

Using optimization for electronic negotiations

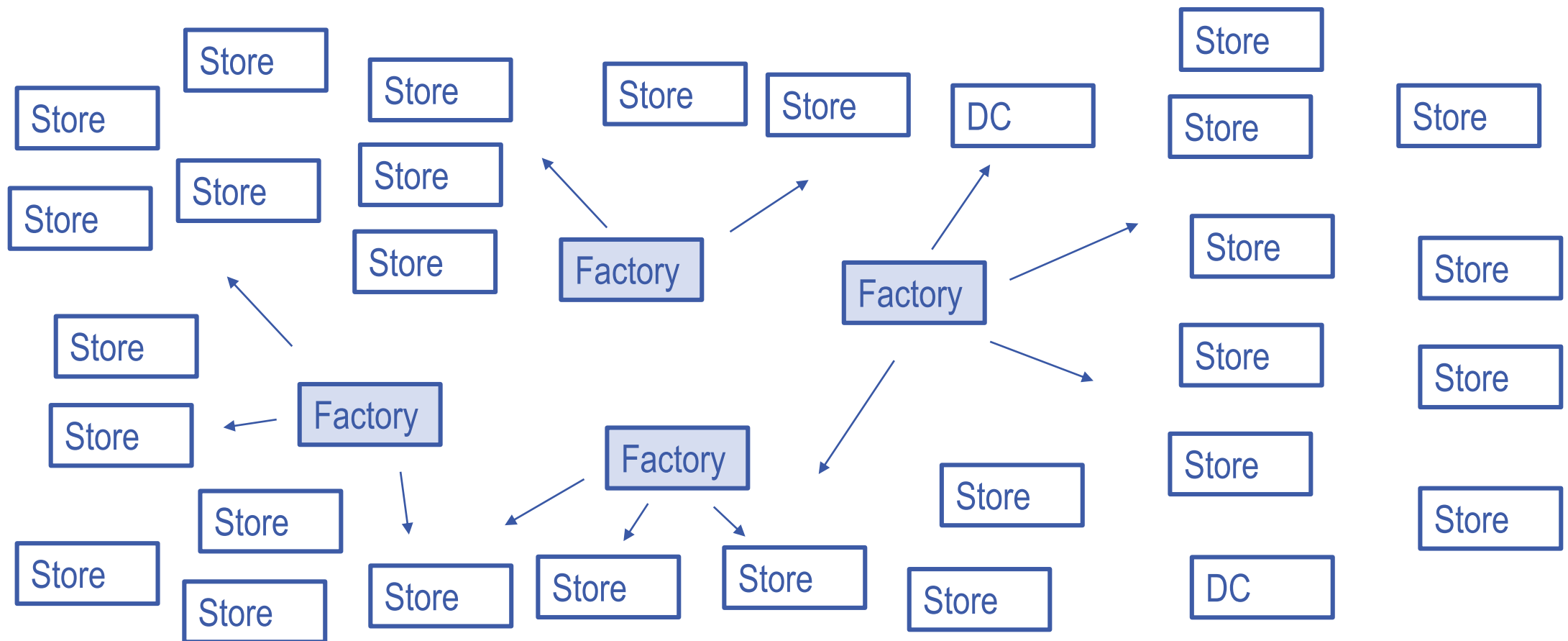
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- What we do
- Why I love my job
- Business meets optimization – our challenges

- **What we do**
- Why I love my job
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What we do - Example 1 – The Task

Assume you are a buyer who should buy all the land transport from your company's 10 factories in Europe to 10 000 stores or distribution centrals.



What we do - Example 1 – E-Sourcing

- Invite a few hundred suppliers to place bids for the 10 000 transport lanes. (There can be a lot of fine-print with weight-classes, transit times, etc.)
- If you have done your preparations well you may receive a few hundred thousands bids.
- Finding the best bid for each transport lane is “easy”, just a weighting of different factors.
- BUT: just taking the best bid for each lane is very rarely an acceptable solution.

What we do - Example 1 – Desired properties

- At most 50 winners in total.
- At most 10 winners per factory.
- No more than 5% of suppliers turnover in award.
- No more than 25% to new suppliers
- Suppliers discounts:
 - If I get these five lanes in combination I can offer a different transit time.
 - I offer 30% discount on backhauls.
 - If I get more than 3MUSD of business I offer a 5% discount.

