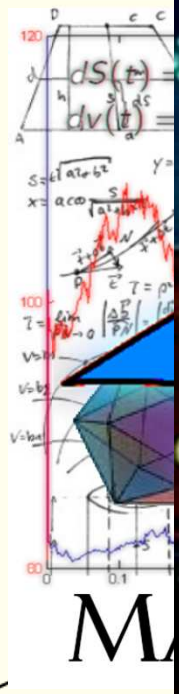
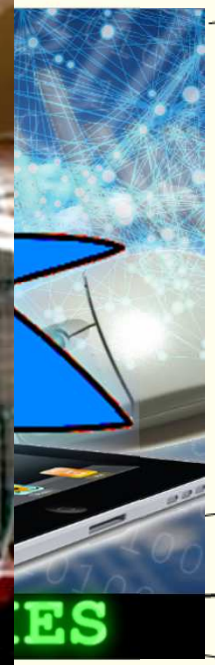
Accessible Optimisation

Dr Andrew Grenfell
Biarri

What the...?





PLEASE WAIT WHILE WE ANNOUNCE THIS PRESENTATION'S VISUAL THEME

More precisely:

- How is technology changing (commercial) mathematics (particularly Operations Research)?
- What techniques and resources can we now use to solve business and research problems?
- Who are the heroes? Who are the villains?

Example 1

Fermat's Last Theorem

- Easy to state – devilish to prove
- Unsolved for 360 years
- Proof by Andrew Wiles in 1993 – 7 years of effort, 108 pages of proof
- Limit of what one brain can achieve?

Example 2

How best to stack oranges?

- The Kepler Conjecture (1611): most efficient way to stack has 74% average density
  - e.g. hexagonal close packing (the way you see them stacked in the shops)
- 1998 proof involved solving about 100,000 Linear Programming problems – by computer!

