Notes on Powell’s Unified Modeling Framework

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The core elements of the universal modeling framework are:

*State variables* – the state variable contains everything we know and only what we need to know to make a decision and model our problem. State variables include physical state variables (e.g. the location of a drone, inventories, investments in stocks), other information about parameters and quantities we know perfectly (such as current prices and weather), and beliefs in the form of probability distributions describing parameters and quantities we do not know perfectly (e.g. an estimate of how much a drug will lower the blood sugar in a new patient, or how the market will respond to price).

*Decision variables* – a decision variable can be binary (e.g. hold or sell), a discrete set (e.g. drugs, products, paths), continuous variables. Decisions are subject to constraints and we make decisions using a method we call *a policy* .

*Exogenous information* – this is the information that we learn after we make a decision (e.g. market response to a price, patient response to a drug, the time to traverse a path), that we did not know when we made the decision. Exogeneous information comes from outside the system we are modeling.

Note: Decisions, from other side, can be thought as an *endogenous information* since we make those decisions, which represent information internal to the process.

*Transition Function* which consists of the equations required to update each element of the state variable . This covers all the dynamics of our system, including the updating of estimates and beliefs for sequential learning problems.

Objective Function – can be expressed as contribution in terms of reward or cost we make each time period, given by where is determined by our policy, and is the current state, computed by the transition function.