

## PSM Fall 2015, Exercise Sheet 1

Return on Tuesday Sep 15 in class

Note. You are encouraged to work in teams of two — but no larger. If you work in a team, submit only a single sheet with both names indicated on it. Nicely type-set solutions are highly appreciated.

**Problem 1 (30 pts).** In insect societies the ratio of female vs. male individuals varies dramatically between species. A myrmecologist<sup>1</sup> wants to determine the f/m ratio for the ant species *Cataglyphis bicolor* (one of the most intensely studied ants – being one of the most heat-tolerant animals known and also being able of stunning navigation feats [https://en.wikipedia.org/wiki/Sahara\\_Desert\\_ant](https://en.wikipedia.org/wiki/Sahara_Desert_ant) ). Your task: Describe in plain but precise English a suitable DGE + DRP, and in formal terms a DVS. Note: there are several natural ways to specify a DGE for this scientific situation.

**Problem 2** Global economists try to model the global economy system (of course, what else should they do). This is a temporal system of stunning complexity, and modeling it formally as a stochastic process is a difficult task. One difficulty is the heterogeneity of relevant information that has an impact on, or should even be considered part of, the global economical system. These relevant components not only comprise standard financial indicators but also factors like natural catastrophies, wars, elections, inventions... almost everything that happens on this planet.

**(a, 20 pts)** The easy part of this modeling problem: Describe in English a suitable DGE. (hint: combine ideas from the Evolutionary Trees I (or II) examples in the LN with what you have learnt about modeling stochastic processes (Section 5 in the LN)). Specifically, what are elementary events  $\omega$ ?

**(b, 50 pts)** The difficult part of this modeling problem: the RVs  $X_i$  and their sample spaces  $S_i$ . A comprehensive model of the global economical system would require an extremely large number of very diverse RVs. Since we are dealing with a temporal system, these RVs will mostly (or even all) be time-indexed. However, it is not so straightforward to come up with a good choice for the time index set  $T$ . Some observables  $X$  will need a fine-grained timescale (for instance sub-second fluctuations of exchange rates in computer trading), others are defined on a daily or monthly grid, yet others are defined for intervals, not points in time (for instance, interest rates fixed by the U.S. Federal Reserve for long times). It wouldn't make much modeling sense to use the finest-grained discrete timescale (or a continuous timescale) to model all of these quantities – e.g. it wouldn't be good modeling to define the interest rates fixed by the U.S. Reserve on a second scale.

Your task: think of a *structured* time set  $T$  that can accomodate time indices  $t$  for the diverse kinds of temporal measurables  $X_t$  which we want to include. A simple linear ordering surely gives not enough structure. Deliverables: (i) a mathematical structure imposed on a time index set  $T$  that seems useful for this modeling task; specify this

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<sup>1</sup> Myrmecology: the science of ants

mathematical structure in formalism and explain your underlying ideas in plain English, (ii) some exemplary, diverse RVs  $X_t$  with their sample spaces  $S_t$ , described in plain English (what do they model) and formally (what is the mathematical format of the corresponding  $S_t$ ).

The best 3 solutions for this task **(b)** will be awarded with 3, 2, 1 bonus points, which count undiluted toward the course percentage. If a solution is handed in by a team of two, both contributors get the respective bonus. We (the TA Xu "Owen" He and I) reserve the right not to award bonus points if we don't find the relatively best solutions actually nice. We also reserve the right to donate more bonus points than mentioned above if we find your solutions awesome.