TEACHING HPC IN DEVELOPING COUNTRIES: A CASE STUDY IN MEXICAN UNIVERSITIES

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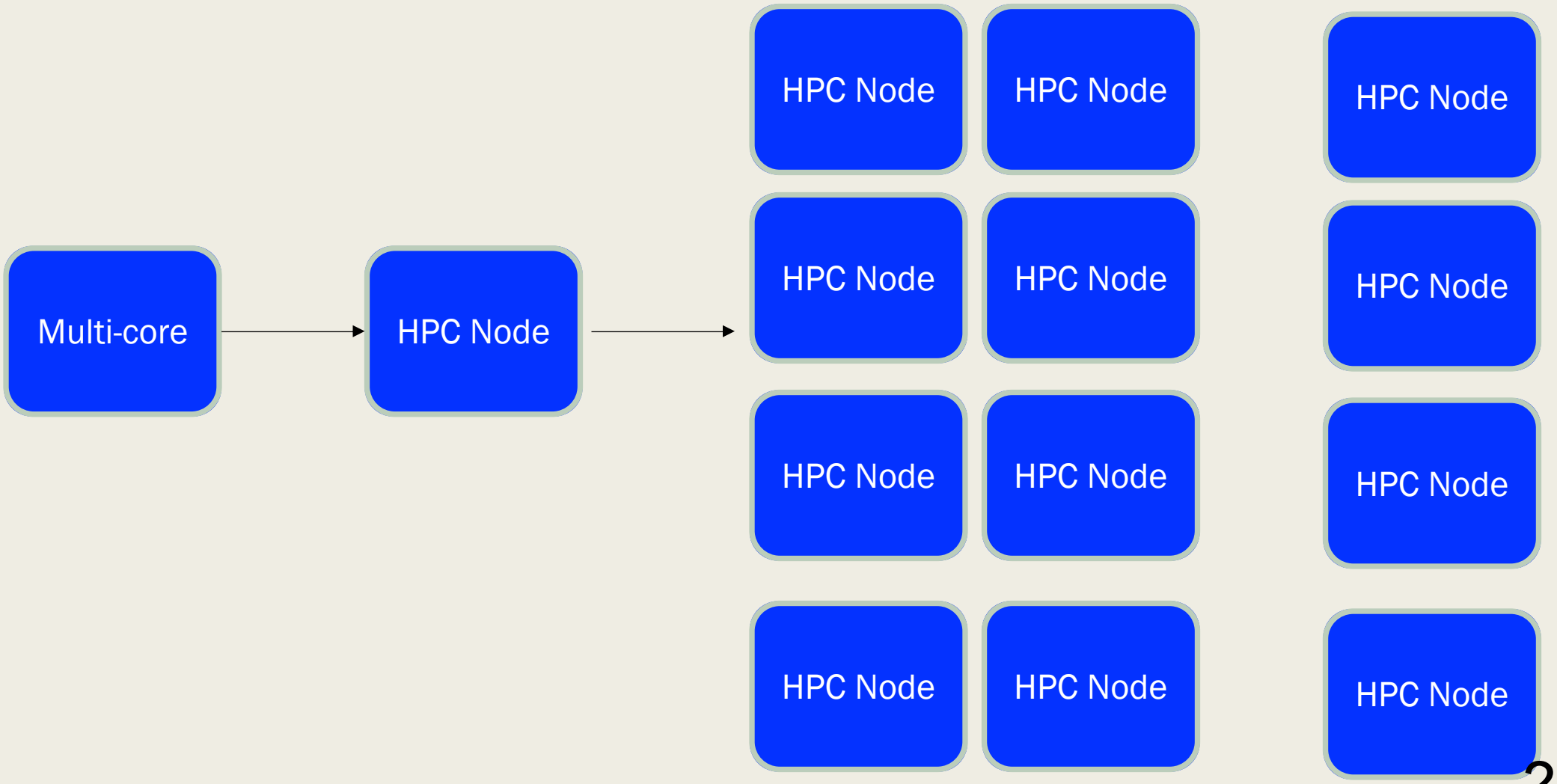
Motivation


Multi-core
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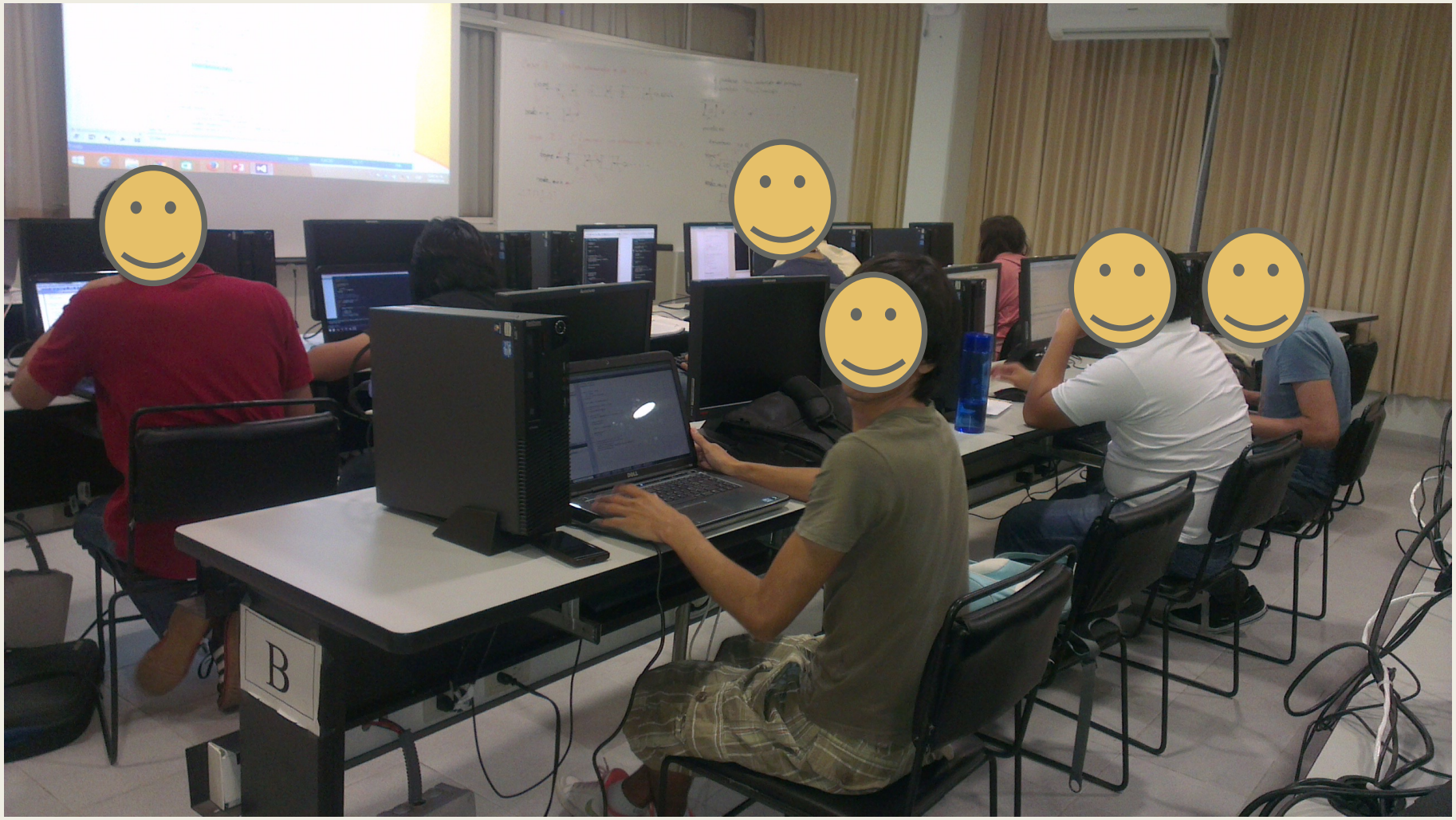
Motivation

