



Green analysis of phosphate in diverse matrixes using a smartphone-based detector

Roberto S. Hernández*, A. Pastor, A. Morales-Rubio, M. L. Cervera

Department of Analytical Chemistry, University of València, Spain.

* roberto.saez@uv.es

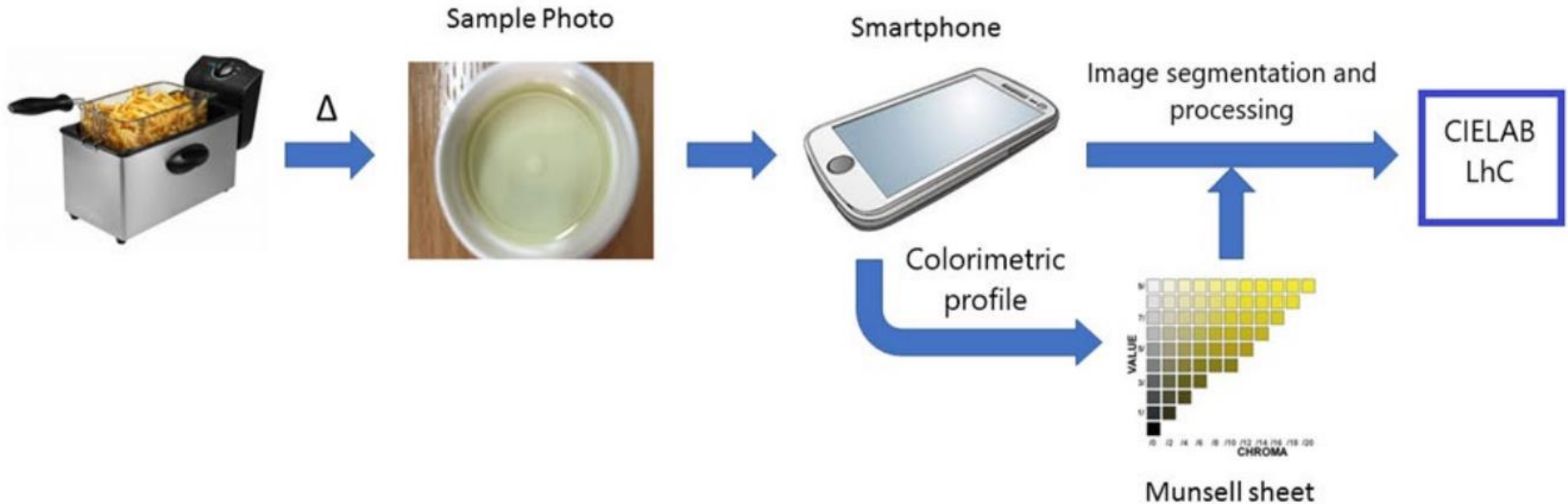


Who are we?

INTRODUCTION

What do we do in the lab?

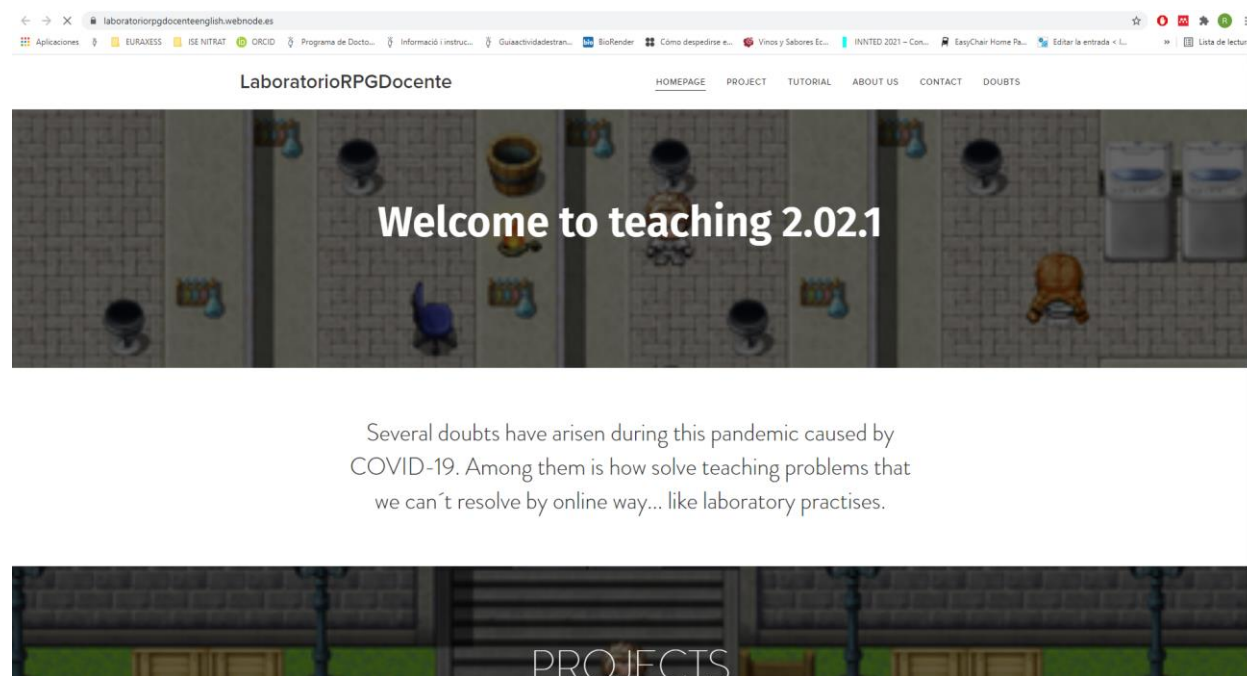
Smartphone applications in Chemical Analysis: Prediction of total polar compounds in used sunflower oil



INTRODUCTION

What do we do in the lab?

