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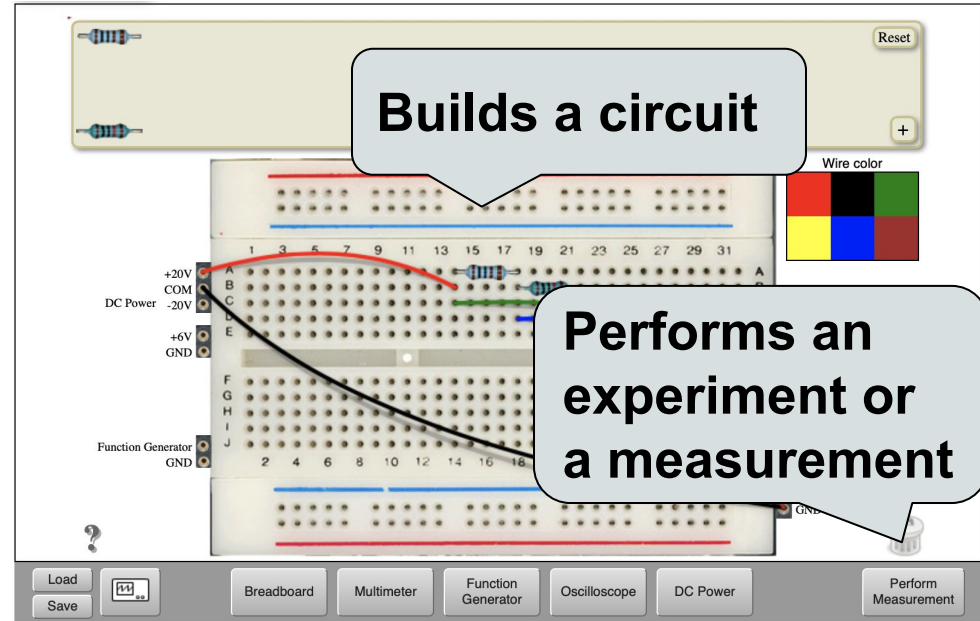
# Mapping VISIR Circuits for Computer-assisted Assessment

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# VISIR & VISIR-DB, our context

VISIR is a remote laboratory for electrical circuits and analog electronics



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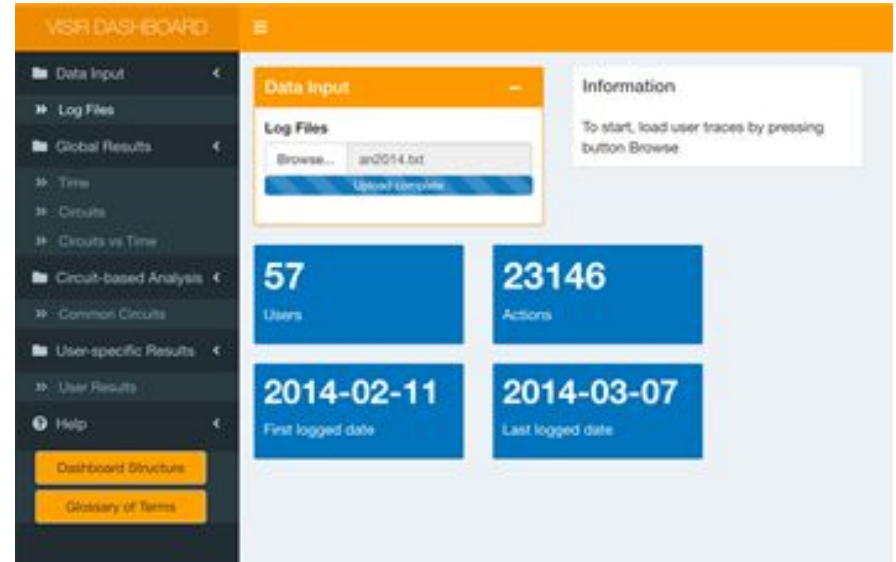
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# VISIR & VISIR-DB, our context

We are working on a learning analytics dashboard for VISIR, VISIR-DB,  
<http://asistembe2.iqs.edu/visirtr/index.htm>



