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Jožef Stefan International Postgraduate School  
and Young Researchers' Day CMBO

*15 and 16 April 2019, Planica*

## How to train your robot

Zvezdan Lončarević,  
Jožef Stefan International Postgraduate School

Poster number: **12**

# Motivation

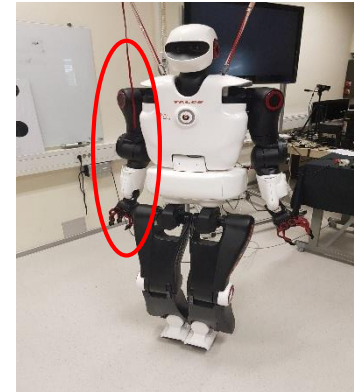
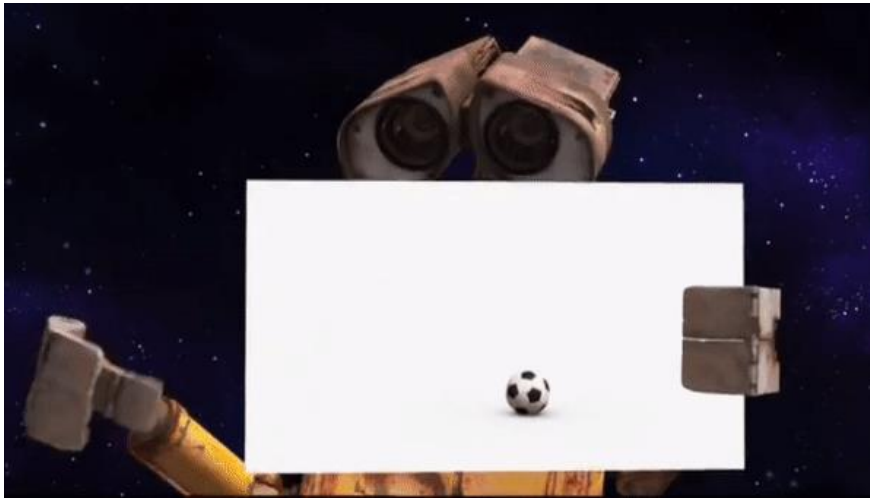
- Robots are expected to become mass-consumer product that will be part of our everyday lives



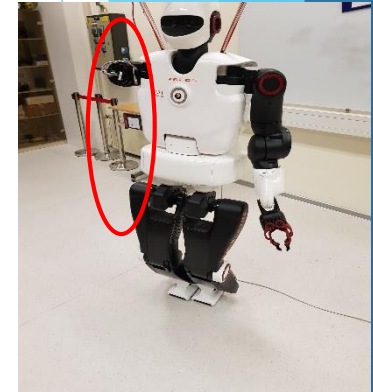
- Two approaches in contemporary robotics:
  - Imitation
  - Reinforcement learning

# Imitation learning

Problem: limits of the robot



Before  
(robot has the hand)



After  
(robot doesn't have  
the hand)

Solution: Filter the movement so that it is within the limits and that it has minimal jerk  
=> Execution is degraded and inaccurate

# Reinforcement (RL) learning

Problem 1:

- High dimensionality of the search space

Solutions:

- Encode the movement as a parametric representation of Dynamic Movement Primitives

$$\tau^2 \ddot{y} = \alpha_z (\beta_z (g - y) - \tau \dot{y}) + f(x) \quad x = e^{-\alpha_x t / \tau}$$

- Simulate executable throws and extract the important features with a neural network

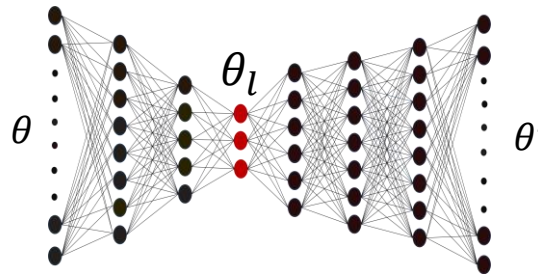
Activation function:

$$y = \tanh(W\theta^\# + b)$$

Neural network parameters:

$$\theta^* = \{W, b\}$$

$$\theta^* = \arg \min \frac{1}{n} \sum_{i=1}^n L(\theta^{(i)}, \theta'^{(i)})$$



EXACT REWARD





# Reinforcement (RL) learning

## Problem 2:

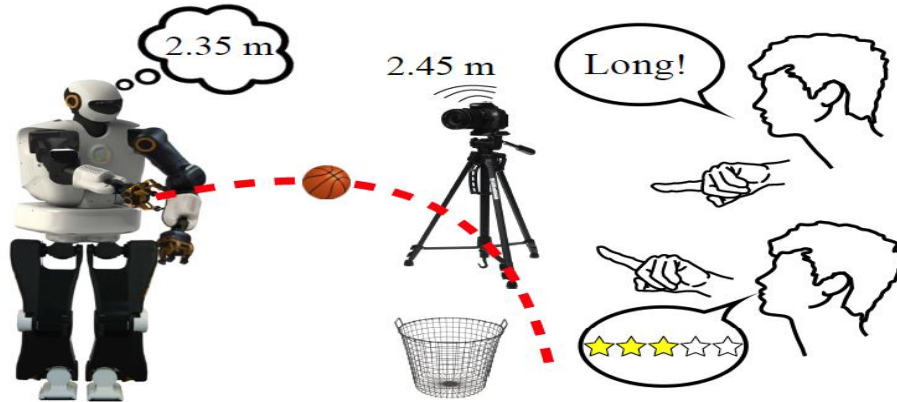
- Inaccurate sensors that are hard to calibrate



wrong readings => confused robot => wrong action =>

## Solution:

- Human intuitive reward systems



*our attention!*

Hula Hoop® Wham-O, Inc.



For more information, please visit poster number 12

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## Life of chemotherapeutics in human organism-Ruthenium based speciation

Katarina Marković

### Department of Environmental Sciences

The Department of Environmental Sciences encompasses a broad range of research activities, diverse and varied as the environment itself.

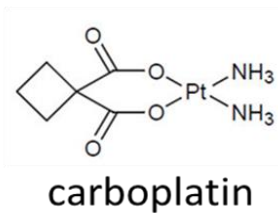
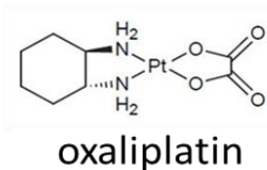
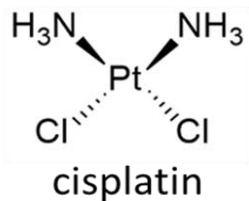


# New generation of chemotherapeutics

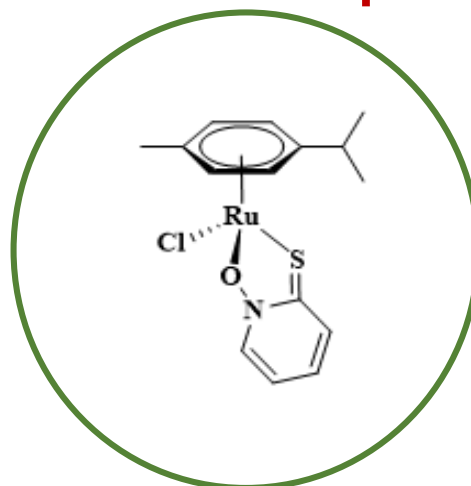


**cancer**

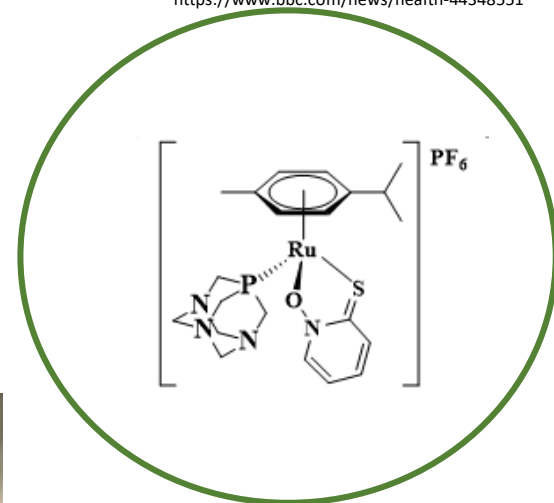
<https://www.bbc.com/news/health-44348551>



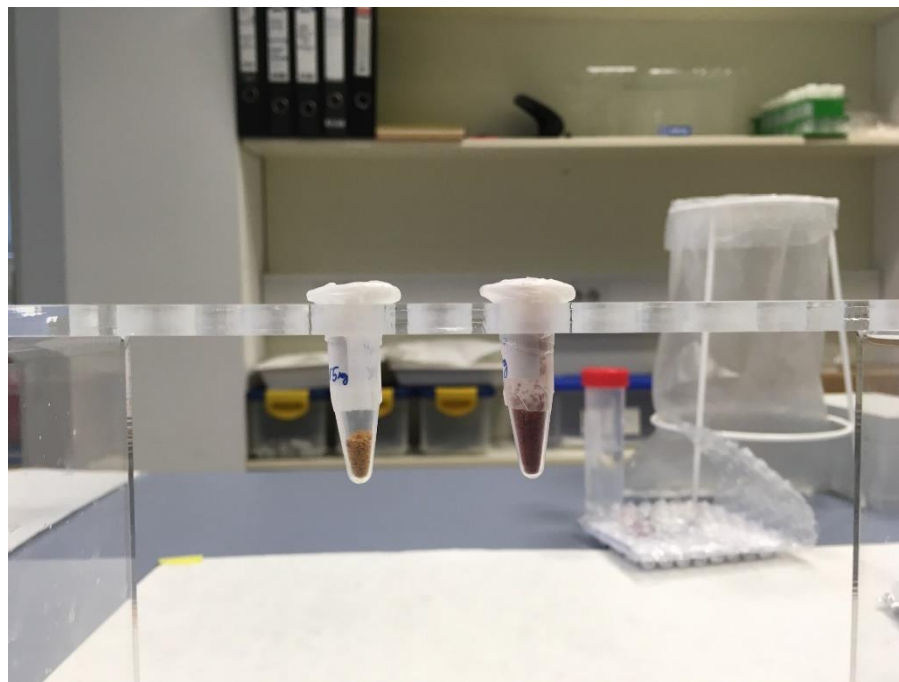
Dhar & Lippard, 2009



RuPthCl

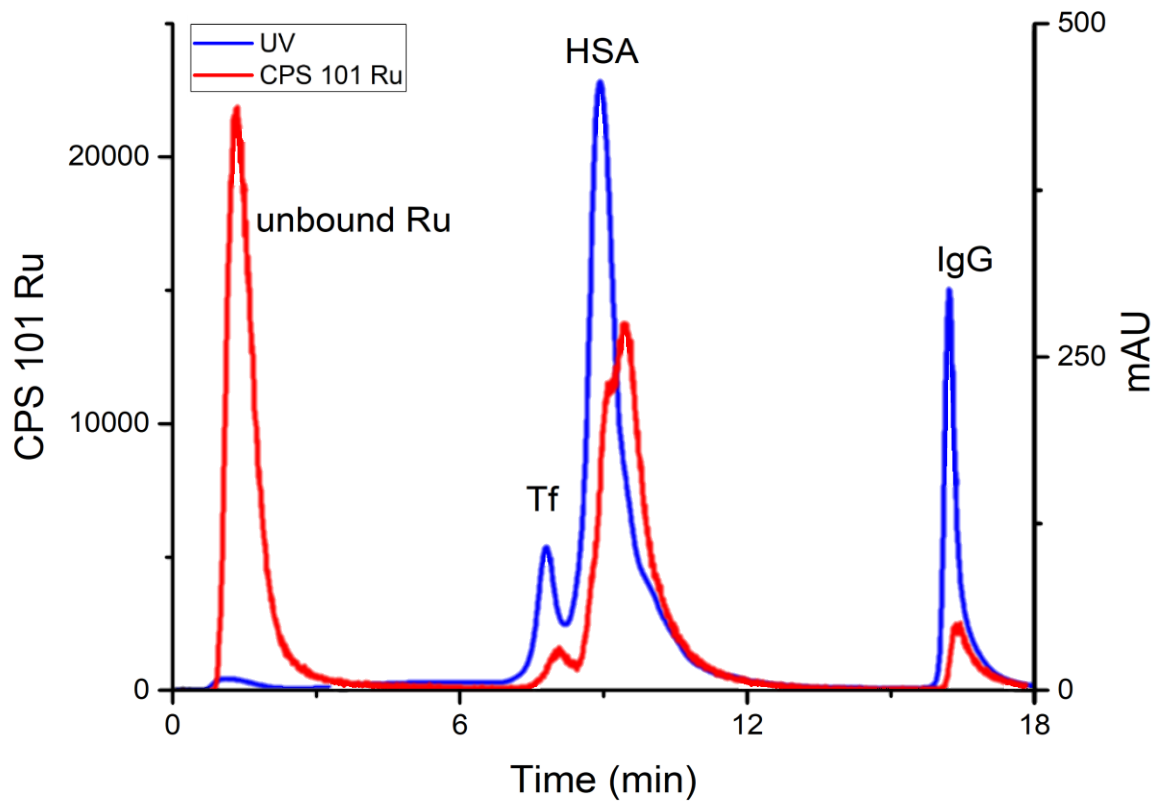


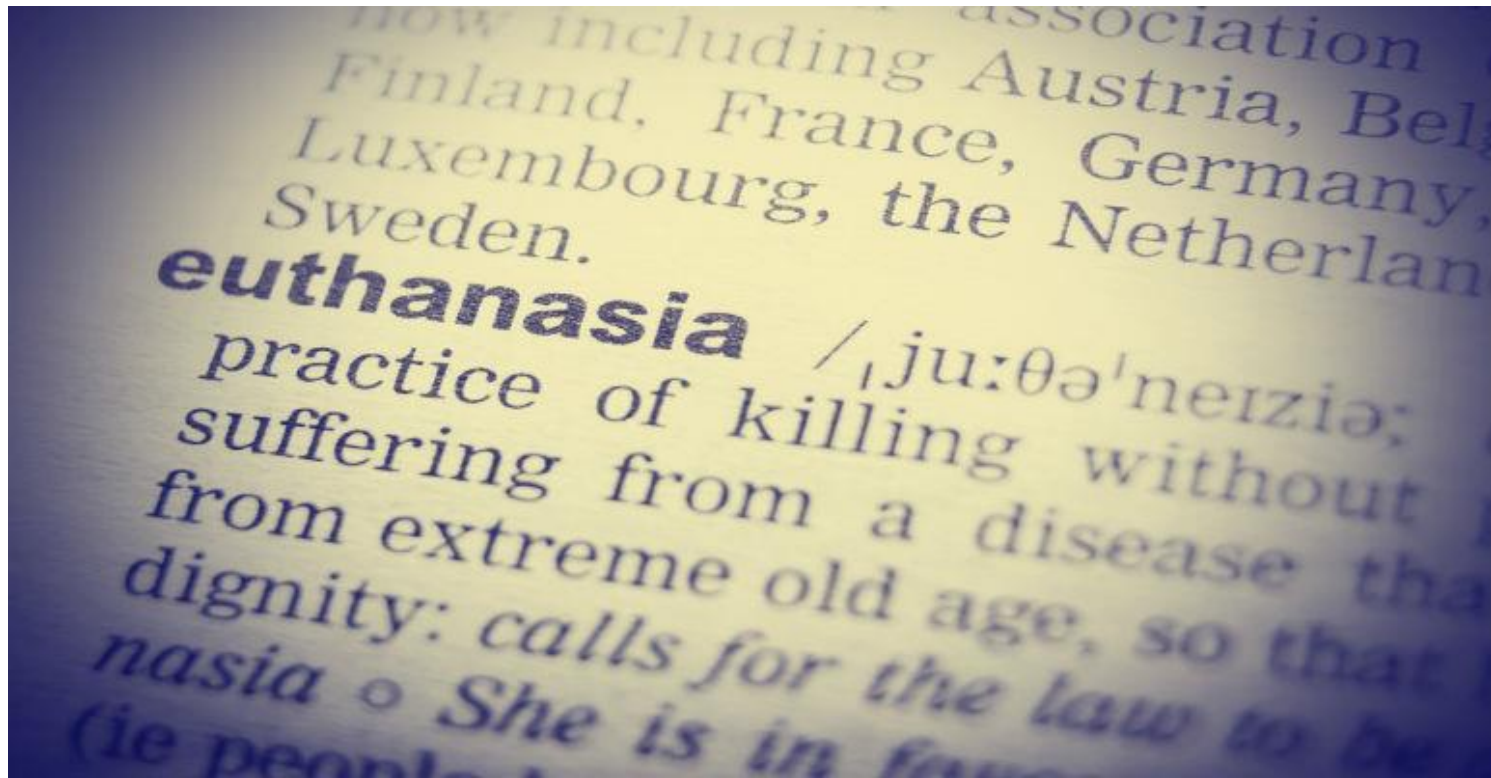
RuPthPTA



Can we do it better?

# Analytical method development





Thank you for attention!

katarina.markovic@ijs.si

Poster number: **39**



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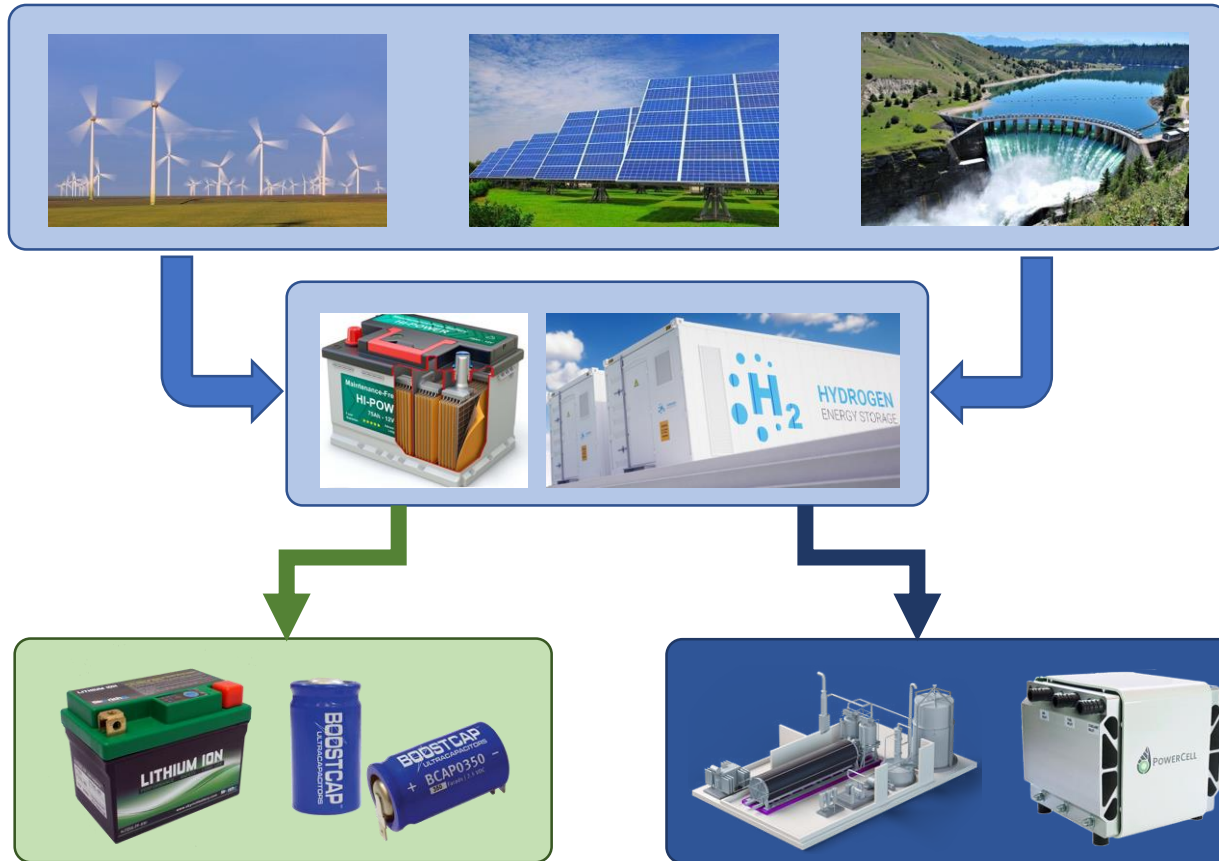
## Method for Fast Estimation of the Parameters In Order to Detect Different Operating Conditions of Electrochemical Energy Devices

Gjorgji Nusev,  
International Postgraduate School Jožef Stefan

Poster number: **11**



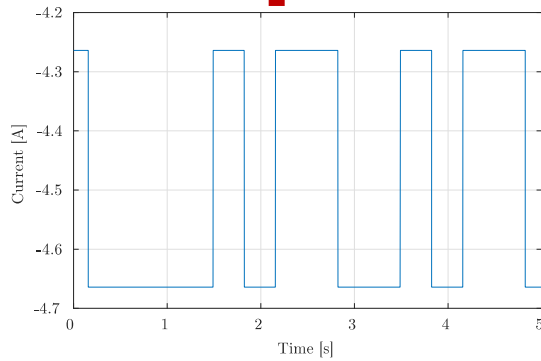
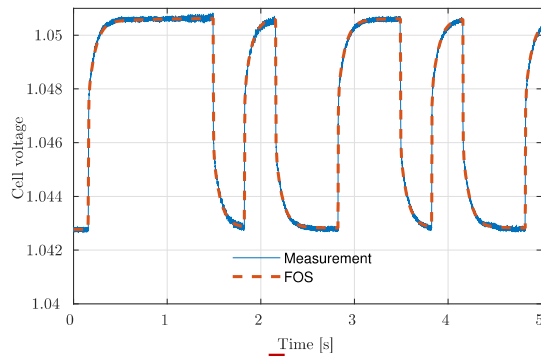
# Energy storage systems



# Fractional-order identification approach

- Fraction of the time compared to the current EIS methods **12 seconds** vs. 5-10 minutes
- No tuning parameters
- Impedance characteristic in closed form - equation describing the Nyquist curve
- DRT is just a side effect - obtained in closed form through a simple mathematical transformation
- Suitable for online implementation and PHM applications

# Algebraic Fractional-order identification approach

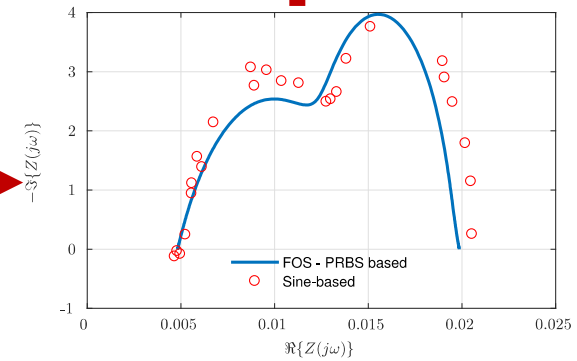
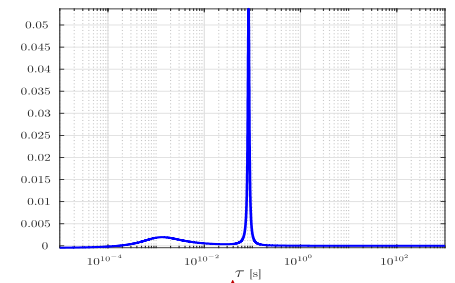


Algebraic time domain identification  
of fractional order systems

6-steps algorithm

$$G(s) = \frac{b_0 s^{\alpha_{n+1}} + b_1 s^{\alpha_{n+2}} + \dots + b_m s^{\alpha_{n+m+1}}}{a_0 s^{\alpha_0} + a_1 s^{\alpha_1} + \dots + b_n s^{\alpha_n}}$$

$$DRT(\tau) = -\frac{1}{\pi} \left( \Im \left\{ G \left( e^{-\log(\tau) - j\frac{\pi}{2}} \right) \right\} + \Im \left\{ G \left( e^{-\log(\tau) + j\frac{\pi}{2}} \right) \right\} \right)$$



# Algebraic Fractional-order identification approach

Original system

$$\frac{b_0 s^{\alpha_{n+1}} + b_1 s^{\alpha_{n+2}} + \dots + b_m s^{\alpha_{n+m+1}}}{a_0 s^{\alpha_0} + a_1 s^{\alpha_1} + \dots + a_n s^{\alpha_n}} = \frac{\mathcal{L}\{u(t)\}}{\mathcal{L}\{i(t)\}}$$

Group by the same fractional order

$$(a_0(s)U(s) - b_0(s)I(s))s^{\bar{\alpha}_0} + (a_1(s)U(s) - b_1(s)I(s))s^{\bar{\alpha}_1} + \dots + (a_r(s)U(s) - b_r(s)I(s))s^{\bar{\alpha}_r} = 0$$

In matrix form by r-time differentiation

$$\begin{bmatrix} a_0(s)U - b_0(s)I & \dots & a_r(s)U - b_r(s)I \\ p_{1,0}(s, \frac{d}{ds})U - q_{1,0}(s, \frac{d}{ds})I & \dots & p_{1,r}(s, \frac{d}{ds})U - q_{1,r}(s, \frac{d}{ds})I \\ \vdots & & \vdots \\ p_{r,0}(s, \frac{d}{ds})U - q_{r,0}(s, \frac{d}{ds})I & \dots & p_{r,r}(s, \frac{d}{ds})U - q_{r,r}(s, \frac{d}{ds})I \end{bmatrix} \times \begin{bmatrix} s^{\bar{\alpha}_0} \\ s^{\bar{\alpha}_1} \\ \vdots \\ s^{\bar{\alpha}_r} \end{bmatrix} = 0$$

Find determinant

$$\det P = 0$$

$$F \left( s^{-1}, U(s), \dots, \frac{d^r U(s)}{ds^r}, I(s), \dots, \frac{d^r I(s)}{ds^r} \right) = 0$$

r-time Integration

$$F(s^{-1}; U(s); I(s)) = 0$$

$$\int_0^t \mathcal{L}^{-1} \{ F(s^{-1}; U(s); I(s)) \} dt = 0$$

$$\vdots$$

$$\underbrace{\int_0^t \int_0^{\tau_1} \dots \int_0^{\tau_{r-1}} \mathcal{L}^{-1} \{ F(s^{-1}; U(s); I(s)) \} d\tau_{r-1} \dots d\tau_1}_{r} = 0$$

Least Squares solution

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## Writing class for the two year humanoid robot

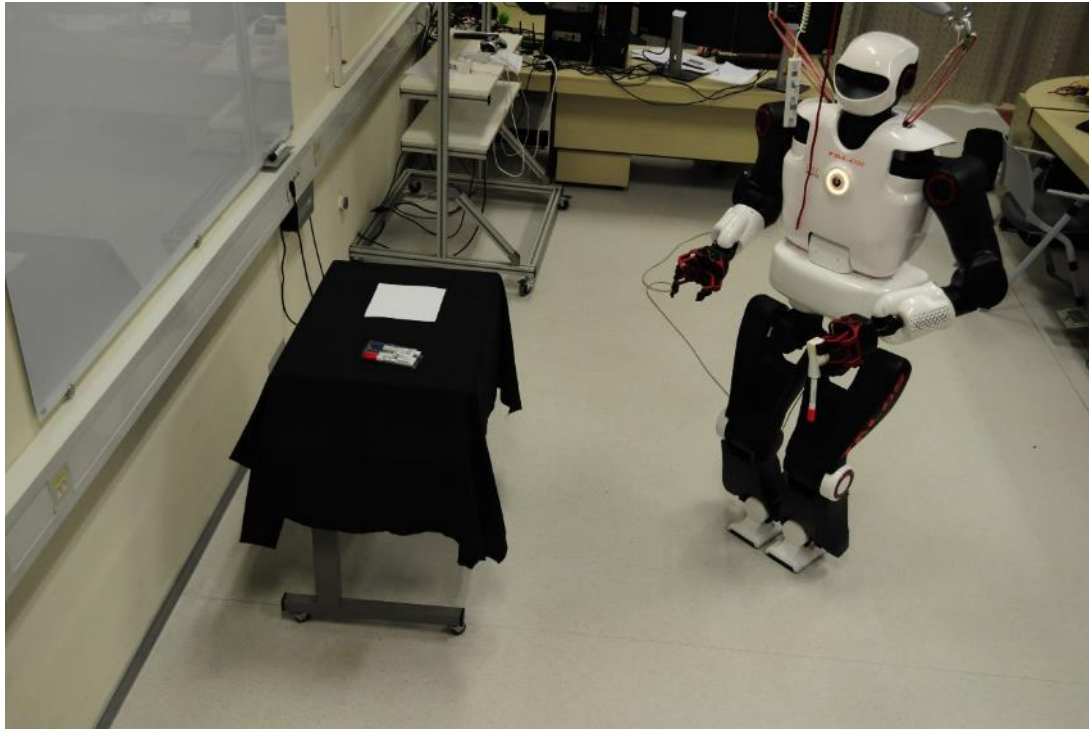
Rok Pahič,

*Jožef Stefan International Postgraduate School*

Poster number: **38**

# Autonomous robots need to

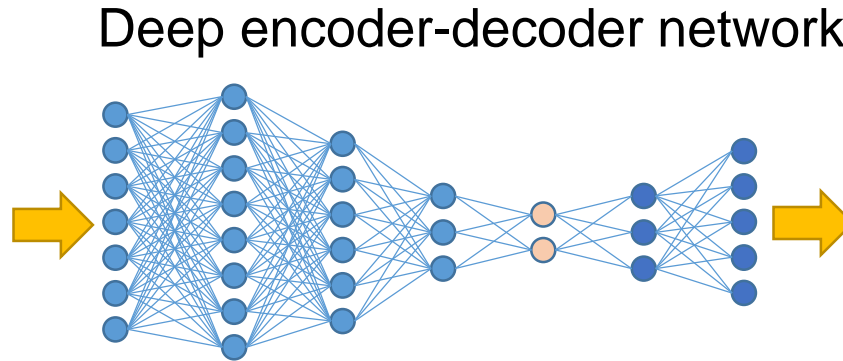
- perceive their environment and interact with the external world – couple perception with action,
- adapt to changes in the environment and acquire new skills – they need to learn.



