

Where do ideas come from?

Ohad Kammar

4th Logic Mentoring Workshop
Thirty-Fourth Annual ACM/IEEE Symposium on
Logic in Computer Science (LICS)
Vancouver 22 June 2019



THE UNIVERSITY of EDINBURGH

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Laboratory for Foundations
of Computer Science



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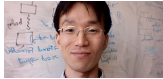


THE ROYAL
SOCIETY

The
Alan Turing
Institute

from: Ohad Kammar to: Hongseok Yang 2015-07-17

Dear Hongseok,



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Dear Hongseok,

I hope you are well, that the remainder of the Concurrency Workshop went smoothly, and that you are safely back home.

Concurrency Workshop 2015
Imperial College



Gardner, Donaldson, Wickerson, Raad

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Thank you for taking the time to explain to me about your current work on probabilistic programming and Bayesian inference.

*Particle Gibbs with ancestor sampling
for probabilistic programs*



van de Meent, Yang, Mansinghka, Wood

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Adam Ścibior



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International Workshop on
Higher-Order Programming and Effects
ICFP'15

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Yours, Ohad.

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Dear Hongseok,

Semantics for probabilistic programming: higher-order functions, continuous distributions, and soft constraints

Sam Staton Hongseok Yang
Frank Wood
University of Oxford

Chris Heunen
University of Edinburgh

Ohad Kammar
University of Cambridge

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Semantics for probabilistic programming: higher-order functions, continuous distributions, and soft constraints

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A Convenient Category for Higher-Order Probability Theory

Chris Heunen
University of Edinburgh, UK

Ohad Kammar
University of Oxford, UK

Sam Staton
University of Oxford, UK

Hongseok Yang
University of Oxford, UK

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A Convenient Category for
Higher-Order Probability Theory

Denotational Validation of Higher-Order Bayesian Inference

ADAM ŚCIBIOR, University of Cambridge, England, UK and Max Planck Institute for Intelligent Systems, Germany

OHAD KAMMAR, University of Oxford, England, UK

MATTHIJS VÁKÁR, University of Oxford, England, UK

SAM STATON, University of Oxford, England, UK

HONGSEOK YANG, KAIST, South Korea

YUFEI CAI, Universität Tübingen, Germany

KLAUS OSTERMANN, Universität Tübingen, Germany

SEAN K. MOSS, University of Cambridge, England and University of Oxford, England, UK

CHRIS HEUNEN, University of Edinburgh, Scotland, UK

ZOUBIN GHAHRAMANI, University of Cambridge, England, UK and Uber AI Labs, California, USA

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Functional Programming for Modular Bayesian Inference

ADAM ŚCIBIOR, University of Cambridge, UK and MPI for Intelligent Systems, Germany

OHAD KAMMAR, University of Oxford, UK

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Functional Programming for Modular Bayesian Inference

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A Domain Theory for Statistical Probabilistic Programming

OHAD KAMMAR
ZOUBIN GHAHRAMANI

MATTHIJS VÁKÁR, Columbia University, USA

SEAN K. MOYER, University of Oxford, UK

CHRIS HEUN, University of Oxford, UK

ZOUBIN GHAHRAMANI, University of Oxford, UK

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Ideas business

- ▶ Generate ideas
- ▶ Manage ideas

My goal

- ▶ **Conceptualise** research ideas
- ▶ Suggest **exercises**:
 - ▶ this week
 - ▶ beyond

Talk structure

- ▶ About me
- ▶ Research questions & answers
- ▶ Managing ideas

Warning

- ▶ Conflicting advice
- ▶ sampling and survivorship biases

About me

BA CS, *Open University of Israel*.

1999–2005

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BA Maths, *Open University of Israel*.

2004–2009

BA CS, *Open University of Israel*.

1999–2005

About me

Graphics software engineer, *LucidLogix Technologies Ltd.*. 2008
BA Maths, *Open University of Israel*. 2004–2009
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PhD Informatics, *LFCS, University of Edinburgh.* 2009–2014
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3 failed lectureship applications, 1 failed fellowship application.

