libARA: A framework for simulation and testbed based studies on ant routing algorithms in wireless multi-hop networks

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From Ant Foraging to Ant Routing Algorithms

- Ant routing algorithms are based on ant-colony-optimization (ACO) metaheuristic
  - inspired by the foraging behavior of ants
    - ants mark paths towards food with a special hormone, called pheromone
    - ants are attracted by pheromones and in turn reinforce them
    - pheromones evaporate over time and thus, only short paths remain
    - probabilistic behavior in terms of finding alternative paths
  - ACO applied to problems and challenges in multiple areas, e.g.
    - Combinatorial Optimization
    - Classification
    - Protein Folding
From Ant Foraging to Ant Routing Algorithms (cont.)

  - mapping concepts of metaheuristic to routing
    - special control packets represent ants
      - part of route discovery and maintenance processes
    - pheromones represent weighted edges in the network
    - evaporation (negative feedback)/reinforcement (positive feedback) on these weights
    - stochastic behavior by means of transmission probability
  - algorithms often differ in
    - broadcast schemes
    - additional heuristics
How everything started ...


ARA: The Ant Colony Based Routing Algorithm

ARA

ns-2, 2003

extended by

ARA

ns-2, 2004

rewritten by

ARA

PocketPC, 2004

rewritten by

Energy Aware Ant Routing Algorithm, Technical Report

EARA

ns-2, 2005

rewritten by


Entwurf und Implementierung eines Layer 2.5 Frameworks fuer reaktives Routing, Master Thesis, 2005

DES-ARA

libdessert, 2009

From Biology to Technology: Demonstration Environment for the Ant Routing Algorithm for Mobile Ad Hoc Networks in Demos at MobiCom, October 2004
Related Work?

- There is no framework to study ant routing algorithms
  - most implementations best kept secret
    - notable counter examples:
      - AntHocNet (2007, QualNet 4.0)
        - (good luck with that)
      - Simple Ant Routing Algorithm (SARA, 2013, ns-2)
  - no (public) implementation for wireless testbeds
  - generally no comparison to existing ant routing algorithms

→ Provide a framework for ant routing algorithms for simulation and wireless testbeds
  - easy to „understand“ for students (and thesis work)
  - considering learned lessons from
    - unmaintainable testbed version
      - grown with student theses
    - (too) old ns-2 code base
Towards a library for Ant Routing Algorithms (libARA)

- A abstract core which summarizes concepts of ant routing algorithms
- Concrete implementations
  - simulation core (OMNeT++)
  - routing framework (DES-SERT)
- Unit tests allow to grasp several concepts easily
  - limited to abstract core
- Easy to extend and adapt
- A small python frontend for
  - running and controlling experiments
  - evaluation
- Written in C++11
How to provide a new ant routing algorithm?

- Typically, inherit and implement several classes
  - \{Evaporation, Reinforcement\}Policy for new evaporation/reinforcement policies
  - Forwarding Policy for a new transmission probability
  - Customize routing daemon behavior
    - Inherit and overwrite methods in Abstract\{Network, ARA\}Client
      - Particularly if in need of broadcast schemes
  - Add/modify code for OMNeT++/DES-SERT
    - Particularly packet structures (if required)
    - Code for simulation tends to be more „extensive“
libARA in Action

plan  →  execute

Experiment control with Baltimore

analyze

Various plots generated with Baltimore

Screenshot of the OMNeT++ GUI
Future Work

- Extending the framework within respect to
  - additional algorithms
    - AntHocNet
  - mechanisms for bridging the gap between simulation and testbed based studies
    - capturing topology and quality of the links
  - configuration
    - domain specific language for experiment for generating settings
      - Integration in existing approach (DES-SCRIPT)
  - (visualization)
    - pheromones and energy consumption
    - topology changes
  - (evaluation)
    - further metrics and analysis
Summary

- Provide a framework for the design, implementation and evaluation of ant routing algorithms for simulation and wireless testbeds
- Allows to investigate properties and effects of ant routing algorithms
  - pheromone models, energy-efficiency, broadcast schemes, …
- Demo (Focus on Simulation)
  - Thursday, 8:30 – 9:30 am
- Would love to get feedback on framework
  - Installation Guide is a bit 'whacky' (drop me a line)
    - Mail: frey@informatik.hu-berlin.de
    - Instant Messaging: mfrey@gk-metrik.de (XMPP/Jabber)

️ Fork Me

http://www.github.com/des-testbed/libara

$ git clone https://github.com/des-testbed/libara.git
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