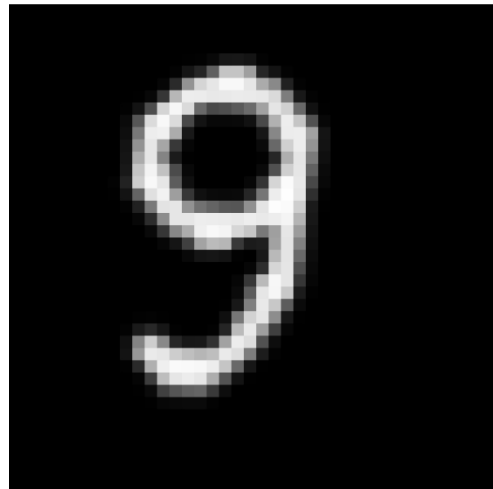
# Learning perception-action couplings



Raw image



Result



DMP parameters

$$\{\mathbf{w}_{k,j}\}_{k=1}^N, \tau_j, \mathbf{g}_j, \mathbf{y}_{0,j}$$

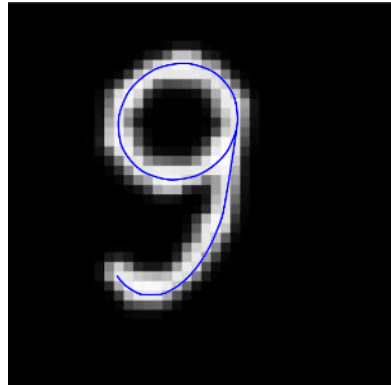


Robot motion trajectory

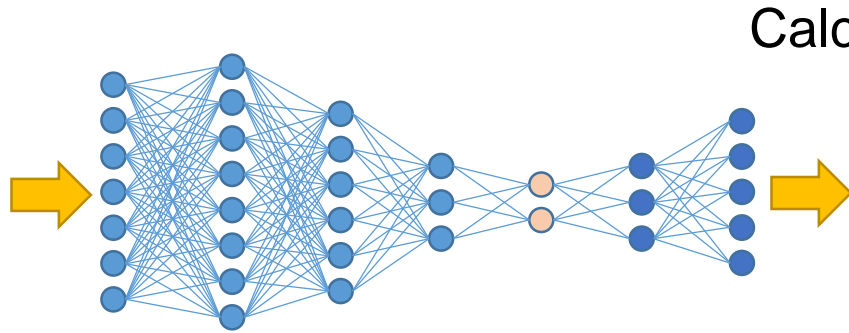




# Deep encoder-decoder training



Training pairs



Original trajectory

$$\{\mathbf{y}_i, t_i\}_{i=1}^T$$

Calculated DMP parameters

$$\{\mathbf{w}_{k,j}\}_{k=1}^N, \tau_j, \mathbf{g}_j, \mathbf{y}_{0,j}$$

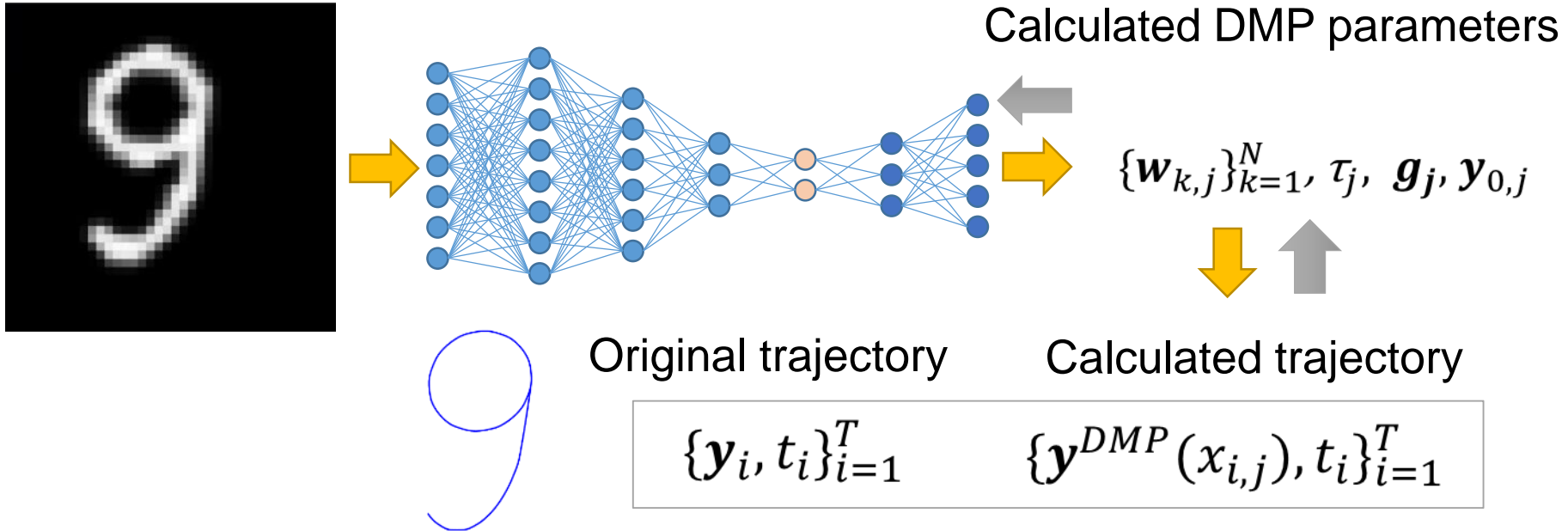
$$\{\mathbf{w}_k\}_{k=1}^N, \tau, \mathbf{g}, \mathbf{y}_0$$

Desired DMP parameters

Objective function:

$$E_p(j) = \frac{1}{2} \left( \sum_{k=1}^N \|\mathbf{w}_k - \mathbf{w}_{k,j}\|^2 + (\tau - \tau_j)^2 + \|\mathbf{g} - \mathbf{g}_j\|^2 + \|\mathbf{y}_0 - \mathbf{y}_{0,j}\|^2 \right)$$

# Deep encoder-decoder training



Objective function:

$$E_t(j) = \frac{1}{2T_j} \sum_{i=1}^{T_j} \|\mathbf{y}^{DMP}(x_{i,j}) - \mathbf{y}_{i,j}\|^2$$

Backpropagation training requires the gradients of the error function

# Fancy math:

$$E_t(j) = \frac{1}{2T_j} \sum_{i=1}^{T_j} \|\mathbf{y}^{\text{DMP}}(x_{i,j}) - \mathbf{y}_{i,j}\|^2$$

$$\frac{\partial E_t(j)}{\partial w_{l,k}} = \frac{1}{T_j} \sum_{i=1}^{T_j} (y_l^{\text{DMP}}(x_{i,j}) - y_{l,i,j}) \frac{\partial y_l^{\text{DMP}}}{\partial w_{l,k}}(x_{i,j})$$

$$\tau \frac{\partial z_l}{\partial w_{l,k}} = \alpha_z \left( -\beta_z \frac{\partial y_l}{\partial w_{l,k}} - \frac{\partial z_l}{\partial w_{l,k}} \right) + (g_l - y_{l,0}) \frac{\psi_k(x)}{\sum_{n=1}^N \Psi_n(x)} x,$$

$$\tau \frac{\partial \dot{y}_l}{\partial w_{l,k}} = \frac{\partial z_l}{\partial w_{l,k}}.$$

$$\frac{d}{dt} \frac{\partial}{\partial w_{l,k}} z_l = \frac{\partial}{\partial w_{l,k}} \frac{d}{dt} z_l,$$

$$\frac{d}{dt} \frac{\partial}{\partial w_{l,k}} y_l = \frac{\partial}{\partial w_{l,k}} \frac{d}{dt} y_l.$$

$$\frac{\partial y_l}{\partial w_{l,k}}(1) = \frac{\partial z_l}{\partial w_{l,k}}(1) = 0.$$

$$\frac{\partial E_t(j)}{\partial g_l} = \frac{1}{T_j} \sum_{i=1}^{T_j} (y_l^{\text{DMP}}(x_{i,j}) - y_{l,i,j}) \frac{\partial y_l^{\text{DMP}}}{\partial g_l}(x_{i,j}),$$

$$\frac{\partial E_t(j)}{\partial y_{0,l}} = \frac{1}{T_j} \sum_{i=1}^{T_j} (y_l^{\text{DMP}}(x_{i,j}) - y_{l,i,j}) \frac{\partial y_l^{\text{DMP}}}{\partial y_{0,l}}(x_{i,j}).$$

$$\tau \frac{\partial z_l}{\partial g_l} = \alpha_z \left( \beta_z \left( 1 - \frac{\partial y_l}{\partial g_l} \right) - \frac{\partial z_l}{\partial g_l} \right) + \frac{\sum_{n=1}^N w_{l,n} \Psi_n(x)}{\sum_{n=1}^N \Psi_n(x)} x,$$

$$\tau \frac{\partial z_l}{\partial g_l} = \alpha_z \left( \beta_z \left( 1 - \frac{\partial y_l}{\partial g_l} \right) - \frac{\partial z_l}{\partial g_l} \right) + \frac{\sum_{n=1}^N w_{l,n} \Psi_n(x)}{\sum_{n=1}^N \Psi_n(x)} x,$$

$$\tau \frac{\partial \dot{y}_l}{\partial g_l} = \frac{\partial z_l}{\partial g_l}.$$

$$\tau \frac{\partial z_l}{\partial y_{0,l}} = \alpha_z \left( -\beta_z \frac{\partial y_l}{\partial y_{0,l}} - \frac{\partial z_l}{\partial y_{0,l}} \right) - \frac{\sum_{n=1}^N w_{l,n} \Psi_n(x)}{\sum_{n=1}^N \Psi_n(x)} x,$$

$$\tau \frac{\partial \dot{y}_l}{\partial y_{0,l}} = \frac{\partial z_l}{\partial y_{0,l}}.$$

$$\frac{\partial y_l}{\partial g_l}(1) = \frac{\partial z_l}{\partial g_l}(1) = 0, \quad \frac{\partial y_l}{\partial y_{0,l}}(1) = 1, \quad \frac{\partial z_l}{\partial y_{0,l}}(1) = 0.$$

$$\frac{\partial E_t(j)}{\partial \tau} = \frac{1}{T_j} \sum_{i=1}^{T_j} (\mathbf{y}^{\text{DMP}}(x_{i,j}) - \mathbf{y}_{i,j})^\top \frac{\partial \mathbf{y}^{\text{DMP}}}{\partial \tau}(x_{i,j})$$

$$\tau \frac{\partial \dot{z}_l}{\partial \tau} = \alpha_z \left( -\beta_z \frac{\partial y_l}{\partial \tau} - \frac{\partial z_l}{\partial \tau} \right) - \dot{z}_l + (g_l - y_{0,l}) \frac{\partial}{\partial \tau} \left( \frac{\sum_{n=1}^N w_{l,n} \Psi_n(x)}{\sum_{n=1}^N \Psi_n(x)} x \right)$$

$$\tau \frac{\partial \dot{y}_l}{\partial \tau} = \frac{\partial z_l}{\partial \tau} - \dot{y}_l.$$

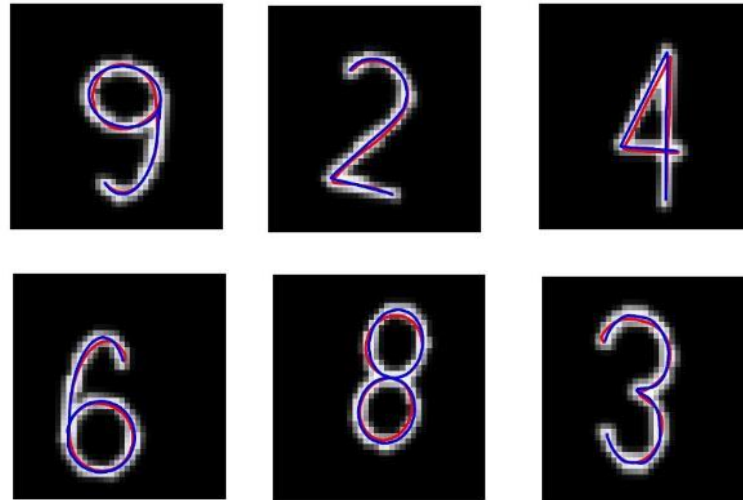
$$\frac{\partial}{\partial \tau} \left( \frac{\sum_{n=1}^N w_{l,n} \Psi_n(x)}{\sum_{n=1}^N \Psi_n(x)} x \right) = \frac{\left( \sum_{n=1}^N w_{l,n} (\Psi_n'(x)x + \Psi_n(x)) \right) \left( \sum_{n=1}^N \Psi_n(x) \right) \frac{\partial x}{\partial \tau} - \left( \sum_{n=1}^N \Psi_n(x) \right)^2 \frac{\partial x}{\partial \tau}}{\left( \sum_{n=1}^N \Psi_n(x) \right)^2} - \frac{\left( \sum_{n=1}^N \Psi_n'(x) \right) \left( \sum_{n=1}^N w_{l,n} \Psi_n(x) x \right) \frac{\partial x}{\partial \tau}}{\left( \sum_{n=1}^N \Psi_n(x) \right)^2}$$

$$\tau \frac{\partial \dot{x}}{\partial \tau} = -\alpha_x \frac{\partial x}{\partial \tau} - \dot{x}.$$

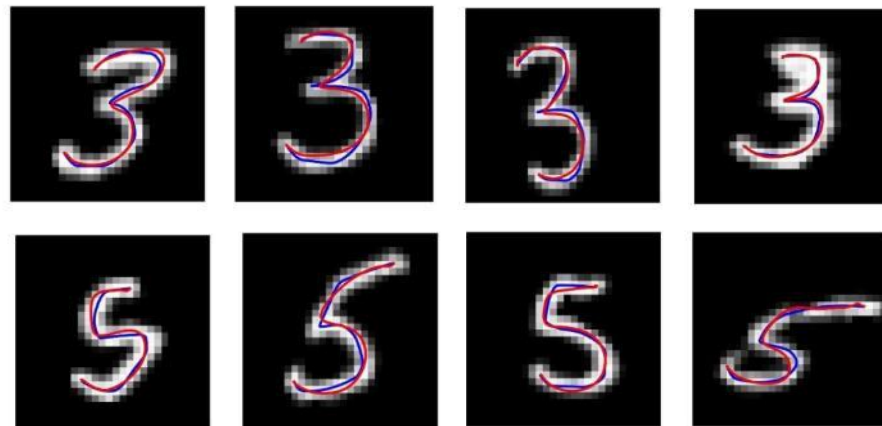
$$\frac{\partial y_l}{\partial \tau}(1) = \frac{\partial z_l}{\partial \tau}(1) = \frac{\partial x}{\partial \tau}(1) = 0, \quad l = 1, \dots, d.$$

# Non-robotic experiment

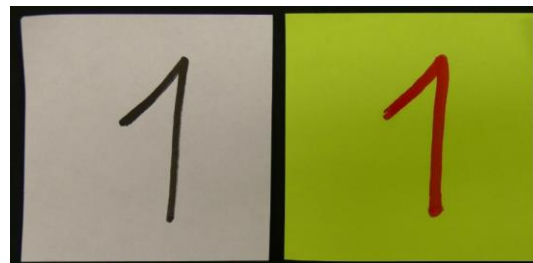
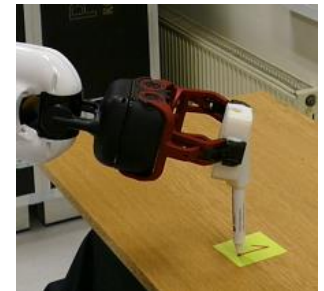
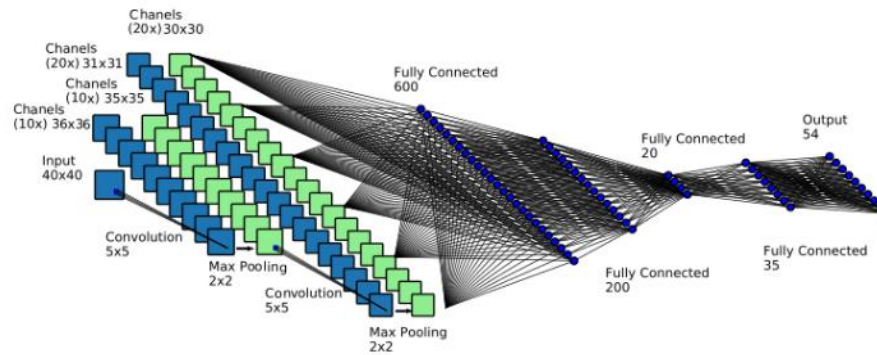
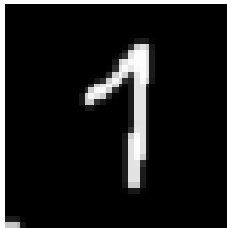
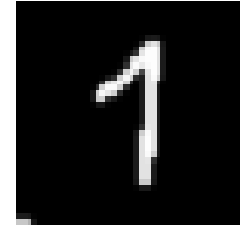
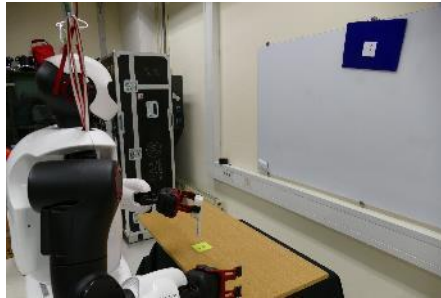
- Synthetic MNIST



- Annotated MNIST

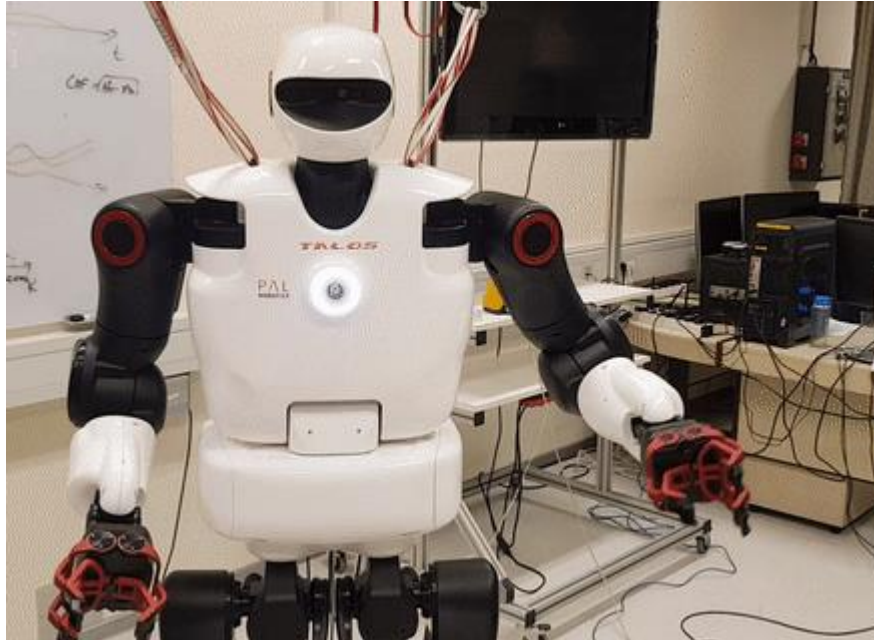


# Robotic experiment



0	0	1	1	2	2	3	3	4	4
0	0	1	1	2	2	3	3	4	4
5	5	6	6	7	7	8	8	9	9
5	5	6	6	7	7	8	8	9	9

# Thank you for your attention



- Poster

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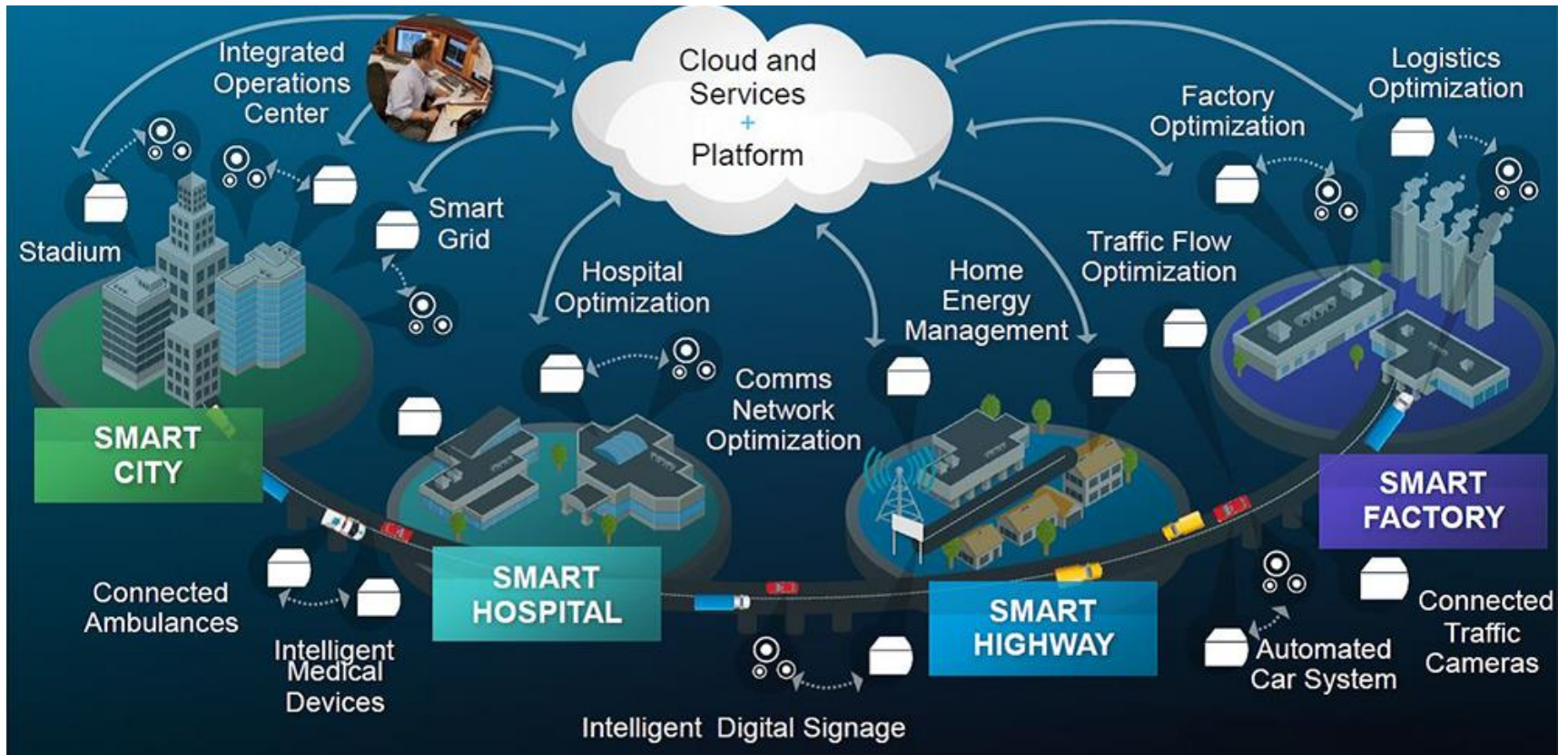
## Automated Baremetal Provisioning for Embedded Devices

Ivan Boškov,  
Jožev Stefan Institute,  
E6 - Department of Communication Systems

Poster number: **51**

# The Internet of Things (IoT)

- Constantly increasing number of IoT devices
- Large variety of sensors and wearable technology



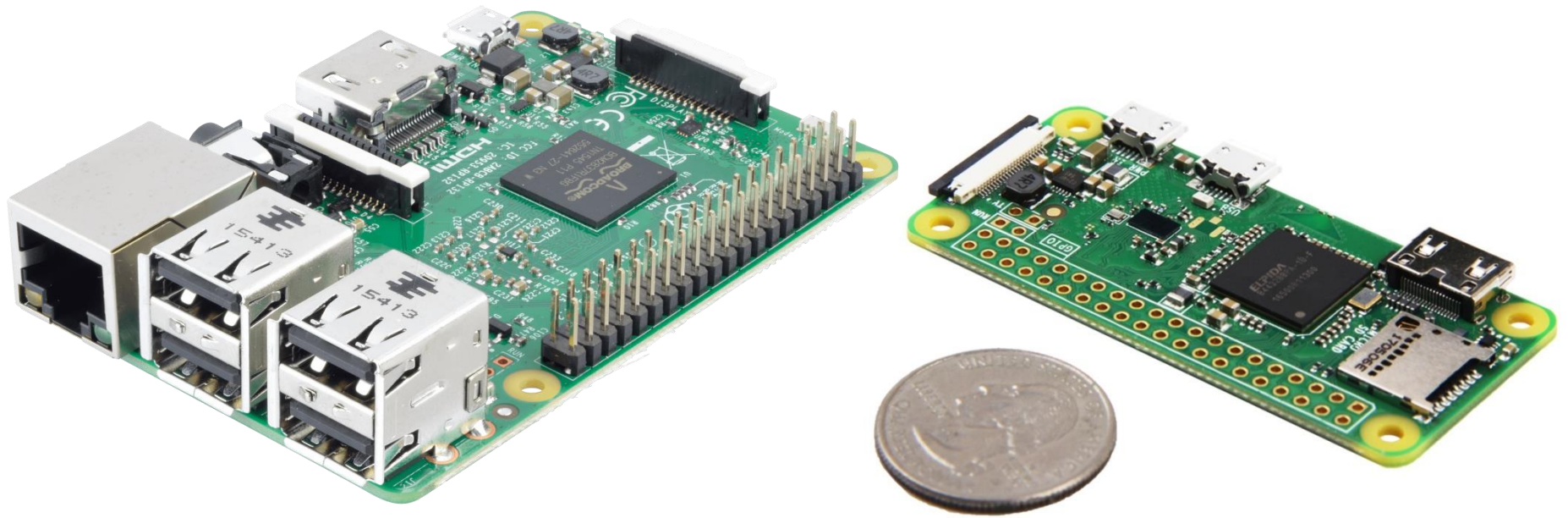
# First step in deploying IoT devices (1)

- Devices with input/output capability
  - Display (User Interface)
  - Keyboard
  - Touchscreen



# First step in deploying IoT devices (2)

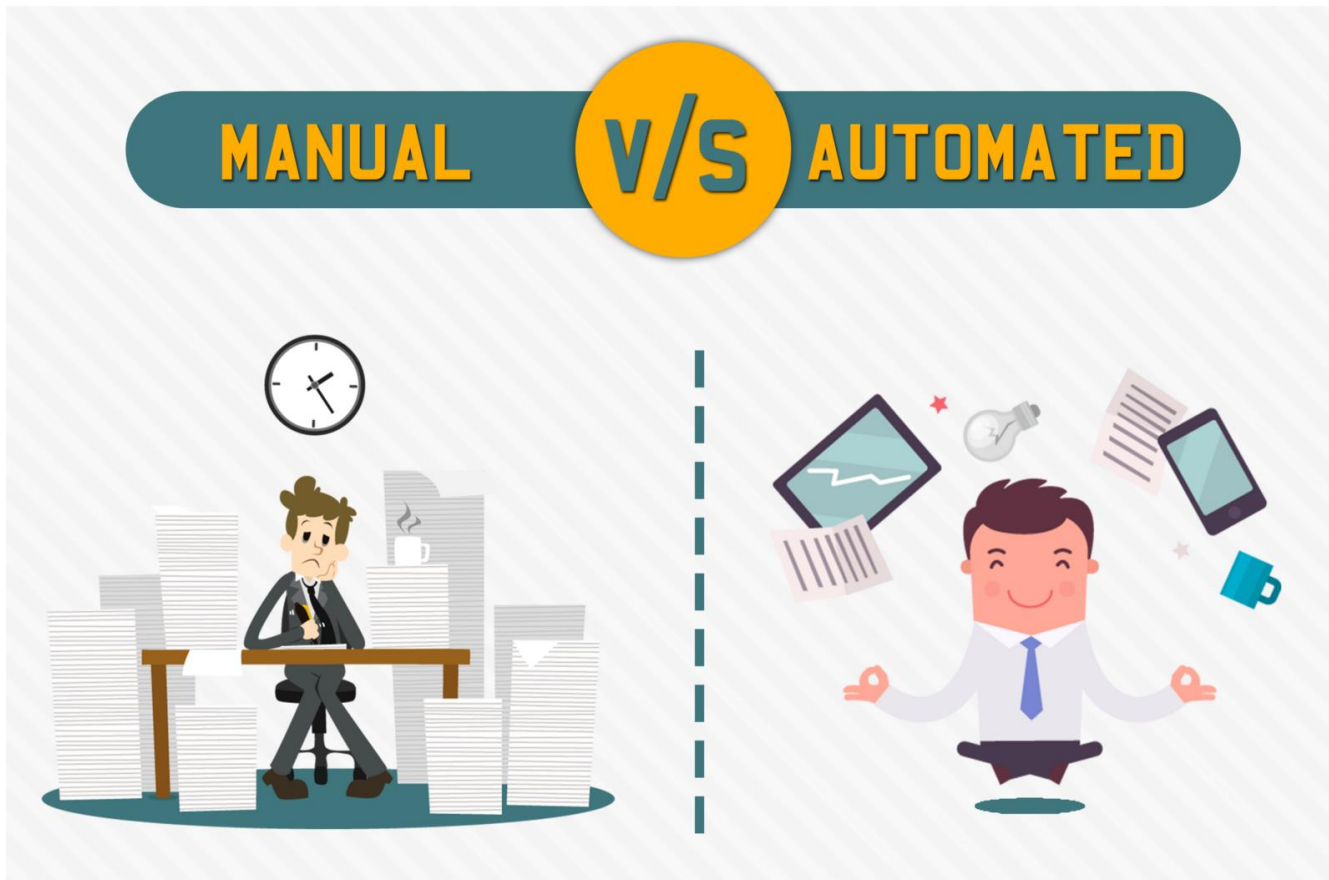
- Devices without input/output capability
  - No feedback whatsoever
  - Additional equipment needed for configuration
  - Potentially very small devices





# Methods for configuration

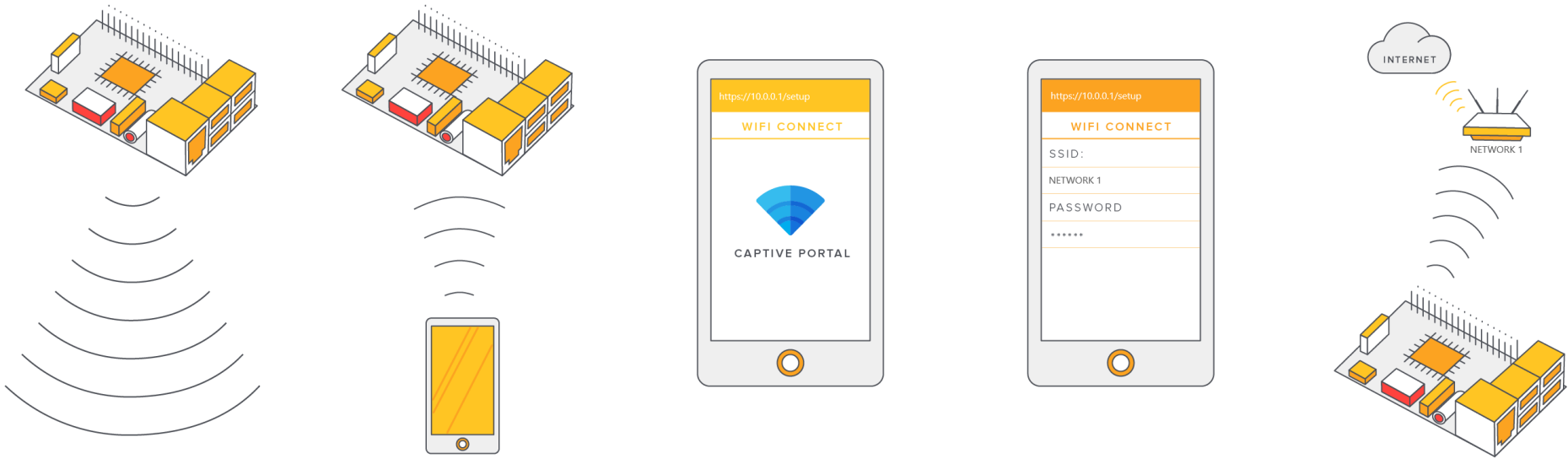
- Manual configuration
  - Time consuming
  - Error prone
- Automated configuration
  - Minimal human interaction
  - Fast and reliable



# Captive Portals



# How it works?



1 ADVERTISE:

Device Creates  
Access Point

2 CONNECT:

User Connects Phone  
To Device Access Point

3 PORTAL:

Phone Shows Captive  
Portal To Use

4 CREDENTIALS:

User Enters Local WiFi  
Network Credentials  
On Phone

5 CONNECTED!:

Device Connects To  
Local WiFi Network



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# DO YOU KNOW WHAT YOU ARE BREATHING?

