COLLEGIUM DA VINCI

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UNIVERSITY OF THE CURIOUS

25 YEARS

Cases & Simulations

Simulations in Education: Transforming Case Studies

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What is a case study?

WALRUS
A large flippered marine mammal, the walrus (Odobenus rosmarus) is renowned for its enormous tusks, which can reach an incredible one metre in length.
(quick summary of 2 levels: level 1: endangered species, Canadian gov, ban on hunting & quota for Inuits / level 2: monetary value)

Original idea from M. Sandel: The moral limits of market

Case study vs Simulation

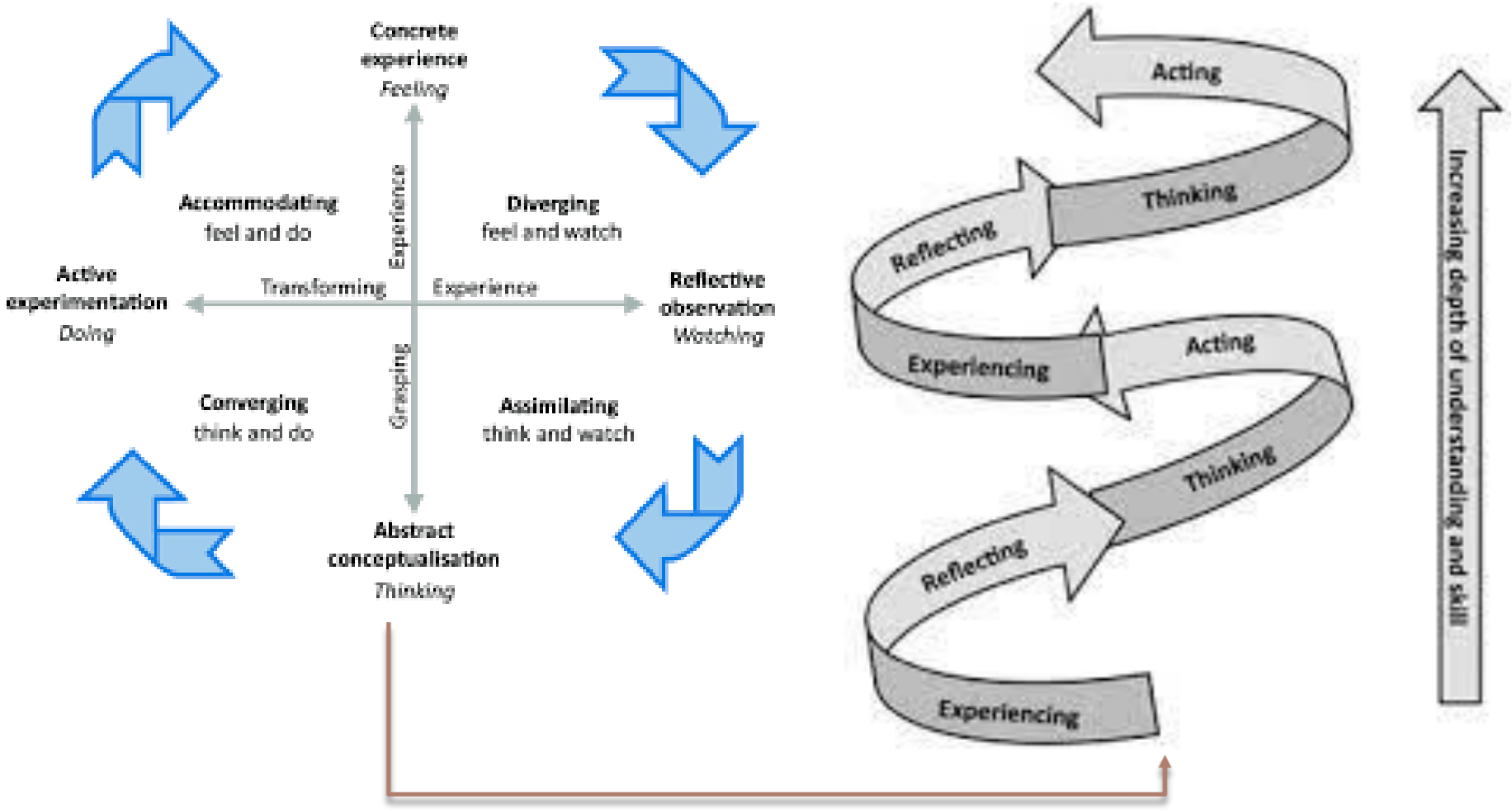
Case method teaching is an active form of instruction that focuses on a case and involves students learning by doing. Cases are real or invented stories that include "an educational message" or recount events, problems, etc. which require analysis and/or decision-making.

