Name: _____

CS523 **Sample** Final Exam.
This version of the exam is for students enrolled in *CS523: Complex Systems*. If you are enrolled only in *CS423: Introduction to Complex Systems* please ask for the corresponding exam. If are enrolled in both CS523 and CS423 take this exam.

The questions in each section refer specifically to the associated reading printed in **bold**. Mark the best answer by filling in the circle next to it. Explanatory comments will not be considered.

The **real** exam is worth 15% of your final grade for this course, and contains 25 questions each equally weighted (1 point each). The exam period is 50 minutes. This sample exam has fewer questions.

Mitchell M. Evolving Cellular Automata to Perform Computations: Mechanisms and Impediments, 1994

1. (1 point) Mitchell describes "GA's breaking of task symmetries in the pursuit of short-term gains in fitness" as an impediment to GAs. To which idea from class is this most closely related?
   - ◯ A flat fitness landscape.
   - √ **The GA being trapped in local maxima.**
   - ◯ Problems with representation of the solution space in the genome.
   - ◯ A common problem seen in Island GAs like the one Mitchell uses.

Axelrod, R. The Evolution of Cooperation Chapters 1, 2, and 9, 1981

2. (1 point) Reciprocity as a strategy depends on which of the following:
   - √ **A durable relationship**
   - ◯ Friendship
   - ◯ Foresight
   - ◯ A referee

Press, W. Iterated Prisoner's Dilemma Contains Strategies that Dominate any Evolutionary Opponent, 2012

3. (1 point) A "sentient" player can beat an evolutionary player by:
   - ◯ Manipulating the pay-off matrix so that is always favours the sentient player
   - √ **Spoofing the evolutionary player with a fictitious fitness landscape**
   - ◯ Guessing the next move the evolutionary player will make
   - ◯ Playing inside the equilibration time scale allows the evolutionary player to win

Ehlen, M., "The Effects of Bank Size on Equilibrium Price Dispersion", 2002

4. (1 point) Ehlen's model shows that large banks can influence the Nash equilibrium because:
   - ◯ Consumers trust smaller banks more than larger banks
   - ◯ Smaller banks are more nimble and able to undercut larger banks
   - ◯ Supply-side economics show that bigger banks are more efficient
   - √ **Searching for smaller banks costs more than searching for larger banks**

Axelrod, R., Timing of Cyber Conflict

5. (1 point) High stealth attacks are likely to be used quickly because:
   - ◯ the risk of detection and recrimination is low.
   - √ **they are likely to be reusable.**
   - ◯ they do more damage than easily detected attacks.
   - ◯ it is easier to place the blame elsewhere.

Tero A. Rules for Biologically Inspired Adaptive Network Design, 2010

6. (1 point) The tradeoff in designing networks that Tero et al. identify is between:
   - √ **robustness and cost**
   - ◯ cost and scaling
   - ◯ scaling and robustness
   - ◯ throughput and cost

Meyers, C., Software systems as complex networks: Structure, function, and evolvability of software collaboration graphs, 2003

7. (1 point) The large scale network structure of major software projects is the result of:
   - ◯ top down control
   - √ **emergent relationships resulting from many changes over time**
   - ◯ design documents provided by project managers
   - ◯ robustness built in explicitly at all levels

West, G. and J. Brown, Life's Universal Scaling Laws, 2004

8. (1 point) West claims that the most commonly observed power law exponent in metabolic scaling is:
   - ◯ $\frac{1}{4}$
   - ◯ $\frac{1}{2}$
   - √ $\frac{3}{4}$
   - ◯ $\frac{3}{2}$

Forrest, S. Computer immunology, 2007

9. (1 point) Which of the following is a central component of artificial immunology inspired by biological immunology:
   - ◯ odd and even selection
   - √ **positive and negative selection**
   - ◯ plus and minus selection
   - ◯ up and down selection

Smith, D. Mapping the Antigenic and Genetic Evolution of Influenza Virus, 2004

10. (1 point) Analysis of antigenetic maps allows:
   - ◯ the effectiveness of vaccination to be questioned
   - √ **prediction of which flu shots to create each year**
   - ◯ tracking disease spread in the archaeological record
   - ◯ the mapping of the opposite of genetic maps

Triani, V. Evolving Aggregation Behaviors in a Swarm of Robots, 2003

11. (1 point) The behaviour of these robots is inspired by:
   - ◯ bacteria
   - √ **social insects**
   - ◯ genetic algorithms
   - ◯ the immune system

Dorigo, M. Swarmanoid: a Novel Concept for the Study of Hetrogeneous Robotic Swarms, 2011

12. (1 point) The swarmanoid swarm consists of robots that:
   - ◯ are all the same so they can be controlled with the same software
   - √ **that are each specialised for a particular task**
   - ◯ change roles as the situation demands
   - ◯ are self-reproducing

Brooks, R. New Approaches to Robotics, 1991

13. (1 point) The subsumption architecture:
   - √ **consists of various simple behaviours that together form higher level behaviours**
   - ◯ is the basis for swarm behaviour
   - ◯ consists of robot kinematics that allow the robot to interact with the environment
   - ◯ requires the robot be situated in the environment but not embodied

Williams, L. Evolution of Tail-Call Optimization in a Population of Self-Hosting Compilers, 2013

14. (1 point) The self-compiling program is evolved by a GA that optimises for increased:
    - √ **effective complexity and compilation efficiency**
    - ◯ lambda expressions and compilation efficiency
    - ◯ effective complexity and lambda expressions
    - ◯ none of the above

Doyle, J., Robustness and the Internet

15. (1 point) The internet is described as having which properties?:
    - ◯ adaptation
    - ◯ self-organising
    - ◯ power-laws
    - √ **all of the above**

Mark Ehlen, Ph.D., Sandia National Labs

16. (1 point) Dr. Ehlen presented his work on modeling which of the following:
    - √ **the food distribution network**
    - ◯ the power grid
    - ◯ airline travel
    - ◯ plague

Melanie Moses, Ph.D., UNM Computer Science

17. (1 point) Scaling laws we see in biology and computer processors are due to:
    - ◯ Power limitations
    - ◯ Volume divided by area
    - ◯ Convergent evolution
    - √ **Fractal-like distribution networks**
    - ◯ Stephen Wolfram

Lance Williams, Ph.D., UNM Computer Science

18. (1 point) The goal of the research presented is to:
    - ◯ Examine the complexity of cytokine signalling transduction networks using Haskell
    - ◯ Show the flaws in a self-reproducing robot built by Jon von Neumann
    - ◯ Present "SimSoup" an artificial-chemistry tool-kit
    - ◯ Design a cell that can replicate using a robot chemist to rapidly explore combinations of chemicals
    - √ **Use a GA to evolve a system analogous to an artificial cell composed of devices borrowed from modern programming languages**

19. (1 point) Which of the following is not a characteristics of a swarm according to Manuel Brambilla:
    - ◯ Agents are autonomous
    - ◯ Agents cooperate
    - √ **Agents have access to a centralized control**
    - ◯ Agents are situated