The Design of Convivial Multiagent Systems

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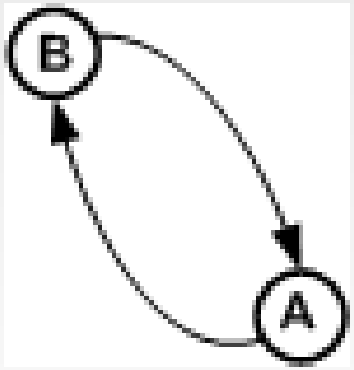
Introduction

- Popular meaning of conviviality:
  - Being sociable, feeling at ease
- Conviviality can be related to existing socio-cognitive concepts in agent theory.
  - Trust, contract, service, coordination and role.
- Why do we need conviviality?
  - Administrators/managers request it
- What problems can conviviality solve?
  - Many things can be wrong in an administration, for ex. bureaucracy
  - No relations between people: Conviviality is lacking
  - Improvements could be made by creating tools for conviviality

Conviviality

- Conviviality is "individual freedom realized in personal interdependence" Illich 1973.
  - Model personal interdependence with (Conte/ Sichman) dependence networks.
  - Model dependencies with: goals and power to fulfill goals.
  - Emphasize empathy and reciprocity, e.g. role swapping.



- Conviviality is "a mask that hides social structures" Taylor 2004.
  - Model mask with dynamic dependence networks.
  - Normative aspect.

Research Questions

- How to design the evolution of convivial social relations?
- How to combine viewpoints from stakeholders?
- How to incorporate normative aspects of conviviality?

Methodology

- Based on the agent-oriented software development process, Tropos
  - **Iterative** process that emphasizes agent's **intentionality** and **point of view**
  - Cover the whole software engineering process from **early requirement** phase to **implementation**

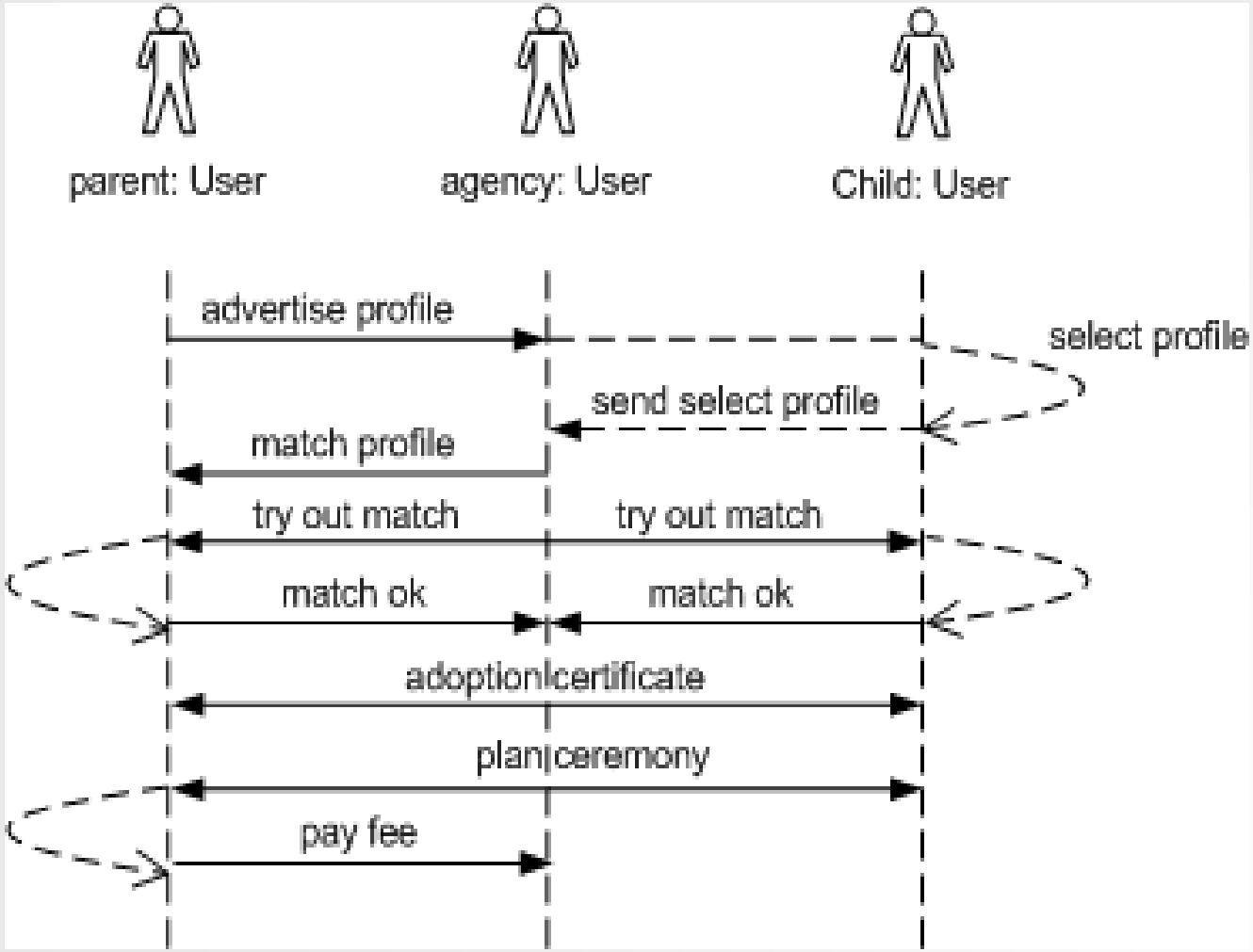
Representing Interdependence with Dependence Networks

