Introduction

This is a dynamic game of incomplete information, but what makes it interesting is that the first player must move without knowing the type of the 2nd player (so the information set that is incomplete is at the Student's level) – draw this into the extensive form of the game.

The text in red below relates to the extension of the payoffs to include ε, but this can all easily be omitted (and I think it should be), but I've left it there for the intuitive explanation and for whoever will be writing the "possible extensions" paragraph.

The game

The game from the student's perspective: Right before the essay hand-in date, the student faces a crisis that has a cost *c* on their final mark for the essay, where $c \geq 0$. If a student is able to delay handing in their essay, they are able to reduce the effect of the cost of the crisis on their potential final mark. The student's resiliency factor, β, determines to what extent a student is able to academically recover from the crisis, where $\beta \in (0,1)$. A low β indicates high resilience, where $\beta \rightarrow 0$ suggests a student, if given an extension, recovers the cost of the crisis on their potential final mark almost entirely.

From the lecturer's perspective: A lecturer wants to help their student to overcome the academic cost of a crisis. However, granting an extension may not always be the best way to help: students who have low resilience will not benefit as much from an extension as those with higher resilience. As an extension maybe add the cost of extension on later academic work. An extension given until after exams will have a low cost of extension. However, their willingness to accommodate a student's late hand-in of an essay depends on the lecturer's degree of empathy, δ, where $\delta \in [0,1]$, and how much other work the lecturer has around the time of the extension's deadline. A higher δ value indicates a greater degree of empathy. The parameter, r, indicates the inconvenience to the lecturer of marking the essay at a later stage, where $r > 0$. Granting an extension places a burden on the lecturer to mark the essay at an inconvenient time, and the benefit of granting the extension (i.e. helping the student) needs to outweigh the cost of granting the extension. If the lecturer does not extension, the lecturer has to give a mark penalty $m > 0$, which is painful for the lecturer since they care about the student's academic success. However, the extent to which the lecturer is negatively affected by giving the mark penalty is scaled by their degree of empathy.

When a student does not hand in on time and the lecturer does not grant an extension, then the student will scramble to hand in what they do have, without completing the essay to the desired quality level, and will receive a small mark penalty, $m > 0$, for handing in a day or two late. On the flip side, the essay will be complete and finishing the essay to the desired level will not come at the cost of completing other work later on during the term.

Beliefs: parameters a, c, β, r, m *and* ε are constant and known to all players. May be worthwhile to elaborate on this a bit, i.e., tell a story. Although the student knows how busy the lecturer will be around the time of the extension hand-in (*r* is known), the student does not know how empathetic the lecturer truly is. The more empathetic a lecturer is, the greater the benefit of granting the extension will be, which is the benefit that needs to offset the cost of giving the extension.

The game is shown in the extensive form in figure 1 [insert]. When handing on time, the student attains a payoff of $a - c$, where a is the student's potential mark for the essay and c is the academic cost of the crisis. When the student hands in on time, the lecturer has a payoff of zero. If a student does not hand in on time, the lecturer may choose to give the student an extension. If the lecturer does not give an extension, the student has to hand in what they do have as soon as possible, and still gets a small mark penalty, yielding a payoff of $a - c - m$. In this case, the lecturer has a negative payoff $-\delta m$ from giving the park penalty, which is scaled by their empathy factor. On the other hand, if an extension is granted, the student gets a payoff of $a - \beta c - \varepsilon$, which is equal to their potential mark, less the resiliency-scaled effect of the crisis, less the cost of the extension in terms of cost on other work later on in the term. The lecturer then receives a payoff of $-r + b(\delta, \beta, c, \varepsilon)$, where $-r$ is the cost of marking the essay at an inconvenient time and the function $b(\cdot)$ is the benefit that the lecturer gets from granting an extension.

[Equation 1 here]

If a lecturer has a higher degree of empathy, δ, then $b(\cdot)$ will be large. If the student is very resilient, i.e., β is small, then the benefit of granting the extension will be large. Further, the larger the academic cost of the crisis is, the larger the benefit is to the lecturer for being able to help the student overcome their hurdle.

The lecturer will grant an extension if the benefit from giving the extension exceeds the cost of giving the extension, less the disutility of giving the mark penalty in the case of no extension.