- Most of students in Mexican Universities

Multi-core

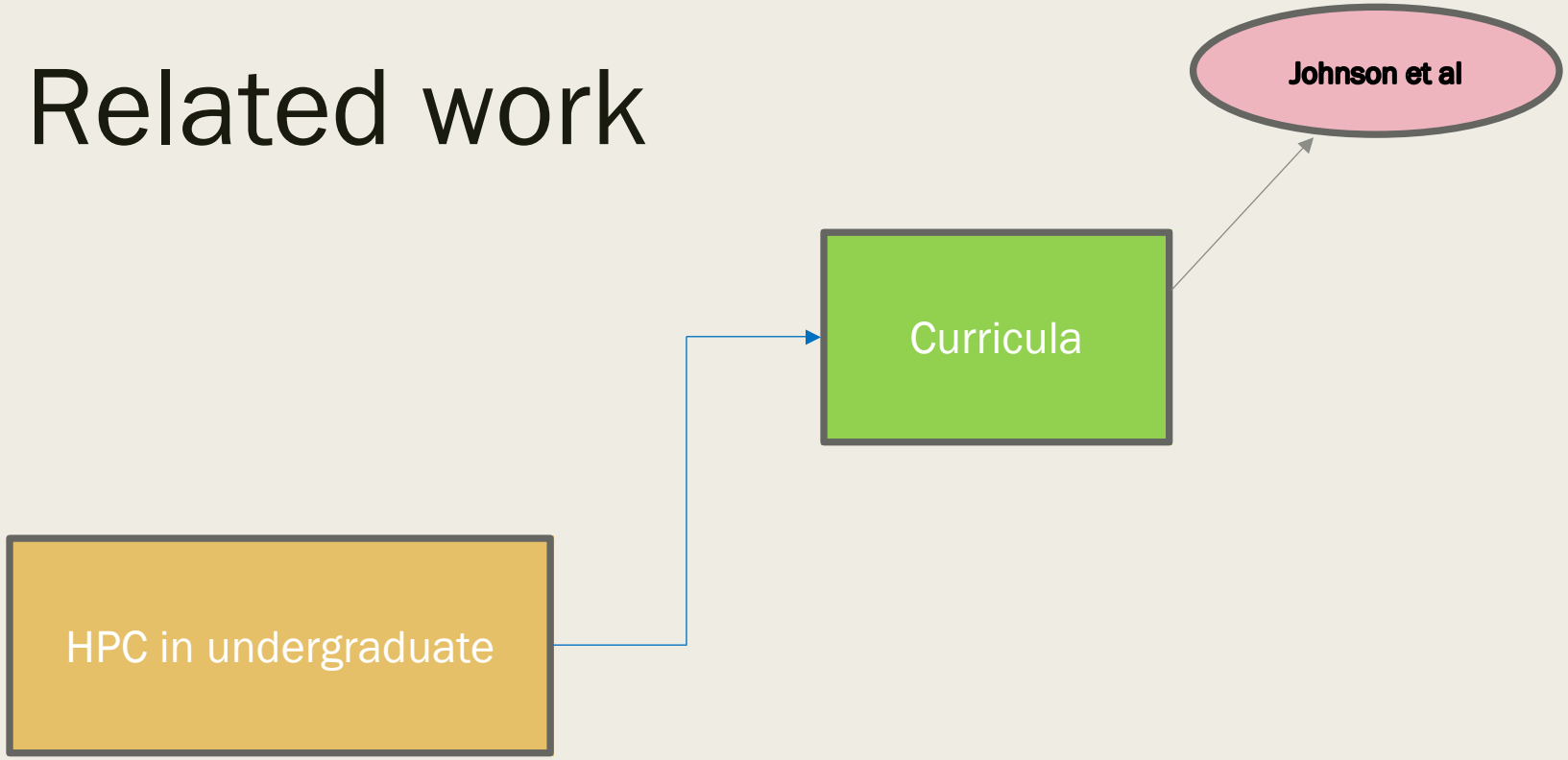
Motivation



Related work

HPC in undergraduate

Related work



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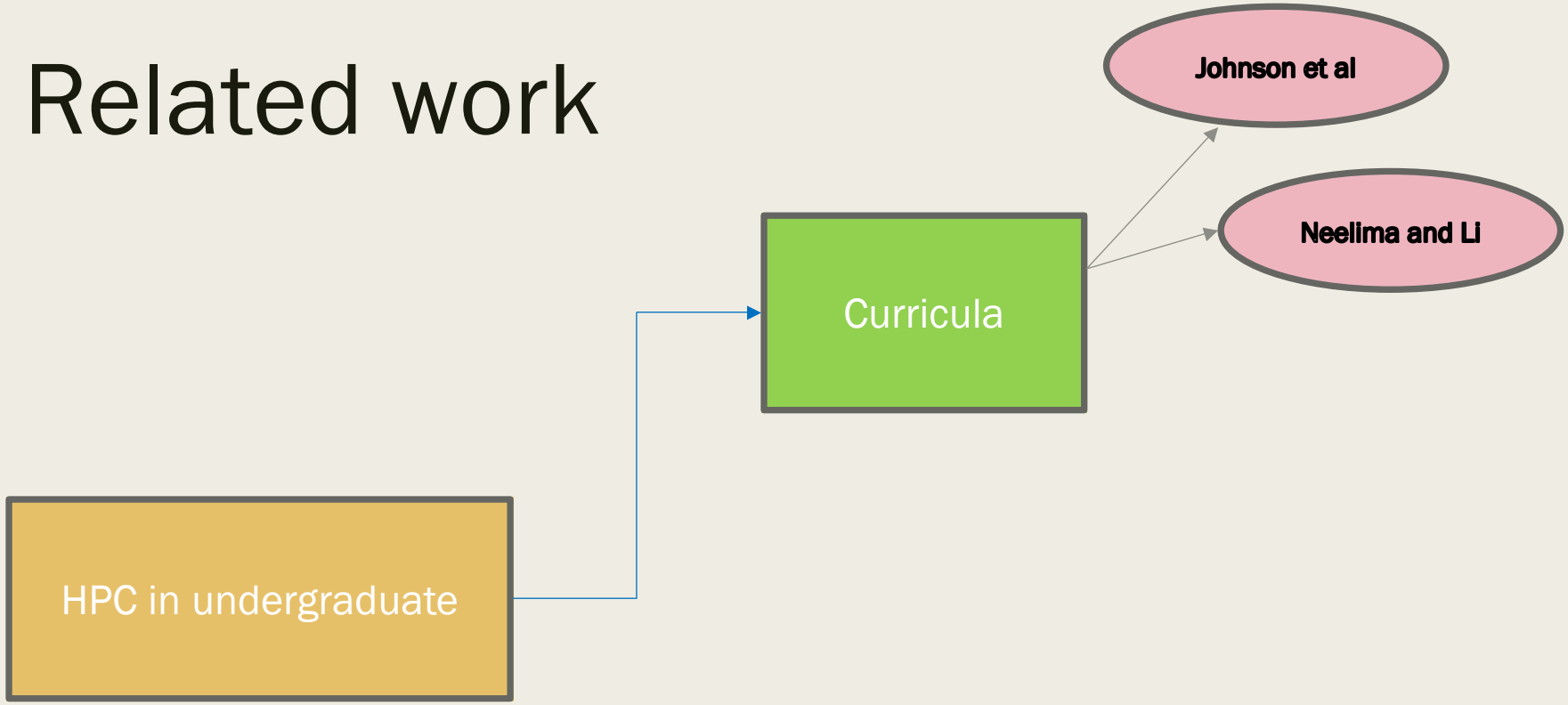
Related work



