Roadblocks for Interdisciplinary Research

To support **interdisciplinary research**,

you need to support …

… _____?

Roadblocks for Interdisciplinary Research

To support **interdisciplinary research**,

you need to support …

… the **interdisciplinary *researcher***.

Motivation: Discussion at Climate Informatics workshops on "Challenges for IS researchers doing IS-GEO research"

- IS-GEO research takes a long time (coming up with new theory is much faster).
- Difficult to publish in IS venues and journals.
- Difficult to get funding and recognition from peers.

Quote from full professor: "I can do this research because I have tenure. Probably wouldn't dare otherwise."

Quote from job seeker: "I can't get a job, because all of my publications are in GEO journals."

Why are IS researchers still doing this research?

- **Very rewarding** to see real impact in a field we care about.
- **Applications challenge us to find new solutions** (because we can't just apply algorithms out of the box).
- Great recruitment tool – students **love** to work on such topics.

Meet Peter and Andrea –
Two collaborating IS-GEO researchers

Peter

Andrea

Which one is GEO? Which one is IS?

Meet Peter and Andrea –
Two collaborating IS-GEO researchers

Peter

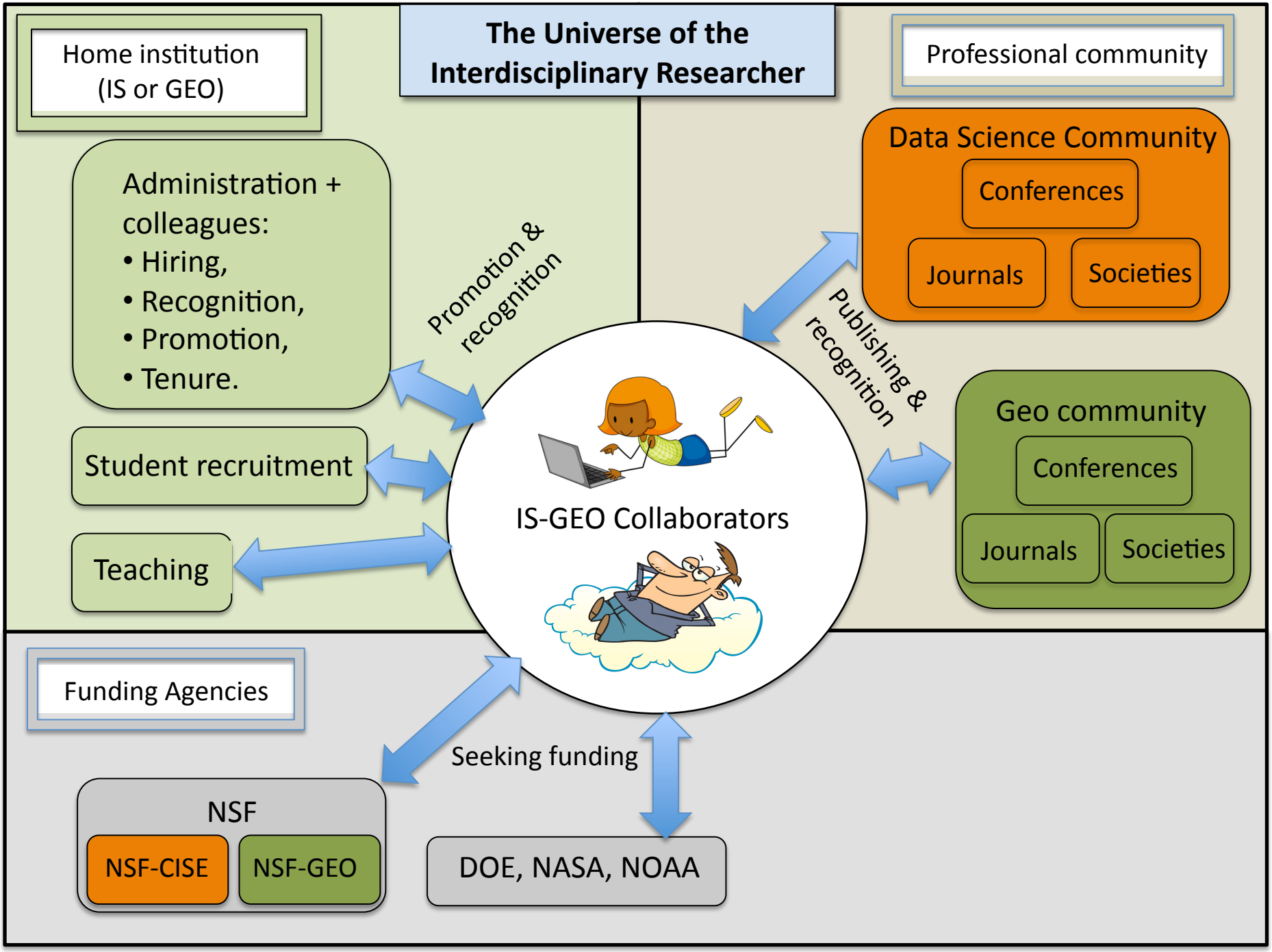
Geo scientist

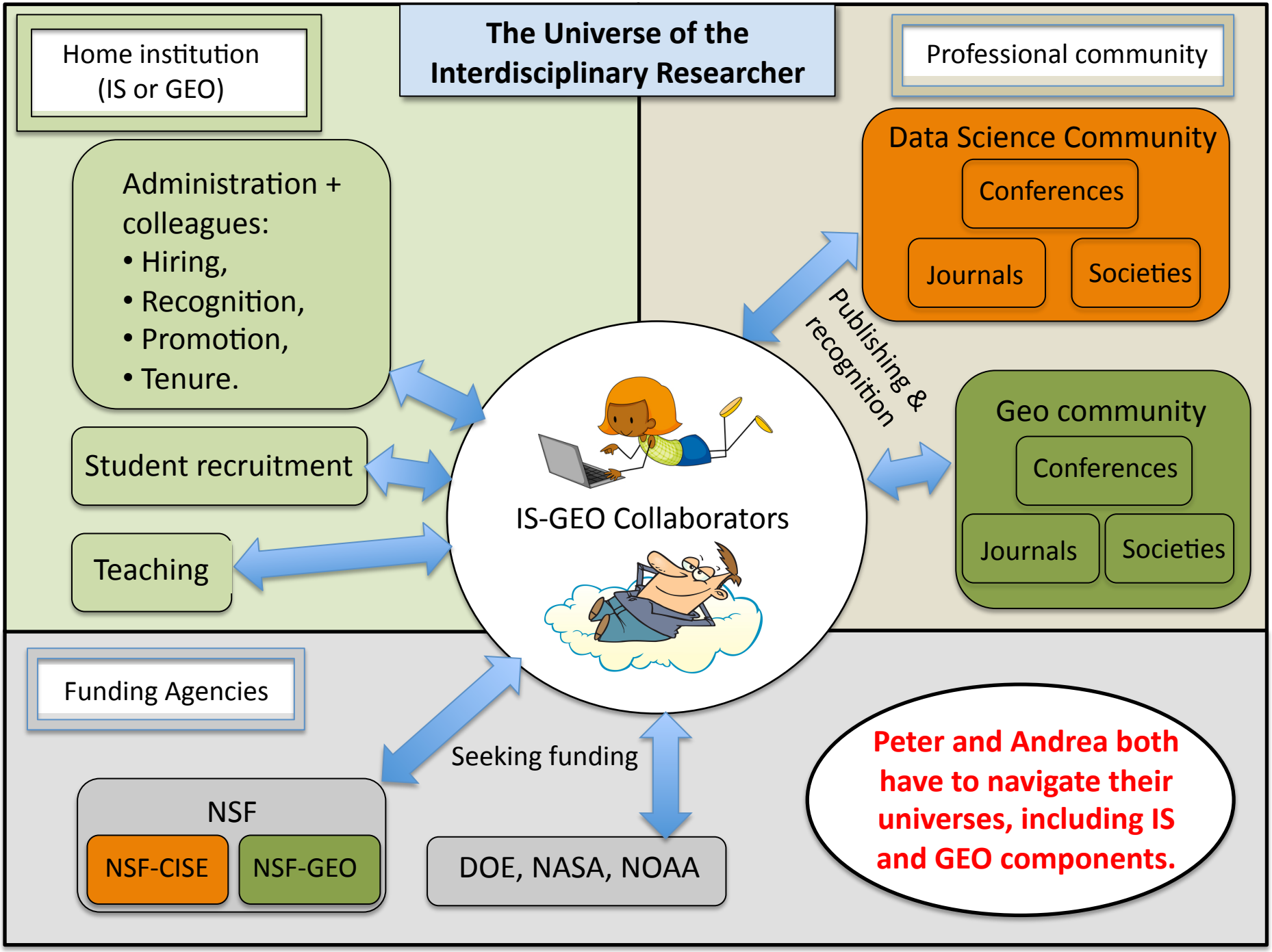
- Dreamy
- Deep thoughts about the world around him.

