

# Gray Scott Reloaded 2024 : Computing on heterogeneous hardware

Pierre Aubert



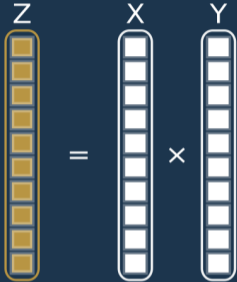
# Simple Examples

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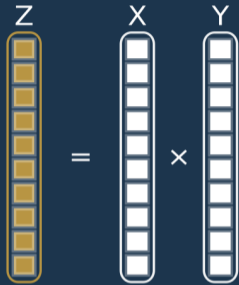
# Simple Examples

## Hadamard Product



# Simple Examples

Hadamard Product

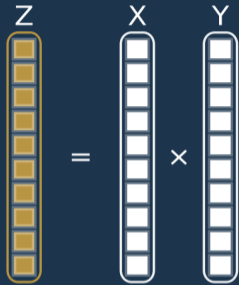


Reduction



# Simple Examples

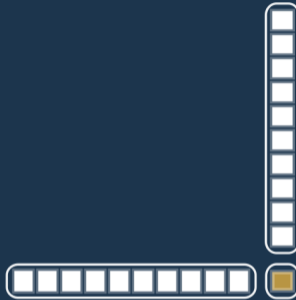
## Hadamard Product



## Reduction

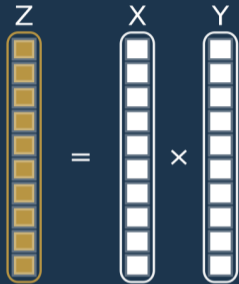


## Dot Product



# Simple Examples

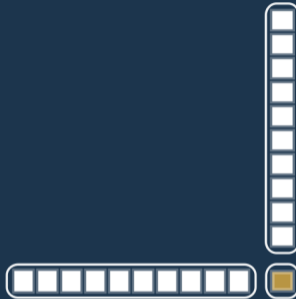
## Hadamard Product



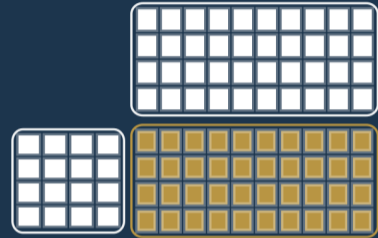
## Reduction



## Dot Product

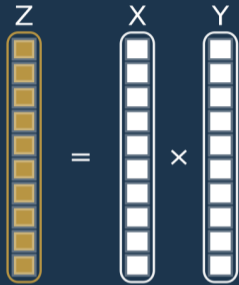


## Matrix Product



# Simple Examples

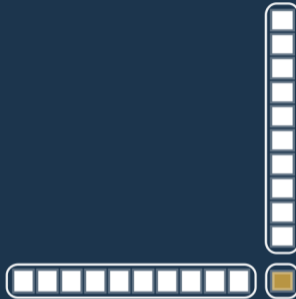
## Hadamard Product



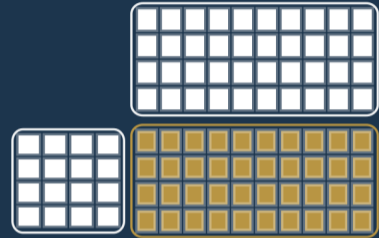
## Reduction



## Dot Product



## Matrix Product

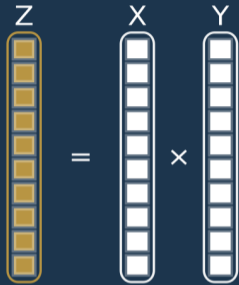


MKL



# Simple Examples

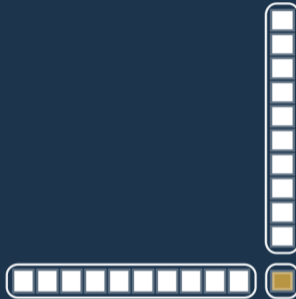
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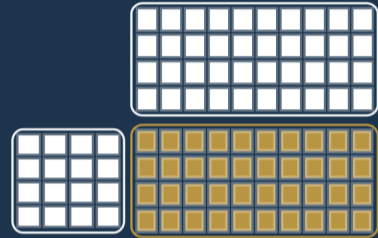
## Reduction



## Dot Product



## Matrix Product



MKL



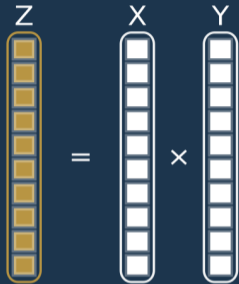
Eigen





# Simple Examples

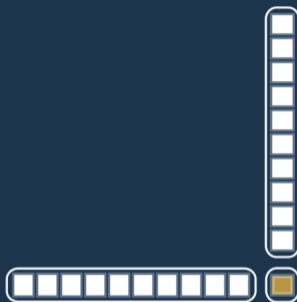
## Hadamard Product



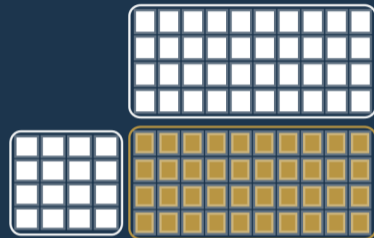
## Reduction



## Dot Product



## Matrix Product



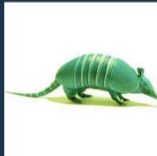
### MKL



### Eigen

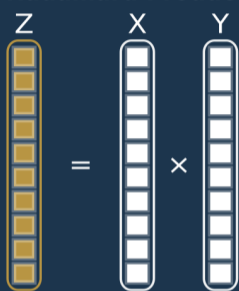


### Armadillo



# Simple Examples

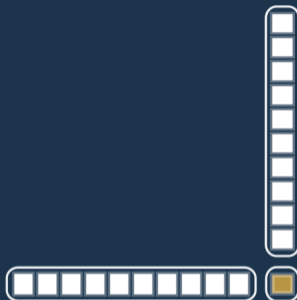
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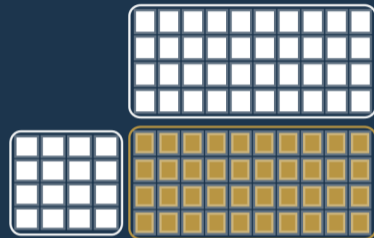
## Reduction



