Overview: Collision Detection in Automous Driving

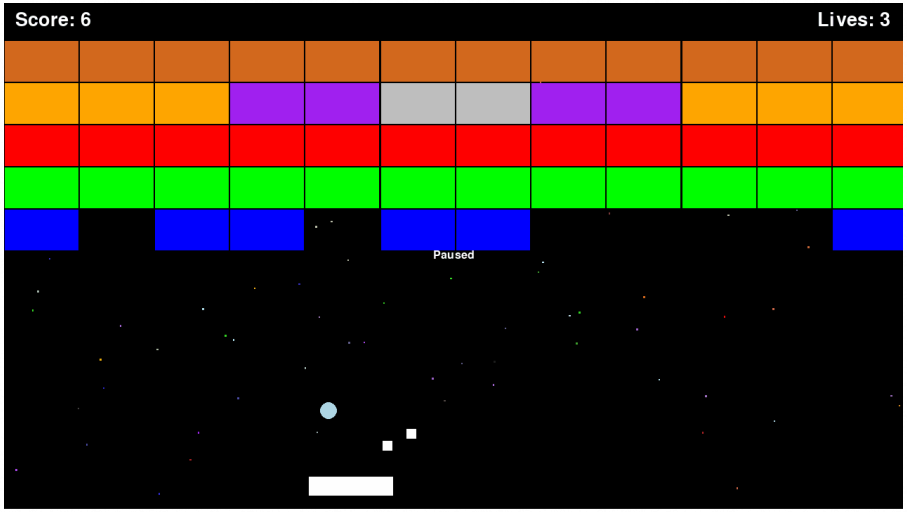
— CHH3213

Motivation and Common Method

We can follow these steps:

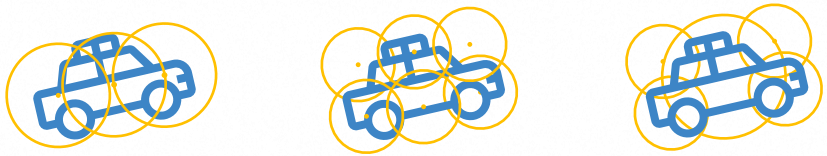
1. Define bounds to simply objects' shape
2. Plan/predict objects' trajectory
3. Collision dection