Our task: Helping buyers to easily set-up such rules, solve the optimization problems, and provide means for quickly and in detail compare different scenarios of allocation. (What is the impact by factory if changing from 45 to 50 suppliers in total?)

What we do – Some more complex example

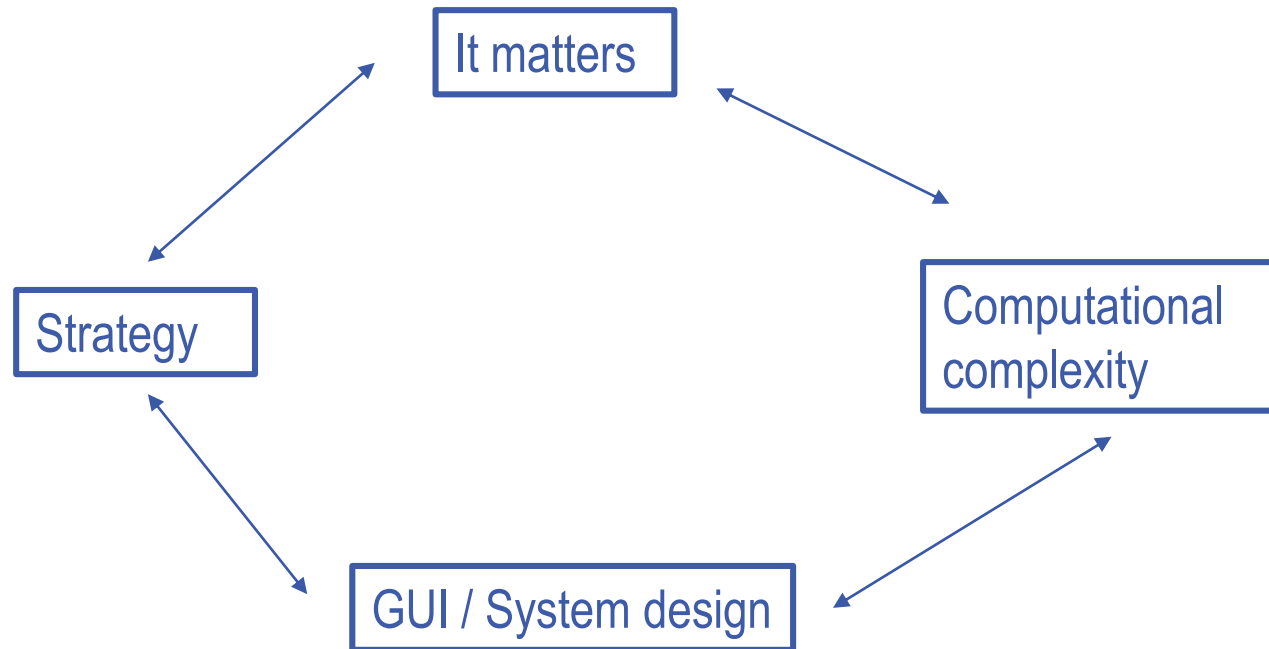
- Multi-modal transport, for example, land-sea-land. Bidding and network optimization combined.
- Entire supply chains, for example the production of printed matters: paper, printing and transport. Bidding and supply chain optimization combined.

Examples like the above often result in extremely hard optimization problems.



- What we do
- **Why I love my job**
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Why I Love my Job



It Matters

- A few billion USD sourced weekly.
- Several Fortune 10 clients. Majority of clients are large multi-national companies. Plus many consultancy firms.
- Frequently projects at several 100 million USD.
- Largest sourcing project was around 8 billion USD.
- What we compute has large real-world consequences. Fantastic and scary.

A few examples of branded Coupa sites

The image displays a horizontal row of seven branded Coupa login interfaces. Each interface includes the company logo at the top, a row of small national flags for language selection, and a login form. The login form consists of two input fields: 'Username or Email' and 'Password', followed by a 'Login' button. Below the login button, there are two links: 'Forgot your password? If so, click here.' and 'Use a One-time Ticket to Login'.

- Kimberly-Clark**: Features the Kimberly-Clark logo and a login form with the same standard layout.
- McKesson**: Features the McKesson logo and a login form with the same standard layout.
- Unilever**: Features the Unilever logo and a login form with the same standard layout.
- TESCO**: Features the TESCO logo and a login form with the same standard layout.
- Dow**: Features the Dow logo and a login form with the same standard layout.
- Agility**: Features the Agility logo and a login form with the same standard layout.
- CABOT**: Features the CABOT logo and a login form with the same standard layout.

