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The Snow Use Case

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The idea

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- There is a lot of multimedia content out there, produced by
  - People
  - Ground sensors (e.g., touristic web cams)
- There are many environmental problems that lack affordable and accessible input data
- Question: is public web visual content good enough to help in such environmental problems?

The content

INPUT

- User generated
  - **700k** Flickr images crawled so far within 300x160 km
- Sensor generated
  - **2k** webcams queried every minute (1 to 1440 images per web cam per day)
  - More than **10M** images crawled
- Digital Elevation Model
  - Dem3: 71GB (World coverage)
  - Dem1: 12GB (Alps coverage)
  - Dem1: 638GB (World coverage | recently released)

OUTPUT

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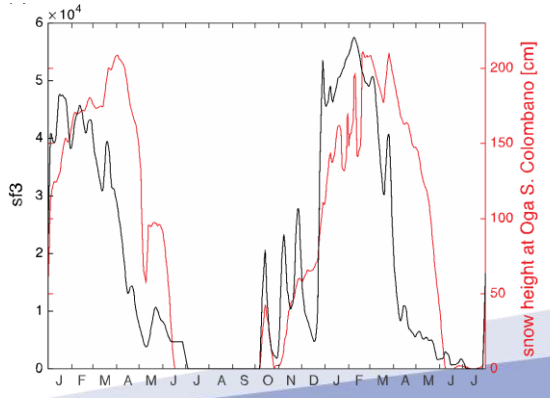
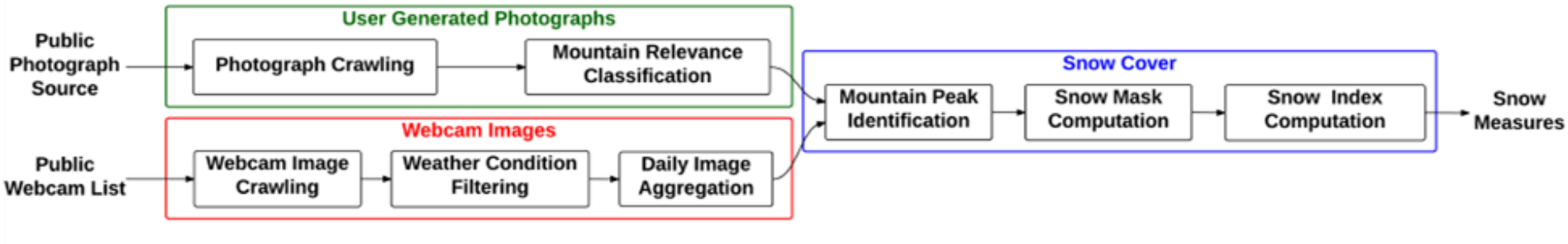
- Virtual Snow Indexes: numerical time series that are a proxy of the quantity of water stored in the snow pack (Snow Water Equivalent – SWE)



The multimedia pipelines



- Differences
  - Web cam images have high temporal density, UG images have broader spatial coverage
  - UG photos searched by keywords may be irrelevant, webcam images always portrait mountains

Webcam image enhancement

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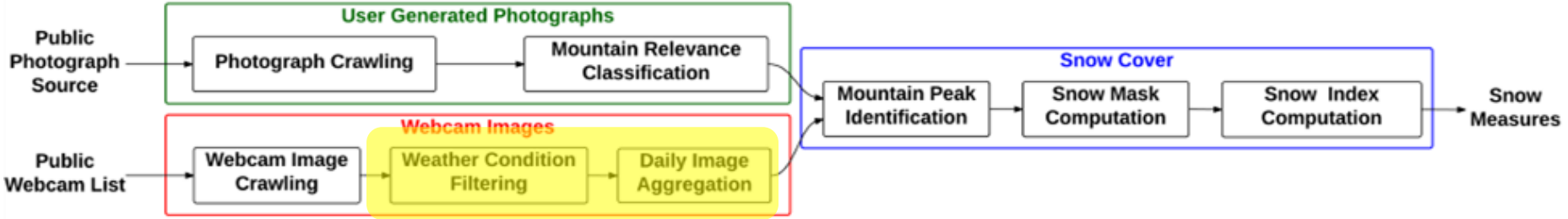

Remove/attenuate:

- Variability of illumination
- Shadows
- People & irrelevant objects

Daily median image

Snow mask extraction

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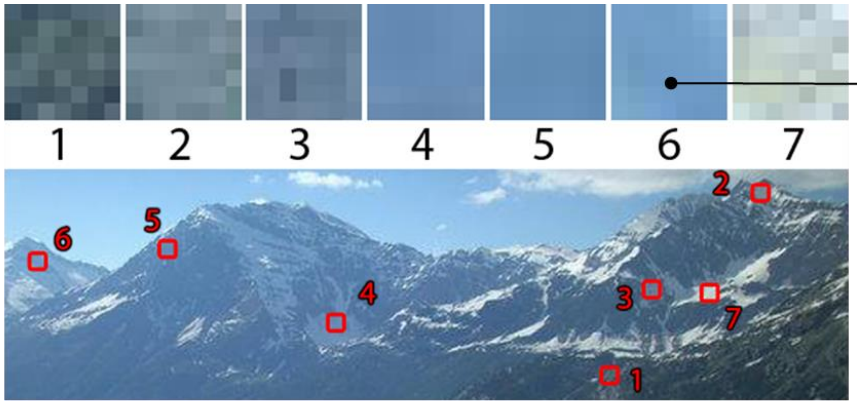
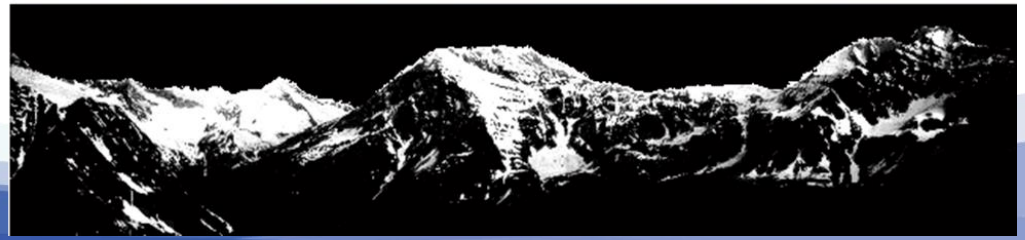


Snow classification at the pixel level

Snow mask extraction



How the SNOW use case relates to the SODALITE goals

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- The data processing pipeline includes CPU-bound, GPU-bound, and IO-bound operations
- Some tasks now use Deep Learning, which is a hot topic for computation optimization
- The UC is a benchmark for an optimized and power-efficient execution environment
- The use of the SODALITE may improve
  - images processed per second & IO management (+20% throughput)
  - Classification accuracy (+5-10%), thanks to the more image pre and post-processing steps granted by the performance increase

Improvements due to SODALITE

- Modelling simplification and effort reduction in developing deployment code.
- No violation of SLA for the Skyline Extractor thanks to the Node Manager where the baseline rule-based approach which obtained 150 violations.
- Optimization of resources consumption, thanks to the Node Manager (~40% speedup with ~20% less core usage)
- Easy configuration of monitoring dashboard and alert service
- Prevention of resource usage violations thanks to the deployment reconfiguration capability

Future work

- Optimize training of DL models on HPC thanks to a MODAK-optimized docker
- Connect the various components through data exchange pipelines (collaboration with RADON)
- Apply Node Manager to all components
- Exploit advanced AI-powered alert and refactoring scenarios

Exploitation

- Support commercial partners willing to implement services for the introduction of AI and Computer Vision solutions in business cases of the Public Administration and of private enterprises.
- The SNOW Use case has been successfully demonstrated to the Environment Agency of Region Lombardy, ARPA. It has spawned interest for a more general and versatile architecture capable of applying analysis components to visual inputs for a variety of environment intelligence tasks.

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Optional slides

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A case study

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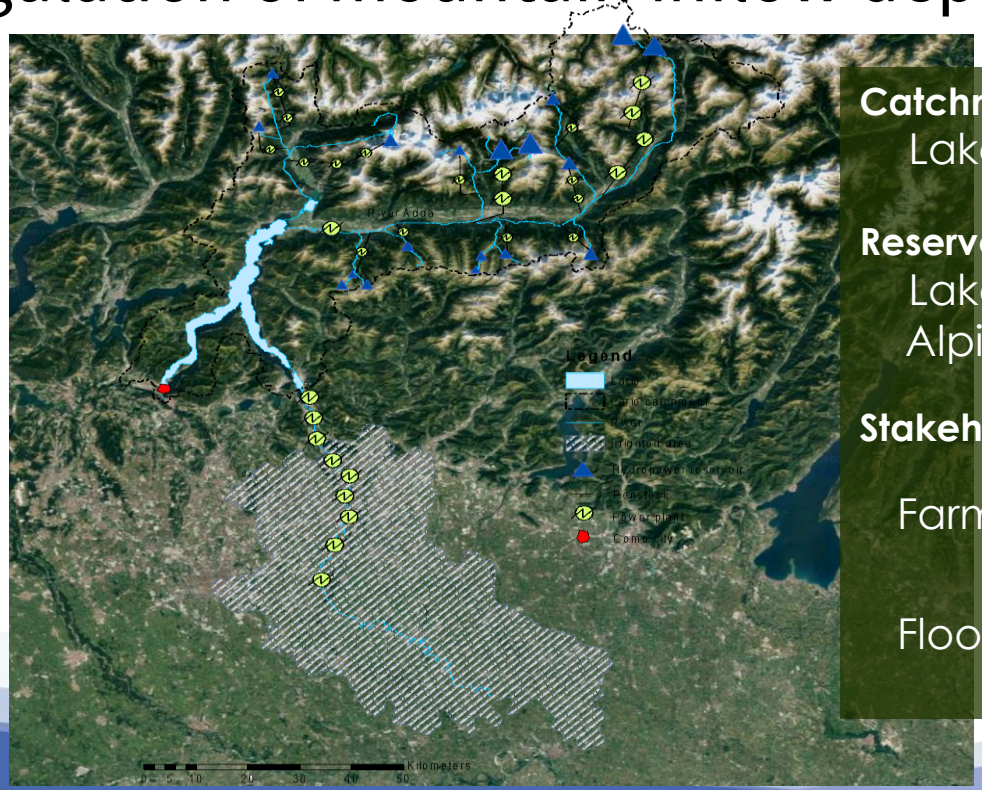
- Regulation of mountain inflow dependent lakes

