toolkit for asset/risk factor allocation, diversification

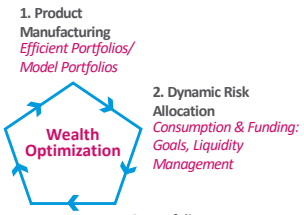
Output: adjusted **client-specific "efficient" Portfolios**



Client Specific Portfolio



Quantitative Portfolio Manufacturing Process

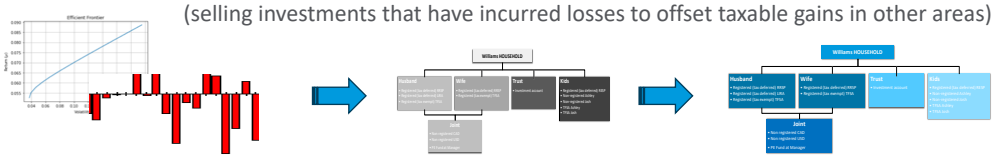


Optimize for Tax Efficiency (*maximize after-tax risk-adjusted returns*)

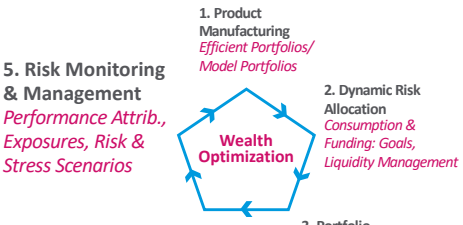
Detailed tax optimization to adjust portfolio location and sources of income streams

- Account for: different tax-advantaged accounts, marginal tax rates for different products, income sources, and legal entities, the timing of realized gains
- Optimization model incorporates details on:
  - Income thresholds, tax brackets, deduction limitations, specific rules related to tax-advantaged accounts, tax lots, etc..
  - Tax Rate Functions applicable to different income levels and types of income (e.g., ordinary income vs. capital gains)

Output: client and account location, income adjusted plan, tactical tax harvesting (selling investments that have incurred losses to offset taxable gains in other areas)

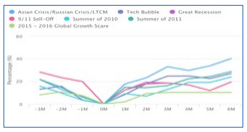


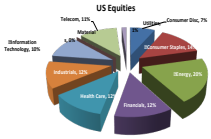
Quantitative Portfolio Manufacturing Process

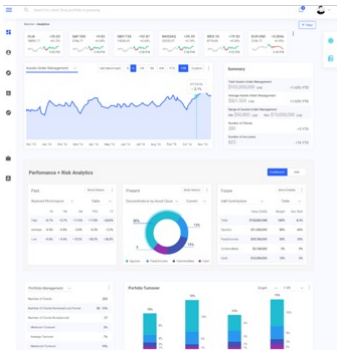


Actively Monitor and Understand Exposures, Performance and Risk

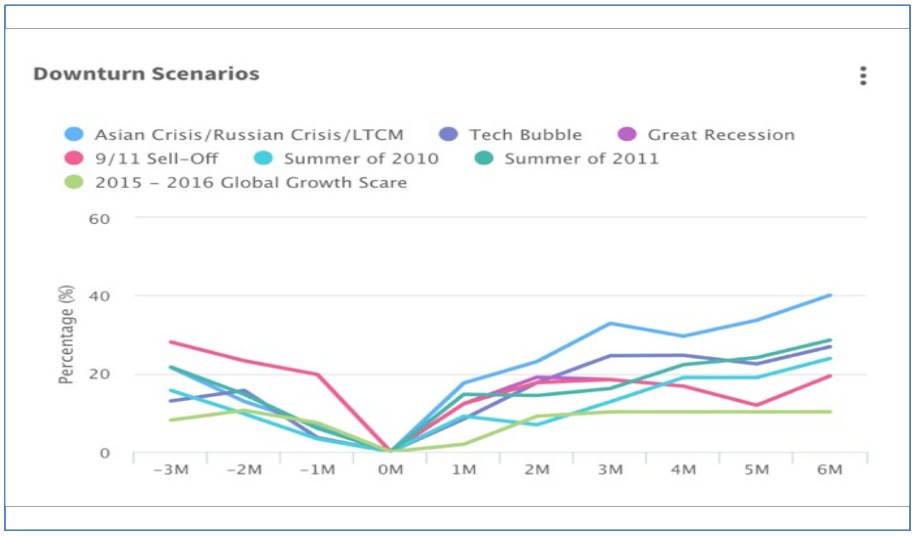
- Compliance with IPSs and client periodic reviews
- Changes in: markets, client's life circumstances, goals, regulation, …
- Performance attribution – how did we make money?
- What if – available new funds or investment opportunities
- Scenario analysis



