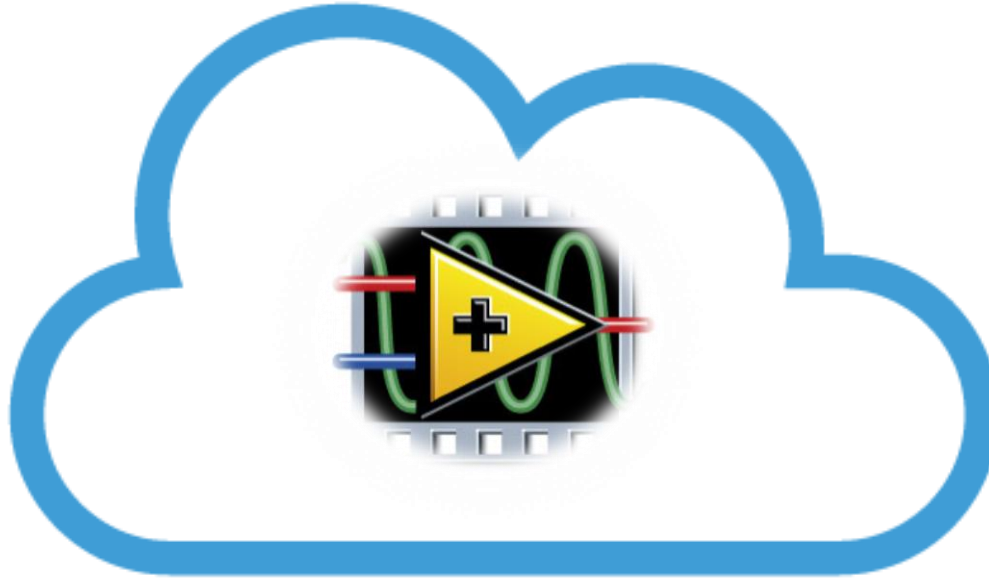




LabVIEW in the cloud





Introduction

- Dries Crauwels
- Electromechanical Engineer
- CLA +13 years LabVIEW

INDUSOL BVBA

.TEST & MEASUREMENT
.AUTOMATION
.CONSULTING



INDUSOL BVBA



Cloud???





Cloud???



Microsoft's data centre in Dublin, Ireland



Cloud???



Microsoft's data centre in Dublin, Ireland



Cloud benefits

- Increased flexibility and reliability
- Better use of resources
- Less capital expense
- ...
- Online access



LabVIEW in the cloud benefits

Examples:

- Cloud storage
- Cloud LabVIEW computing
- LabVIEW magic show – Machine learning



Before we start

- Which cloud platform?



- Windows server / x86 - 64



Which cloud platform?



- NI support:
 - **LabVIEW Cloud Toolkit for AWS by NI**
- Amazon marketplace: Preconfigured Windows server LabVIEW runtime 2013
- FPGA cloud compiler



Labview Cloud benefits

Examples:

- Cloud storage
- Cloud LabVIEW computing
- Cloud advanced features



Cloud storage

- Power Camp – diesel generator alternative



Tiger Power – Power Camp



Cloud storage

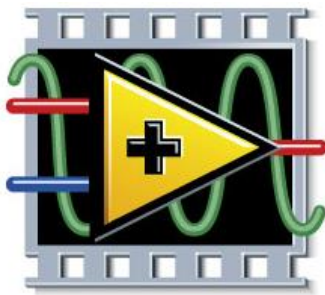
Problem:

- Data needs to be logged and accessible
- Power camp's will be deployed all over the world
- Number of Power camps will increase
- Bad or no internet connections are possible



Cloud storage

- cRIO
- Python on AWS cloud for analysis
- Log to cloud





Cloud storage



Internet
GPRS / 3G / 4G...



SEA module: GPS + Time synchronisation + 3G



Cloud storage

Simple as 1 – 2 – 3!





Cloud storage

- Simple as **1** – 2 – 3:
- Setup bucket in AWS management console

Create bucket

✓ Name and region ✓ Set properties 3 Set permissions 4 Review

▼ Manage users

User ID	Objects	Object permissions
dries(Owner)	<input checked="" type="checkbox"/> Read <input checked="" type="checkbox"/> Write	<input checked="" type="checkbox"/> Read <input checked="" type="checkbox"/> Write

▼ Manage public permissions

Group	Objects	Object permissions
Everyone	<input type="checkbox"/> Read <input type="checkbox"/> Write	<input type="checkbox"/> Read <input type="checkbox"/> Write

▼ Manage system permissions

Group	Objects	Object permissions
Log Delivery	<input type="checkbox"/> Read <input type="checkbox"/> Write	<input type="checkbox"/> Read <input type="checkbox"/> Write

Previous Next



Cloud storage

- Simple as 1 – **2** – 3:
- Download toolkit from NI website

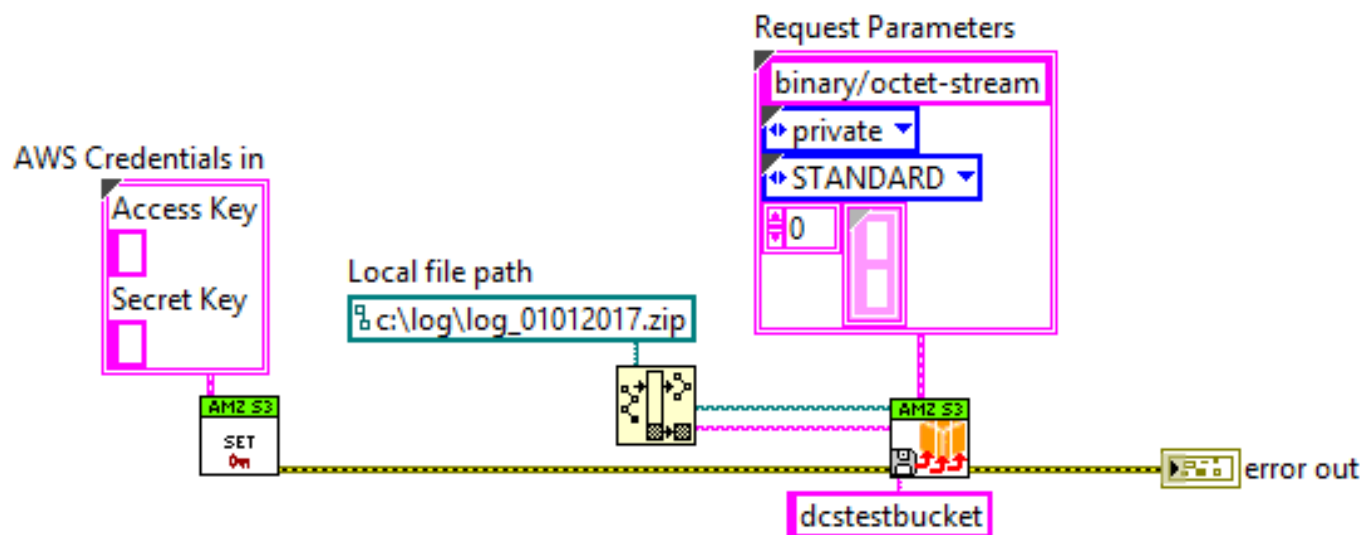


LabVIEW Cloud Toolkit for AWS



Cloud storage

- Simple as 1 – 2 – **3**:
- Use VI's in project





Cloud storage

Not as simple as 1 – 2 – 3!