*Do you care?*

---

Johanna Amalia Robinson



Poster number: 23

# WHAT ABOUT AIR QUALITY?



# Do you know where to find info?

## Onesnaženost zraka

Sreda, 10. aprila 2019, med 8:00 in 9:00

### Povprečne urne koncentracije

Merilno mesto	PM10 µg/m <sup>3</sup>	SO <sub>2</sub> µg/m <sup>3</sup>	CO mg/m <sup>3</sup>	O <sub>3</sub> µg/m <sup>3</sup>	NO <sub>2</sub> µg/m <sup>3</sup>
Ljubljana	30	5	0.5	11	50
Maribor	39		0.3		36
MB Vrbanski plato				46	
Celje	33	2		16	56
Murska Sobota	37			75	9
Nova Gorica	6			7	80
Otlica				98	
Koper	43			9	60
Trbovlje	42	5	0.8	4	54
Zagorje	34	4		4	42
Hrastnik		1		9	
Iskrba		2		14	4
Krvavec			0.2	120	
<b>Mejna vrednost</b>	*	<b>350</b>	*	<b>180</b>	<b>200</b>

Torek, 9. aprila 2019

\* Mejna vrednost ni določena

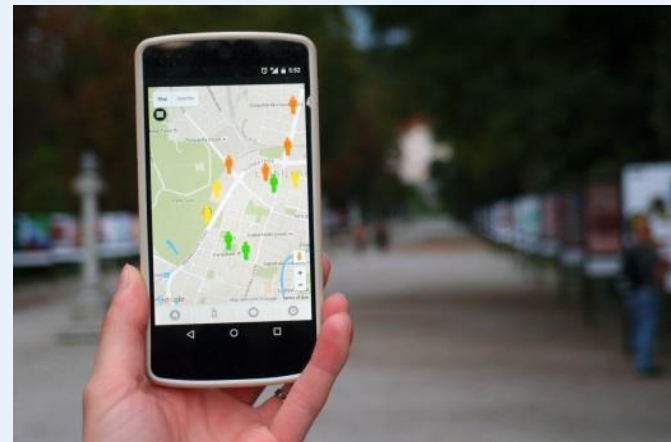
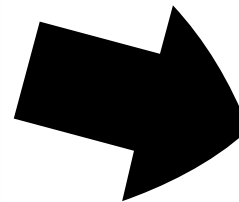
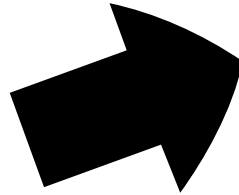
Merilno mesto: Bežigrad, Ljubljana Datum: 10.4.2019 Izberi

Prikaži kolone

Ura	SO <sub>2</sub> µg/m <sup>3</sup> (normativi)	NO µg/m <sup>3</sup>	NO <sub>2</sub> µg/m <sup>3</sup> (normativi)	NO <sub>x</sub> µg/m <sup>3</sup>	CO mg/m <sup>3</sup> (normativi)	Trdni delci PM <sub>10</sub> µg/m <sup>3</sup> (normativi)	Temperatura °C	Hitrost vetra m/s	Smer vetra	Vlaga %	Pri ml
00:00	4,75	27,2	53,4	94,95	0,54	36,617	9,7	225	?	90,9	97
01:00	4,9	20,05	45,65	76,3	0,545	29,304	9,1	180	?	92,1	97
02:00	4,6	13,4	40,15	60,6	0,555	33,269	9,2	45	?	94	97
03:00	4,95	17,55	40,95	67,75	0,555	40,376	9,5	270	?	93,9	97
04:00	5,95	19,3	40,6	70,05	0,54	43,312	9,5	45	?	94	97
05:00	4,8	9,3	31,35	45,55	0,455	32,085	9,4	45	?	94,3	97
06:00	5,3	4,7	25,15	32,25	0,32	22,609	9,9	1,45	?	92,3	97
07:00	5,25	47,9	38,5	111,65	0,485	21,527	9,4	225	?	93,6	97
08:00	5,75	73,15	44,1	155,9	0,575	26,574	9,5	225	?	92,8	97
09:00	?	?	?	?	?	?	10,6	?	?	88,9	97
mejne vrednosti	350		200			50					
alarmne vrednosti	500		400								

Vir: ARSO

# YOU CAN GET INVOLVED!





# BUT THERE ARE ISSUES...



# CHALLENGES EXIST BEYOND DATA QUALITY ISSUES



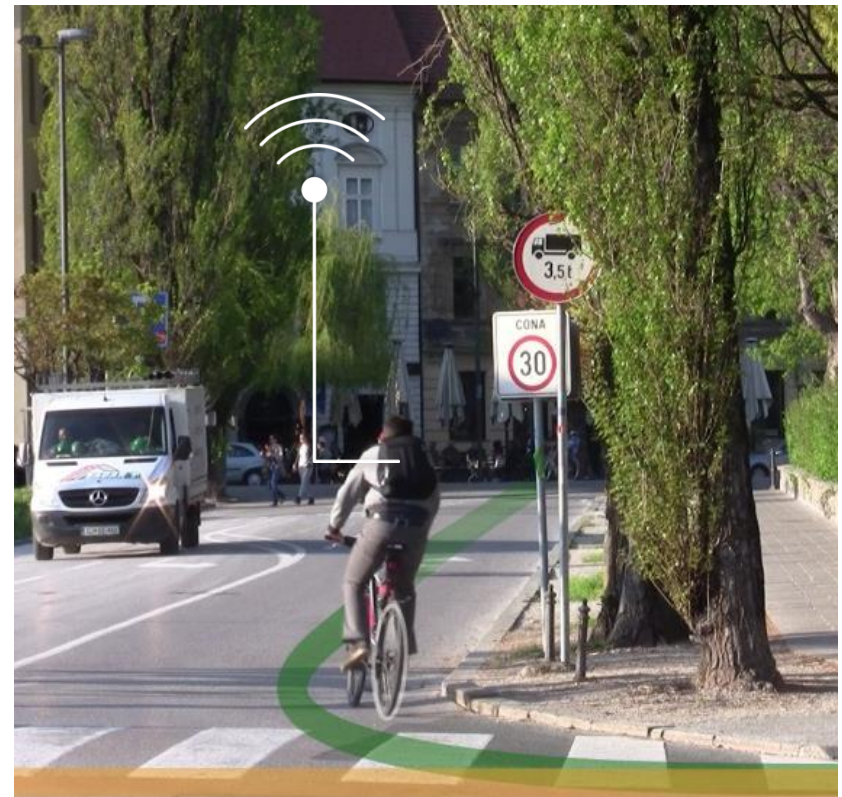
Which is why I study the user involvement



# WHAT DO THEY WANT?

- User friendly
- Small: similar to sport watches
- Multiple layers of information for different users
- More intelligent information output

...



# SUMMARY

## The mission:

*To have user friendly devices providing meaningful information*

## How to get there?

- *Involve the people!*
- *User centered design*





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# Ice Age VI: Metallic Materials

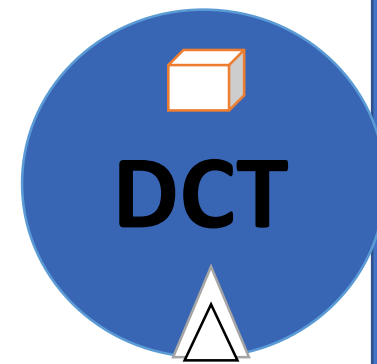
Patricia Jovičević Klug<sup>1,2</sup>, Bojan Podgornik<sup>1</sup>

<sup>1</sup>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana

<sup>2</sup>Jožef Stefan International Postgraduate School, Jamova cesta 39, 1000 Ljubljana

Poster number: 61

# Deep CRYOGeNIC TREATMENT



- Deep Cryogenic Treatment
  - Heat Treatment
  - Temperature is below  $-160\text{ }^{\circ}\text{C}$
  - Aim: to improve
    - thermo-chemical
    - tribological
    - mechanical properties



- Different Results: + = -
- Problems/Reasons:
  - unsystematically developed approaches to DCT
  - etc.

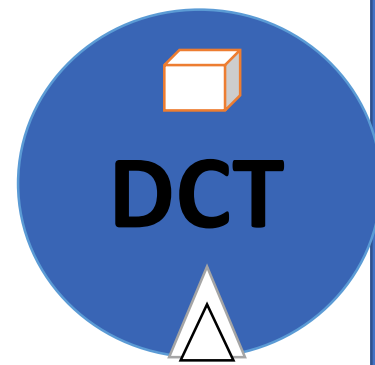


# Metallic Materials

- Solutions

- Systematical Approach to DCT
- Selected Parameters
  - Temperature  $-196\text{ }^{\circ}\text{C}$  ( $\text{LN}_2$ )
  - Soaking Period 24 h
  - Cooling/warming rate 0.5 and  $6\text{ }^{\circ}\text{C}/\text{min}$
  - After quenching

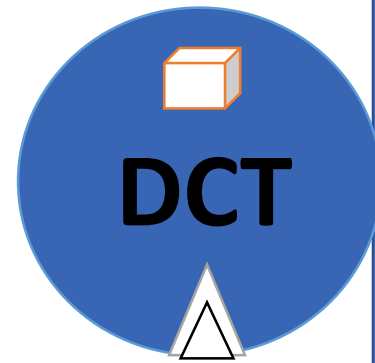
- Material



<b>Ferrous Alloys</b>	<b>Non-ferrous Alloys</b>
Cold work steel	Aluminum alloy
Hot work steel	Titanium alloy
HSS	Nickel alloy
Stainless steel	
Structural steel	

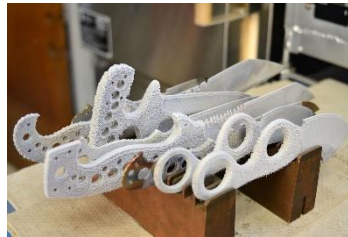
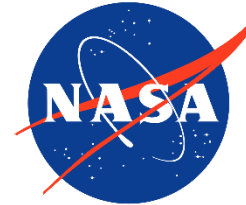


# Deep Cryogenic Treatment of Metallic Materials



Application of DCT in Industry

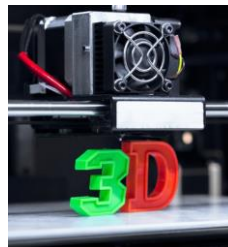
- aerospace
- automotive
- electrical and tools
- medicine
- nanofluid
- music
- oil and gas
- 3D printing



<http://www.n2tank.com/uploads/180411/1-1P4111519494.jpg>



[http://www1.pwv.com.gr/file/2014/05/15/02700207/organic\\_nano40201unet.jpg](http://www1.pwv.com.gr/file/2014/05/15/02700207/organic_nano40201unet.jpg)



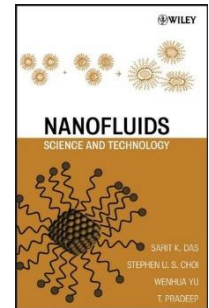
[investorplace.com](http://investorplace.com)



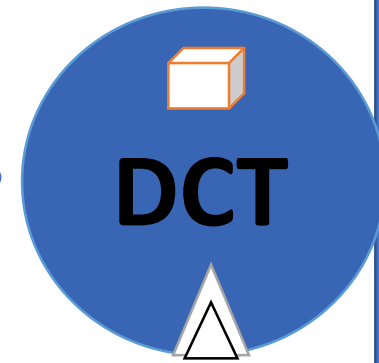
[www.industrialheating.com](http://www.industrialheating.com)



<http://www.kidskunst.info/linked/bicon-dental-implants-research-abstract-6269630be7cm>



# Deep Cryogenic Treatment of Metallic Materials



11<sup>th</sup> Jozef Stefan International Postgraduate School Students' Conference and 13<sup>th</sup> CMBE Day  
**Deep Cryogenic Treatment of Metallic Materials**  
 Patricia Jovičević Klug<sup>1,2</sup>, Bojan Podgornik<sup>1</sup>  
<sup>1</sup>Institute of Metals and Technology, Ljubljana, Slovenia  
<sup>2</sup>Jozef Stefan International Postgraduate School, Jamova cesta 39, 1000 Ljubljana, Slovenia  
[patricia.jovickevicklug@imt.si](mailto:patricia.jovickevicklug@imt.si)

For more information you are welcome to visit me at my poster - **number 61**.



**1 Deep Cryogenic Treatment**

- Heat treatment
- alloys are very cold
- agencies = to produce
- Aim of DCT is to improve
  - thermo-chemical properties
  - biological properties
  - mechanical properties
- temperature is below -160°C
- microstructure changes due to:
  - new grains
  - change in grain size
  - change of solubility of atoms
  - movement of dislocations
  - alteration of crystal structure
  - new phase formation

**2 Mechanisms of DCT**

Probable mechanism explaining changes in the microstructure and properties of metallic materials:

- retained austenite into martensite
- carbon redistribution and size reduction
- precipitation of fine carbides
- reduction of free energy of crystal structure

**3 DCT Methods**

Technique: Gradual immersion, Heat Exchanger, Direct immersion, Hybrid method

Temperature: -163 °C to -269 °C

Soaking period: from min to week, multistage DCT

Medium: Methane (-162 °C), Oxygen (-183 °C), Nitrogen (-196 °C), Hydrogen (-253 °C), Helium (-269 °C)

Cooling rate: from 0.3°C/min to 6°C/min

Application: Before quenching, After quenching, After tempering

**4 Metallic Materials and DCT**

Metallic Materials	
<b>Ferrous Alloys (Steel)</b>	<b>Non-ferrous Alloys</b>
<ul style="list-style-type: none"> <li>SS</li> <li>Structural steel</li> <li>Stainless steel</li> <li>Hot work steel</li> <li>Cold work steel</li> </ul>	<ul style="list-style-type: none"> <li>Al alloys</li> <li>Mg alloys</li> <li>Ni alloys</li> <li>Ti alloys</li> </ul>
<b>Induced changes by DCT</b> <ul style="list-style-type: none"> <li>to minimize retained austenite</li> <li>to improve wear resistance</li> <li>precipitation of fine dispersed carbides</li> <li>to increase tool life</li> <li>hardness</li> <li>performance</li> <li>to remove residual stress</li> <li>to improve dimensional stability</li> <li>strength and ductility</li> <li>to increase tool life</li> <li>to improve corrosion stability etc.</li> </ul>	

**5 DCT in Industry**

Aerospace, Automotive, Electronics and tools, Medicine, Music, 3D printing, Gas and oil applications

**6 References**

**7 Conclusions**

Different Results: Positive effect, No effect, Negative effect

Reasons: Empirically developed approaches to DCT, Different steel grades and types of non-ferrous alloys, Variable chemical composition, Measurement and interpretation errors, Comparing industry batches with well defined laboratory specimens

**8 Acknowledgment**

Project P2\_0050 is funded by ARRS



Contact:

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Institute of Metals and Technology

Department of Metallic Materials and Technology

[patricia.jovickevicklug@imt.si](mailto:patricia.jovickevicklug@imt.si)

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## Gaussian Process Regression for Big Data

Tadej Krivec,  
Jožef Stefan Institute, E2 Department

Poster number: 31



# Nonlinear Identification of Dynamic Systems

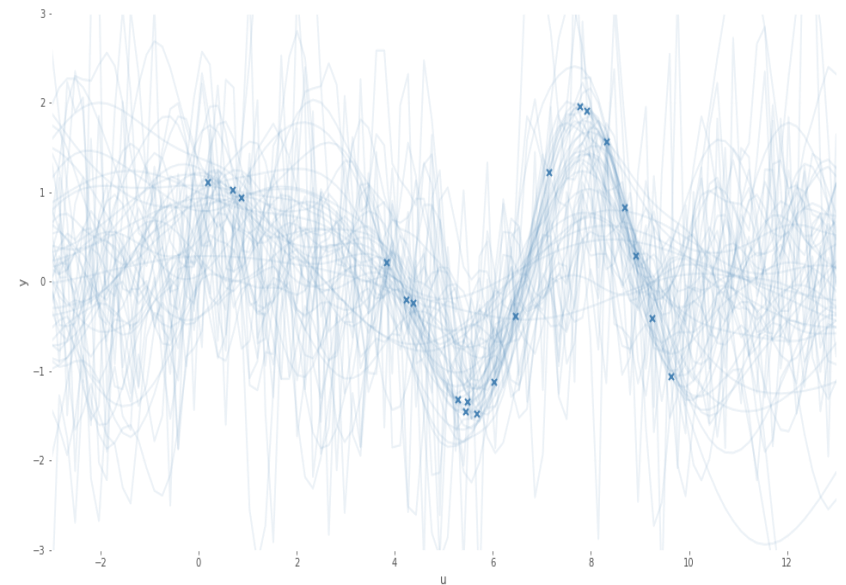
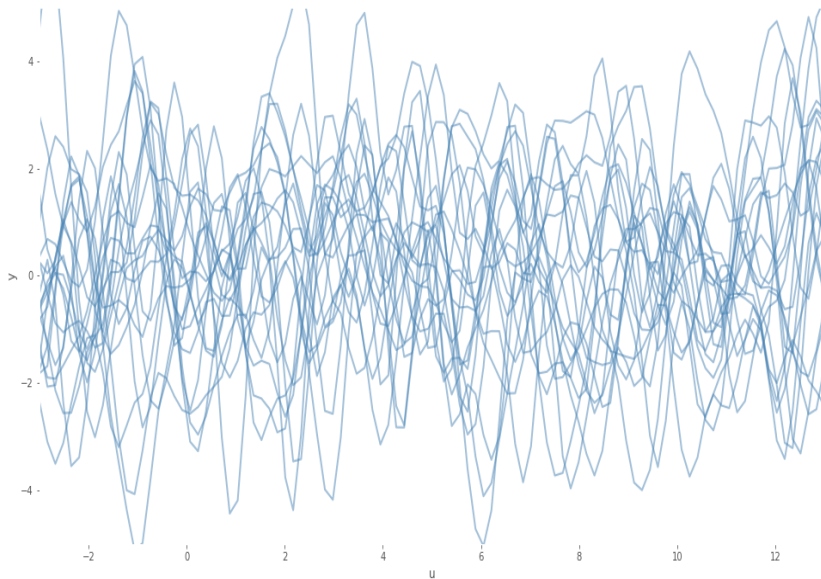
- Output and Input dependent of time.
- Input is mapped through a nonlinear mapping to output.



Nonlinear  
system

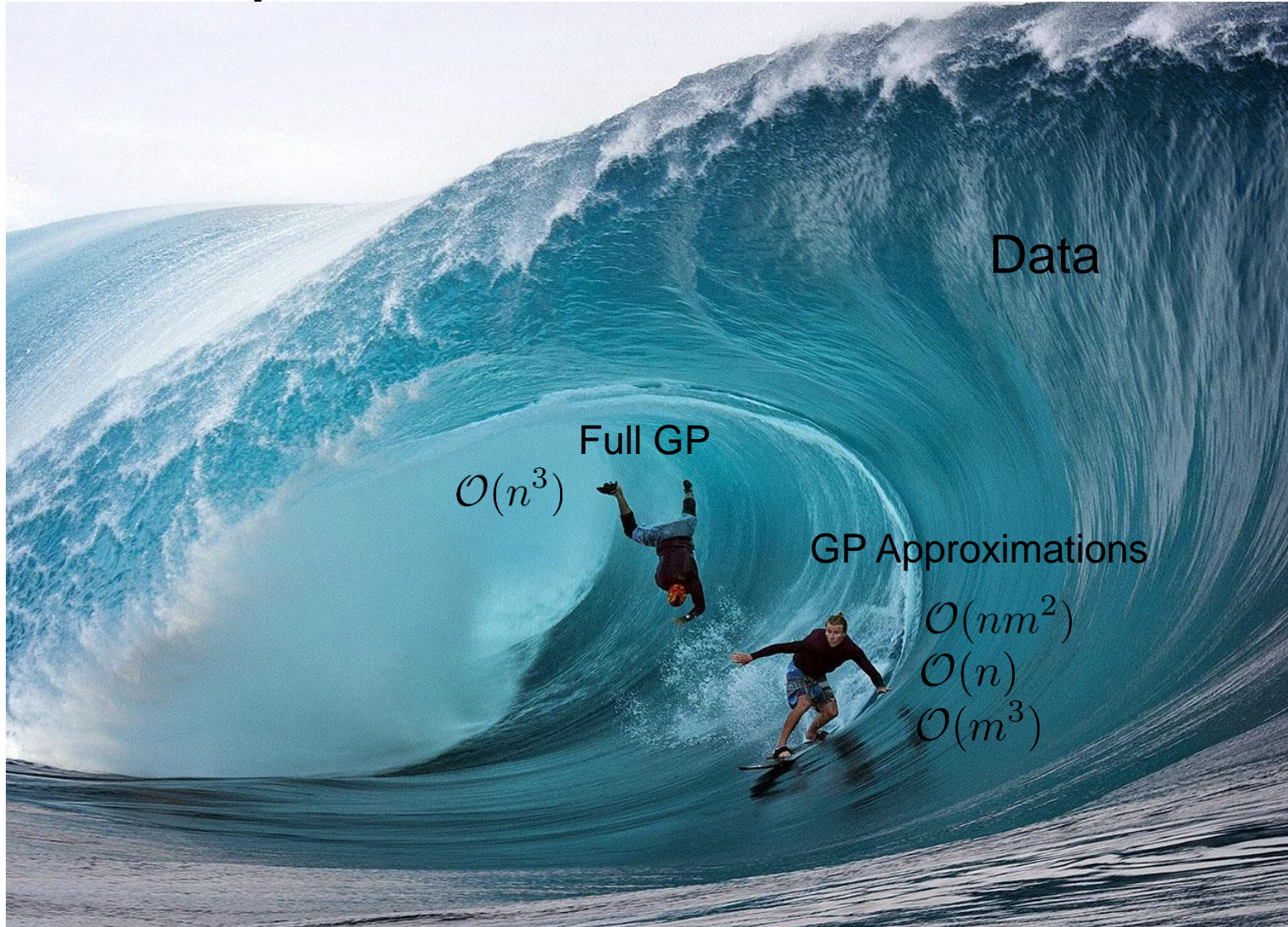
# Gaussian Process Regression

$$f|\theta \xrightarrow{p(f|y, \theta) = \frac{p(y|f, \theta)p(f|\theta)}{p(y|\theta)}} f|y, \theta$$





# Scalability



# Sparse Approximations

Deterministic Training Conditional

Partially Independent Training Conditional

Fully Independent Training Conditional

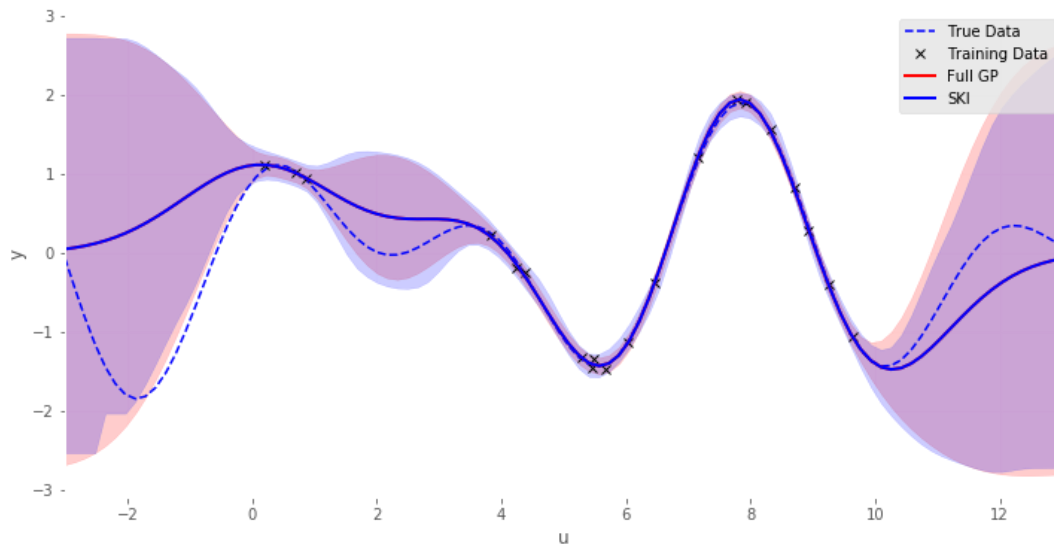
$$p(\mathbf{f}, \mathbf{f}_* | \mathbf{y}) = \frac{p(\mathbf{y} | \mathbf{f}) p(\mathbf{f}, \mathbf{f}_*)}{p(\mathbf{y})}$$

Variational Free Energy

Stochastic Variational Inference

# Local Approximations and Fast Matrix Multiplication

- Local Approximations: Global model composed of local models responsible for sub regions.
- Fast Matrix Multiplication: Iterative approach to solve the linear system for prediction.



