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Neuroevolutionary Inventory Control in Multi-Echelon Systems

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Inventory control

inventory control theory often uses dynamic programming and focuses on policies for special cases

impractical for large *multi-echelon systems*

we may use *simulation optimisation* to handle large/messy problems (production scheduling, network design, financial planning, hospital administration, manufacturing design, waste management & distribution...)

but for *multi-stage* problems we get an exponential/infinite *scenario tree*

an alternative form of approximation: an artificial neural network (ANN) to represent the policy

Neural policies

the ANN **input:** current stock levels plus current time (unary encoding); **output:** recommended order quantities; **form:** order quantities are *affine functions* of stock levels & time (no thresholding or hidden layers)

trained by **cellular (μ+1)-evolution strategy** with **Cauchy mutation** & **resampling**, plus a **decoder** to avoid constraint violation (negative orders, negative stock levels)

training an ANN by evolution is *neuroevolution* (NE), applied to control problems and game learning, but not extensively to inventory control

we call this combination NEMUE: NE for MUlti-Echelon systems

Experiments

we compare NEMUE & stochastic programming (SP) on 28 problems with 3 stocking points, 2–9 time periods, various costs & demands, and arborescent/serial topology

(quite small problems, but anything larger can't be solved optimally by SP so NEMUE can't be evaluated)

NEMUE scaled far better than SP & often found optimal policies (where known)

the affine ANN+decoder works surprisingly well, but more complex ANNS can be used if necessary

Conclusion

NEMUE seems to be the *first NE method* for approximating optimal plans in multi-echelon stochastic inventory control

it is simulation-based and uses general-purpose techniques such as evolutionary algorithms and ANNs, so it does not rely on special properties of the problem

it can quickly find near-optimal solutions & scales better than SP

we will extend it to handle problem features such as capacity constraints