Source：https://jancsitech.net/#/community



Source：https://github.com/GuilhermeJuventino/Breakout-Pygame

Simply objects' shape—2D

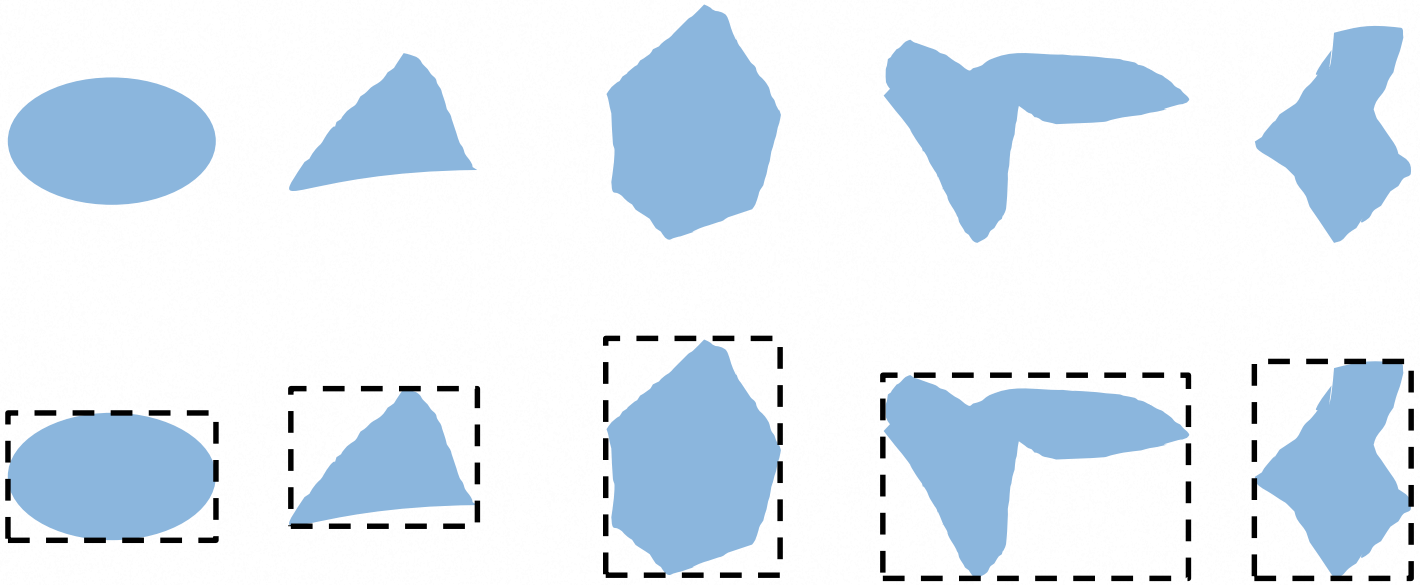


Disk approximations of vehicle shape
https://sci-hub.se/10.1109/ivs.2010.5547976

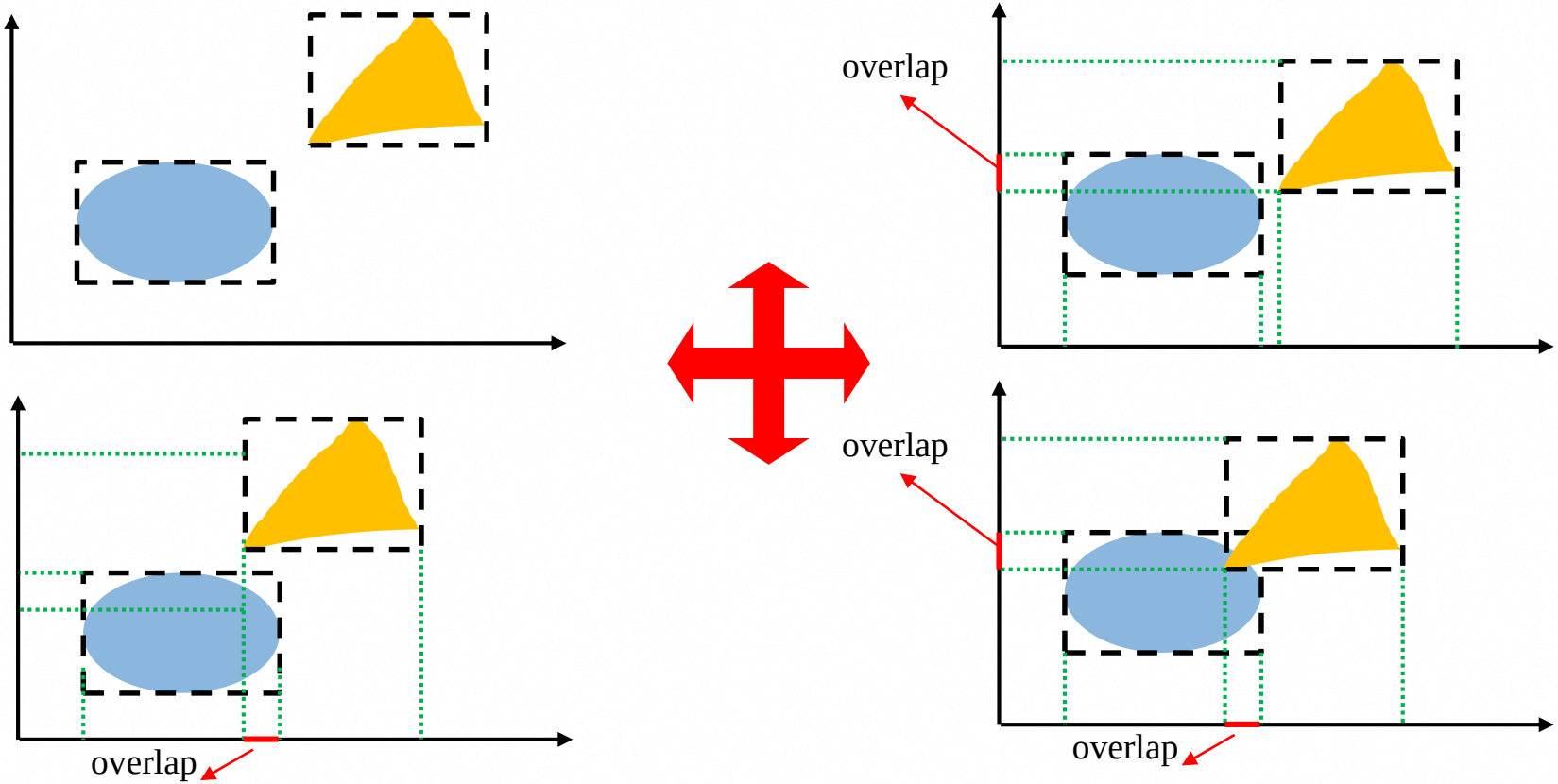
Oriented bounding box(OBB)
https://sci-hub.se/https://doi.org/10.1016/B978-155860594-7/50014-X
Chapter:11.12.1