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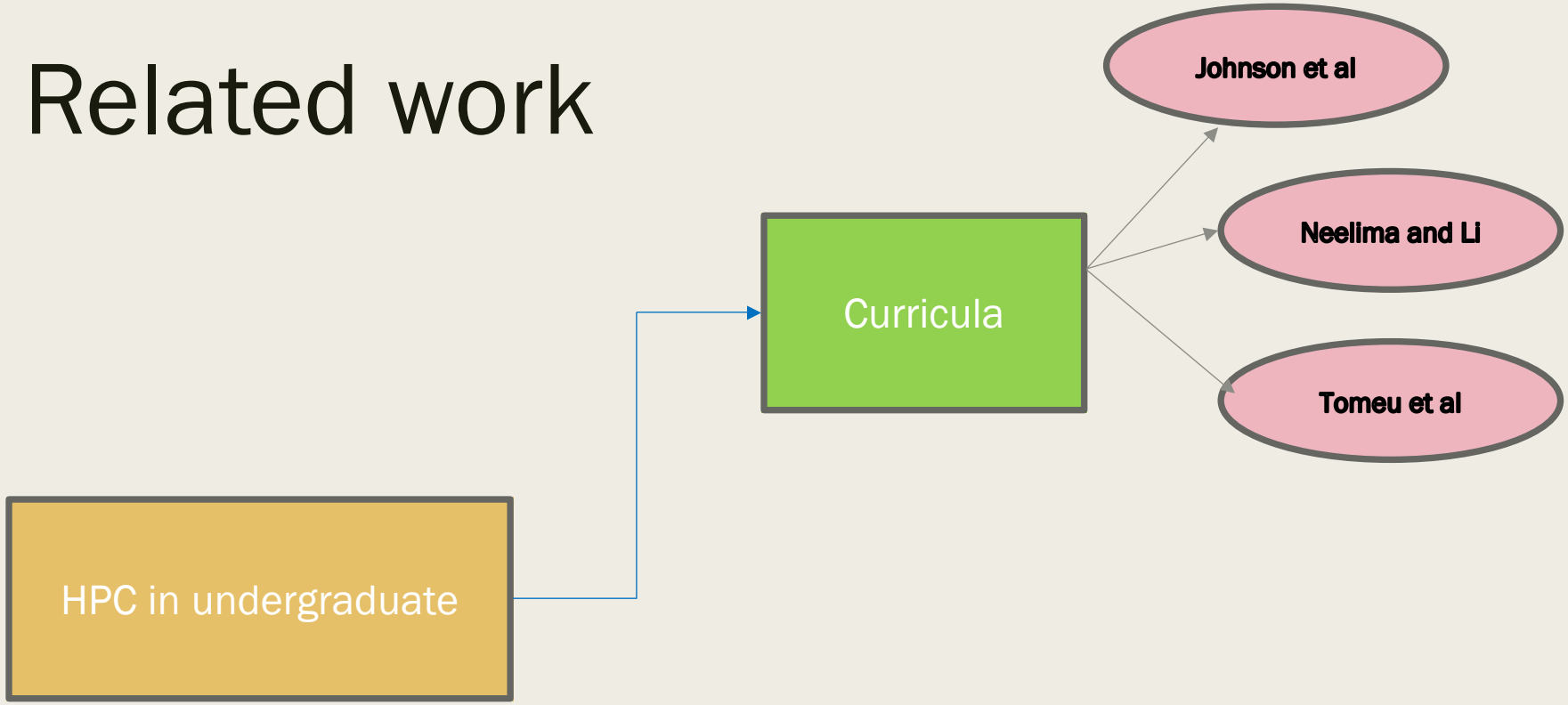
Related work



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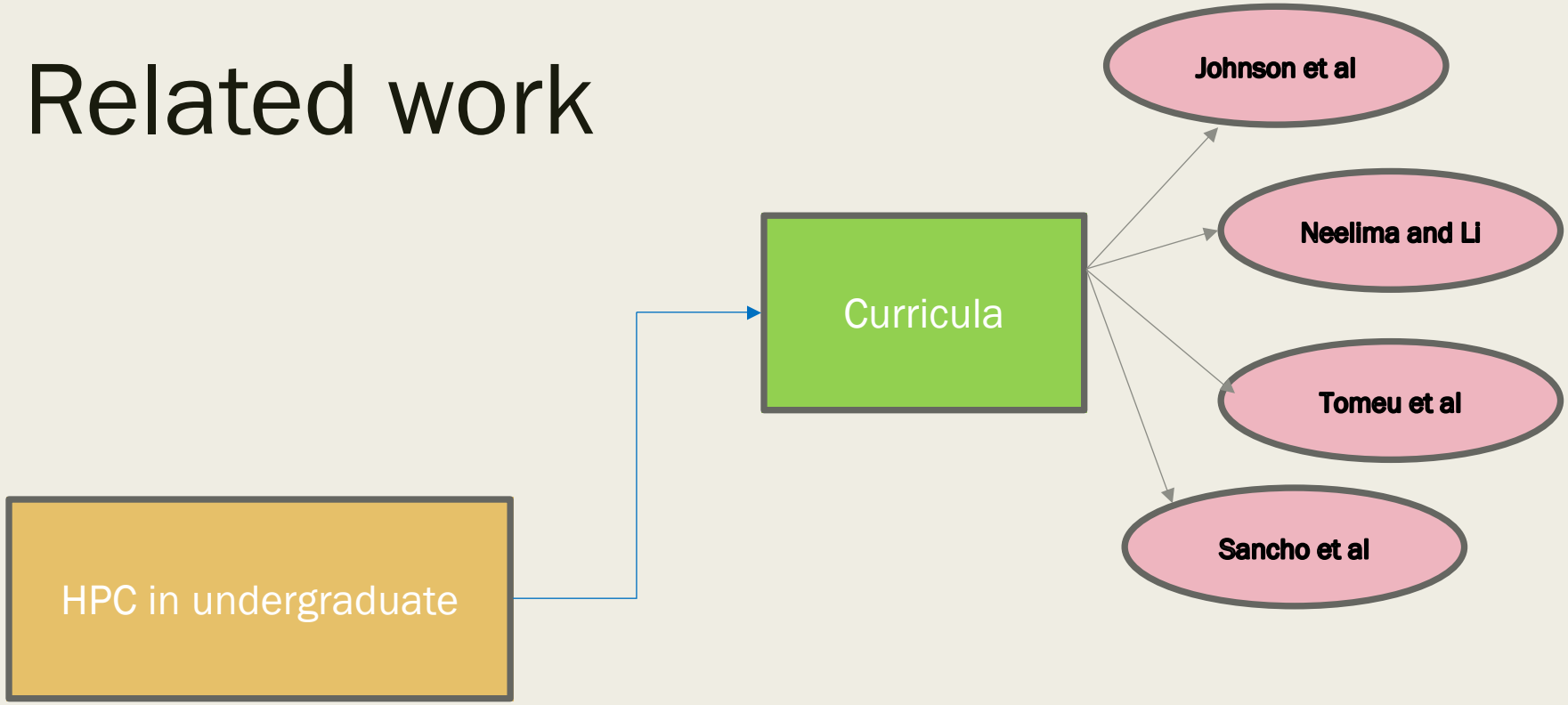

