Universidad Nacional Autónoma de México

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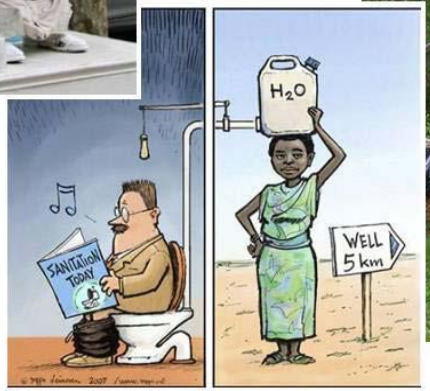
INSTITUTO DE INGENIERÍA UNAM

CCADET

CENTRO DE CIENCIAS APLICADAS Y DESARROLLO TECNOLOGICO

BILL & MELINDA GATES foundation



Software to identify and quantify pathogenic helminth eggs

Global Development Grant Number OPP1094904 GCE PHASE II

Blanca E. Jiménez, PI

Addressing Strategies Sectors: Agriculture, water, sanitation and hygiene, criteria and policies

Wastewater in agriculture

-Saves water for the first use

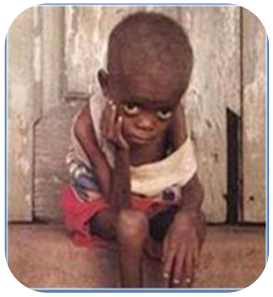
- Less production costs, and reduces artificial fertilizer

-Increase crop yield

-Decrease pollution

Health risks

- >1.5 billion people (24% of the world´s population) is infected with soil-transmitted helminths (WHO, 2014).
- 200 million people are infected with schistosomiosis (WHO, 2001).
- *Ascaris* infections cause approximately 60,000 deaths per year, mainly in children (WHO, 2001).
- Helminth eggs enter the environment trough feces from infected people and are transported in wastewater.



Malnutrition

Anemia

Gastrointestinal diseases

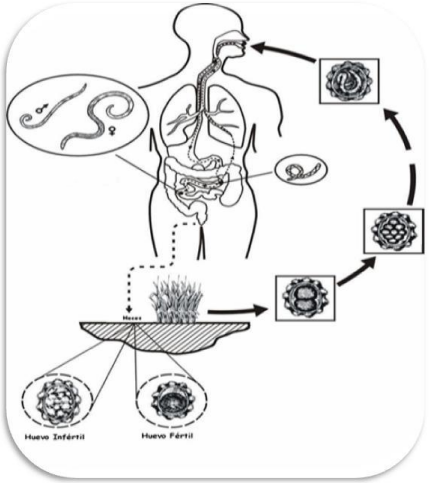
Malformations

Is it a cell?

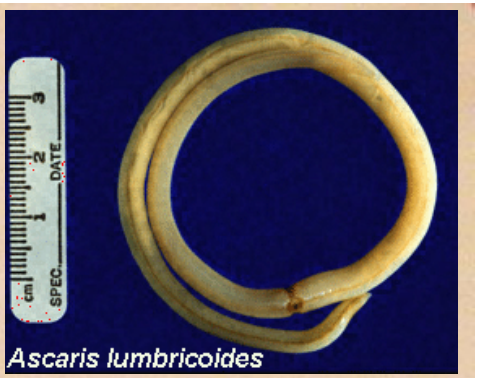
In fact is a world threat

It is a microscopic egg

Parasite associated to human life



High resistance and reproductive capacity

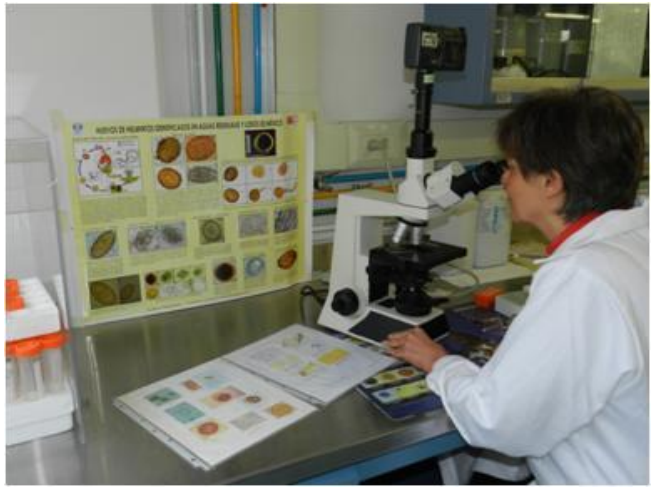


It is an Helminth

Children from developing countries suffer physical and mental detriment

Regulations to control the content of helminth eggs (OMS, 1989; 2006;…)