Educative innovation: Game-based learning of Chemistry



laboratoriorpgdocenteenglish.webnode.es

Aplicaciones EURAXESS ISE NITRAT ORCID Programa de Docto... Informació i instruc... Guiaactividadestran... BioRender Cómo despedirse e... Vinos y Sabores Ec... INNTED 2021 - Con... EasyChair Home Pa... Editar la entrada < L... Lista de lectura

LaboratorioRPGDocente

HOME PAGE PROJECT TUTORIAL ABOUT US CONTACT DOUBTS

Welcome to teaching 2.02.1

Several doubts have arisen during this pandemic caused by COVID-19. Among them is how solve teaching problems that we can't resolve by online way... like laboratory practises.

PROJECTS



$$\text{Sn}^{2+} + 2\text{Hg}^{2+} + 8\text{Cl}^- \rightleftharpoons \text{SnCl}_6^{2-} + \text{Hg}_2\text{Cl}_2$$

$$\text{Sn}^{2+} + \text{Hg}^{2+} + 6\text{Cl}^- \rightleftharpoons \text{SnCl}_6^{2-} + \text{HgCl}_2$$

Según las proporciones de S
formará un precipitado dens
blanco grisáceo que oscurec
negro)

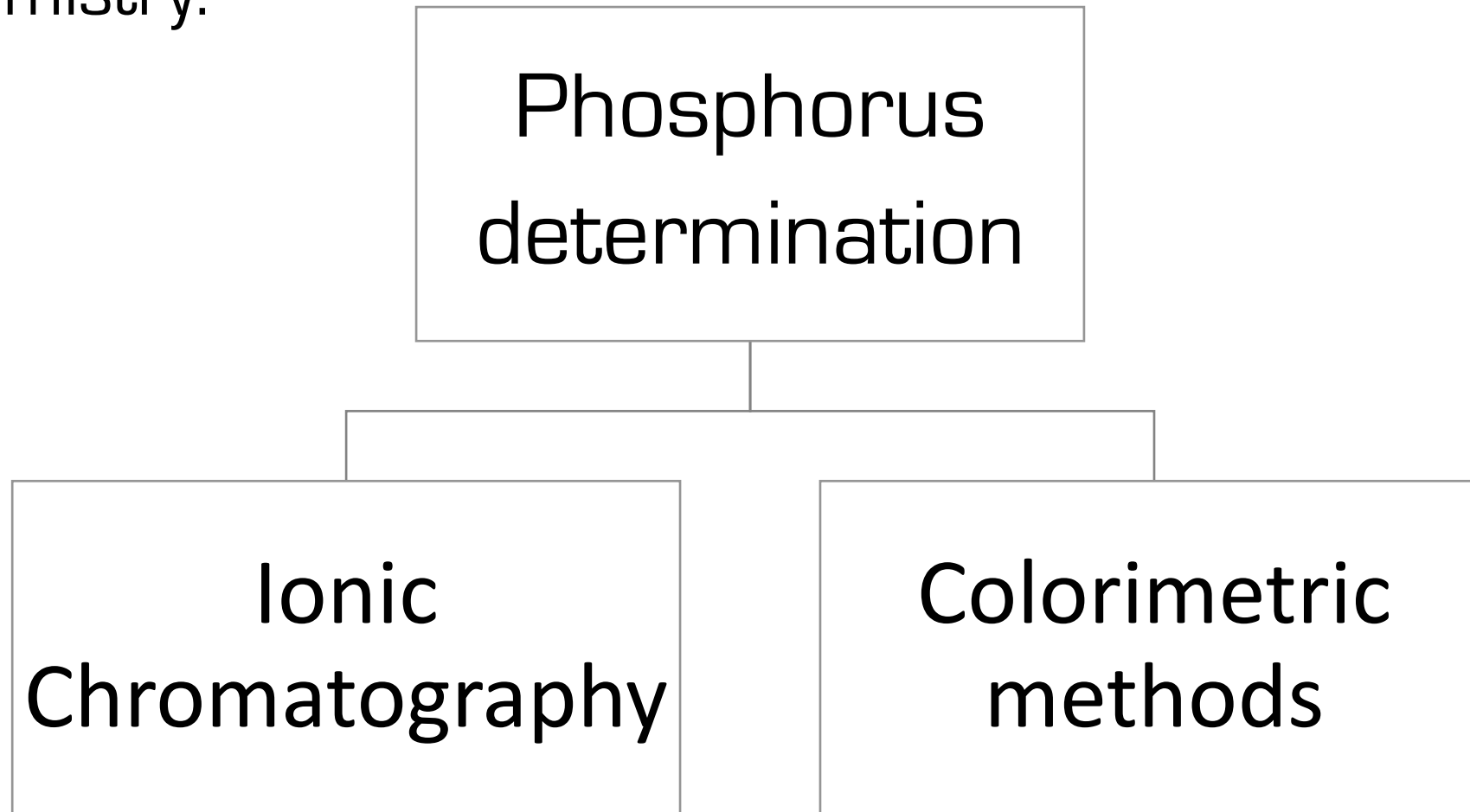
se observa un color
azul en la capa orgánica