Strategy

- What information do you collect from the bidders?
- What information do you reveal to the bidders?
- What are the rules of the negotiation?
- Let us do some trading!

Strategy – Auction 1

- I have a 500 SEK note for sale. It is guaranteed to be a genuine valid note.
- Give a bid out loud.
- When no more bids, the note goes to the highest bidder at the bid price.

Strategy – Auction 2

- I have a 500 SEK note for sale. It is guaranteed to be a genuine valid note.
- Write a bid on a note. Do not show to anyone. Put it upside down in front of you.
- When bids are revealed, the note goes to the highest bidder at the bid price.

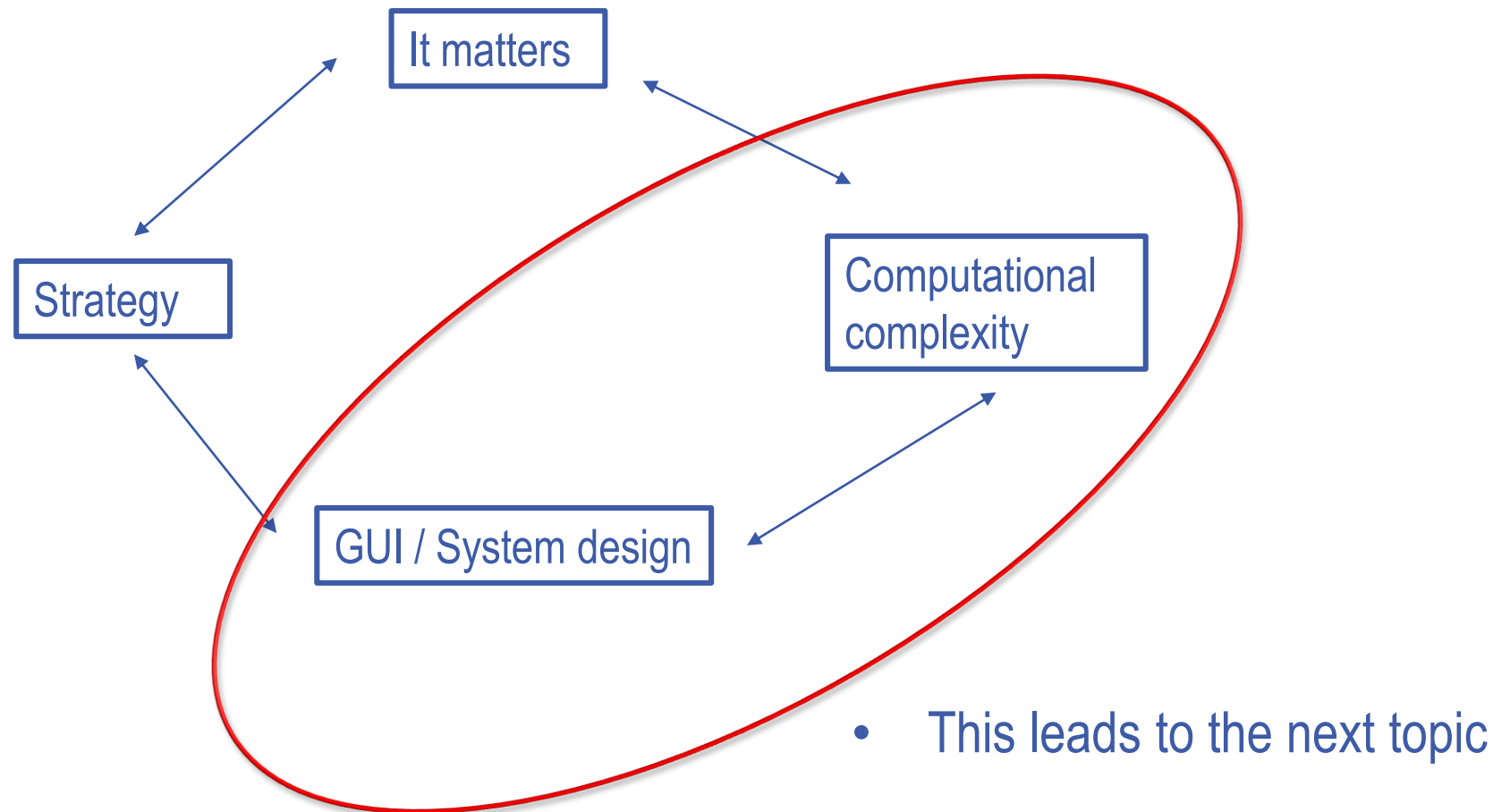
Strategy – Auction 3

- I have a 500 SEK note for sale. It is guaranteed to be a genuine valid note.
- Write a bid on a note. Do not show to anyone. Put it upside down in front of you.
- When bids are revealed, the note goes to the **bidder** with the **highest** bid, but at the **second highest** price.

