

SmartCam Design Framework

Smart Cameras

Smart cameras are surveillance-camera sized devices with on-board programmable image processing logic. This allows them to be used in stand-alone applications such as robotics, industrial inspection, and security systems. The added intelligence enables functions like positioning, fault detection and face recognition.

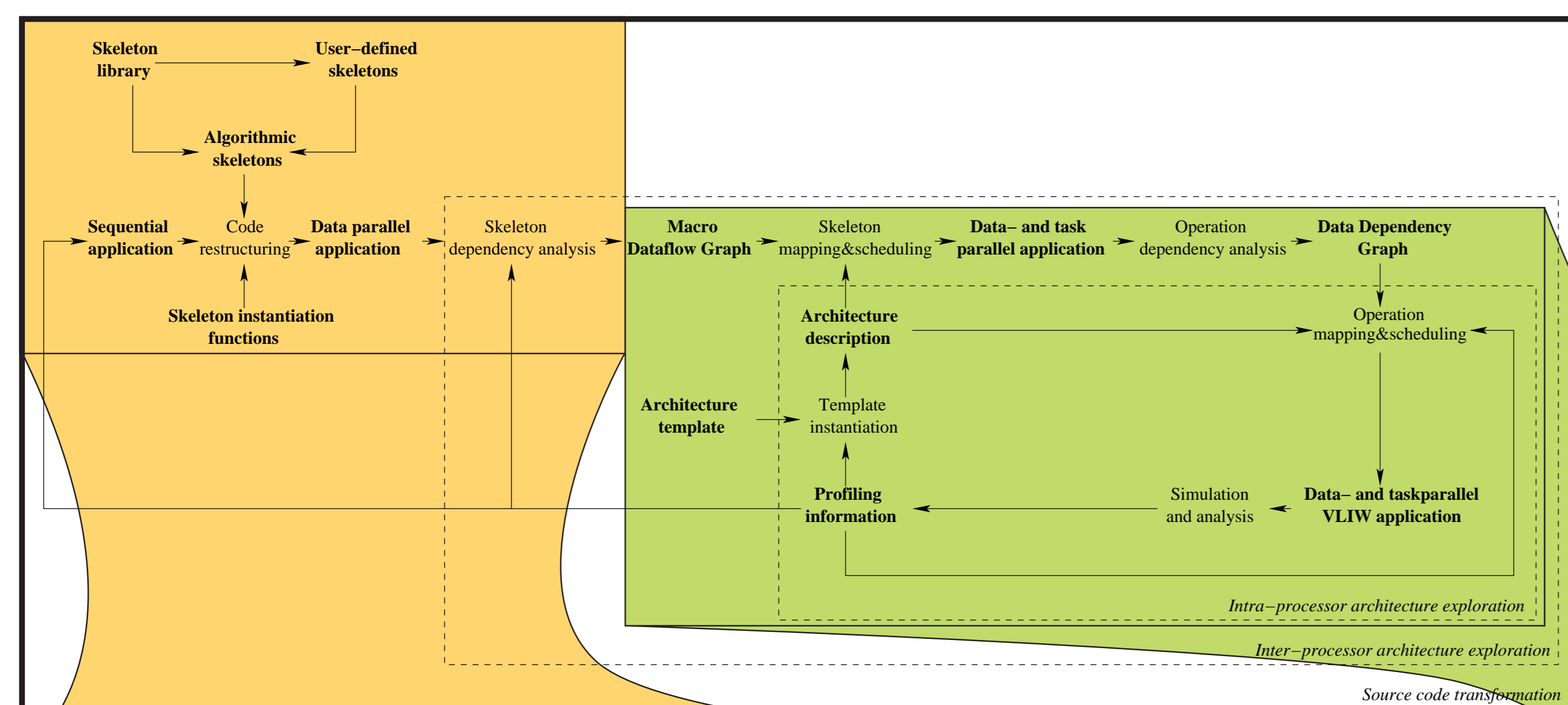
Image Processing Architectures

Because smart cameras need to process images in real-time, with as little power consumption as possible, and in as small a package as possible, special computer architectures are needed. Single-Instruction, Multiple-

Data architectures, in which a number of processors each perform the same function on a different pixel, are especially well suited. The problem then becomes how to select the specific processor type, and how to program it.