Andrea

Data scientist

- Curious
- Fascinated by data and what you can learn from them.


The Universe of the Interdisciplinary Researcher
Home institution (IS or GEO)
Administration + colleagues:
• Hiring,
• Recognition,
• Promotion,
• Tenure.
Promotion & recognition
Student recruitment
Teaching
IS-GEO Collaborators
Professional community
Data Science Community
Conferences
Journals
Societies
Publishing & recognition
Geo community
Conferences
Journals
Societies
Funding Agencies
Seeking funding
NSF
NSF-CISE
NSF-GEO
DOE, NASA, NOAA


The Universe of the Interdisciplinary Researcher
Home institution (IS or GEO)
Administration + colleagues:
• Hiring,
• Recognition,
• Promotion,
• Tenure.
Student recruitment
Teaching
Professional community
Data Science Community
Conferences
Journals
Societies
Publishing & recognition
Geo community
Conferences
Journals
Societies
IS-GEO Collaborators
Funding Agencies
Seeking funding
NSF
NSF-CISE
NSF-GEO
DOE, NASA, NOAA
Peter and Andrea both have to navigate their universes, including IS and GEO components.

Challenges for ANY type of interdisciplinary research

Getting started and doing research:

1. Defining projects/applications
2. Finding collaborators
3. Making collaboration efficient/successful

(all covered by Deana!)

Making your research count:

1. Finding funding.
2. Places to publish your work.
3. Getting recognized for interdisciplinary work
   a) within your institution, and
   b) from your peers.

Making your research count

1. Finding funding.
2. Places to publish your work.
3. Getting recognized within your institution and from your peers, for interdisciplinary work.

Deana made me realize: all three above come back to a single question!

What constitutes an important intellectual contribution in YOUR field?

Learning about "Intellectual contribution models"

Exercise:

Think of an IS-GEO topic in your area, i.e. applying IS method to GEO topic.

What constitutes – in your opinion – a sufficient contribution for publication

a) in a mainstream IS journal?

b) in a mainstream GEO journal?

Which **components** are needed for IS/GEO paper (or IS/GEO NSF proposal)? 5-minute exercise.

GEO - Intellectual contribution model

Necessary components:

- Must addresses important science question
- Others?

PLUS – **which one** of the following conditions?

- New insight into physical mechanism
- Better prediction, but without insight into physics?
- New pattern, but without insight into physics?

IS - Intellectual contribution model

Necessary components:

- Must contain a **new method/algorithm**.
- Evaluation: Must measure error quantitatively (difficult, because no ground truth available)?

PLUS – **which one** of the following conditions?

- Better prediction, but without insight into physics. Yes!
- **Existing** algorithm applied to new application, yielding better results and physical insights. No!

Publication culture

IS (draft):

1. Conference papers are important and very competitive (acceptance rate often < 10%!)
2. Journal paper reviews can take years. Usually go for conf. paper first to avoid long delays.

GEO (draft):

1. Conferences: abstracts only, high acceptance rate.
2. Journal papers: reviews are fast, often < 1 year to publication. Often go for those directly.

Best practices to publish cross-disciplinary IS-GEO research

How do you sell the research in IS vs. in GEO to address the challenges? Tips & Tricks?

- ?

What are good cross-disciplinary outlets?

- Computers & Geosciences journal
- Climate Informatics
- New cross-disciplinary AGU journal?
- ?

Understanding of intellectual contrib. models

- Helps us to better **target** publication and funding tasks in both IS and GEO.
- Makes us understand **needs** of collaborators.

Another useful resource:

NAS report: *Bridging Disciplines in the Brain, Behavioral and Clinical Sciences* (2000).

Describes **very similar challenges for interdisciplinary BIO/health researchers**, and **how to navigate them**.

NAS report
(clinical + brain science + behavior collaboration)

Barriers:

- Perception of interdisciplinary science as second-rate.
- Sense of superiority within each discipline (other disciplines seen as less rigorous and less important).

  → Challenges for publication, recognition and funding.

Some Recommendations:

- NIH: Require commitments from university administrators (e.g. supportive promotion policies) for NIH grants;
- NIH: implement new review criteria for such proposals + include reviewers from multiple disciplines for reviews;
- Universities: allocate appropriate credit; revise hiring, promotion and tenure policies;
- Universities: provide shared facilities, centers, programs for interdisciplinary research.

