Asian Actuarial Conference

# 2025 Bangkok

## How AI can manage insurance portfolios

13 Nov | 15:30-16:10

### Saiyan Raja

Investment & ALM Solutions Director, Ortec Finance

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# Scenario-Based Machine Learning for Portfolio Optimization

Saiyan Raja
Director, Investment & ALM Solutions
Ortec Finance

November 2025

# A radically uncertain world

A complex world has complex problems to solve


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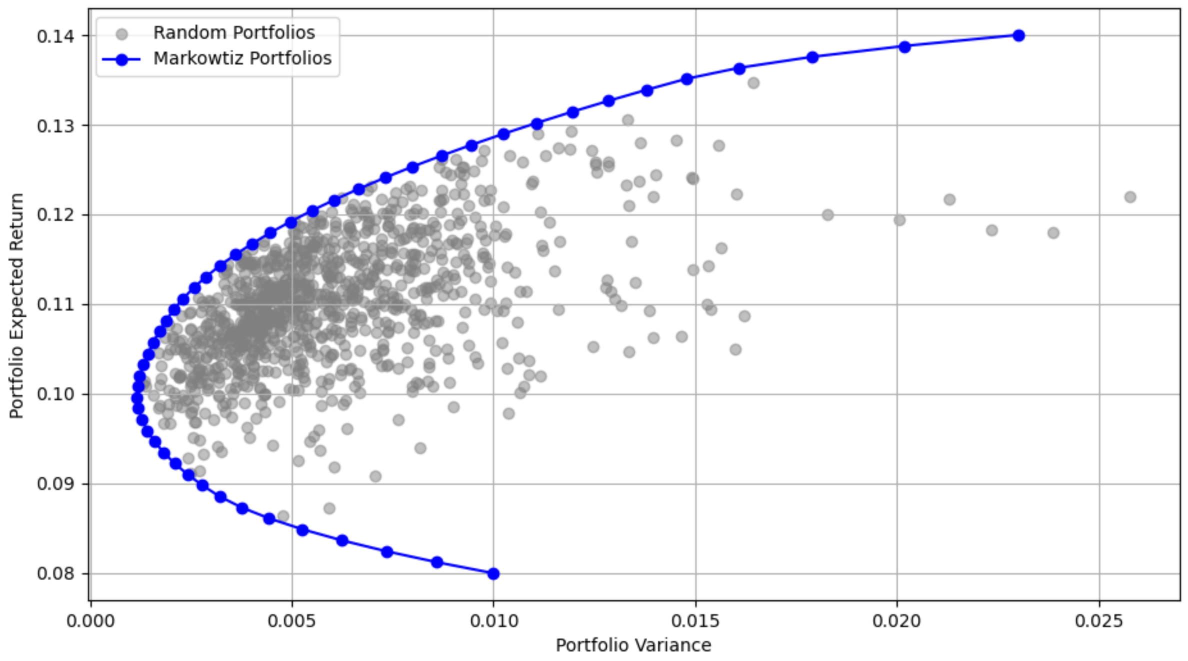
# Mean Variance Optimization

Minimize the **variance** (risk) and maximize the **expectation** of portfolio return (return)

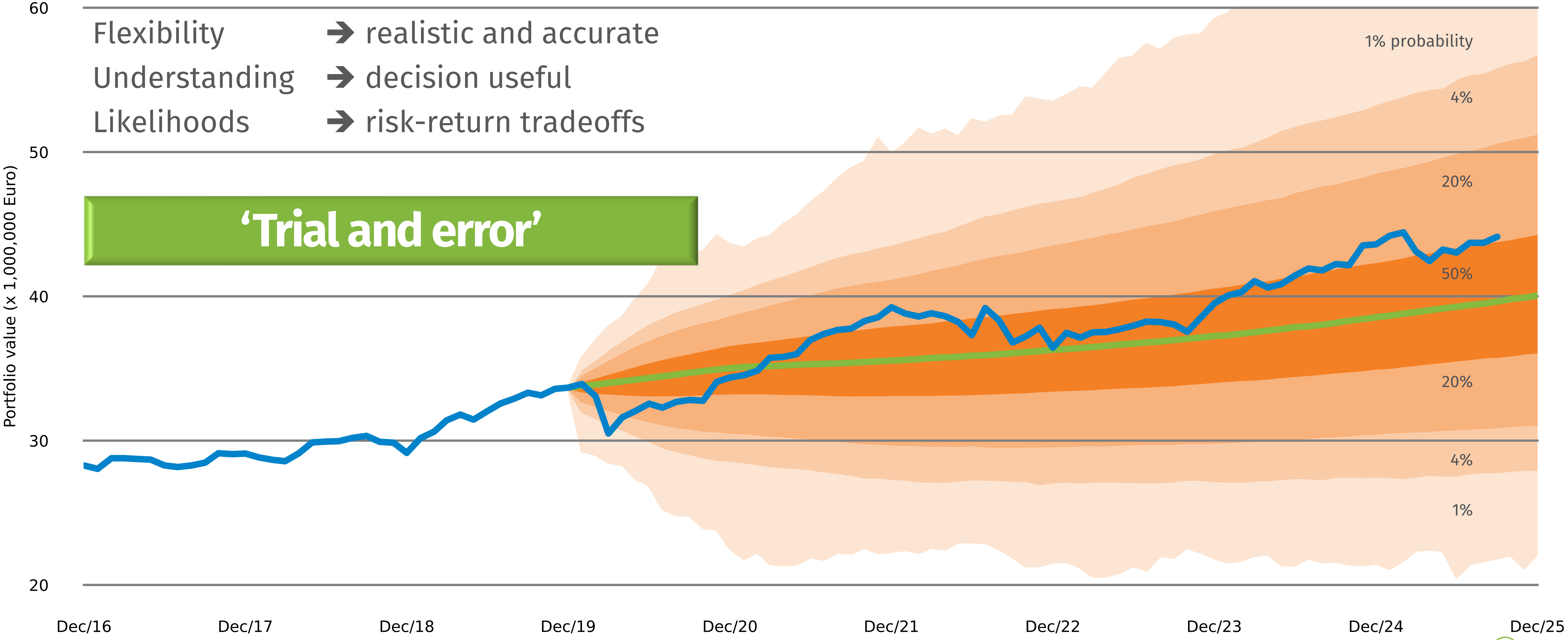
- Minimize variance of portfolio return: $\sigma_p = w^T \Sigma w$
- Subject to constraints:
  - Expected portfolio return $w^T \mathbb{E}[R_t]$ = target return
  - Sum of portfolio weights $w$ = 100%
  - Other linear constraints on portfolio weights
- Where:
  - $w$ = vector of portfolio weights
  - $\mathbb{E}[R_t]$ = vector of expected returns
  - $\Sigma$ covariance matrix of returns




**Closed form solution**

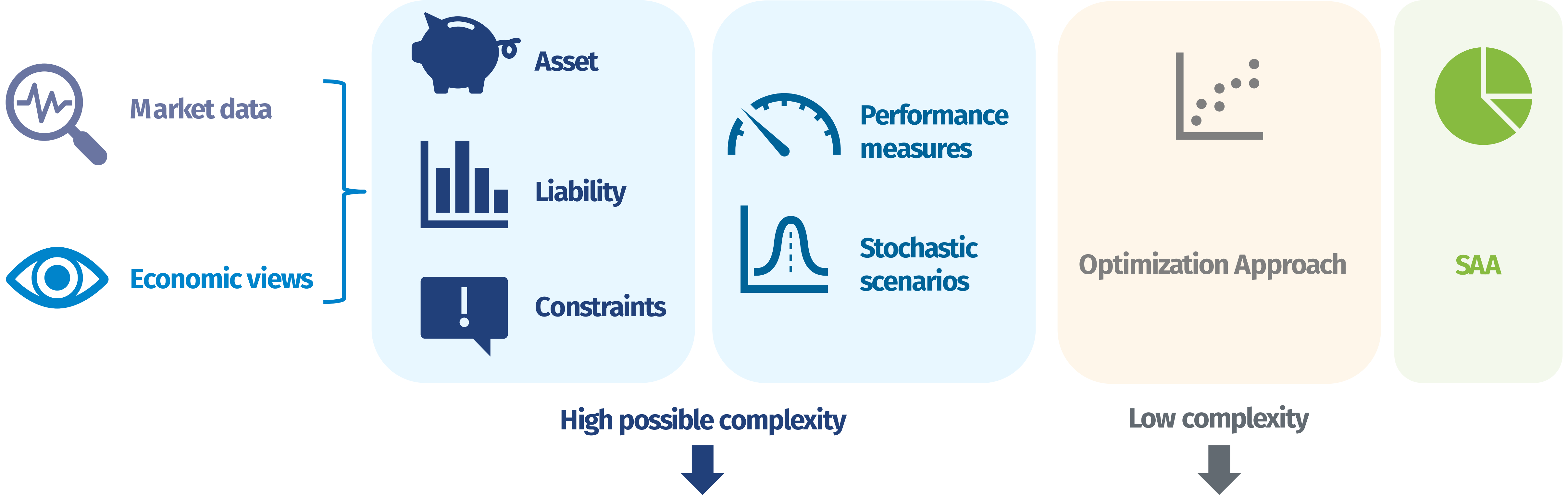
# Stochastic scenario approach

Evaluate portfolio performance on **‘any’** set of investor specific risk and return measures