Nevertheless,



Visual identification

- Trained Personal
- Subjective Interpretation
- Long time
- Sub o over counting

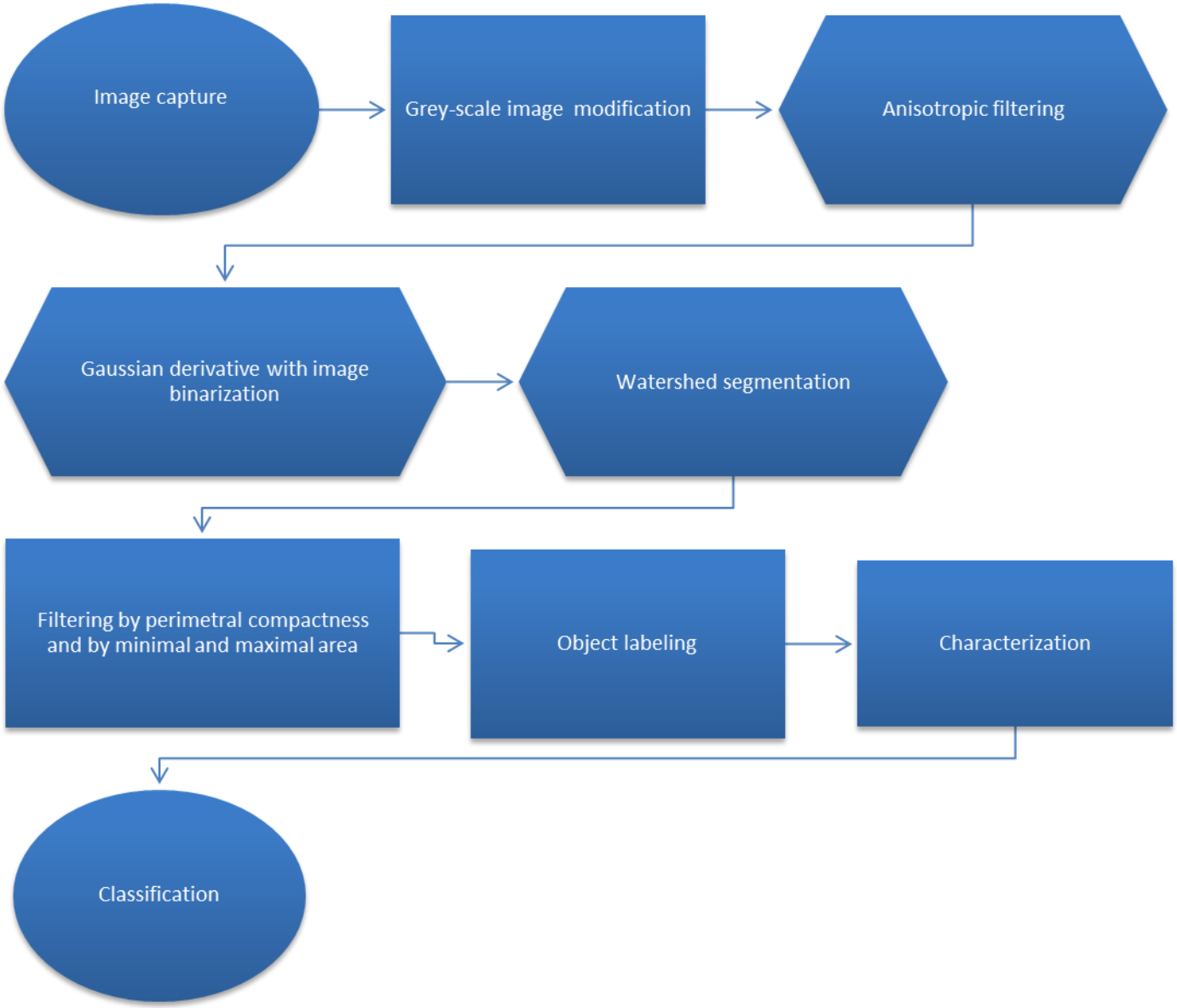
An alternative…

Advances in algorithms and processing systems and digital image recognition

Program and system offers:

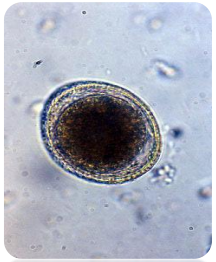
- An alternative tool and helpful
- A precise, reliable and fast alternative
- A real alternative for users involved in monitoring and environmental studies
- Minimize errors identification interpretation
- Improves health and quality of life

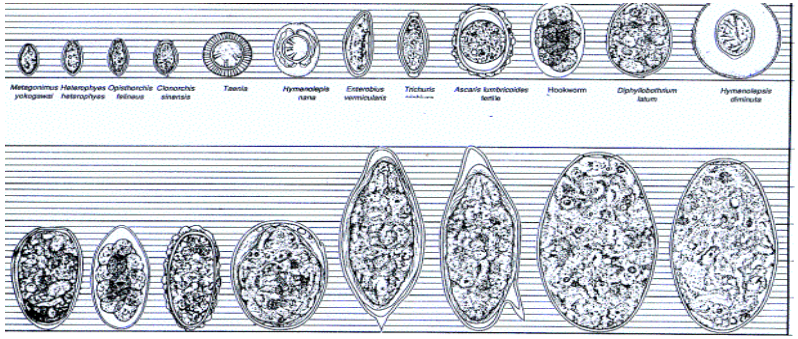
- Structural Features

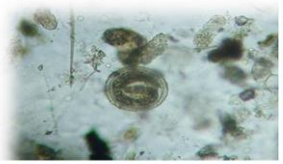


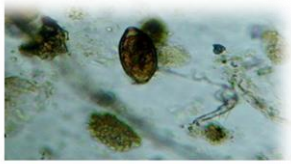
Acquisition of digitized images

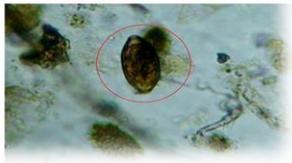
Helminth eggs



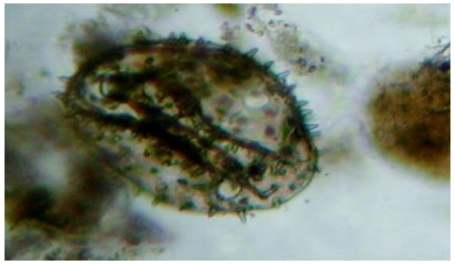


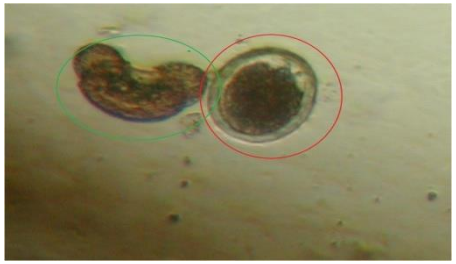






Artifacts

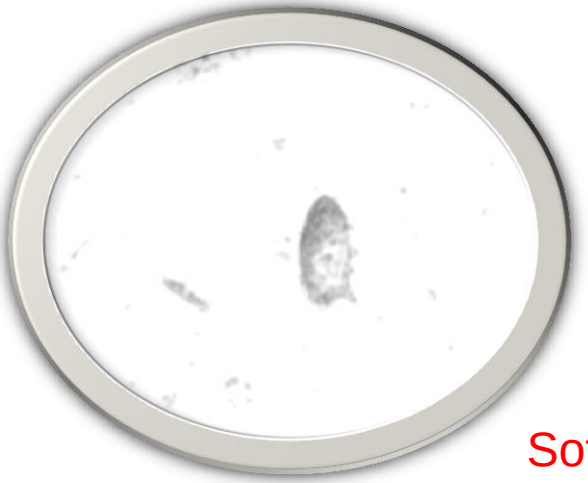