Strategy – Summary

- Mechanism design can have a *major impact* on outcome.
- Many options in a complex tender (like a transport tender):
- Do you reveal lowest bid? If so, at what level?
 - Total by lane
 - Sub-components, like transfer-time
 - Aggregations
- Do you reveal allocations? (That is, current decision if the bidding would stop here.)
- When do you reveal information? Continuously / in rounds?

Why I Love my Job

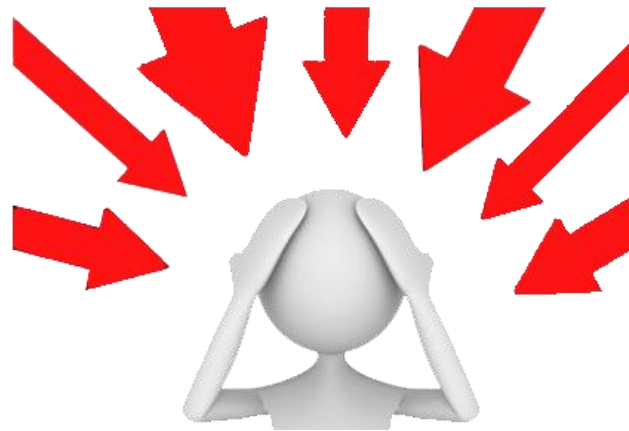


- What we do
- Why I love my job
- **Business meets optimization – our challenges**
- A few words on optimization in the cloud

Business meets optimization – our challenges



Buyer



This is why we get a salary.



The
mathematical
world

Business meets optimization – our challenges

- The challenge is to integrate totally different perspectives.
- A **buyer** has no notion of NP-hardness, numerical stability etc. It just has to work. “I have changed almost nothing since yesterday, but today the platform says ‘Timeout’. I have a critical meeting with the team in 2h. Can you urgently fix this please?”
- When we consult **optimization experts** (like researchers, solver software support etc.), we often get comments like “The differences in coefficients are too large”.
- **Coupa**’ task: Juggling on a slack line made easy. How do you make something look very easy while dealing with extremely complex problems and maintaining high performance and accuracy?

Even though dialogs on this and coming slides stems from actual experience, they are **exaggerated** for illustration and comic effect. A Coupa’ **consultants would act wiser** and the **software would guide better**. Majority of buyers are far more understanding.

Business meets optimization – our challenges



Buyer

- I like to allocate these 10 000 lanes based on the received bids.
- Ok, how important is it to have a lane allocated?
- ??? That was the strangest question I have had. My job is to buy these 10 000 lanes, ok?
- Fine, then I put in a rule saying that everything must be allocated.
- Of course!



Sourcing experts

Business meets optimization – our challenges



Buyer

- I tried to run your set-up, but the system says “Infeasible”. Can you please fix this?
- I looked into your data and you do not have bids for all lanes and you said that you needed everything allocated. That is not feasible.
- Oh, I thought the system was smarter than that. You should of course only allocate when possible.
- Ok, then I change the rule so that it can be broken, but at a high penalty.
- Sounds better.



Sourcing experts

Business meets optimization – our challenges

- It still doesn't work. Supreme Transport is the cheapest everywhere, but they are still not allocated. Instead the system allocated Mediocre Transport which is far more expensive. Can you please fix this? I need to add that the team's trust in the system is really low at this point.



Buyer



Sourcing experts

Business meets optimization – our challenges

| Lane | Supreme Transport | Mediocre Transport |
|-----------------------|-------------------|--------------------|
| Berlin – Hamburg | 1 000 000 | 1 200 000 |
| Hamburg – Salzburg | 1 500 000 | 1 700 000 |
| Göteborg – Uppsala | 400 000 | 600 000 |
| Rotterdam – Amsterdam | 2 000 000 | 2 300 000 |
| Bern – Innsbruck | 300 000 | 400 000 |
| Paris – London | 3 000 000 | 3 400 00 |
| Tranemo – Svenljunga | | 50 000 |



Sourcing experts

Plus a rule on at most one winner in total for the above lanes.