- Cloud no connection? -> local storage
- Local storage -> monitor disk space
- Queue based system, parallel loop!





Cloud storage

Conclusion:

- Not as simple as 1 – 2 – 3
- But still very easy to implement



Cloud storage

Cost: as cheap as peanuts!



1 peanut = \$0.001874



100 mb - \$0.00245/month



Cloud storage

Cost: **almost** as cheap as peanuts!



1 peanut = \$0.001874



100 mb - \$0.00245/month



LabVIEW in the cloud benefits

Examples:

- Cloud storage
- Cloud LabVIEW computing
- LabVIEW magic show – Machine learning



Cloud LabVIEW computing

- Neurosciences at *Johnson & Johnson*
- Alzheimer research
- EEG data analysis

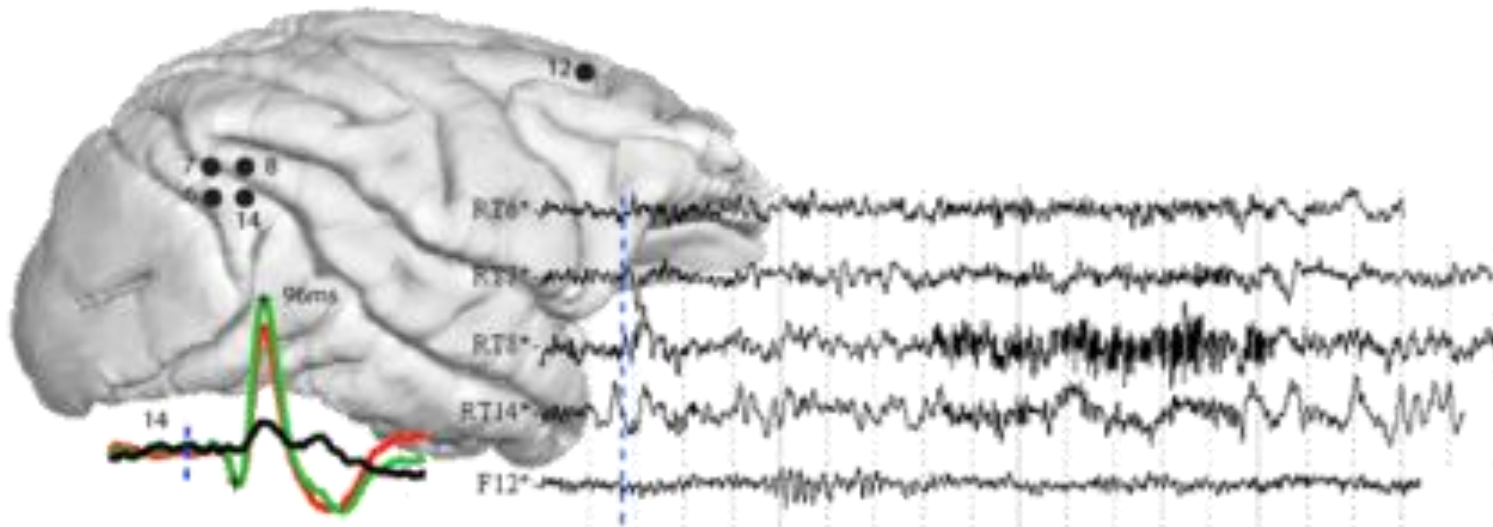


Cloud LabVIEW computing

Neurosciences example:

1) EEG recording

- local measurement PC with LabVIEW





Cloud LabVIEW computing

Neurosciences example:

2) EEG analysis

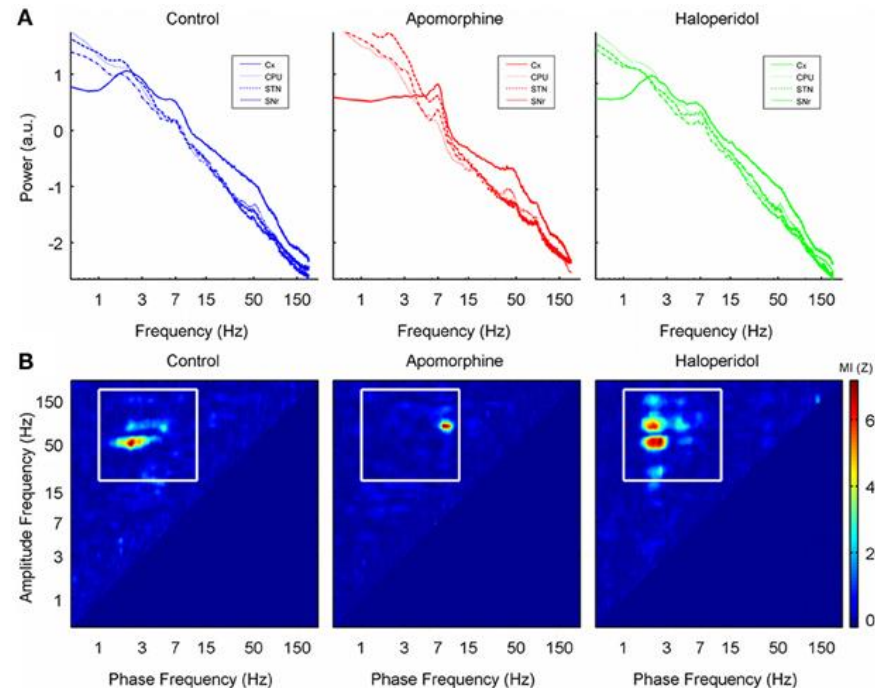
- LabVIEW performs analysis of EEG recordings
- Different types of analysis
 - Power spectrum
 - Activity
 - Response to sound AEP
 - ...