SCAN ME



Green analysis of phosphate in diverse matrixes using a smartphone-based detector

A bit of chemistry:



A bit of chemistry:

Ionic Chromatography



Pros

Selective
quantification

Multiple analysis at
once

Cons

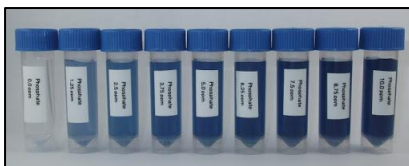
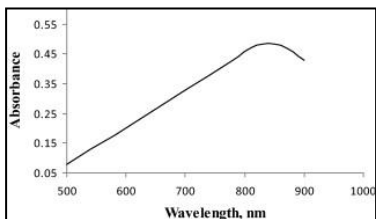
Expensive equipment

Large mobile phase
usage

Requires expertise

A bit of chemistry:

Colorimetric methods



Pros

Easier and cheaper
technique

Faster approach
and less
consumption of
reagents

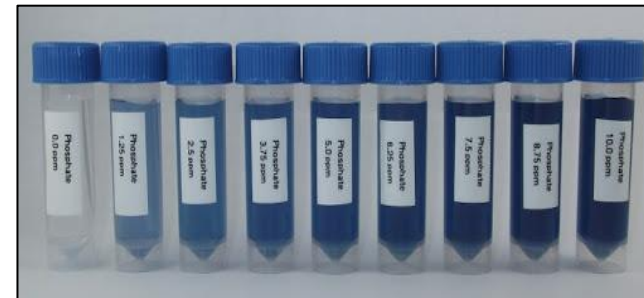
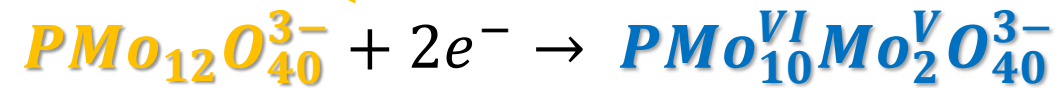
Cons

May suffer from
matrix interferences

A bit of chemistry: Phosphomolybdenum blue method



(Ascorbic acid reduction)



There is already a phosphorus determination lab practice...

YouTube



Determinación de fósforo en suelos por formación de azul de fosfomolibdeno

Práctica 2. Determinación de fósforo en suelo por formación de azul de fosfomolibdeno

126 visualitzacions · 16 de nov. 2020



GRAU EN QUÍMICA
Departament de Química Analítica

Assignatura: **Laboratori d'anàlisi instrumental aplicada**

Pràctica 2. Determinació de fòsfor en sols per formació de blau de fosfomolibdè

LAIA_18-19
Pàgina 8 de 37

1. OBJECTIUS

- Conèixer la forma de treball de l'extracció sòlid-líquid
- Conèixer la forma de treball dels mètodes espectrofotomètrics d'anàlisi
- Determinació de fòsfor en sòls.

Proposal: a home-made colour reader for phosphate analysis



Methacrylate support

Proposal: a home-made colour reader for phosphate analysis



Desktop lamp
+
LED bulb (*light source*)

