Role-play games to advance probabilistic forecasting in hydrology

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Context of game applications

Weather forecasts

Input scenarios

Catchment model

River flow forecasts

Output scenarios

Q (m³/s)

t₀

t₀+Ν

Decision-making

RESERVOIR MANAGEMENT

FLOOD WARNING

Uncertainty assessment

Impact model (user)
Use and communication of uncertain, probabilistic forecasts

- What scenario should I base my decision on?
- What are the implications of getting it wrong?
- What is the critical probability threshold?
- How can I communicate this information?
Our motivation

- Busting forecasting myths:
  - “Probabilistic forecasts are not useful”
  - “We cannot make decisions with forecast scenarios”

- Reflecting about the “real world out there”: investigating wrong or missing perceptions about forecast users and the way forecasts are used in practice

- Curiosity

- To have fun
Examples: try it yourself!

Game:

- Do probabilistic forecasts lead to better decisions?
- Ramos et al., 2013

1. Set the scene

Your company has received 30,000 tokens for a flood protection contract. You have to manage a gate which is the inlet of a retention basin designed to protect the town of Bigrivers.

If you do not open the gate and a flood occurs, the town is flooded and you have to pay a fine of 7,000 tokens.

2. Provide information and ask for a decision

Expected output: 3.52 metres +/- 0.51

Probability of flooding: 23.59 %

Do you want to open the gate to the retention basin?

[Yes] [No]
Examples: try it yourself!

Game:

- Do probabilistic forecasts lead to better decisions?
- Ramos et al., 2013

Your company has received 30,000 tokens for a flood protection contract. You have to manage a gate which is the inlet of a retention basin designed to protect the town of Bigrivers.

If you do not open the gate and a flood occurs, the town is flooded and there is no benefit to the company.

Do you want to open the gate to the retention basin?

[Yes] [No]
Examples: try it yourself!

Game:

- Peak box Game
- Zappa et al., 2013

How big will the observed peak discharge be?
At what time will the peak discharge occur?

Write your co-ordinates, e.g.: G-26

You need a pencil!

-> Check one box!
Examples: try it yourself!

Game:

- Peak box Game
- Zappa et al., 2013

How big will the observed peak discharge be?
At what time will the peak discharge occur?

Write your co-ordinates, e.g.: G-26

A game that challenges the “wisdom of the crowds”: how additional information extracted from the ensemble prediction can help in the analysis of forecast events.
Examples: try it yourself!

Game:

- The Shopkeepers Dilemma
- Werner et al., 2016

Make Your Decision:
- Do Nothing
- Raise Flood Defences
- Move Inventory

If you are the owner of...

<table>
<thead>
<tr>
<th>Shop 1: Ferraris</th>
<th>Shop 2: Groceries</th>
<th>Shop 3: Gravestones</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ferraris</td>
<td>Groceries</td>
<td>Gravestones</td>
</tr>
<tr>
<td>Initial Savings</td>
<td>€ 500,000</td>
<td>€ 100,000</td>
</tr>
<tr>
<td>(-) Do Nothing</td>
<td>€ 0</td>
<td>€ 0</td>
</tr>
<tr>
<td>(D) Raise Defences</td>
<td>€ 10,000</td>
<td>€ 10,000</td>
</tr>
<tr>
<td>(I) Move inventory</td>
<td>€ 25,000</td>
<td>€ 5,000</td>
</tr>
<tr>
<td>(L) Losses if flooded</td>
<td>€ 100,000</td>
<td>€ 20,000</td>
</tr>
<tr>
<td>(P) Profits when open for business</td>
<td>€ 25,000</td>
<td>€ 10,000</td>
</tr>
</tbody>
</table>
Examples: try it yourself!