## Dot Product



## Matrix Product



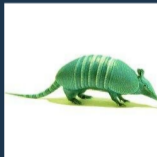
### MKL



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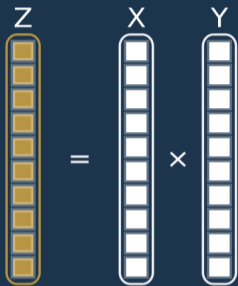


### Armadillo



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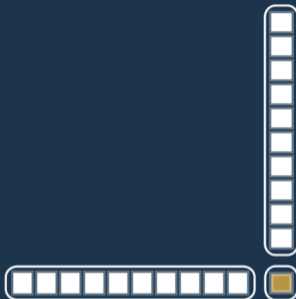
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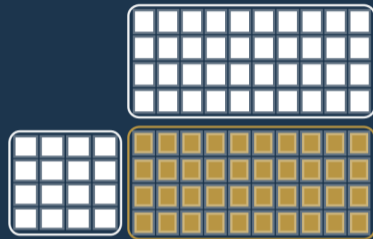
## Reduction



## Dot Product



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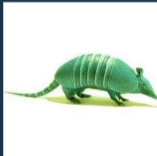
### MKL



### Eigen

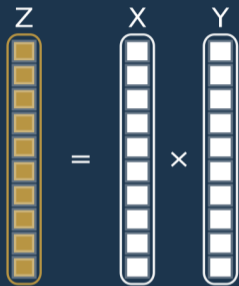


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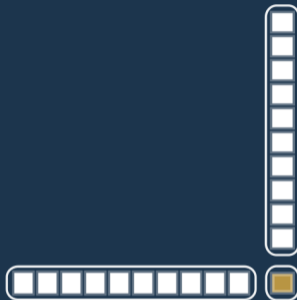
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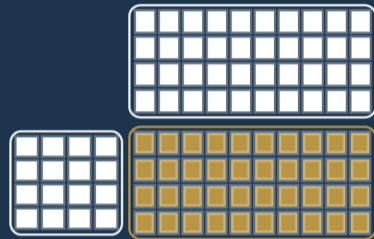
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## Dot Product



## Matrix Product



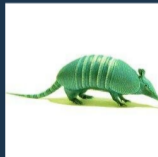
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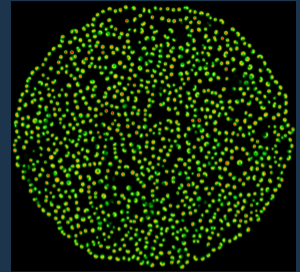
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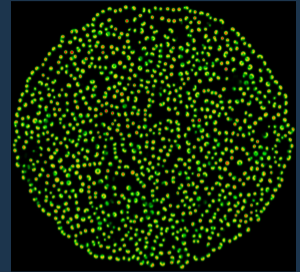
### Armadillo



Gray Scott reaction (a chemistry game of life)



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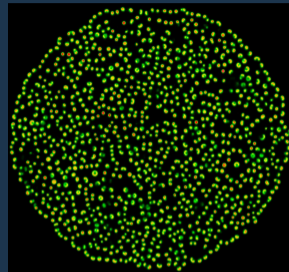
Gray Scott reaction (a chemistry game of life)



Computing :

$$\frac{\partial u}{\partial t} = r_u \nabla^2 u - uv^2 + f_r \times (1 - u)$$

$$\frac{\partial v}{\partial t} = r_v \nabla^2 v + uv^2 - (f_r + k_r) \times v$$



- ▶  $u$  and  $v$  are concentration of product **U** and **V**
- ▶  $r_u$  and  $r_v$  diffusion rate of **U** and **V**
- ▶  $k_r$  (**Kill Rate**), conversion rate from **V** to **P**
- ▶  $f_r$  (**Feed Rate**), speed of process which feed **U** and kills **V** and **P**
- ▶  $\nabla^2 u$  and  $\nabla^2 v$  are différence of space concentration between current cell and its neighbours

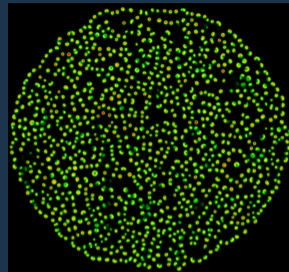
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- ▶  $\nabla^2 u$  and  $\nabla^2 v$  are différence of space concentration between current cell and its neighbours
- ▶ Easy to understand
- ▶ Not so easy for the compiler
- ▶ Possibility of high speed up



- ~ **40** Attendees
- **21** - **56** years old
- **Ingeneers, PhD Students, Students, Researchers or Professors :**
  - **ONERA, Collège de France, INRIA, CEA, CNRS, CERN, GANIL,**
  - **ENS** (Lyon, Paris-Saclay),
  - **Université** (Bordeaux, Aix-Marseille, Paris-Saclay, La Rochelle, Lyon1, Savoie-Mont-blanc)

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### **Satisfaction Globale :**

Satisfait (50.00%), Très Satisfait (50.00%)

### **L'école a-t-elle répondu à vos attentes ?**

Totalement: (50.00%), Au delà de mes attentes: (50.00%)

### **Etes-vous satisfait de l'organisation générale de l'école ?**

Satisfait (50.00%), Très Satisfait (50.00%)





- **Association**
- **Valorisation / Dissemination** of Knowledge :  
**Schools / Seminars / Interviews**
- **Bridge** between **Academy** and **Industry**

France



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## EuroCC (Catalog of HPC/HTC/HPDA formations)