Portfolio of 15 million Euro at the end of 2005 simulated forward on a monthly basis assuming an investment strategy with an asset allocation of 50% fixed income (60% government bonds, 40% corporate bonds), 25% global equities and 25% alternatives (including real estate), bi-annual rebalancing and a quarterly 50% hedge of all FX risk. The blue line represents the realized value of the portfolio until the end of September 2025. The orange “fan chart” represents the possible scenario developments of the value of the portfolio based on the December 2019 Ortec Finance scenario outlook in terms of the 1%, 5%, 25%, 75%, 95% and 99% percentiles.

# Strategic Asset Allocation framework

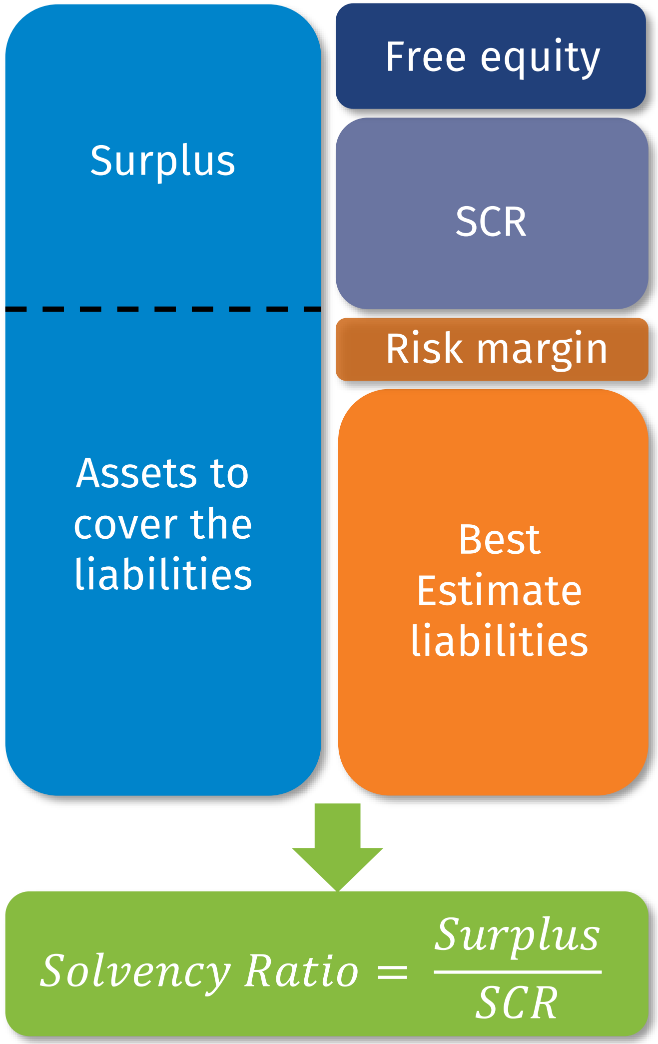



There is a **disconnect** between the evaluation and optimization complexity

# Example: Insurance PVDE optimization

PVDE = ‘Present Value of Distributable Earnings’

- Life insurer under Risk-Based Capital framework
- If Solvency Ratio (SR) is high, dividends are paid
- If SR is low, capital injections are called for
- Optimization problem:
  - Objective: Maximize PVDE and minimize capital injections on 10-year horizon
  - Decisions: SAA portfolio weights
  - Constraints: sum portfolio weights 100% and min/max portfolio weights