[Equation 2 here]

Note here that even if there is no crisis and the student is reasonably expected to hand in on time, a lecturer will not never grant an extension. If there is no crisis, a lecturer will still grant an extension if $r < \delta m$. This part of the argument is really important if later on we want to argue that lecturers may reveal something about their degree of empathy through the value they set as a mark penalty.

> *INSERT FOOTNOTE: The function specification allows that $b \propto \delta \propto {}^{1}/_{\beta} \propto c \propto {}^{1}/_{\varepsilon}$ if $c > 0$, and for $b(\cdot) = 0$ if $c = 0$. When there is no external crisis affecting the student's academic performance, the lecturer does not derive any benefit from giving a student an extension since they do not help the student by giving them an opportunity to dampen the effect of an external crisis on their final marks. Further, the model makes the assumption that a student will attain their potential mark *a* when they hand in on time, and handing in on time would be a weakly (strictly) dominant strategy for a student with no crisis. For this reason, we restrict the analysis to cases where $c > 0$, since the study of $c = 0$ is uninteresting.

Simplified, the lecturer will grant the extension if their degree of empathy is larger than a certain value determined by the constants in the payoffs known to all players:

[Equation 3]

The threshold level of empathy, where the lecturer is indifferent to giving an extension, is specified in [4] below. If $\delta > \bar{\delta}$, then the lecturer will give an extension. If $\delta > \bar{\delta}$, the lecturer will not give an extension.

[Equation 4]

Intuitively, if r is higher (i.e., the cost of marking an essay at an inopportune time, then $\bar{\delta}$ would be higher, meaning that from the student's perspective there would be a smaller likelihood of a lecturer granting an extension.

> *INSERT FOOTNOTE: The student chooses their action based off of their expected utility from their various strategies. Their beliefs about the lecturer type is based off a continuous

type space of the lecturer (assume: uniform distribution). The higher the threshold empathy level is, the less likely it is that a lecturer drawn from a uniform distribution will have an empathy level above the threshold level. This part about the continuous type spaces must be explained well, and should definitely be discussed in the body of the text, either before the explanation of the game, or during the 'intro' to the game where we explain the beliefs.

If β is smaller, then $\bar{\delta}$ is lower (since $\beta \to 0$ means that the numerator nears zero and the effect of β on the denominator becomes negligible), meaning that from the student's perspective, the chances of the lecturer granting the extension is greater. If c is large, then $\bar{\delta}$ will be low. If m is large, $\bar{\delta}$ will be large m will make the denominator smaller.

Note that, for the problem to be interesting, the inequality $0 < \frac{r\beta}{c-m\beta} < 1$ must hold. Since $r, \beta, c, m > 0$ by definition, the restriction (is it a restriction? For an interesting equilibrium…) can be simplified to $c > m\beta$. If $c < m\beta$, then $\bar{\delta}$ will be negative and the lecturer will always grant an extension. Even if the LHS is scaled down by β if the mark penalty is so big that it exceeds the cost of the crisis, a lecturer of any empathy level (save for Sigma = 0) will have a hard time justifying not giving the extension, since the cost of not giving the extension (in terms of disutility) is so great. Helpful to get some literature to back up refining this concept.

Let $\theta = Prob(Extension|Late)$. The student will hand in late if the expected payoff of handing in late is greater than the payoff of handing in on time.

[Equation 5]

Where $\bar{c}$ is the threshold cost of the crisis at which a student will be indifferent to handing in on time or handing in late. If $c > \bar{c}$, then the student will hand in late. If $c < \bar{c}$, then the student will hand in on time. If m is greater, or the probability of not getting an extension is greater, $\bar{c}$ will be greater. That is, the cost of the crisis needs to be larger for a student to rationally submit late. However, if the likelihood of the lecturer giving an extension is large, or the student is very resilient, then $\bar{c}$ will be relatively low.

The student's belief of the lecturer's type δ, along with the lecturer's best response, informs the value of θ.For simplicity, we have assumed that $\delta \sim uniform[0,1]$, the probability that δ is greater than the threshold $\bar{\delta}$ is $1 - \bar{\delta}$. Further, δ will be lower than $\bar{\delta}$ with probability $\bar{\delta}$. This distribution informs the student's expectations regarding the payoffs of their different available strategies. Therefore, $\bar{c}$ is defined as:

[Equation 6]

We substitute from [4] above, which yields the following equation.