France



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+33 Countries



## EuroHPC

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+33 Countries





**4 Days @ LAPP**

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**4 Days @ LAPP**



**Fortran**

4 Days @ LAPP



Fortran



4 Days @ LAPP



Fortran



4 Days @ LAPP



Fortran



4 Days @ LAPP

TBB



Fortran



4 Days @ LAPP

TBB



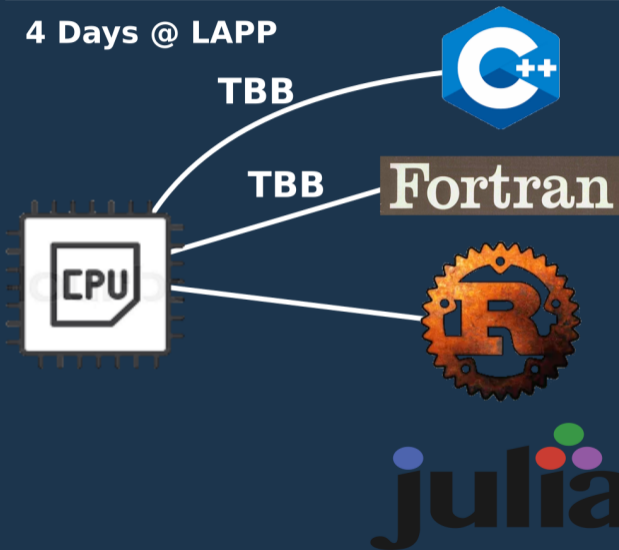
TBB

Fortran



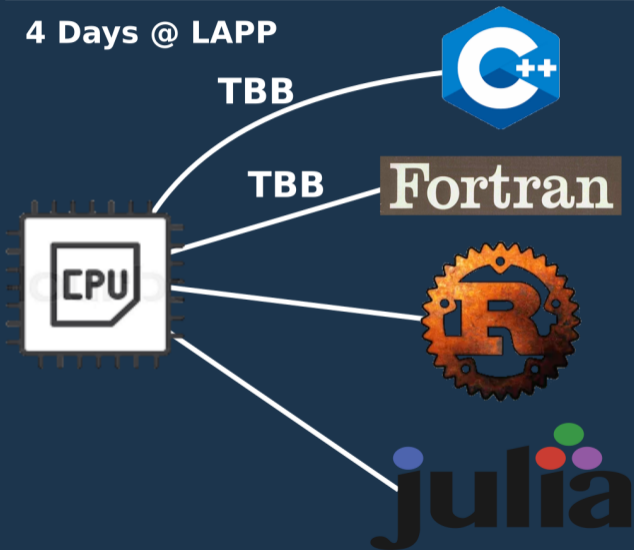


4 Days @ LAPP

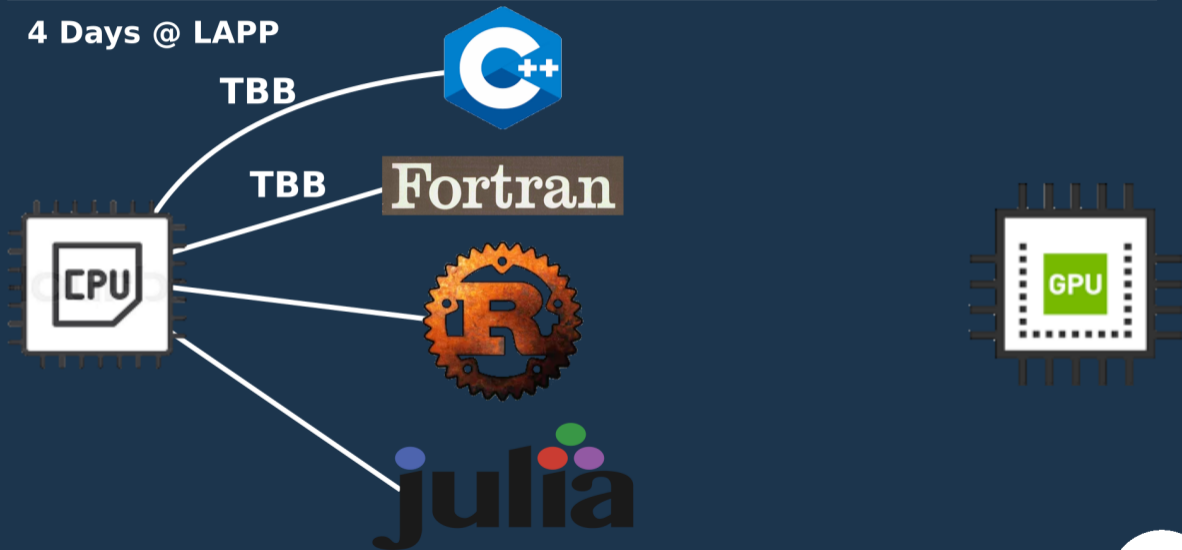


julia

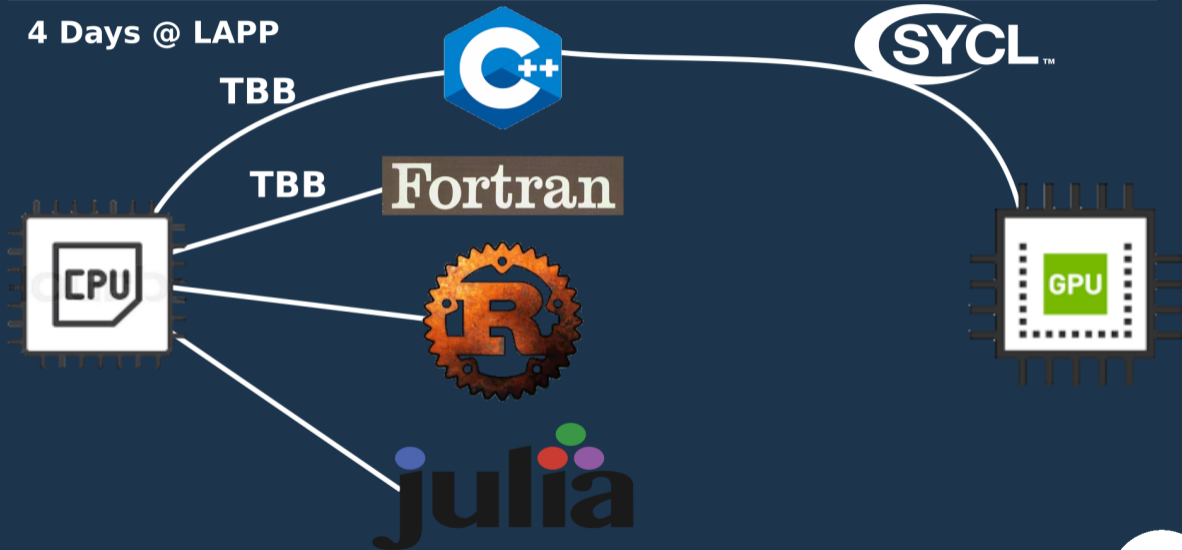
4 Days @ LAPP



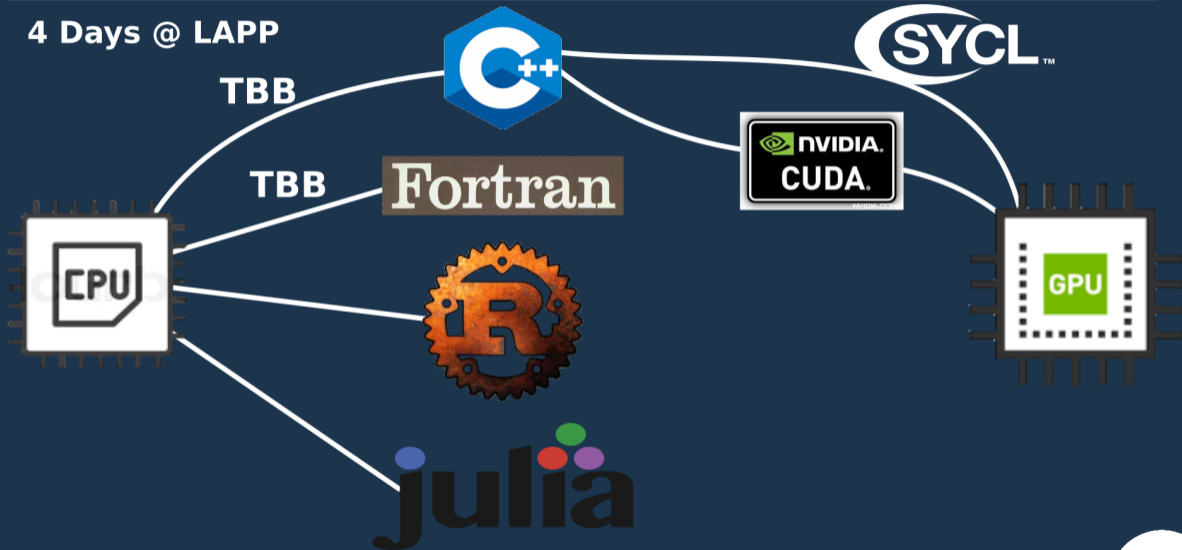
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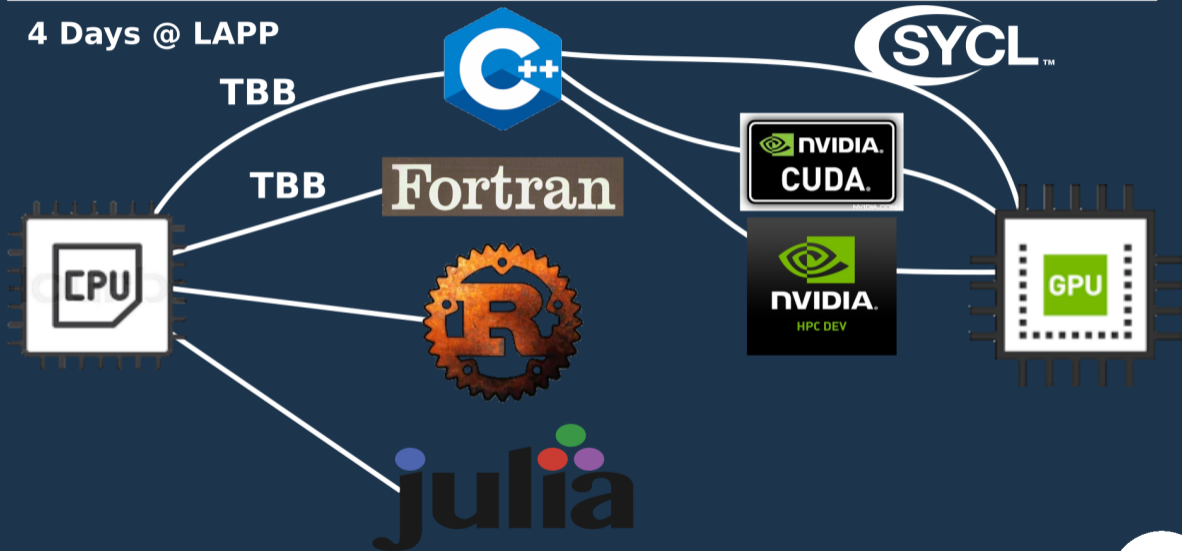
4 Days @ LAPP