# What's a circuit in VISIR?

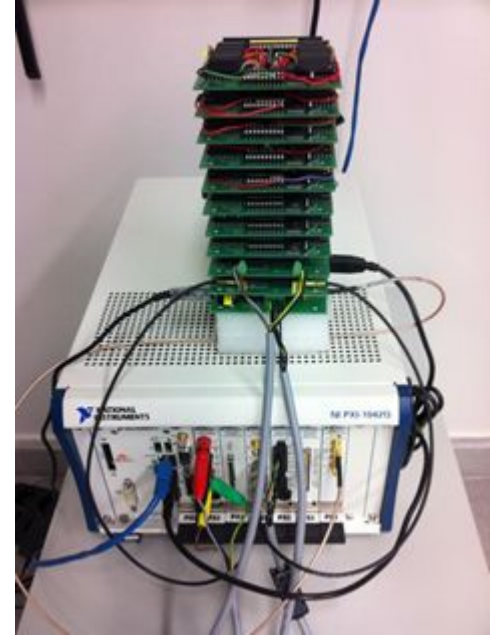
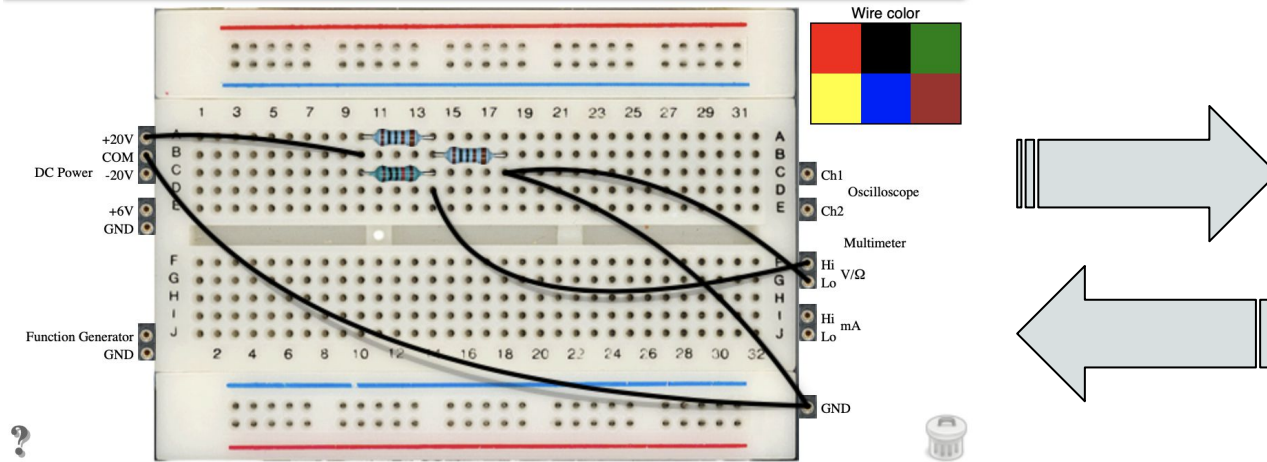
## Are any two circuits equivalent?

Unless we are able to answer these questions, we won't be able to...

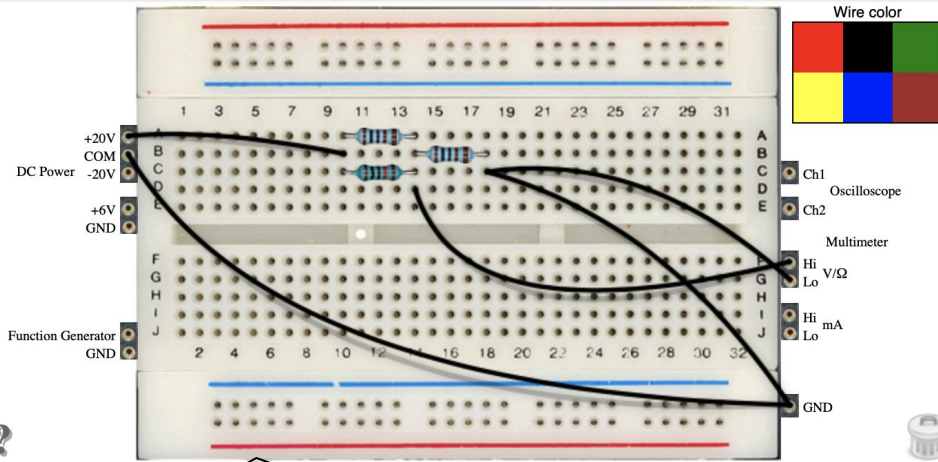
- computationally assess students' work,
- investigate common mistakes,
- provide real-time feedback...