[Equation 7]

For [7] to be interesting for the problem, i.e. restricting $c \geq 0$, $c > m\beta$.

Solving for the quadratic yields the following best response for the student. The threshold $\bar{c}$:

[Equation 8]

*APPENDIX OR FOOTNOTE: this solution concept was derived as follows: if [Insert Equation A1], the student will choose to hand in late. This becomes [Insert Equation A2]. We can solve for the quadratic, yielding the following two solutions for $\bar{c}$.

[Equation A3]

Since $r, \beta, m > 0$, the constant term in the quadratic function specified in [A2] will always be negative. Thus, one of the $\bar{c}$ solutions from the quadratic will be negative, specifically, the solution where the student will hand in late if:

[Equation A4]

This solution for $\bar{c}$ is ruled out since the game only allows for cases where $c \geq 0$. Thus, the only solution valid for this game is:

[Equation A5]

Where the critical value $\bar{c}$ is written as:

[Equation A6]

Where the student will hand in late if *c* exceeds $\bar{c}$, and hand in on time otherwise.

This best response has three key elements. First, if β is small, $\bar{c}$ will be low. Students who are more resilient have a lower threshold crisis cost that needs to be present in order to justifiably hand in late. Second, if the penalty for handing in late m is small, $\bar{c}$ will also be low. Intuitively, if the cost associated with the risk of not getting an extension is smaller, a student ought to be more likely to hand in later. Finally, as r increases, the threshold $\bar{c}$ increases. This means that, irrespective of lecturer's degree of empathy, since a busier lecturer is less likely to give an extension than a less busy lecturer, since the 'cost' of granting the extension is greater for the busier lecturer. The student accounts for this in their best response, and thus the $\bar{c}$ is higher, the greater *r* is.

The general solution for the game is that the lecturer will grant the extension if:

[Equation 9]

And the student will hand in late if:

[Equation 10]

Just some of my thoughts: Two really interesting insights from the model is that resilient students will be more likely to take an extension, even if the crisis is not that big. The second is the relationship between the empathy level and the mark penalty – lecturers may make the mark penalty far lower if they are known to be more empathetic, in order to reduce the cost of not giving an extension. A low mark penalty may be indicative of a higher level of empathy. This may be especially true at the department level, where there is a standard penalty per day set. The economics department, known for being more flexible has a 2% per day penalty that doesn't count weekends, whereas the law faculty for instance has a 5% per day including weekends penalty. It serves as a kind of commitment device for a lecturer to not have to give an extension, even though they may be very empathetic. On the other hand, if a lecturer has a preference of giving extensions, they may choose to set the mark penalty really high, making the threshold Sigma very low, increasing the probability that a lecturer will give a deadline (but maybe this is more at the department level).

It would maybe be interesting to discuss the various different solutions that will occur for different values of the parameters (defined in relation to one another), this is already done a little throughout the explanation, especially in footnotes. But maybe it can be expanded on in the discussion.

CONCLUSION

Shortcomings

Potential extensions

Can use different kinds of probability distributions for Sigma (lecturer's type), but this would not significantly change the interpretation of the solution concepts.

One can add an extension for the cost of the extension on other academic work. This would make the calculus far more complex, but the interpretation would be that the a greater cost of an extension would mean that the threshold Sigma would be higher, and the threshold cost would also need to be higher.

Can make the student's type unknown to the lecturer but known to the student.

<u>Literature review:</u>

Articles about games of incomplete information/signalling games:

Articles about essay hand-ins and student/lecturer behaviour:

Methodology articles:

Siniscalchi, M., 2008. Epistemic game theory: Beliefs and types. *The New Palgrave Dictionary of Economics. Palgrave Macmillan, Basingstoke*.

This article shows mathematically how to arrange beliefs about types hierarchally as a kind of NE refinement. This stems from a player having a certain belief about the other player's type, but some beliefs are more likely than others, and that should be accounted for.

The article also briefly discusses other applications in the literature.

I will have to read it again to get the full grasp of the maths, but this could be really interesting for our equilibrium refinement – especially because its not a technique that was dealt with in class.

Milgrom, P.R. and Weber, R.J., 1985. Distributional strategies for games with incomplete information. *Mathematics of operations research*, *10*(4), pp.619-632.