- Agents described by a set of prioritized goals.
- The dependence relation expresses that an agent depends on other agents to fulfill its goals.

$$< A, G, dep, \geq >$$

- ***A***: *set of agents,* ***G***: *set of goals*
- ***dep***: $A \times 2^A \rightarrow 2^{2^G}$ *relates with each pair of an agent and a set of agents all the sets of goals on which the first depends on the second.*
- **≥**: $A \rightarrow 2^G \times 2^G$ *for each agent a total preorder on goals which occurs in its dependencies.*

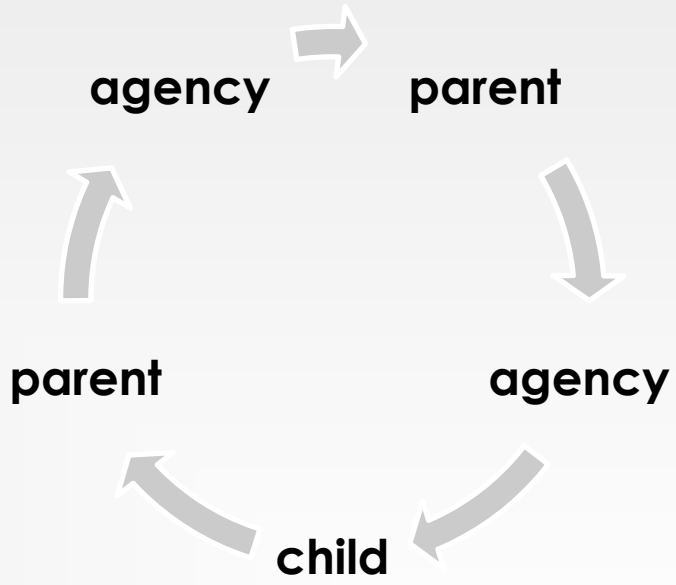
Introducing our running example: The virtual adoption agency