Cloud LabVIEW computing

Neurosciences example:

3) Results :



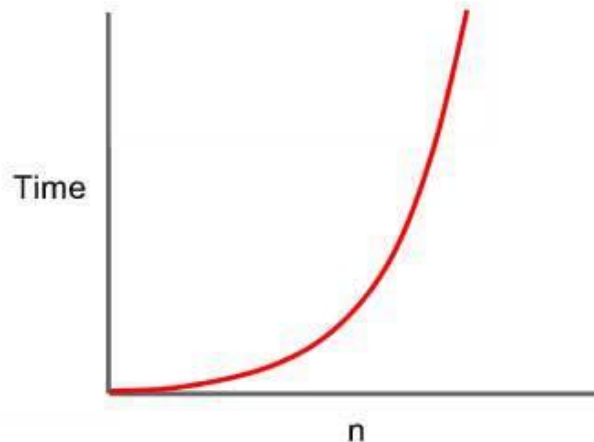
Excel / PDF / image / DB / LabVIEW viewer



Cloud LabVIEW computing

Problem:

- EEG data analysis – More and more complex
 - More data / channels
 - More advanced analyse: PAC – CFC
 - PC runs 3 days...





Cloud LabVIEW computing

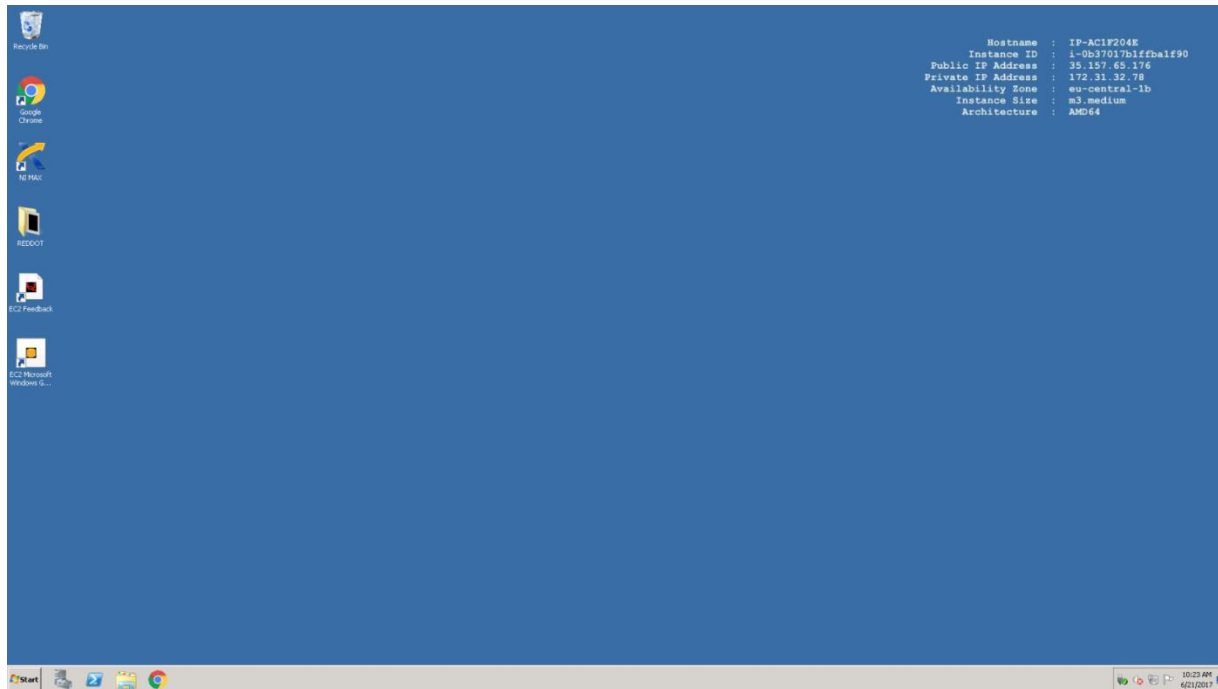


Elastic Cloud Computing



Cloud LabVIEW computing

- EC2 - Multiple configurations
- Windows server / linux
- AWS marketplace, press button to build