# VISIR and its messages

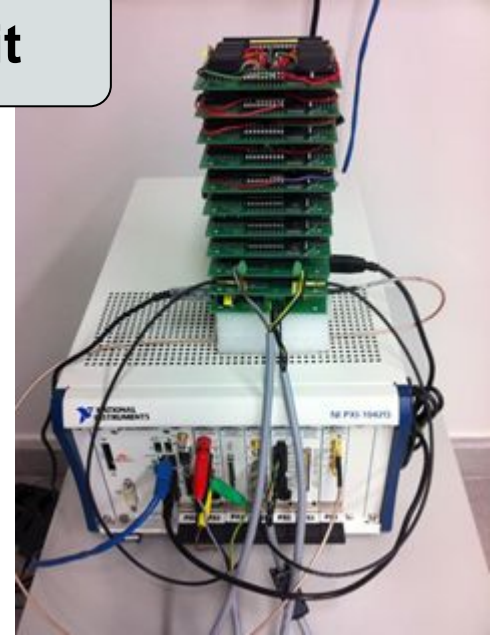
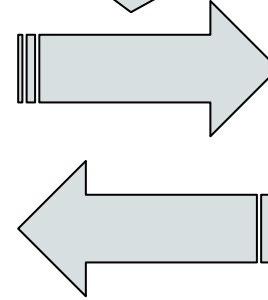


# VISIR and its messages



**Built circuit**

**Coded circuit**



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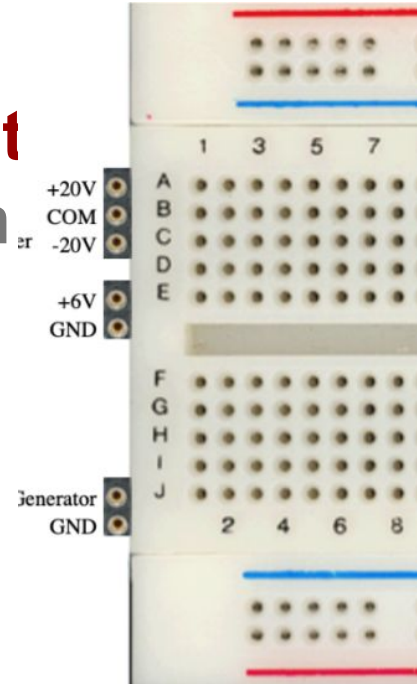
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# Comparing circuits (I) - Coded circuits

Fortunately, built circuits can be **different** and render **identical coded circuits** when there are only minor differences in the position of the components and/or the wires.

**B1 , C1 , D1 , E1      ≡      A1**

**G1 , H1 , I1 , J1      ≡      F1**



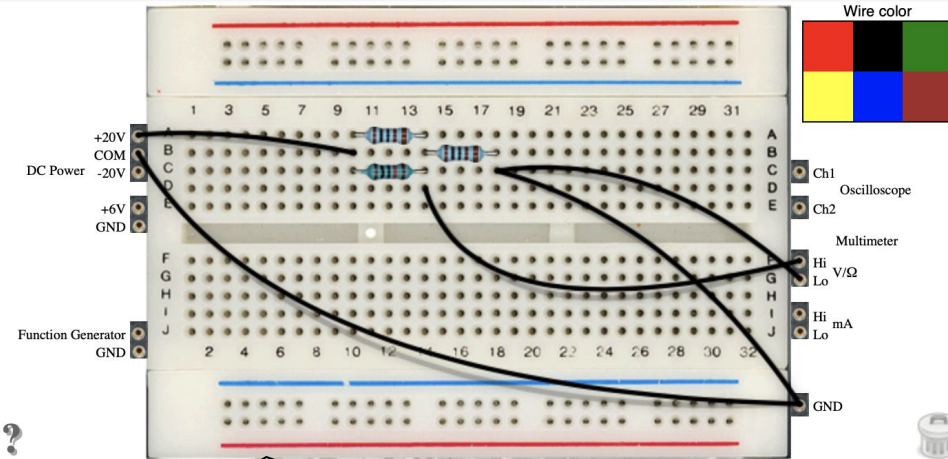
# Comparing circuits (I) - Coded circuits

Coded circuit

```

W_X DMM_VHI A14/W_X
DMM_VLO A18/W_X DC_+25V
A10/W_X 0 A18/W_X DC_COM
0/R_X A14 A18 1k/R_X A10
A14 10k/R_X A10 A14 1k
  