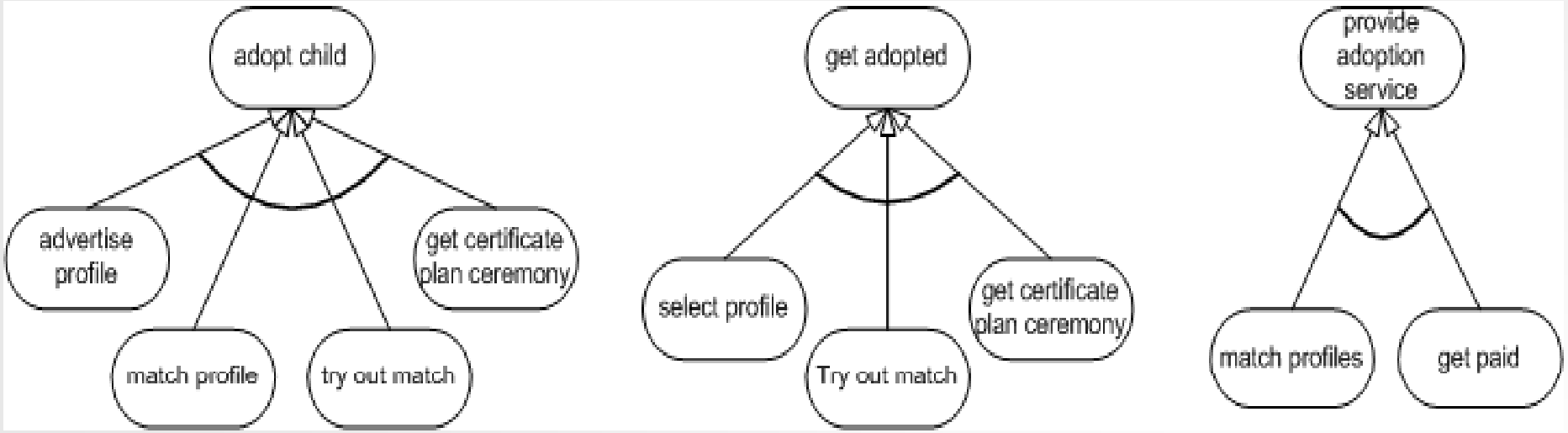
Sequence Diagram Modeling Stakeholders' Interactions

Measures for Conviviality

Even a simple count of dependence relationships (cycles) among participating agents could serve as an indicator for conviviality.



Iterative AND-Decomposition of Root-Goals into leaf sub-goals:



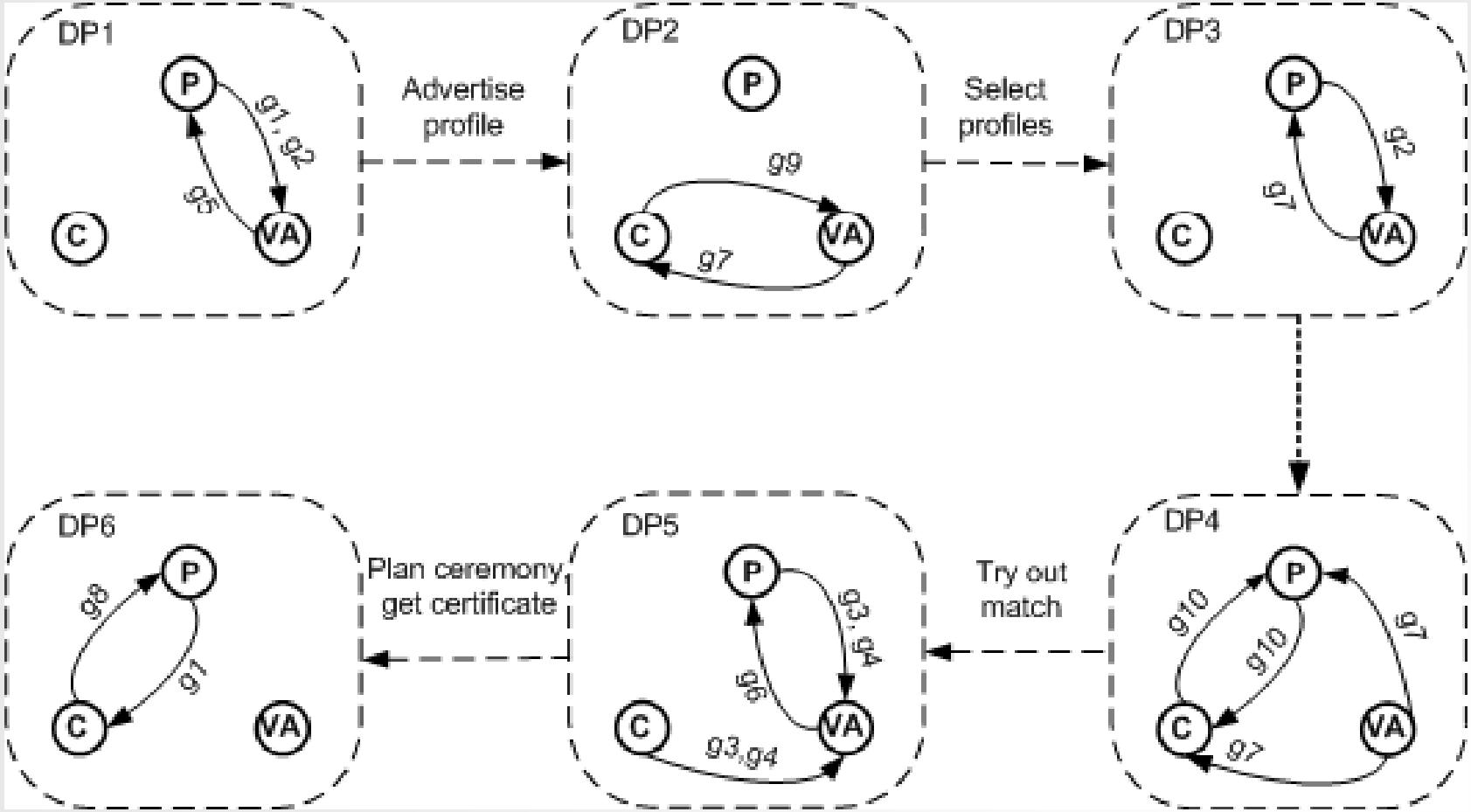
Introducing Temporal Dependence Network

- To model dynamic evolutions of dependence networks and convey conviviality over time

$$< A, G, T, goals, dep >$$

- ***A**: set of agents, **G**: set of goals, **T**: set of natural numbers*
- ***goals:*** $T \times A \rightarrow 2^G$ *a function that relates with each pair of a sequence number and an agent, the set of goals the agent is interested in.*
- ***dep***: $T \times A \times 2^A \rightarrow 2^{2^G}$ *is a function that expresses the dependence relation between an agent a∈A and a set of other agents regarding the goals of agent a, in sequence t ∈ T.*

