Deadlock Analysis (The Dining Philosophers Problem)

SFWRENG 3BB4:

Software Design III — Concurrent System Design

Deadlock

Definition

A deadlock is a situation in which all constituent processes of a system are blocked.

In other words, a system is deadlocked if there are no eligible actions that it can perform.

Four Necessary and Sufficient Conditions

1. Mutual Exclusion: The processes involved share resources which they use under mutual exclusion.
2. Incremental acquisition: Processes hold on to resources already allocated to them while waiting to acquire additional resources.
3. No pre-emption: Once acquired by a process, resources cannot be forcibly withdrawn, they are only released voluntarily.
4. Wait-for cycle: A circular chain of processes exists such that each process holds a resource which its successor in the chain is waiting to acquire.

The Dining Philosophers Problem

Background

The dining philosophers problem is a classical example problem used in concurrent system design to illustrate synchronization issues (deadlock) and techniques for resolving them.

The Dining Philosophers Problem was originally formulated in 1965 by Edsger Dijkstra as a student exam exercise, presented in terms of computers competing for access to tape drive peripherals. Soon after, Tony Hoare gave the problem its present formulation.

EWD

Edsger W. Dijkstra
(May 1930 – August 2002)

Dutch computer scientist

1972 Turing Award winner

Edsger W. Dijkstra was one of the most influential members of computing science's founding generation.

In addition, Dijkstra was a highly prolific writer. A large number of his manuscripts can be found here:

The Manuscripts of EWD (The U of Texas @ Austin)

The manuscripts of Dijkstra are an interesting read not only because of their technical contributions also because of their view on the discipline of computer programming.

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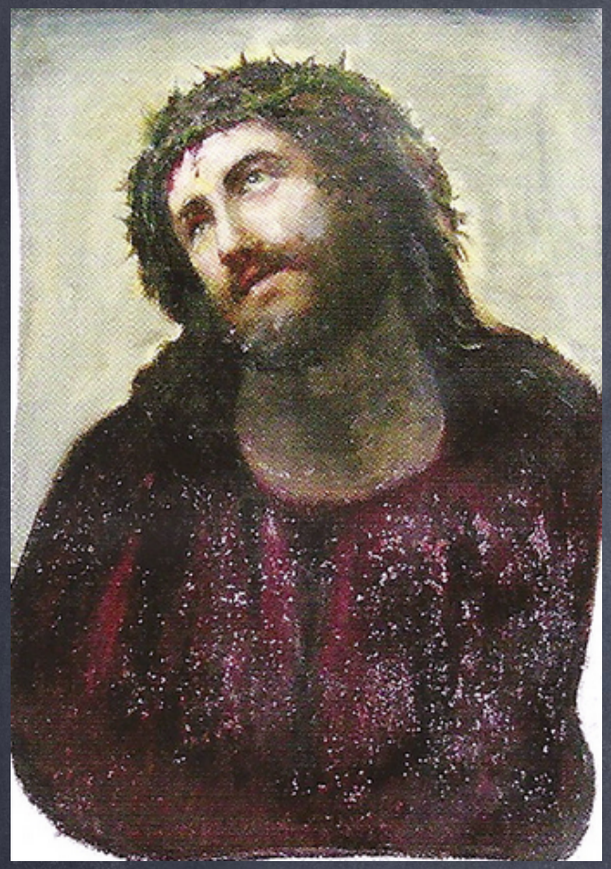
A programmer has to be able to demonstrate that his program has the required properties. If this comes as an afterthought, it is all but certain that he won't be able to meet this obligation: only if he allows this obligation to influence his design, there is hope he can meet it.

"Answers to questions from students of Software Engineering" (EWD1305)

The Restoration of Ecce Homo (Behold the Man)



Ecce Homo of Borja

Elías García Martínez
(1858 - 1934)

Spanish painter

The Ecce Homo (Behold the Man) in the Sanctuary of Mercy church in Borja, Spain, is a fresco painted circa 1930 by the Spanish painter Elías García Martínez depicting Jesus crowned with thorns.

The fresco rose to fame in 2012 due to a botched restoration attempt by Cecilia Giménez, an untrained elderly amateur.

Before restoration

Restoration attempt
by Doña Cecilia

The Restoration of Ecce Homo (Behold the Man)

Requirements

(i) Resources are used in a mutually exclusive manner.

(ii) Artists obtain the resources one at a time.

Deadlock

Reading Material

Chapter 6 of
Magee and Kramer Concurrency: State, Models, and Java Programming.