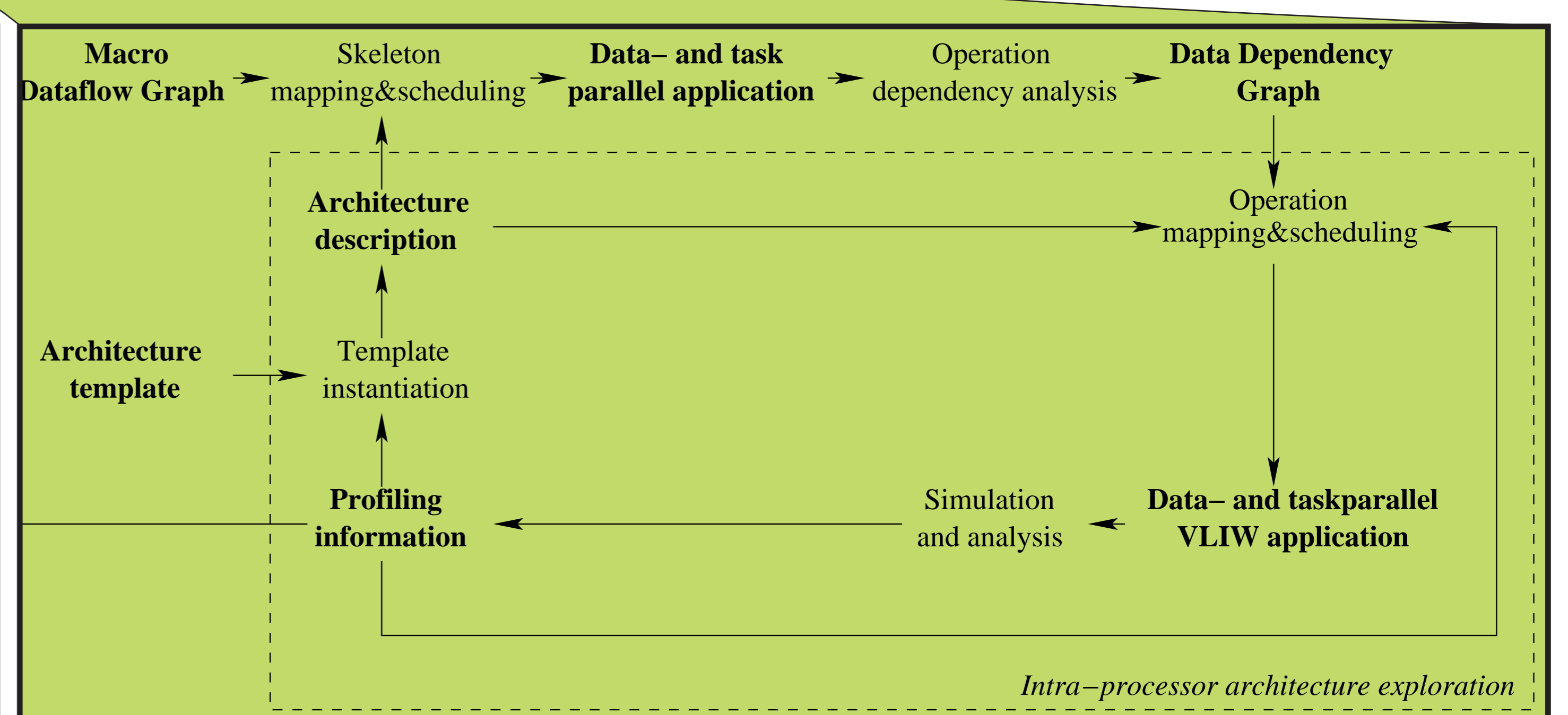
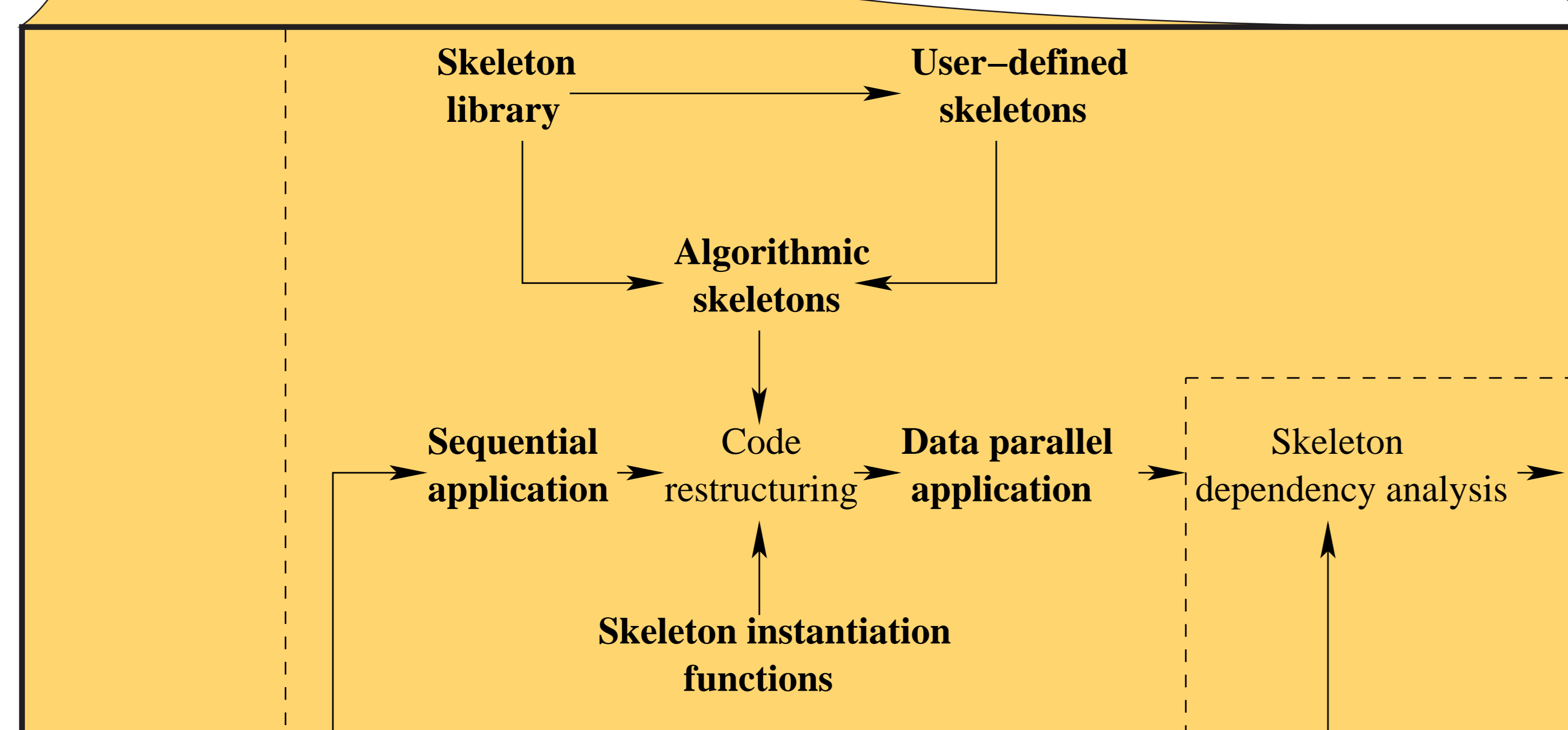