Proposal: a home-made colour reader for phosphate analysis



Diffusive materials

Proposal: a home-made colour reader for phosphate analysis



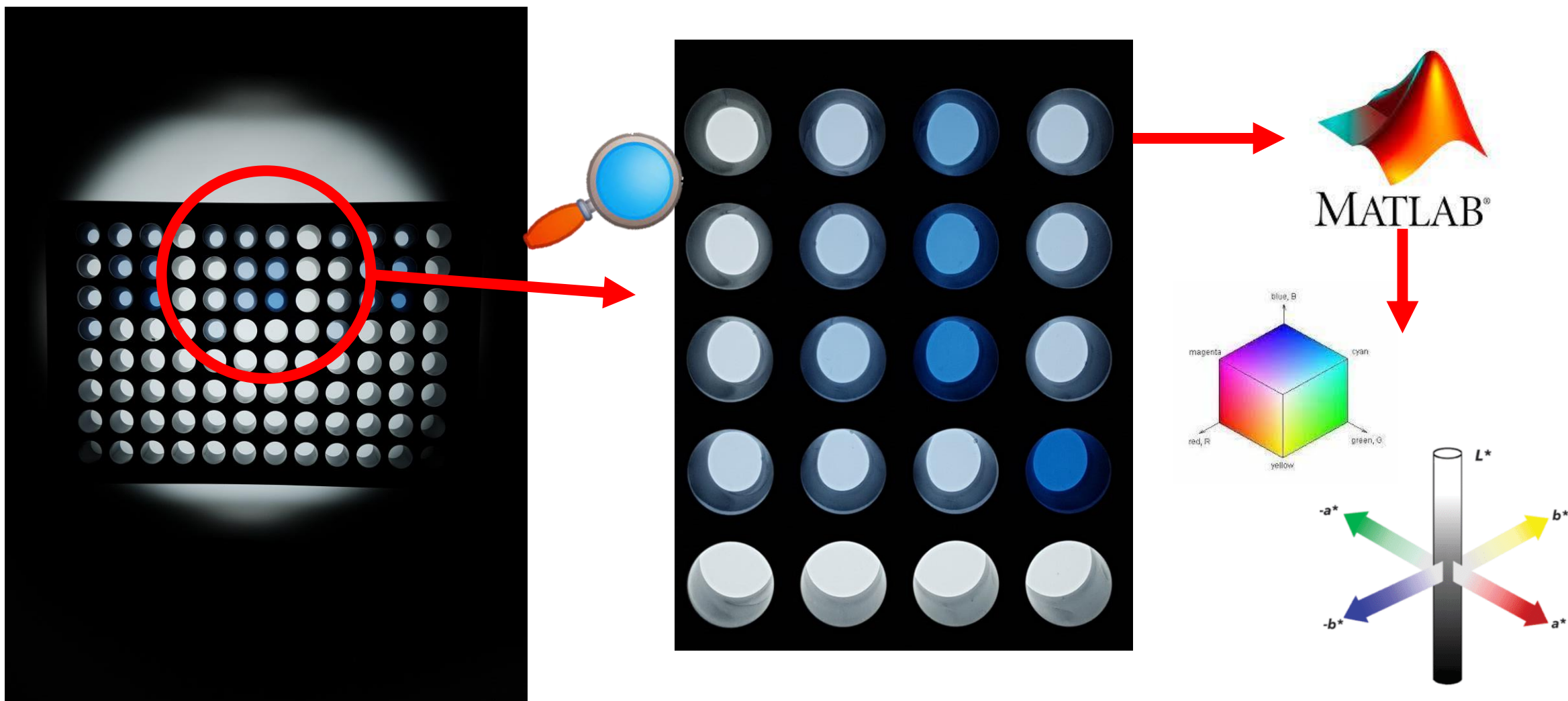
96-microwell plate

Proposal: a home-made colour reader for phosphate analysis