This article considers the distributional view of informational variables and how changes in those variables may result in changes in the equilibrium of the game – also deals with how sensitive the equilibrium outcome is to modelling parameters. However, the focus is on empirical findings of game theory, so perhaps a nice citation for explaining how a continuous type space should be considered.

Simple game:

2 players: lecturer and student

Types: Both have continuous types. Student ranges from super lazy to super organised and determined. Lecturer ranges from being very empathetic to very strict/uncaring. These affect the payoff parameters in various ways.

Actions: student chooses to either hand in on time or late. The lecturer chooses whether to give an extension. The student acts first, and the lecturer only plays their action if the student hands in late.

Beliefs: the lecturer believes the student the student is on a certain place in the typespace with a certain probability distribution. The student believes the lecturer is at a specific place on their typespace with a specific distribution.

Payoffs: The student gets a payoff *a* from handing in their best possible essay. This parameter is determined by the type of the student; the more invested they are in their studies, the higher *a* is. For all values of *a*, *a*>0. The student potentially suffers an exogenous negative shock that causes them not to be able to focus all of their energy on their assignment. If the student hands in on time, the cost of this shock *c*, is subtracted from their utility from the essay final mark, since they were unable to write their best possible essay. For all values of *c, c*>0. If a student hands in their essay late, they are able react to the negative shock and give themselves more time to work on the essay, thus the 'cost' of the shock when handing in late is only βc, where $0 < \beta < 1$. If the lecturer does not give the students an extension and, instead, imposes a penalty for late hand-in, the student's payoff reduces by m. *Extend the game to let the lecturer set m.*

The student of any given type's best possible essay does not vary based on when the essay is handed in, thus *a* is constant over time. The final mark of the essay will, however, be determined by the amount of time and effort a student could put into the essay, thus the final mark of an essay shows how close the student came to their best possible essay.

The lecturer attains a payoff of $\delta(a-c)$ if the student hands in on time, where δ denotes the degree to which the lecturer derives utility from seeing their students be successful and takes on a value $0 \leq \delta < 1$. If the student hands in late, then the lecturer has the option of granting the student with an extension. If the lecturer grants an extension, then the lecturer's payoff is $\delta(a-\beta c) - r + w$, where $\delta(a-\beta c)$ is the lecturer's benefit from seeing their student succeed, r is the disutility of having to mark the essay at a later date, and w is the utility the lecturer gets from helping a student in need. The value parameter w depends on whether the lecturer helped a student that was lazier/more motivated (i.e. type of the student), and the size of *c*. If *c* is large, *w* will be larger (and maybe positive), but if the student is lazy and *c* is small (or zero), then *w* will be negative. If the student is motivated and c > 0, then *w*>0. To show the effect of type on *w*, *a* is used as a parameter.

$$w > 0 \; if \; a > 0 \; and \; c > 0$$

$$w < 0 \; if \; c = 0$$

$$w \propto a \propto c$$

Proposed function for *w* is:

$$w = \begin{cases} ac \; if \; c > 0 \\ -\dfrac{1}{a} \; if \; c = 0 \end{cases}$$

If the lecturer does not give an extension, their payoff is $\delta(a - \beta c) - r$.

A student of any type in the type space will prefer to hand in late if

$$a - c < (1 - \theta)(a - \beta c) + \theta(a - \beta c - m)$$

Where θ is how likely the lecturer is to not grant an extension, from the student's perspective, where $0 \leq \theta \leq 1$, such that:

$$a - c < a - \beta c + \theta m$$

$$c < \beta c + \theta m$$

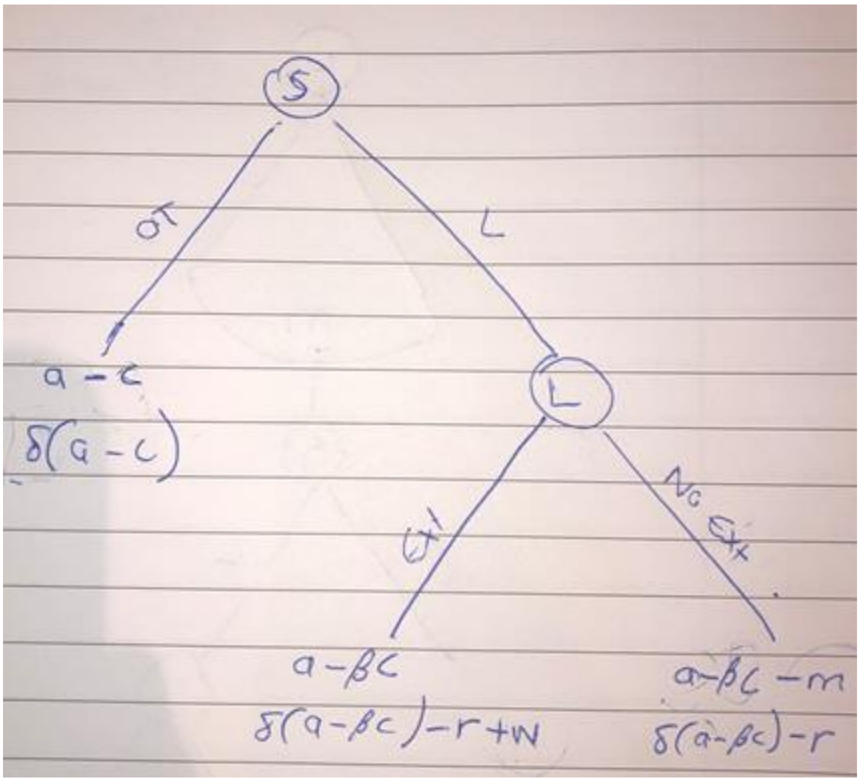
$$\therefore\ c - \beta c < \theta m$$

θ would need to be determined using a general solution concept – with the probability over all types being summed and multiplied with the type-space (using notation $\sum and \prod$.) To solve simpler versions of the game we can assign values to *a* and δ which will denote the type (like assigning values to beta for hyperbolic discounters in BE).

We can assume constant values for *r*, β, and *m* in the simpler version of the game.

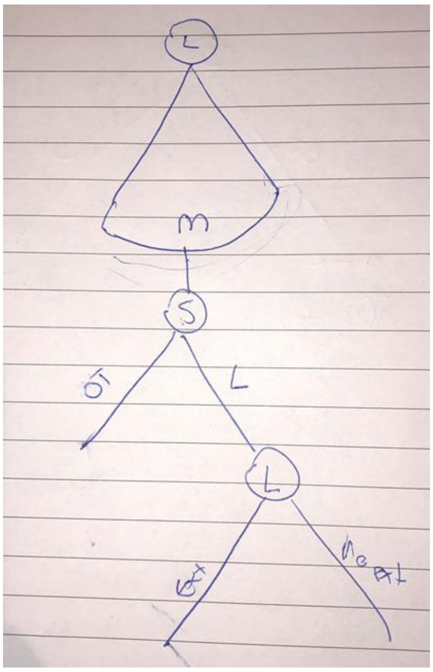
Thus, the student type (degree of hard working?) influences payoffs through parameter *a*, and the lecturer's type (degree of empathy) influences payoffs through parameter δ.

Simple game:



*edit: lecturer payoff for (L, No Ext) should be $\delta(a - \beta c - m) - r$

Potential extension: the lecturer moves first by setting the mark penalty



The payoffs have not been entered here, but they would be the same as in the simple game; however, now the *m* is varying and no longer just a given value and can be interpreted as a kind of signal. Then, a certain value of *m* may show that a lecturer has a type where δ is greater or smaller than a certain value.

What would also be interesting is to graph the best responses of the players, since the best responses now become functions, rather than just simple payoffs.

I think what makes this game interesting is that if the student hands in on time, the student will never know what the lecturer's type is for sure, but with the introduction of a varying parameter *m*, the student can narrow down the lecturer's type on the continuous type-space.

The penalty is influenced by the

PRE-RULOF MEETING NOTES & IDEAS:

The game:

Elements:

1. 3 Players: Lecturer, student 1 and student 2.
2. Types: Both the students can be either proactive or procrastinating (organised or unorganised?), so each student player exists on type space Ti element {t^/*ia*, t^/*ib*}. The lecture is of type T^/L element {t^/L}. Extension of the game can be the lecturer has type of being either lenient or strict, meaning whether they will give a deadline extension. If they are lenient and give a deadline extension, then the students don't get a penalty on marks if they hand in late. The only penalty is that they hand in before or after exams. Otherwise, there is a penalty for late hand in (the student still hasn't finished the paper so must hand in late) at a % point reduction in marks for the essay.
3. Actions: The lecturer can choose to set the deadline early in the semester, or late in the semester. The students can choose to either hand in on time, or hand in later (in the extension of the game, the student can also choose to ask for a deadline extension, and the Lecturer may have the action to choose to grant this deadline extension).
4. Beliefs: Students inform their beliefs about whether the lecturer is lenient or strict, based off of their experience with previous lecturers in the department (e.g. 70% lenient, 30% strict). Each game repeats with the same student, and a new lecturer. Or, the game can repeat for a particular module, in which case the lecturer reveals their type in the first iteration of the game, provided at least one of the students asks for a deadline extension. (Can also extend game for the student whether to decide whether they will ask for a deadline extension or just hand in late, if they ask for an extension and don't get it, they will be embarrassed, and the lecturer will feel bad (disutility for both).
5. Payoffs: The first game is structured as follows: student 2 (who is known to be organised) gets the highest payoff from handing in the essay on time if the other student hands in on time. If student 1 hands in late, student 2 prefers to hand in late as well, since she will have extra time to complete the assignment …. The structure of the game should be as follows: If both players were known to be organised, the NE would always be to hand in on time. However, due to Student 2's uncertainty about Student 1's type, they will always hand in late.

*If both students hand in late, the lecturer feels bad that they set the deadline too early, and then waives any penalty for both students. The only cost to students is that they needed the time to write other essays, so now they are behind on their other work because they completed the one essay later.

The only problem I can identify with the structure of this game is that it includes types and it includes imperfect information (student 1 and student 2 don't know whether the other handed in the essay in on time). – maybe a way to solve this is to make student 1 and student 2's payoffs independent of what the other student does. However, then it doesn't seem like there needs to be 2 students in the game (then can maybe model with just 2 players, student and lecturer, but this is then not so realistic with the real world situation, where students cooperate on a WhatsApp group to decide whether to band together for a deadline extension). Coordination solution would then be to ask for a deadline extension together – the only way to do this is to set the payoffs higher for both handing in late, but the lowest payoff for the lecturer. The coordination element will become really important for the evolutionary game, where the students will learn to always coordinate (SPNE) to hand in late, and the lecturer will then always choose the earlier deadline, knowing that the players will coordinate to hand in late, and then hand in the essay in period 2.

Can simplify by saying that if a student is of a certain type, they will act in accordance with that type (i.e. an organised student will hand in on time and a disorganised student will hand in late).

Simplicity is NB so look into ways to simplify, and *then* only expand.

Game structure and extensions:

1. Simple game with 3 players – can do NE, SPNE, BNE solutions. This is a dynamic game, but its Bayesian element is static.
2. Extend with possibility of giving deadline extensions, and students either hand in on time or hand in late and ask for a deadline extension (and whether that is granted depends on the type of the player). Here nature determines the lecturer's type and the students do not know which node they are operating from.
3. (Optional) Extend to whether student either just hands in late or asks for a deadline e
4. Extension: need to use each extension that we build – everytime we extend we first need to decide what the outcome will be e.g. first one we could model either a game between two students or we can play the game between a lecturer and one student. The single student
5. In the end we can have the signalling have a negative effect on the lecturer (early or late)
6. First model: model lecturers behaviour
7. Add complexity of subgames: students who are in the class don't know each other's types
8. Change student organised or disorganised for one game so the payoffs are only change to save word limit
9. Essay: lecturer say early or late and two students play their game
10. Questions
11. Put both games into proposal, propose work list for each member, include questions in proposal; hand in proposal early and ask questions after behavioural. How to structure the payoffs
12. Add scenarios to appendix for all calculations (just give solution assessments in actual essay)
13. We can use different types of refinement criteria because the whole game is a subgame, all the spne will also be BNEs and PBE refinement use trembling hand and intutivie

Structure of essay

1. Introduction (include lit review in?)
2. Methodology
3. Game figures
4. Inferences
5. Extension
6. Conclusion

Game

- Nature chooses whether lecturer: strict or lenient
- Lecturer observes what type they are
- Lecturer decides to set the deadline early or late
- Early: prefers because more time for marking