Combinatorial Explosion

Exampl

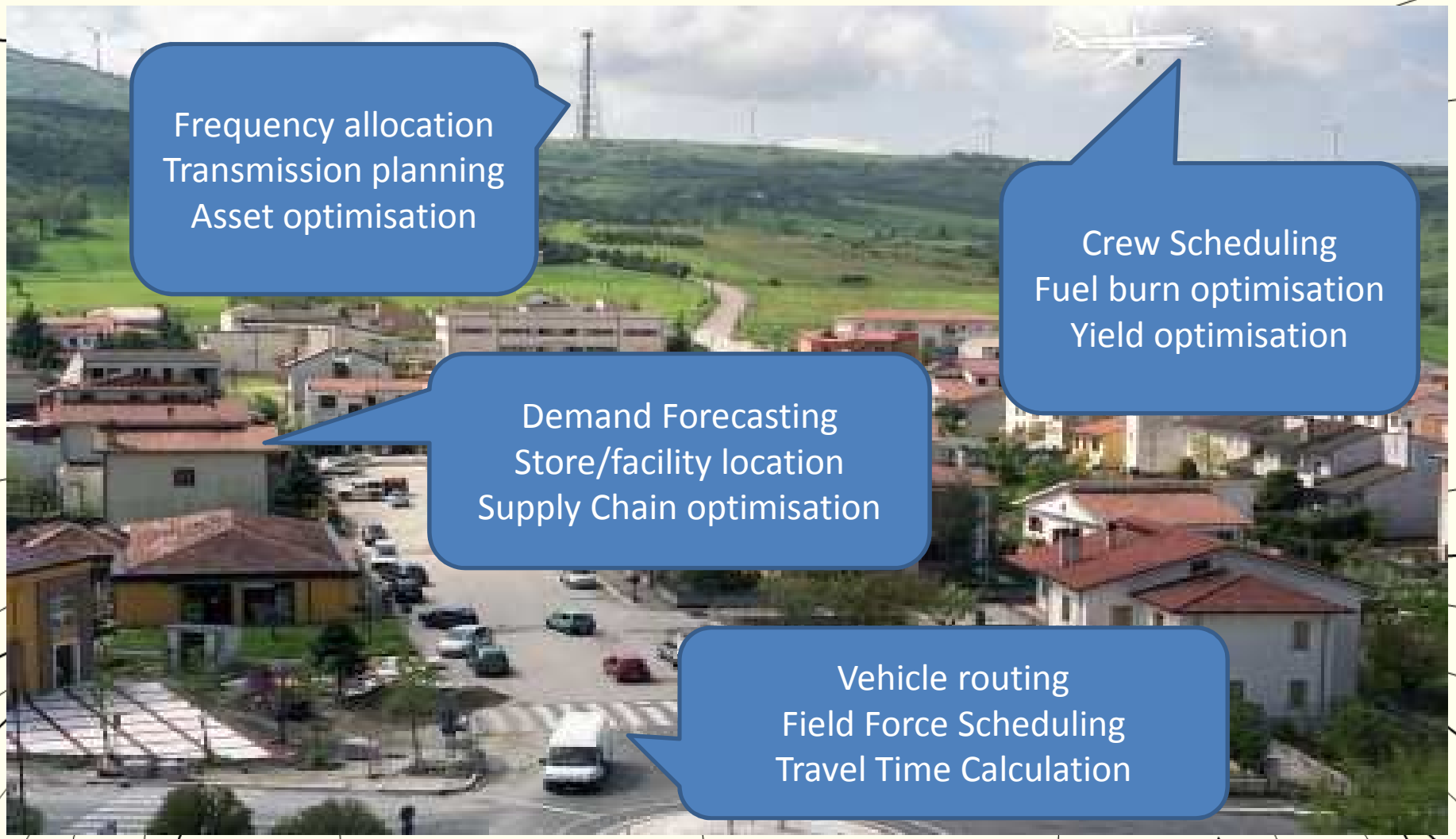
5 cities

10 citie

60 citie

Where?

Do we find these problems?



Transforming Business

- More data, faster mach
  - Ubiquitous compu
- The Internet
  - Mashups, SaaS, APIs, clo
- Prevalence of the brows
- Knowledge distribution
- Crowd sourcing and col

Increasing market efficiencies

Perfect information

Direct business to consumer connection

Commoditising products

“Long tail” – niche goods and services

Hypercompetition

Abolition of geography (global village)

Examples

- SETI – digital signal processing
- Protein folding – simulation
- Netflix prize
recommenda
- Millenium p
- Human Gen
- Citizen Scie
- arXiv
- Polymath pr

Villains?

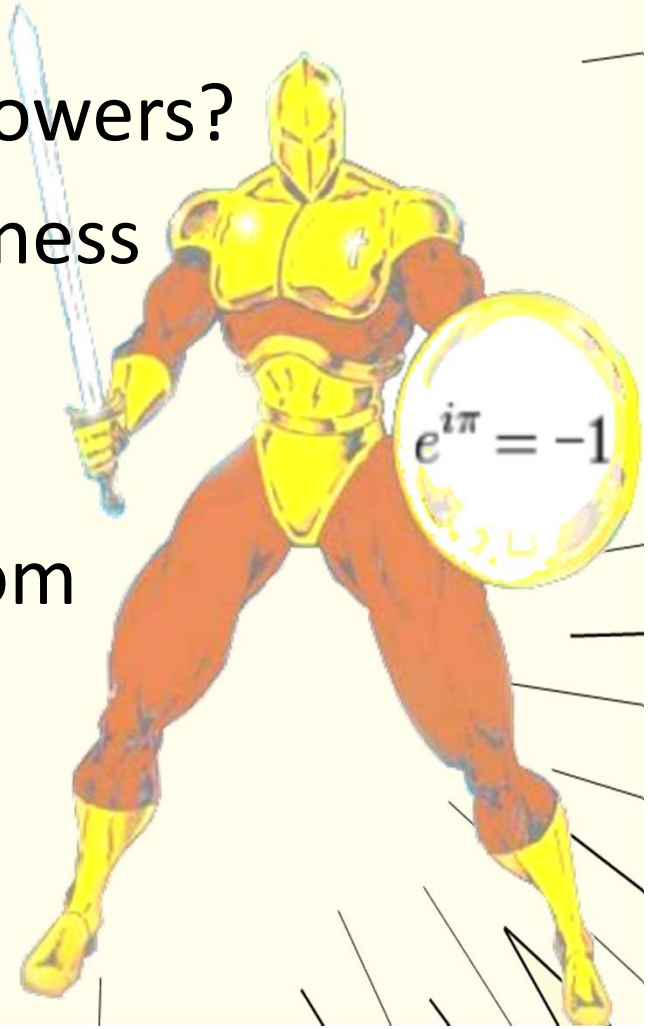
- Complexity / hard decisions
- Unnecessary IT burdens
  - Benefits get lost under software installation
  - Tail wags the dog
- High costs
  - esp. capital costs
- Institutionalised interests


I’m getting used to the simplicity of Google, aesthetics of Apple
Get the job
Oh yeah, and make it real cheap

Making it Accessible

- How can we harness the superpowers?
- To solve practical, everyday business problems?
- What if we could solve some of these mathematical problems from anywhere in the world?