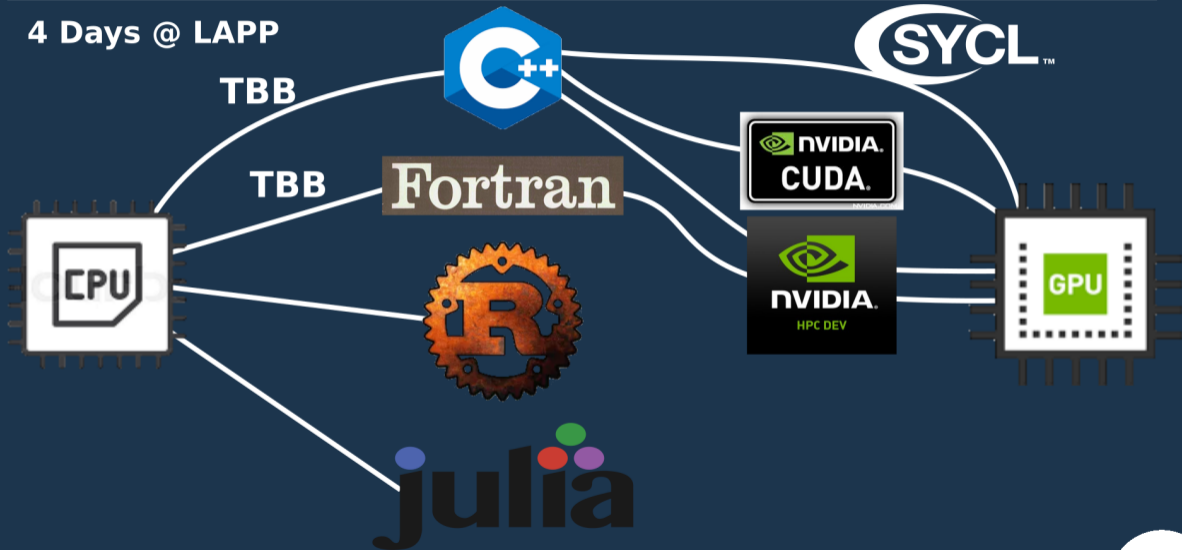
4 Days @ LAPP



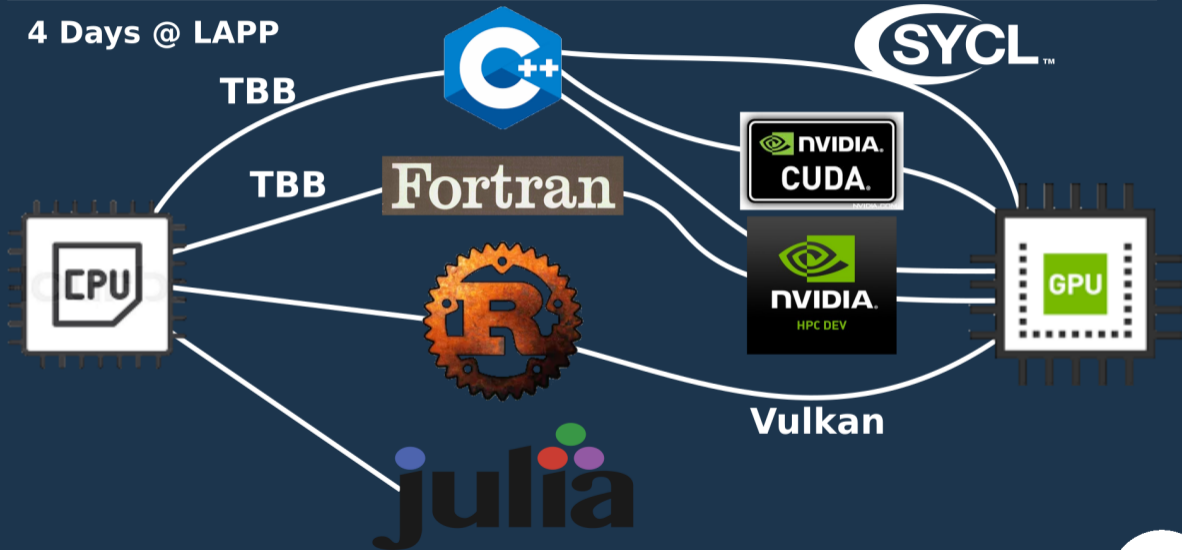
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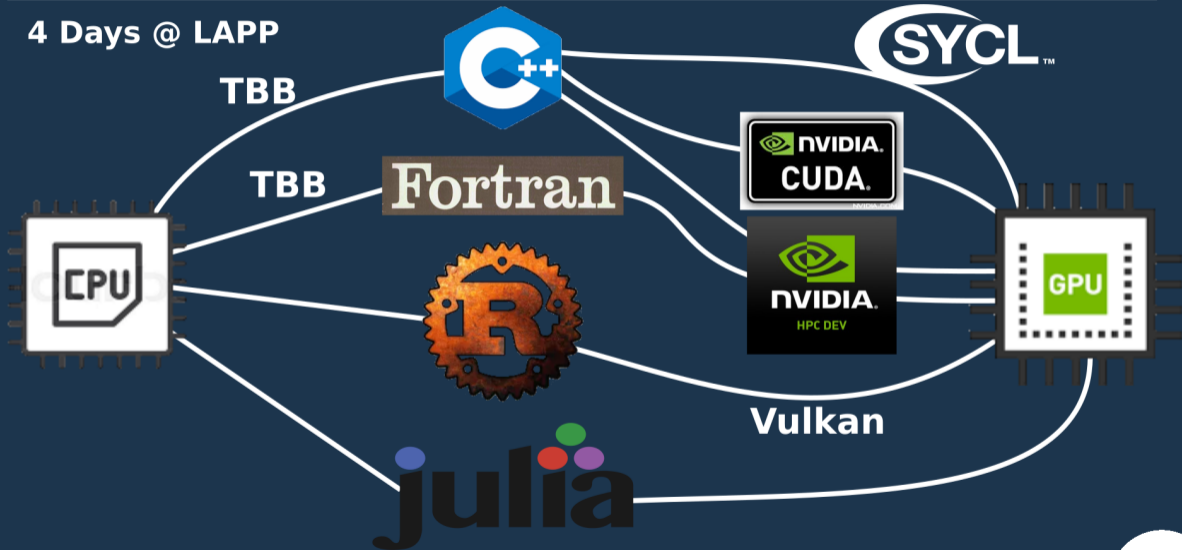