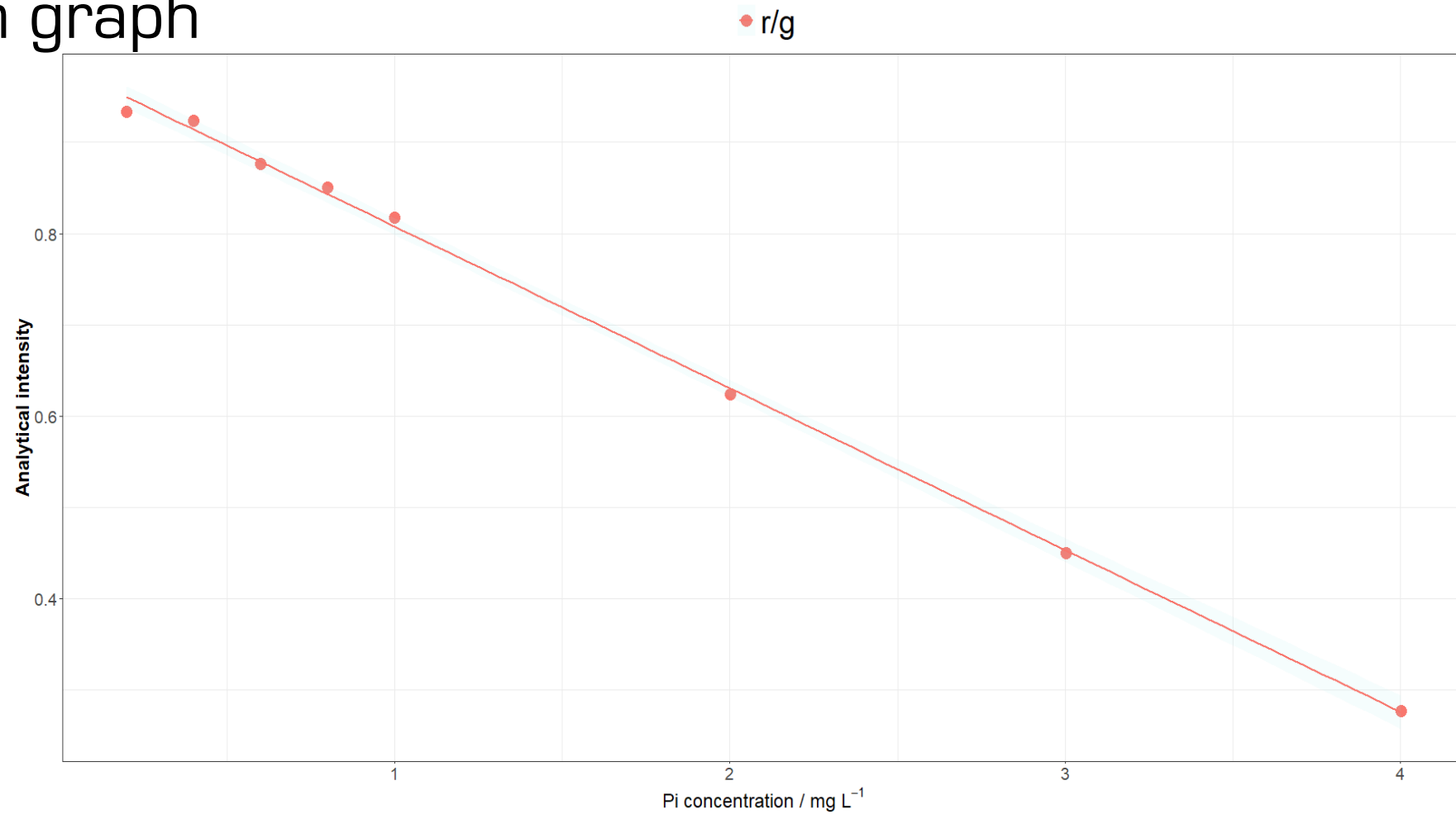


Smartphone

Proposal: a home-made colour reader for phosphate analysis



Calibration graph

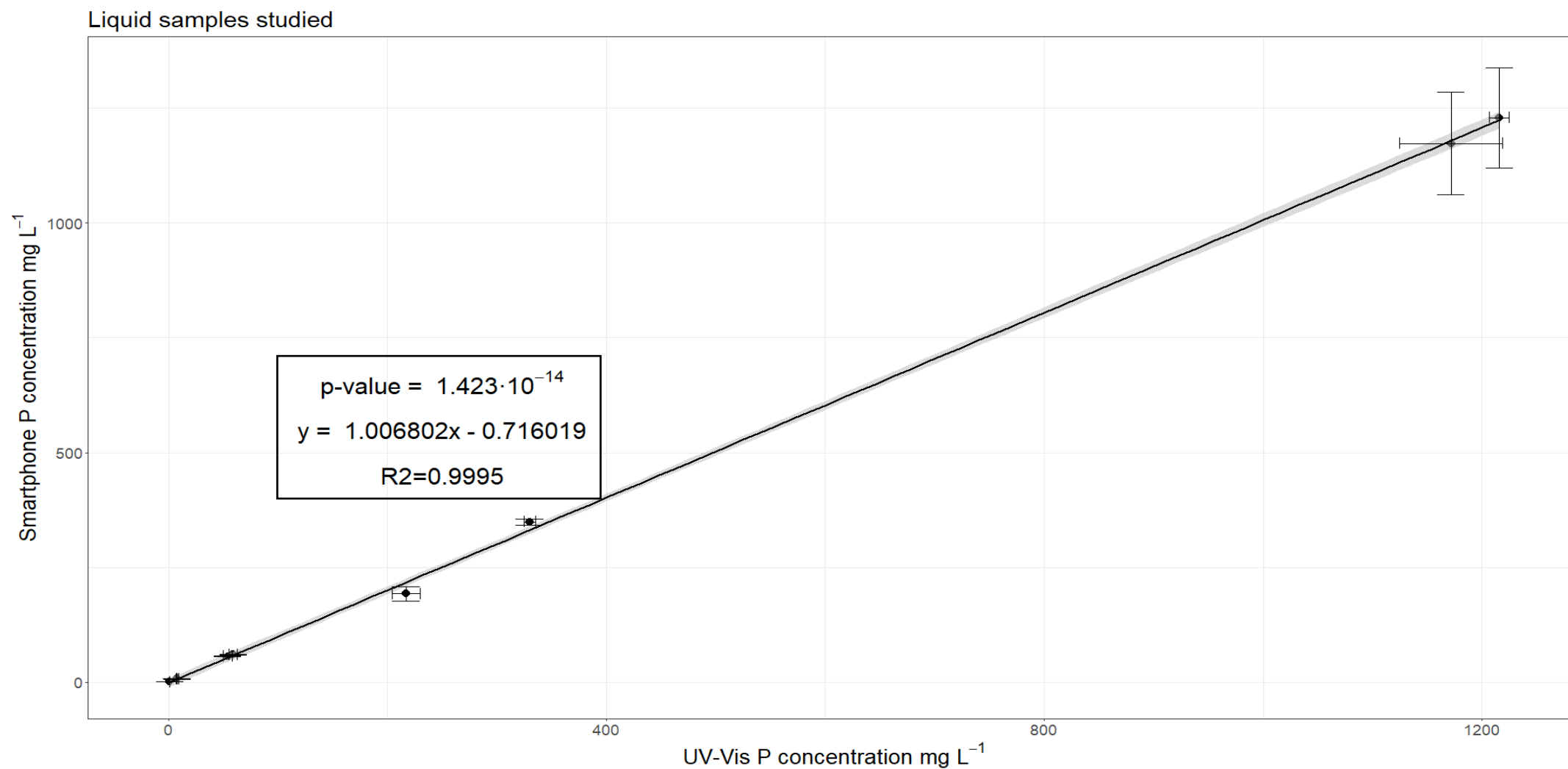


$$r/g = (-0.177 \pm 0.003) \cdot [Pi]_{mg L^{-1}} + 0.985 \pm 0.005 ; R^2 = 0.9986$$