Grey-scale image

Removes tonalities and saturation, no image brightness

Anisotropic filtering image

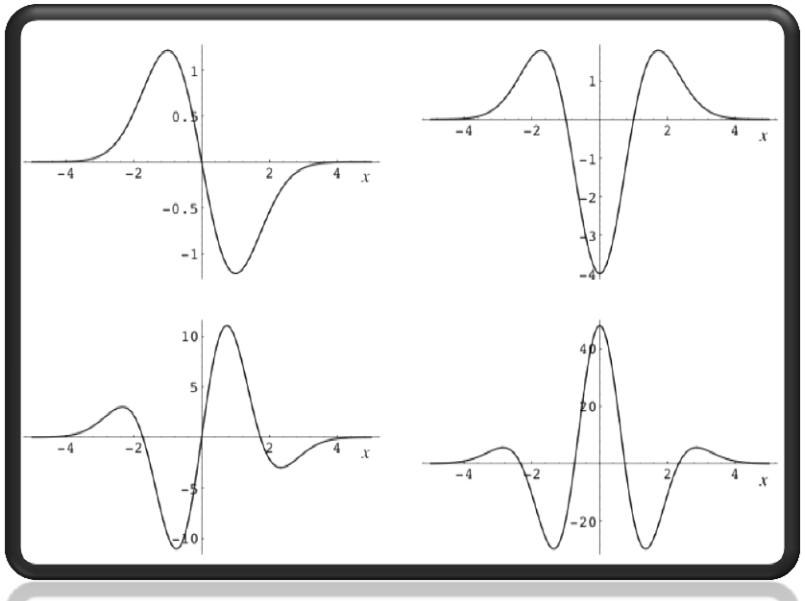


Softens image within regions bounded by edges and preserves them.

Gaussian derivative binarizated

Similar to human vision filters, specialize in detecting abrupt changes: edges.

4 Gaussian derivatives



First derivative

Sigma or Standard Deviation

Second derivative

$$N = \sigma = 1$$

Gaussian derivatives

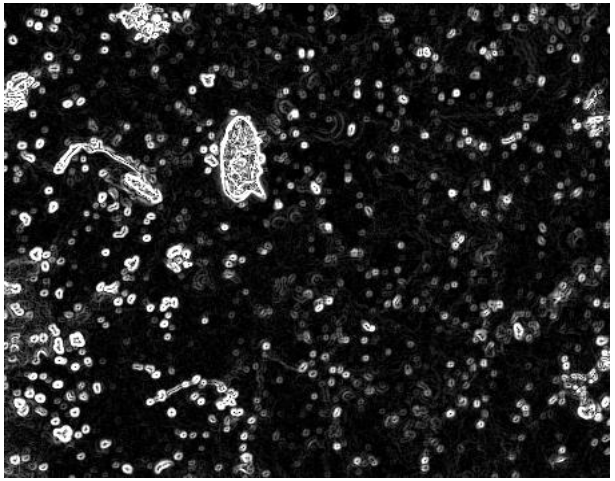
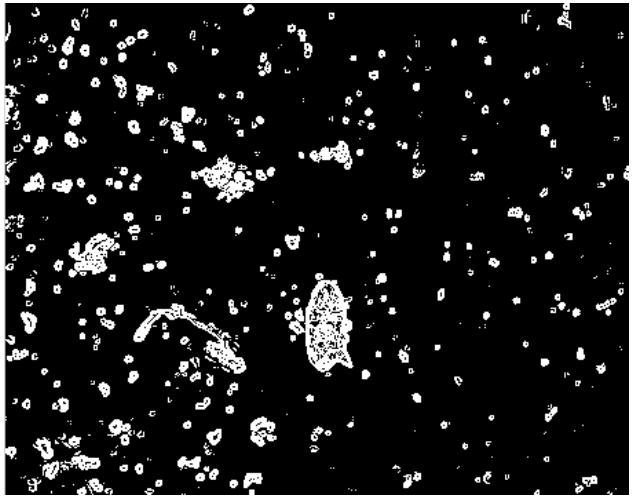
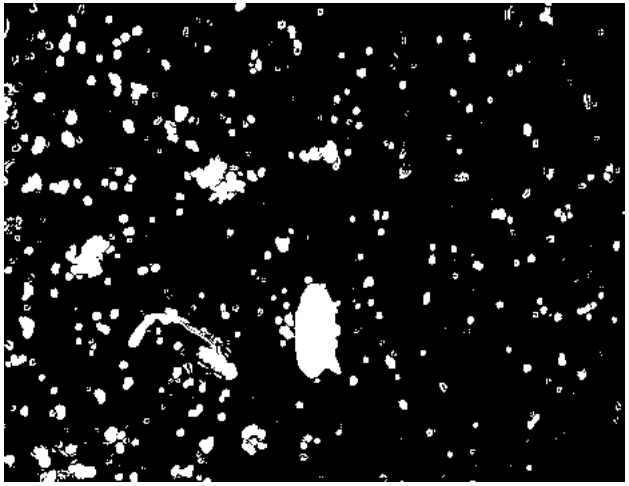


Image processed with Sigma value or standard deviation.