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## Ectodomain shedding of epidermal growth factor receptor by cysteine cathepsins

Marija Grozdanić,

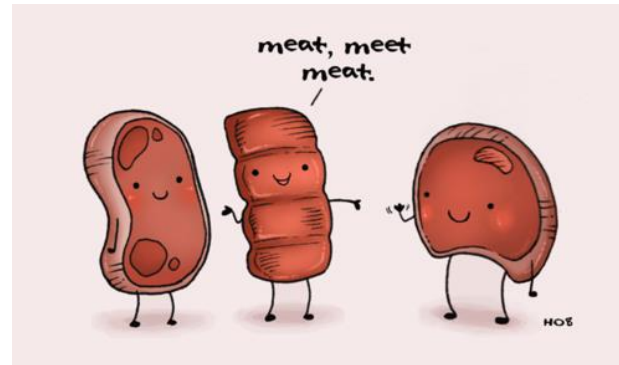
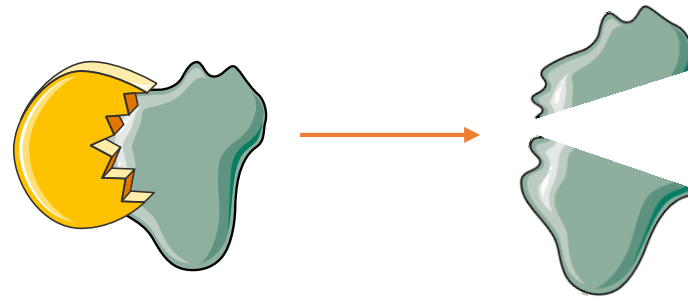
Department of Biochemistry, Molecular and Structural Biology, IJS

Jožef Stefan International Postgraduate School

Poster number: **56**



# Protease

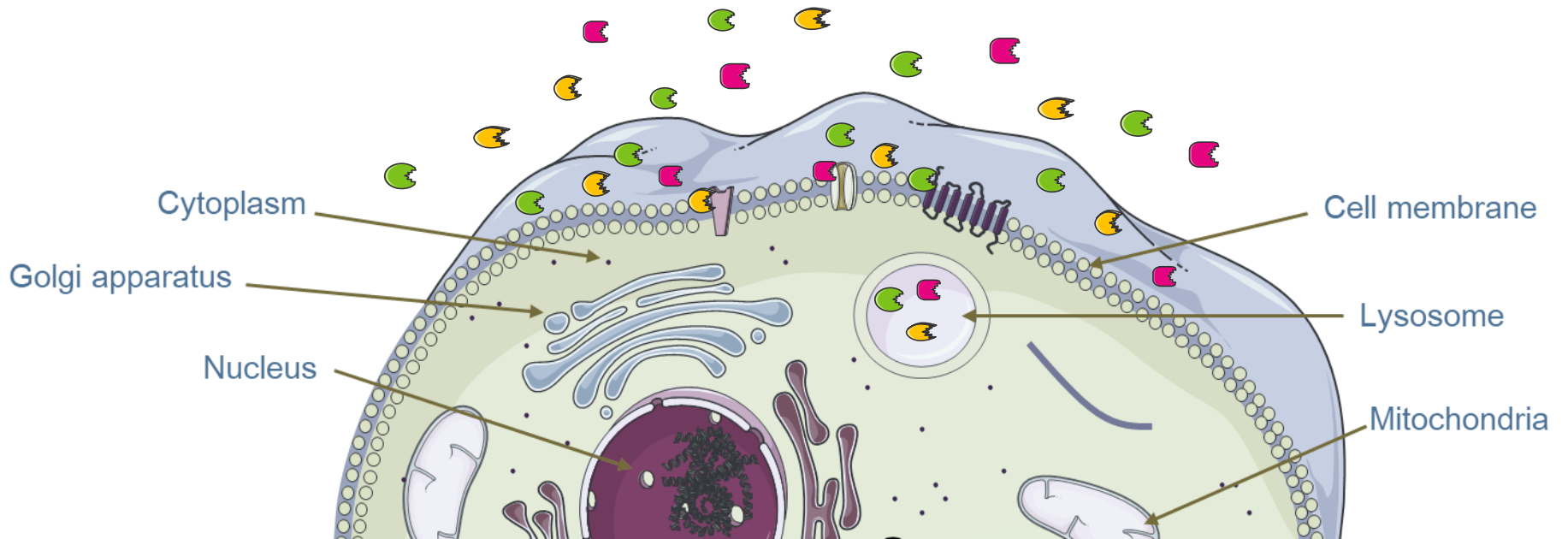




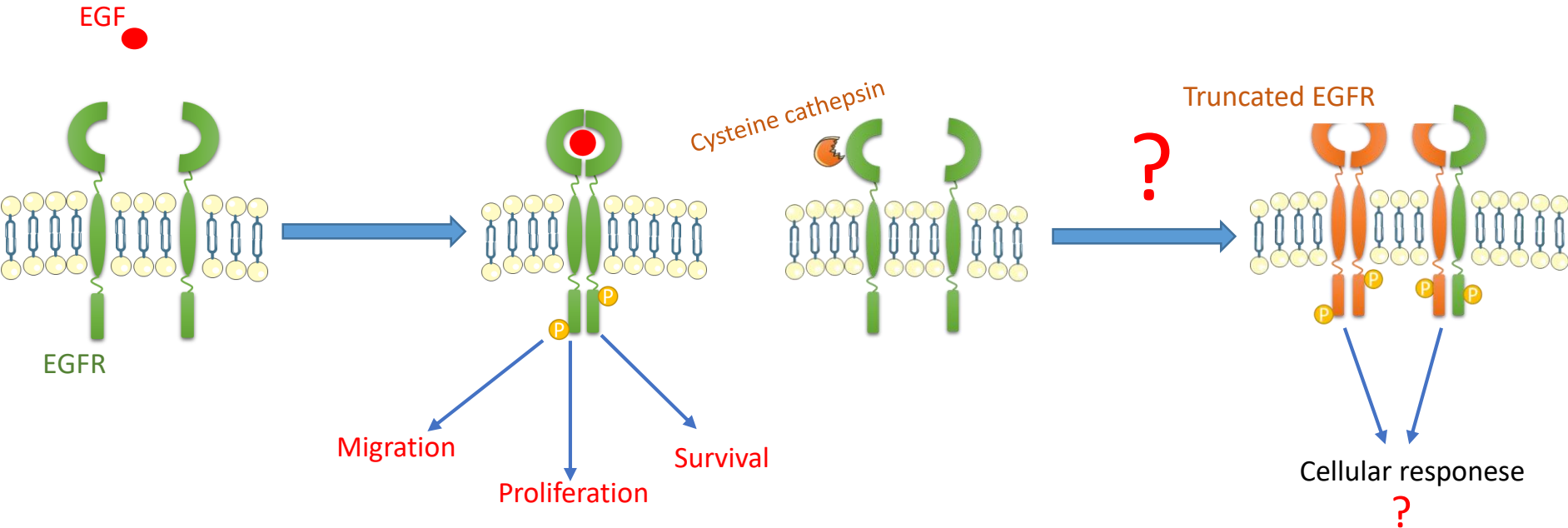
Cathepsins



Cancer



# Epidermal growth factor receptor



Thank you for your attention!

Poster number : 56



## ECTODOMAIN SHEDDING OF EPIDERMAL GROWTH FACTOR RECEPTOR BY CYSTEINE CATHEPSINS

Marilja Grošdanič<sup>1,2</sup>, Barbara Sobotič<sup>1</sup>, Matej Vizovisek<sup>1</sup>, Nežka Kavčič<sup>1,2</sup>, Boris Turk<sup>1,2,3,4</sup>, Marko Fonovič<sup>1,4</sup>

<sup>1</sup> Department of Biochemistry, Molecular and Structural Biology, Jozef Stefan Institute, Jamova cesta 39, SI-1000 Ljubljana, Slovenia <sup>2</sup> Jozef Stefan International Postgraduate School, Jamova cesta 39, SI-1000 Ljubljana, Slovenia <sup>3</sup> Faculty of Chemistry and Technology, University of Ljubljana, Slovenia <sup>4</sup> Centre of Excellence for Integrated Approaches in Chemistry and Biology of Proteins, Jamova cesta 39, SI-1000 Ljubljana, Slovenia



Background

Cysteine cathepsins are lysosomal proteases which are also known to be secreted to the extracellular space. Secreted cysteine cathepsins can cleave ectodomains of membrane proteins including receptors, growth factors, cytokines and adhesion proteins. Among the receptors, epidermal growth factor receptor (EGFR) was identified as cathepsin substrate candidate with high physiological relevance. Signaling through EGFR is commonly triggered by ligand binding, however, deletions in extracellular region of EGFR can also cause constitutive activation which is ligand independent. Such deletions can influence receptor activation and downstream signaling cascades such as phosphatidylinositol 3 ON (PI3K) pathway.

Ectodomain shedding of EGFR by cathepsins

MDA MB231 or Hs5783 (stably expressing EGFR) cell line were treated with cathepsins. After treatment supernatants were collected and prepared for Western Blot analysis.



We confirmed that EGFR is a substrate of extracellular cysteine cathepsins.

Determination of exact cleavage site of cathepsin L on EGFR:

Hs5783 cell line stably expressing pcDNA4 His/Myc EGFR were treated with cathepsin L. After shedding cells were lysed and trypsin acetylated. After affinity enrichment of EGFR-c-Myc, proteins were sent for MS/MS identification.



We have shown that cathepsin L proteolytically cleaves domain II of EGFR, it can be suggested that this truncated part is constitutively active and it can create dimers more easily.

EGFR activation



Our aim is to determine if this truncated EGFR is active, and how this truncation of EGFR influences the receptor signaling, and kinase phosphorylation profile.

Phosphorylation of cellular kinases

MDA MB 231 cell line transiently expressed pcDNA4/pcDNA4 EGFR/pcDNA4-1-EGFR. The Human Phospho-Kinase Array:



Hs5783 cell line expressing pcDNA4/pcDNA4 EGFR/pcDNA4-1-EGFR:



Expression of tEGFR generates different downstream signals and cellular responses than full length EGFR. Expression of tEGFR cause inhibition of Akt/mTOR pathway and reactivation of p53.

Phosphorylation of truncated EGFR



Truncated EGFR is constitutively active. It can be suggested that truncated EGFR creates dimer with the full length EGFR.

Conclusions

- Cysteine cathepsins cleave ectodomain of EGFR.
- Truncated EGFR is phosphorylated.
- Expression of truncated EGFR change phosphorylation profile of intracellular kinases.

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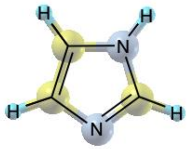
## How azole inhibitors affect the adsorption of corrosion relevant species

Matjaž Dlouhy,  
*K3 @ J. Stefan Institute*  
*J. Stefan Postgraduate school*  
Poster number: 37

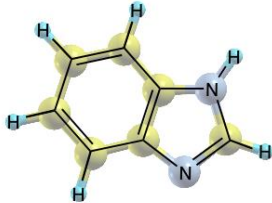
# What are we doing?

Modelling **corrosion inhibitors** on **copper surfaces** using DFT.

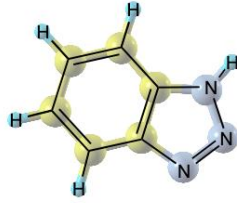
substances with ability to reduce corrosion



imidazole

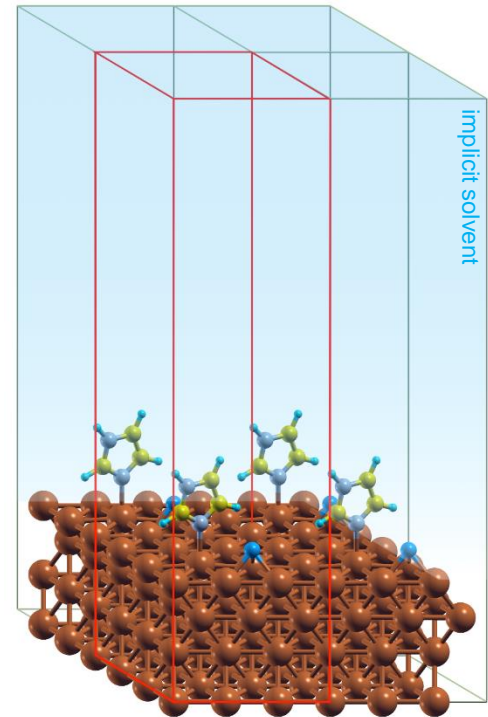


benzimidazole

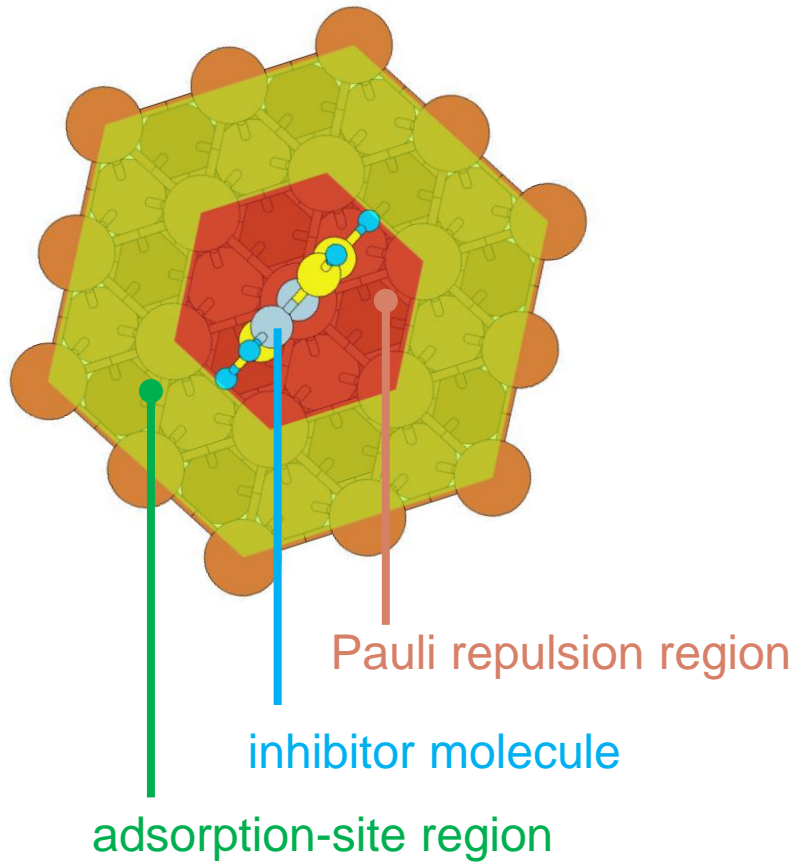


benzotriazole

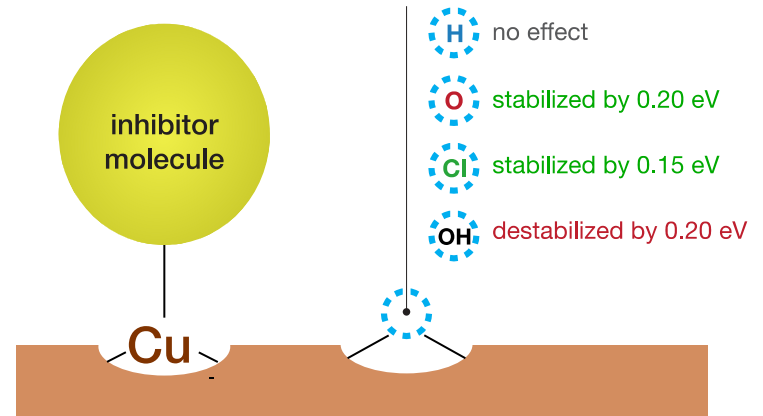
periodic multi-slab model  
of Cu(111) surface



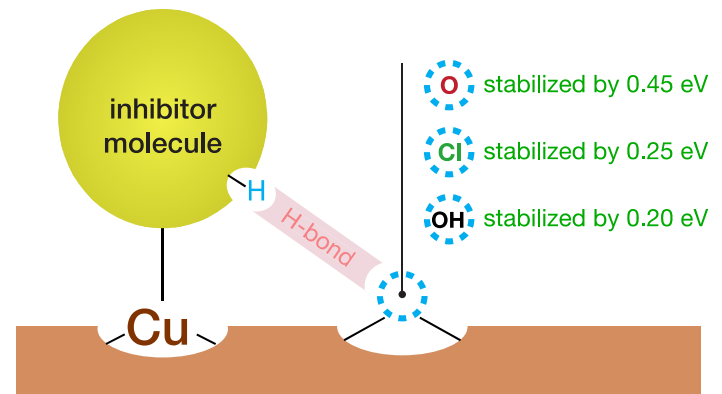
# How are we doing it?



## Effect of inhibitor on other species

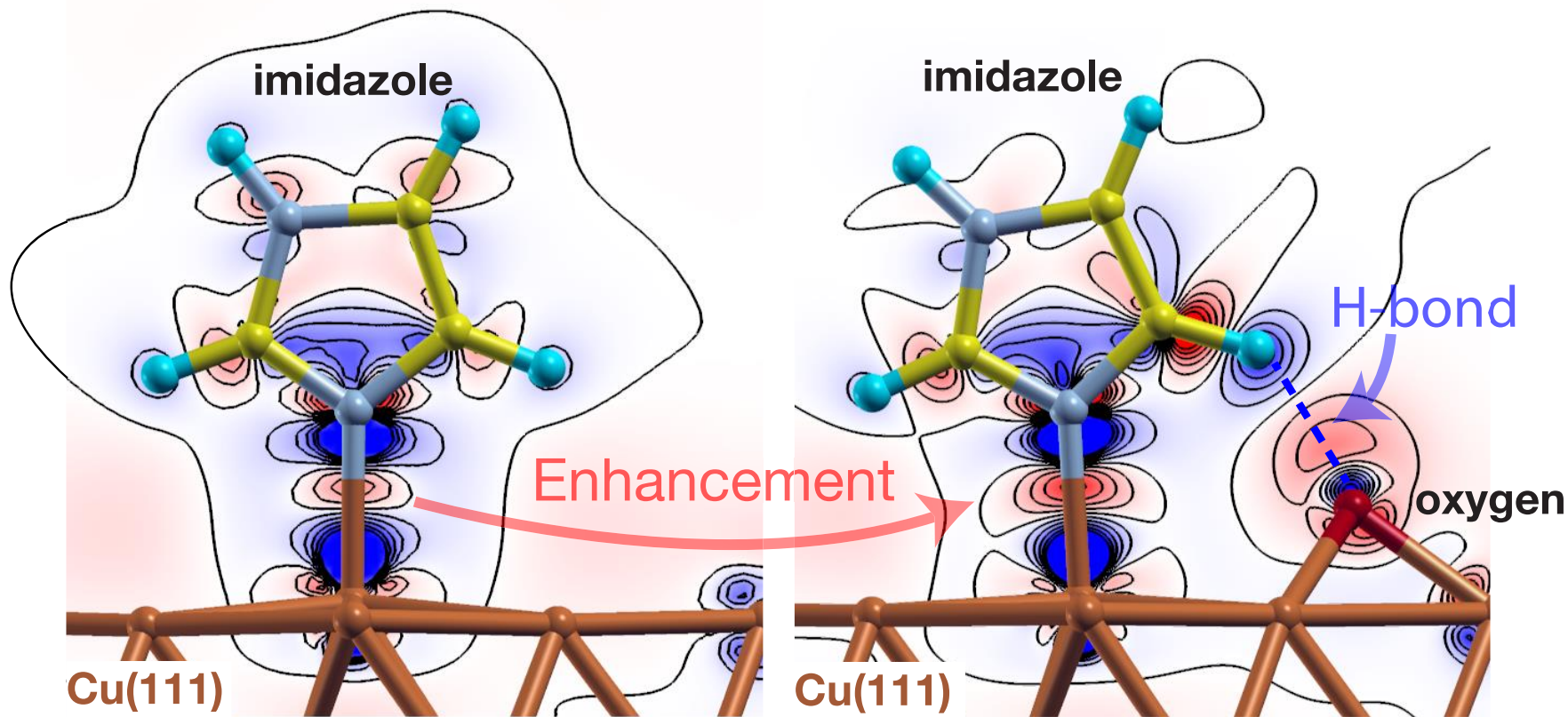


## Effect ... when H-bond forms



## Enhanced stabilization

# What we discovered so far?



Charge density difference

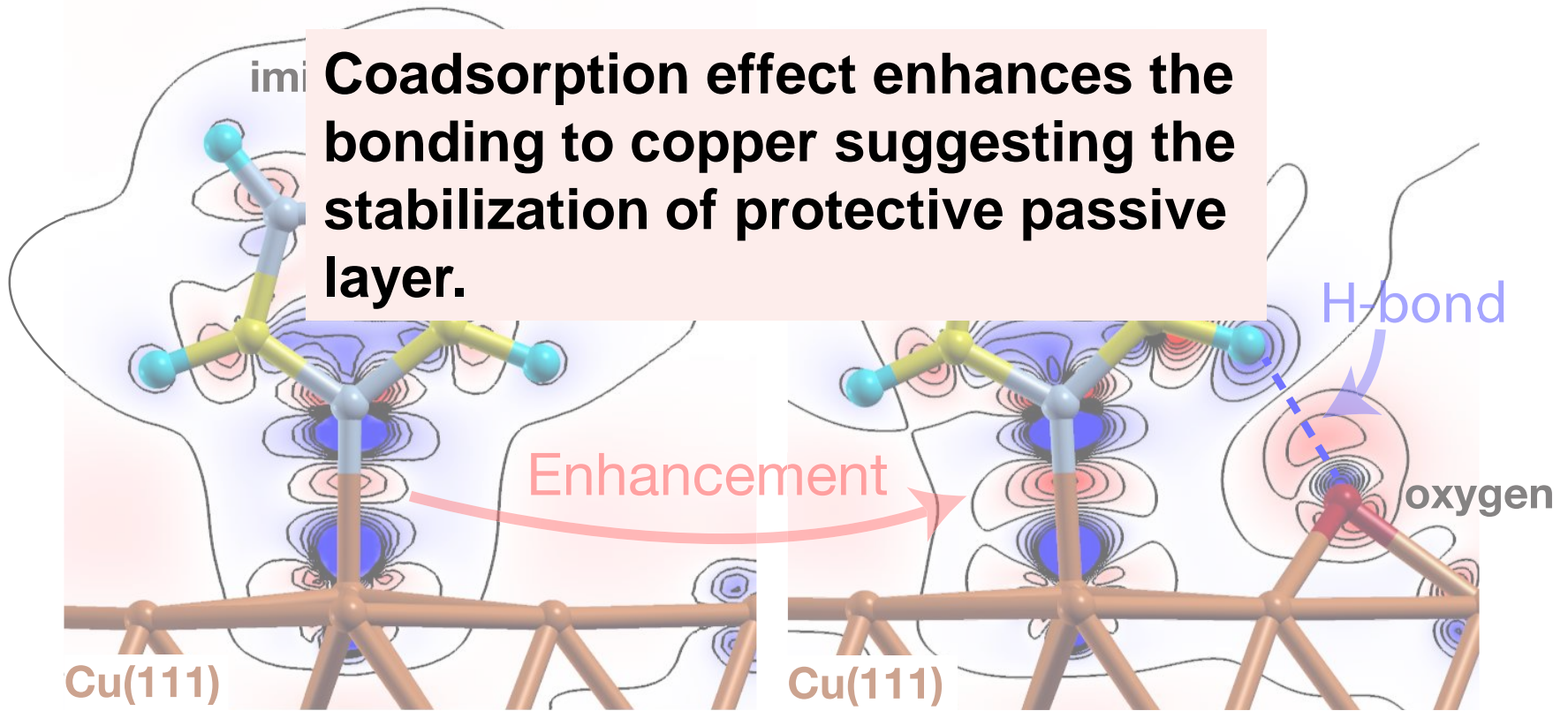
■ electron excess

■ electron deficit



# What we discovered so far?

**Coadsorption effect enhances the bonding to copper suggesting the stabilization of protective passive layer.**



Charge density difference

■ electron excess

■ electron deficit

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## Virus inactivation in water by plasma

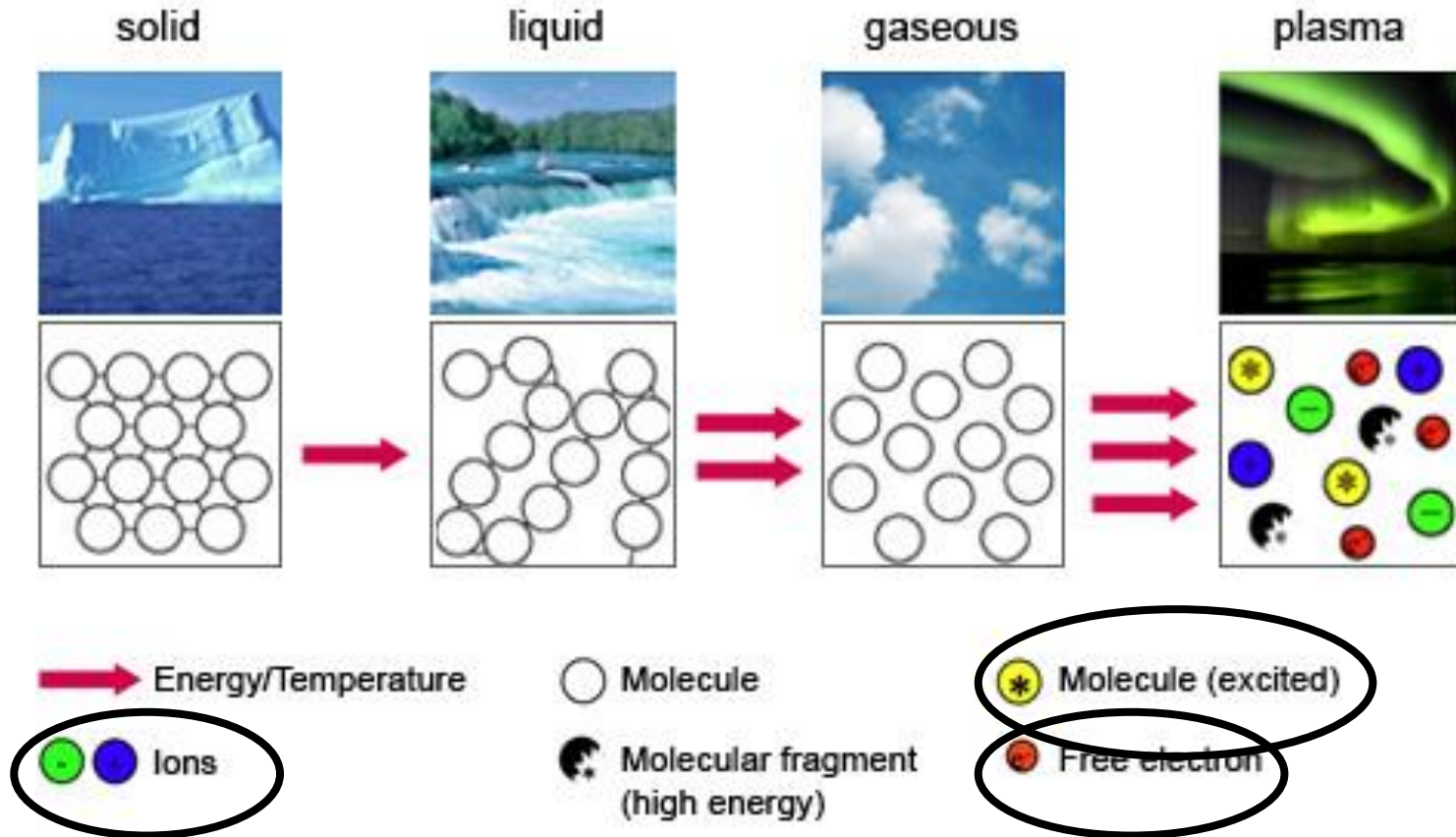
Arijana Filipić,  
National Institute of Biology