Simulations are instructional scenarios where the learner is placed in a "world" defined by the teacher to represent a reality within which students interact. The teacher controls the parameters of this "world" and uses them to help students achieve the learning outcomes.

To review (based on the Kolb-cycle)

- concrete experience with the case (facts, story, problems)
- reflective observation (key issues)
- abstract conceptualization (analysis, proposing alternatives) and
- active experimentation (recommend best course, discuss outcomes).

Case study vs Simulation



EVA Manufacturing I

EVA Manufacturing has been contracted to provide Boston Dynamics (BD) with printed circuit (PC) boards. **BD will pay $5.00 for each board** under the following terms:

- **100,000 PC boards will be delivered to BD in one month, and**
- **BD has an option to take delivery of an additional 100,000 boards** in three months by giving EVA 30 days notice.

EVA manufactures the PC boards using a batch process, and manufacturing costs are as follows:

- there is **a fixed setup cost of $250,000 for any manufacturing batch run** (regardless of the size),
- and there is a marginal **manufacturing cost of $2.00 per board** (regardless of the size).

EVA believes there is a 50% chance BD will exercise its option to buy the additional 100,000 PC boards.

Exercise was adapted by T. Voros from C. W. Kirkwood (2002) Decision Tree Primer

EVA Manufacturing II

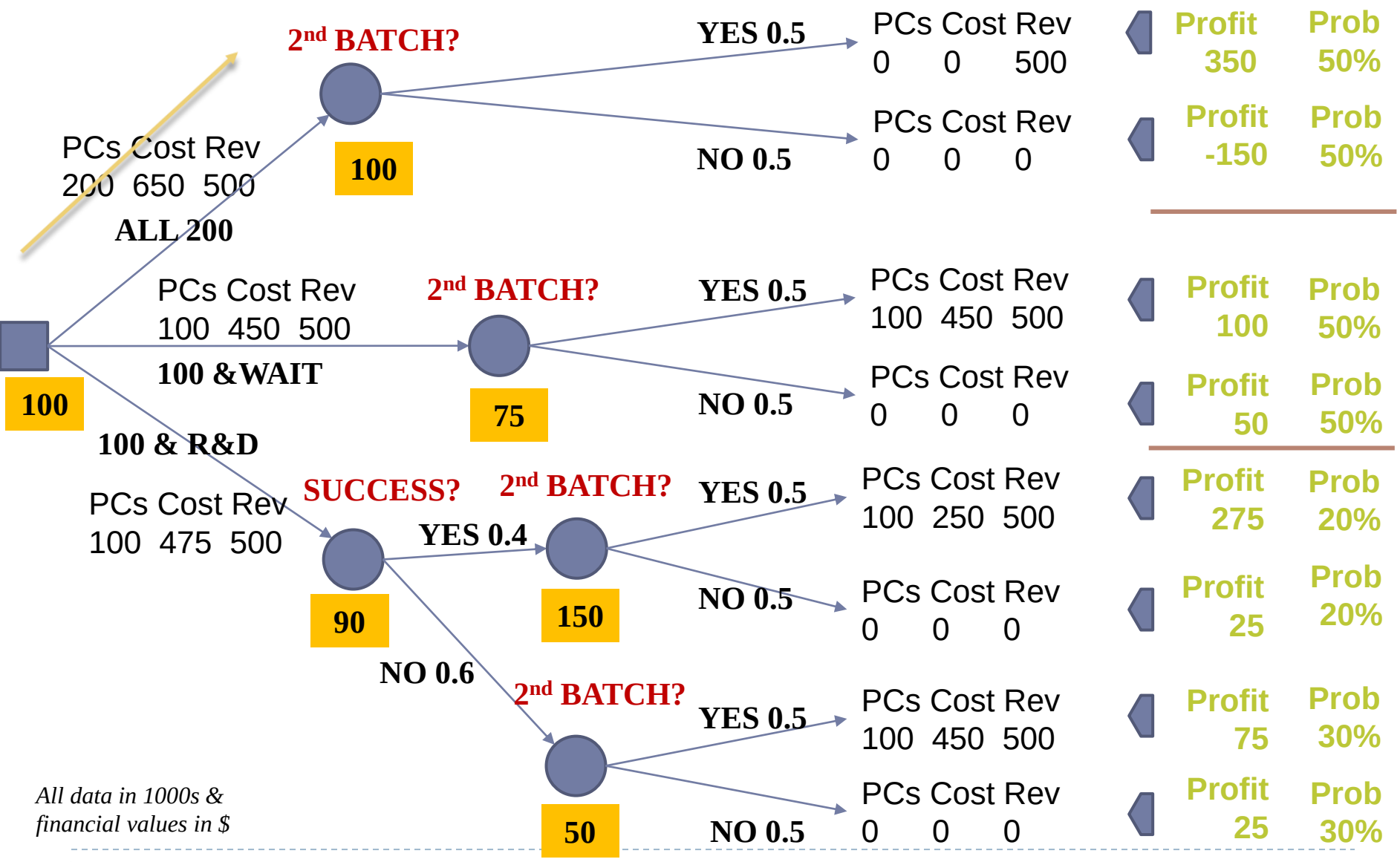
EVA's options

- manufacture all 200,000 PC boards now (if EVA manufactures 200,000 now and BD does not exercise its option, then the manufacturing cost of the extra 100,000 boards will be totally lost);
- manufacture 100,000 now and manufacture the other 100,000 later (only if BD exercises its option to buy those boards);
- EVA can also conduct some research and development along the manufacturing of the first batch: if successful, this would reduce the fixed setup cost associated with manufacturing the boards for BD. The R&D will cost $25,000, and there is a 40% probability that it will be successful. If it is successful, then the fixed setup cost would be reduced to $50,000.

Should EVA manufacture 100,000 or 200,000 units based on the profit EV?

There will be four levels of the case by altering the variables!

