

Please let me know if any of the problems are unclear or have typos.

Exercise 5.1. Let $X = \mathbb{C} - \{0\}$ be the punctured plane. Show that the map $p: X \rightarrow X$ defined by $p(z) = z^2$ is a covering map. Explain why the squaring map on \mathbb{C} itself is not a covering map.

Exercise 5.2. [Exercise 12, page 39, of Hatcher's book.] Show that for every homomorphism $\phi: \pi_1(S^1) \rightarrow \pi_1(S^1)$ there is a map $f: S^1 \rightarrow S^1$ so that $\phi = f_*$. In other words, f induces ϕ .

Exercise 5.3. Exercise 16, page 39, of Hatcher's book.

Exercise 5.4. [Perron–Frobenius] Suppose that A is a real three-by-three matrix, with all entries positive. Show that A has an eigenvector with all entries positive.