Six Dependence Networks Sequences for our Running Ex: Virtual Adoption



Introducing Epistemic Dependence Network

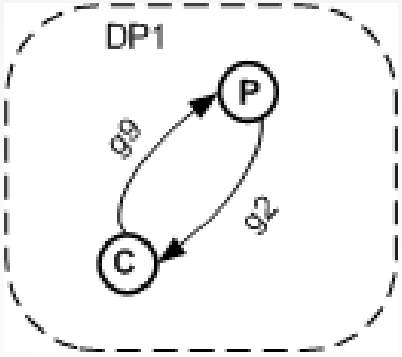
- To combine stakeholders' viewpoints

< A, G, T, goals,dep>

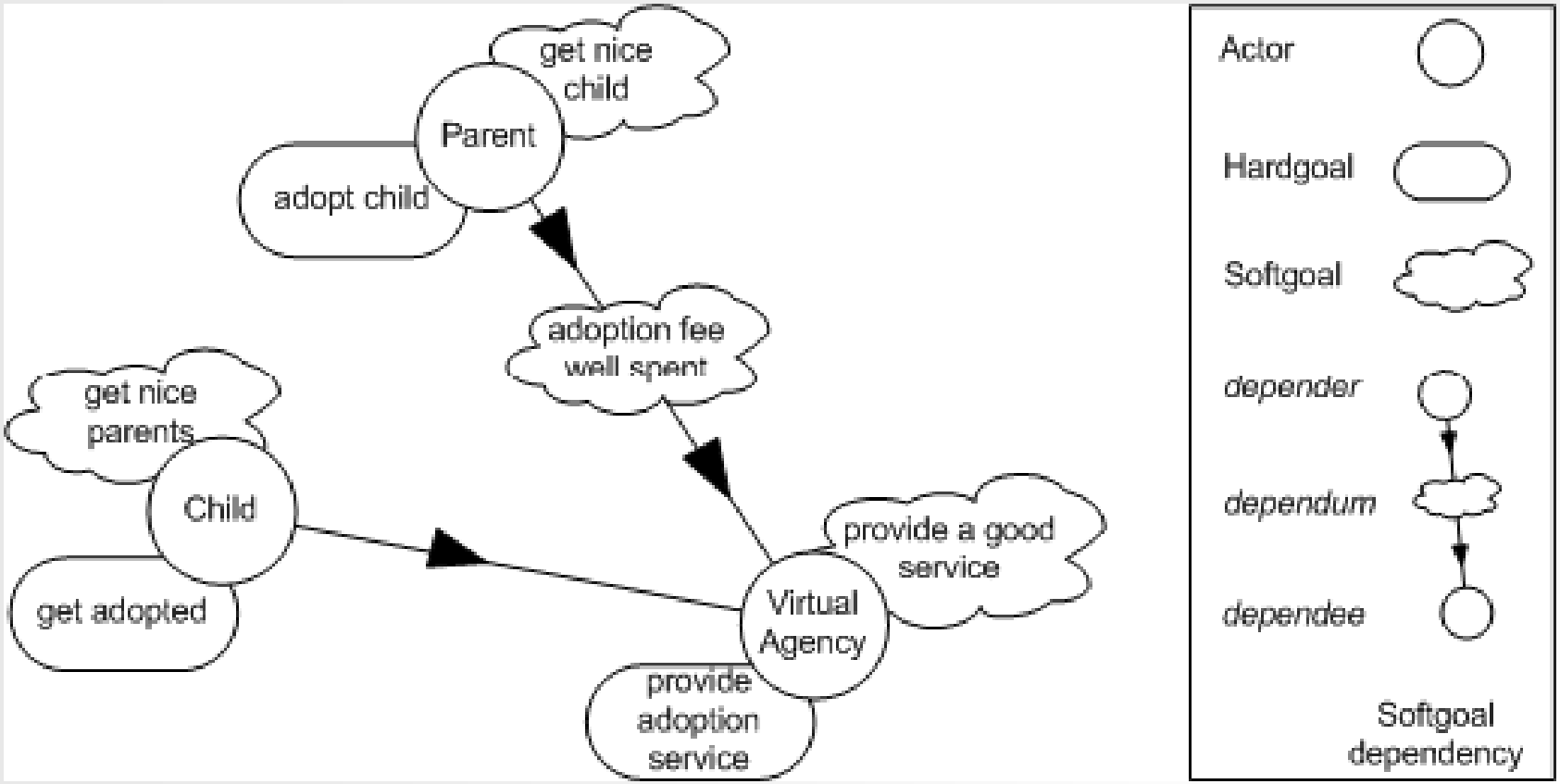
- ***A**: set of agents, **G**: set of goals, **T**: set of natural numbers*
- **goals**: $T \times A \rightarrow 2^G$ *a function that relates with each pair of a sequence number and an agent, the set of goals the agent is interested in.*
- **dep**: $A \rightarrow T \times A \times 2^A \rightarrow 2^{2^G}$ the *function expresses from the POV of an agent a∈A, the dependence relation between another agent b∈A and a set of other agents regarding the goals of agent b in a sequence t ∈ T.*

