Early Aspects in Agent Oriented Modeling

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Plan of the talk

- Introduction to ideas from aspect orientation
- Applying aspect orientation at requirements level
- Aspect oriented paradigms in agent oriented methods

A Canvas of Programming Abstractions

events types D-structures

variables functions exceptions

structures

connectors

classes objects

continuations

components

processes

packages

threads agents

ambients files

synchronizers

Abstractions + Related Processes

events
modularity
types
contracts
D-structures
reuse
variables
functions
exceptions
structures
encapsulation
connectors
classes
objects
continuations
components
composition
decomposition
processes
packages
services
threads
agents
ambients
files
synchronizers

Abstractions + Related Processes + Properties

encapsulation

parallelism

events

modularity

types

D-structures

ACIDITY

contracts

synchronization

variables

functions

exceptions

structures

persistence

availability

decomposition

reuse

connectors

classes

objects

networkability

contributions

components

composition

deadlines

processes

movement

packages

threads

agents

security

services

ambients

distribution

synchronizers

files

Is this space enough for today’s computations?

- Maybe enough

  but …
- Do we have a clean organized view of all aspects of your software that is traceable from architecture to implementations?
- Do you maximize reuse?
  - Could you eliminate all redundancies!

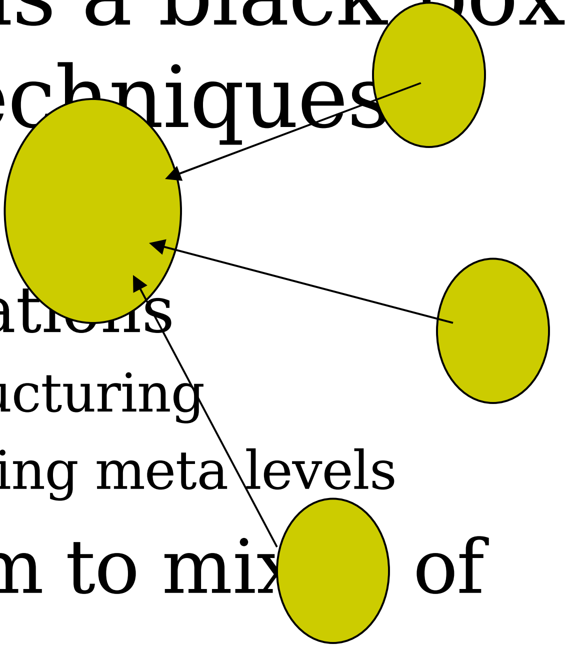
- The key: methods of separation and integration

Let’s Take a look at Some Empirical Studies

- Code redundancies reported (an old research)
  - Application projects: 75%
  - System programs: 50%
  - Telecommunication projects: 70%
- Reengineering projects find redundancies and eliminate them: 20-50%
- A latest study: 60% code in one Java class library was found to be

How to eliminate the redundancies?

- Just keep a copy of the redundant code and simply use it as a black box through conventional techniques
  - Not always possible!
    - – Technology imposes limitations
      - methods and models of structuring
      - varying flexibility for reaching meta levels
  - We can trace the problem to mixing of multiple concerns



Another perspective on non-separated concerns

- Redundancy results when a concern occurs in many entities, but each manifests it independently
- A single bundle may also host multiple concerns that are tangled and not separated
- A concern may get scattered over many entities
- Some examples follow

Concerns that tangle with other concerns

To tangle: To mix together or intertwine in a confused mass

- Functional code (business logic) and properties about the code
  - Assertions that capture contracts (pre/post/invariants)
  - Invariants across objects
  - Creational control and object’s instance behavior
- Exception handling code and functional code
- Nonfunctional code and functional code
  - Whenever function pop() is invoked, print the return value to a file
  - Log all calls to a specific object
  - Log all calls to all objects
  - Make a distributed object persistent