4 Days @ LAPP

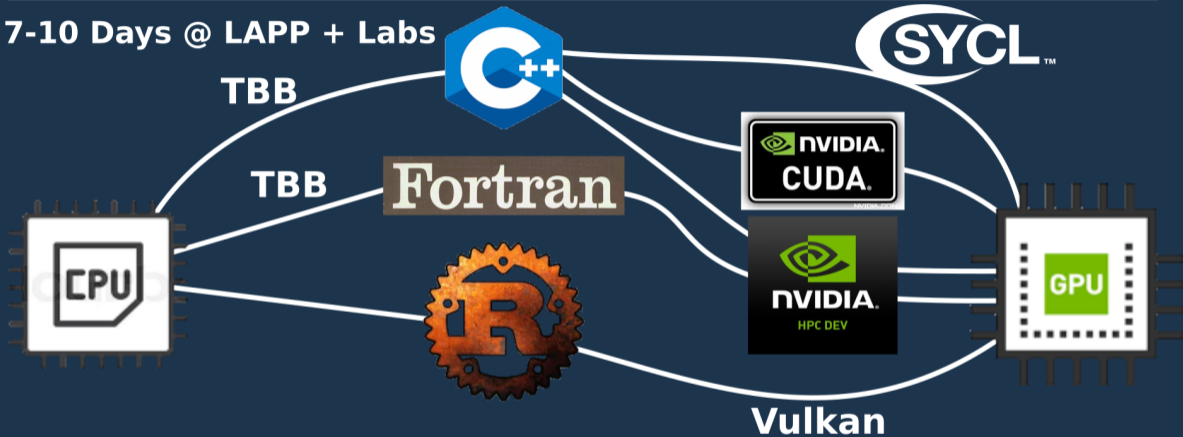




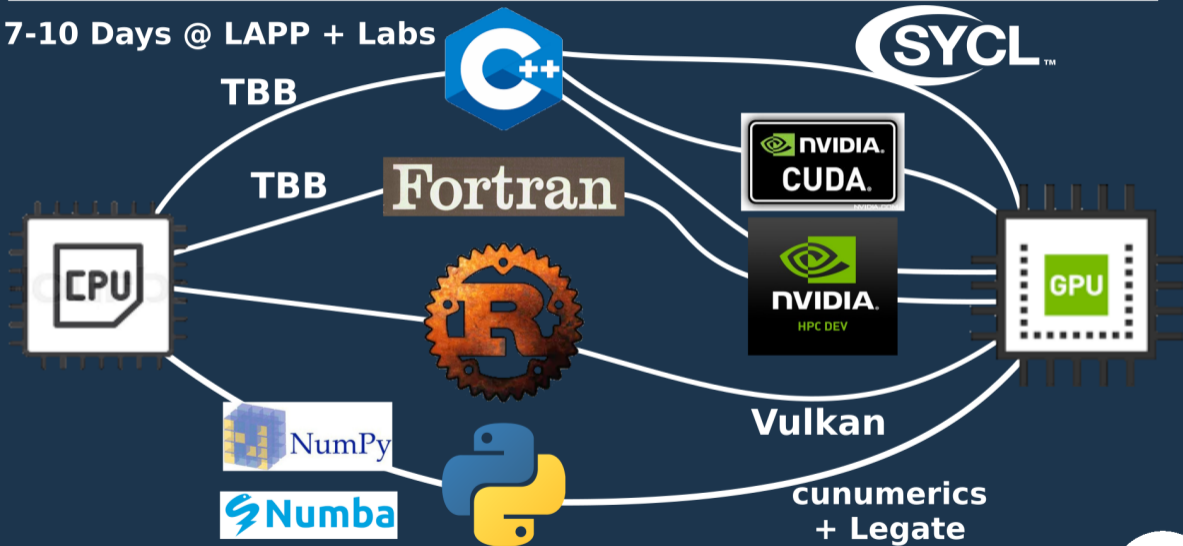
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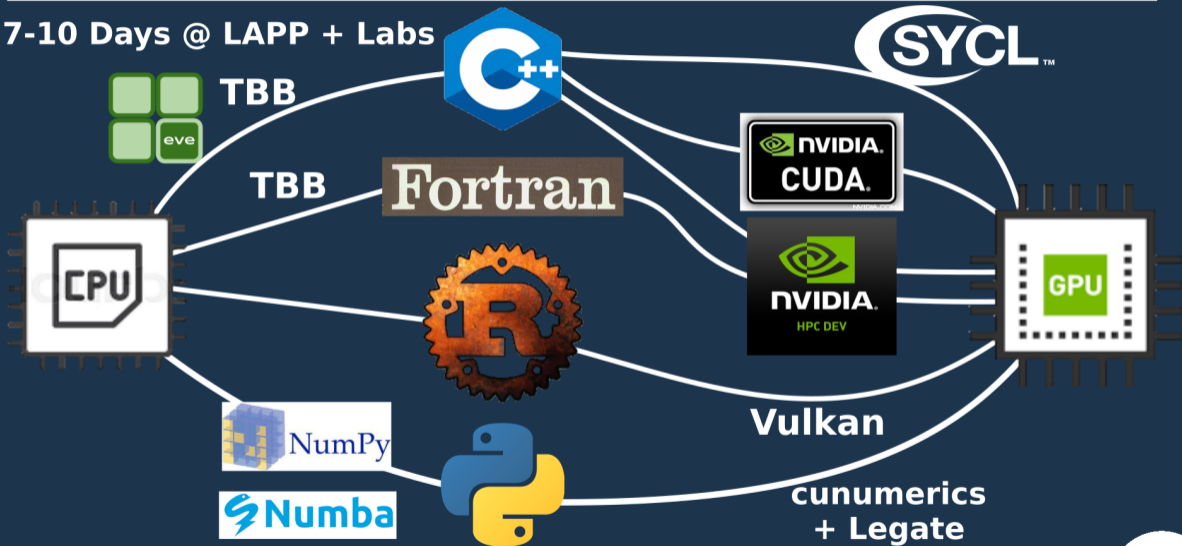
7-10 Days @ LAPP + Labs