```

Built circuit





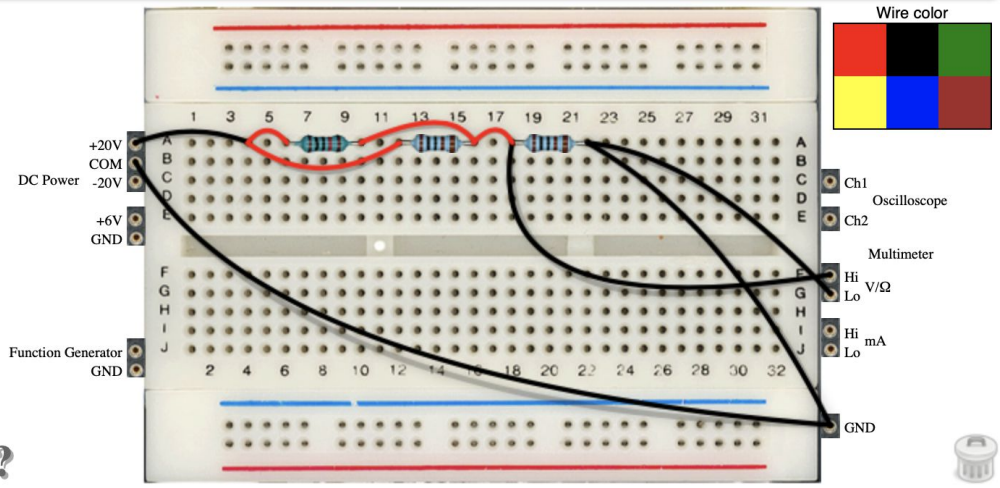
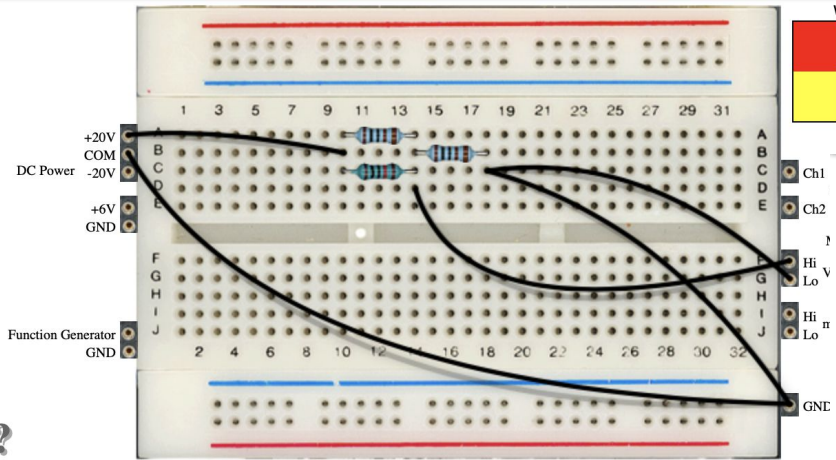
# Comparing circuits (II) - Normalization

But different coded circuits are sometimes *equivalent*. Circuits should be equivalent if they contain **the same components connected in the same manner**. This is what offers the **normalized circuit**.

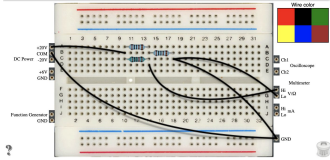


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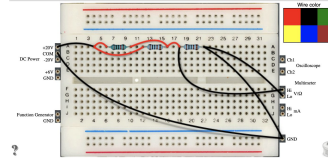
# Comparing circuits (II) - Normalization



# Comparing circuits (II) - Normalization



Built circuit



```

W_X DMM_VHI A14/W_X
DMM_VLO A18/W_X DC_+25V
A10/W_X 0 A18/W_X DC_COM
0/R_X A14 A18 1k/R_X A10
A14 10k/R_X A10 A14 1k
  
```

Coded circuit

```

W_X A4 A6/W_X A4 A12/W_X
A10 16/W_X A16 A18/W_X
DMM_VHI A18/W_X DMM_VLO
A22/W_X DC_+25V A4/W_X
DC_COM 0/W_X 0 A22/R_X
A18 A22 1k/R_X A6 A10
10k/R_X A12 A16 1k
  