Axis-aligned bounding box(AABB)
https://sci-hub.se/https://doi.org/10.1016/B978-155860594-7/50014-X
Chapter:11.12.2

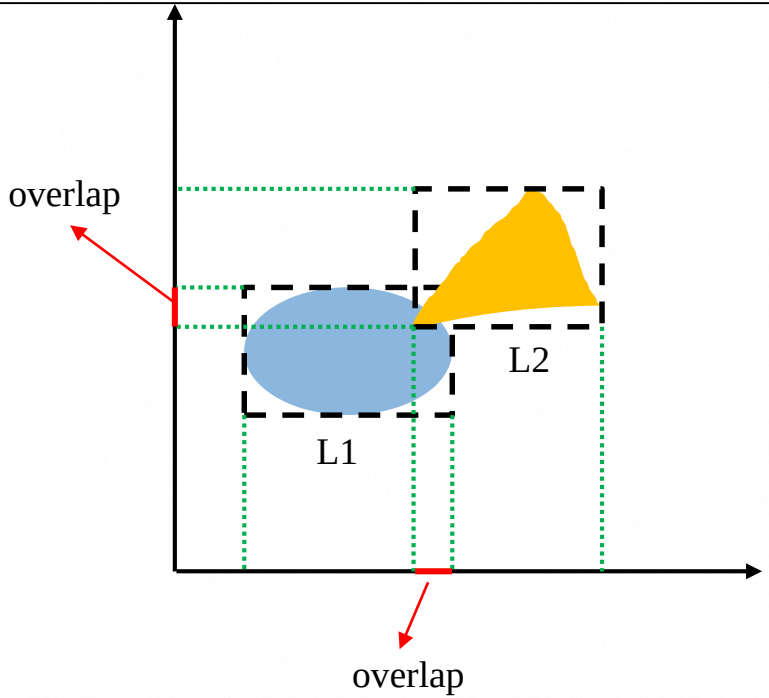
Axis-aligned bounding box

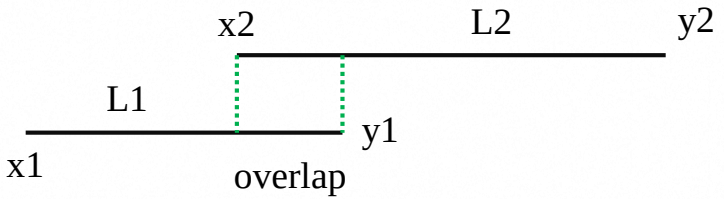


How to detect?