Applications to samples

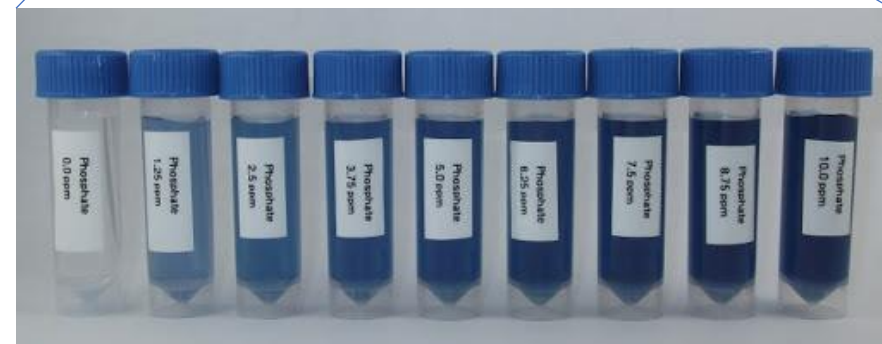
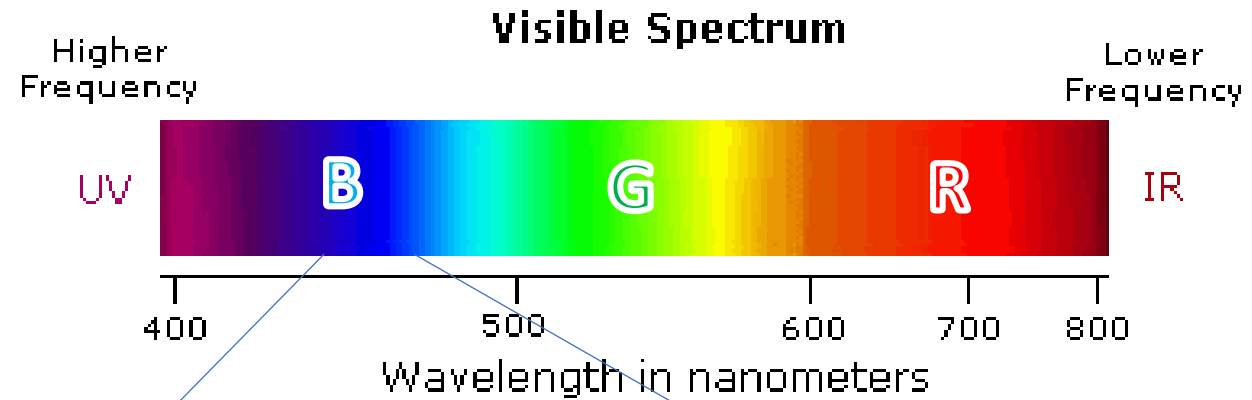
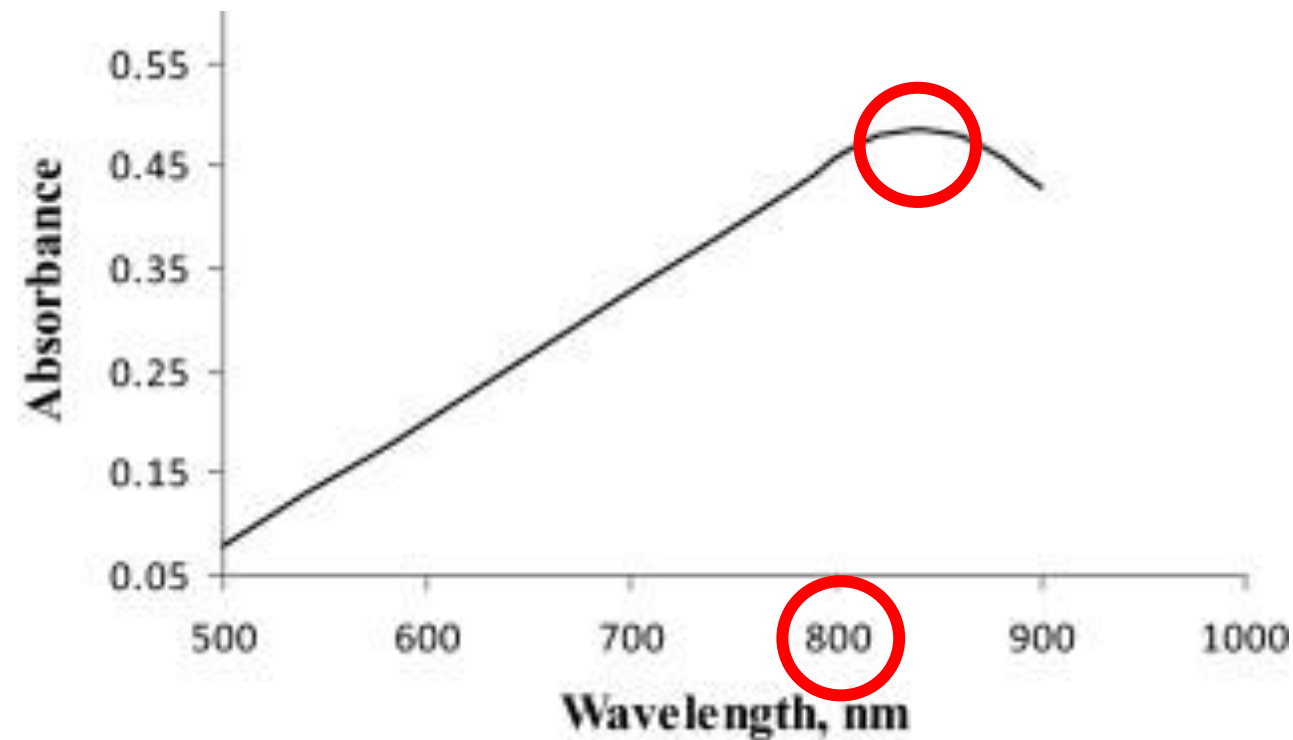