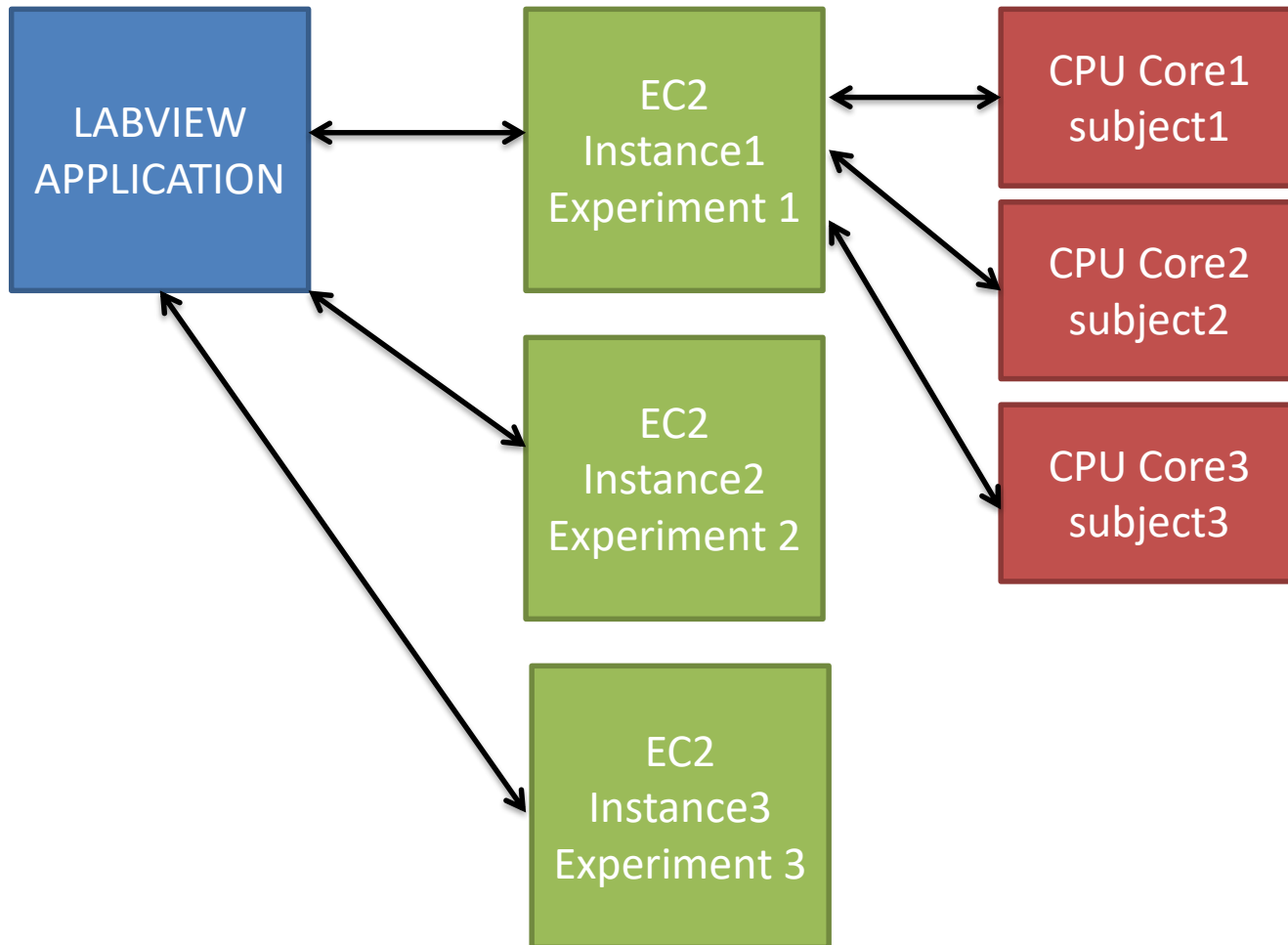
Cloud LabVIEW computing

- Start an EC2 instance when you want, how many you want
- High computing resources come available, you only pay for what you need
- Multiple parallel analysis possible



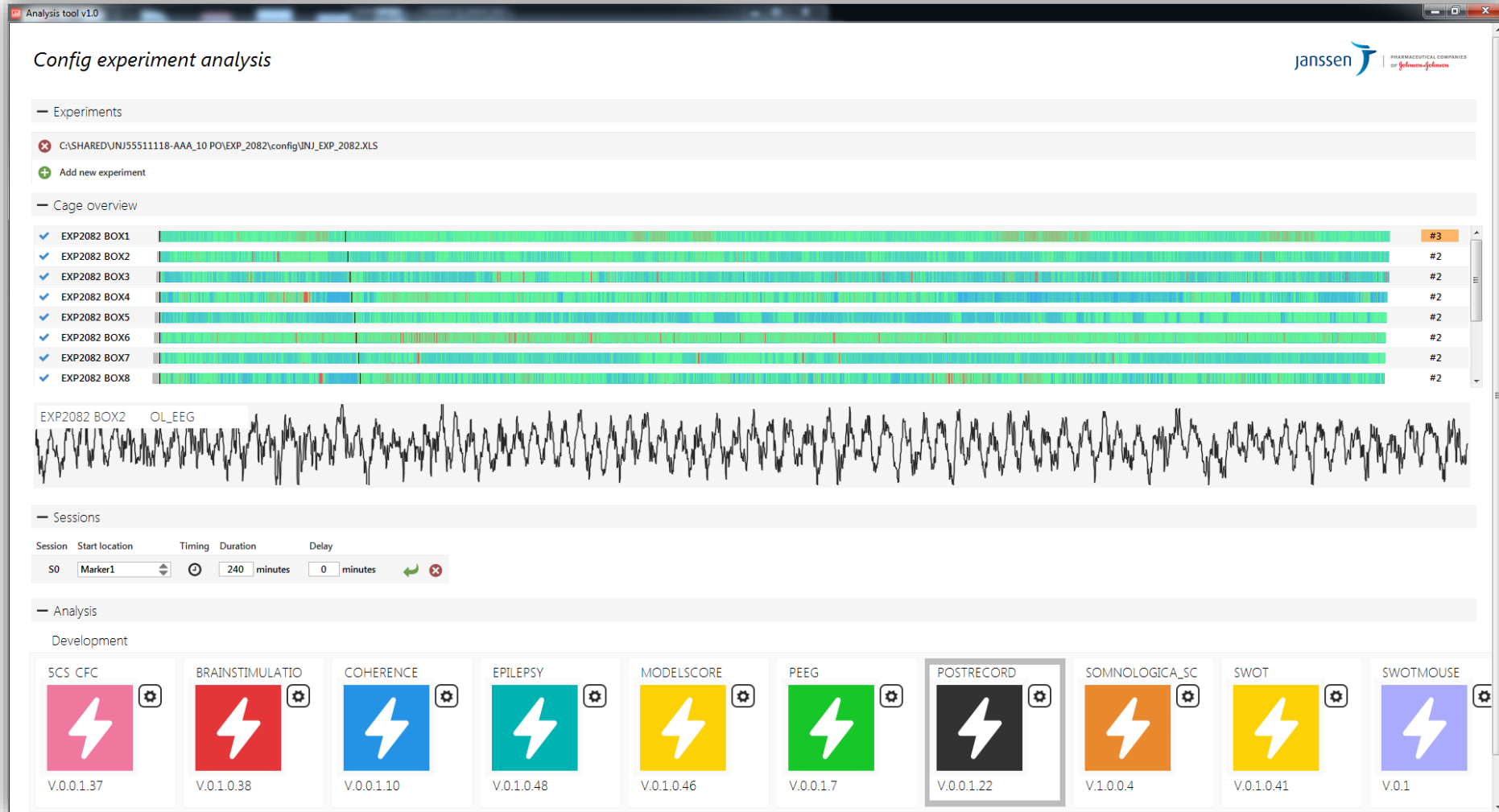


Cloud LabVIEW computing





Cloud LabVIEW computing



**INDUSOL BVBA**



Cloud LabVIEW computing

Technical details:

- AWS SDK .NET library
- S3 storage EEG recordings
- Web services for communication
- CPU load optimisation performed by LabVIEW
- Type instance for number of processed subjects and type analyse (future)



Cloud LabVIEW computing

Conclusion:

- LabVIEW runs in the cloud EC2 instance
- Windows server environment
- Reduces cost and computing time



Cloud LabVIEW computing

Cost

- Depends how long and which type of instance you are using:
 - T2 nano \$0.0068 per Hour
 - x1.32xlarge \$ 18.674 per Hour
 - 128 vCPU - 2TB RAM - 8TB SSD
- Up to 90% discount on Spot instances
- Pay per instance time , not CPU time!
- > **Stop instance if not required**



LabVIEW in the cloud benefits

Examples:

- Cloud storage
- Cloud LabVIEW computing
- LabVIEW magic show – Machine learning