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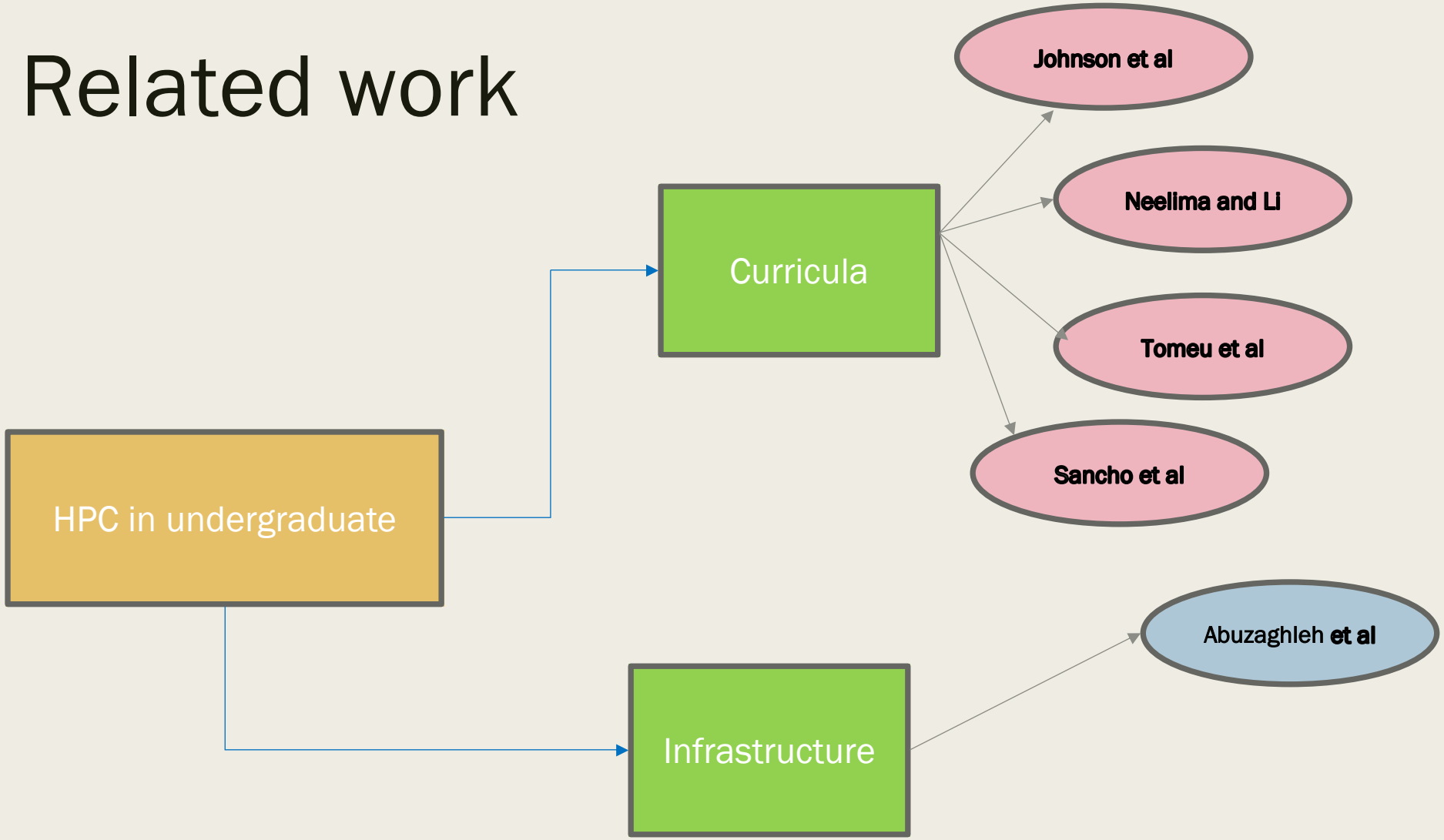
Related work



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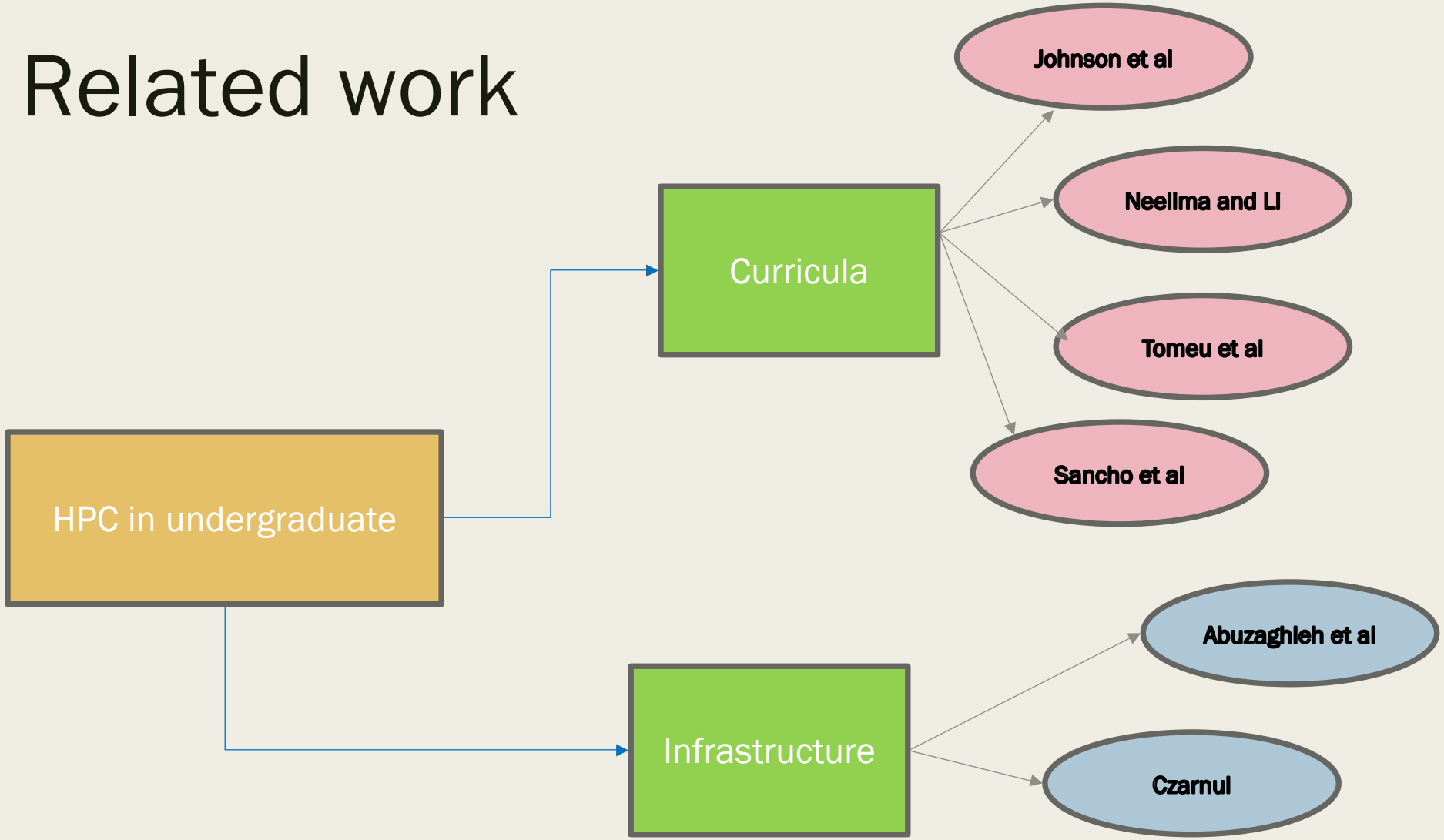
Related work