Epistemic Dependence Network For our Running Ex: Virtual Adoption

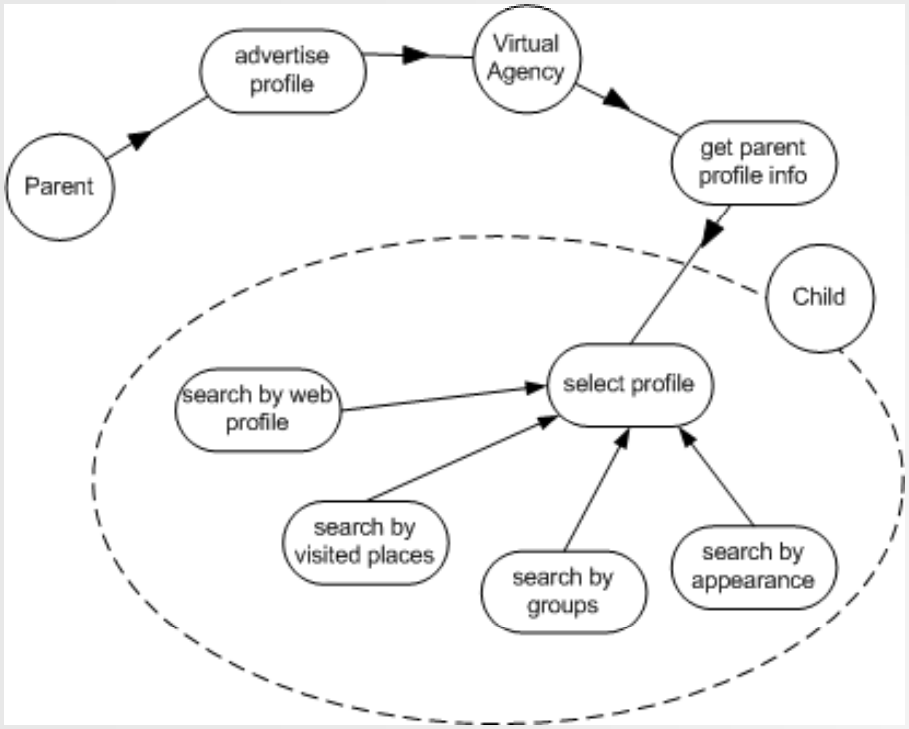
- Empathy for example can be expressed with nested dependencies as follows:
- ***dep(P) = (1,C, {P}) = {g_9}***: *agent P believes that in sequence* 1, agent *C depends on P to achieve its goal g_9: select parents' profile.*
- ***dep(C) = (1, P, {C}) = {g_2}:*** *agent C believes that in sequence* 1, agent *P depends on C to achieve its goal g_2:* advertise its profile.



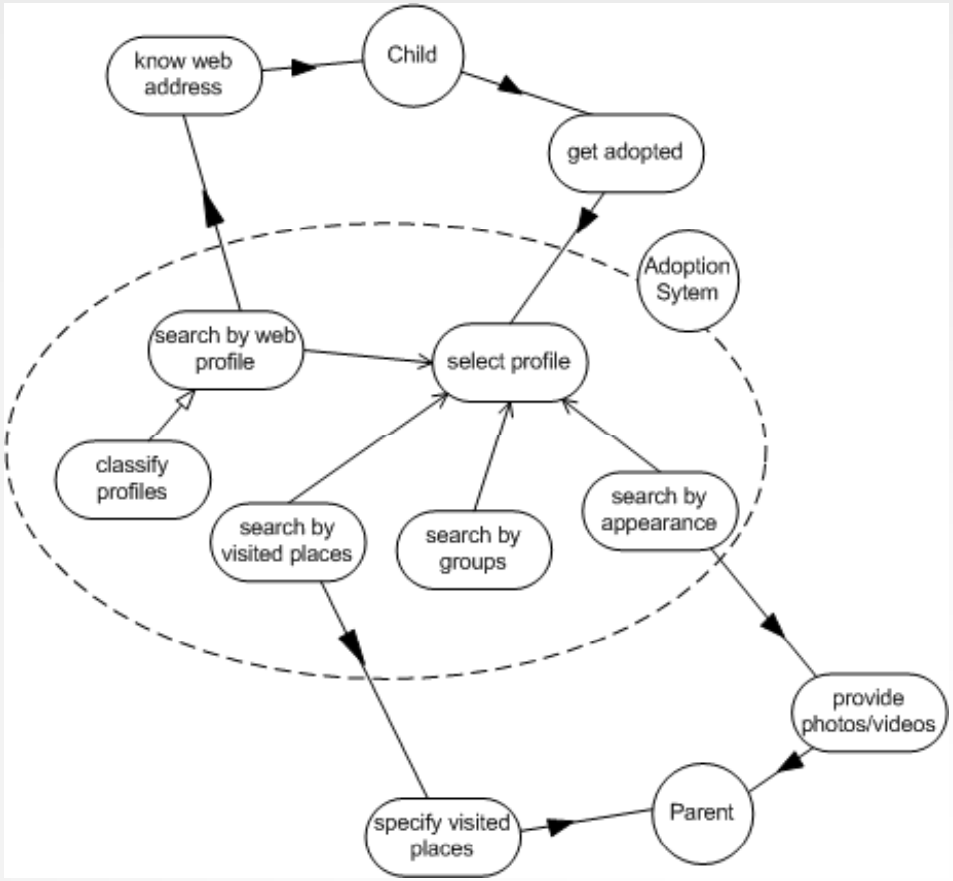
Actor Diagram Modeling Stakeholders for Virtual Adoption