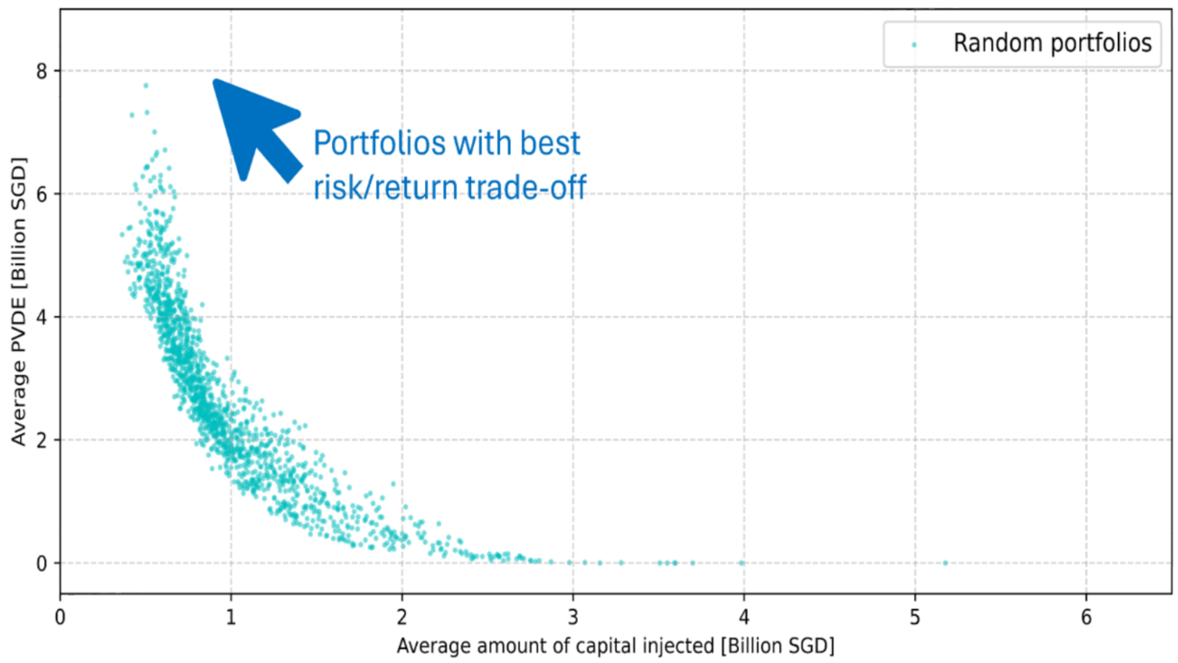


# Approach 1: pure trial and error

Computationally expensive with possible local optimality

Heavy computational burden

No guarantee of optimality




## Case details

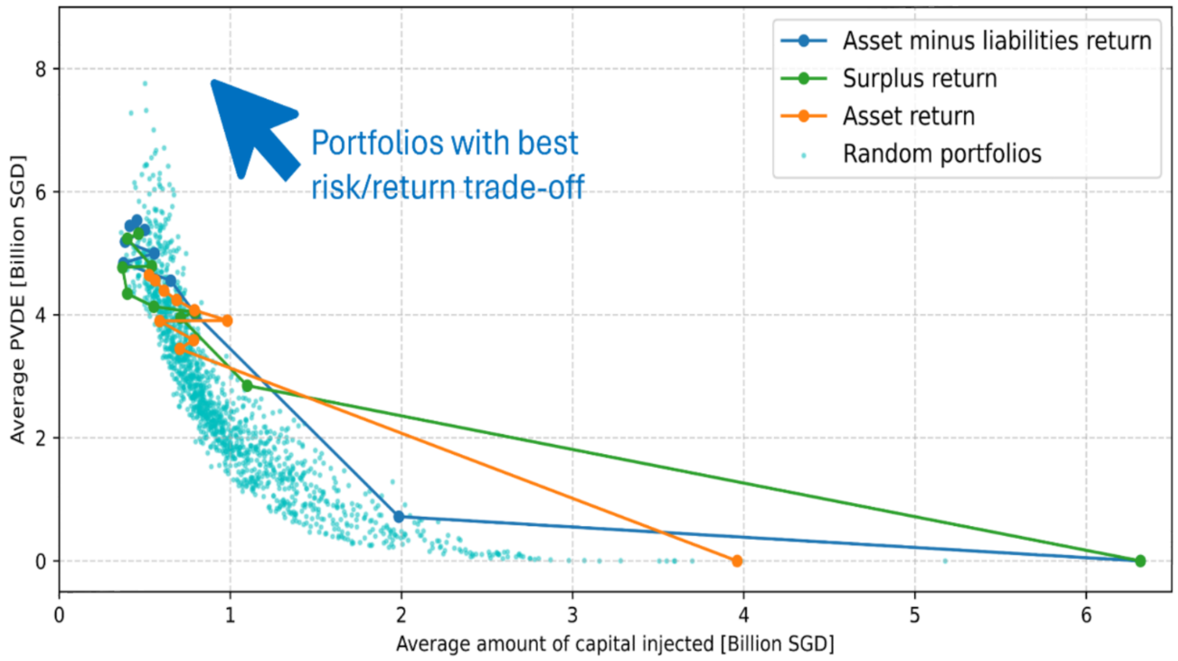
- 2000 economic scenarios with 10 asset classes
- Annual rebalancing to the optimized static portfolio weights within a time horizon of 10 years

# Approach 2: Markowitz and hope for the best

Not flexible enough for the inherent complexity

Fast, but specific for simple and unrealistic risk-return objectives

Mean-variance or other closed-form algorithms does not always map well to other performance measures



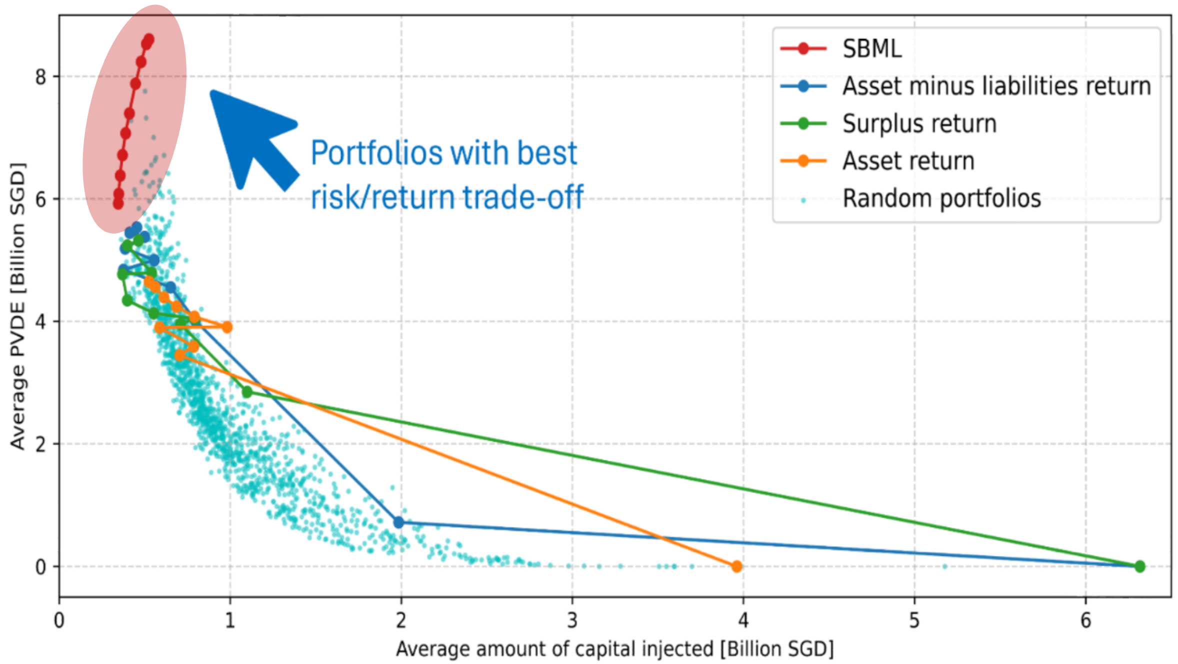
# Scenario-Based Machine Learning – What it can do

The best of both worlds – realistic and “easy” to find optimal portfolios

Combines the flexibility and accuracy of a stochastic scenario approach with the efficiency of closed-form optimizers

By training Machine Learning algorithms on infinite training data from stochastic scenarios

Generic approach to optimize on any combination of risk-return measures that can be evaluated in a stochastic scenario approach



# Scenario-Based Machine Learning – How it works

Three-step approach

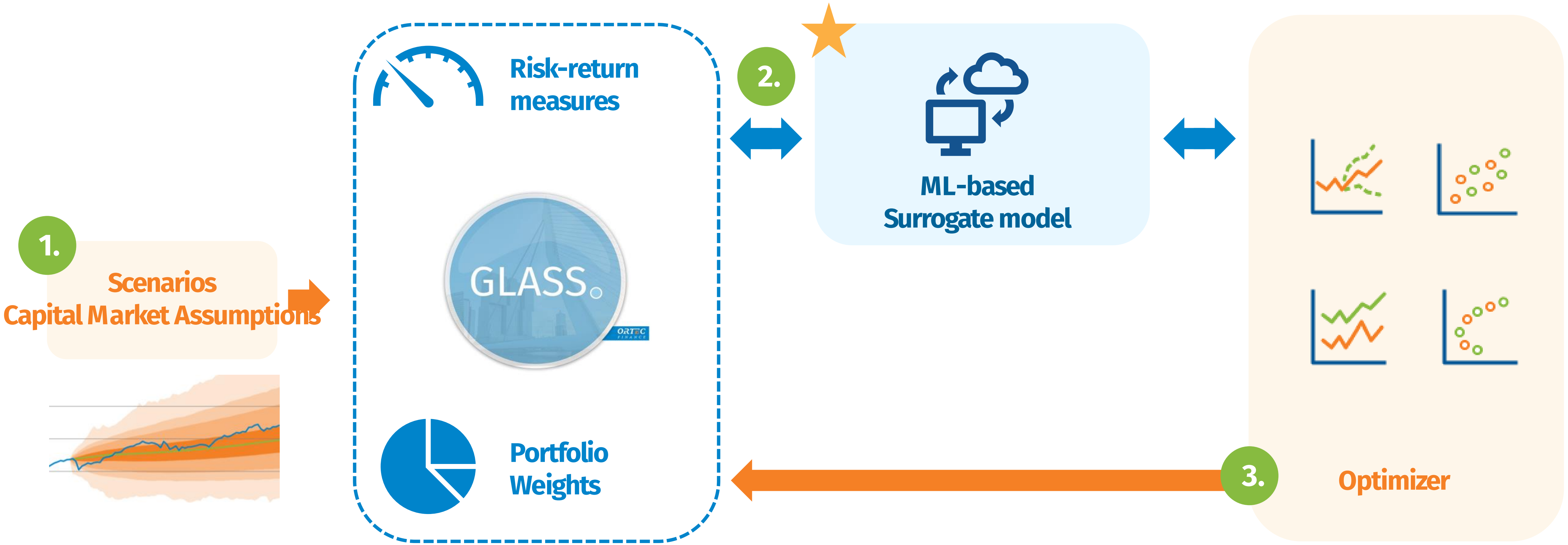
1. **Initialization**: Generate scenarios based on Capital Market Assumptions to evaluate portfolios in terms of investor specific risk-return measures

2. **Calibration**: Simulate various (random) portfolios and estimate (ML-based) surrogate models

3. **Optimization**: Find portfolios that perform best on the investor specific risk-return measures in surrogate space and evaluate in full scenario model