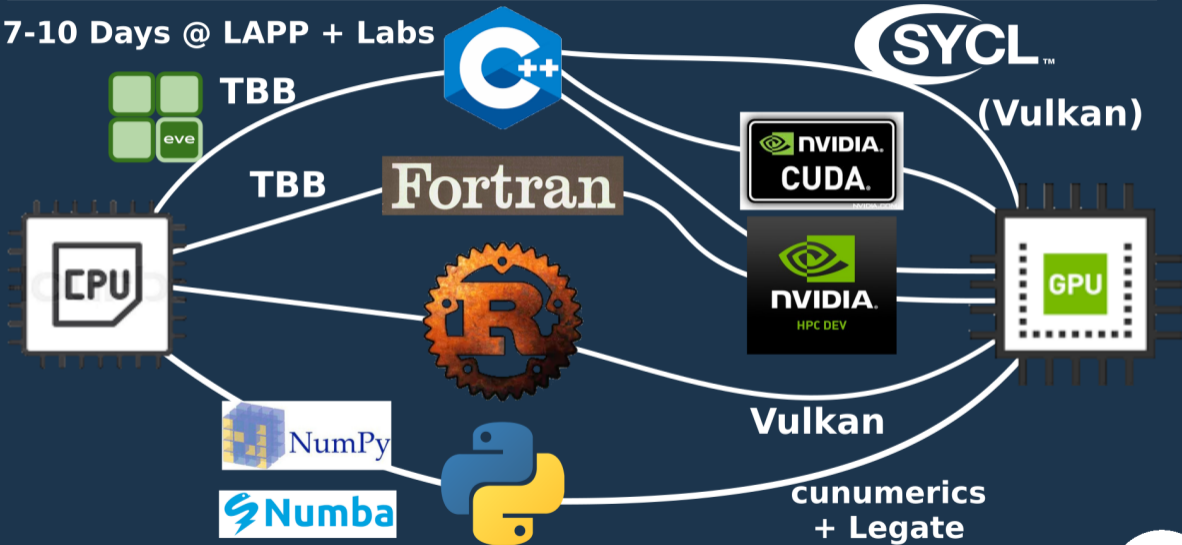
7-10 Days @ LAPP + Labs



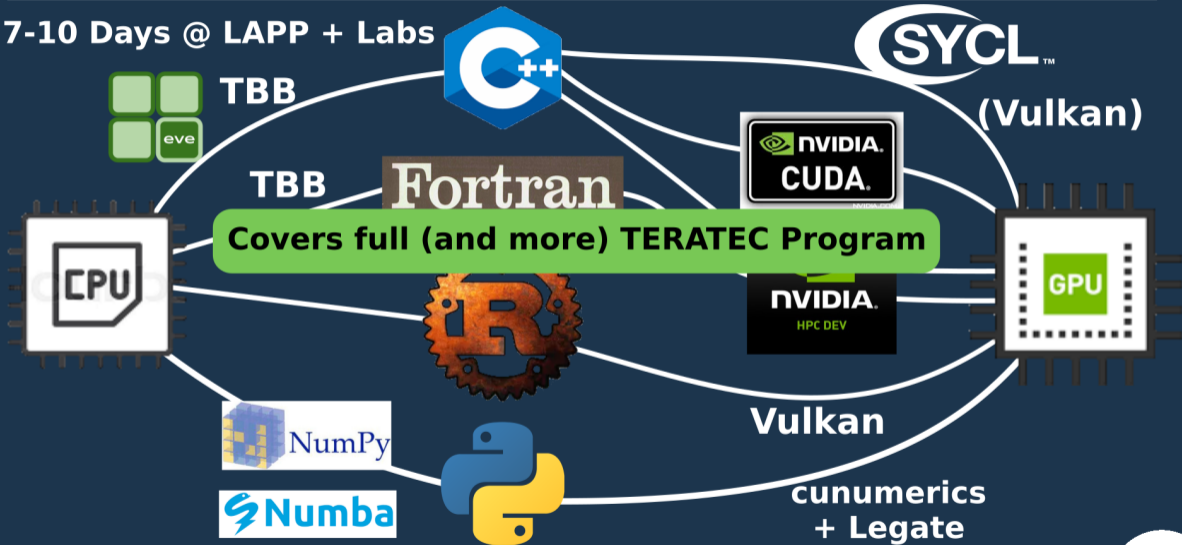
7-10 Days @ LAPP + Labs



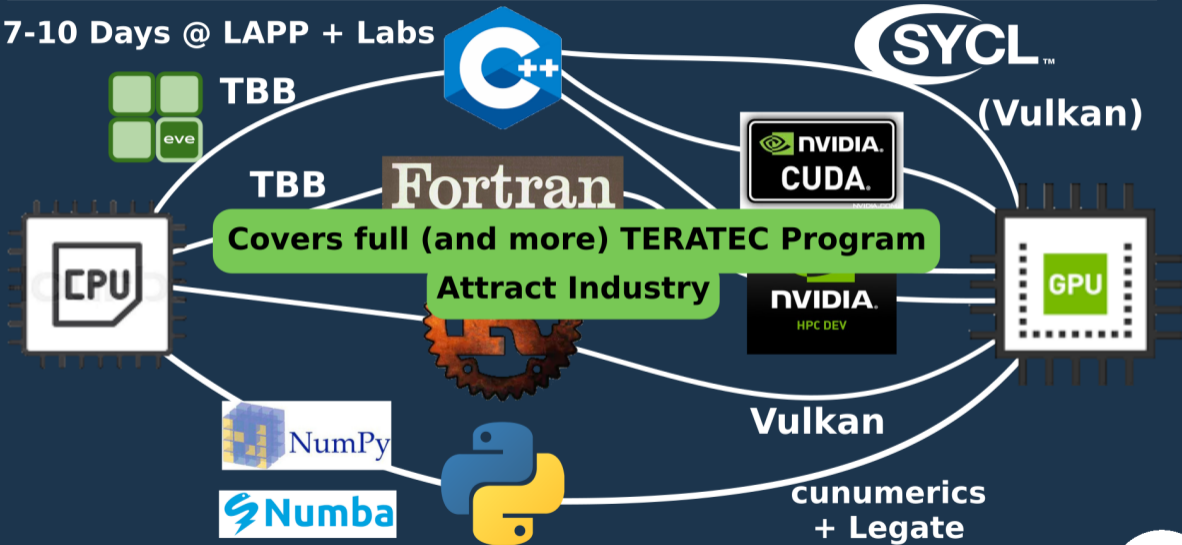
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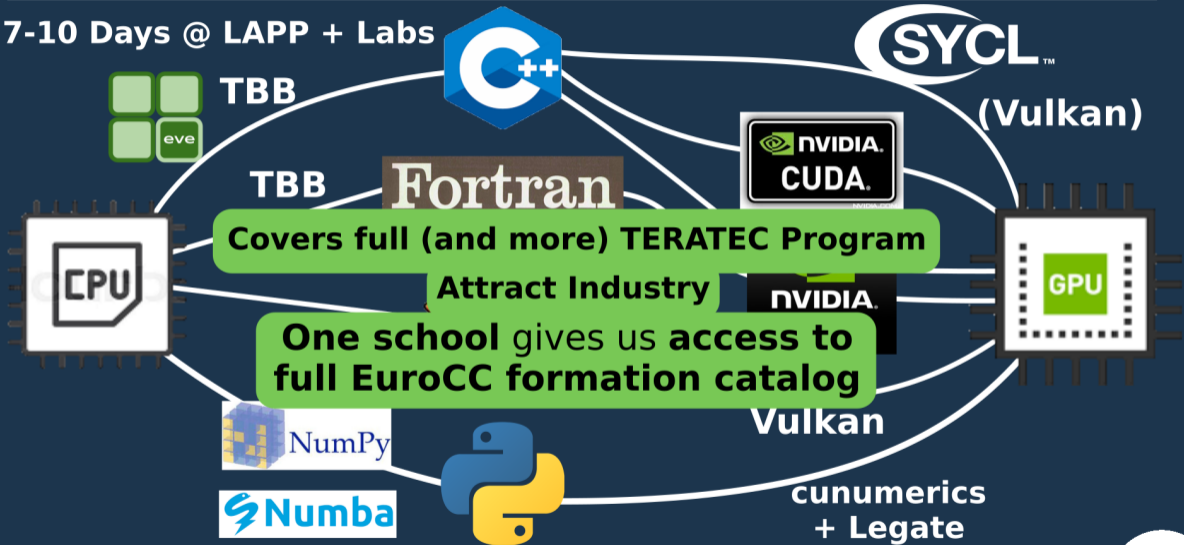
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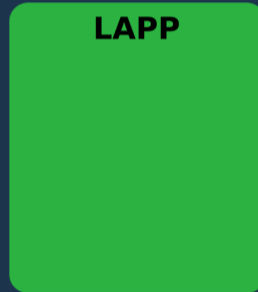
7-10 Days @ LAPP + Labs