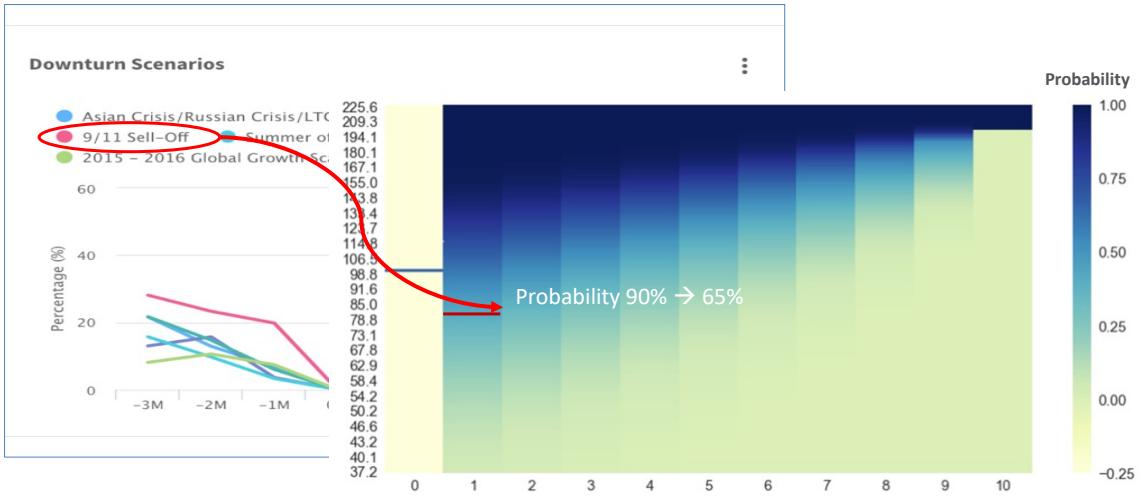




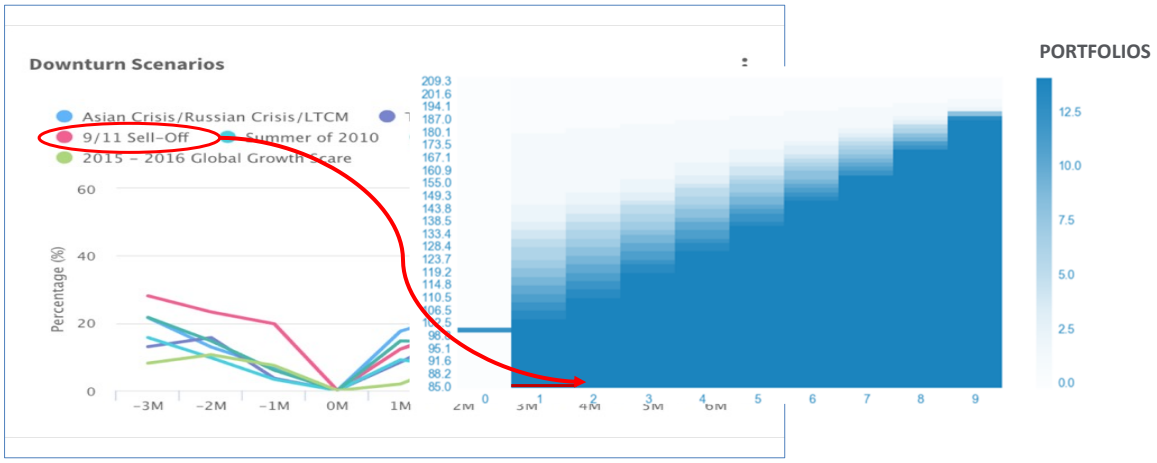
Example: Overlaying Historical Scenarios & Drawdowns