# Scenario-Based Machine Learning – How it works

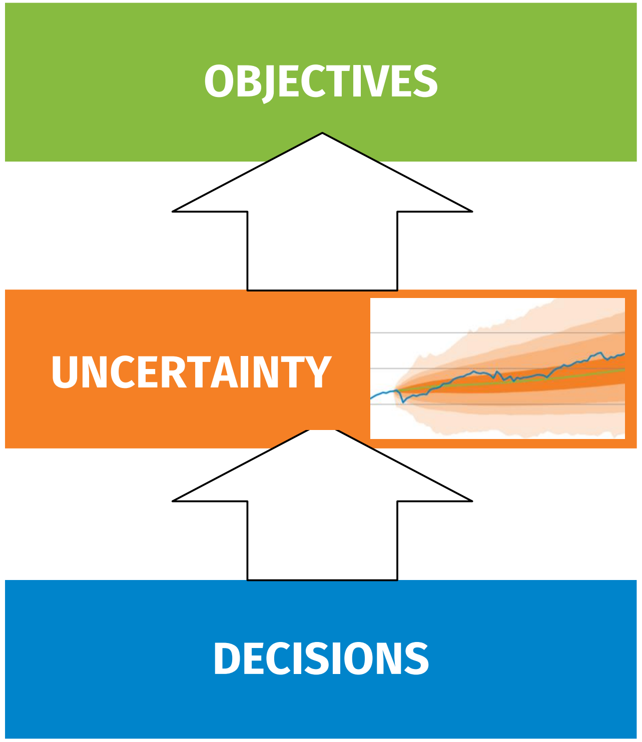
## Three-step approach



Solvency Capital Requirements

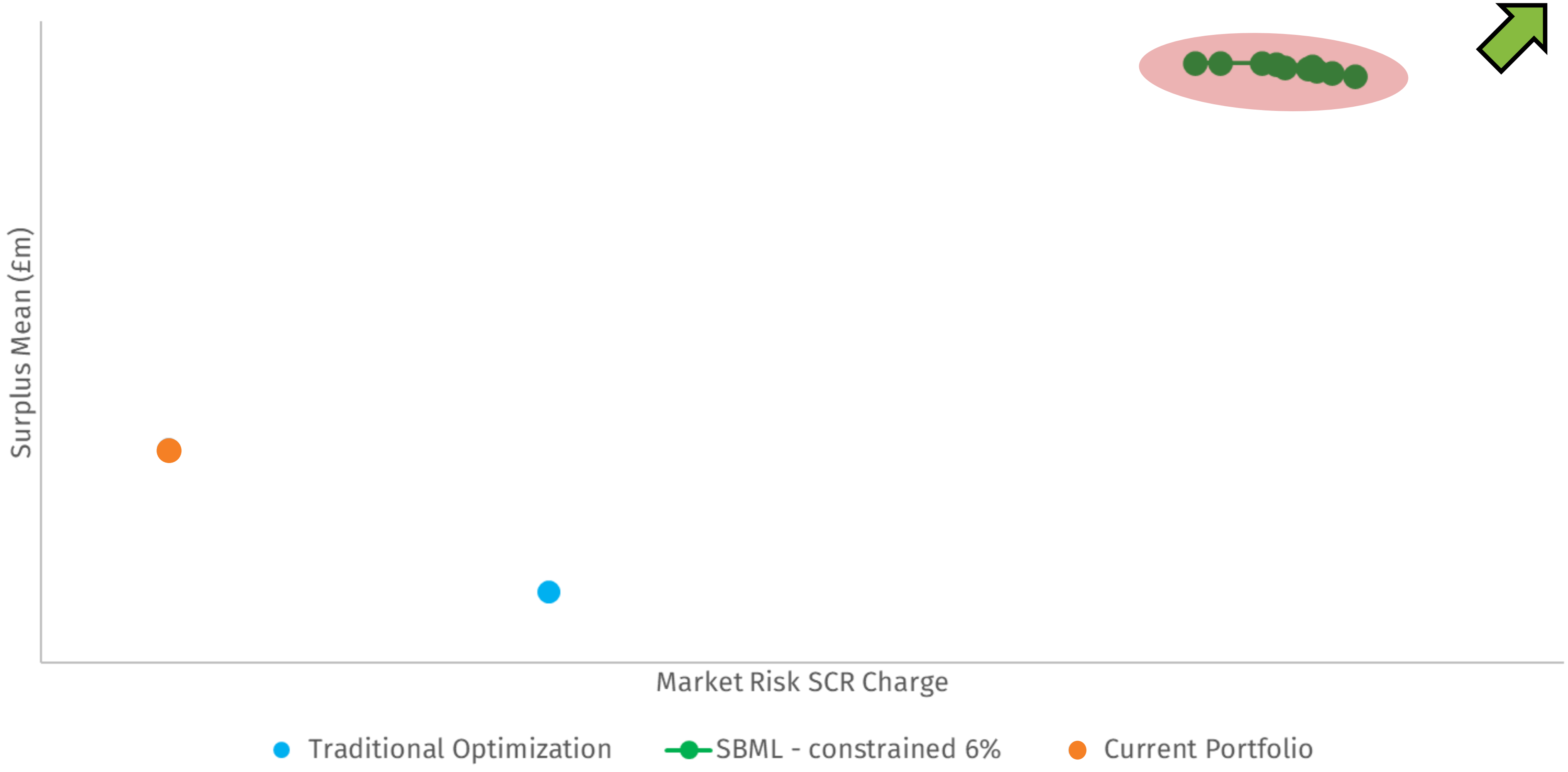
Present Value of Distributable Earnings


SAA



# Solvency Capital Requirements

Constrain Market Risk SCR Charge between 5%-6%