Poster number: **9**

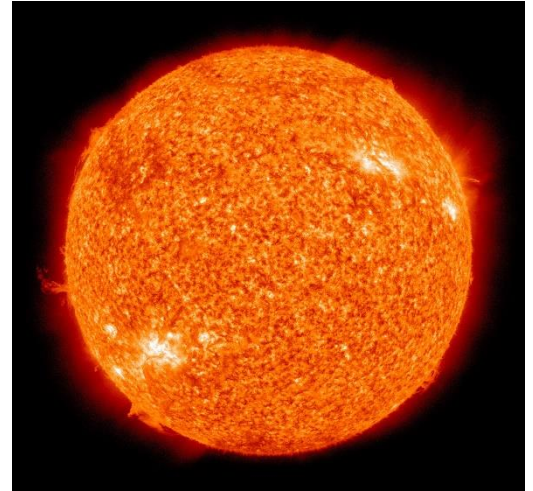




# Plasma





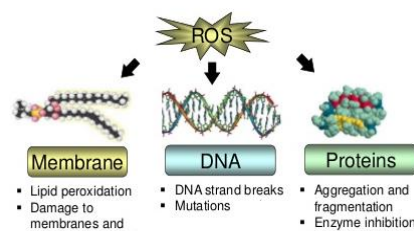
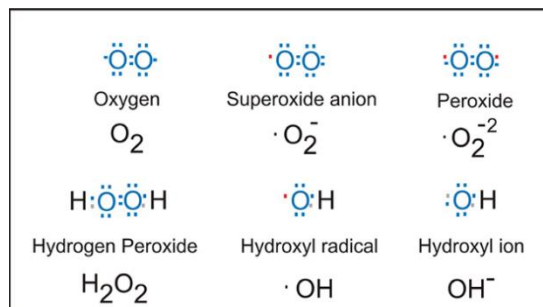
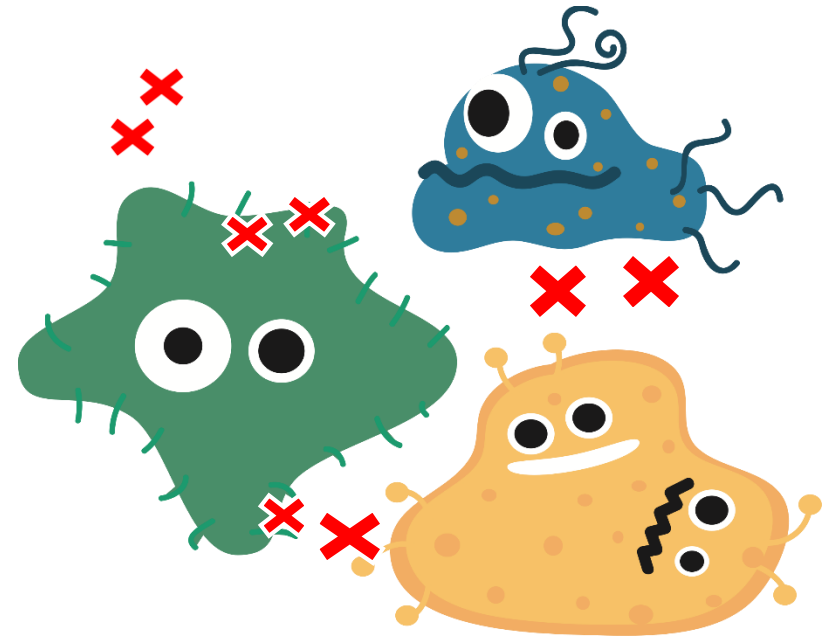
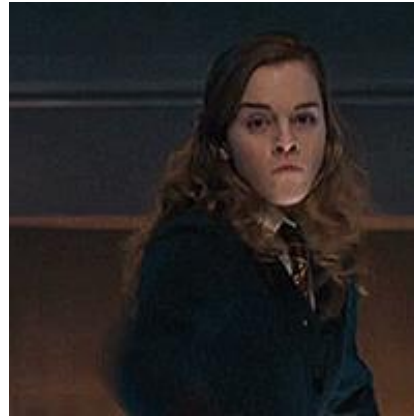


# Organic material

Charged particles

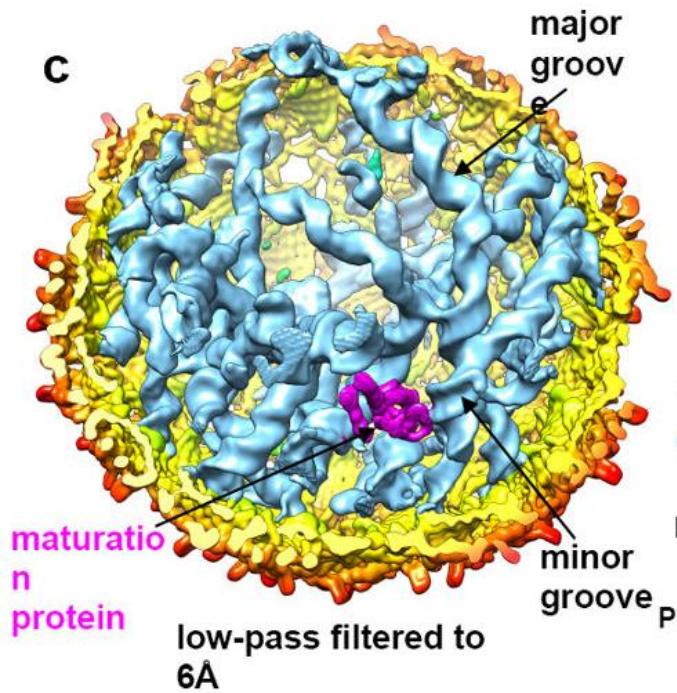
UV radiation

Reactive species



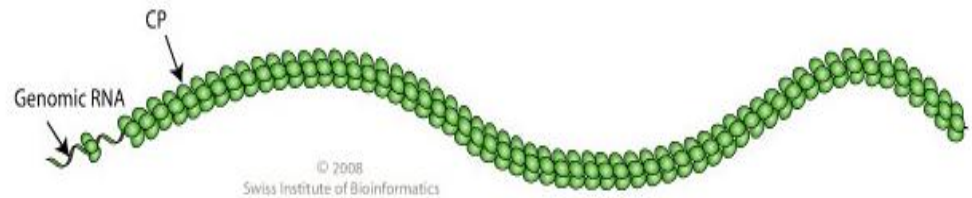
Andrea José Fuentes Bisbal,  
2013 (<https://www.slideshare.net/AndrealosFuentesBisbal/oxidative-stress-2014>)

# MS2 bacteriophage



Dai et al., Nature. 2017; 541(7635): 112–116.

# Potato virus Y



**THANK YOU**

**FOR YOUR ATTENTION**



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## Towards a mechanically compliant exoskeleton

**Miha Dežman,**

Dep. for Automatics, Biocybernetics and  
Robotics, Jožef Stefan Institute

Poster number: **4**



## Fiction



No matter how bad  
**It works**

## Reality



No matter how good  
**It quickly fails**



# Mechanical error buffer



# Mechanical error buffer

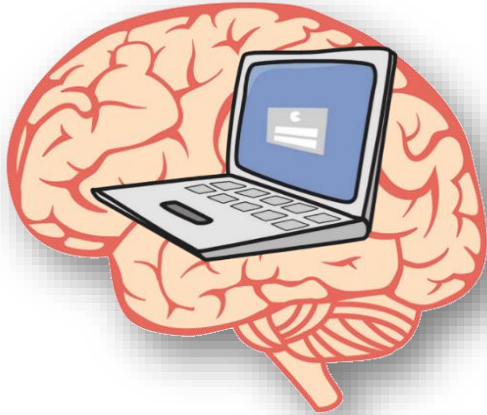


Bad suspension

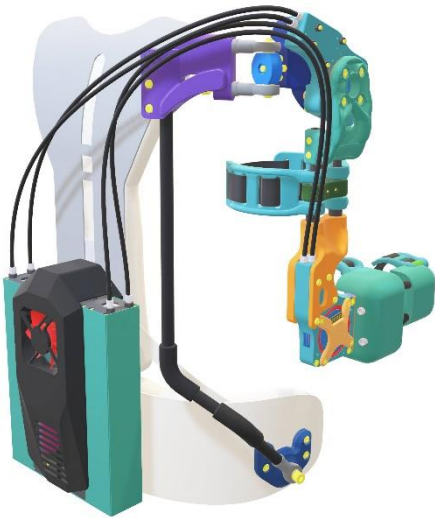


Good suspension

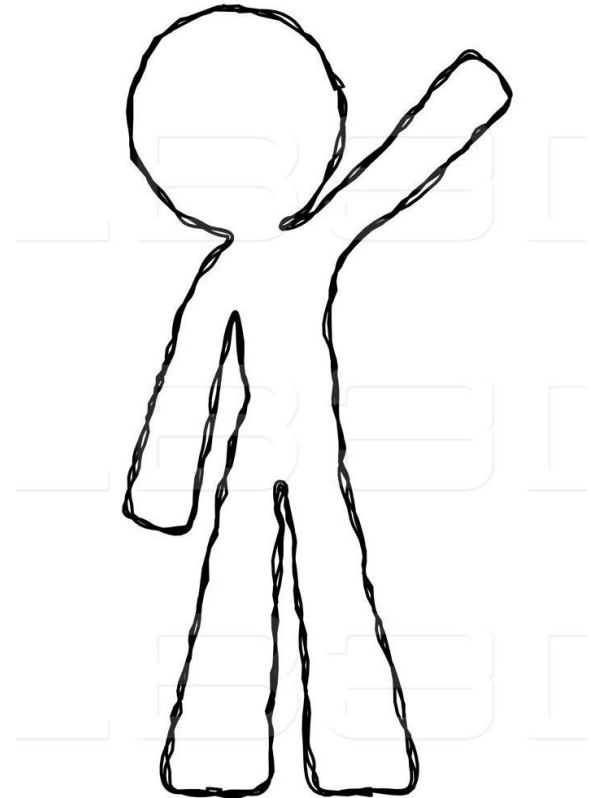
# Exoskeleton control problem



**My controller**

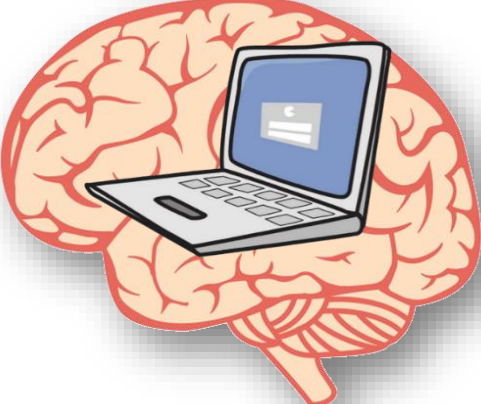


**My exoskeleton**

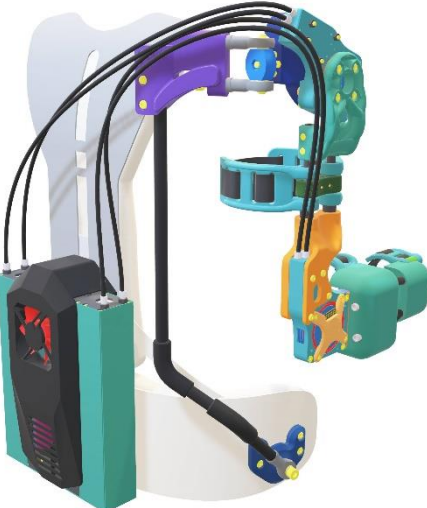


**Human = Car**

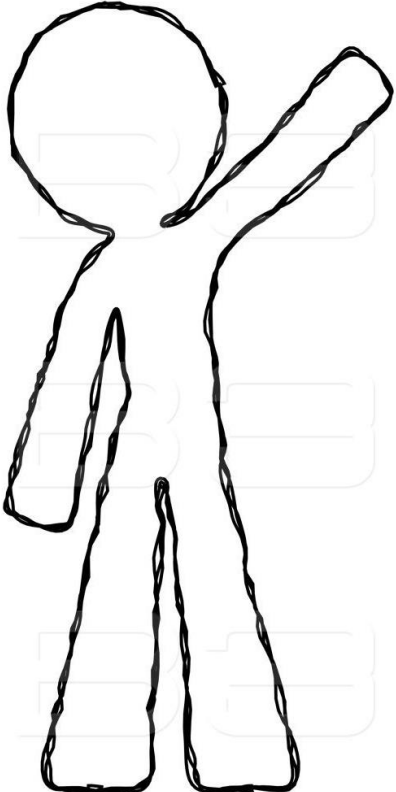
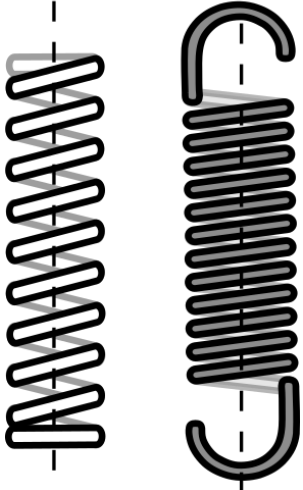
# Exoskeleton control problem



My controller



My exoskeleton

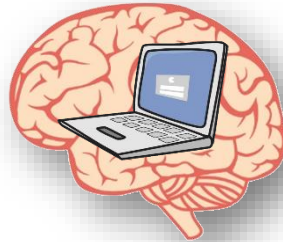


Human = Car

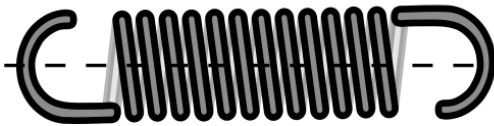
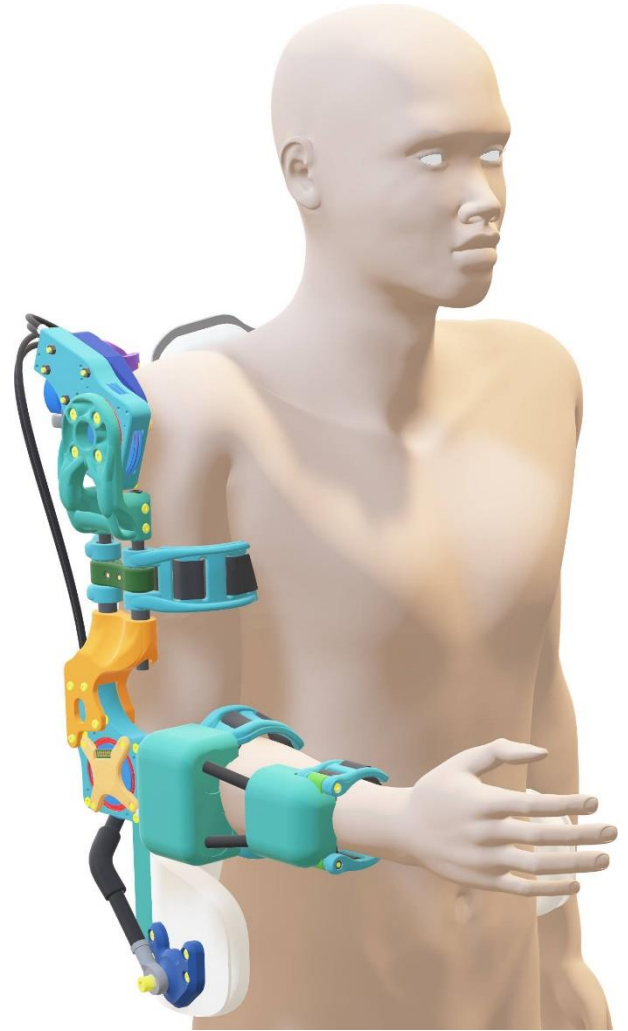
# Exoskeleton control problem



+



=





# What do have?

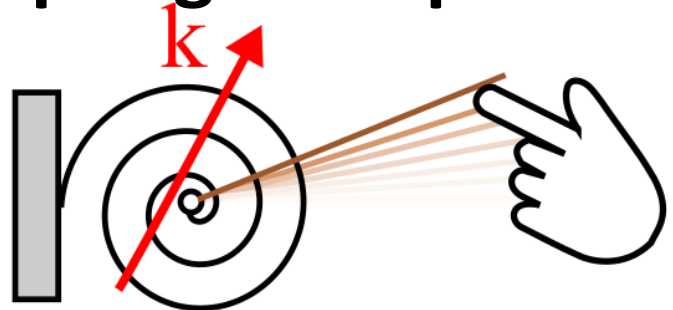
## Clasical motor



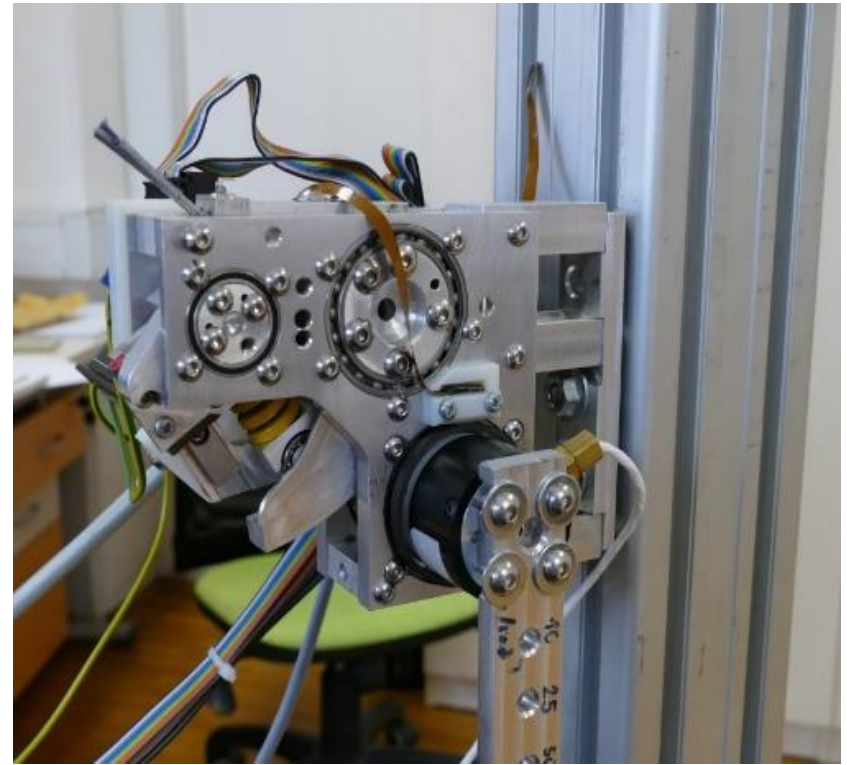
+

=

## Spring – adaptable



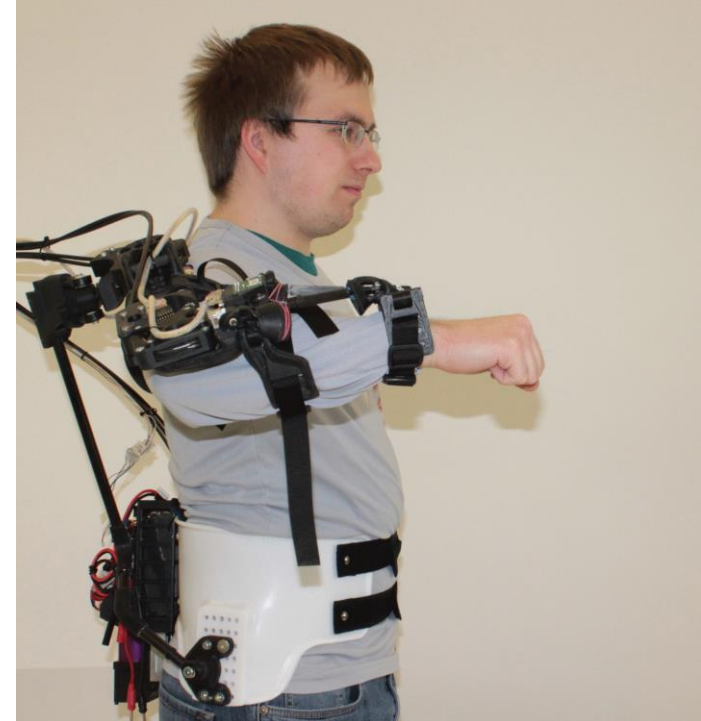
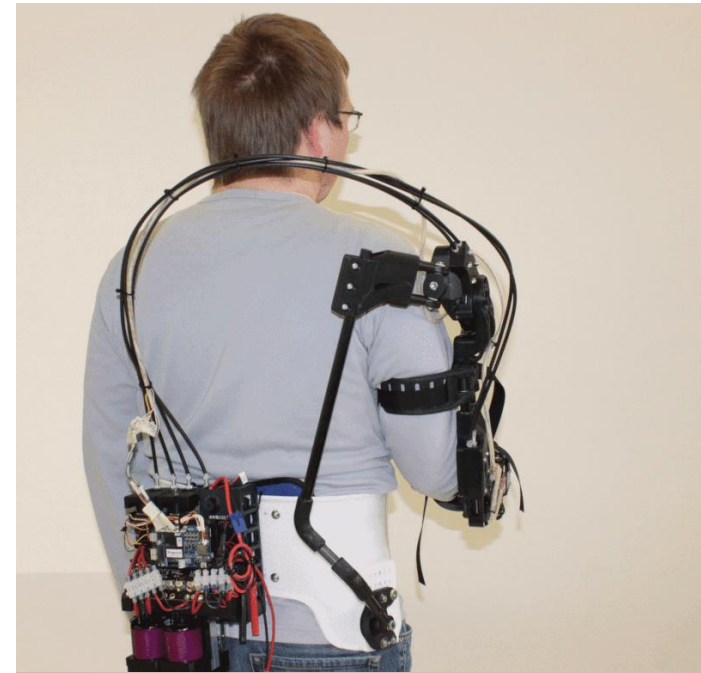
## Variable stiffness actuator



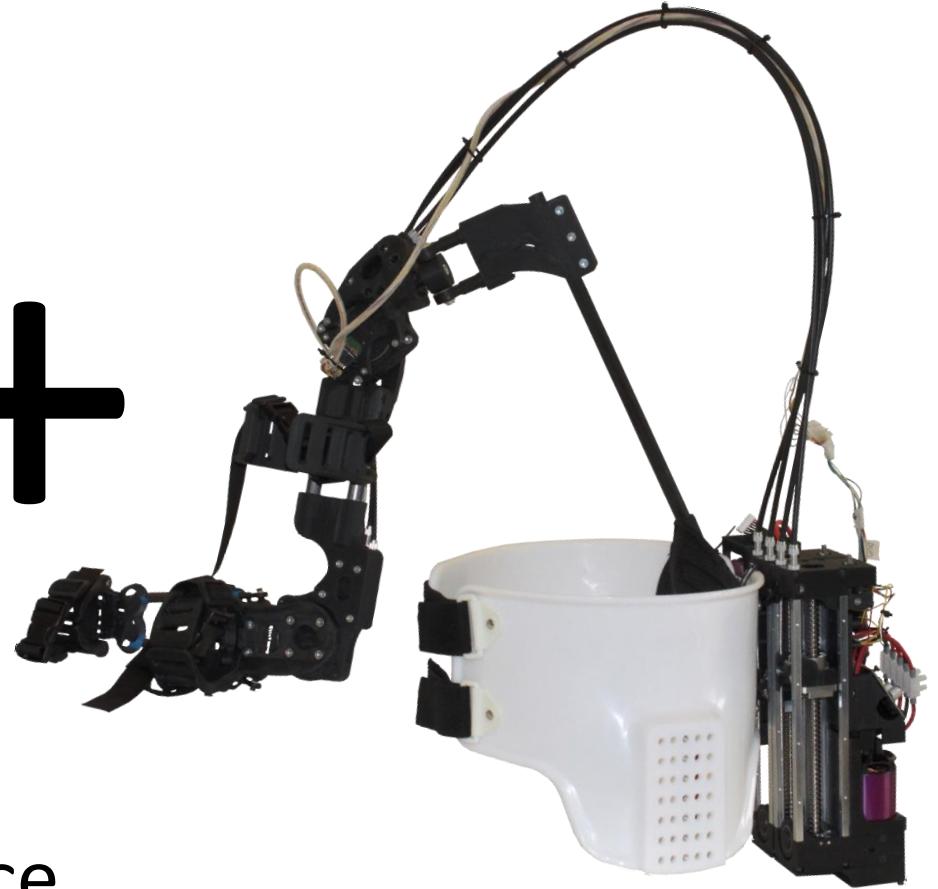
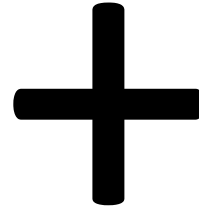
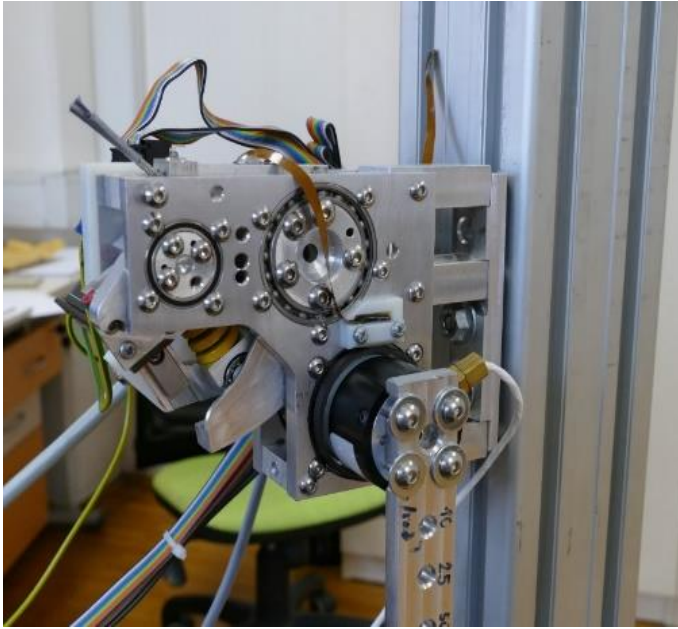


# What do have?

## Exoskeleton prototype



# Future work



- Reduce exoskeleton price
- Ease high-level control design
- Increase performance



Join me at  
poster 4

IPSSC +  
CMBO

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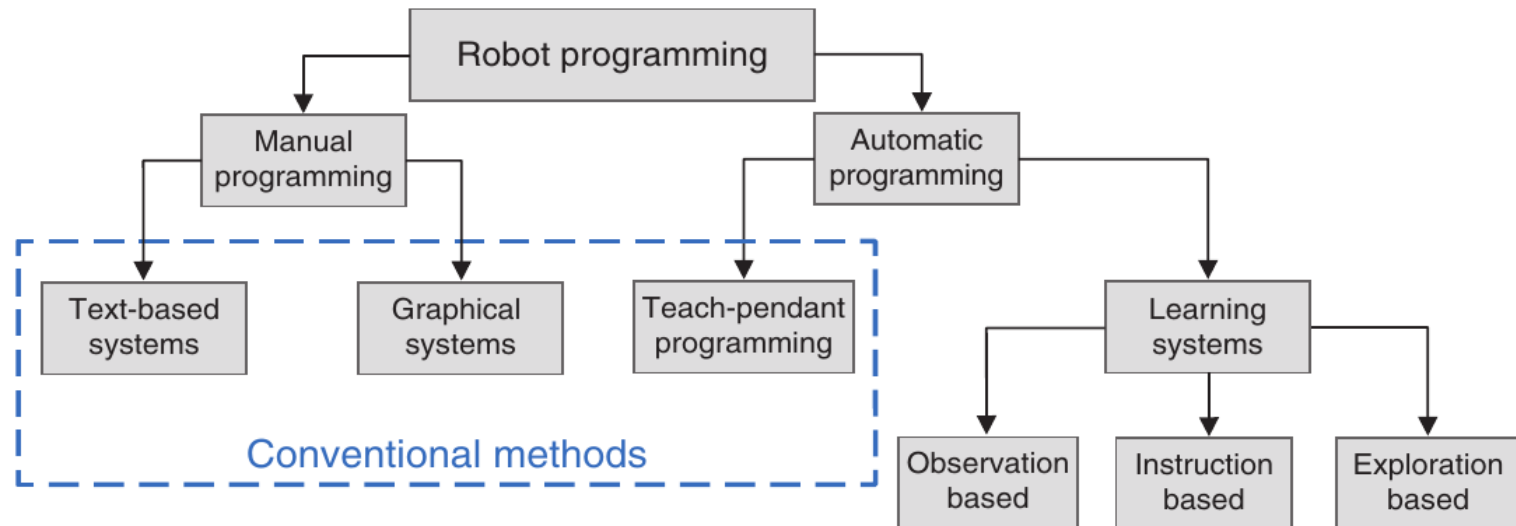
## Autonomous Learning of Assembly by Disassembly: (Un)screwing a lightbulb

Mihael Simonič,

Humanoid and cognitive robotics laboratory, IJS

Poster number: 14

# Manual programming vs. human-like learning



How do children learn? How do small children try to assemble, e.g. lego blocks?

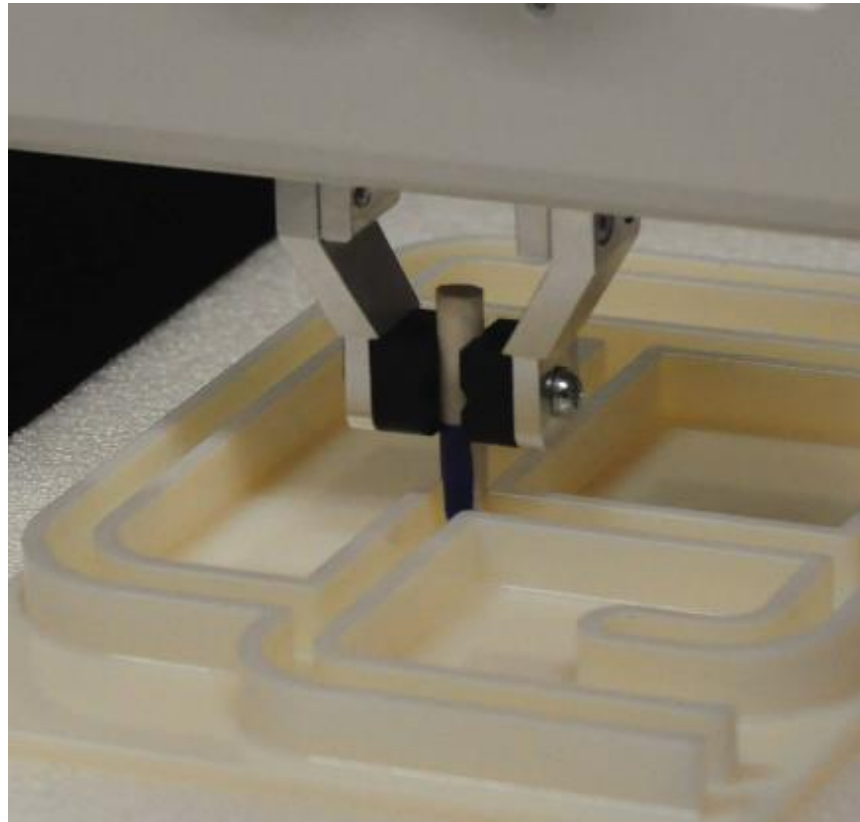
# Compliant robot reacts to force by utilizing force sensor data



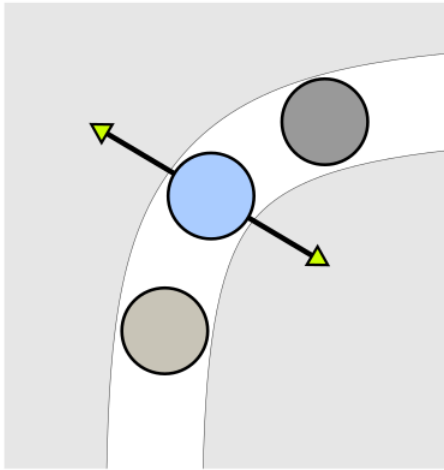
Is it easier to move in constrained or unconstrained environment?