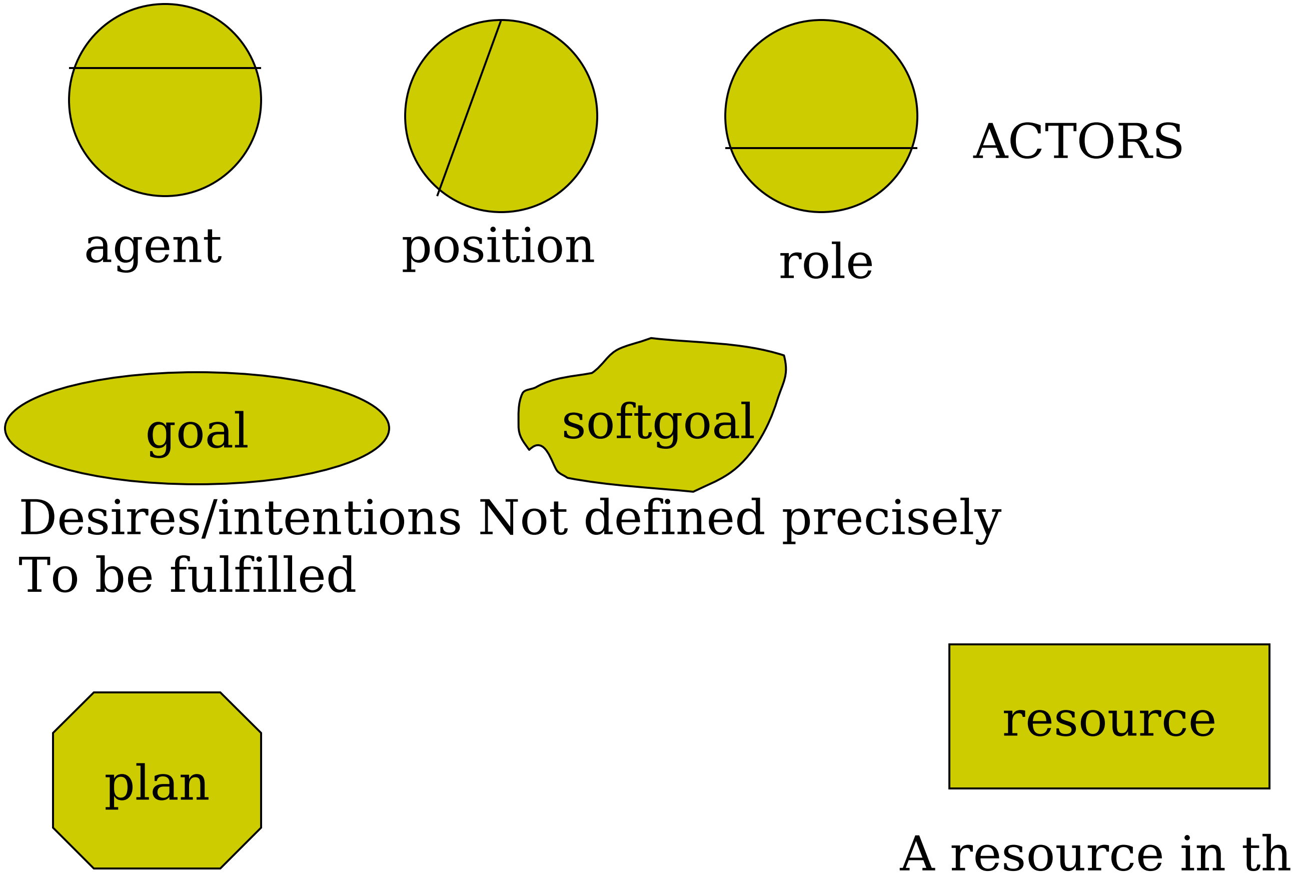
Programming paradigms influence the way we organize software…

- The problem can be attacked at programming level
  - By evolving programming paradigms

Separation of concerns at requirements level

- Separately express the requirements concerns
- Can you change them independently?
  - Or does a change in one use case lead to changes in many other use cases?
- Are requirements specs tangled?
  - The question is not about correctness and completeness
  - It is about modularity in expression in requirements capture

An Agent Oriented Requirements Capture Model (entities)