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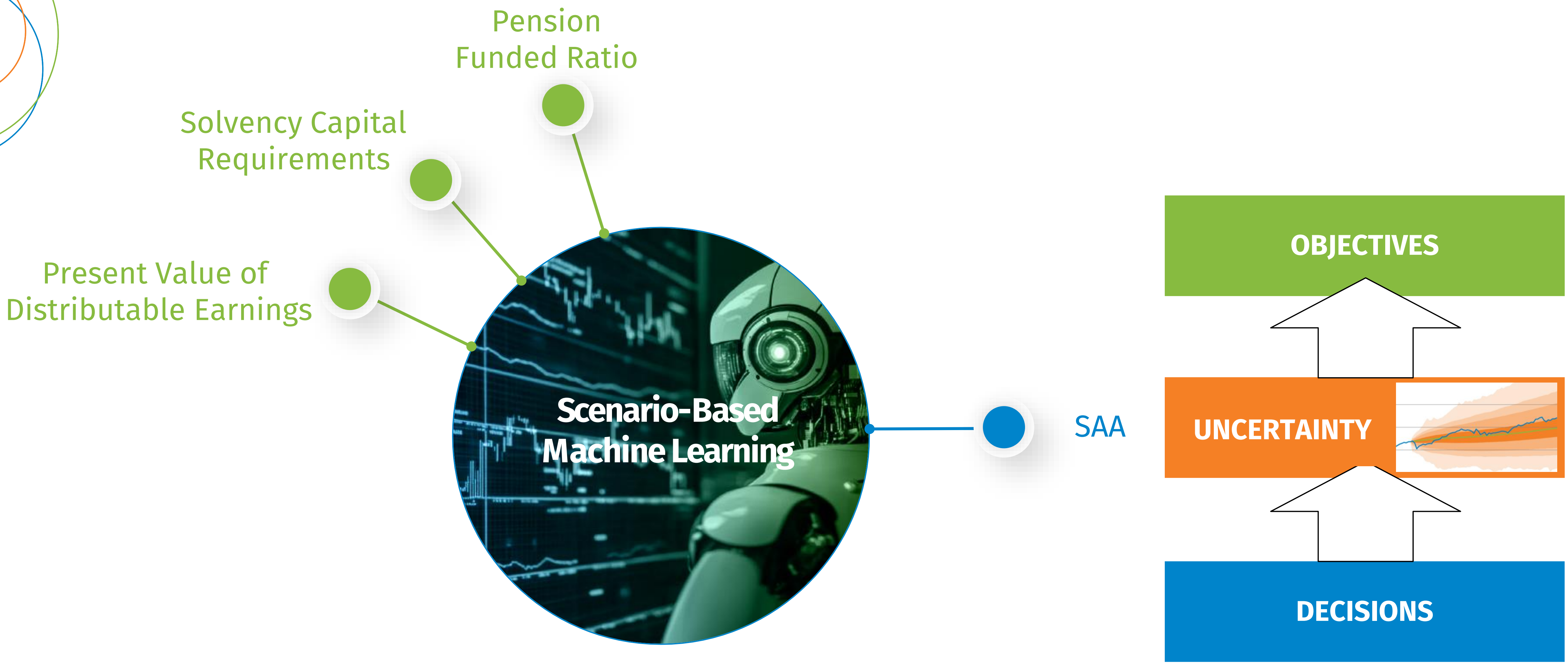
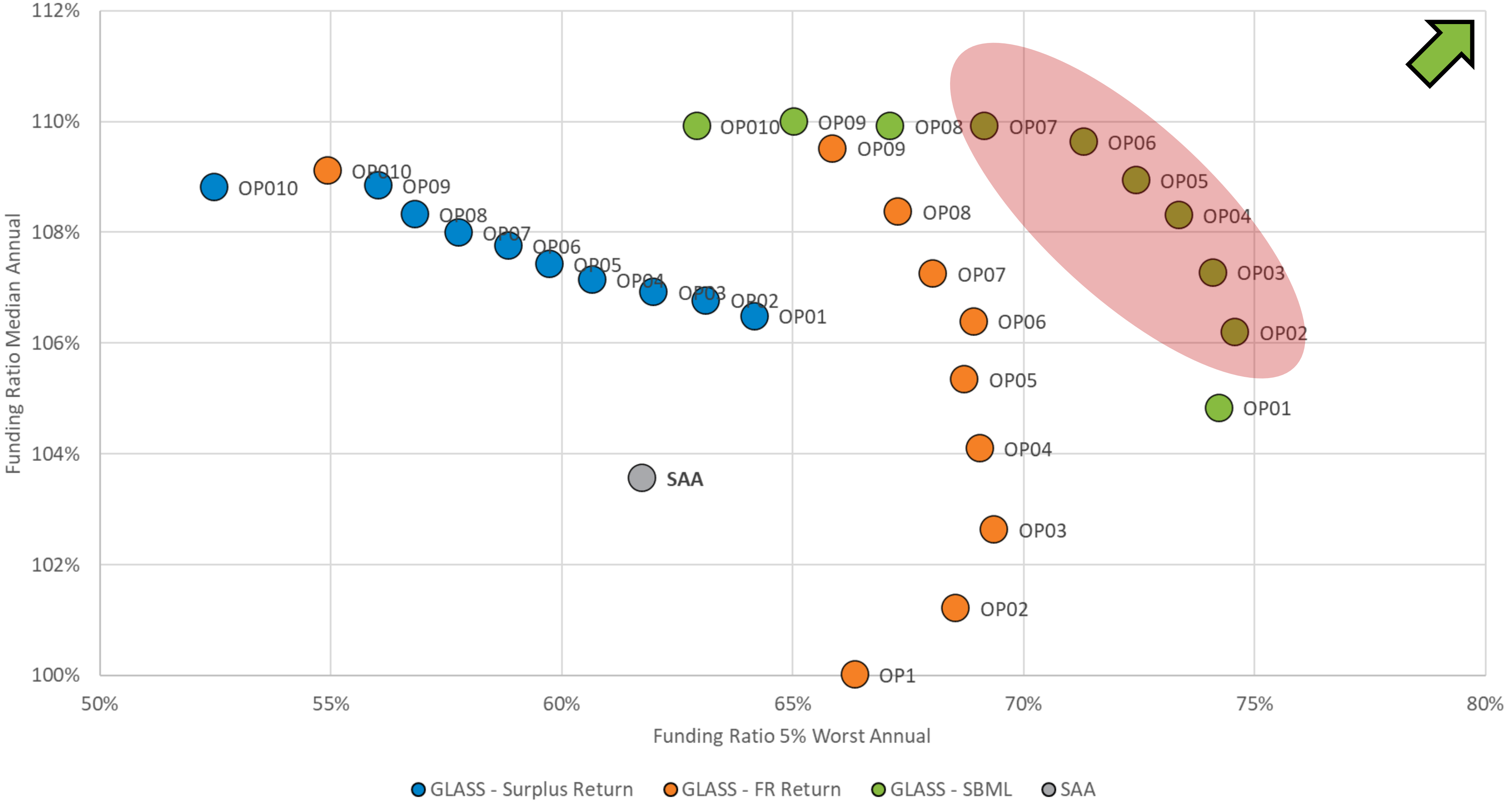
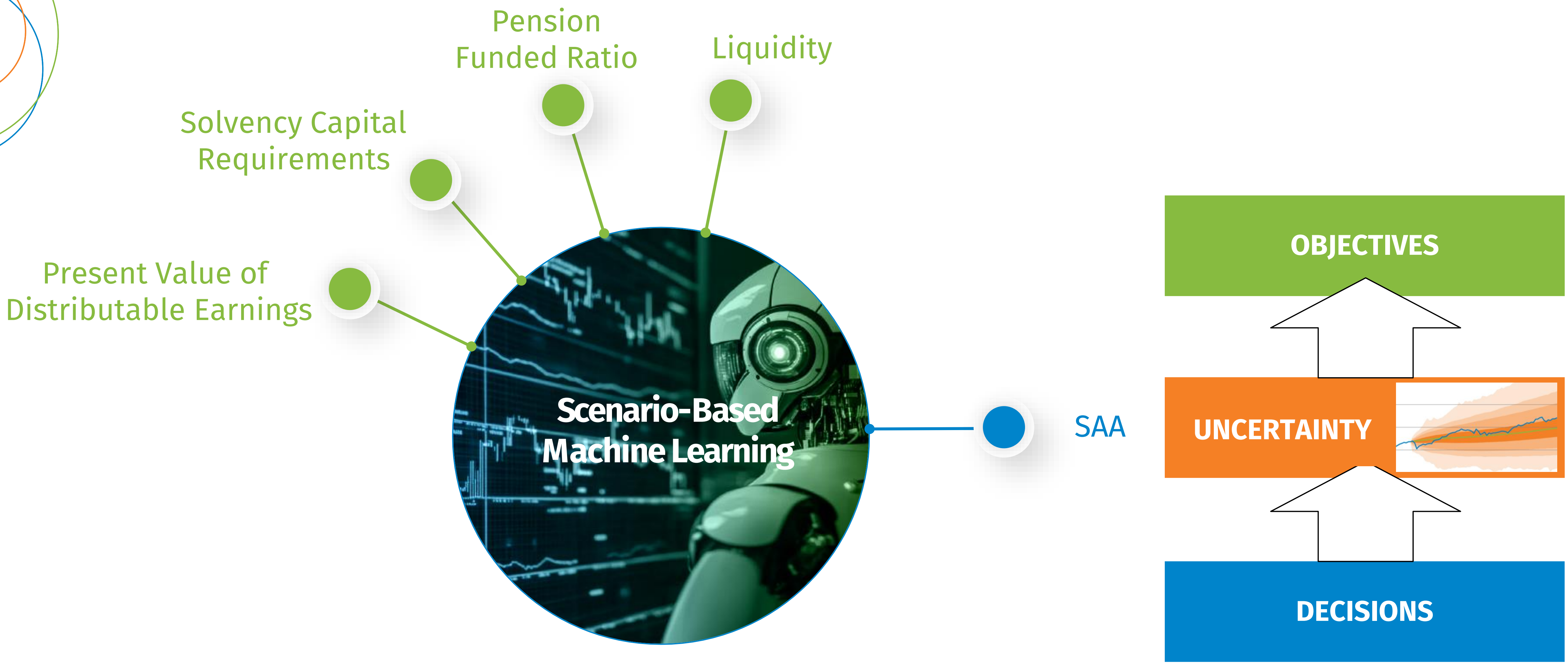

Pension
Funded Ratio
Solvency Capital
Requirements
Present Value of
Distributable Earnings
Scenario-Based
Machine Learning
SAA
OBJECTIVES
UNCERTAINTY
DECISIONS