```



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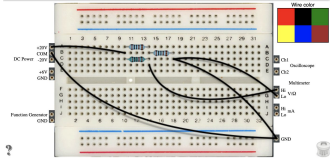
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# Comparing circuits (II) - Normalization



**Built circuit**

**Normalized circuit**

```

W_X DMM_VHI A14/W_X
DMM_VLO A18/W_X DC_+25V
A10/W_X 0 A18/W_X DC_COM
0/R_X A14 A18 1k/R_X A10
A14 10k/R_X A10 A14 1k
  
```

```

R_X DC_+25V DMM_VHI
10k/R_X DC_+25V DMM_VHI
1k/R_X DMM_VHI DMM_VLO
1k/W_X DC_COM GND/W_X
DMM_VLO GND
  
```

**Coded circuit**



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# Comparing circuits (II) - Normalization

**Normalization** requires:

- removing wires
- repositioning components
- sorting components
- sorting nodes

6327 coded circuits

2313 **normalized** circuits

In our checks, all coded circuits are equivalent to the normalized circuit.



# Comparing circuits (III) - Simplification

When using VISIR, it is not uncommon to leave unconnected fragments on the breadboard.

To account for this, two circuits should be equivalent if they have **the same components connected in the same manner in the fragment being measured**. This leads to the **simplified** circuit.

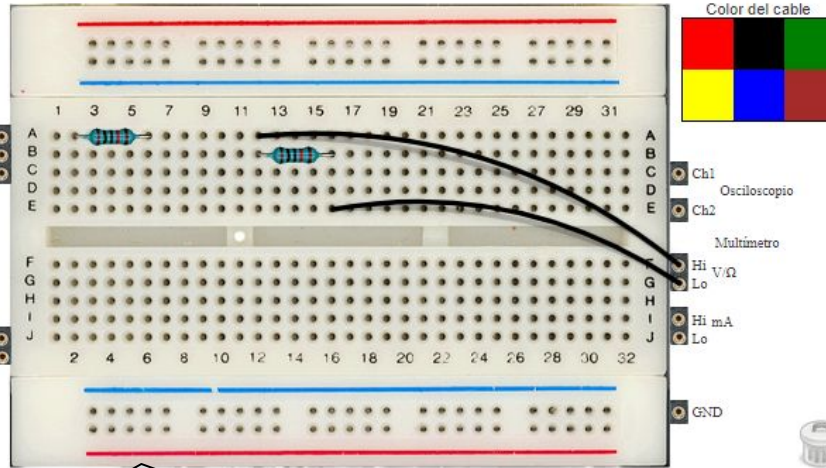


# Comparing circuits (III) - Simplification

Coded circuit

```
W_X A12 DMM_1_1/W_X A16
DMM_1_2/R_X A2 A6 10k/R_X
A12 A16 10k
```

Built circuit



# Comparing circuits (III) - Simplification

```

W_X A12 DMM_1_1/W_X A16
DMM_1_2/R_X A2 A6 10k/R_X A12
A16 10k
R_X P01 P02 10k/R_X DMM_1_1
DMM_1_2 10k
R_X DMM_1_1 DMM_1_2 10k
  
```

**Coded circuit**

**Normalized circuit**

**Simplified circuit**





# Comparing circuits (III) - Simplification

Simplification implies:

- removing unconnected fragments
- removing short-circuit components

6327 coded circuits

2313 **normalized** circuits

1649 **simplified** circuits

For two-resistor combinations, the simplified circuits map the expected ones.



# Summarizing

<b>built circuit</b>	as in the breadboard
<b>coded circuit</b>	as sent to the remote lab server
<b>normalized circuit</b>	sequence of components
<b>simplified circuit</b>	sequence of components being effectively measured



# Conclusions

- We have proposed different ways of interpreting what a circuit in VISIR.
- We have devised and validated algorithms to transform a coded circuit to **normalize** and **simplify** it to facilitate its computer-based comparison.



# A BIG THANK YOU!

To all colleagues and anonymous VISIR users that have contributed to make this research possible

To our sponsors

- *Aristos Campus Mundus*
- *Obra Social La Caixa*

To all of you for your attention

Please reach us at...

- [jordi.cuadros@iqs.url.edu](mailto:jordi.cuadros@iqs.url.edu)
- [zubia@deusto.es](mailto:zubia@deusto.es)

for additional questions, comments or signs of appreciation.