agent

position

role

ACTORS

goal

softgoal

Desires/intentions
To be fulfilled

Not defined precisely

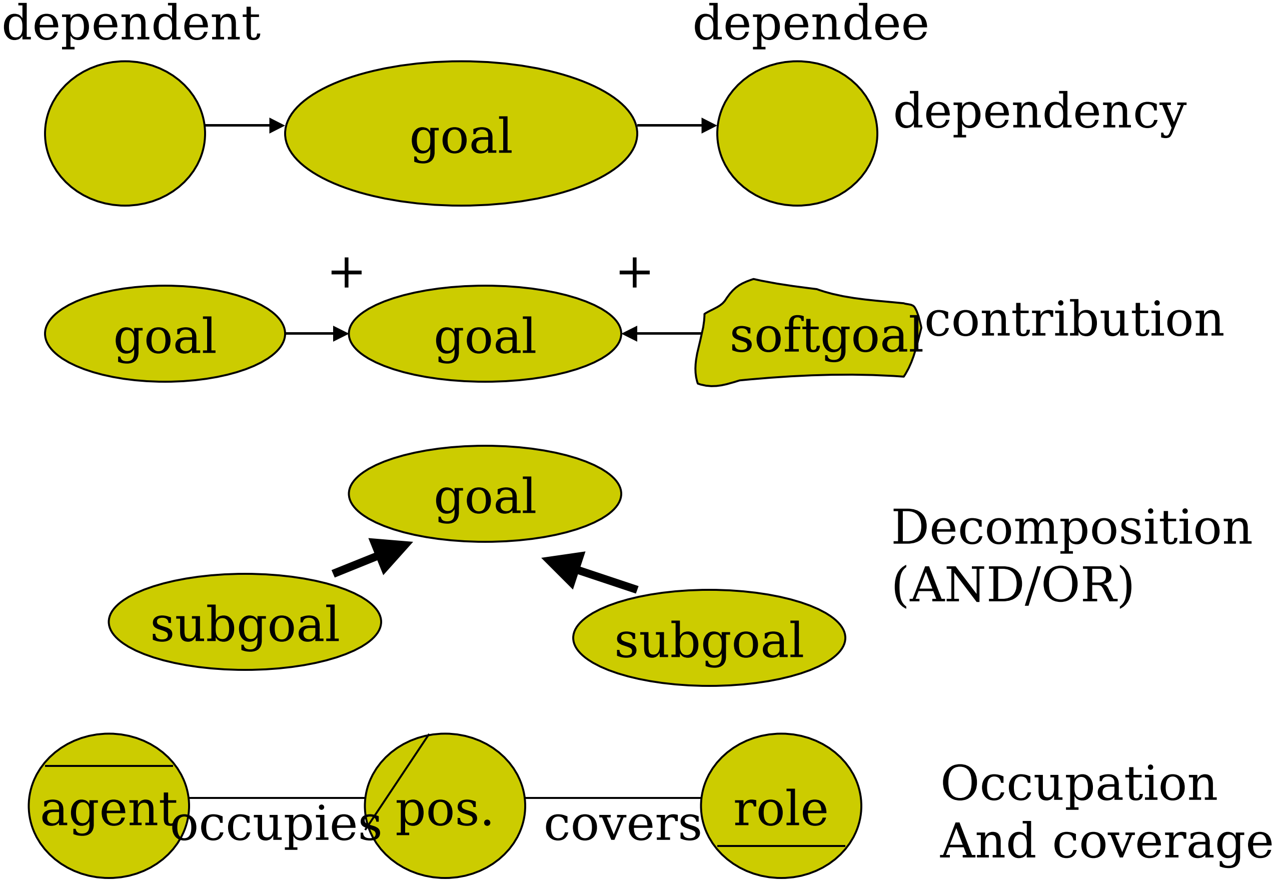
plan

Set of actions for satisfying goal(s)

resource

A resource in the system

An Agent Oriented Requirements Capture Model (relations)



dependent

dependee

goal

dependency

+

+

goal

goal

softgoal

contribution

goal

subgoal

subgoal

Decomposition
(AND/OR)

agent

occupies

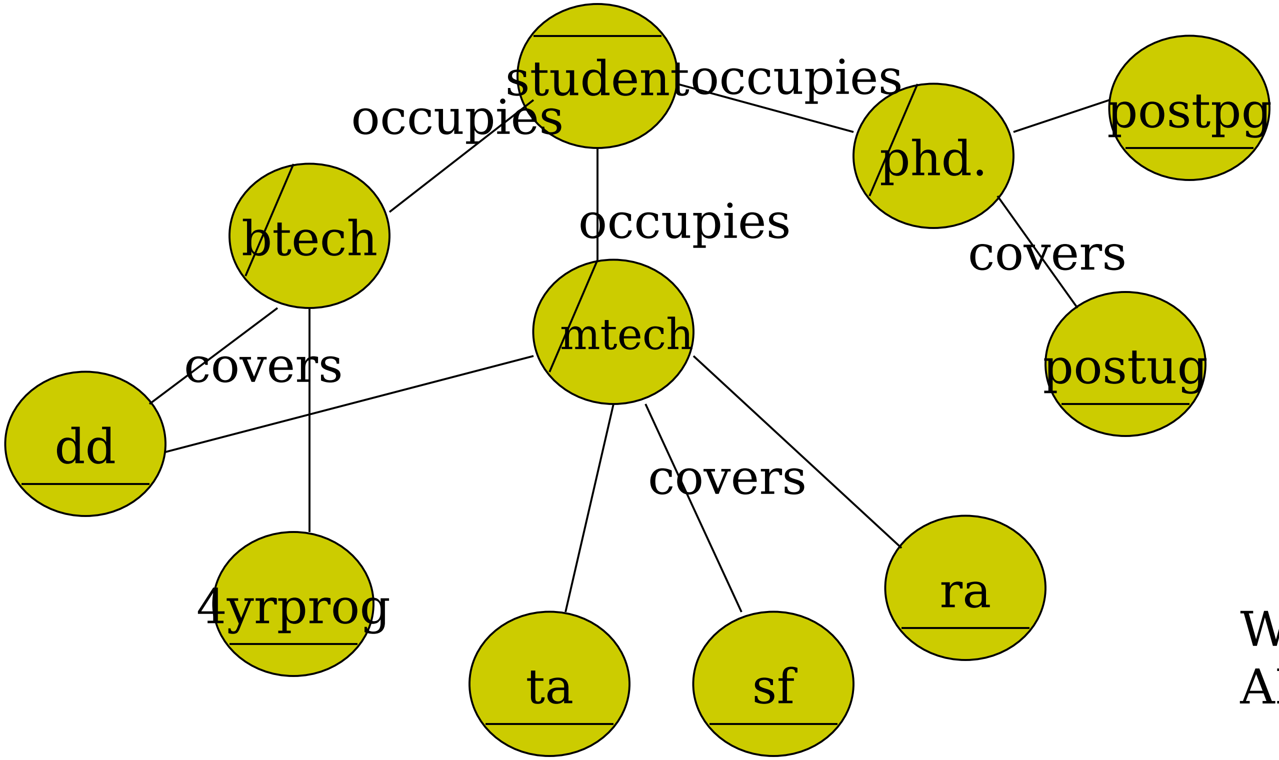
pos.