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3 failed lectureship applications, 5+ failed fellowship applications

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6 failed postdoc applications, 1 failed lectureship application

PhD Informatics, LFCS, University of Edinburgh. 2009–2014

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Forms of research questions

Examples:

- ▶ Fill a gap:

Gödel's incompleteness theorems



- ▶ Bridge seemingly unrelated areas:

*From parametricity to conservation laws,
via Noether's theorem,*



Robert Atkey



- ▶ Extend knowledge in a new direction:

Cook-Levin theorem and polynomial time reductions



- ▶ Shed new light on old ideas:

Quantum channels as a categorical completion,

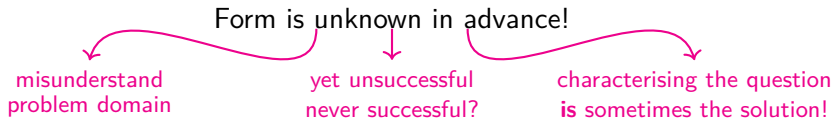
Mathieu Huot and Sam Staton



Tues 10:30am
Room A



Forms of research questions



Exercises

Goal: recognise and taxonomise research forms.

1. Think about your past/current research.
What form of contribution is it?
Was it always of this form?
2. You're going to see many talks this week.
What form of contribution is each?
Discuss your opinions with others.
Discuss your opinions with the **authors**:
was the contribution always clearly of this form?

Who cares?

Synthetic/internal:

questions and answers that

- ▶ interested in
- ▶ care about
- ▶ find useful/important
- ▶ want to understand

Analytic/external:

others

non-standard terminology, but
Kant, Frege, Carnap, and co
don't agree either

Who cares? (Synthetic-analytic distinction)

Example

Algebraic foundations for effect-dependent optimisations



with Gordon Plotkin



Synthetic

Q: What are the semantics of effect systems?

A: A (category theoretic) construction: conservative restriction.

Analytic

Q: How to justify more compiler optimisations?

A: Use an effect-system and its denotational semantics.

Who cares? (Synthetic-analytic distinction)

Consequences

Q: S

A: S

S=Synthetic

A=Analytic

N=Neither

Rev. C: I don't see the point.

Next step: Look for applications.

Who cares? (Synthetic-analytic distinction)

Consequences

Q: S A

A: S S

S=Synthetic

A=Analytic

N=Neither

Rev. C: Quickly degenerates to definitions and theorems.

Next step: Look for alternative (additional) proofs

Who cares? (Synthetic-analytic distinction)

Consequences

Q: S A A

A: S S A

S=Synthetic

A=Analytic

N=Neither

Rev. C: Best paper award!

Next step: Why are **you** doing this?

Who cares? (Synthetic-analytic distinction)

Consequences

Q: S A A N
A: S S A S/A

exercises/workout
exploratory research.



S=Synthetic
A=Analytic
N=Neither

Exercises

Goal: use this taxonomy to guide research

1. Consider the other combinations.
2. Where does your project lie?
Are you content with this position?
If not, what would you do to change it?

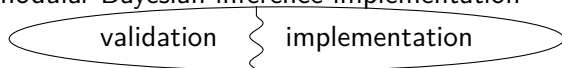
Who cares? (Synthetic-analytic distinction)

dynamic distinction!

Synthetic

- ▶ changing interests
- ▶ break into new areas / learn new techniques
- ▶ changing goals

modular Bayesian inference implementation



POPL'18

ICFP'18

Analytic

- ▶ Government/industrial interest or funding.
- ▶ Charismatic figureheads.
- ▶ Different communities

Who cares? (Synthetic-analytic distinction)

Exercises

Goal: assess your relationship to your research community.

Review the difference, if any, between your synthetic Q&A and the analytic Q&A in your research group, department, and workshops/conferences.

1. Where do you find a close fit?
2. Where do you find the largest difference?
3. Have your synthetic Q&A changed over time?

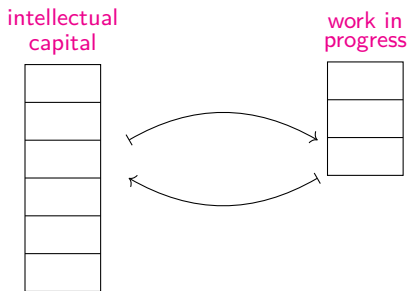
Managing ideas

intellectual
capital

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intellectual capital: non-blocked suspended