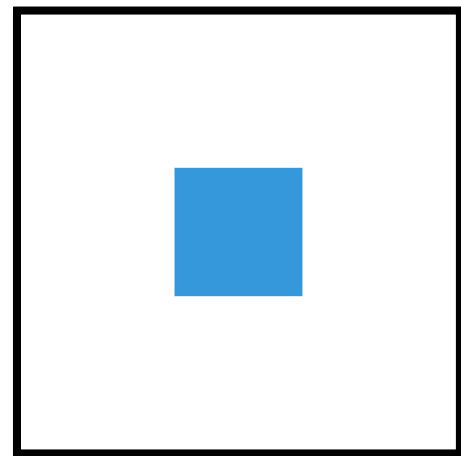
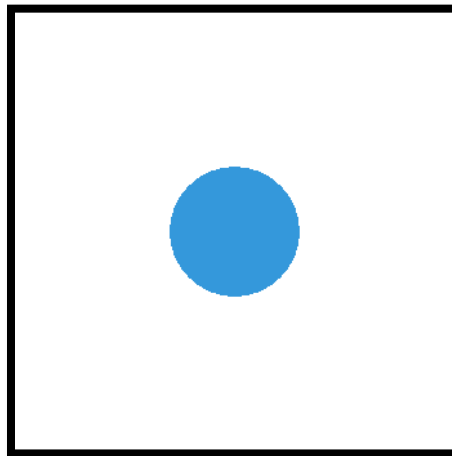
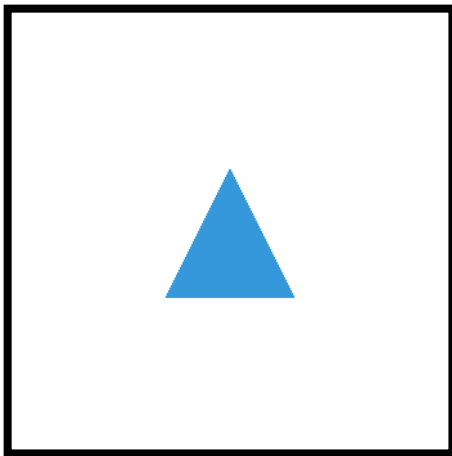
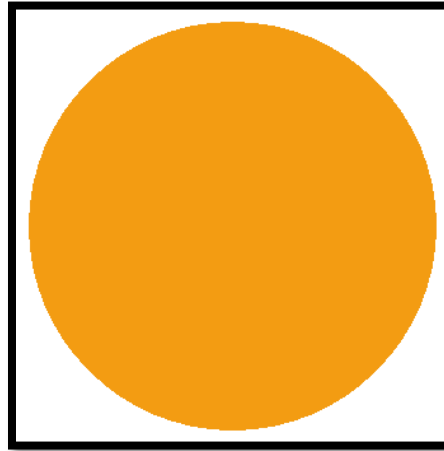
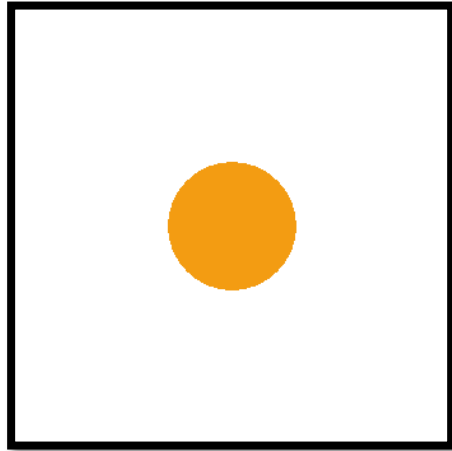