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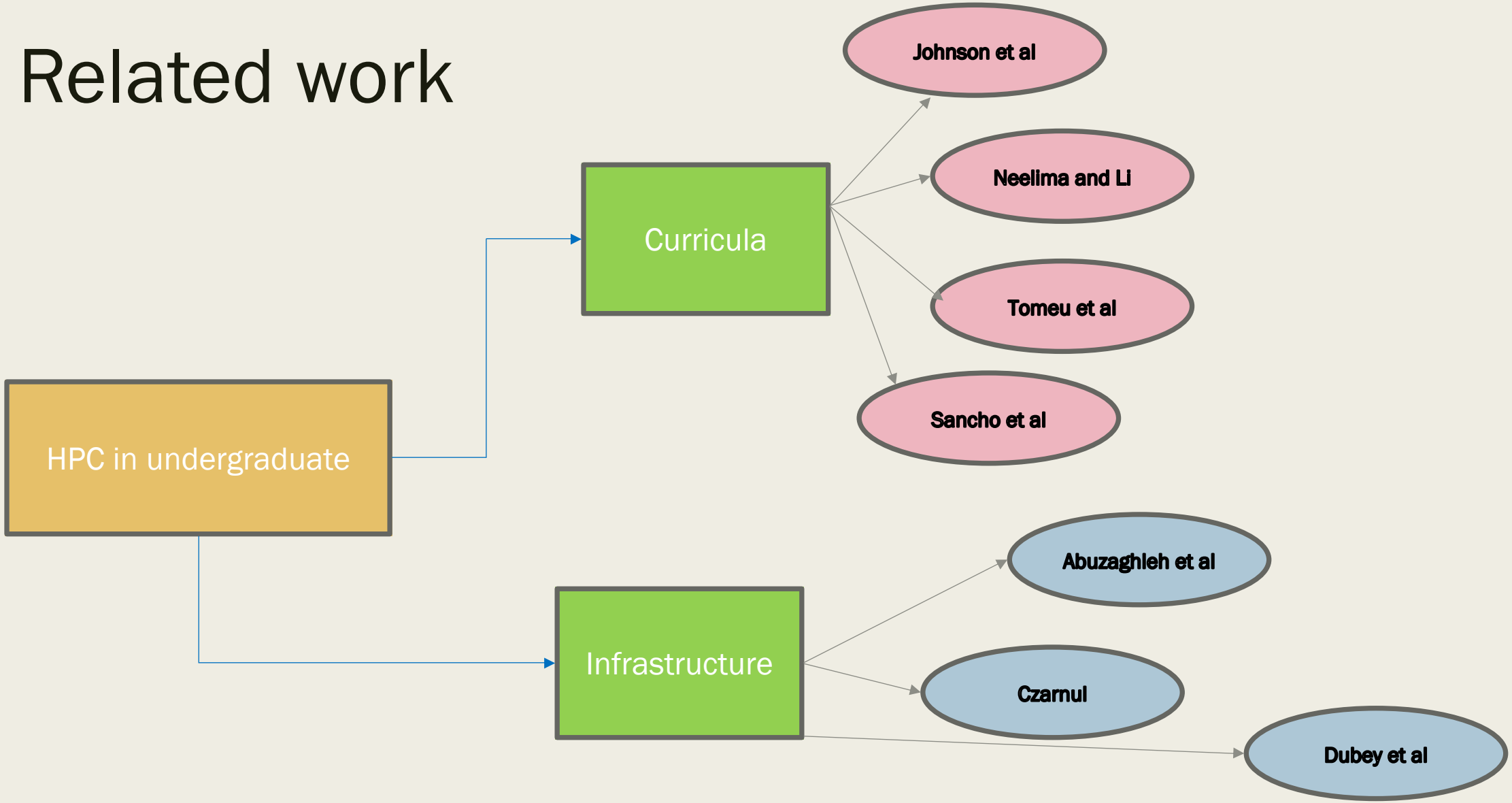
Related work



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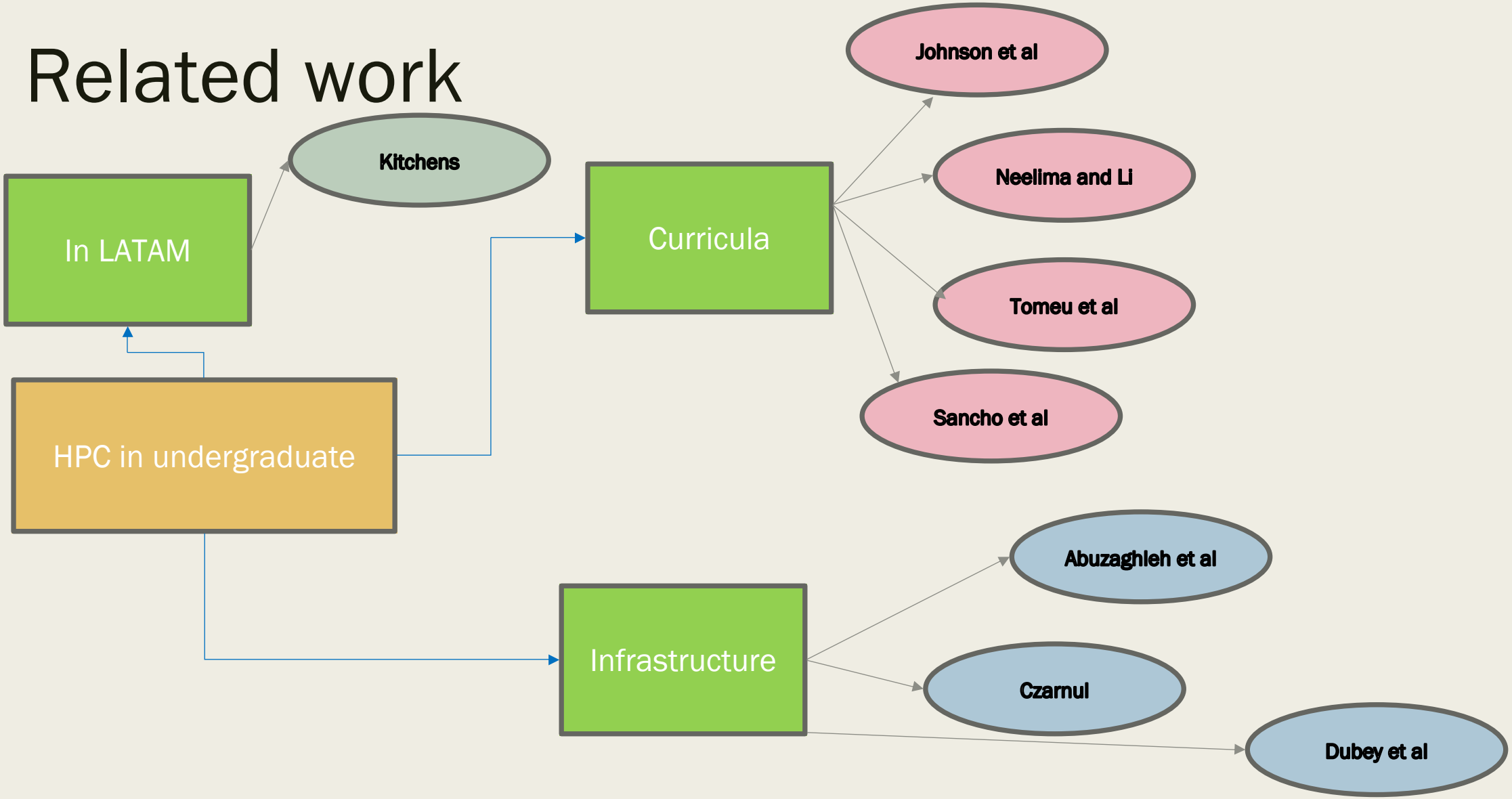

