**Agro & Food**
- Plant disease detection (virus and fungal infections)
- Plant phenotyping (segmenting plant parts)
- Food authenticity by geographical origin and variety
- Foreign object detection in food processing (stone, plastic, nut shells, wood)
- Food sorting applications such as:
  - Detect greening, rot and peel in French fries
  - Detect seed potato diseases
  - Detect unripe/overripe fruit
  - Tomato brix estimation
  - Packaged product segmentation

**Recycling & Material Science**
- Plastic separation
- Sorting of textiles by material irrespective of color (also dark textiles)
- Paper sorting
- Material transition identification
- Paint defect detection

**Medical & Pharma, Forensic**
- Tissue classification
- Pill type identification
- Blood smear analysis
- Detecting sufficient oxygenation
- Wound assessment
- Blood detection
- Crime-scene documentation

**Remote Sensing & Environmental**
- Land cover classification
- In-flight image segmentation for drone operations (plants, soil types, fruit)
- Cloud removal
- Plastic detection

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**Making Sense of Spectral Imaging**

*We found perClass Mira extremely user-friendly and efficient compared to the interface software that is currently available.*

Dr. Sara W. Erasmus, WUR

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The Challenge

Modern spectral sensors provide gigabytes of high-resolution images with hundreds of bands. The interpretation process is currently very time-consuming. It typically requires programming and a high-level of expertise in applied statistics, machine learning and chemometrics. The path to real-time production is often unclear and deployed solutions are not easily reconfigurable.

The Solution

perClass Mira enables anyone to create and deploy automatic interpretation solutions without programming or machine learning expertise.

The Workflow

1. Define classes of interest
2. Automatic model-search
   - Paint labels
   - Inspect decisions
3. Improve labeling
   - Retrain model
   - Validate or learn from more images
   - Active Learning guidance to paint new relevant labels
4. Fine-tune performance
   - Interactively lower errors with a direct feedback
5. Export for deployment in a custom application using perClass Runtime

Key features

- Easy-to-use, results in minutes
- Automatic model building using state-of-the-art Machine Learning
- Intuitive and precise labeling and annotation tools
- Higher quality labeling with Active Learning guidance
- Better models learned from and validated on multiple images
- Interactive fine-tuning of performance based on application requirements

Use-cases

- **Object detection**
  - Example: Nut shells removal
  - Object coordinates/sizes
- **Object classification**
  - Example: French fries grading
  - Content-based object decisions
- **Object quality**
  - Example: Moisture content
  - Quality per-object and pixel

High-speed deployment with perClass Mira Runtime

- Easy integration (<1h)
- Line-scan processing
- Delivers object positions
- Real-time capable

Data formats

- ENVI (BIL, BIP, BSQ layouts, uint8, uint16, float, double precision data)
- Matlab® .mat files,
- Tiff files, one for each spectral band

System requirements

- **perClass Mira GUI**
  - MS Windows 7-10, 64-bit, Linux 64-bit
  - Optional NVIDIA GPU with CUDA9 and later or OpenCL
- **perClass Mira Runtime DLL**
  - multi-core GPU and GPU acceleration
  - MS Windows 64-bit, Linux 64-bit (x86 and NVIDIA® Jetson™)

Benchmark on foreign object detection

- Linux, Xeon, GTX1080 GPU: 1.45 milliseconds/frame (average on 10k frames)
- Windows 10, i7 CPU: 2.36 milliseconds/frame
- NVIDIA Jetson TX2 GPU: 3.24 milliseconds/frame

Input: raw frames (640 pixels/224 bands)
Two product types, four contaminants
Output: Object coordinates

Object quality

Example: Moisture content
Quality per-object and pixel

Object detection

Example: Nut shells removal
Object coordinates/sizes

Object classification

Example: French fries grading
Content-based object decisions

Object quality

Example: Moisture content
Quality per-object and pixel

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