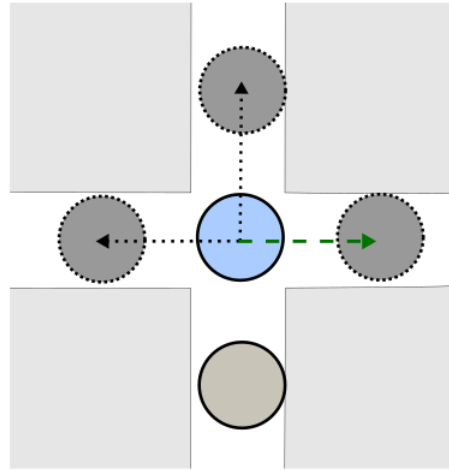
A compliant robot will follow the environmental constraints



# Intelligent compliant control

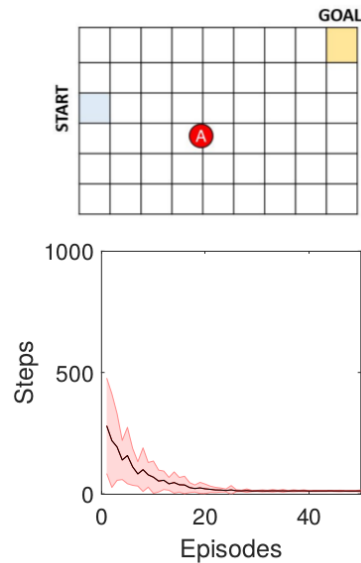


Following through the corridor  
and searching for possible crossways

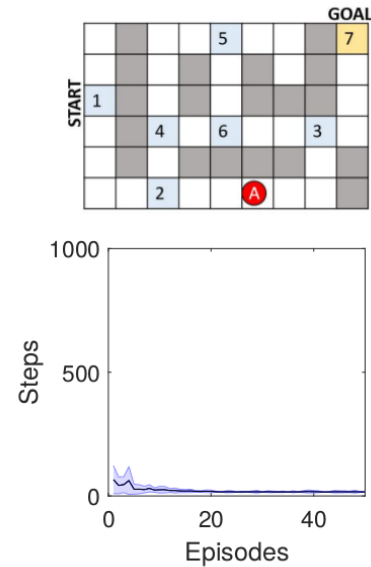


Robot discovers a crossway

# Maze solving with reinforcement learning



Unconstrained environment and learning statistics (number of steps to come from start to goal point)



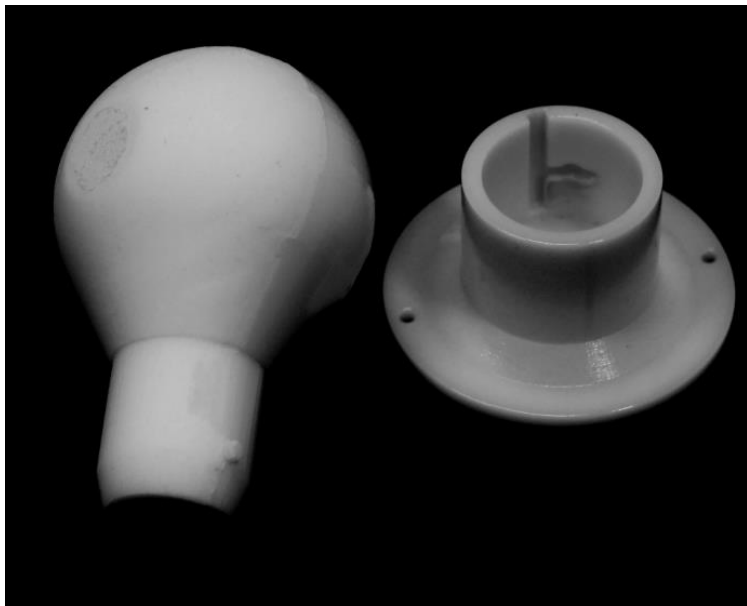
Constrained environment and learning statistics (number of steps to solve the labyrinth)

# Robot can autonomously learn how to exit a maze

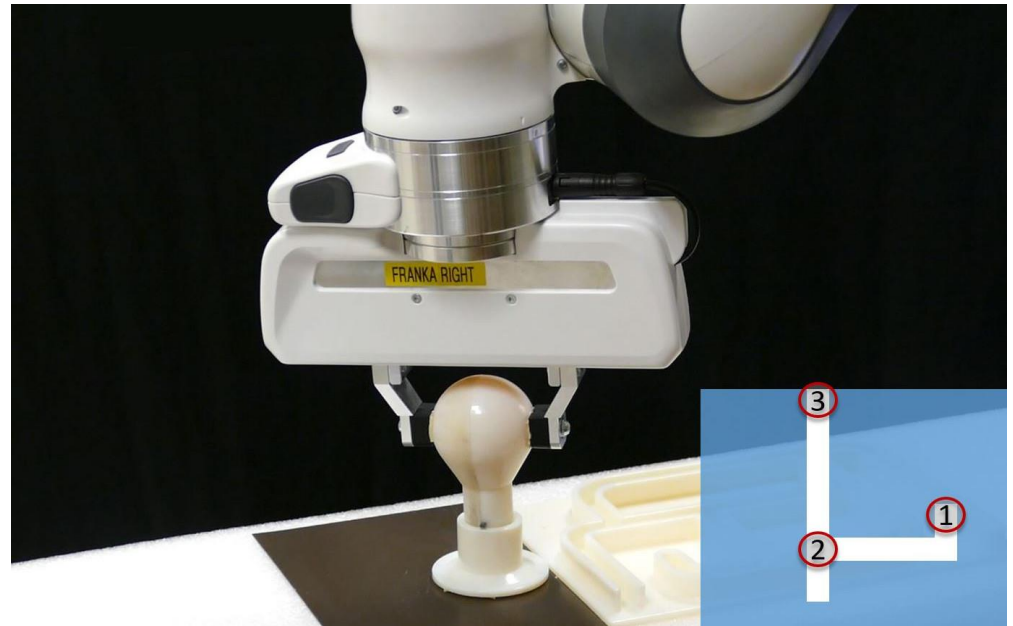


How to represent assembly and disassembly operations?

# Learning of disassembly is similar to the maze learning



Bulb and the casing



Trying to remove bulb from the casing can be represented as exiting the maze



# Assembly is in the most cases just reverse execution of disassembly



Is it easier to assemble or disassemble?

**Thanks for your attention!**

**You are welcome to ask questions at  
poster 14**

IPSSC +  
CMBO

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*15 and 16 April 2019, Planica*

## “Cutting the entropy crisis” using environmental friendly corrosion inhibitors on aluminum substrates

Dževad Kozlica,

*<sup>1</sup>Jožef Stefan Institute, Department of Physical and Organic Chemistry, Jamova c. 39, 1000 Ljubljana*

*<sup>2</sup>Jožef Stefan International Postgraduate School, Jamova c. 39, 1000 Ljubljana*

Poster number: **59**



The

ENER

大寒

能源危機

PUMPS  
CLOSED

TRA  
PRESS

CRISIS  
CUT  
TION 9%

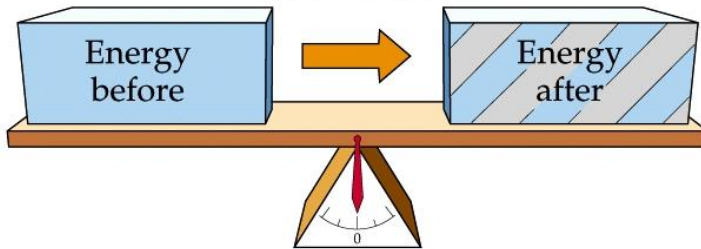
OBAMA SEEKS TO  
CALM JITTERY NATION



# Energy vs. Entropy

## The First Law of Thermodynamics

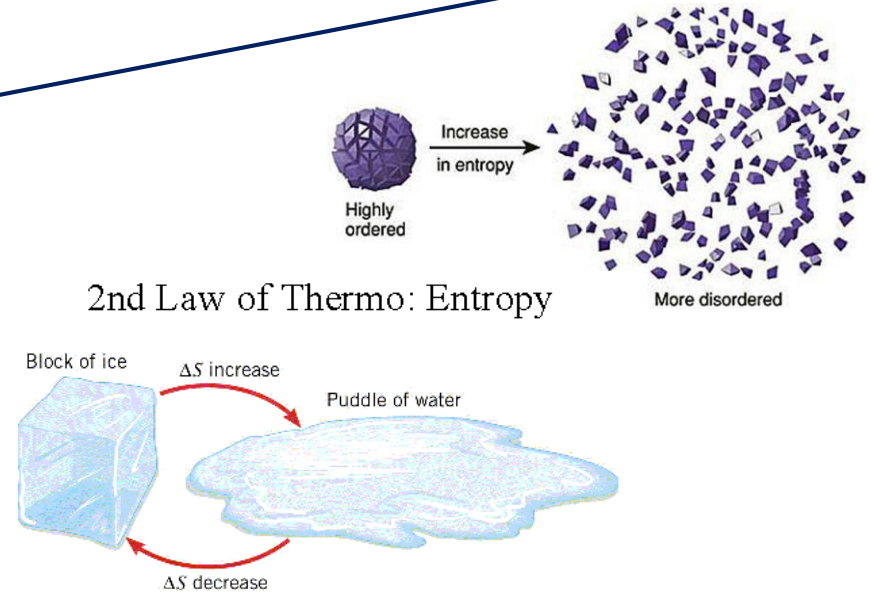
Energy transformation



Energy cannot be created nor destroyed!

Energy is always conserved!

## 2nd Law of Thermo: Entropy



Entropy = dispersion (dissipation) of energy

Low energy quality!

Entropy of the Universe always increases!

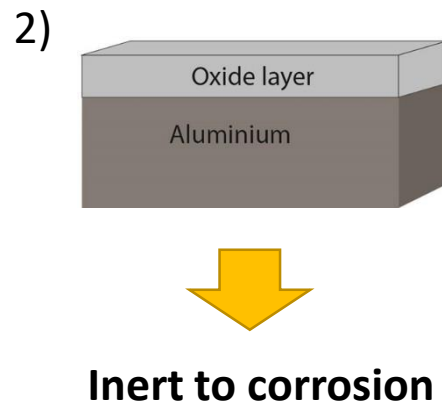
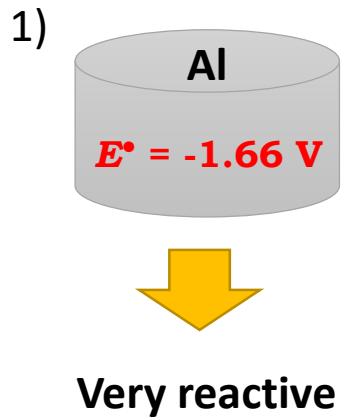
We are moving towards

the  
**entropy**

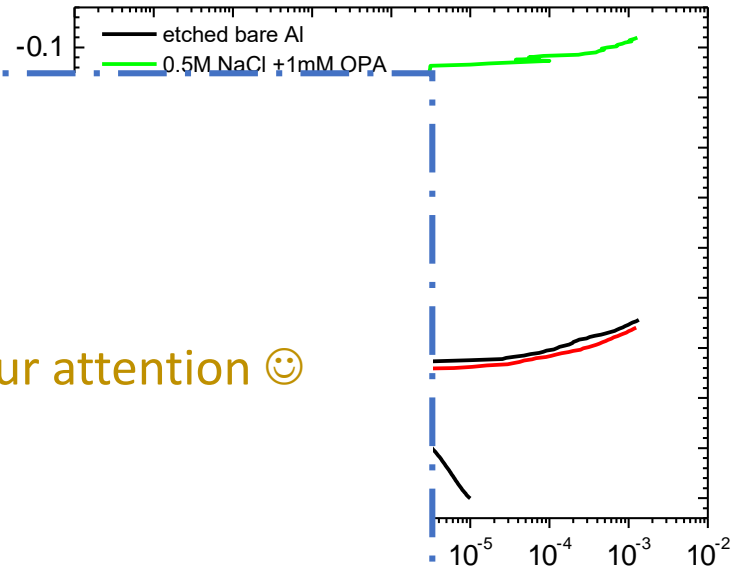
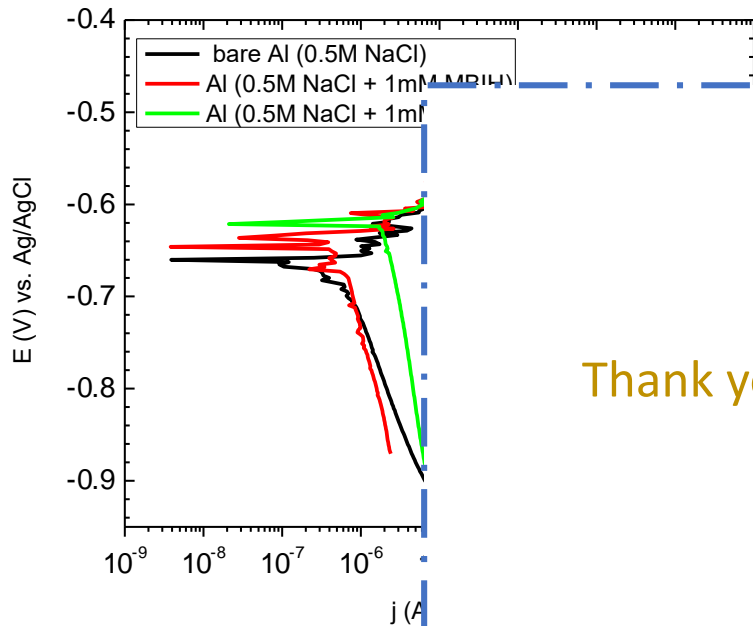
**Crisis**



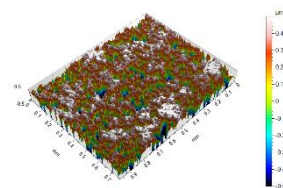
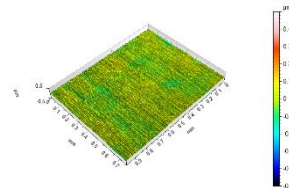
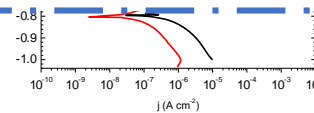
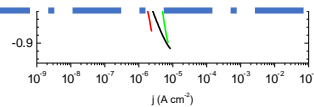
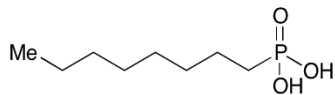
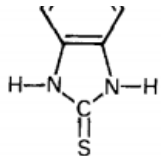
# Corrosion process



# Increasing the quality of life



Thank you for Your attention 😊



Poster No.

**59**

Entropy is directly proportional to the dispersion of money

IPSSC +  
CMBO

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*15 and 16 April 2019, Planica*

## Web API for DEX Decision Modeling

Adem Kikaj

Jožef Stefan International Postgraduate  
School

Poster number: **01**

# John Doe and the Car



IPSSC +  
CMBO

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and Young Researchers' Day CMBO

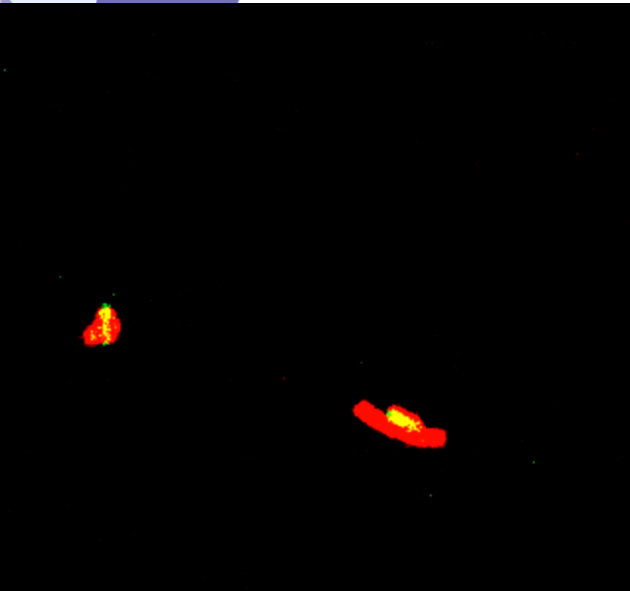
*15 and 16 April 2019, Planica*

## UNITED TINY FACTORIES AS THE FUTURE FOR NEW METABOLIC PATHWAYS

Iaroslav Rybkin

1. Jozef Stefan Institute, Department of Environmental Sciences, Slovenia
2. Jozef Stefan Institute, International Postgraduate School, Ljubljana, Slovenia
3. Saratov State University, Remote Controlled Theranostic Systems Lab, Russian Federation

Poster number: **20**





# Current challenges

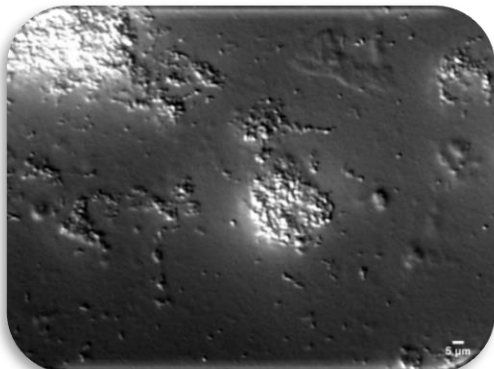
Invasive plants



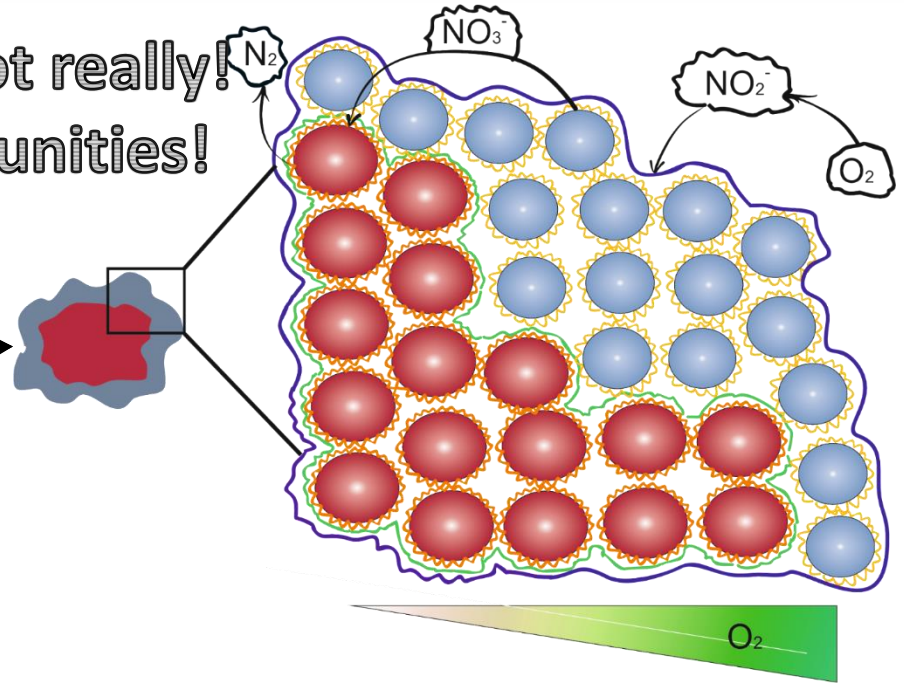
Salt pollution



Use of bacteria



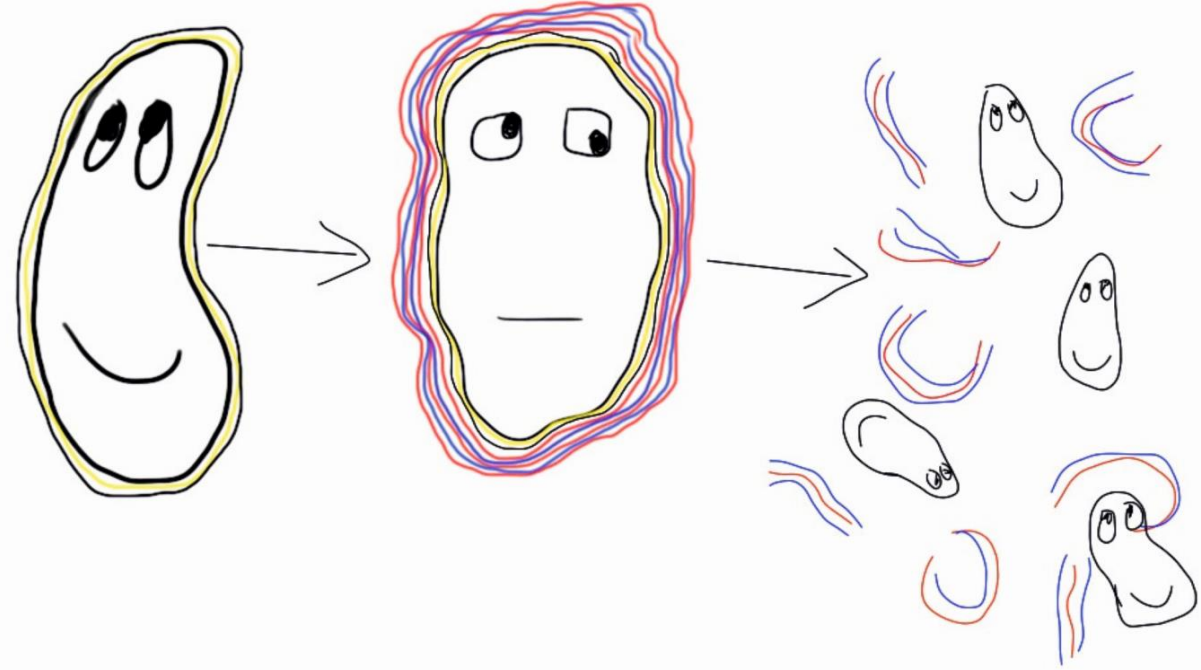
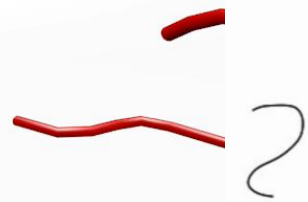
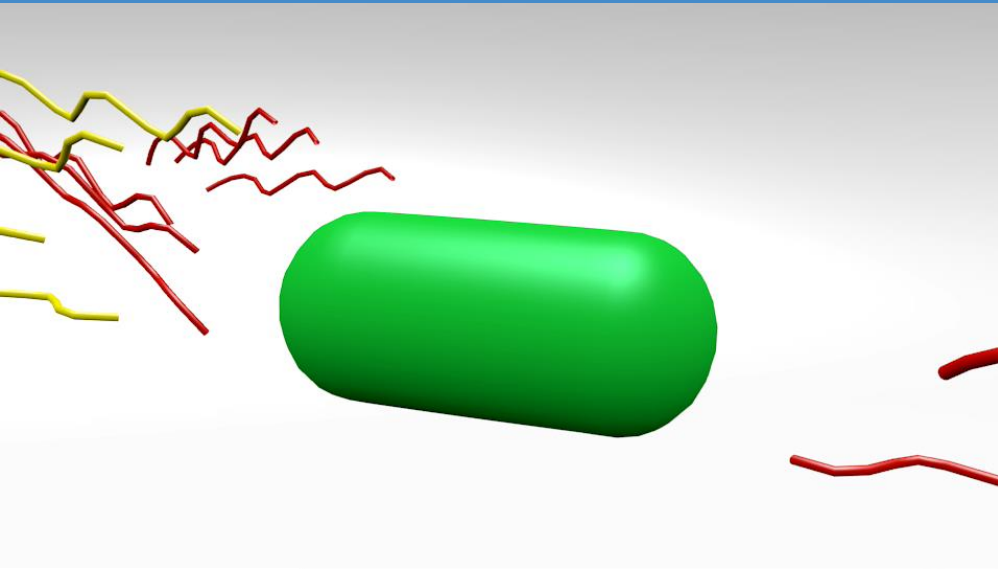
-Problems? -Not really!  
Rather opportunities!



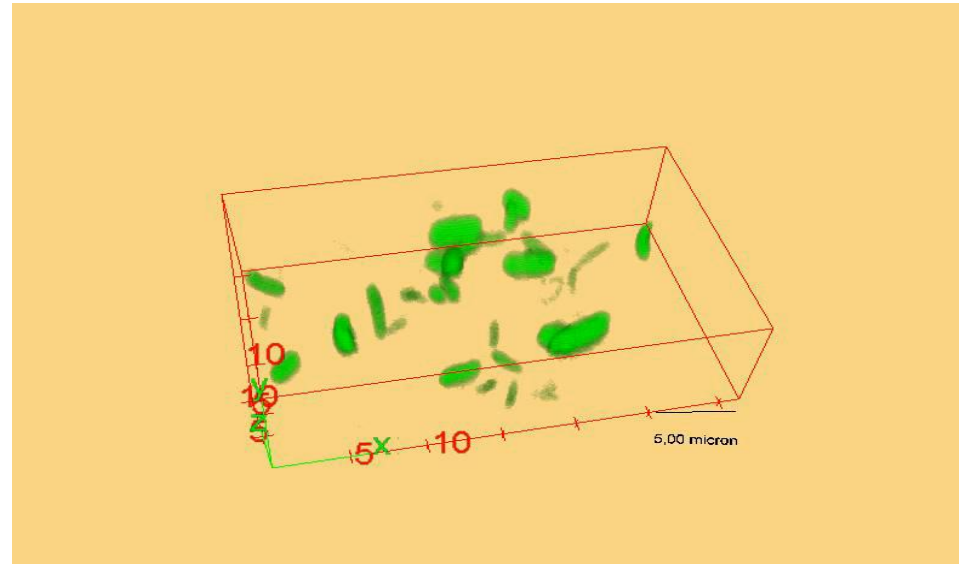
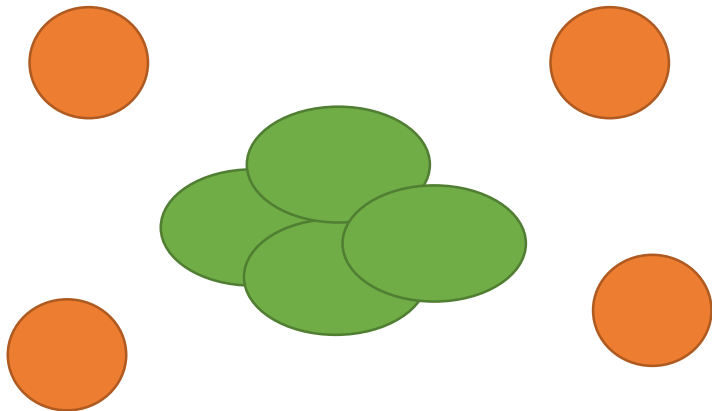
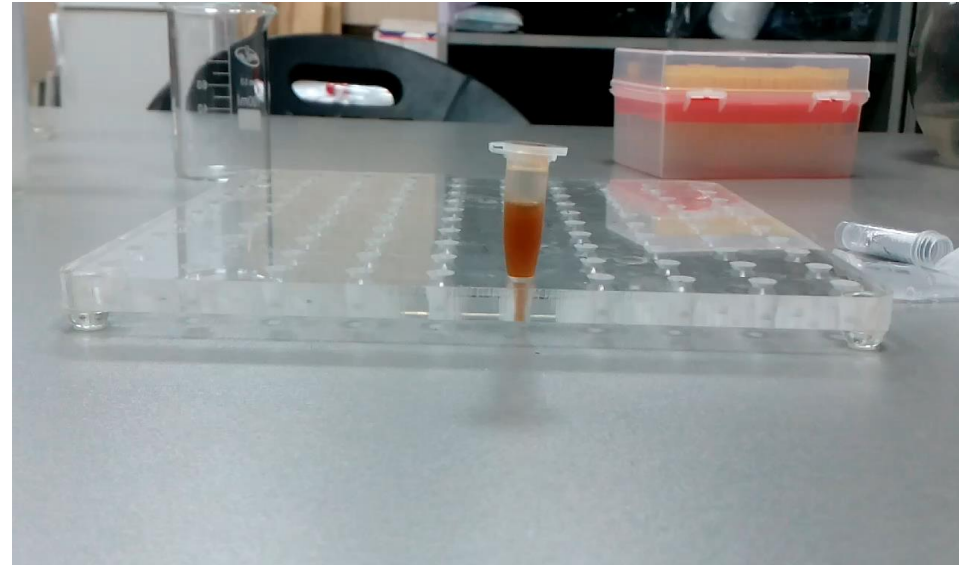
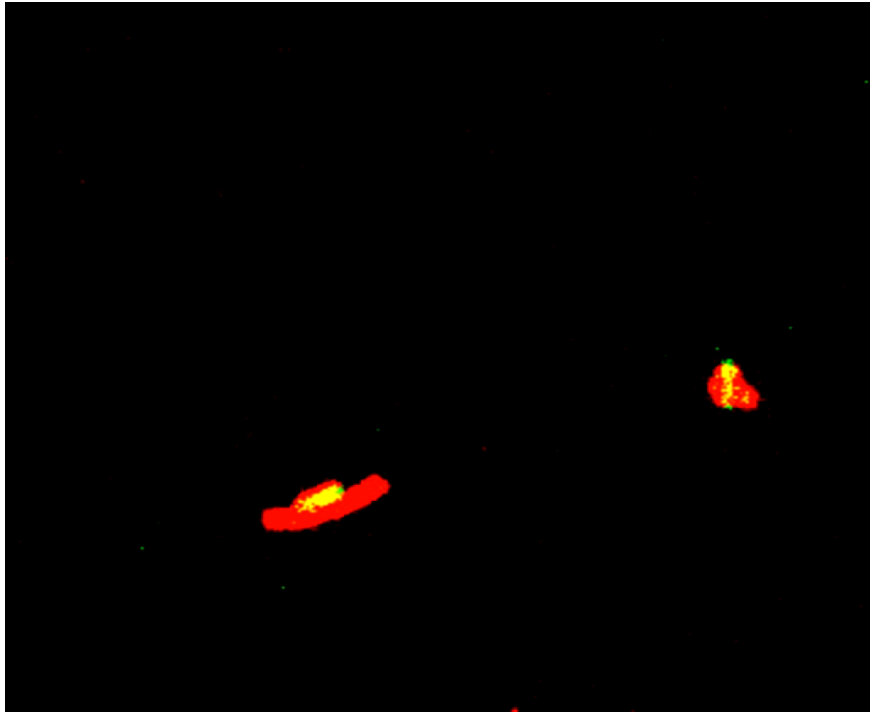
For obtaining  
new valuable  
products!