With just a smart phone?



How?

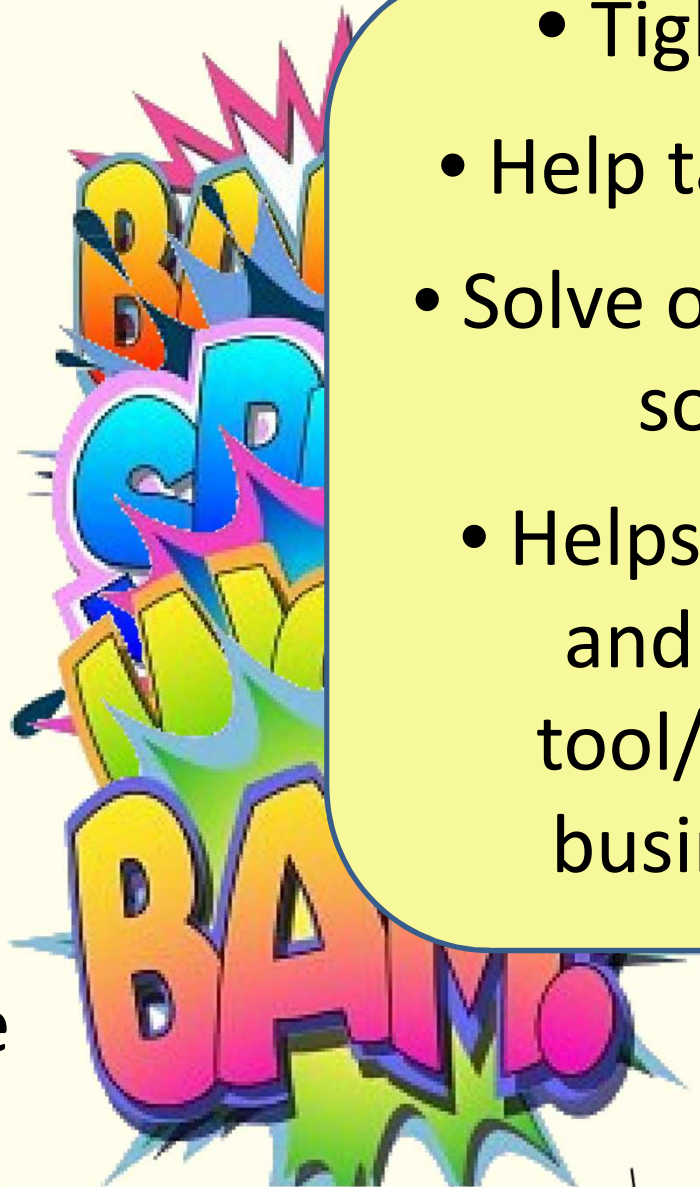
- Tightly focussed
- Help tame complexity
- Solve one problem, but solve it well
- Helps keep structure and language of tool/model in the business domain

Remove IT burdens

Low cost / no capital

Easy on/ easy off

Easy to use



ols,

Linear ows;
“point” solutions

Standing on the

- O
- Li
- C
- Cplex/G
- Enab

Out
G
Co
SalesFo
Cloudmade (map rendering)
SaaSy (payments)

