Algoritmy pre AI robotiku, V. Diel

LCS, NEAT

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RL + GA = LCS

From animals to animats...
LCS - flavours

- Bucket brigade vs. Q-learning

- No message list, added strength to the rules -> ZCS, strength-based ZCS

- predict reward in addition to select action -> accuracy-based LCS (XCS)

- anticipatory-based LCS -> ACS
LCS - formalism

- classifier: \(<c,a,p>\)
  c: condition
  a: action
  p: prediction of expected accumulated reward

Condition – test on attribute values, e.g.
\((0,1,1,#,1,#)\)  # = don't care
alternately: integers, real numbers, S-expressions

Action – multiple can be selected
  - set \(M\) (match set),
    one is chosen – a (wrt. Exploration/exploitation)
  - \([a]\) set – rules that advocated for this action a
LCS – strength-based: ZCS

Quality – both fitness and reward estimation
Action selection – roulette wheel
Classifier evaluation – three step mechanism
LCS – strength-based: ZCS

Classifier evaluation – three steps mechanism:

1. all classifiers that advocated for action \(a(t-1)\) share equally a fraction \(\alpha \cdot \gamma\) of the sum of the values of classifiers in \([a]\)

2. all classifiers in \([a]\) share a fraction \(\alpha\) of the reward \(r(t)\)
   Received for executing \(a(t)\)

3. the value of all classifiers in \(M - A\) is reduced with a tax \(\tau\)
LCS – strength-based: ZCS

Classifier creation/deletion

- at each time step, run GA with probability $p$

- select two (roulette), recombine (1-point crossover), and mutate, initial fitness: average of parent classifiers, replace by inverse roulette

- each time M is empty or contains too weak classifiers, use „covering operator“ that generates new rule, using # with 33% probability and random action, fitness equal to average fitness of all classifiers
LCS – strength-based: ZCS

Typical parameters

Population size: 400
Initial fitness: 20
Learning rate ($\alpha$): 0.2
Discount factor ($\gamma$): 0.71
Tax ($\tau$): 0.1
GA firing rate $p$: 0.25
Crossover rate $P_c$: 0.5
Mutation rate $P_m$: 0.002
Covering operator firing rate: 0.5
NEAT – evolving RNN

See article in materials at the webpage of the course