List of topics

(Numbers correspond to lecture number.)

2. information theory:
   information entropy: the required properties and functional form; joint and conditional information entropy, mutual information

3. the Maximum Entropy principle:
   general formulation, derivation of the solution

4. Legendre transform:
   definition, inverse, applications eg. $S(F)$ vs $-\log Z$

5. reciprocity and fluctuations:
   the reciprocity laws; constraint variables: covariance and variance, dependence on extra parameters

6. microcanonical and canonical ensemble:
   partition function and probability of states, fluctuations of energy, Helmholtz free energy

7. canonical ensemble of physical systems:
   particle in a 1d box, ideal gas, harmonic oscillator, quantum harmonic oscillator

8. grand canonical ensemble:
   partition function and probability of states, fluctuations, reciprocity relation, grand free energy, partial trace

9. the "widget problem":
   formulation of problem (eg. loss function) to take decisions, worked out case

10. thermodynamic limit:
    size dependence of fluctuations, central limit theorem, Cauchy/Lorentz distribution, stable distributions

11. thermodynamics:
    laws of thermodynamics, state variables, free energies

12. phases and defects:
    phases and symmetries, order parameter field, topological defects

13. abrupt phase transitions:
    example phase diagram, behaviour of free energies of phases near abrupt phase transition, nucleation, (Maxwell construction)

14. continuous phase transitions:
    example phase diagram, universality, universality classes, percolation, sketch of renormalisation

15. granular matter:
    slope of granular piles, Edwards' ensemble, compactivity, (spatial structure of granular force networks, jamming transition)

16. transport and traffic models:
    continuity equation, fundamental diagram of traffic models, phase separation

17. flocking:
    model of self-propelled particles, nature of phase transition

18. surface growth:
    scaling relations, self-affine surfaces, discrete models, continuum equations

    . . . and put concepts into practice!