Goal Diagrams for Goal Delegation: the *Select Profile* Goal



Left: Dependencies between actor Child and the environment



Right: Dependencies between actor Child and the environment

Introducing Normative Epistemic Dependence Network

- To model the transformation of social dependencies by hiding power relations and social structures to facilitate social interactions.

< A, G, T, N, O, V, goals,dep>

- ***A**: set of agents, **G**: set of goals, **T**: set of natural numbers, **N**: set of norms.*

< A, G, T, N, O, V, goals,dep>

- $O : N \times A \rightarrow 2^G$ *is a function that associates with each norm and agent the* ***goals the agent must achieve to fulfill the norm.***
- $V : N \times A \rightarrow 2^G$ *is a function that associates with each norm and agent the* ***goals that will not be achieved if the norm is violated*** *by agent a.*
- **goals:** $T \times A \rightarrow 2^G$ *is a function that relates with each pair of a sequence number and an agent, the set of goals the agent is interested in.*
- **dep:** $A \rightarrow T \times A \times 2^A \rightarrow 2^{2^G}$ *is a function that expresses* ***from the POV*** *of an agent a∈A, the dependence relation bet. another agent b∈A and a set of other agents regarding the goals of agent b in a sequence t∈T.*

Normative Epistemic Dependence Network for Virtual Adoption

Let's assume that: C must select profile, P must do no child look up, if P violates it must make a donation before it can achieve its goal to advertise its profile.

- $O(n_1,C) = g_9$: *agent C has the obligation to fulfill norm* n_1 *to* achieve goal g_9, *select parent profile*.
- $O(n_2 , P) = g_{14}$: *agent P has the obligation to fulfill norm* n_2 to achieve goal g_{14}, *no look up child*.
- $dep(P) = (2,C, \{VA\}) = g_{14}$: *agent P believes that in sequence* 2, agent *C depends on agent VA to achieve its goal* g_{14}: *no look up child*
- $V (n_2, P) = g_{15}$: *agent P violating norm* n_2 *will not be able to* achieve goal g_2, *advertise its profile, because a new goal* g_{15}, *make* a donation, is added. Until this new goal is achieved, g_2 *cannot be* achieved.

Summary and Next Steps

- To express conviviality as **interdependency**, we use dependence networks.
- To express the **temporal** aspects of goal-oriented agents' interactions in MAS, we use **sequences** of dependence networks.
- To take into account the **individual perspectives** of agents for the design of convivial MAS, we model **one dependence network for each agent**.
- To design **interaction mechanisms** that ensure **conviviality** in MAS, we use **norms.**
- **Challenges:** Implementation of our model and validation.