Applications to samples



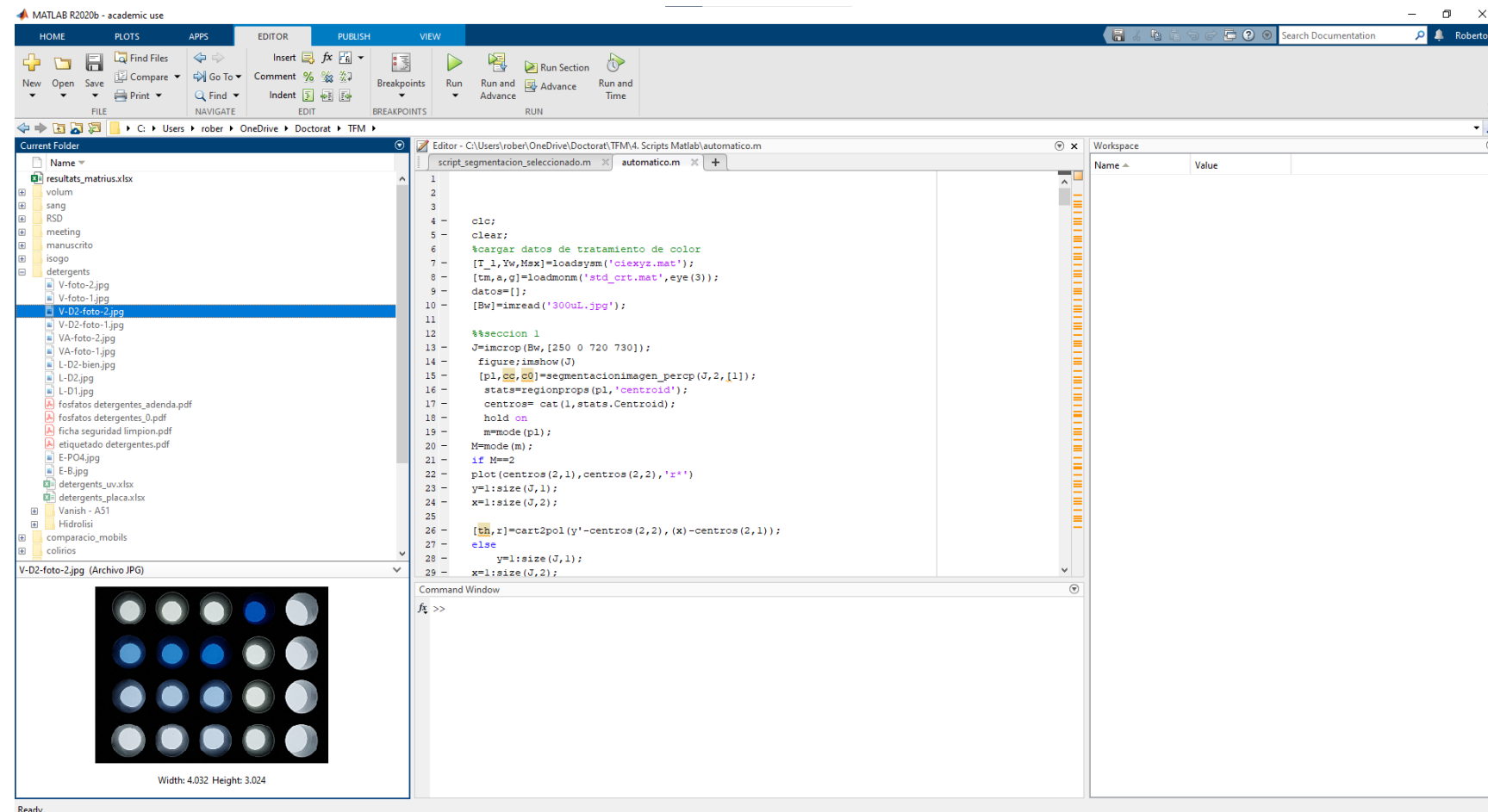
Learning objectives

1. Learning about colour spaces and their correlation with chemical change



Learning objectives

2. Introducing students to Image Treatment



MATLAB R2020b - academic use

Current Folder: C:\Users\rober\OneDrive\Doctorat\TFM\4. Scripts Matlab\automatico.m

```

1
2
3
4 - clear;
5 - clear;
6 %cargar datos de tratamiento de color
7 [I, Iw, Hsx]=loadsym('ciexyz.mat');
8 [m, a, g]=loadmonm('std_crt.mat', eye(3));
9 datos=[];
10 [Bw]=imread('300uL.jpg');
11
12
13 %%seccion 1
14 J=imcrop(Bw, [250 0 720 730]);
15 figure; imshow(J);
16 [pl, ee, ee]=segmentacionimagen_percp(J, 2, [1]);
17 stats=regionprops(pl, 'centroid');
18 centros= cat(1, stats.Centroid);
19 hold on
20 m=mode(pl);
21 if M==2
22 plot(centros(2,1), centros(2,2), 'r*');
23 y1=size(J,1);
24 x1=size(J,2);
25
26 [tb, x]=cart2pol(y1-centros(2,2), (x)-centros(2,1));
27
28 else
29 y1=size(J,1);
30 x1=size(J,2);

```

Workspace: Empty

Command Window: f_t >>

V-D2-foto-2.jpg (Archivo JPG)

Width: 4.032 Height: 3.024

Real world application
of the contents learnt
in IT class

Learning objectives

3. Learning about Green Analytical Chemistry

- S** – Select direct analytical technique
- I** – Integrate analytical processes and operations
- G** – Generate as little waste as possible and treat it properly
- N** – Never waste energy
- I** – Implement automation and miniaturization of methods
- F** – Favor reagents obtained from renewable source
- I** – Increase safety for operator
- C** – Carry out *in-situ* measurements
- A** – Avoid derivatization
- N** – Note that the sample number and size should be minimal
- C** – Choose multi-analyte or multi-parameter method
- E** – Eliminate or replace toxic reagents

Learning objectives

3. Learning about Green Analytical Chemistry

- S** – Select direct analytical technique
- I** – Integrate analytical processes and operations
- G** – Generate as little waste as possible and treat it properly
- N** – Never waste energy
- I** – Implement automation and miniaturization of methods
- F** – Favor reagents obtained from renewable source
- I** – Increase safety for operator
- C** – Carry out *in-situ* measurements
- A** – Avoid derivatization
- N** – Note that the sample number and size should be minimal
- C** – Choose multi-analyte or multi-parameter method
- E** – Eliminate or replace toxic reagents

By using the proposed procedure, a x160 reduction of volume is obtained.

Learning objectives

3. Learning about Green Analytical Chemistry

- S** – Select direct analytical technique