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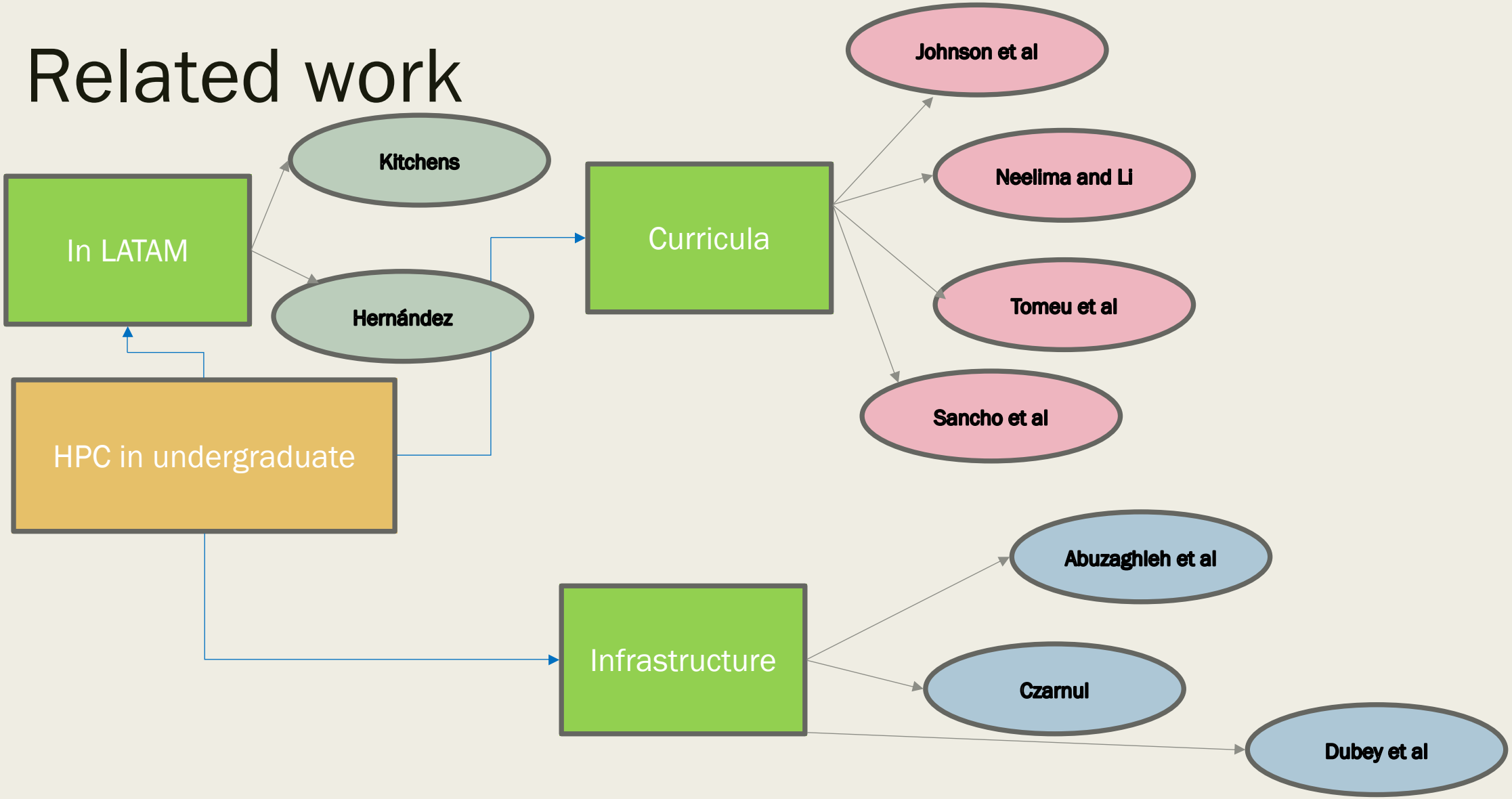

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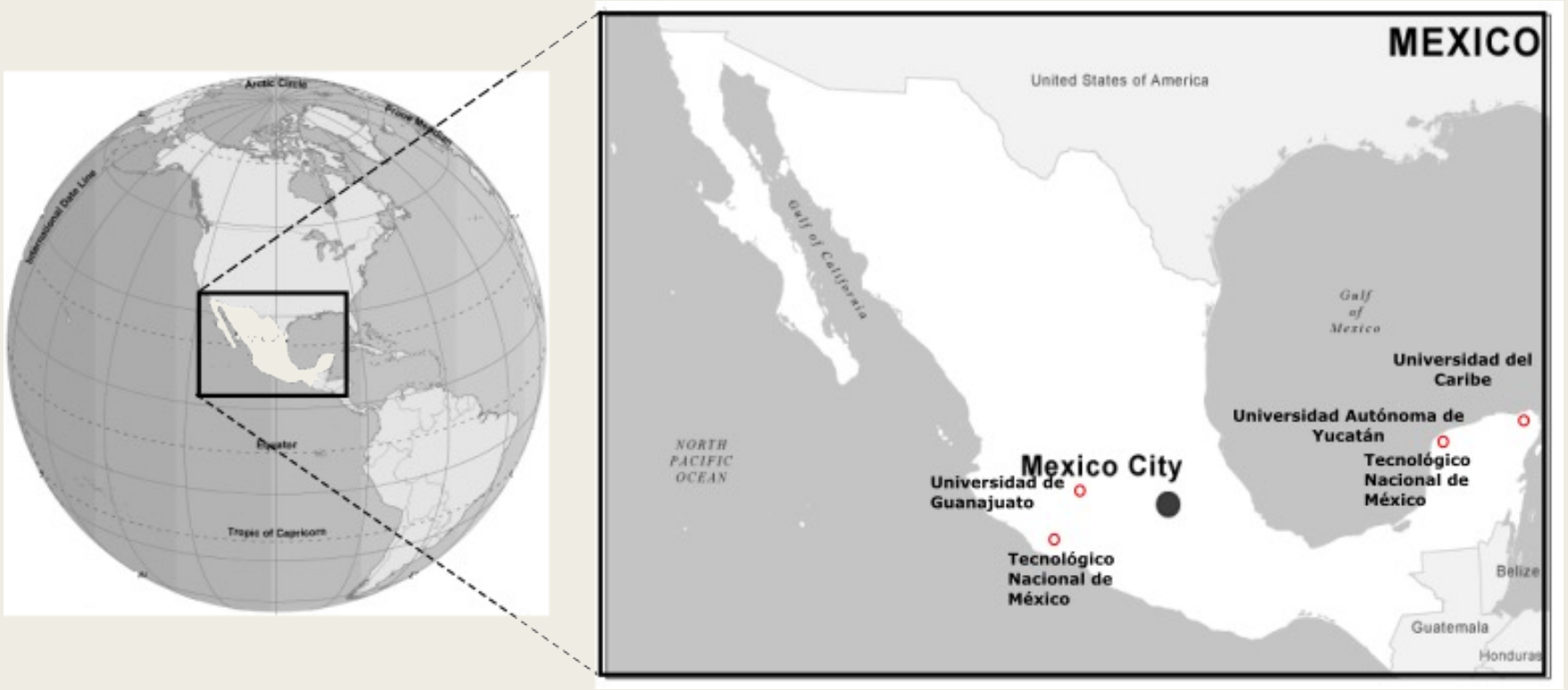
Our case study