- Late: has less time to mark before marks are due
- Use t0 at start, use t1 for early use t2 for late and t3 for late late
- Student 1 doesn't observe the lecturers type but must choose:
- On time: prefer if late deadline
- Not on time: prefer if early deadline
- We add a second student to account for class competition (non-cooperative game) both students want to be top of the class
- Student 2:
- Nature decides whether student 1 is hones tor not honest
- Student 2 does not observe the lecturer's type and they don't see whether student 1 is honest or not honest
- Both lecturer and student 1 knows own type
- Player 2 talk to student 1, and student 1 can send a signal of on time or not on time
- Student 2 can choose then to hand in by deadline or not by deadline
- Student 1 has type honest not honest
- **Payoffs:**
- If student 1 is honest: has same preference
- If student 2 hands late, student 2
- Player 1 gest the highest payoff if student 2 hands late and 1 hands in early

Game A:

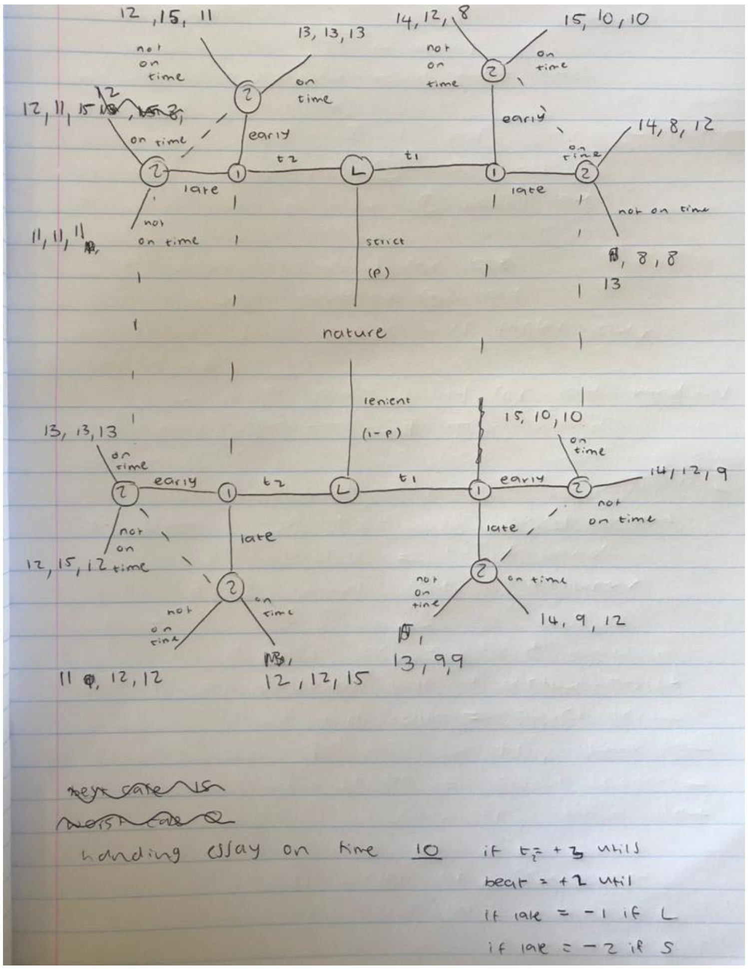
Players and Actions

- 3 Players: Lecturer, Student 1 and Student 2, excluding Nature
- Nature chooses whether lecturer is strict (S) or lenient (L) with probability p and 1-p respectively.
- The lecturer observes what type she is and then decides to set the essay deadline either at t1 or at t2.
- Student 1 does not observe the lecturer's type but does observe whether the essay deadline is at t1 or t2.
- Student 1 then chooses to hand in the essay early (E) (which is actually on time but we use early to differentiate from the 'On time' action of student 2) or student 1 hands in late (L).
    - Early means that the student meets the deadline set by the lecturer i.e. if the lecturer sets the deadline at time t, then the student hands in at time t, where $t \in \{1,2\}$.
    - Late means the student hands in after the deadline i.e. if the lecturer sets the deadline at time t, then the student hands in at time t + 1, where $t \in \{1,2\}$.
- Student 2 has to choose whether to hand in on time (O) or to not hand in on time (N).
    - On time means that the student meets the deadline set by the lecturer i.e. if the lecturer sets the deadline at time t, then the student hands in at time t, where $t \in \{1,2\}$.
    - Not on time means the student hands in after the deadline i.e. if the lecturer sets the deadline at time t, then the student hands in at time t + 1, where $t \in \{1,2\}$.
- Student 2 observes whether the deadline is t1 or t2.
- Students 1 and 2 must choose simultaneously when each will hand in her essay.