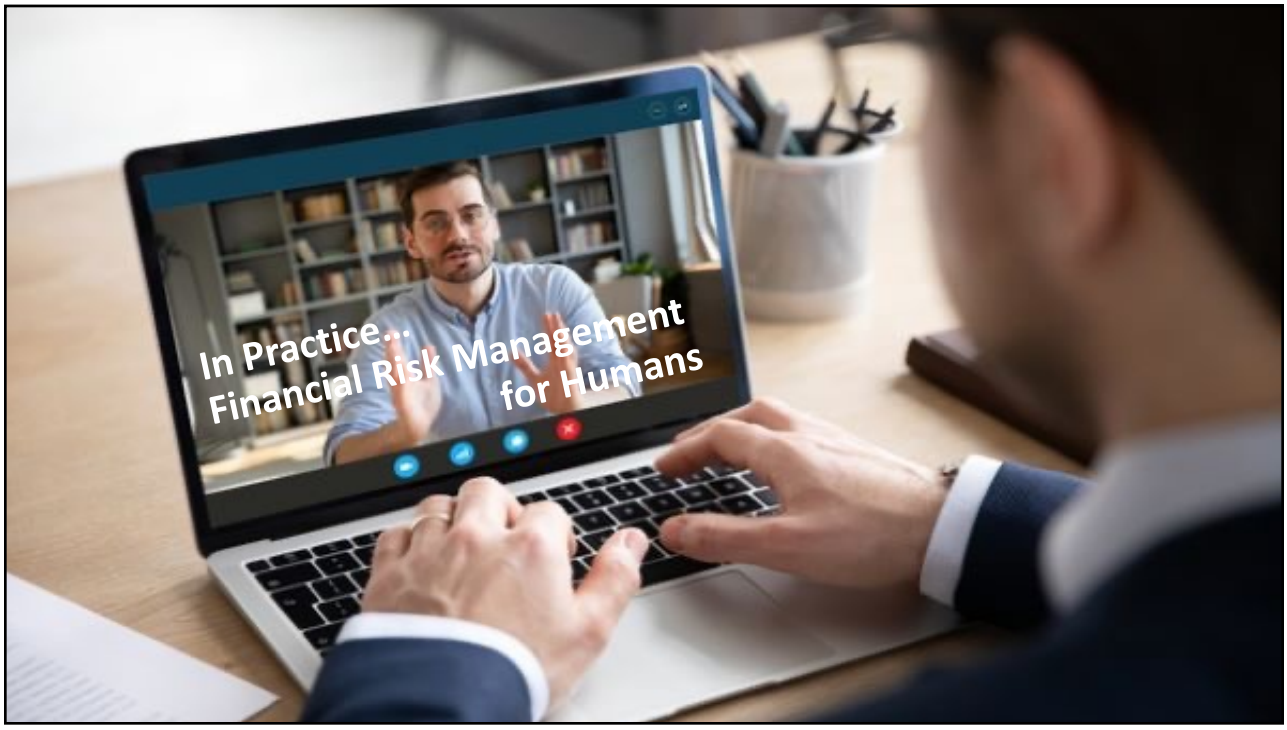


Example: Overlaying Historical Scenarios & Drawdowns



Example: Overlaying Historical Scenarios & Drawdowns

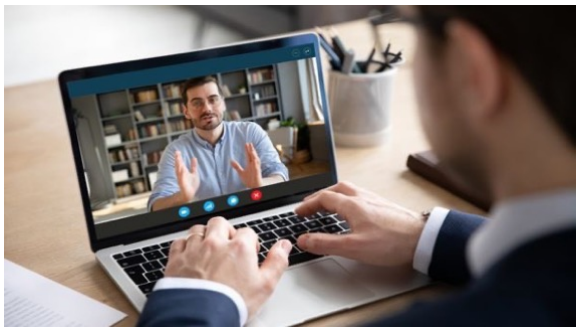




In Practice… Financial Advice & Risk Management for Humans

Interactive engagement and coaching – multiple goals & questions the client/investor relates to

- How does the likelihood of achieving the goal changes with a drawdown?
- What's the max drawdown I can take? When do I need to worry?
- If I can't meet a goal precisely, how far are we?
  What are my trade-offs between multiple goals?
- How else can I fund the plan?
- When can I de-risk portfolio?
  How much can I take out and not affect goal?
- How much do I need to change goal/plan to be OK?



THANK YOU !

Dr. Dan Rosen

CEO *d1g1t*

dan.rosen@d1g1t.com