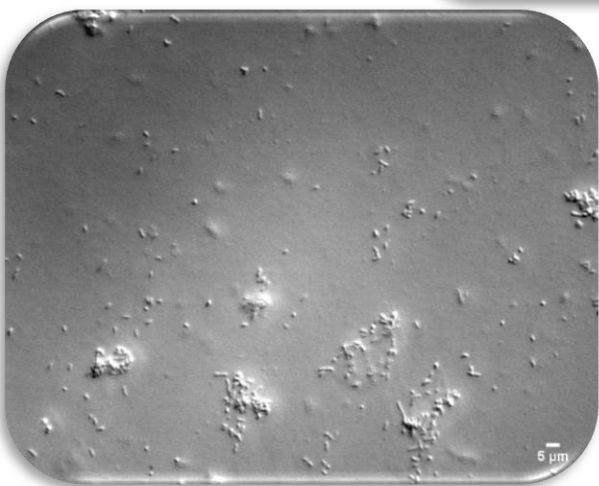
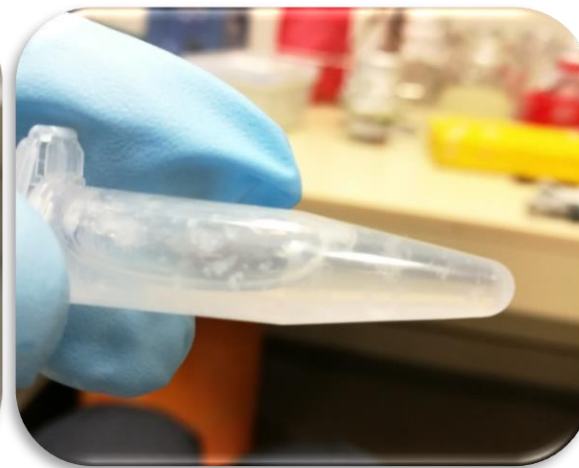
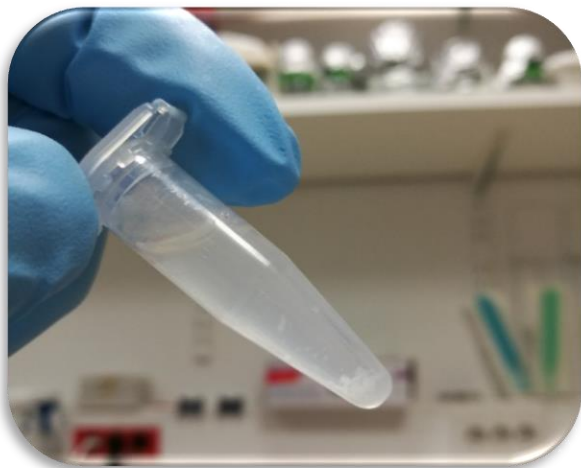


# How does it work?



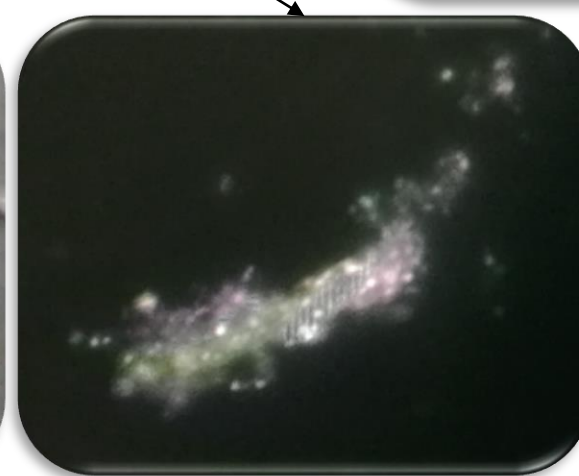
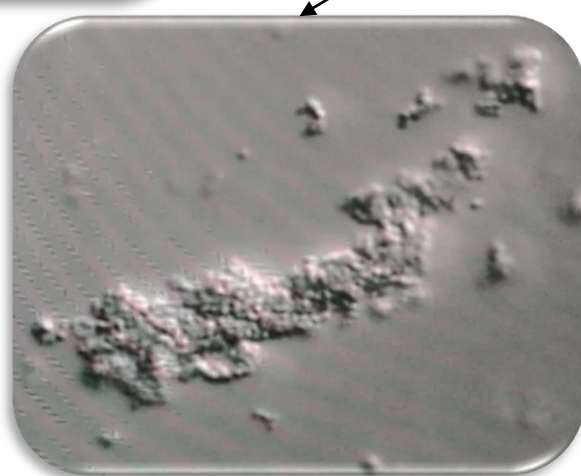
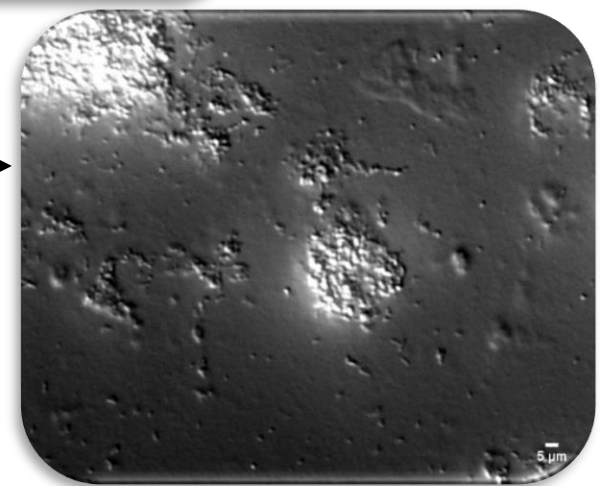
# Proof of concept





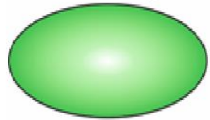
← **Single-type aggregates** →

**Interspecies aggregates**



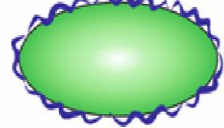


E.coli Top 10



+

Pei-Cy7

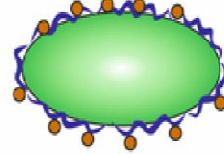


+

Fe<sub>3</sub>O<sub>4</sub>



E.coli with magnetite



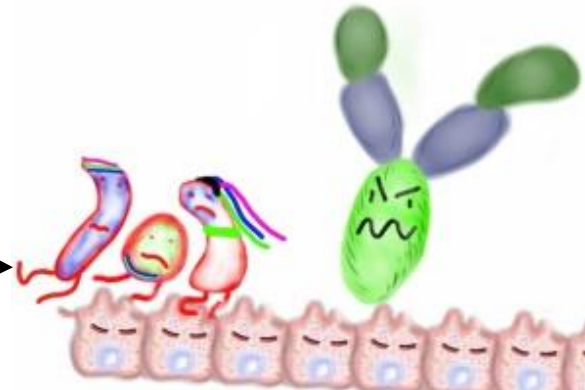
→



↑



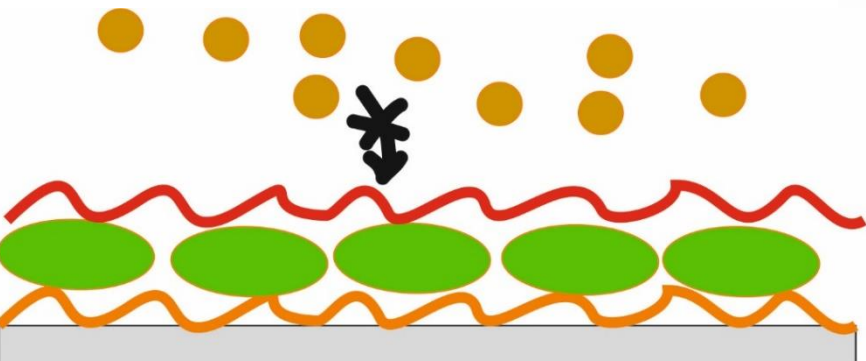
→



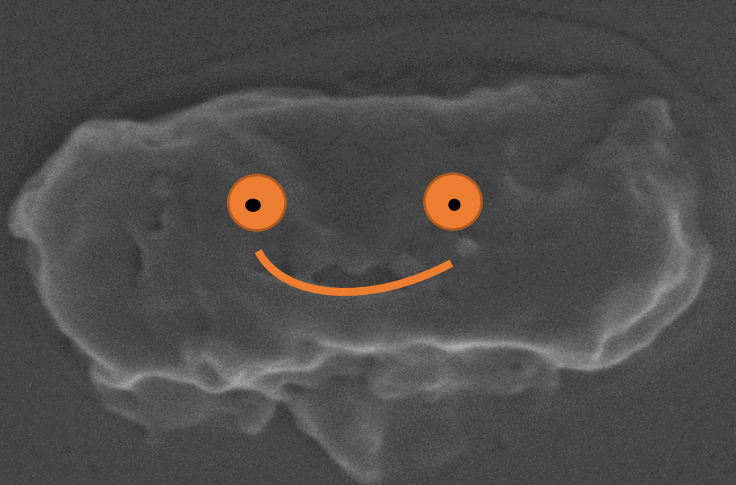
↘



↓



Thank You for  
Your kind attention!



X 40,000

2.00kV SEI

100nm IJS  
SEM

WD 4.3mm

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*15 and 16 April 2019, Planica*

## Can nanoparticles be tamed?

**Hermina Hudelja**

*Department for Nanostructured Materials, Jožef Stefan Institute, Jamova 39, 1000  
Ljubljana, Slovenia*

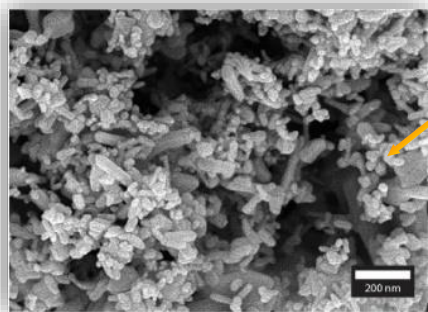
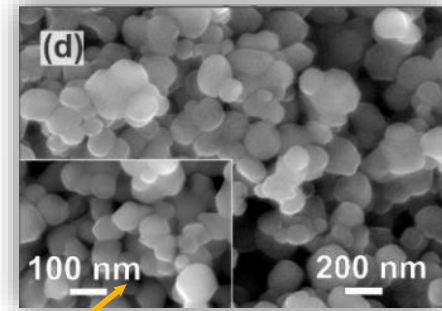
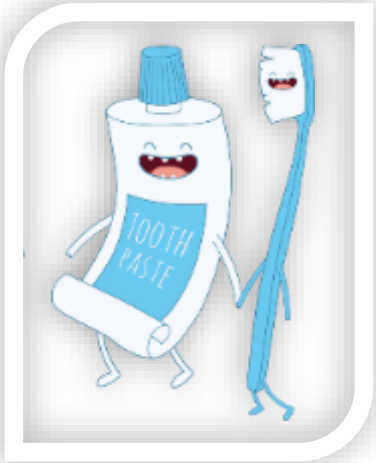
*Jožef Stefan International Postgraduate School, Jamova 39, 1000 Ljubljana, Slovenia*



**Poster number: 41**



# Nanoparticles in everyday life



# What are nanoparticles?



One dimension of  
a particle  
<100 nm.

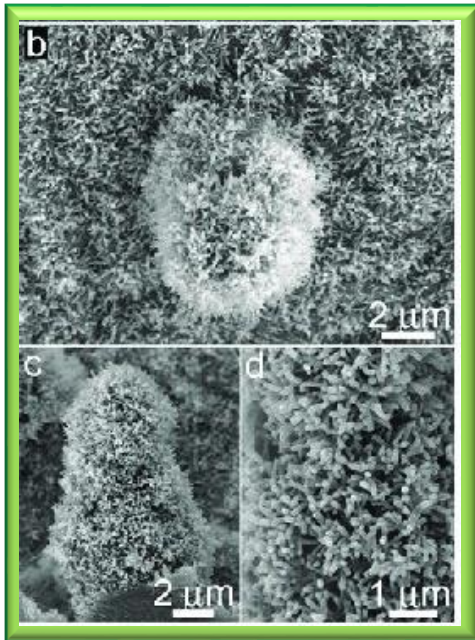
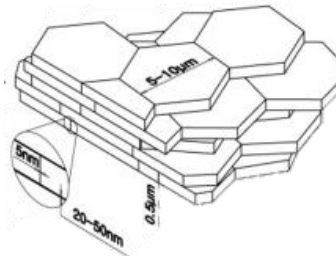
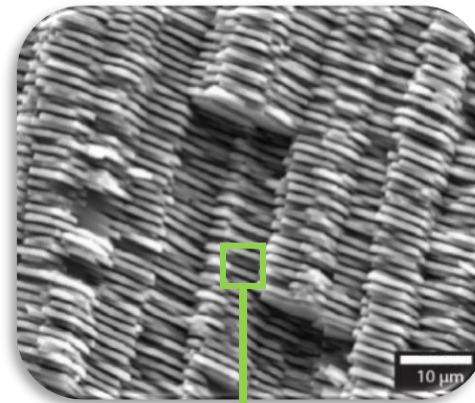
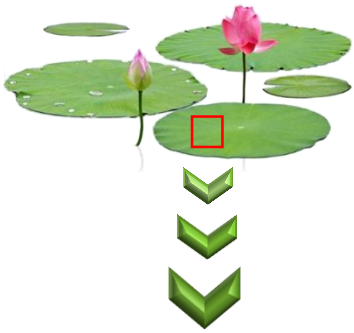
High surface-to-volume  
ratio.

Easily form clusters  
(aggregation)

Health and  
environmental hazards.



# Nano or micro? Or can we have both?



**IMAGINE  
THERE IS A MATERIAL ...**

★ *Easily prepared*

★ *Inexpensive*

★ *Mimics nature*

★ *Not hazardous*

**JACKPOT**

G.S. Watson et al., Appl. Mater. Interfaces, 2017, 24381–24392.

Z. Wang et al., Constr. Build. Mater., 2018, 851–858.

T.L. Tan et al., Optical Express, 2004, 4847

# Taming of nanoparticles → hydrolysis of AlN

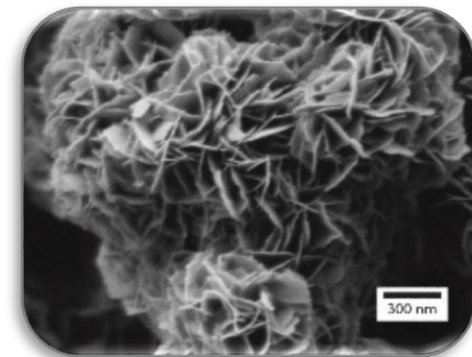
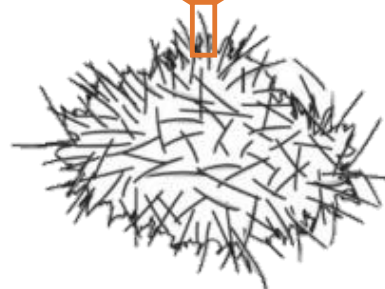
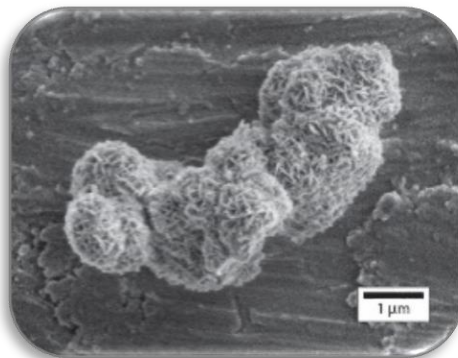
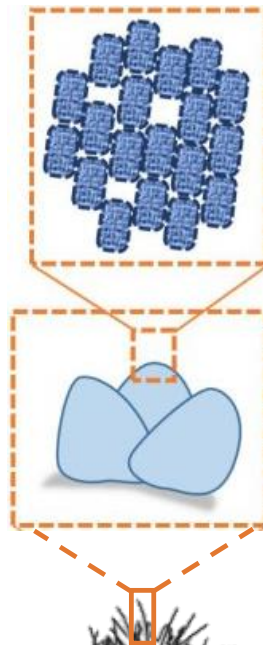


Simple method

Hierarchially assembled  
(nano→micro)

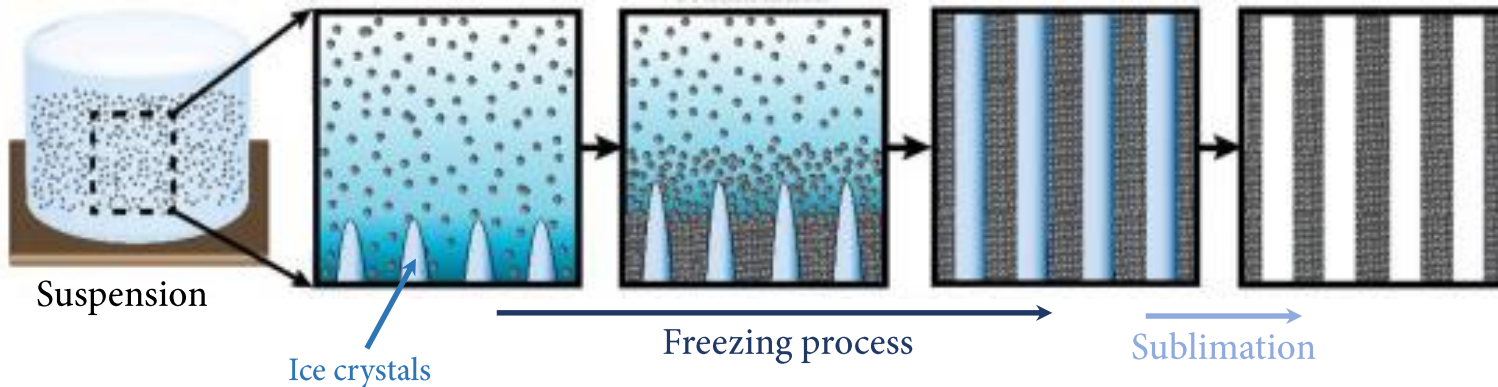
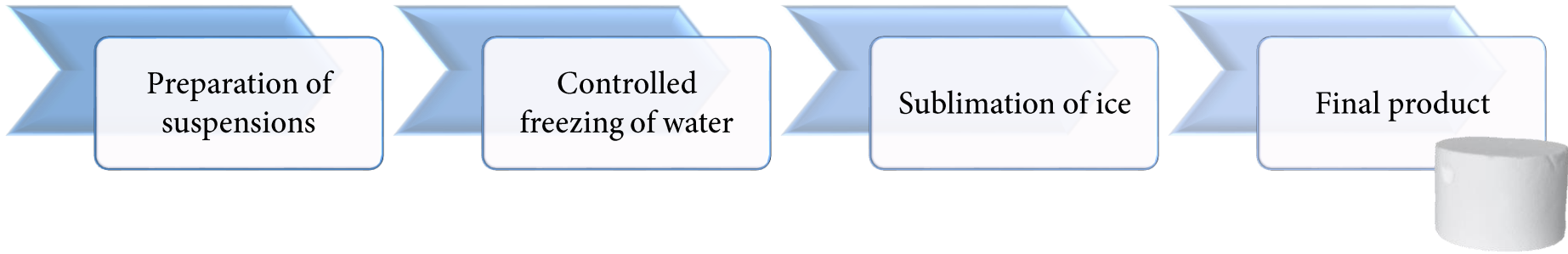
Naturally self-driven  
process

Preserved  
nanoproperties

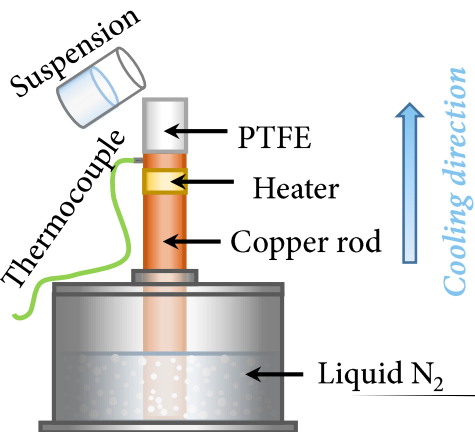




# "Winter is coming!"



K.L. Scotti et. al,  
 Prog. Mater. Sci. 94  
 (2018) 243–305.





# Feather-light and strong!



Applications

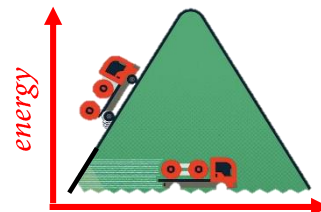
Thermal insulation



Fire retardancy

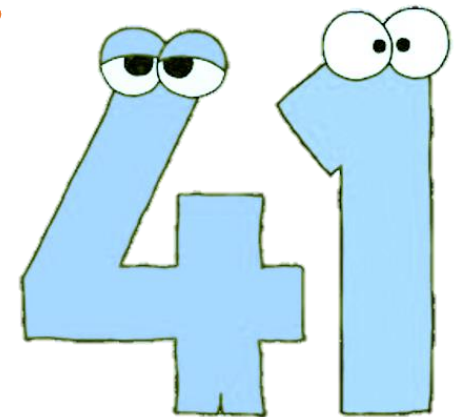


Catalysis





**For more information you can find  
me next to my poster!**



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## Dangerous seafood? Not anymore!

Timotej Turk Dermastia,  
National Institute of Biology, Marine Biology Station Piran  
Jožef Stefan International Postgraduate School

Poster number: **29**

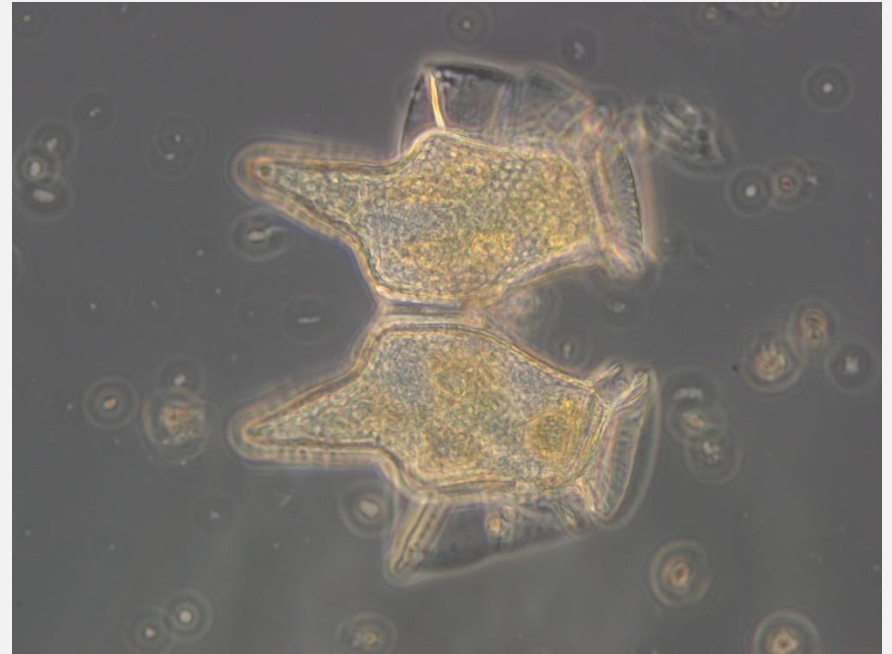


NACIONALNI INŠTITUT ZA BIOLOGIJO  
NATIONAL INSTITUTE OF BIOLOGY

MORSKA BIOLOŠKA POSTAJA PIRAN  
MARINE BIOLOGY STATION PIRAN



# HARMFUL ALGAL BLOOMS (HABs): What are they?



***Pseudo-nitzschia multistriata* and *Dinophysis caudata***

FOOD

# Dungeness crab season nears in California, but toxins pose a familiar threat

 Tara Duggan | Oct. 22, 2018 | Updated: Oct. 25, 2018 9:01 a.m.