Lake Como



Catchment area

Lake Como 4500 km^2

Reservoirs

Lake Como 247 Mm^3

Alpine HP 545 Mm^3

Stakeholders

Farmers:

irrigated area 1400 km^2

Floods:

lake and downstream

Exam em

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La Provincia

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COMO - ERBA

Per il Como rimonta vincente

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Tutto a TASSO 0

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Paratie, Roma prova a dare la sveglia

Vertice con il governo e Italia Sicura per cercare di superare l'impasse Maroni-Lucini

Filo di Seta

Como
Emergenza migranti
Fuori dal cimitero tornano i bivacchi

Formalization as an optimization problem

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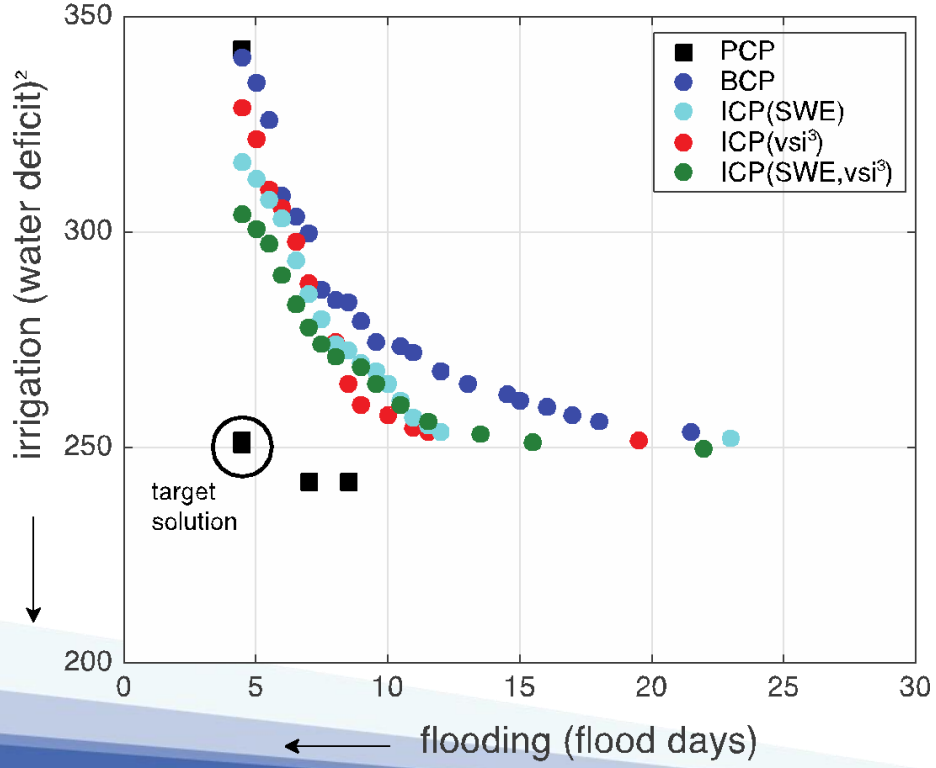
- Decide the daily lake outflow (⊠ lake level)
- So to
  - Maximize water for downstream irrigation
  - Minimize # of flood days
- Respecting
  - Minimum outflow requirement for ecological preservation of effluents
- Based on
  - Policy input (X)

Results



PCP: upper bound policy with perfect knowledge of future

BCP: Baseline, regulator only considers lake level and day of year

ICP (X) regulator knows information X

SWE: snow water equivalent data estimated from Region Lombardy

VSI: virtual snow indexes from nearby mountain images

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