- I** – Integrate analytical processes and operations
- G** – Generate as little waste as possible and treat it properly
- N** – **Never waste energy**
- I** – Implement automation and miniaturization of methods
- F** – Favor reagents obtained from renewable source
- I** – Increase safety for operator
- C** – Carry out *in-situ* measurements
- A** – Avoid derivatization
- N** – Note that the sample number and size should be minimal
- C** – Choose multi-analyte or multi-parameter method
- E** – Eliminate or replace toxic reagents

Only one photograph is required to measure 20 samples.

A energy cost reduction compared to a UV-Vis measuring 20 samples.

Learning objectives

3. Learning about Green Analytical Chemistry

- S** – Select direct analytical technique
- I** – Integrate analytical processes and operations
- G** – Generate as little waste as possible and treat it properly
- N** – Never waste energy
- I** – Implement automation and miniaturization of methods
- F** – Favor reagents obtained from renewable source
- I** – **Increase safety for operator**
- C** – Carry out *in-situ* measurements
- A** – Avoid derivatization
- N** – Note that the sample number and size should be minimal
- C** – Choose multi-analyte or multi-parameter method
- E** – Eliminate or replace toxic reagents

Since a lower volume of reagents and waste is used, a safer procedure overall is achieved.

Learning objectives

3. Learning about Green Analytical Chemistry

- S** – Select direct analytical technique
- I** – Integrate analytical processes and operations
- G** – Generate as little waste as possible and treat it properly
- N** – Never waste energy
- I** – Implement automation and miniaturization of methods
- F** – Favor reagents obtained from renewable source
- I** – Increase safety for operator
- C** – Carry out *in-situ* measurements
- A** – Avoid derivatization
- N** – Note that the sample number and size should be minimal
- C** – Choose multi-analyte or multi-parameter method
- E** – Eliminate or replace toxic reagents

Proposal for further analysis:

What other compound of interest could be analysed colorimetrically in this same plate?

Learning objectives

4. Building home-made analytical devices and comparing them to reference methods



Learning objectives

5. Encouraging students to get involved in the learning process by using their own tools to analyse samples

ACTIVE LEARNING





Green analysis of phosphate in diverse matrixes using a smartphone-based detector

Roberto S. Hernández*, A. Pastor, A. Morales-Rubio, M. L. Cervera

Department of Analytical Chemistry, University of València, Spain.

* roberto.saez@uv.es