Business meets optimization – our challenges



Buyer

- I looked into your scenario Supreme Transport is not allocated as they did not bid for Tranemo – Svenljunga, as you have a high penalty if we do not allocate everything and you want at most one winner for these lanes.
- Oh, I thought the system was smarter than that. That is such a tiny lane. I can always manage that afterwards. Can you please fix this?
- Ok, then I change the rule so that we only allocate if the bid is at most 30% above historic price.
- Of course, why didn't you do this in the first place?

Recall that this was the first question asked. Then it did not make sense to the buyer. Once he has seen the effect, it does.



Sourcing experts

- Ok, how important is it to have a lane allocated?
- ??? That was the strangest question I have had. My job is to buy these 10 000 lanes, ok?

Business meets optimization – our challenges

- It is **hard/impossible** to **hide the complexity** of the **underlying problem** from the end user.
- (Recall that this was a really simple example for illustration.)

Business meets optimization – our challenges



Buyer

| Supplier | Number of weekly containers awarded |
|-----------------------|-------------------------------------|
| Supreme Transport | 134.5 |
| Mediocre Transport | 34.1 |
| Splendid Transport | 100.4 |
| Transporting Hipsters | 22 |

Different rules can split the allocation. (For example, at most 25% to non-incumbents, volume discounts in money etc.)

A buyer checks an allocation report and discovers that some suppliers are allocated partial containers.

Business meets optimization – our challenges



Buyer

- This buyer had some training on the platform and can add rules, so he adds a rule to only allocate whole containers.
- Now the solver has a timeout also with solver time of 2h.
- He calls the support:
 - How can a system not understand that you cannot ship parts of a container.
 - I put in a rule to fix it, but the system now crashes.
 - Can you urgently fix?

Business meets optimization – our challenges

| Supplier | Number of weekly containers awarded |
|-----------------------|-------------------------------------|
| Supreme Transport | 134.5 |
| Mediocre Transport | 34.1 |
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- It is **hard/impossible** to **hide the mathematics and performance** of the **underlying solver** from the end user.
- Many times long solver times reflect poor set-up.
- How would you talk the buyer out from forcing integer allocation of containers?

Business meets optimization – our challenges

Demand on accuracy, example.

- Total spend around 450 MUSD, around 1 000 000 bids. Objective value (including different penalties) around 3 bUSD.
- Time-out after 2h with a max gap to optimality of 20 000 USD (0.007% of objective).



Buyer

“It is **not acceptable** here to have a tolerable, but **not fully optimized solution**.”

“This is especially important as we compare the results from one scenario to another, which are entirely the same except for one variable.”

So demands on accuracy are comparable to those used by national testing institutes for references of weight, length etc.

Business meets optimization – our challenges

Breaking old habits can be hard.

- A traditional buyer guidance rule: allocate no supplier less than 100 000 USD of business. Makes some sense for an organization not having a good sourcing system.
- Superior rule: Add a penalty of 10 000 USD for every supplier allocated.

Often very hard to explain why the established work practices are not good. “We have done this for 20 years and it works great...”

Why is the “superior rule” above superior?



Buyer

Business meets optimization – Summary



Buyer

- Hard / impossible to hide complexity of the underlying problem from user.
- Hard / impossible to hide properties of mathematical solvers from user.
- Extreme requirements on accuracy.
- Extreme requirements on reliability, security, consistency.
- Hard to break old habits.
- Hard (and not of real interest) for buyer to separate complexity of underlying problem and optimization mathematics from usability of our software.

“If the user can’t use it, it doesn’t work” –Susan Dray

- Much can be achieved by great consultants and software.
- Coupa has come a really long way with the above during its 17 first years and *is* world-leading, but still:



The mathematical world

9

Most things still remain to be done.
A glorious future!

Ingvar Kamprad, founder of IKEA
from The Testament of a Furniture Dealer



- We are always looking for bright and ambitious persons.
- A few diploma workers yearly.
- At present – special interest in persons with high interest / competence in UI design.
- Contact:
 - Arne Andersson, arne@coupa.com, head of software team in Uppsala, or
 - Fredrik Ygge, ygge@coupa.com for more info.

