“Decision Theory and Design in Multi-level hierarchical management structures”

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GENERAL THEME

CONTROL & DECISION MAKING PROBLEMS IN INTEGRATED OPERATIONS IN MANUFACTURING & FINANCE

ISSUES:

▲ INTEGRATED MANUFACTURING & HIERARCHICAL DECISION MAKING PROBLEMS

▲ FINANCE PROBLEMS & HIERARCHICAL DECISION MAKING

▲ NESTED DECISION & CONTROL PROBLEMS

▲ MULTI-LAYER CONTROL THEORY: GLOBAL CONTROLLABILITY & GLOBAL OBSERVABILITY
INTEGRATED PROCESS OPERATIONS

Integrated System

(I) Logistic Functions & Business

II) Desired Operation

III) Supervisory Activities

IV) Process Control

Systems Classification: Discrete, Continuous, Mixed (Batch)
PROBLEM: ORGANISATION OF INFORMATION AND CONTROL-DECISION MAKING STRUCTURES

CLASSIFICATION:
- HIERARCHICAL ORGANISATION
- HETERARCHICAL ORGANISATION
- HOLONIC ORGANISATION
- OTHERS (BIONIC, GENETIC, FRACTAL, RANDOM)

HIERARCHICAL ORGANISATION
CONTROL ARCHITECTURE IN A HIERARCHICAL ORGANISATION

Integration of Operations in Technological Processes:

- HYBRID SYSTEMS
- “TOP DOWN”: GLOBAL CONTROLLABILITY
- “BOTTOM UP”
Multi-level Hierarchical Management System In Financial Institution

1. Board of Governors set targets in risk and profit and they are infiltrated to the lower levels.
2. Results at the client level are observed and they are aggregated at the higher levels until they reach top level.
Intermediate Level Views

Intermediate Levels have Different Views

- Top level-Macro
  - Business Units
    - Client level-Micro
  - Risk types
    - Client level-Micro
- Top level-Macro
  - Products
    - Client level-Micro
- Top level-Macro
**Problem to be Solved in Every Level**

Maximise Profit

\[ Risk < d \]
Top-Down Approach

TASKS

1) The Board sets the *profitability targets* and the *risk appetite* of the institution.

2) This is translated to *profitability* and *risk appetite* to the lower levels.

3) It is also translated to *credit risk policy* for *loan approval and management* at the lowest client level.
Main Tools for Credit Risk Management

- Rating Systems.
- Econometric Models for the calculation of PD, LGD, EAD.
- Database systems keeping the risk information for every client and transaction and being able to aggregate – disaggregate.
- Credit Management policies.
- Capital Management and allocation systems.
Solution of the Optimisation Problems

Maximise Profit

\[ \text{Risk} < d \]

Difference Equations of possible different sampling rates/scales
Models related to the problem

NOTE: In every level, loans are observed in various states according to their repayment status and there is a state vector \( \mathbf{x} \) containing the total balance of loan at every state.

\[ \mathbf{x}_{n+1} = A \cdot \mathbf{x}_n + B \cdot \mathbf{u}_n \]

where \( \mathbf{u}_n \) is the vector of loans (approved). The output: \( \mathbf{y}_n = C \cdot \mathbf{x}_n \) describes the target values of risk and profit.

The problem is then to maximise profit and keep risk in acceptable levels. We may also have other algebraic constraints, such as, liquidity, capacity and capital constraints.

The optimal control problem can then be solved at each level using the solution of previous level as input to the next.

The above system is related to the next level system by disaggregation and to the previous by aggregation.
Outcome of the Optimisation Problem

▲ Top Level, risk appetite, capital levels for Credit Risk and optimal profit target

▲ Bottom Level, types of acceptable clients in terms of rating, exposure limits for every rating, exposure limits for every rating, collateral setting for every type of rating, pricing of loan.

▲ Intermediate Level, limits in average PD for every unit or product, limits of exposure for every unit or product. Profitability of every unit or product.
CONCLUSIONS

▲ Multilevel Hierarchically Nested Systems introduce the need for studying **Multilevel Hybrid Systems**
▲ Multilevel Hybrid Systems require the introduction of notions of **Global Controllability** and **Global Observability**.
▲ The family of **Financial, Management Systems** is a paradigm of Multilevel Hybrid Systems
▲ Decisions are infiltrated from the top to the bottom level and results of actions are observed from the bottom to the top level
▲ An optimization problem can be defined by optimising profit keeping risk in acceptable levels
▲ This problem can be solved in stages starting from a macro level solution at the top and ending at an analytical or micro level at the bottom.