# Pension Funded Ratio

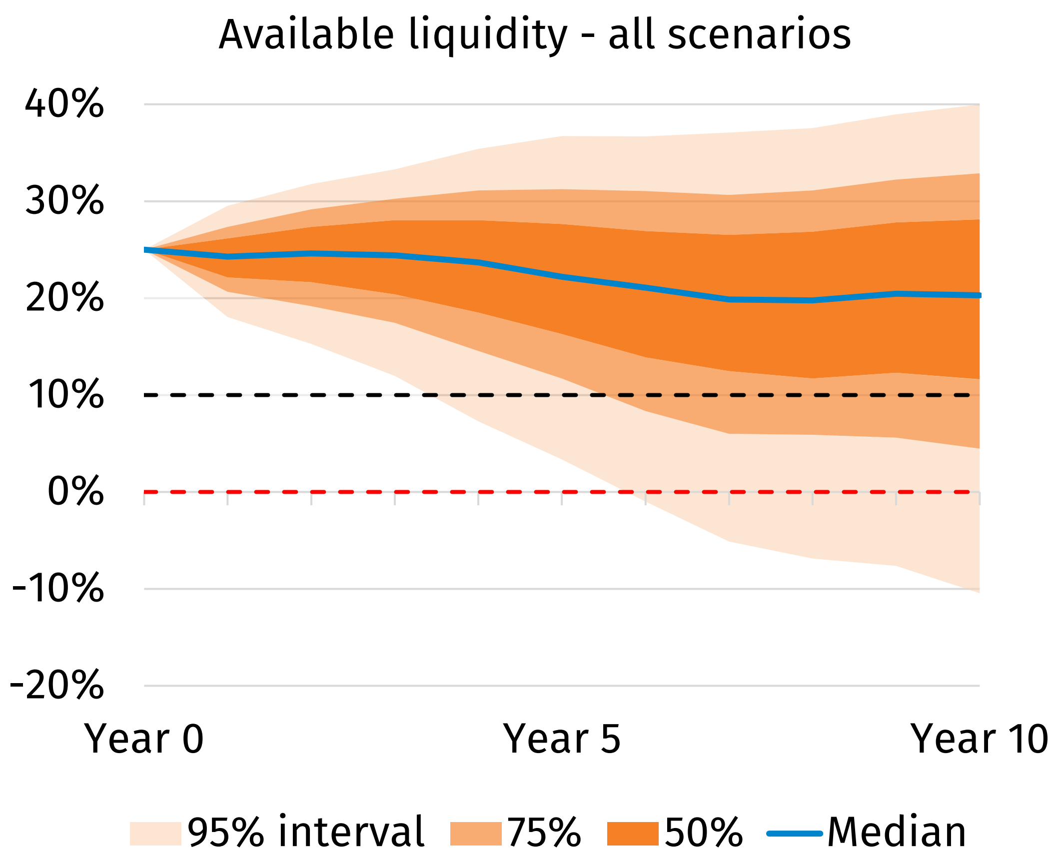



Pension
Funded Ratio
Liquidity
Solvency Capital
Requirements
Present Value of
Distributable Earnings
Scenario-Based
Machine Learning
SAA
OBJECTIVES
UNCERTAINTY
DECISIONS