Open source OR: lets you be solver-agnostic

Used to be IBM's OSL
LPs with 1.5 million variables

eb apps;
e it all
gether

Commercial math solvers

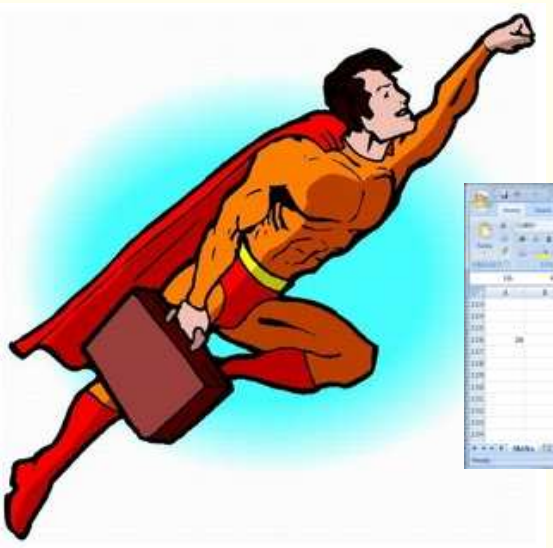
Gurobi

- A few guys, no office
- Commoditised offering
- World class
  - Built from ground up to be parallelisable
- New interfaces:
  - Pay as you go option

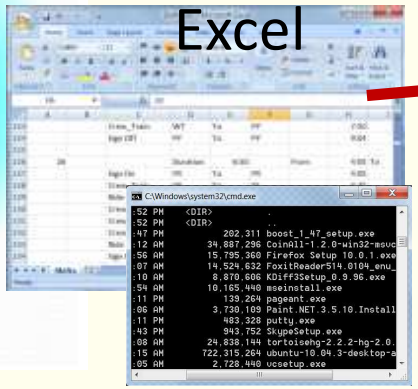
    e.g. Amazon EC2
  - Python interface

Solving in the Cloud

Excel front end



Super
Business Guy



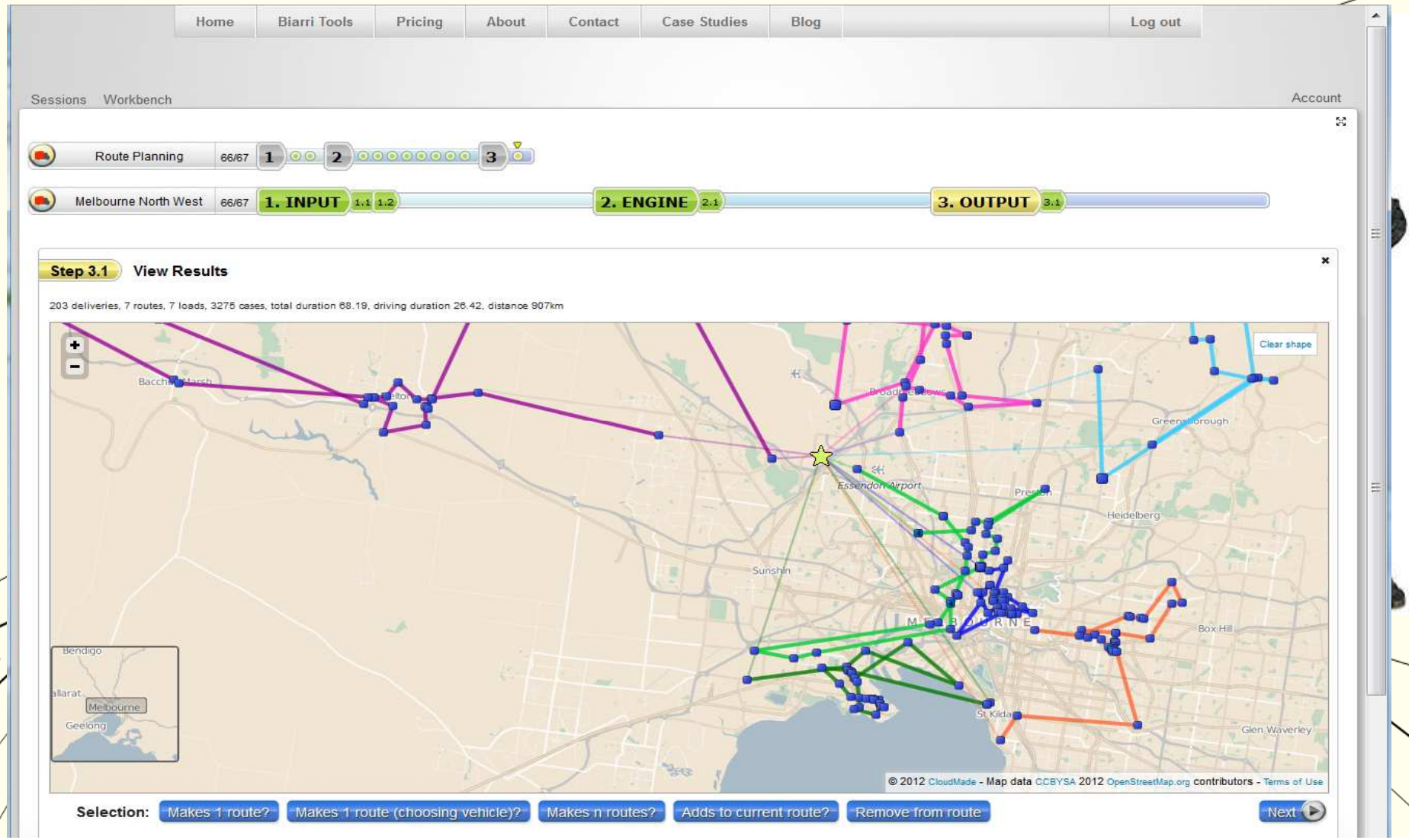
Serialise MIP as compressed string; send using CURL

