

### Homework 3

Due Monday, April 22.

- (1) Hatcher, Chapter 0, Exercises 1, 5, 6. (In Problem 5, look up the definition of *nullhomotopic* on p. 4.)
- (2) Hatcher, Section 1.3, Exercises 1, 2.
- (3) Show that if there is a collection of group homomorphisms  $\phi_\alpha : G_\alpha \rightarrow H$  indexed by  $\alpha \in I$ , then there is a unique extension to a group homomorphism  $\phi : *_{\alpha} G_\alpha \rightarrow H$ .
- (4) Compute the fundamental group of  $S^2$  with 5 points removed.
- (5) Hatcher, Section 1.2, Exercises 1, 7, 8, 21. (In Problem 21, you may assume that  $X$  and  $Y$  are *both* path-connected. Look up the definition of the *join* on p. 9.)