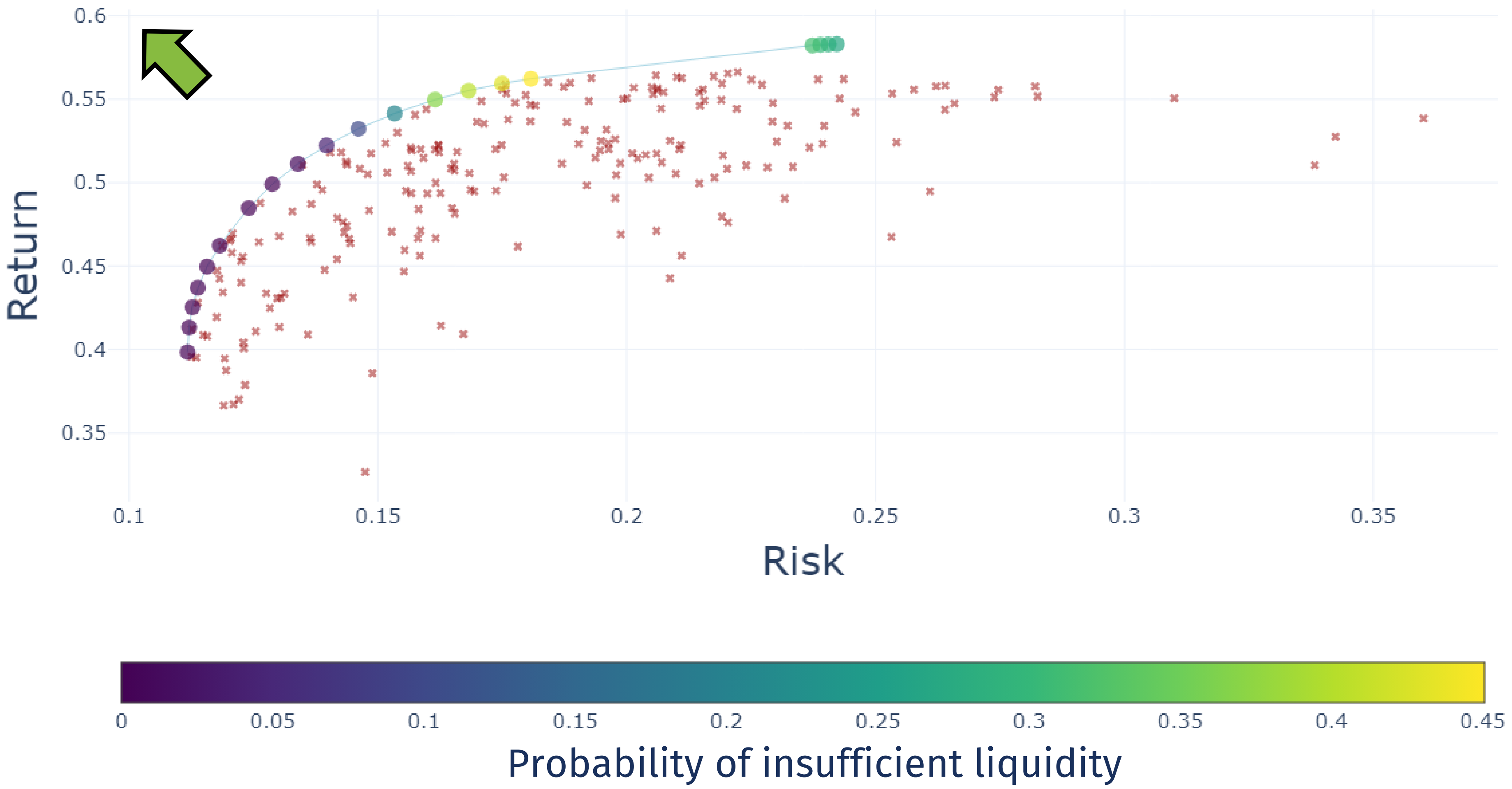
# Liquidity risk scenario modeling

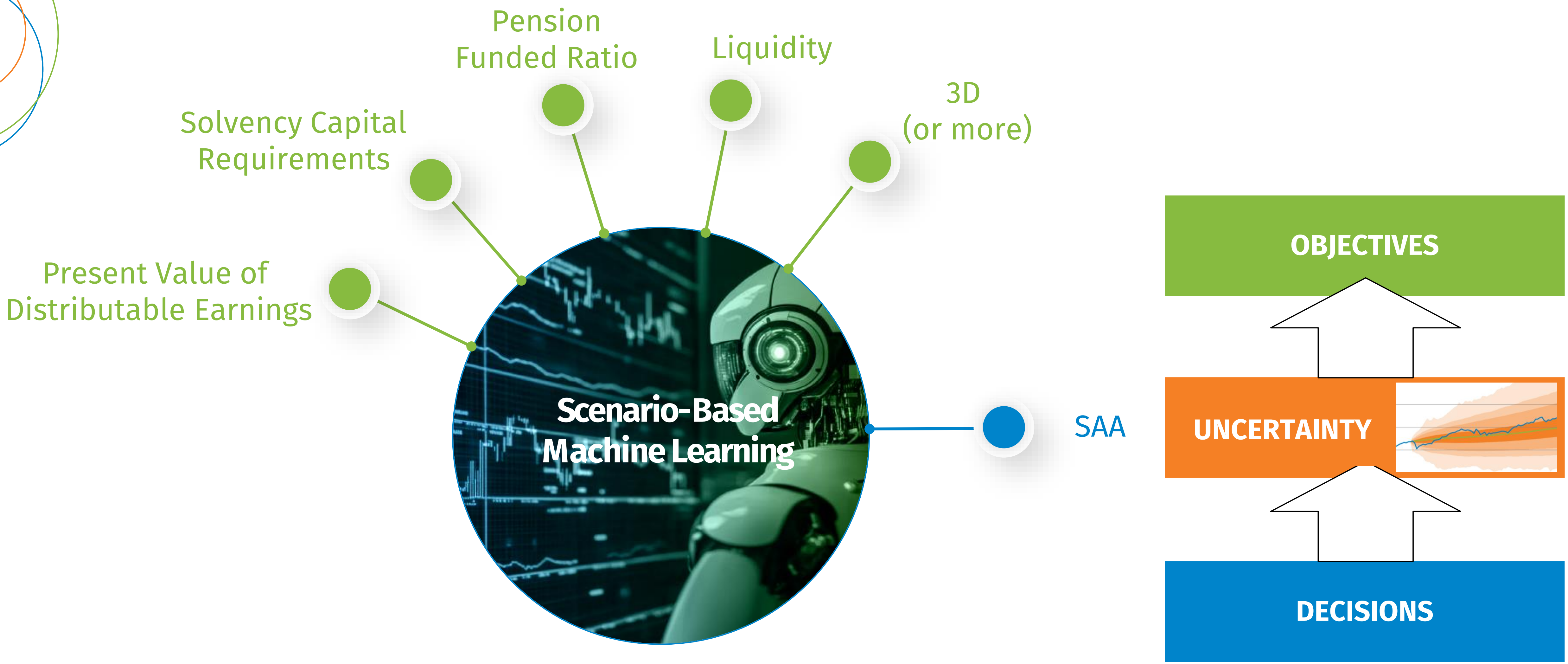
- Stochastic scenario approach used to model asset and liability cashflow dynamics, including PE capital calls and distributions

- Optimization problem:
  - Objective: Maximize return and minimize probability of available liquidity < 0%,
  - Decisions: SAA portfolio weights
  - Constraints: Portfolio weights, diversification penalty, asset only risk not larger than reference portfolio

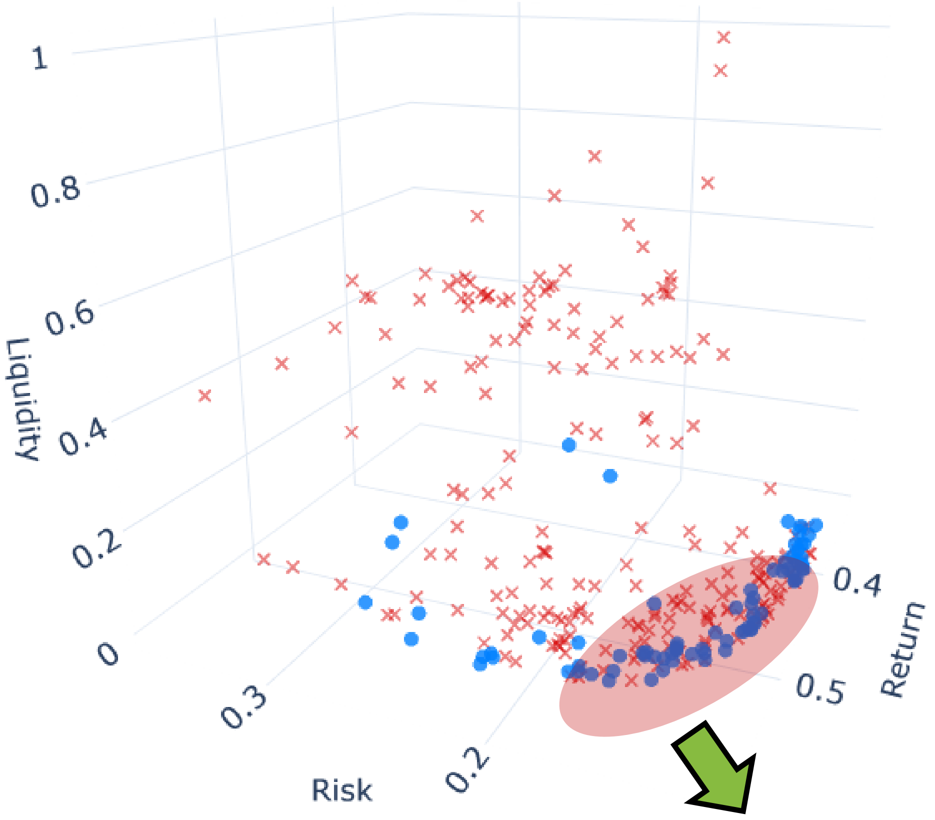


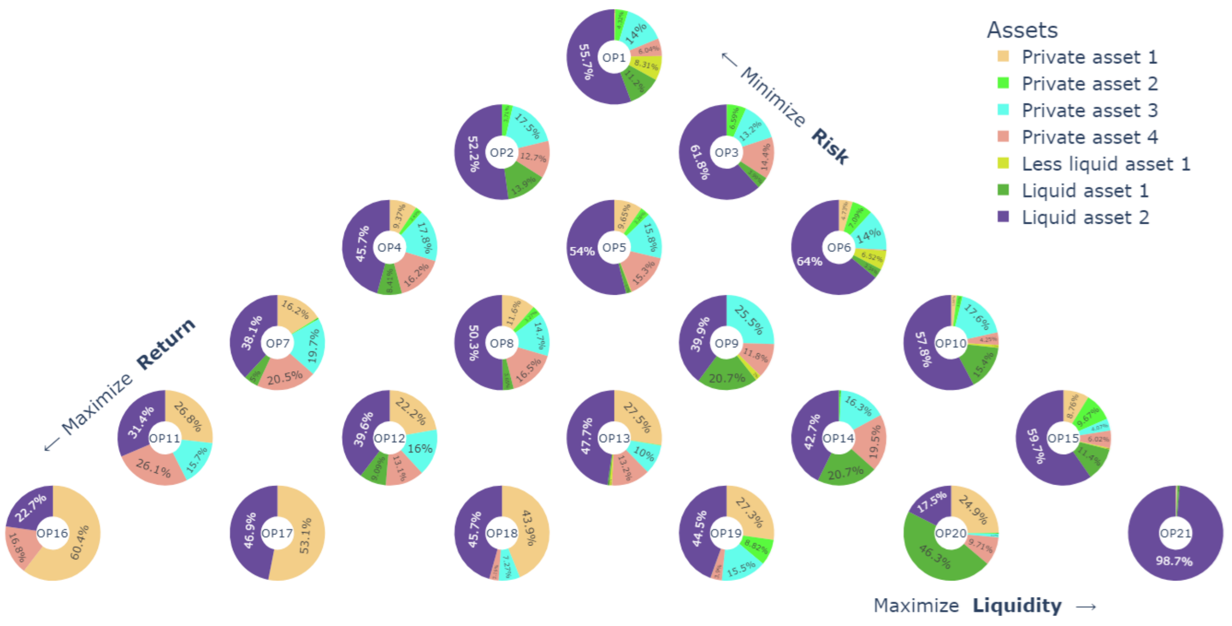
# Liquidity risk along the efficient frontier