# Multi-site diffusion



**LAPP**  
~ 40 people

**LAPP**

**~ 40 people**

**Teachers : 6-7**

**LAPP**

**~ 40 people**

**Teachers : 6-7**

**Webcast CC IN2P3  
x4-5**

**LAPP**

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**Industry**

**LAPP**

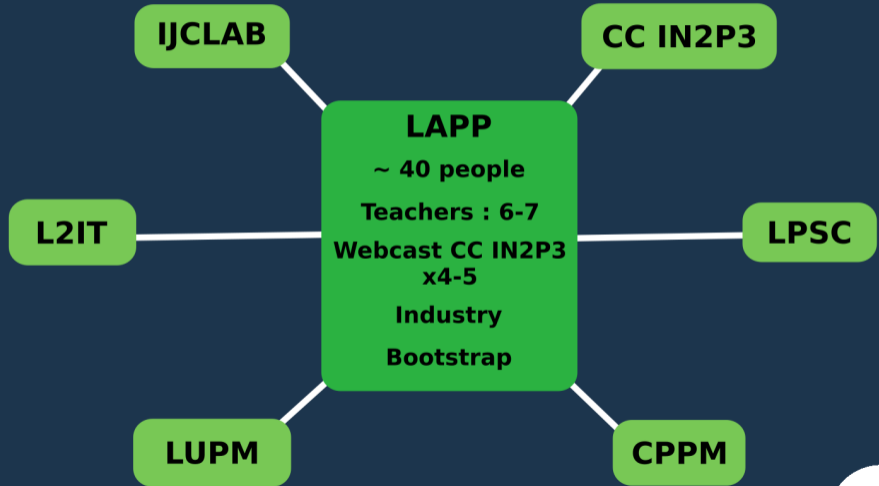
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**Teachers : 6-7**

**Webcast CC IN2P3  
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**Industry**

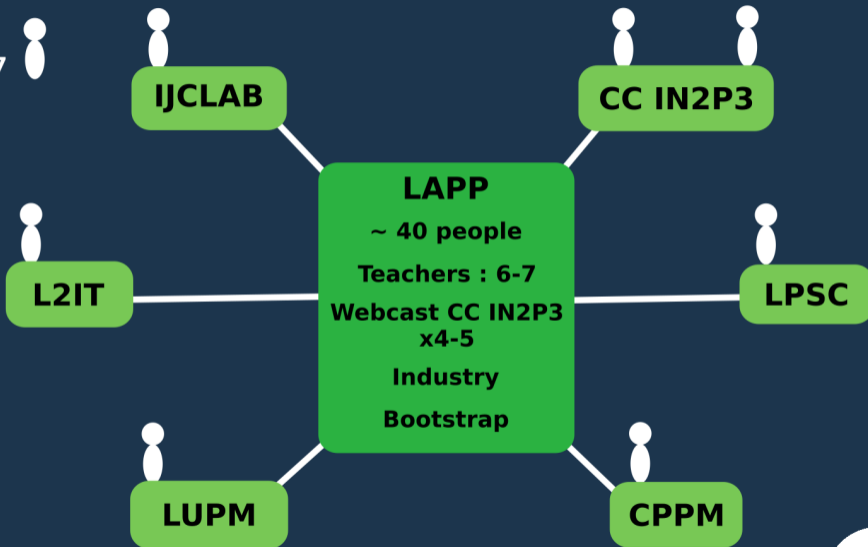
**Bootstrap**



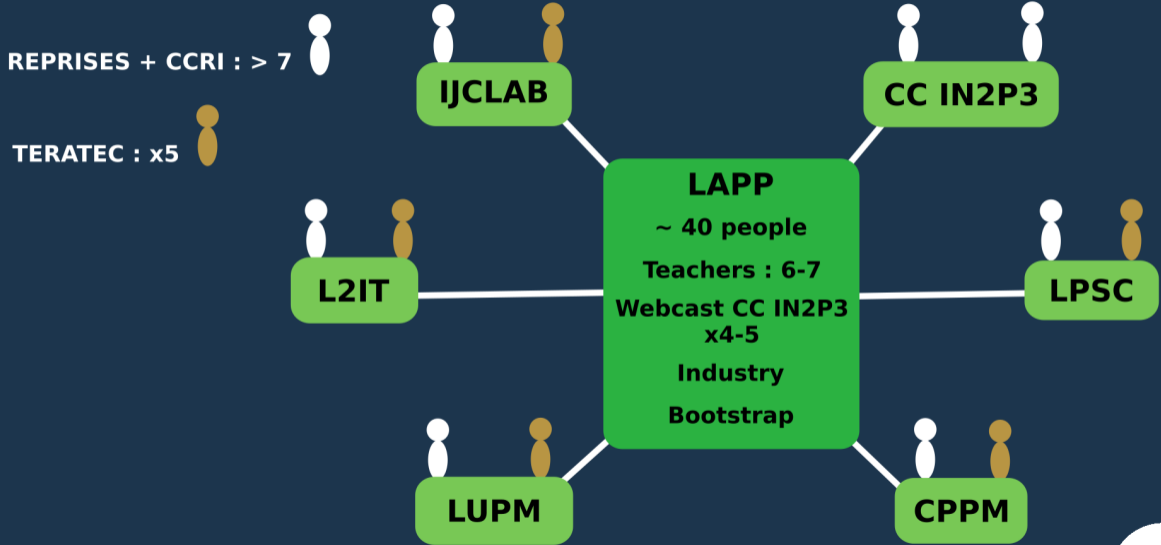


# Multi-site diffusion

REPRISES + CCRI : > 7



# Multi-site diffusion



- **TERATEC** partnership :
  - **Highlight** Laboratoires
  - **Seminars**
  - **Conferences**
  - **Opportunities** with industrials
  - **Fête de la science**
  - **Eutopia**
  - Connection with **CCRI** :
    - **Webinars / Techninars**
    - Highlight **Journées Informatique**