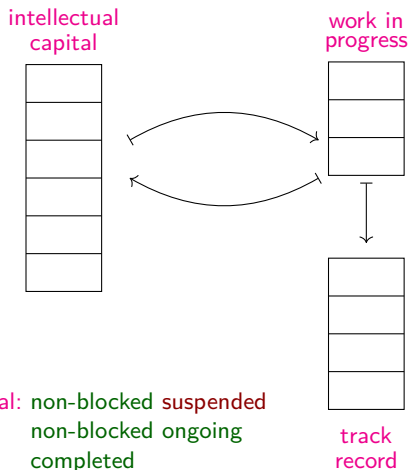
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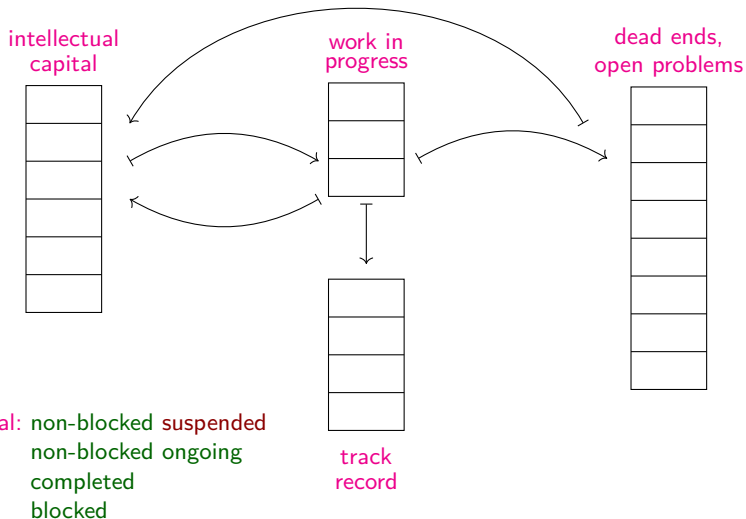
intellectual capital: non-blocked suspended

work-in-progress: non-blocked ongoing

Managing ideas



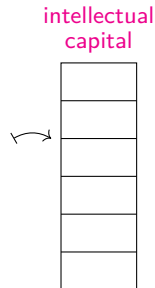
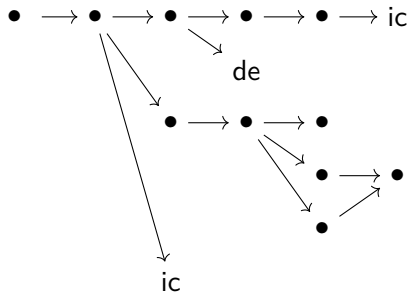
Managing ideas



Managing ideas

Generating ic and de with wip

calculate, prove, program, verify, experiment!

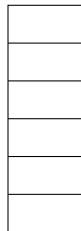


Managing ideas

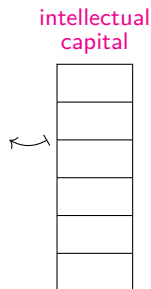
Generating ic

- ▶ wip
- ▶ collaboration, esp. 1:1
- ▶ networking
- ▶ sparks of inspiration
- ▶ technical reading (papers/books/grants)
 - ▶ reading groups
 - ▶ reviewing
- ▶ taking courses
summer schools
- ▶ writing notes
and papers
- ▶ giving talks/seminars
- ▶ teaching
- ▶ going to talks/seminars
 - ▶ detailed and technical (seminars, tutorials, workshops)
 - ▶ high-level (conferences, invited talks)
- ▶ supervising researchers
 - ▶ students
 - ▶ interns
 - ▶ postdocs
- ▶ writing grants & project proposals

intellectual
capital



Consuming ic



- ▶ supervising researchers
 - ▶ students
 - ▶ interns
 - ▶ postdocs
- ▶ writing grants & project proposals

Managing ideas

wip

A small and focussed:

- ▶ Quicker completion
- ▶ Higher-quality ic

Completion criteria:

- ▶ communicability
- ▶ usability
- ▶ substantiality
- ▶ self-contained
- ▶ published/shared/executed/used.

“Go for the
most-publishable unit.”

Peter Sewell



“Publication is a form
of attainment.”

Gordon Plotkin



Managing ideas

Role of track record

- ▶ You're doing great work!
- ▶ evidence-based sense of achievement
- ▶ confidence building
 - ▶ you in yourself
 - ▶ others in you:
 - ▶ peers
 - ▶ students, interns, postdocs
 - ▶ potential funders
 - ▶ governments
- ▶ Reputation \rightsquigarrow generated ic
- ▶ also builds your cv

Role of dead ends

- ▶ asking hard questions (in seminars, in person)
- ▶ writing survey papers
- ▶ reviewing papers
- ▶ identify breakthroughs
- ▶ taking advantage of new developments
- ▶ Identifying analytic questions

Exercise

Goal: take stock and ownership of your ideas pipeline

1. Work out your ic, wip, and tr (de might be too much!).
2. What is limiting your ic generating abilities?
Is it necessary?
Is it necessary **now**?
3. What **new** activities can you try to generate ic?

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Summary