Challenges of teaching HPC in our case study

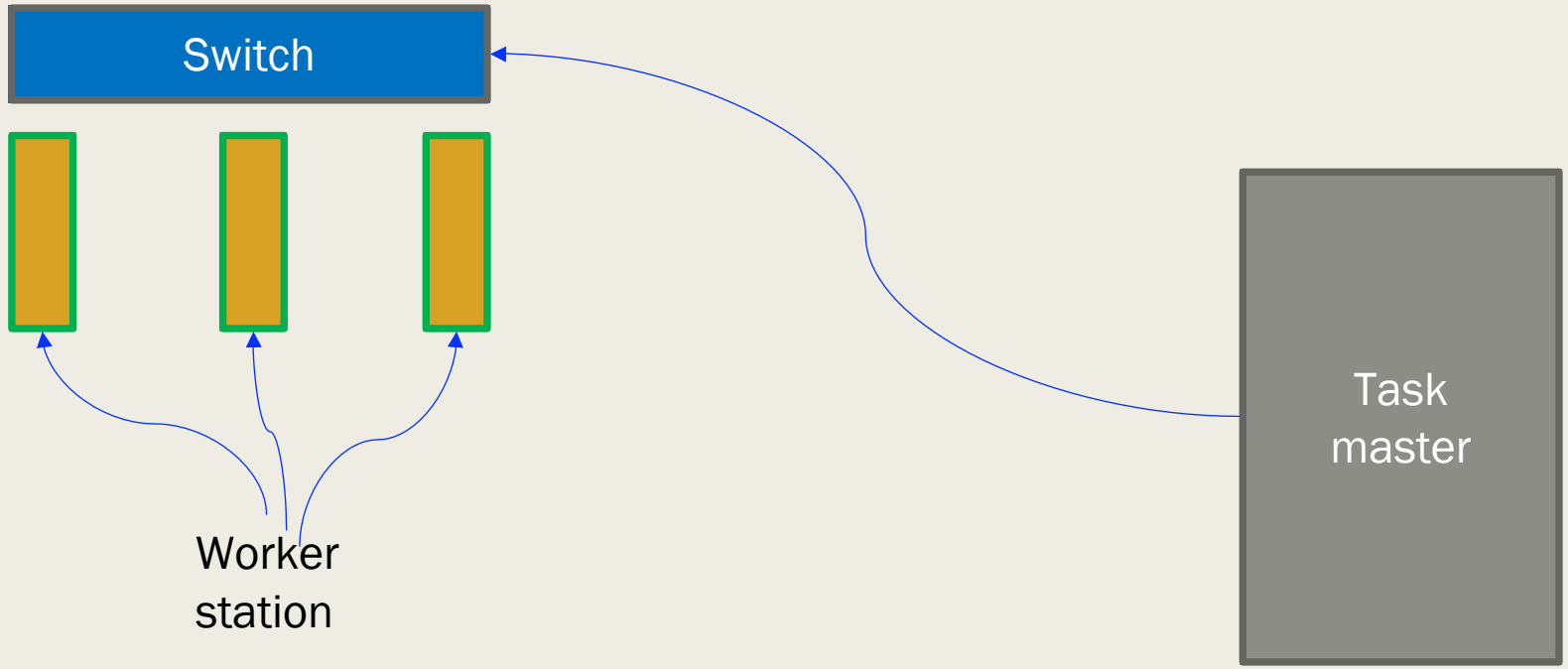
- HPC infrastructure
- Parallel programming (with no infrastructure)
- Domain specific problems
- COVID-19

Strategies to incorporate HPC into the universities of the case study

- Design of an effective infrastructure
- Development of parallel/distributed programs
- Domain specific problems
- Teaching HPC in the COVID-19 era

Design of an effective infrastructure

- Design of a Beowulf cluster



Design of an effective infrastructure

- Students of Universidad del Caribe use a set of computer with Nvidia GeForce in speciazed laboratories

Design of an effective infrastructure

- Students of UADY, and ITM- Mérida use two servers with multi-core and GPU capabilities at CIMAT-Merida
  - *Intel Xeon Gold 5222*
    - 16 hyper- threading cores
    - NVIDIA Quadro RTX 8000 with 48GB RAM
  - *Intel(R) Core(TM) i9-9920X CPU*
    - 24 hyper-threading cores
    - NVIDIA TITAN RTX with 24GB RAM

Design of an effective infrastructure

- Students of UADY, Universidad de Guanajuato and ITM- Mérida use the insurgente cluster at CIMAT
  - *32 servers*
    - One master node and 31 Slave nodes
  - *One GPU server*
  - *Five PS3 consoles*

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

Universidad del Caribe

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

Universidad del Caribe

- Object oriented programming
- Operation Research
- Design of the course “parallel computing”

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

UADY
Universidad Autónoma de Yucatán

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

UADY
Universidad Autónoma de Yucatán

- **Course Parallel Computing**
  - Introduction to parallel algorithms
  - GPU programming
  - Introduction to CUDA
  - Introduction to OpenCL

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

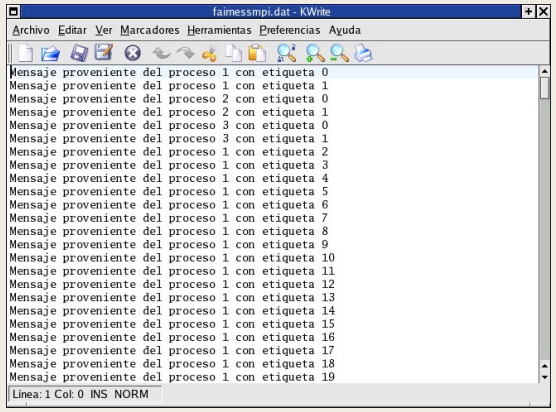
TecNM
Ciudad Guzmán

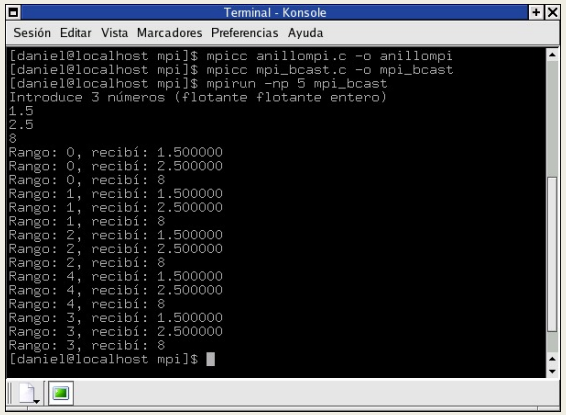
Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