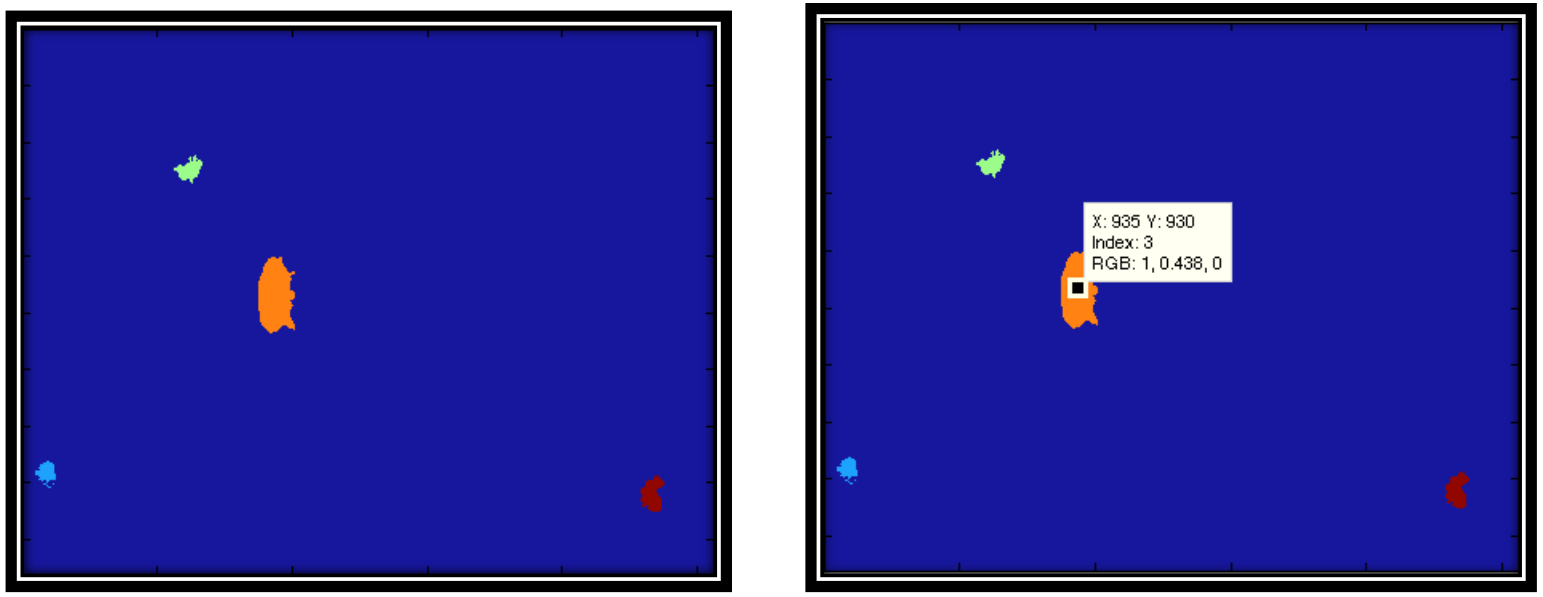
Binarized image from the first Gaussian derivative.



Filling gaps in the binarized image.