Game:

- The Shopkeepers Dilemma
- Werner *et al.*, 2016

Make Your Decision:
- Do Nothing
- Raise Flood Defences
- Move Inventory

Flood Bulletin Issued at each event shows probability of water level exceeding embankment & probability of water level exceeding top of demountable defences

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<th>Gravestones</th>
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<tr>
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<td>€ 10,000</td>
<td>€ 5,000</td>
</tr>
</tbody>
</table>

A game that shows that users with different cost/loss ratios react differently to the forecast information they receive.
Examples: try it yourself!

Day 1

You are in your office.
You can see a computer.
1. Would you like to see the latest forecast on it?
2. Or would you rather work on the paper you’re about to submit?
Or
3. You can go to the forecasters’ room
4. Or to the flood incident room and talk to the people working there.

Click on the option of your choice.

Game:

• Pathways to designing and running a flood forecasting system
• Arnal et al., 2017
• H2020 IMPREX project
Examples: try it yourself!

Game:

- Pathways to designing and running a flood forecasting system
- Arnal et al., 2017
- H2020 IMPREX project

Day 1

You are in your office. You can see a computer.
1. Would you like to see the latest flood forecast?
2. Or would you rather work with the people working there?
Or
3. You can pick another option. Your choice.

An adventure game where you can gain popularity but lose money if you don’t take action at the right moment!
Step 1: Design

- Clear definition of what you want to know/investigate
- Setup:
  - the player’s goals (as decision-maker)
  - actions available to the decision-maker
  - relevant information that should be available (ex., forecasts, management constraints, a decision rule based on a flood threshold level)
  - consequences following each possible action-event pair (payoff function)
  - outcomes (how they will impact the decision-maker and provide an answer to what you want to know)
Step 2: Build

- PPTs/PDF: step by step instructions (test it extensively!)
- Worksheets to be distributed and collected at the end, or online game (with access to results)

Worksheet:

Do probabilistic forecasts lead to better decisions? Try it yourself!

--- Game 1 --- Game 1 ---

<table>
<thead>
<tr>
<th>Game</th>
<th>Do the Game?</th>
<th>Can the Game?</th>
<th>Won?</th>
<th>Defeat</th>
<th>Focus</th>
<th>Damage (if you do not choose the greatest focus)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Round 1</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 2</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 3</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 4</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 5</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 6</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 7</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Round 8</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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Online game:

Pathways to running a flood forecasting centre: an adventure game! by HEPExers

This game is unlisted. Only those with the link can see it.

You are not logged in.

If you log in before playing, you'll be able to save your progress - which means you can come back later and pick up where you left off.

Log in

Play online
Step 2: Build

- PPTs/PDF: step by step instructions (test it extensively!)
- Worksheets to be distributed and collected at the end, or online game (with access to results)
- Game over: think about conclusions, take-home messages

Water management game (Crochemore et al., 2015)
Step 3: Play

- Make sure people are ready to play a role!
- Raising hands, volunteers, individual players/groups
- Save their answers (game sheets)
- Award the winner(s)

EGU Ensemble Forecasting session in 2012

IMPREX project meeting in 2017

HEPEX Workshop in 2016
Step 4: Write about the results

- Don’t think your results are useless (just because things didn't happen exactly as you expected!)

- Avoid falling into over-interpretations: stick to what your observations can tell you, cross check with your colleagues

- Avoid individual/personal responses: go for statistics

- Link your findings to other people’s findings: contribute to build a body of role-play game experiences in your field

- Make your game (and results) public and disseminate it!
Last remarks

- Excellent way to introduce complex concepts or test new products during teaching, training or workshops
- Opportunities to engage early career scientists (science ⇨ practice)
- Great for demonstrating different concepts / play with real world scenarios / perceptions
- Our games:
  - not designed to robustly test a hypothesis about decision-making behaviour (need of replication in a particularly controlled setting)
  - mostly target modellers / forecasters. Another target group could have been the general public (another design and implementation approach needed)
All games are available for free!

www.hepex.org (international volunteer effort since 2004)

If you have a forecasting game to share, send it to us!

Thank you!