Model setup

(a)

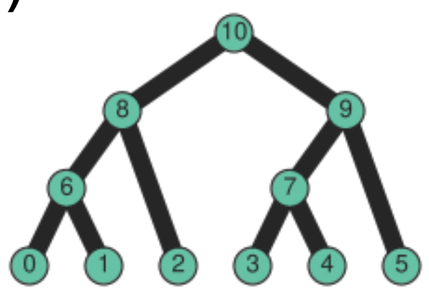
```python
# create a balanced tree with large Ne values on one side
tree = toytree.rtree.baltree(ntips=6, treeheight=1e6)
ntree = tree.set_node_values(
    "Ne", default=1e5, values={i: 1e4 for i in (3,4,5,7,9)}
)

# create a simple ipcoal Model with fixed Ne and 3 samples
model1 = ipcoal.Model(tree=tree, Ne=1e5, samples=3)

# or, create a Model that inherits Ne from the tree object
model2 = ipcoal.Model(
    tree=ntree,
    samples=3,
    recomb=1e-9,
    mut=1e-8,
)

# or, create a model that includes admixture and a
# parameterized Markov sequence substitution model
model3 = ipcoal.Model(
    tree=ntree,
    samples=3,
    recomb=1e-9,
    mut=1e-8,
    admixture_edges=[(3, 2, 0.5, 0.25)],
    substitution_model={
        "state_frequencies": (0.3, 0.2, 0.2, 0.3),
        "kappa": 0.5,
    },
)
```

(b)



model1: species tree

model1: genealogies

model2: species tree

model2: genealogies

model3: species tree

model3: genealogies

Simulation

(c)

```python
# simulate independent genealogies and snps
model3.sim_snps(10)

# or, simulate linked genealogies along the length of a chromosome
model3.sim_loci(nloci=1, nsites=10000)

# or, simulate multiple loci
model3.sim_loci(nloci=10, nsites=1e6)
```

(d)

independent genealogies

linked genealogies

Results

(e)

```python
# write loci to separate files in phylip format
model3.write_loci_to_phylip(outdir="ipcoal_sims/")

# or, write loci as a concatenated alignment
model3.write_concat_to_phylip(outdir="ipcoal_sims/", name="test")

# or, infer gene trees directly for each simulated locus
model3.infer_gene_trees(inference_method="raxml")

# access the dataframe of simulated and inferred results
model3.df
```

(f)

	locus	start	end	nbps	nsnps	genealogy	inferred_tree
0	0	0	19	19	2	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...
1	0	19	599	580	39	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...
2	0	599	838	239	25	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...
3	0	838	948	110	13	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...
4	0	948	966	18	1	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...
5	0	966	1208	242	19	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...
6	0	1208	1362	154	11	((r9:881040,(r4:659789,(...	((r4:0.00564396548050874...