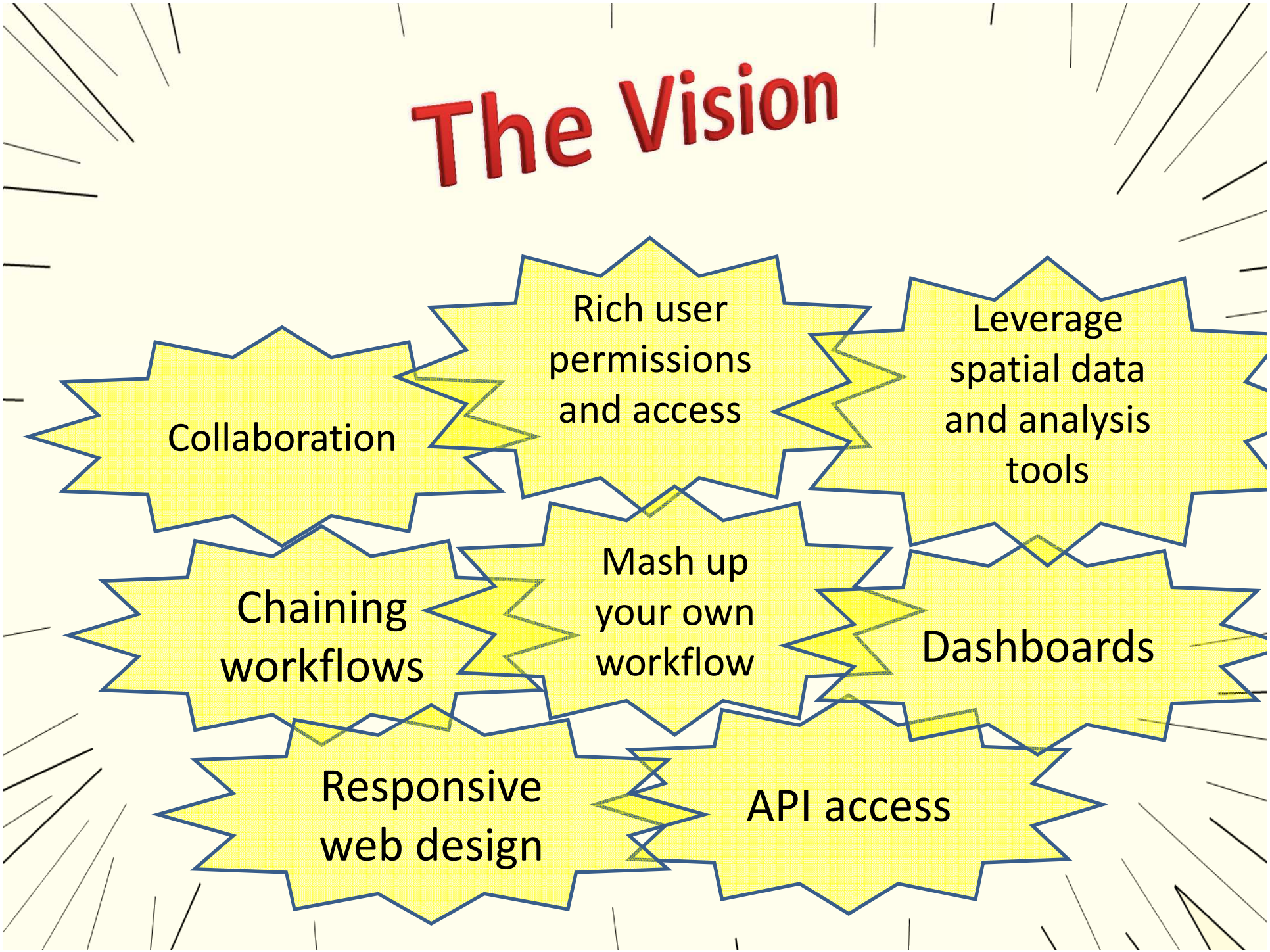
Serialised result

