Learning Reliability Models of Grid Resource Supplying

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Cracow '05 Grid Workshop

Agenda

- Motivation
- Resource trading

  in an unstable resource environment
- Distributed bartering
- Grid resource supplying reliability
- Summary, conclusions

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Grid resource exchange: current trends

- Interactions between multiple admin. domains: exchange of resource allows Grid sites to use the resources of other Grid sites
- Sites have to be motivated to supply their resources
- Current trends = Grid economy, market methods

How do you select a supplier when several suppliers offer the same price ?

- Current focus of most market-based methods = How to balance supply and demand ?

- But ... when supply and demand are balanced ... which criteria do you take into account to select a resource supplier ?

  => focus of this presentation

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Resource trading is not an easy problem

Real-world resource environment:

- sites enter and leave the Grid without notice

    => risks of free riding (due to ID changing)

- PI (Partial and Intermittent) resources

    => unstable resource availability

Resource trading is not a simple problem

Grid users/Grid sites:

- not necessarily willing/able to pay real $$$
  for the consumption of external resources

2 trends of resource trading will probably coexist:

- commercial supplying of resource (1-sided: sell only)
- « goal-oriented » exchange of resources

(2-sided: sites both consume and supply resources)

Decentralized resource trading

Benefits of decentralized resource trading:

- no requirement for a central banking component
- more scalable
- more resilient to a degraded environment

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Auctions are common, moneyless methods are gaining attention

Distributed bartering =

- decentralized
- moneyless
- market-based

resource trading method

Accounting of resource consumption is very important to avoid free riding

Network of Favors model

Example of a recent successful middleware:

OurGrid, based on the Network of Favors model

- a peer supplies its non-busy resources to other peers (= makes favors)
- each peer maintains a separated « favors count » (= debt count, always > or = 0) with all other peers
- priority in supplying given to the peers who have contributed the most resources in the past

Resource exchange accounting

OurGrid currently proposes 2 accounting schemes:

- simple accounting model: time-based

  => biased towards slower resources

- more robust accounting model: relative power

  => weight supply time with relative computing power between consumer and supplier

Known problem: the accounting may be asymmetrical

Asymmetrical accounting is unavoidable

Task execution may be affected by multiple factors:

- preemption of the supplied resources
  (when the supplier has more urgent local tasks)
- resource failure
- supplier departure from the Grid

=> asymmetrical accounting

- supplier: some computing time has been supplied
- consumer: the task has not been completed

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Back to the initial interrogation: how do you select a supplier ?

Existing middleware selected as an illustration

of current work in distributed bartering:

- Network of Favors model =

  how to prioritize resource supply ?

What we propose:

- Another interesting question =

  how to prioritize resource consumption ?

Asymmetrical accounting: what can be done ?

An interesting couple of observations:

- resource unreliability leads to task uncompleteness,
  which causes asymmetrical accounting
  and delays increase of consumer utility
- a peer should then avoid to consume resources
  supplied by an unreliable peer
  (use of explicit or implicit resource negotiation)

Modelling the reliability of resource supplying

Available data for a given peer about remote execution of tasks (= supplying of resources) by another peer:

- favors count: mean and recent history
- task acceptation/rejection: recent history
- task execution times: mean and recent history
- success/failure: mean and recent history
- ... only own data + externally observable data

Modelling the reliability of resource supplying

For a given peer, let:

- *p* = another peer
- *a(p)* = [favors count at submission time,

  expected execution time of a task on p,...]
- *c(a(p))* = task success/failure

  => *c(.)* = classification of *p* as reliable/unreliable from the perspective of the given peer

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Modelling the reliability of resource supplying

Learning problem:

- given a finite set of examples [*a(p)* , *c(a(p))*],
- find a decision model *d(a(p))* that classifies a peer given the collected input data about it (e.g. *(a(p)*)
- decision model *d(.)* should be as close as possible to the true classification *c(.)*

Then, use the model to select reliable suppliers.

Modelling the reliability of resource supplying

How to automatically find such a model *d(.)* ?

=> Automatic Learning algorithms:
k-NN, Decision Trees, ...

Be aware that the true classification *c(.)*

might/will change over time:

learning must be continuous/periodic (=> challenge)

Modelling the reliability of resource supplying

Results ?

All this is **early work**, we are currently (now !) testing:

- different AL algorithms
  (k-NN seems OK, requires instance editing ...)
- different attributes vector

=> seeking balance between precision, complexity

Further uses of reliability modelling ?

A Grid peer may obviously:

- consume preferably reliable resources

  => increase own utility

It may also:

- supply preferably its own resources to peers owning reliable resources

  => increase potential of reliable consumption

Delayed rewards : use of Reinforcement Learning ?

Roadmap of future work on resource profiling

- linking models that are computed when consuming with models that are computed when supplying, seeking to select optimal action (resource selection) with delayed reward
- exploiting temporal variations of reliability (modelling with time series)
- going further than simulation: implementation into existing middleware of machine learning algorithms used to compute reliability models

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Summary

- distributed bartering
  (decentralized, moneyless, market-based)
  is interesting, middlewares are appearing
  (OurGrid with the Network of Favors approach)
- we have observed that resource exchange/trading might benefit from studying consumption, supplying, and linking both
- we have proposed that sites consuming resources should avoid unreliable suppliers,
  and formulated this as a learning problem

Conclusions

- Use of Automatic Learning in the new context of distributed bartering
- Early work
- Links with scheduling, Multi-Agent frameworks, ...

Thank You