OCEANS · Published 19 hours ago

## Florida's red tide blamed for lousy stone crab season

By Madeline Farber | Fox News



The prolonged red tide bloom in Florida is apparently impacting the stone crab population. (iStock)

The New York Times

## A Toxic Tide Is Killing Florida Wildlife



### Trending in Science



NASA looks to private co building reusable Moon for astronauts

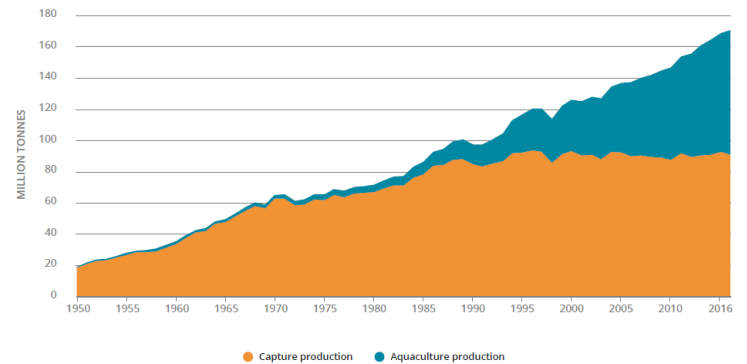


Meteor is cause of mystic SF Bay Area, observatory

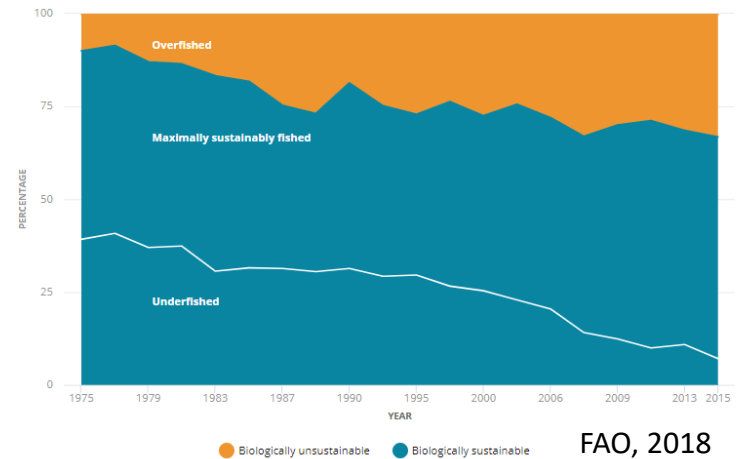


WATCH: Australian lizard

### World capture fisheries and aquaculture production



### Global trends in the state of the world's marine fish stocks, 1974-2015



FAO, 2018



FEATURED VIDEOS \ SCIENCE \ HEALTH \

# Who's to blame for the neurotoxin that's poisoning the Pacific?

*Why a Pacific coast fishing organization is suing 30 fossil fuel companies*

## LIVESCIENCE

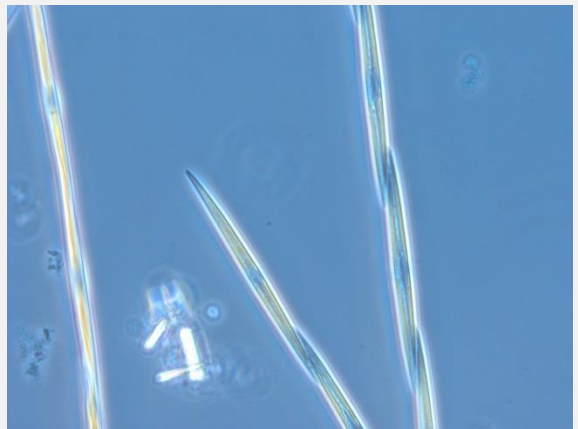
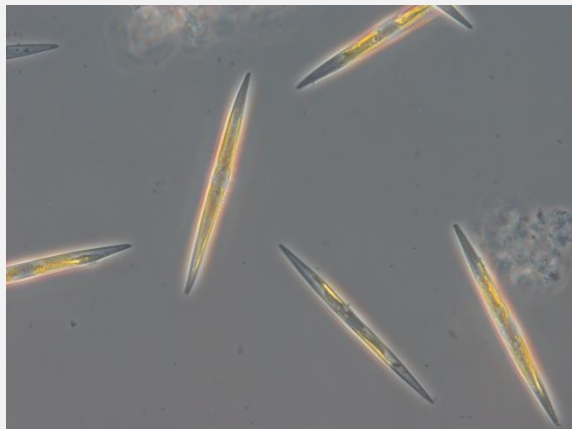
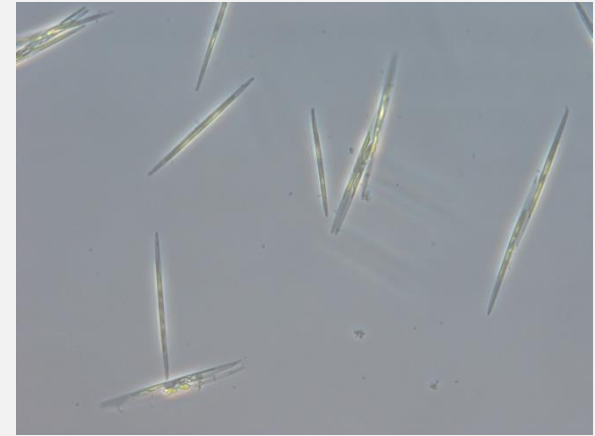
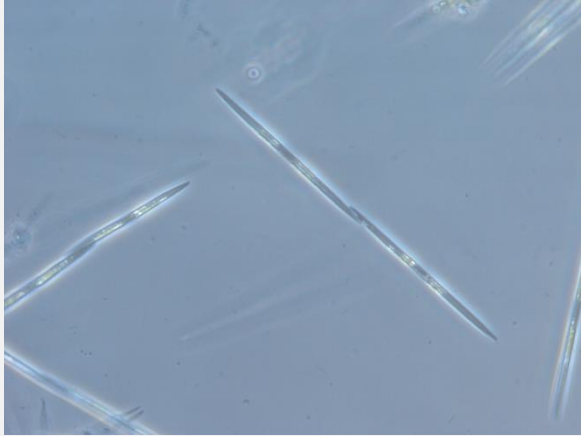
NEWS TECH HEALTH PLANET EARTH STRANGE M

[Live Science](#) > [Health](#)

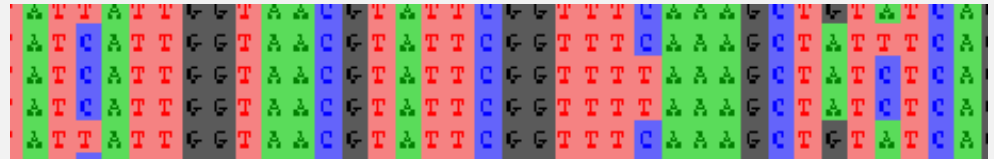
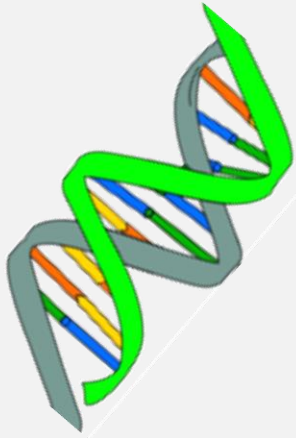
# Warmer Waters Linked to Higher Levels of Shellfish Toxin

By [Stephanie Bucklin](#), [Live Science Contributor](#) | January 9, 2017 05:58pm ET

# Monitoring issues – What is what?



# Genetic tools come handy



## Descriptions

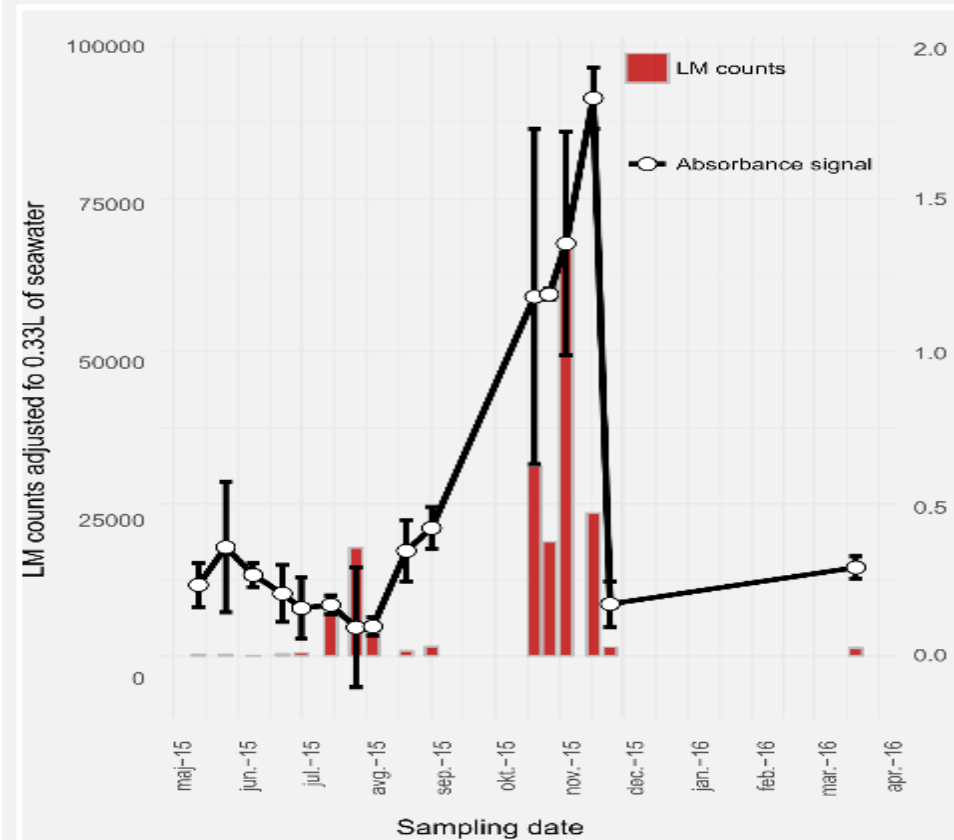
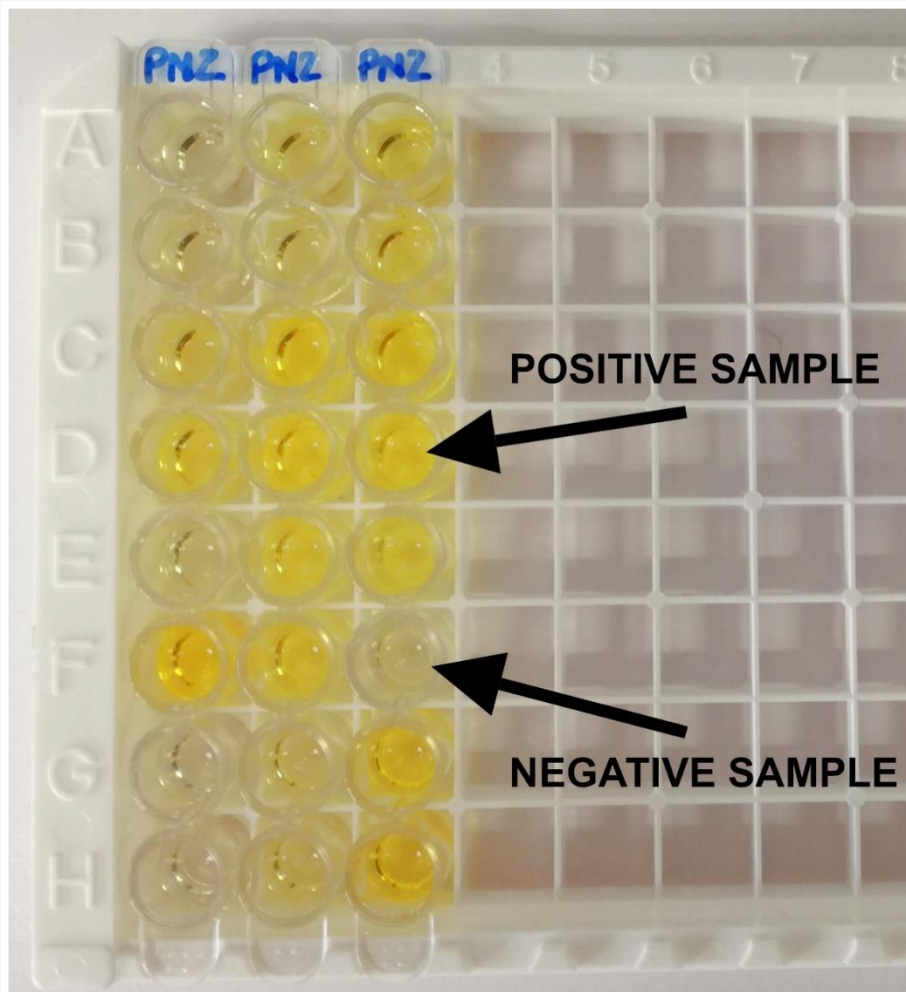
### Sequences producing significant alignments:

Select: [All](#) [None](#) Selected: 0

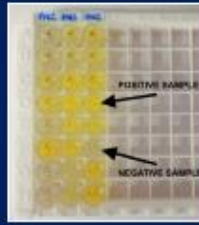
[Alignments](#) [Download](#) [GenBank](#) [Graphics](#) [Distance tree of results](#)

	Description	Max Score	Total Score	Query Cover	E value	Per. Ident	Accession
<input type="checkbox"/>	<a href="#">Pseudo-nitzschia delicatissima strain AL-22 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcl), gene, partial cds; and rbcl-rbcS intergenic spacer, partial sequence; ct</a>	2647	2647	100%	0.0	99.79%	<a href="#">DQ813818.1</a>
<input type="checkbox"/>	<a href="#">Pseudo-nitzschia delicatissima strain CLA1.A2 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcl), gene, partial cds; chloroplast</a>	2525	2525	100%	0.0	98.26%	<a href="#">EF520341.1</a>
<input type="checkbox"/>	<a href="#">Pseudo-nitzschia arenysensis strain AL-24 ribulose-1,5-bisphosphate carboxylase/oxygenase large subunit (rbcl), gene, partial cds; and rbcl-rbcS intergenic spacer, partial sequence; ch</a>	2525	2525	100%	0.0	98.26%	<a href="#">DQ813819.1</a>

# Solution – genosensor for rapid and highthroughput detection



**Our genosensor ensures high-throughput detection (80 samples in 2-3 hours) of harmful organisms that cause a lot of damage to the global aquaculture industry.**



**DIATOX: Sandwich hybridization-based genosensor for high-throughput detection of toxic marine diatoms from the *Pseudo-nitzschia* genus**

Timotej Turk Dermastia<sup>1,2</sup>, Eliza Villa<sup>1</sup>, Janja Franci<sup>1</sup>, Patricija Mozetič<sup>1</sup>, Delphine Gallebaudi<sup>3</sup>,  
<sup>1</sup>National Institute of Biology, Marine Biology Station Piran, Pomorje 4L, Piran, Slovenia, <sup>2</sup>International Postgraduate School Josip Stefan, Jamova cesta 39, 1000 Ljubljana, Slovenia, <sup>3</sup>Microbia Environnement, Obz. Cosmonautique, Avenue Pierre Pabre, 66630 Iannuzet-sur-Mer, France

**INTRODUCTION**

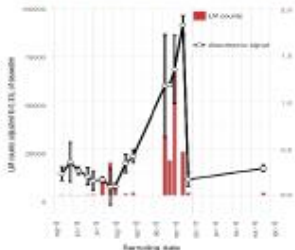
- Harmful algal blooms (HABs) are an emerging threat to human and ecosystem health, as well as a threat to economy in the booming aquaculture industry.
- Managing, predicting and understanding HABs is crucial to prevent and minimize damage
- Diatoms from the *Pseudo-nitzschia* (PN) genus form blooms and produce a potent neurotoxin domoic acid that can accumulate in shellfish.
- The identification and monitoring for this group is difficult and time-consuming, so fast, cheap and reliable methods need to be developed.

**METHODS**

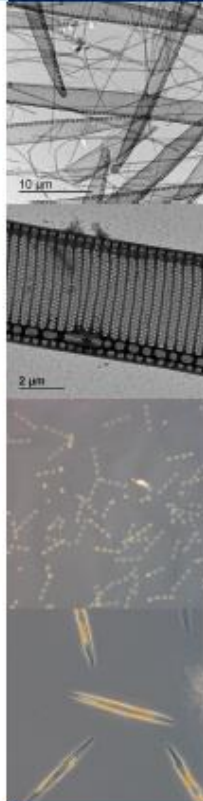
- We used an in-house developed microplate immuno-sensor, developed by Microbia Environnement and modified it so PN specific RNA probes were used.
- Probes were tested against RNA extracted from previously identified species cultures isolated in the Gulf of Trieste, Slovenia.
- Most specific probes were filtered out, and tested against microscope-counted natural samples for validation.

**RESULTS**

- Analysis time: 2-3 hours
- Sample throughput: up to 80 samples
- By measuring the RNA content, we measure the live cell activity, by which we can better understand bloom progression



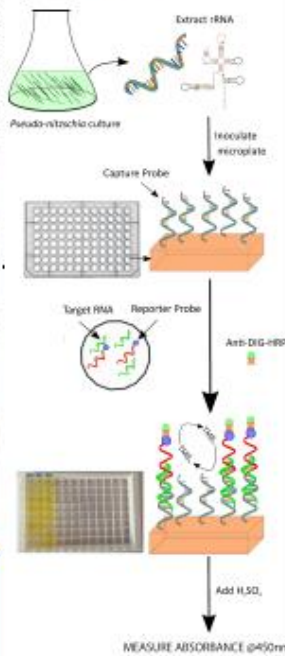
Correlation between light microscopy counts and absorbance signal which is a function of RNA concentration



**DISCUSSION**

- The analysis is considerably faster and efficient compared to conventional microscopy (1 hour per sample).
- The sensor is well accustomed to Adriatic species, but should be tested in other areas as well.
- Additional test considering new strains and species as well as probes are needed.

**Sensor simplified procedure**



Take a picture to download the poster PDF

CONTACT: timotej.turkdermastia@nib.si



**Find me at poster 29 to see how the sensor works and how it can be improved**

Acknowledgements:  
 I would like to thank the staff @MicrobiaEnvironnement

This work was made possible under the FEMS grant number FEMS-GO-2018-134





IPSSC +  
CMBO

# STUDENTS' CONFERENCE

Jožef Stefan International Postgraduate School  
and Young Researchers' Day CMBO

*15 and 16 April 2019, Planica*

## Characterization of plasma by optical emission spectroscopy

Nastja Mahne<sup>1, 2</sup>,

<sup>1</sup>*Department of Thin Films and Surfaces, Jožef Stefan Institute, Ljubljana, Slovenia*

<sup>2</sup>*Jožef Stefan International Postgraduate School, Ljubljana, Slovenia*

Poster number: **5**

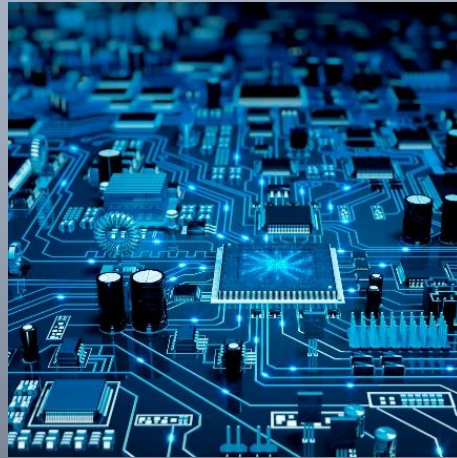
# Thin film applications

protective coatings

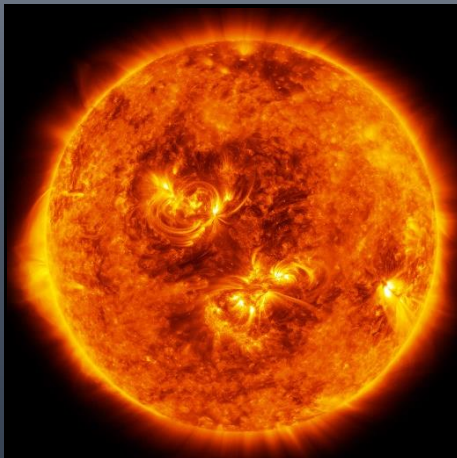
microelectronics

optical coatings

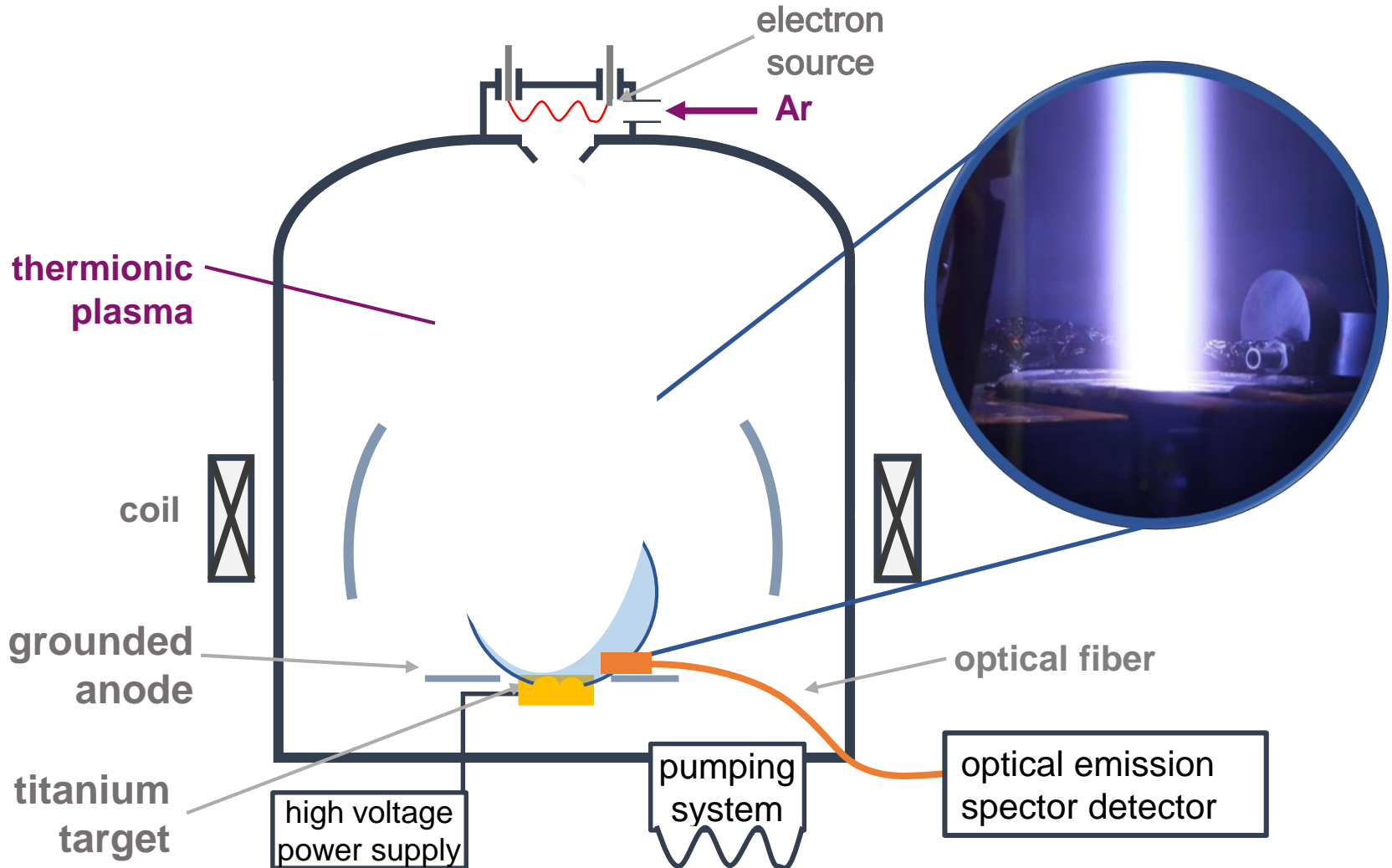
photovoltaics



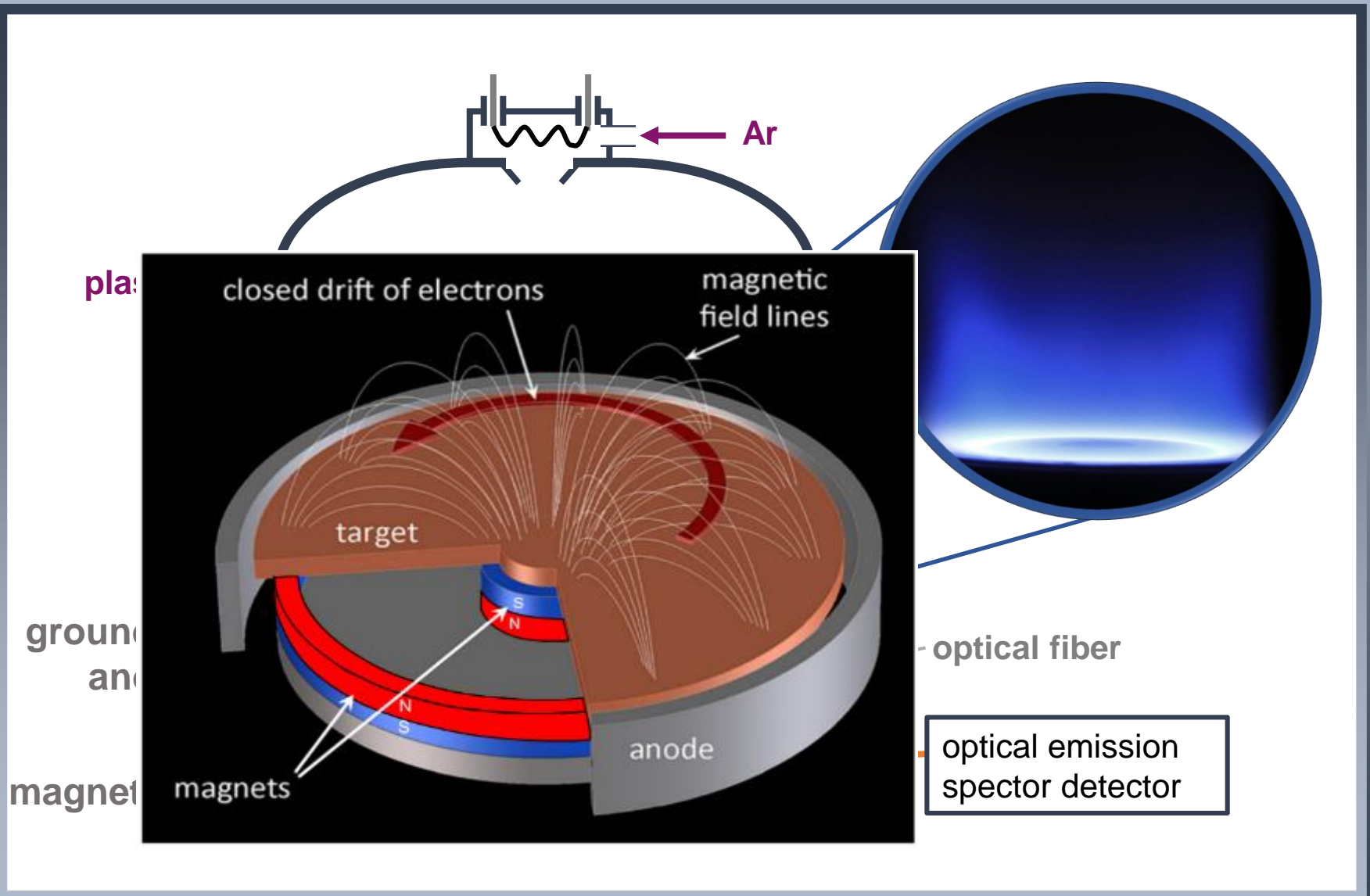
# Artificially patched plasma



# Triode sputtering

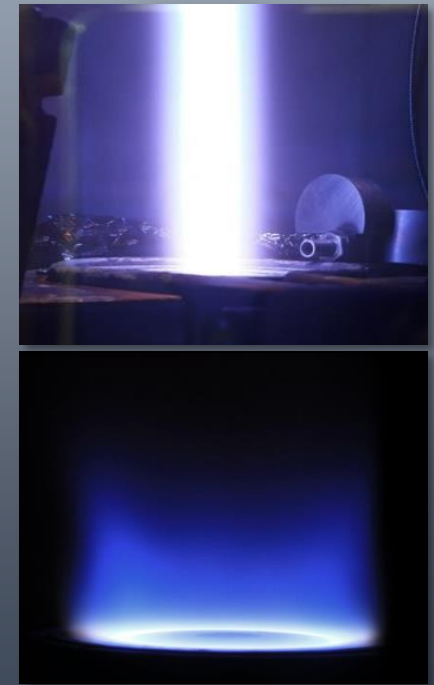
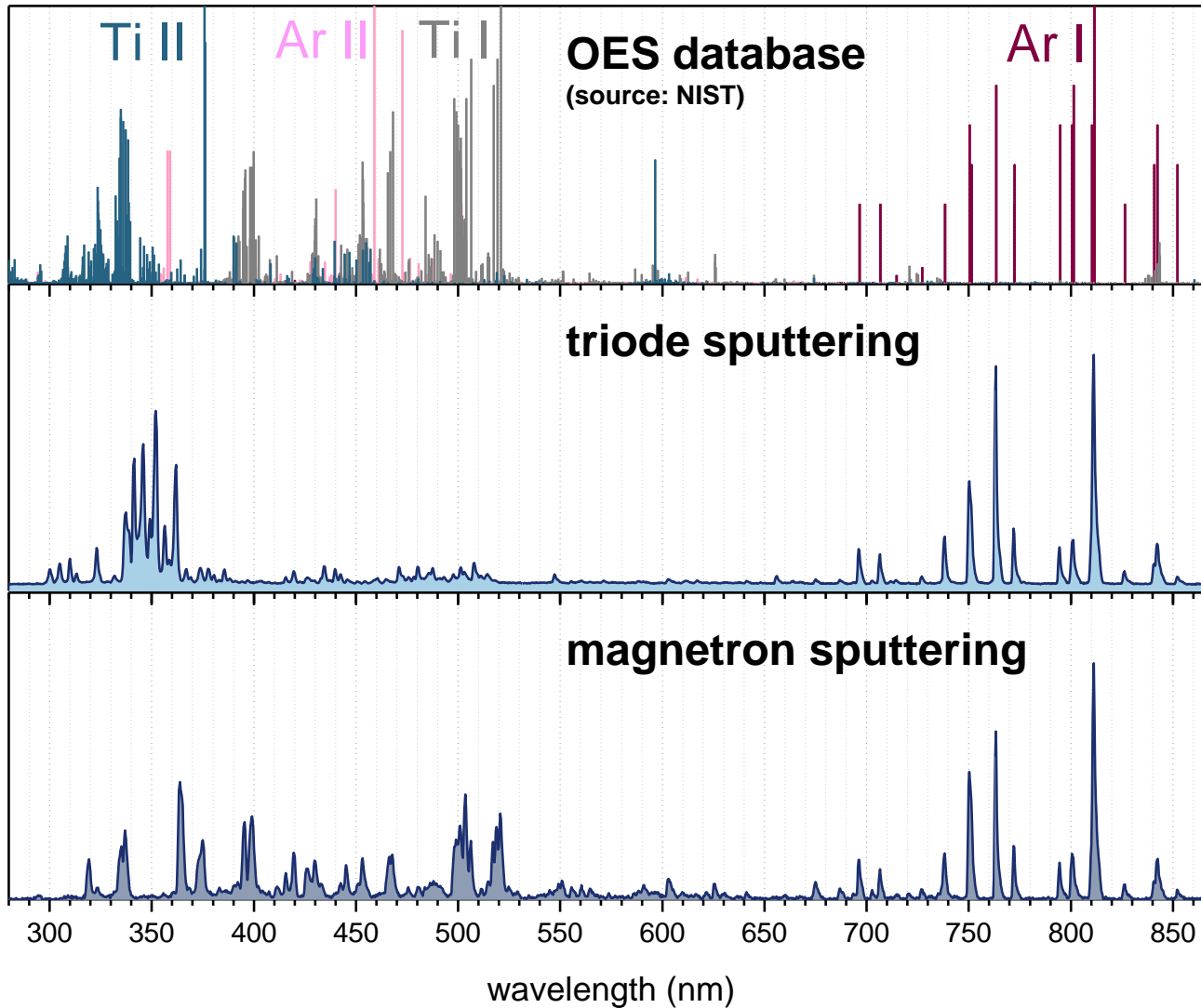


# Magnetron sputtering





# Optical emission spectroscopy

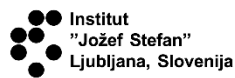




# COFFEE BREAK & POSTER SESSION 2

15:00 - 15:30

SUPPORTED BY



## VWR Quiz

[www.kahoot.it](http://www.kahoot.it)

[si.vwr.com](http://si.vwr.com) → register

15:30 - 15:40

**INVITED LECTURE**  
prof. dr. Brane Širok,  
Wind Tunnel Operation

15:40 - 16:20

## **CONCLUDING SESSION**

16:20 – 16:30

## **HOTEL CHECK-IN HOTEL DOM PLANICA**

16:30 – 18:00

## **DINNER HOTEL DOM PLANICA**

18:00 – 19:30