LabVIEW magic show





LabVIEW magic show





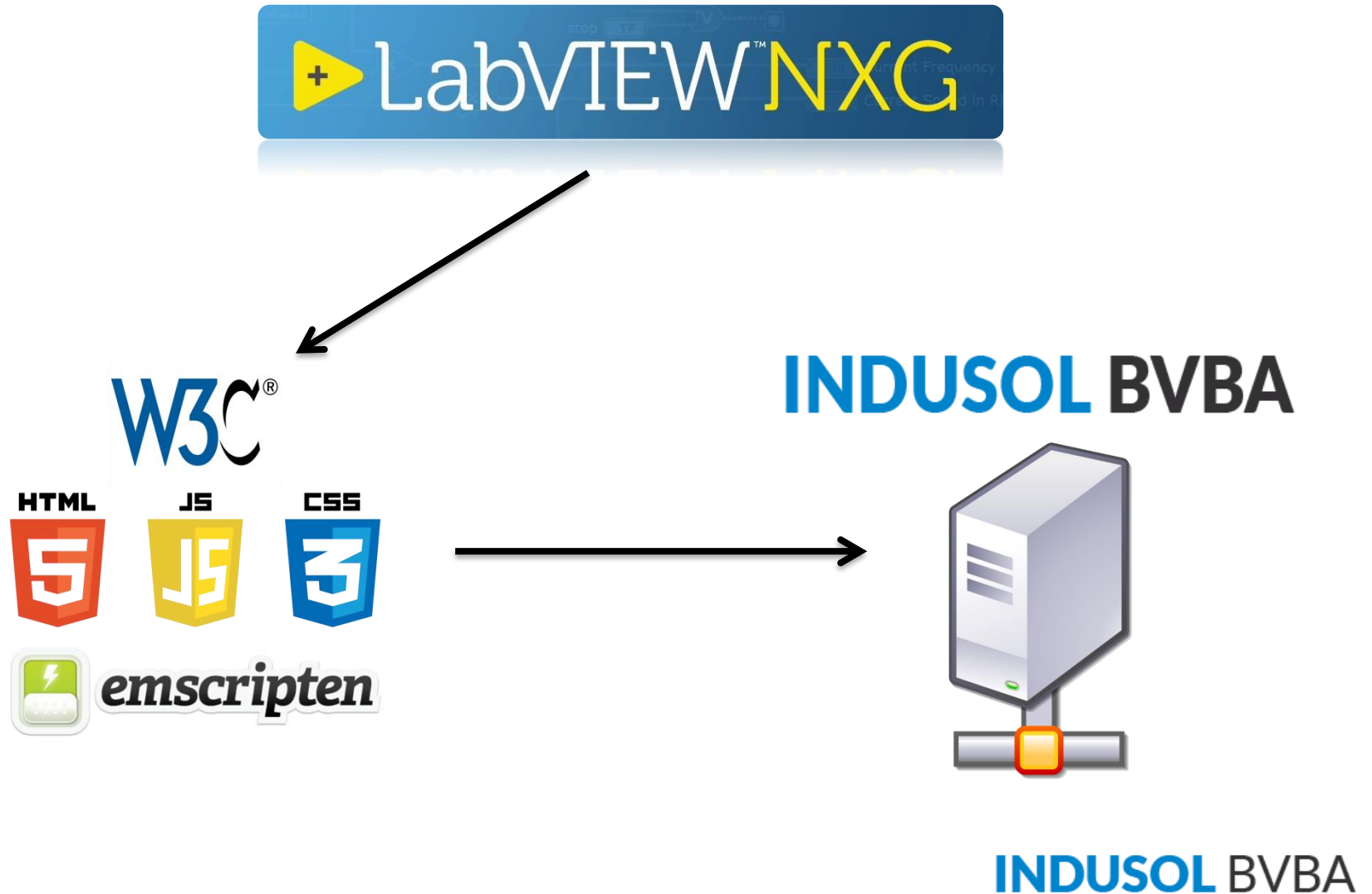
LabVIEW magic show

www.indusol.be/ni





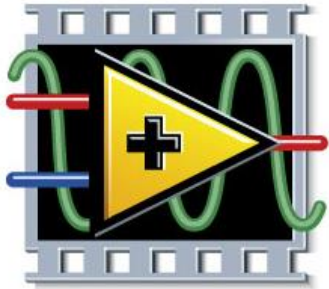
LabVIEW magic show





LabVIEW magic show

LabVIEW web server

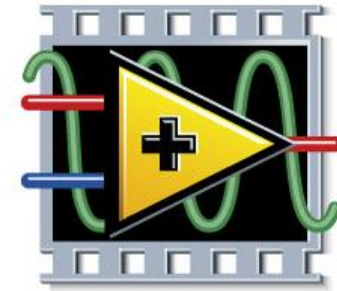




LabVIEW magic show

LabVIEW running in the cloud

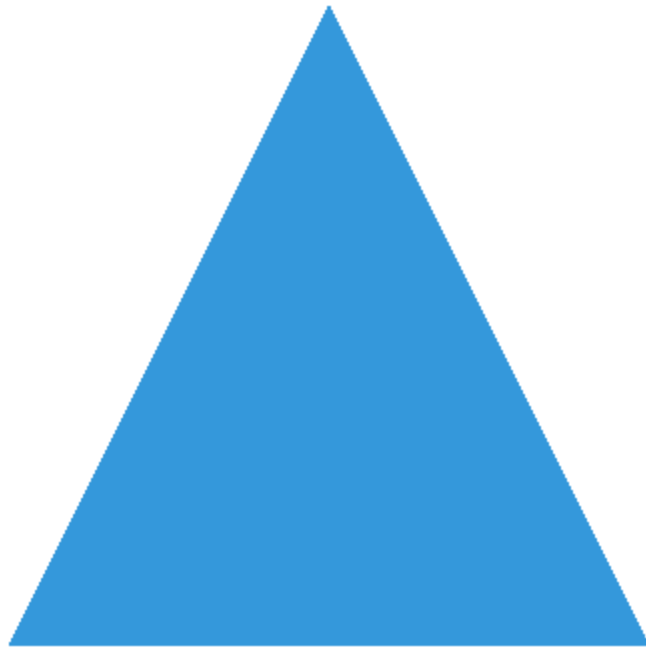
- Handle HTTP requests
- Image feature extraction:
 - Size (# pixels)
 - Color (RGB value)
 - # Horizontal lines
 - # Vertical lines





LabVIEW magic show

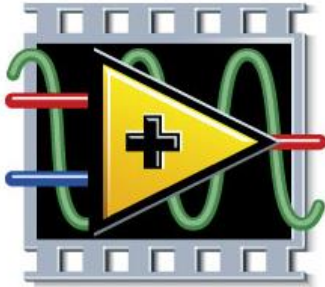
- Image feature extraction:



# coloured pixels	51520	▲▼
RGB value	344700	▲▼
# Vertical edges	0	▲▼
# Horizontal edges	1	▲▼



LabVIEW magic show

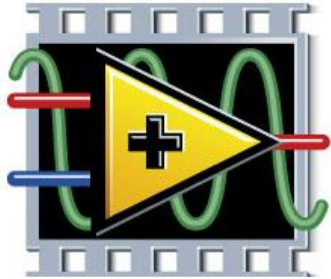


#Pixels	RGB value	#Vertical edges	#Horizontal edges
51520	3447003	0	1
10000	3447003	2	2
102400	3447003	2	2
7952	15965202	0	0





LabVIEW magic show



**Binary Classification
Model**

←→
**Solvable with machine
learning!**

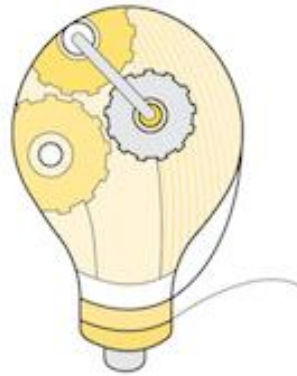


Amazon AI



LabVIEW magic show

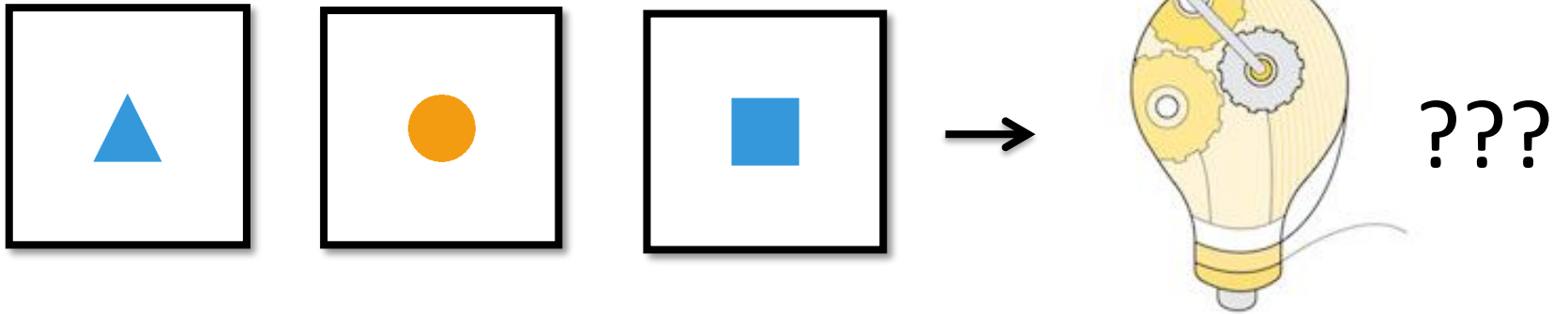
#Pixels	RGB value	#Vertical edges	#Horizontal edges
51520	3447003	0	1
10000	3447003	2	2
102400	3447003	2	2
7952	15965202	0	0