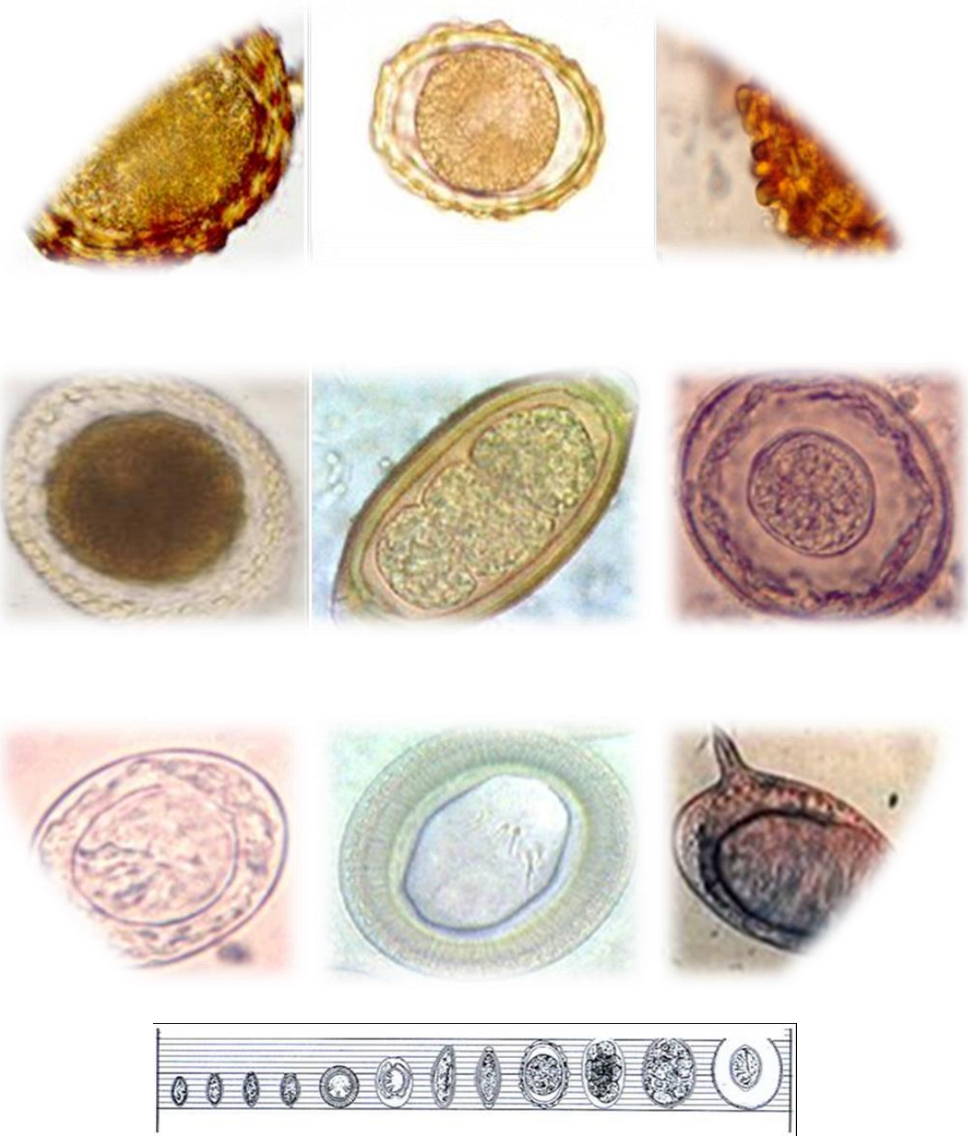
Finally all the small objects are removed.