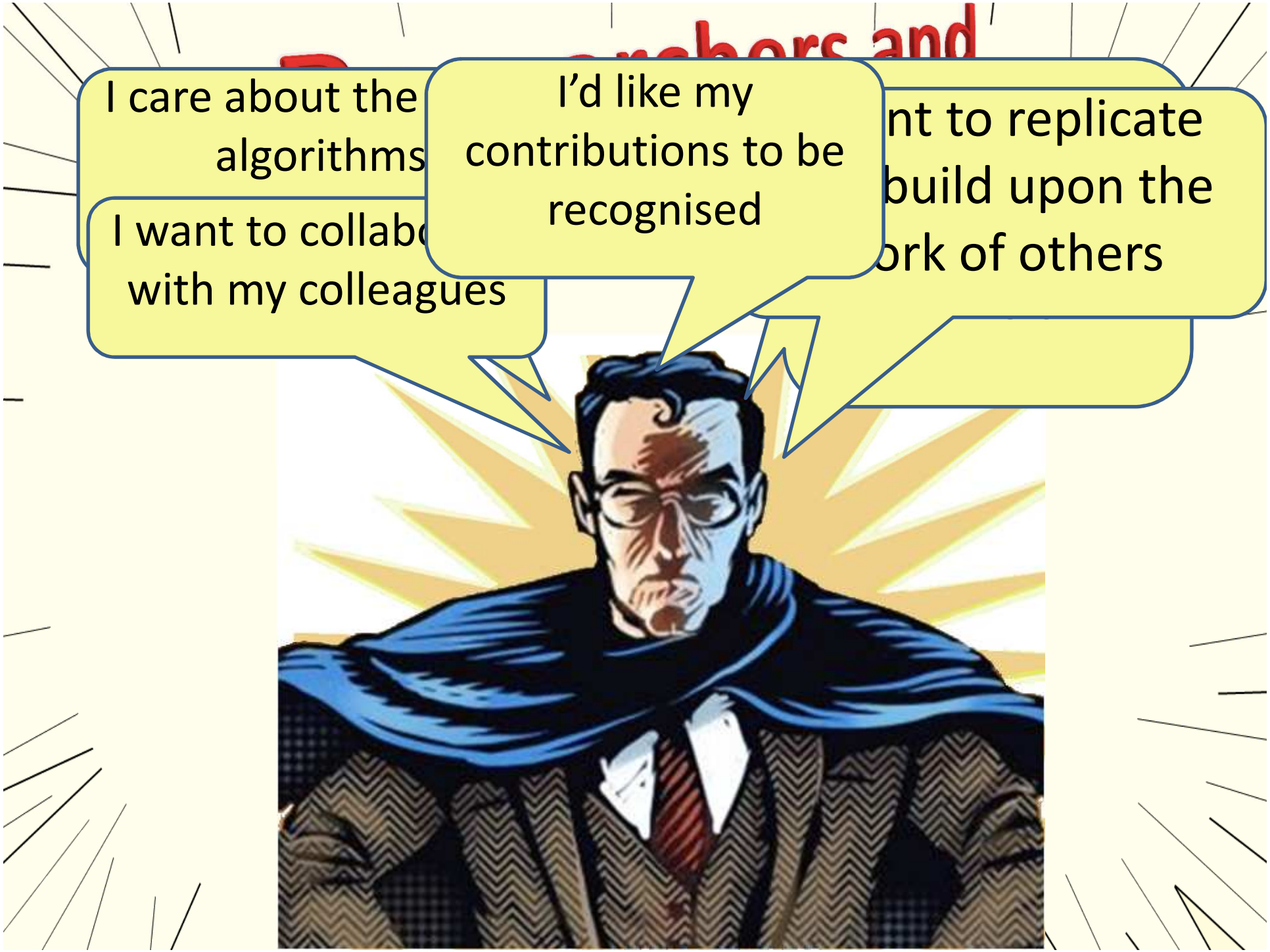
Looks like it is running locally!