Machine learning model



LabVIEW magic show



www.indusol.be/result

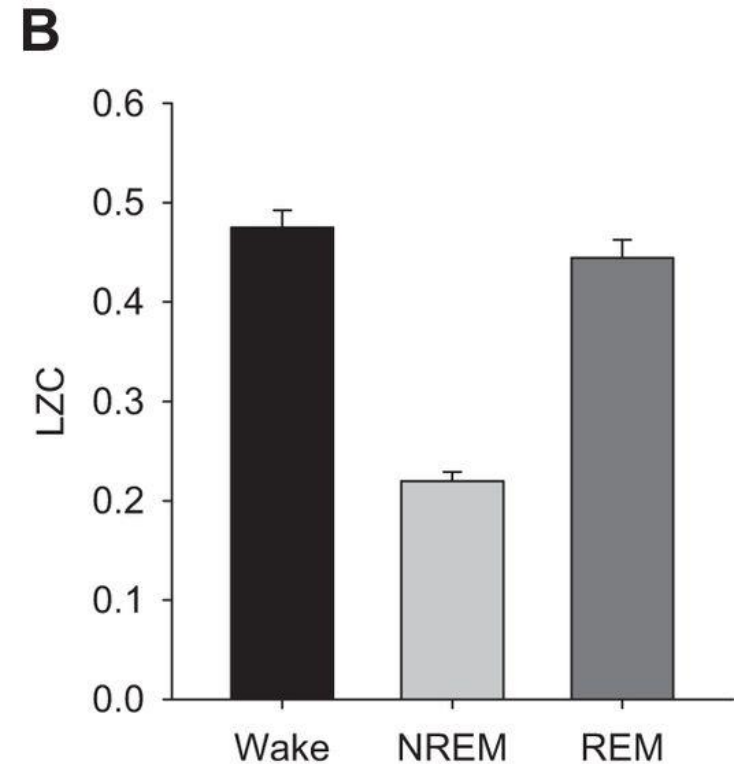
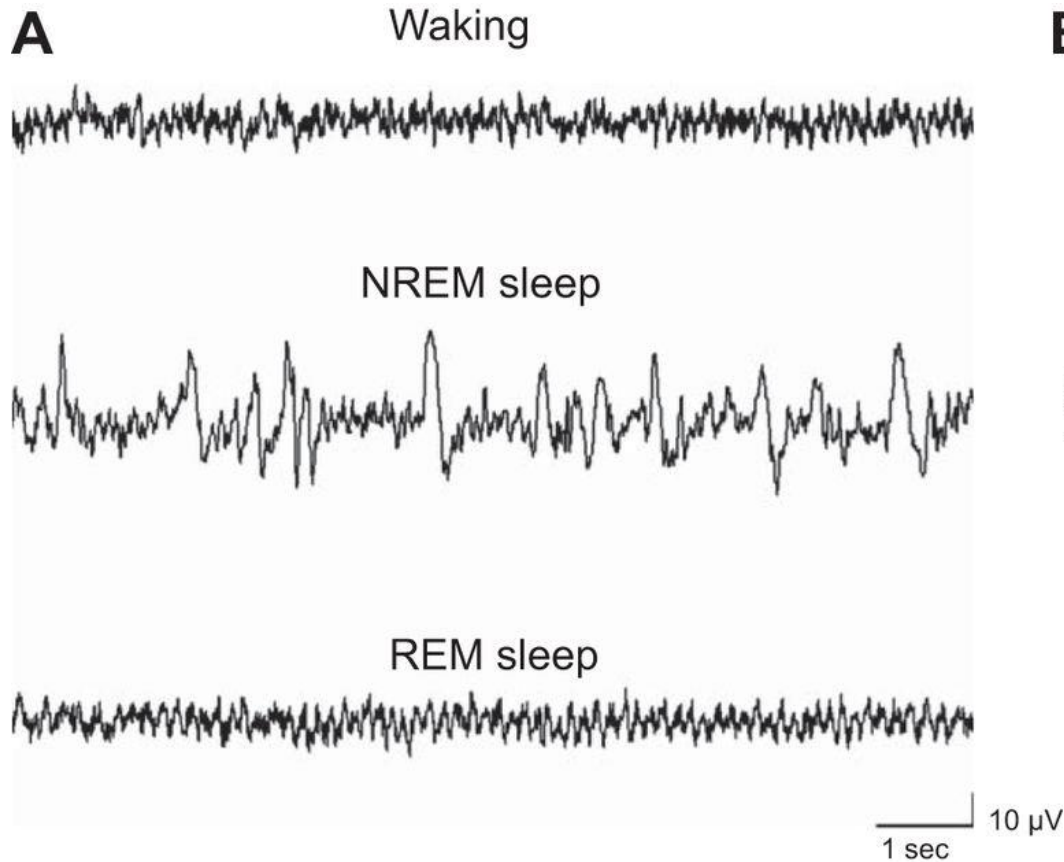


LabVIEW in the cloud

- Neurosciences at *Johnson & Johnson*
- Alzheimer research
- Vigilance state subject from EEG data
 - Active / non Active / light Sleep / deep sleep /REM
 - Epilepsy – Artefact – Intermediate state



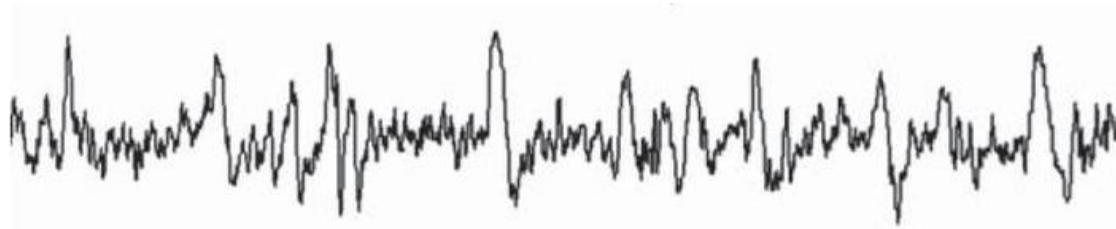
LabVIEW in the cloud



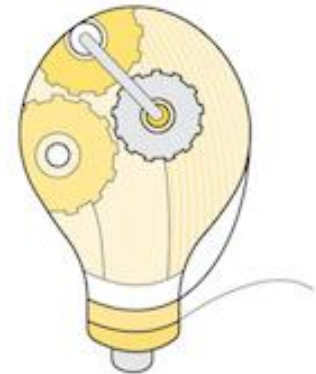


LabVIEW in the cloud

EEG



- FFT
- Coherence
- Activity



Subject is sleeping!