Level 1 – EVA Decision Tree

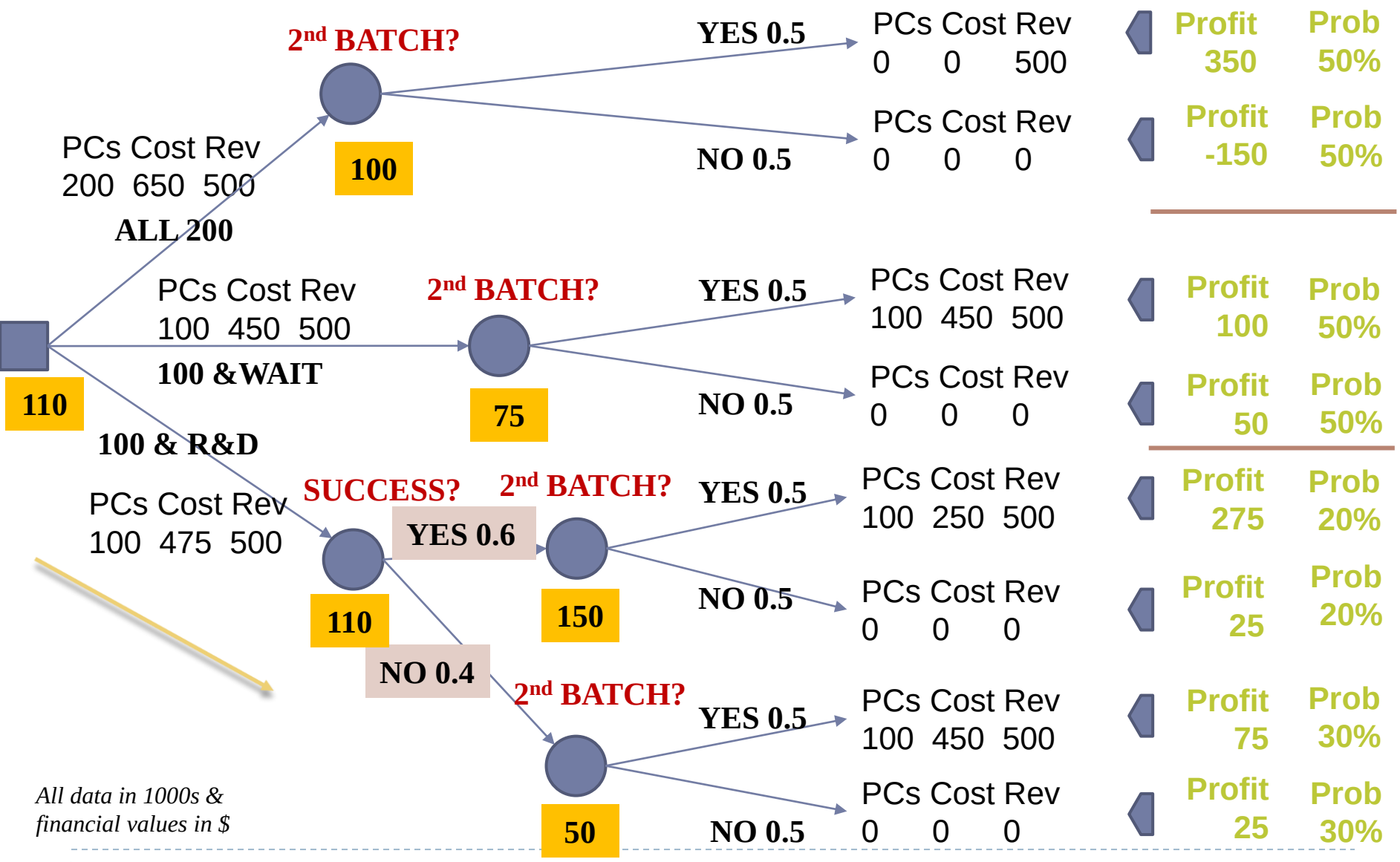


All data in 1000s & financial values in $

Level 1 - Answers

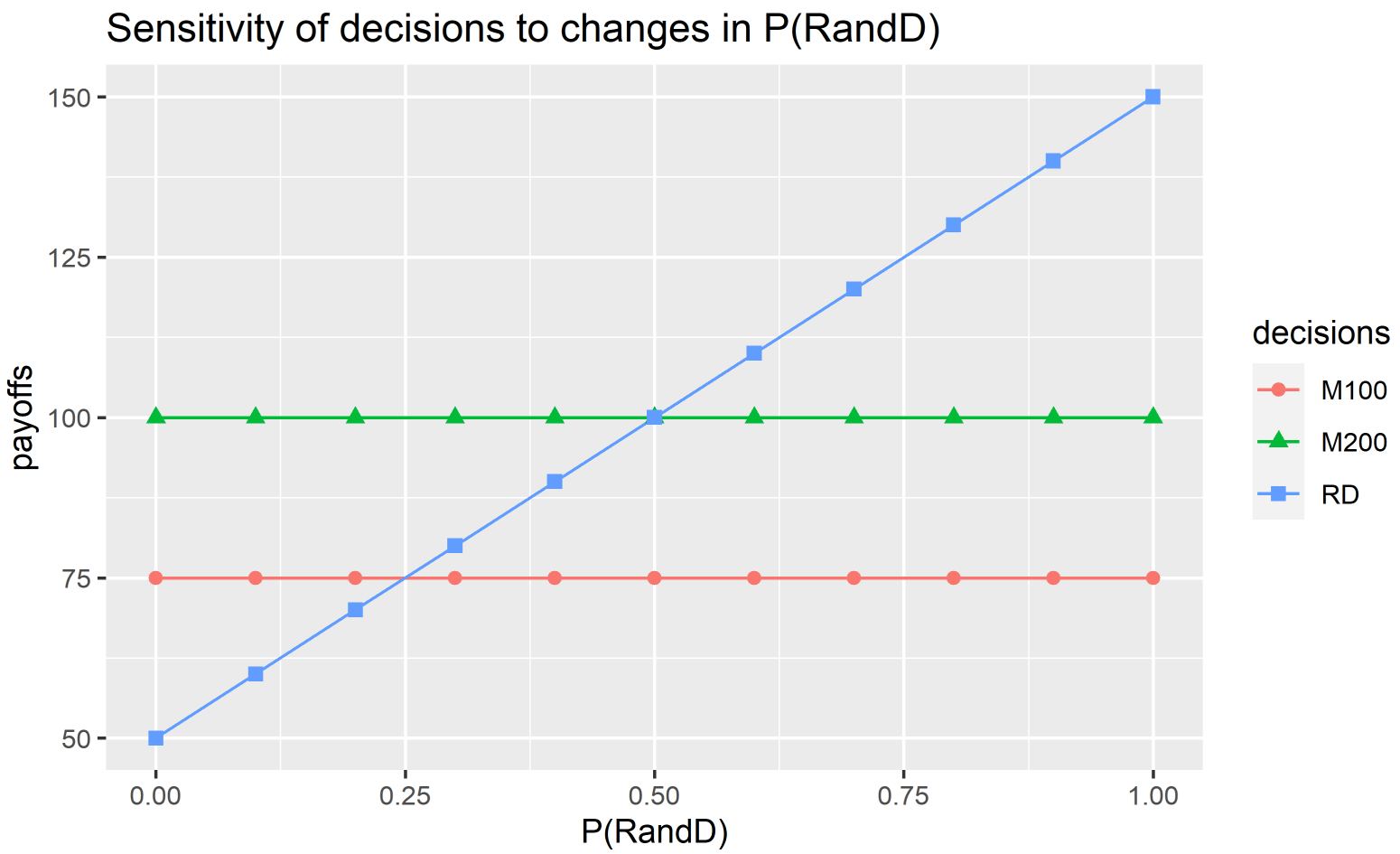
- Based on profit EV, the 200,000 production branch has the highest EV ($100,000). However, in this case there is a 50% chance of making $350,000 and 50% losing $150,000.
- If the decision maker is risk-averse (and the business cannot allow losses), this branch should be taken out of the analysis. The other branches have no loss events. In case of the 100,000 manufacturing & no R&D, there is a 50% chance of making $100,000 and also 50% chance of making only $50,000. The decision tree EV shows us that the R&D is a better option, with 20% probability of $275,000, 30% of $75,000 and 50% of $25,000 only, having a higher EV of $90,000 vs $75,000 for the w/o R&D option.
- Thus the analysis of the tree is considerably more than just stating the EV. Solving the tree involves finding expected values of all possible states at chance nodes. Understand that the EV is NOT the true value that one would reach in a single given decision. It is the ‘mean’ of repeating the given decision several times.
- **Level 2 introduced: How sensitive is the tree to the R&D success?**

