Paper Assignment. Due Monday May 8.

(a) Choose one of the following topics and respond to it in an essay of no less than 5 pages and no more than 7 pages (not including title page and bibliography). Your paper should be typed, 10- or 12-point, double-spaced and spell-checked. Please submit your paper to the link in the NYU-Brightspace Assignments folder.

(b) Your essay should conform to the Paper Guidelines available on the second course website research.engineering.nyu.edu/~jbain/philrel. Make Absolutely Certain that you have read and understood these guidelines before you attempt to begin writing your essay. If you do not follow these guidelines, the grade for your essay may suffer!

(c) All papers must include a bibliography with at least 2 entries (at least one of these should be from the list of required class readings). Your essay must use this bibliography as a source to cite for all claims and quotes you attribute to authors. If you do not include a bibliography that you cite for claims and quotes, the grade for your essay may suffer! Lecture notes should NOT be listed or referred to in your essay. Lecture notes merely summarize topics in the texts and related material. Similarly, online lecture notes from other sources should not be listed or referred to. Be extremely careful of other types of online sources that have not been vetted by me. If you are in doubt as to the reliability of an online source please check with me before using it.

(d) Please make use of Tandon's Writing Center if you have trouble with spelling or grammar. If your essay contains so many spelling/grammatical errors that a reader cannot understand what your claims are, then your grade may suffer. Information about Tandon's Writing Center can be found at http://engineering.nyu.edu/academics/support/polytechnic/writing.

(e) _Late paper policy_: There are no extensions on paper due dates. Late papers will be accepted but will be given an initial penalty of a third of a grade point, and a further penalty of a third of a grade point for every period of 7 days after the due date. _Example_: An A paper turned in 1-7 days late will receive an A-. An A paper turned in 8-14 days late will receive a B+. An A paper turned in 15-21 days late will receive a B, _etc. Under no circumstances will late papers be accepted after the date of the final._

1. What are the prospects for building a time machine according to general relativity? (_Sample sources_: Arntzenius & Maudlin 2009; Earman 1995; Earman _et al_. 2020; Gott 2001; Hawking 2001; Nahin 1993; Thorne 1994.)

2. Discuss the "Grandfather Paradox" and its implications for the possibility of time travel within the contexts of special relativity and general relativity. How does the paradox affect the possibility of tachyons, which travel back in time for some observers, and closed timelike curves in general relativistic spacetimes? (_Sample sources_: Arntzenius & Maudlin 2009; Earman 1995; Gott 2001; Hawking 2001; Nahin 1993; Smith 2018; Thorne 1994.)

3. Special relativity is often understood to have broader philosophical consequences concerning the nature of time and change, and the ontological status of objects with respect to time. Pick _one_ of these debates and explain clearly how well it connects with special relativity. (_Sample Source_: Savitt 2021.)

4. Modern cosmology, based on Friedmann-Robertson-Walker spacetimes, is faced with a number of problems. These include the "horizon problem", the "cosmological constant problem", and the problem of "dark matter". Explain what these problems are and some ways they might be overcome. (_Sample sources_: Abbott 1988; Earman 1995; Guth 1998; Guth & Steinhardt 1984; Krauss 2001; Krauss 1986; Smeenk & Ellis 2017.)

5. Friedmann-Robertson-Walker (FRW) spacetimes are solutions to the Einstein equations that describe universes that expand from an initial singularity. Mathematically, the initial singularity is _not_ a point _in_ spacetime, but a _missing_ point of spacetime. Discuss the implications this has for the "beginning and end" of time. (If time has a beginning in such spacetimes, then what happened before the first instant? And exactly where/when did it begin?) In addressing this topic, be sure to provide an account of FRW spacetimes, how they are derived from

the Einstein equations of general relativity, and their essential features. (*Sample sources*: Frieman *et al*. 2008; Earman 1995; Hawking 1988; Smeenk & Ellis 2017)

6. Where does general relativity come down in the debate between substantivalists and relationalists over the nature of spacetime and motion? (*Sample sources*: DiSalle 2009; Hugget & Hoefer 2021a, 2021b; Norton 2022.)

Sample Sources (in addition to class text)

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