Payoffs

- Each player has 16 payoffs, so we need to come up with a total of 48 utility numbers. I.e. there are 16 different outcomes, which all have a payoff for the 3 players.
- **Payoff framework:**
- Both strict and lenient lecturers prefer a deadline of t1 to t2 because it gives them more time to mark.
- A strict lecturer subtracts more marks for a late essay than a lenient lecturer. However, both the strict and lenient lecturer give the same mark as one another for the same essay if it is handed in on time.
- Both students prefer to hand in their essays as late as possible (before accounting for subtraction of marks). A deadline of t2 is preferred because it gives them more time to work on the essay.
- Students 1 and 2 are competitive and want to get a higher mark than the other one. They usually score the same mark on essays so the only way for one of them to beat the other is if the one hands in on time, while the other hands in late.
- Students care more about when the essay is due than they care about scoring higher than the other student.
- Thus, student 1's best case scenario is: the deadline is t2, student 1 hands in early and student 2 hands in not on time.
- Student 1's worst case scenario is: the lecturer is strict, the deadline is t1 and student 1 hands in late.
- Student 2's best case scenario is: the deadline is t2, student 1 hands in late and student 2 hands in on time.
- Student 2's worst case scenario is: the lecturer is strict, the deadline is t1, and student 2 hands in late.
- Students who hand in their essays on time get a base utility of 10:
    - +3 utils if the deadline is t=2
    - +2 utils if you get a higher mark than the other student
    - -1 util if you hand in past the deadline and the lecturer is lenient
    - -2 utils if you hand in past the deadline and the lecturer is strict
    - Should we subtract utility if a student gets a lower mark than another student?? This will make a difference in that a student who hands in late and who gets beaten by the other student will have a lower utility than if they both hand in late.
- A lecturer's best case scenario is a deadline of t1 and both students hand in at time t1.
- A lecturer's worst case scenario is a deadline of t2 and both students hand in at time t3.
- Marking 2 essays in t1 gives a utility of 15.
- Marking 1 essay in t1 and 1 essay in t2 gives a utility of 14.
- Marking 2 essays in t2 gives a utility of 13.
- Marking 1 essay in t2 and 1 essay in t3 gives a utility of 12.
- Marking 2 essays in t3 gives a utility of 11.

Extensive form of Game A with utility numbers



Game theory software

http://www.maths.lse.ac.uk/Personal/stengel/gte/index.html#document-index - create decision trees and solve games (turns games into strategic format)

https://economics.stackexchange.com/questions/15346/visualization-tools-for-game-theory-game-trees - suggestions for other visualisation solutions

Questions

- Are the diagrams of the extensive forms of game A and game B accurate?
- Is the payoff framework for game A logical?
- Is game B too complicated for this essay?

Game explanation

- The game has four time periods. The game starts in t0, when the lecturer sets the deadline for the essay. She may set it for either t1, in the middle of the semester, or in t2, which is right before exams. If a student hands in on time, then they submit the essay in the period it is due, or the following period if it is late. If the lecturer sets the deadline for t2 (before exams), then the student will submit in t3 if they are late, which is after the exams.

- The lecturer observes her own type. The lecturer, regardless of whether she is strict or lenient, will receive the same payoffs from students handing in on time, or one student handing in late.
- The lecturer prefers that both students hand in on time over one student handing in late, since having to mark essays over two time periods messes with the lecturer's schedule. If both students hand in late, the strict lecturer will have the same (or less than both on time but more than one handing in late) payoffs as both students handing in on time if both students hand in late, since they will mark both essays in the same later time period. The strict lecturer will also heavily penalise students' essay marks if they hand in late (leading to drastically lower payoffs). The lenient lecturer, on the other hand, will receive significant disutility from both students handing in late since she would blame herself for setting the deadline too early, not giving the students enough time to manage the workload.
- The students do not observe the lecturer's type, determined by nature, but guess that there is a 70% chance the lecturer is lenient, and a 30% chance the lecturer is strict. The students base this belief on their experience with other lecturers in different courses within the Economics Department. The students do, however, observe whether the deadline is set for t1 or t2.

Should we subtract utility if a student gets a lower mark than another student? This will make a difference in that a student who hands in late and who gets beaten by the other student will have a lower utility than if they both hand in late.