Solving in the Cloud

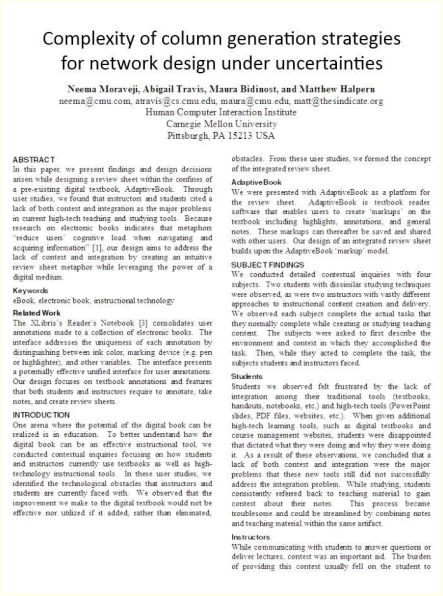
Web front end




The Vision
Collaboration
Rich user permissions and access
Leverage spatial data and analysis tools
Chaining workflows
Mash up your own workflow
Dashboards
Responsive web design
API access


I care about the algorithms
I want to collab with my colleagues
I'd like my contributions to be recognised
nt to replicate build upon the ork of others

Typical OR paper



Complexity of column generation strategies for network design under uncertainties

Neema Moraveji, Abigail Travis, Maura Bidinost, and Matthew Halpern
neema@cmu.com, atravis@cs.cmu.edu, maura@cmu.edu, matt@thesindicate.org
Human Computer Interaction Institute
Carnegie Mellon University
Pittsburgh, PA 15213 USA

ABSTRACT
In this paper, we present findings and design decisions arisen while designing a review sheet within the confines of a pre-existing digital textbook, AdaptiveBook. Through user studies, we found that instructors and students cited a lack of both context and integration as the major problems in current high-tech teaching and studying tools. Because research on electronic books indicates that metaphors "reduce users' cognitive load when navigating and acquiring information" [1], our design aims to address the lack of context and integration by creating an intuitive review sheet metaphor while leveraging the power of a digital medium.

Keywords
eBook, electronic book, instructional technology

Related Work
The XLibris's Reader's Notebook [3] consolidates user annotations made to a collection of electronic books. The interface addresses the uniqueness of each annotation by distinguishing between ink color, marking device (e.g. pen or highlighter), and other variables. The interface presents a potentially effective unified interface for user annotations. Our design focuses on textbook annotations and features that both students and instructors require to annotate, take notes, and create review sheets.

INTRODUCTION
One arena where the potential of the digital book can be realized is in education. To better understand how the digital book can be an effective instructional tool, we conducted contextual inquiries focusing on how students and instructors currently use textbooks as well as high-technology instructional tools. In these user studies, we identified the technological obstacles that instructors and students are currently faced with. We observed that the improvement we make to the digital textbook would not be effective nor utilized if it added, rather than eliminated, obstacles. From these user studies, we formed the concept of the integrated review sheet.

AdaptiveBook
We were presented with AdaptiveBook as a platform for the review sheet. AdaptiveBook is textbook reader software that enables users to create 'markups' on the textbook including highlights, annotations, and general notes. These markups can thereafter be saved and shared with other users. Our design of an integrated review sheet builds upon the AdaptiveBook 'markup' model.

SUBJECT FINDINGS
We conducted detailed contextual inquiries with four subjects. Two students with dissimilar studying techniques were observed, as were two instructors with vastly different approaches to instructional content creation and delivery. We observed each subject complete the actual tasks that they normally complete while creating or studying teaching content. The subjects were asked to first describe the environment and context in which they accomplished the task. Then, while they acted to complete the task, the subjects students and instructors faced.