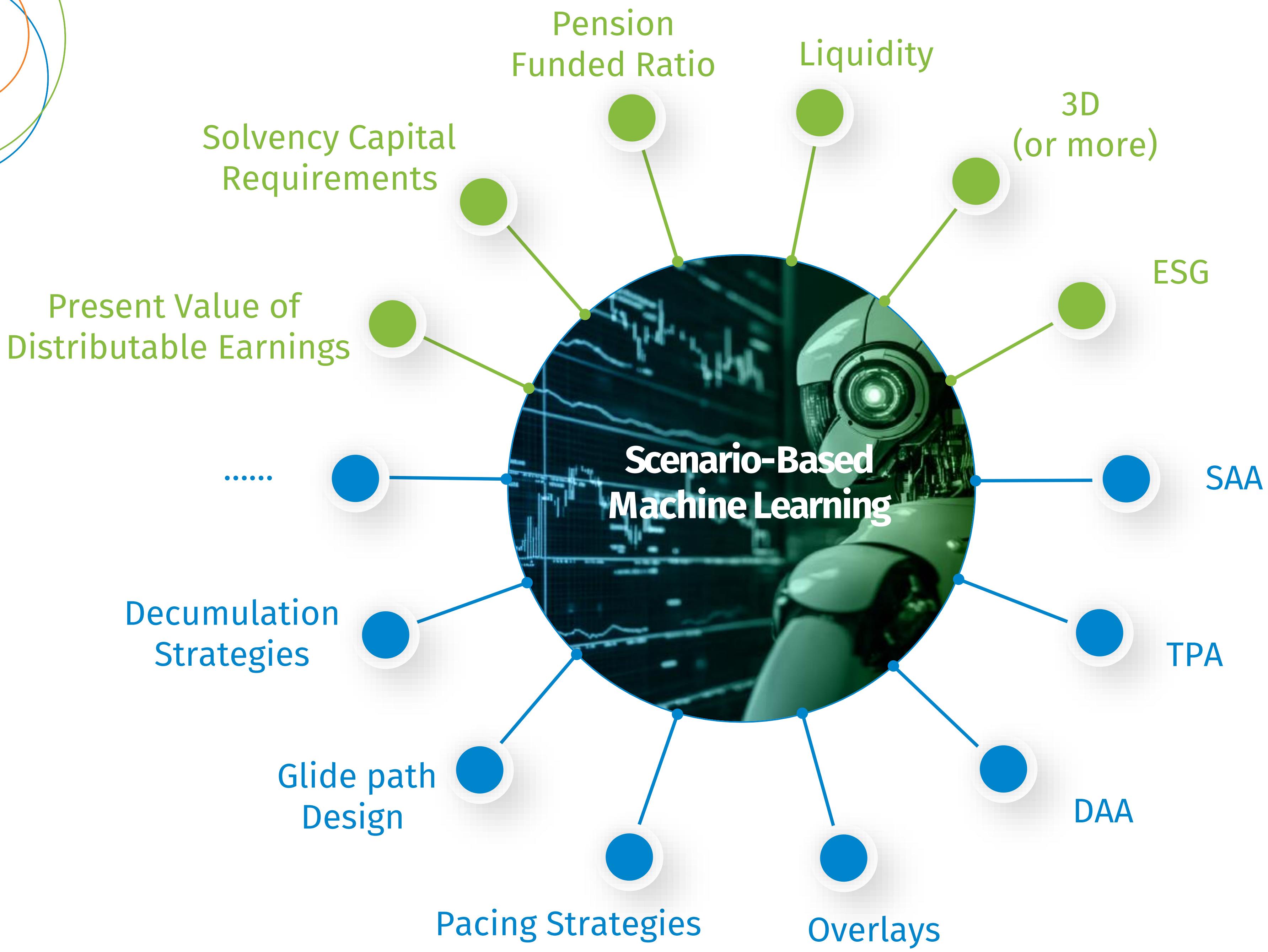


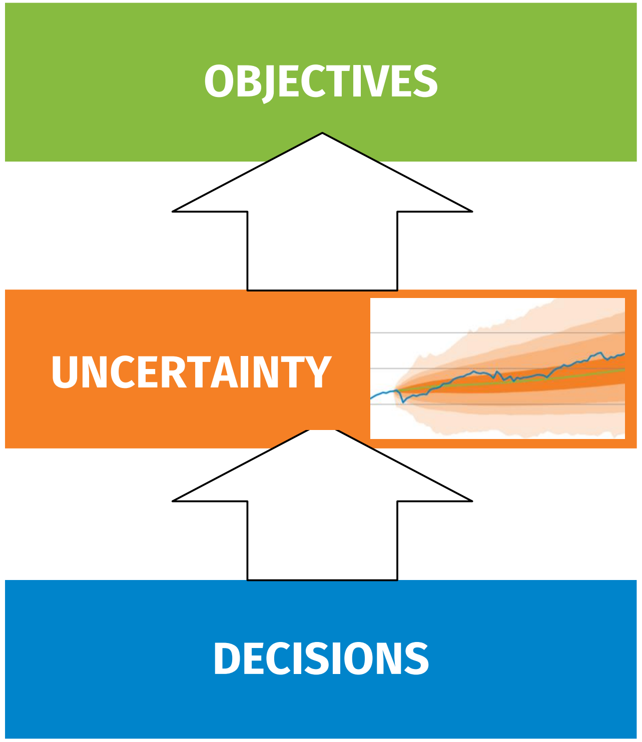

Present Value of
Distributable Earnings
Solvency Capital
Requirements
Pension
Funded Ratio
Liquidity
3D
(or more)
Scenario-Based
Machine Learning
SAA
OBJECTIVES
UNCERTAINTY
DECISIONS

# 3D optimization

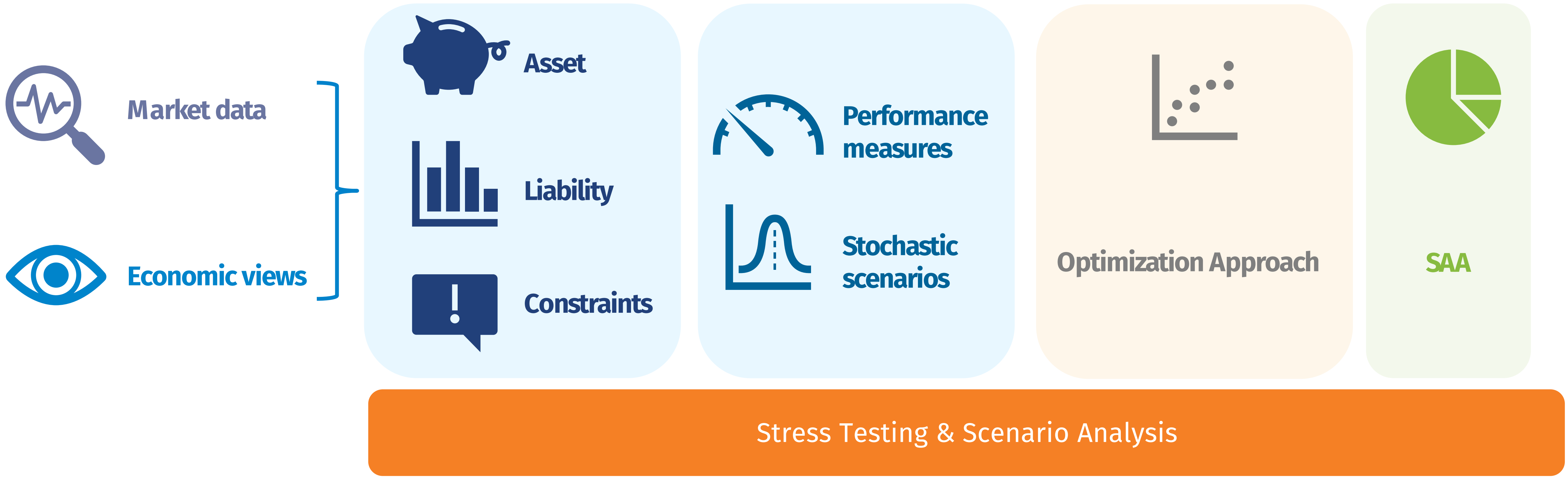



Pension Funded Ratio
Liquidity
3D (or more)
Solvency Capital Requirements
ESG
Present Value of Distributable Earnings
Scenario-Based Machine Learning
......
SAA
Decumulation Strategies
TPA
Glide path Design
DAA
Pacing Strategies
Overlays


OBJECTIVES
UNCERTAINTY
DECISIONS

# SAA – Completing the loop



# AI augmented decision making

## Not replacing the analyst

### Ownership of SAA

Although SBML is powerful, the strategist must ultimately own the SAA process

### Human input

Human decision-making and explainability is a must

### Robust framework

Models can help investors but the framework within which the AI agent operates should be robust.

- Assumptions must be set in a structured way
- Outcomes must be realistic and plausible, validated by users
- Enable analysts to focus on ‘storytelling’ and providing holistic advice to clients

# More Information and Q&A