Further Reading

Deana Pennington:

1. *The EMBeRS project (2016)*
2. *A conceptual model for knowledge integration in interdisciplinary teams: orchestrating individual learning and group processes (2016)*
3. *Collaborative, cross-disciplinary learning and co-emergent innovation in eScience teams* (2011)

Yolanda Gil:

Virtual Crowdsourcing Community for Open Collaboration in Science (especially Fig. 1&2)

NAS reports

1. *Bridging Disciplines in the Brain, Behavioral and Clinical Sciences (2000)*
2. *Facilitating Interdisciplinary Research (2005)*
3. *Enhancing the Effectiveness of Team Science (2015)*

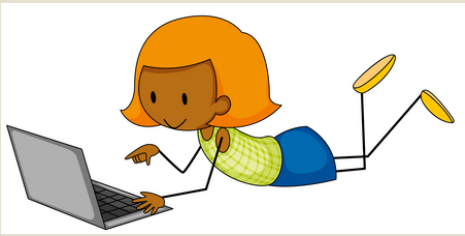
Slides on collaboration (time permitting)

3 phases of interdisciplinary research projects

Perspectives from machine learning applied to atmospheric science.

PHASE 1:
Define problem and approach

Peter



Andrea

Understanding of physical processes

What is already known?

What is important?

Available data sets

Required temporal/spatial resolution

Selection of physical problem + scientific question(s)

discussion

discussion

Algorithm selection

Understanding of ML methods

What can we expect to achieve?

How many samples are needed?

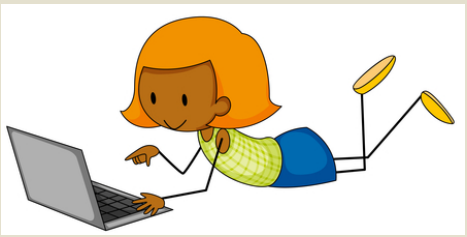
Computational effort?

Likely pitfalls: overfitting, etc.

Selection of problem + questions + approach (algorithm) + data set

Peter

PHASE 2: Experiments



Andrea

Data set

Which type of Interpolation?

Smoothening (e.g. sliding average)?

Normalize data?

Geographical area to focus on?

Use only certain seasons?

Preprocessing (exposing strong signals in data)

Apply ML algorithm

Visualize results

Do results make physical sense?

Yes

No

Great! On to evaluation phase

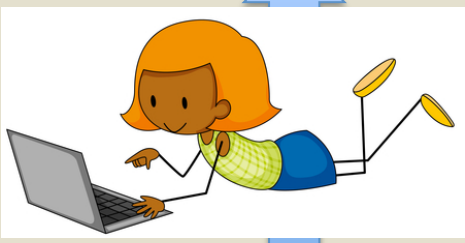
Understanding of physical processes

"Debugging"
What went wrong?
*Problem with **data**?*
*Problem with **algorithm**?*
*Are we asking the **right question**?*
*Using the **right tool**?*

Understanding of ML methods

Peter

PHASE 3:
Evaluation and Interpretation



Andrea

Results *appear* to be physically meaningful

Are results **robust**?
Can we **verify** results by other means (simulation model)?
Did we answer the original question?

More iterations ...

Understanding of physical processes

Interpretation

Visualize results

Communicate results to community:
Translate all results back into geo language

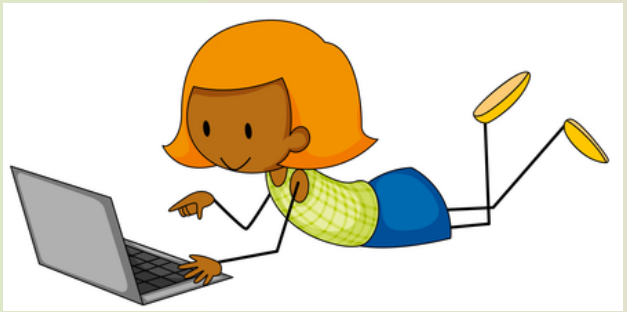
Observations:

1) Many tasks cannot be split into two separate parts that each person works on independently.
2) Many decisions must be made *together,* requiring both of their special knowledge.

Therefore:

1) Peter and Andrea cannot stay completely on their own side.
2) Each person needs to have a basic understanding of the thinking process of the other person.
3) Each person must be willing to teach / learn some basic vocabulary and tools.
4) Constant feedback from both sides is essential. Many, many iterations required…
5) It's lots of fun!

Geo science



Data science