The Inca+ prototype by Philips CFT is a smart camera targeted at industrial inspection



Design Framework

The SmartCam project aims to quantify the design of smart cameras by providing an integrated framework. The programming model is based on user-transparency via algorithmic skeletons, while the architecture selection uses design space exploration to iteratively find the most suitable architecture.



Algorithmic Skeletons

Algorithmic skeletons allow data parallel applications to be created from sequential code by abstracting over the outer loop:

```
for y in range(1, HEIGHT), x in range(1, WIDTH):
    if (src[y][x] > .5): gx=gx+x; gy=gy+y; n=n+1
gx=gx/n; gy=gy/n
```

becomes:

```
IsoPixelOp(src, bin, lambda p: (p>.5)) # Binarization
AnisoPixelReductionOp(bin, (gx,gy,n), lambda (p, x, y, (gx,gy,n)): if (p): gx=gx+x; gy=gy+y; n=n+1, # Pixel operation
    lambda ((gx1,gy1,n1), (gx2,gy2,n2)): (gx1+gx2,gy1+gy2,n1+n2)) # Reduction operation
gx=gx/n; gy=gy/n
```

Design Space Exploration

Design space exploration finds an optimal architecture by compiling and simulating an application for different instantiations of an architecture template. It uses the profiling results, along with user constraints, to steer the exploration of the architecture design space.