Marking and labeling of objects



An index is assigned

Retrieve the characteristics of the identified object

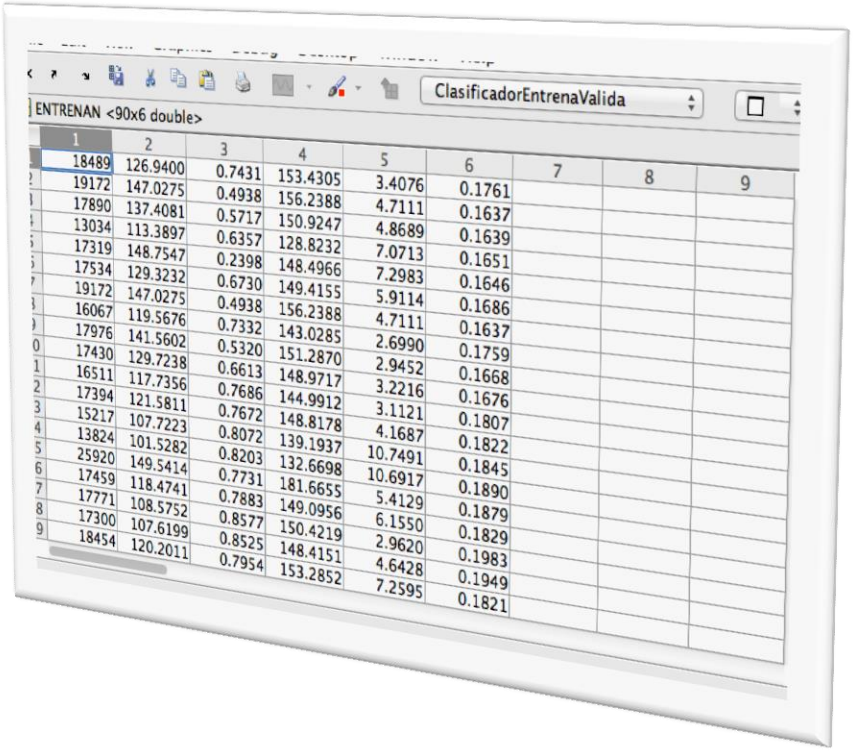


Training:

a) **Area**
b) **Eccentricity**
c) **Major and minor axes**
d) **Diameter**
e) **Entropy**
f) **Texture…**

Classification

Naive Bayesian classifier or probabilistic classifier predicts the conditional probability of which species are related to such values and than an egg belongs to a species or to an object.



	1	2	3	4	5	6	7	8	9
	18489	126.9400	0.7431	153.4305	3.4076	0.1761			
	19172	147.0275	0.4938	156.2388	4.7111	0.1637			
	17890	137.4081	0.5717	150.9247	4.8689	0.1639			
	13034	113.3897	0.6357	128.8232	7.0713	0.1651			
	17319	148.7547	0.2398	148.4966	7.2983	0.1646			
	17534	129.3232	0.6730	149.4155	5.9114	0.1686			
	19172	147.0275	0.4938	156.2388	4.7111	0.1637			
	16067	119.5676	0.7332	143.0285	2.6990	0.1759			
0	17976	141.5602	0.5320	151.2870	2.9452	0.1668			
1	17430	129.7238	0.6613	148.9717	3.2216	0.1676			
2	16511	117.7356	0.7686	144.9912	3.1121	0.1807			
3	17394	121.5811	0.7672	148.8178	4.1687	0.1822			
4	15217	107.7223	0.8072	139.1937	10.7491	0.1845			
5	13824	101.5282	0.8203	132.6698	10.6917	0.1890			
6	25920	149.5414	0.7731	181.6655	5.4129	0.1879			
7	17459	118.4741	0.7883	149.0956	6.1550	0.1829			
8	17771	108.5752	0.8577	150.4219	2.9620	0.1983			
9	17300	107.6199	0.8525	148.4151	4.6428	0.1949			
	18454	120.2011	0.7954	153.2852	7.2595	0.1821			