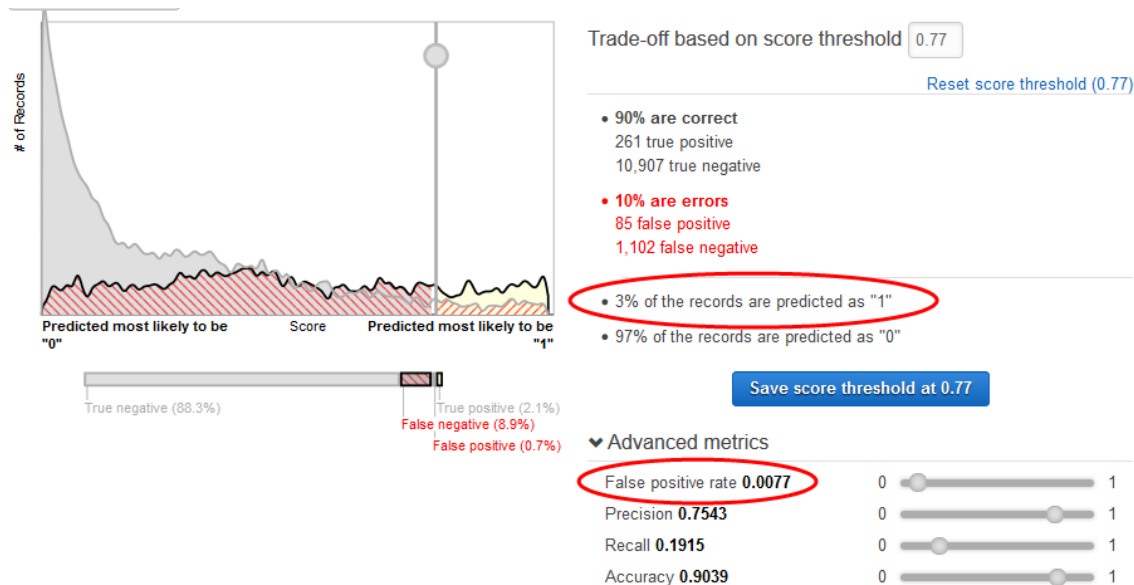


LabVIEW in the cloud

How good does it work?

Depends how good your data is!

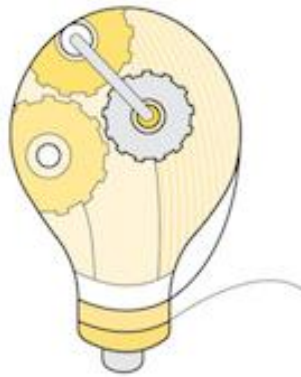
Tools to review performance:





LabVIEW in the cloud

- AWS machinelearning tries to take the best fit in a manual scored model.





LabVIEW in the cloud

Example diamond classification

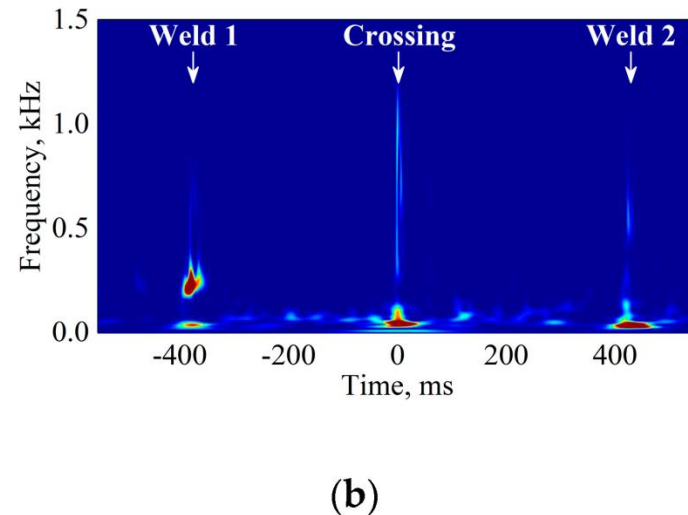
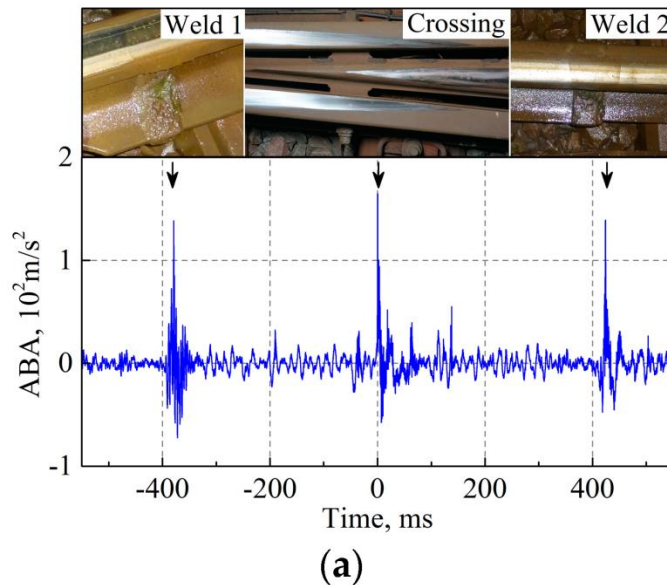




LabVIEW in the cloud

Example railway

- Possible defect / Chance of failure?
-> Preventive maintenance



Wei, Z.; Núñez, A.; Li, Z.; Dollevoet, R. Evaluating Degradation at Railway Crossings Using Axle Box Acceleration Measurements. *Sensors* **2017**, *17*, 2236.



Cloud advanced features

Conclusion:

AWS machine learning can solve complex problems on a fairly easy way.



Cloud advanced features

Cost

- \$0.0001 per prediction



1 peanut = 18 predictions



LabVIEW in the cloud benefits

Examples:

- Cloud storage
- Cloud LabVIEW computing
- LabVIEW magic show – Machine learning



LabVIEW in the cloud

Conclusion:

- Today:
LabVIEW and Cloud = No problem
- Future:
LabVIEW NXG - Webvi's



LabVIEW magic show

www.indusol.be/result



LabVIEW in the cloud

Any Questions?

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