TecNM
Ciudad Guzmán

- Advanced topics for programming
- Client/server programming





Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

TecNM
Mérida

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

- Advance Programming and Parallel Computing Techniques
- CUDA programming

TecNM
Mérida

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

Universidad de Guanajuato
Guanajuato

Development of parallel/distributed programs

- Incorporate HPC experiences into the curricula of the universities of the case study

- Parallel Computing

Universidad de Guanajuato
Guanajuato

Domain specific problems

- Numerical methods
  - *Comparison of sequential versus parallel implementation*
- Video Processing
  - *Implementation using CUDA of some concepts in Video Processing*
- Computational geometry
  - *Implementation of Convex Hull in Parallel using CUDA*

Teaching HPC in the COVID-19 era

- Video conference platforms
- Detailed information of the practices
- Use of remote servers to perform the practices

Discussions and results

- Involving of students in HPC research pojects
- Extracurricular external interactions
- Design of a new course

Involving of students in HPC research pojects

- In 2015 students from Universidad del Caribe implementing a Bewful cluster
- In 2016 students from Universidad del Caribe replicated a load balancing in a Bewful cluster.

Involving of students in HPC research pojects

- Video processing
  - *Video colorization*
  - *Object tracking*
  - *Change detection*
  - *Binarization of a huge number of document and images*
  - *Traffic flow estimation from aerial video captures*

Involving of students in HPC research pojects

- Video processing
  - *Video colorization*
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  - *Binarization of a huge number of document and images*
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Involving of students in HPC research pojects

- Image processing
  - *Image restoration using GPU*
  - *Fluid dynamics simulation*

Involving of students in HPC research pojects

- Video processing in a server
  - *Counting ellipses*
  - *Counting edges*

Involving of students in HPC research pojects

- **Publication of research papers**
  - *Jose M Vasquez-Velazquez, Francisco J Hernandez-Lopez, and Mario R Moreno-Sabido. Implementación en paralelo de un algoritmo de binarizacion automática de imágenes. In Academia Journals Tabasco, 2017.*
  - *Yam-Uicab, R., Lopez-Martinez, J. L., Trejo-Sánchez, J. A., Hidalgo-Silva, H., & Gonzalez-Segura, S. (2017). A fast Hough Transform algorithm for straight lines detection in an image using GPU parallel computing with CUDA-C. The journal of supercomputing, 73(11), 4823-4842.*
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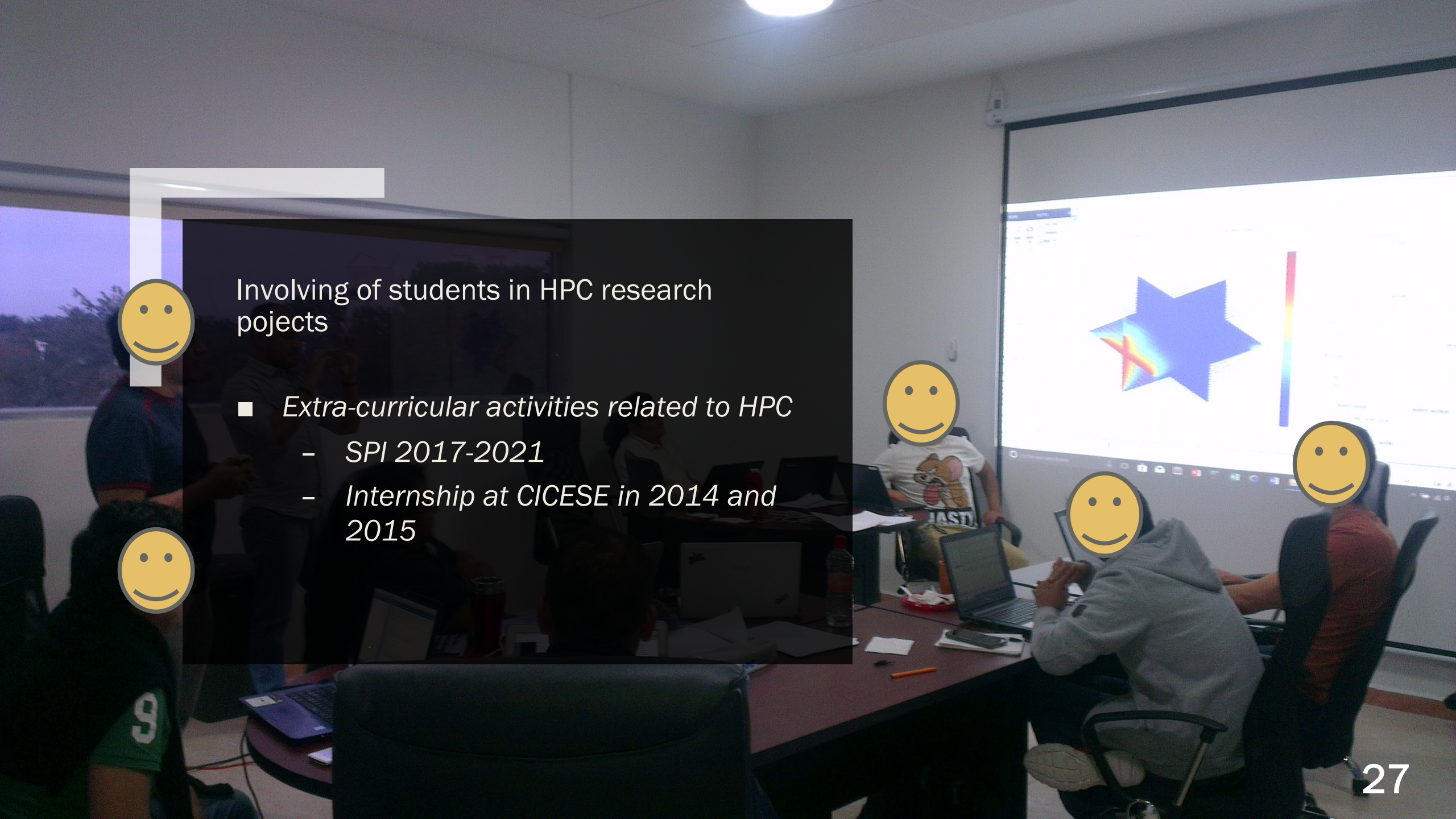

Involving of students in HPC research pojects

- *Extra-curricular activities related to HPC*
  - *SPI 2017-2021*
  - *Internship at CICESE in 2014 and 2015*

Involving of students in HPC research pojects

- Design of the course “selected topics of parallel programming”
  - *Introduction to parallel computing*
  - *Numerical solutions to equations using parallelism*
  - *Parallel combinatorial optimization*

Involving of students in HPC research pojects

- Design of the course “selected topics of parallel programming”
  - *Introduction to parallel computing*
  - *Numerical solutions to equations using parallelism*
  - *Parallel combinatorial optimization*

- 45 practical hours
- 30 theoretical hours
- This course is offered in UADY since 2017 to date

Conclusion

- We highlighted the difficulties to incorporate HPC in the universities of the case of study
- We presented a set of strategies to overcome such difficulties
- As a consecuence we listed some of the most relevant results of incorporating such strategies

Any questions?

Thank you!!!

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