Validation

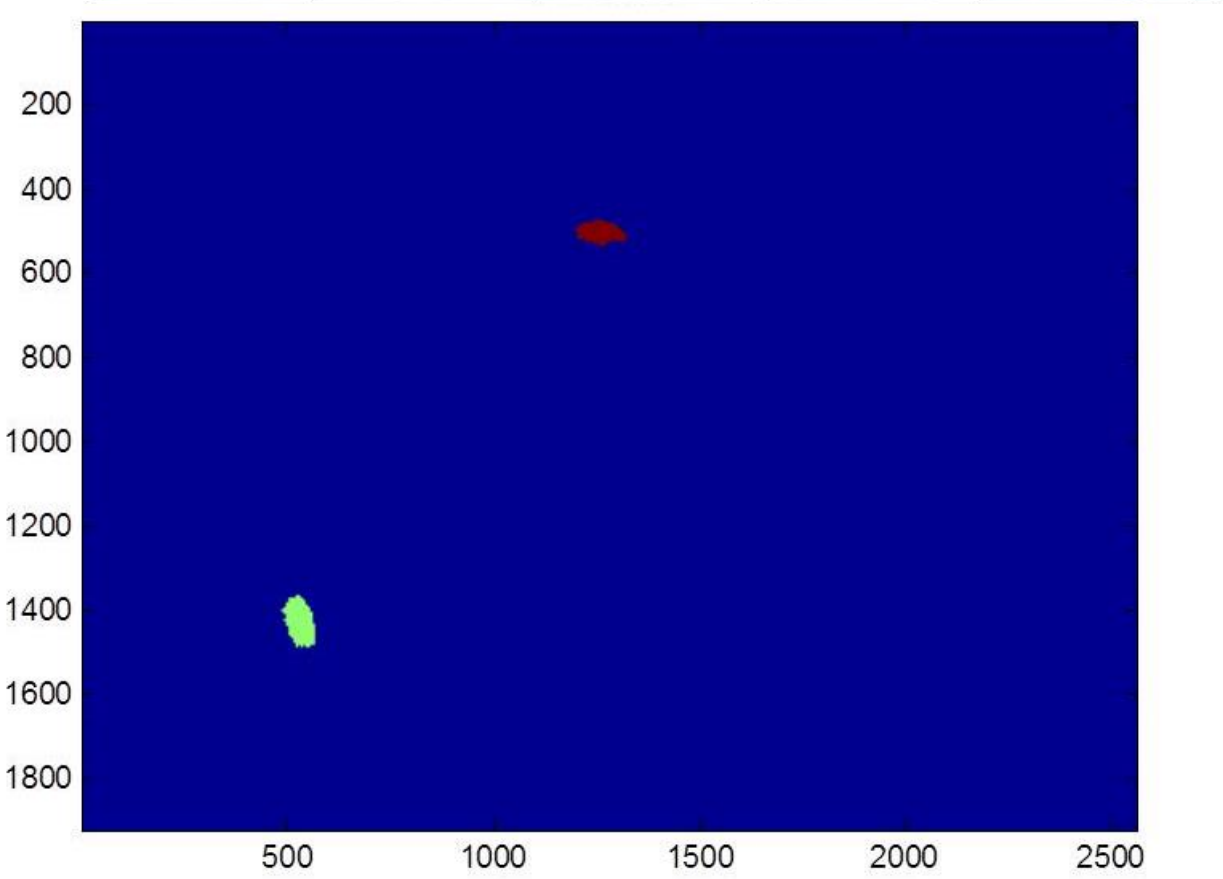
$$Sensibility = \frac{TP}{TP + FN}$$

True positives: number of helminth eggs correctly identified = 0.9585

$$Specificity = \frac{TN}{TN + FP}$$

True negatives: number of other objects different than helminth eggs that were identified correctly = 0.9944

Program and System



Pumping Station

Genus of helminth eggs identified:

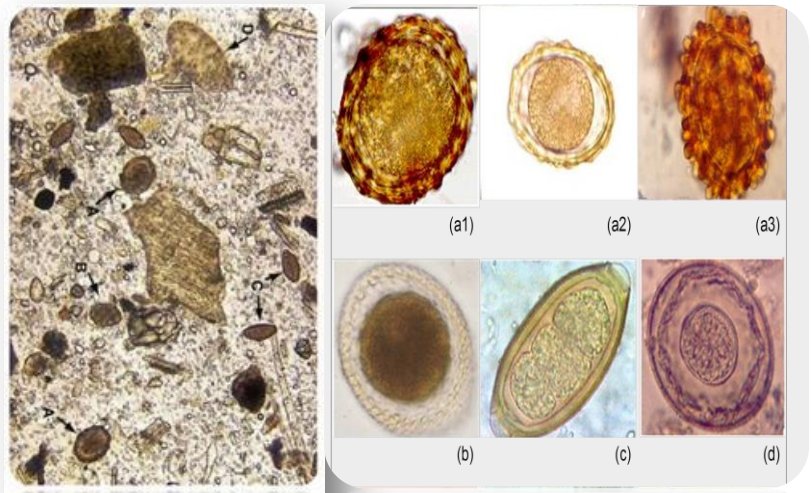
Ascaris lumbricoides

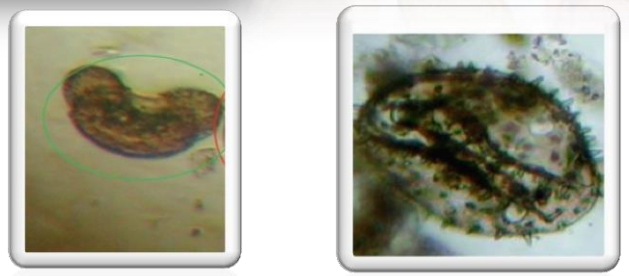
Toxocara canis

Trichuris trichiura

Hymenolepis diminuta

Taenia sp.





Other objects

Faecal coliforms = 8.5×10^{7} CFU/100 mL

Thank you!!

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Raminta Hanzelca

"All lives have equal value and every person should have the opportunity to live a healthy, productive life"