Level 2 – EVA Decision Tree



All data in 1000s & financial values in $

Level 2 - Sensitivity



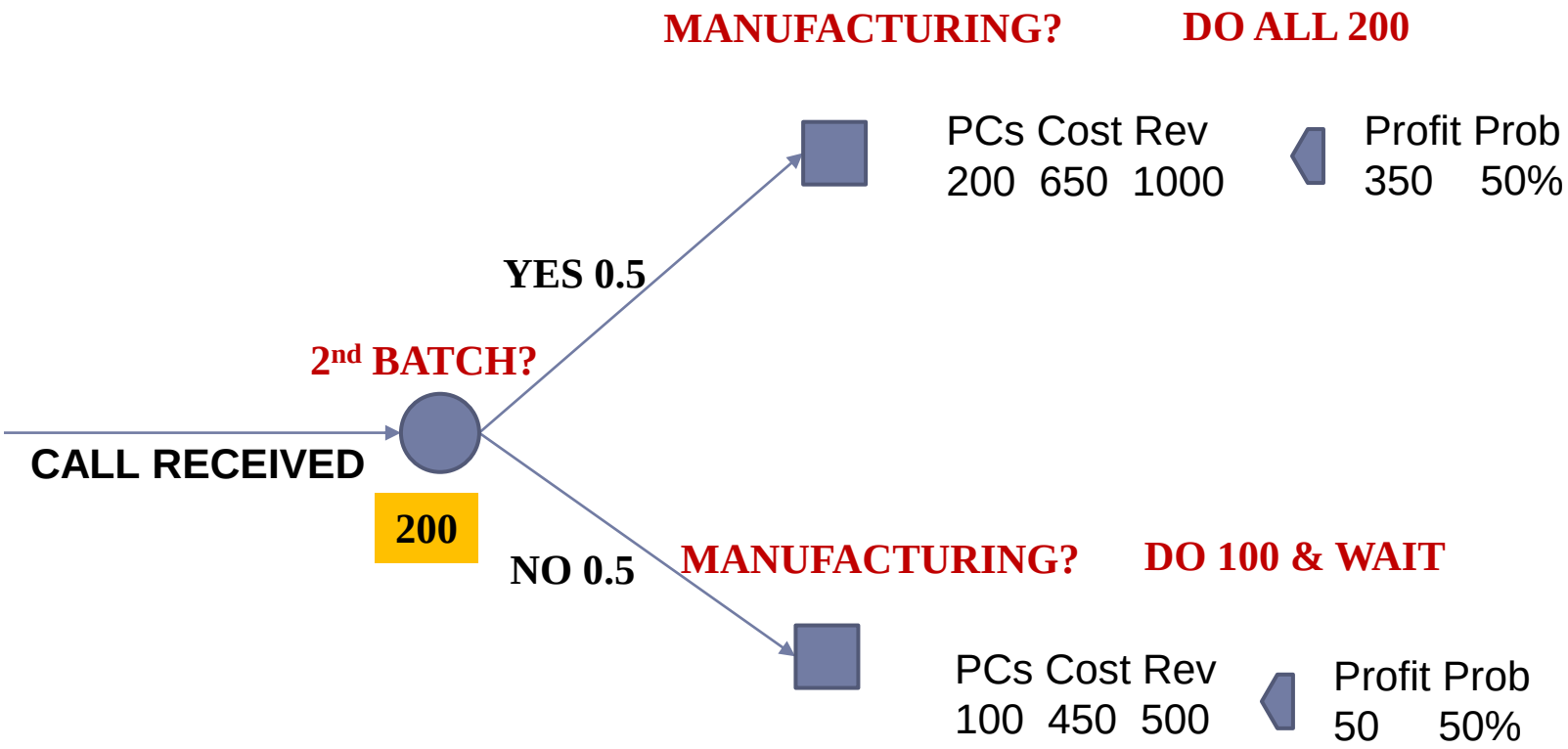
Level 3 - EVA Manufacturing III

Going back to the initial case – R&D success rate is 40%.

Suppose that an internal government / defense tender committee source (BD's decision on the second batch would depend on winning this particular tender) can give EVA a definitive 'BD will or will not win' answer BEFORE the first 100,000 order is manufactured.

- Determine the value of learning for certain whether BD will or will not exercise the additional delivery option.