Students
Students we observed felt frustrated by the lack of integration among their traditional tools (textbooks, handouts, notebooks, etc.) and high-tech tools (PowerPoint slides, PDF files, websites, etc.). When given additional high-tech learning tools, such as digital textbooks and course management websites, students were disappointed that dictated what they were doing and why they were doing it. As a result of these observations, we concluded that a lack of both context and integration were the major problems that these new tools still did not successfully address the integration problem. While studying, students consistently referred back to teaching material to gain context about their notes. This process became troublesome and could be streamlined by combining notes and teaching material within the same artifact.

Instructors
While communicating with students to answer questions or deliver lectures, context was an important aid. The burden of providing this context usually fell on the student to

- Abstract and intro
- Literature Review
- Statement of Problem
- Approach
- Results and experiments
- Conclusion
- References

✓ Self contained
✓ Peer-reviewed
✓ Easily reproduced by same author(s)
x Hard to search for and find
x Hard to reproduce results
x Long gestation and review
x "Soft" fields

Making it Accessible

?

- How can we harness the new superpowers?
- To do Operations Research?
- What if we could complement (or avoid!) slow journal-focused progress?
- How can we improve upon silo'ed academic results and source code?

How?

Remove IT burdens

Share models and data

Frictionless global collaboration

Build a community

Cloud power

Use versioned, wiki-style tools

Forums and social network integration

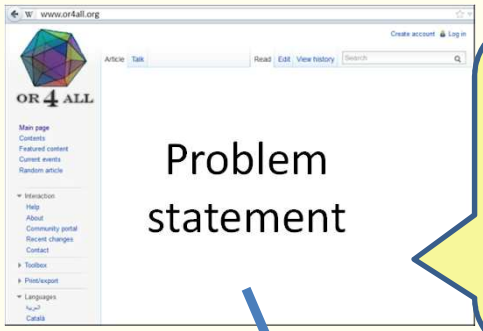
User reputations on common platform

OR in the cloud?

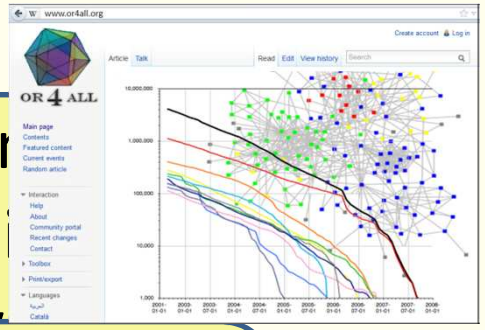
- Many of the pieces are already (conceptually at least) in place:
  - www.or-cyc[illegible].com
  - [illegible]
  - [illegible]
  - [illegible]
  - Online IDEs
  - Cloud storage

Global crowd-sourced Operations Research in real time!

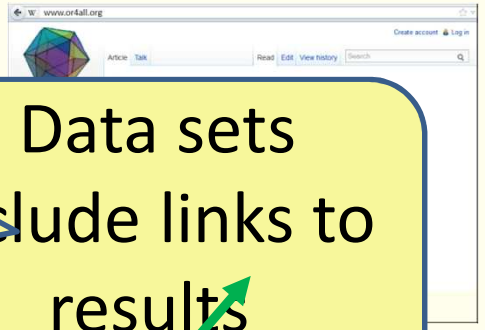
The Vision



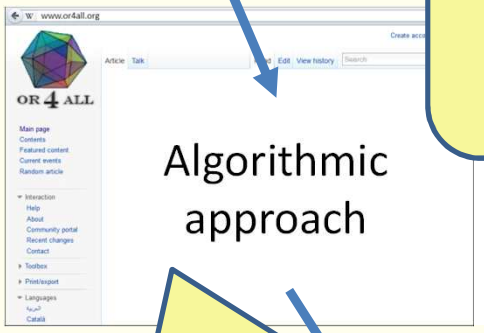
Description formulati



Results include history (versioned snapshots)



Data sets slude links to results



Algorithm and effects of parameters; links to proofs

Modelling language/Python in an online IDE

The Vision

Each page has:

- versioning
- comments
- API access
- voting
- social media integration
- access control – public/private
- links
  - e.g. related data sets & problems
- opt-in alerts for updates

The Final Battle!?

- We've seen a little of:
  - How technology is changing commerce, and mathematics
  - How we can harness some of this technology for OR
- Change is already happening
- This is just the beginning!


"Even if you fail at your ambitious thing, it's very hard to fail completely."
- Larry Page, Google co-founder and current CEO
Google