covers

role

Occupation
And coverage

An example entity model



With appropriate
AND/OR constraints

A goal analysis

Some Extensions for Separation of Concerns

- Extended actors
  - Before
  - After
- Abstract actors
  - Before
  - After
- Similar extensions for goals
- Shared goals

Aspect Goals

- Goals may be decomposed further into subgoals, and shared goals
- But it is not always possible to share goals “as it is”.
- Certain refinements may be necessary
- Aspect goals: an example

Meta goals

- Supporting meta goals (like around advise, before advise and after advise)
  - Wrapper goals (performance criteria)
  - pre goals (preconditions)
  - Post goals (postconditions)

Goal Ordering

- Partial orders may be defined
- Does not indicate goal decomposition but captures workflows (activity dependencies in UML)
- An example

Early Aspects: some pointers

- Concerns
  - Core Functionality
  - Security
  - Deadlines
  - Persistence
  - Mobility
  - Replication
- Tangling within the specs

Aspect Oriented Programming Constructs:

A Summary, More Examples and Related Approaches

Join Points

- A point in a source program
  - Method call
  - Constructor call
  - Variable read/write
  - Exception handler
  - Variable initializer
  - Destructor

Point cuts

- A set of join points + optionally some of the execution context values
  - Call (void Point.setX(int))
    - A call to a specific function
  - Call (public * Figure.*(..))
    - Calls to all public functions on Figure
  - Pointcut move: call … || call …
    - Any of the above calls
  - !instanceof (X) && call …
    - Call originates not from instance of X and to specified method

Advices

- Advices executed at the code at joinpoints for given pointcuts
  - Before advice
    - After reaching a join point, but before the computation proceeds
  - After advice
    - After the computation at join point has completed
  - Around advice
    - Run first. Proceed() inside around advice makes the computation proceed
  - After returning
  - After throwing
- Introductions: add new fields to classes, change relationships

Some more examples

- Aspects in a distributed objects domain
  - Object’s functionality
  - It’s location
  - It’s itinerary
  - Communication and synchronization
  - Its persistence
  - Its security

Aspect Orientation in middleware

- Write objects in your application first
- Add on services to the application later
  - Use AOP techniques (interceptor/static transformation) techniques

Feature interaction problem

- Effects of one aspect may interfere with that of another

- Careful ordering of aspect application is important

Product Line Approaches

High level transformation code

+

High level Base code

→ Actual Variant

Base-Meta Separation

- Meta-object protocols

- Reflection

  - Ideas are quite old
  - Some of the recent technologies have discovered them only now!

Filter Objects Approach

- Message based paradigm
- Based on interfaces and capture on messages
- Dynamic and First class aspects
- Pluggability at runtime
- Weaving not possible
- Filter objects for C++/Java/CORBA/COM, patterns, configurations

Open Problems

- Static vs. Dynamic aspects
  - Commercial Tools and Technologies are picking up
- Early aspects and traceability into code
- Aspects in processes
- Large scale applications and actual practice
- Impact on Systems design and software Engineering lifecycle in general
- Impact on Modeling Languages