Level 3 - Value of Information 2nd Batch



Initial tree EV: $100,000
Tree with information EV: $200,000

→ *Value of information: $100,000*

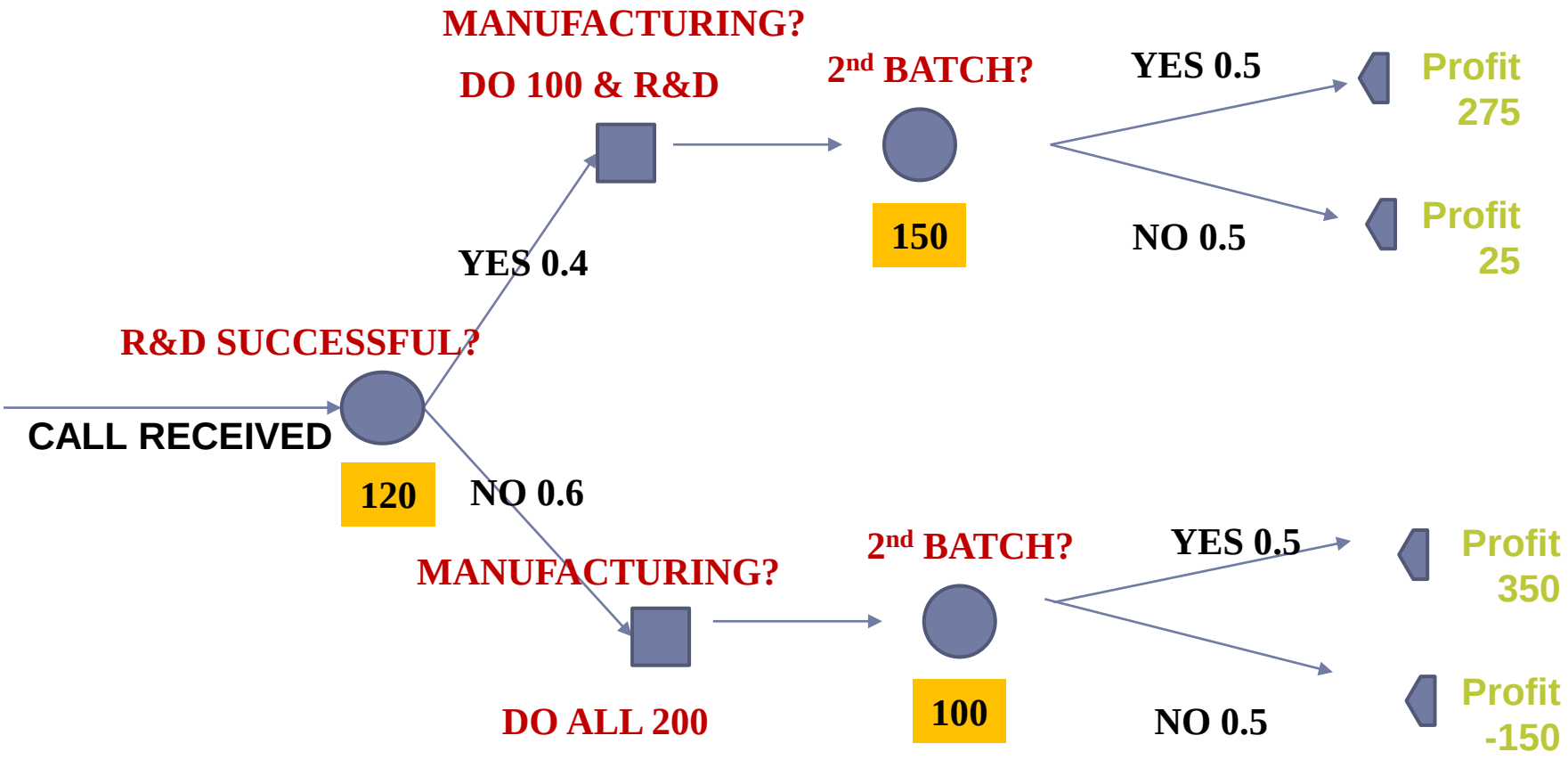
Level 4 - EVA Manufacturing IV

Going back to the initial case – R&D success rate is 40%.

Suppose that you can hire an (expensive) R&D expert: she can tell you whether the R&D will succeed or not BEFORE the first 100,000 order is manufactured.

- Determine the value of learning for certain whether the R&D will or will not succeed.

Level 4 - Value of Information R&D



Initial tree EV: $100,000

Tree with information EV: $120,000

Value of information: $20,000

The EVA case / simulation

- Level 1: one page of initial case / introducing probability, decision trees, independent events, expected value etc. with the case
- Level 2: existing variable of success probability of R&D is introduced and allows for different outcomes of the original case, without really increasing complexity
- Level 3: the idea of acquired information is introduced, now we have information about BD decision (to acquire additional 100,000 pcs) – we are increasing complexity for the learner!
- Level 4: we modify the variable of acquired information: now we have information about the success of R&D

- From a single exercise => case => a multi-level simulation
- Changing variable is not just changing a value within a financial example / exercise: its changing an element in the worldview of the case
- 'Dynamically changing' case – several levels, with changing variables within the 'worldview' of the case – not just a multi-stage case, but an 'active' simulation

Cookbook: How to do this?

- Simulation-based approach to case studies
- Multiple levels with changing variables
- You are NOT introducing theory (or minimizing this before the case) – the theory will come organically during level 1 solution of the case
- This simulation levels can be used for exams / grading etc.

Simple recipe / cookbook: converting case to simulation

- Take your exercise / example / case
- Develop a case / worldview of your exercise with parameters & learning objectives / goals (case method)
- Consider which variables you can modify, the impact of the variable(s) on the case / outcomes and how it fits into your case / simulated world (simulation method) & learning objectives / goals
- Try for at least 3 rounds – i.e. each round brings in a modified variable or adjusts an already introduced variable
- Remember: each round should introduce a change in the case variable(s) & a change in the case outcome(s)

If any questions, feel free to email / ask
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