Check whether two line segments overlap





Approach: easy to understand

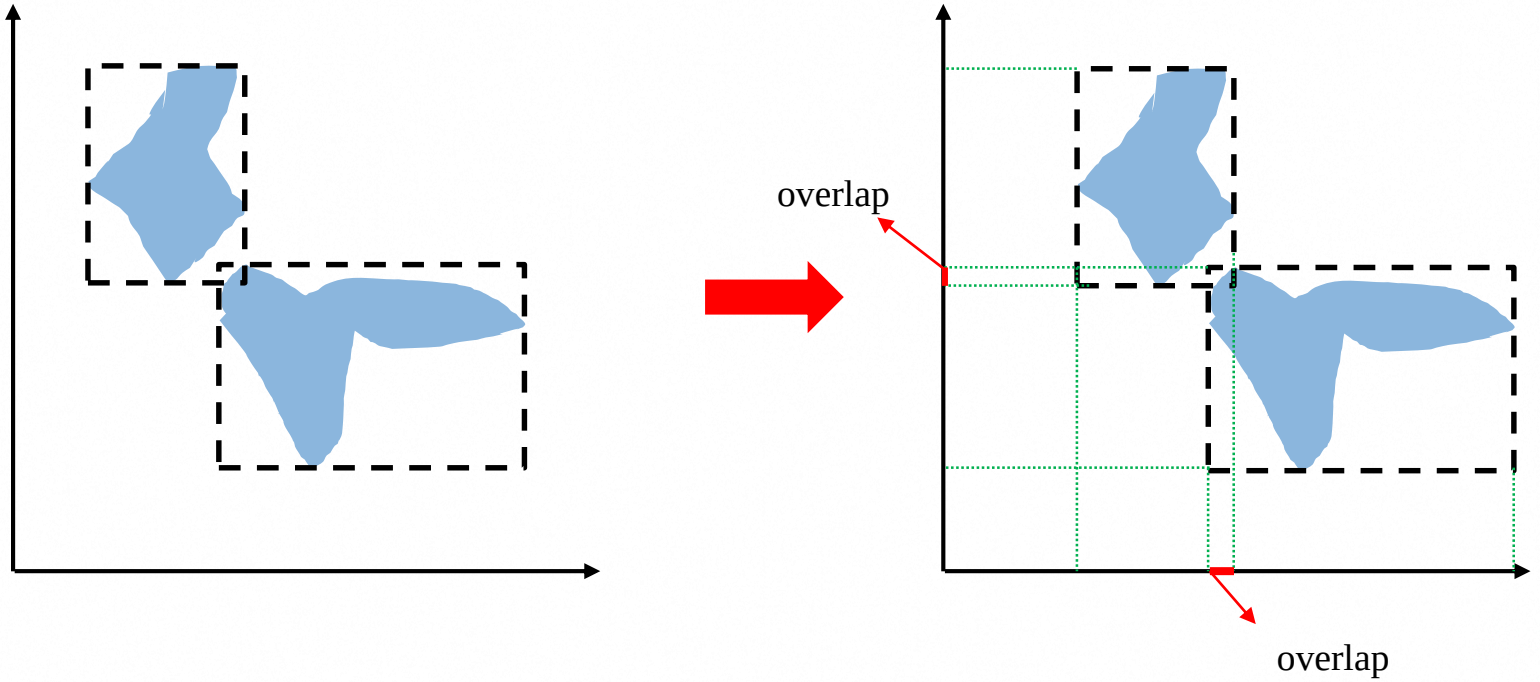
1. Sort the intervals based on their start/end points.
2. Iterate through the sorted intervals.

56. 合并区间 - 力扣（LeetCode）

435. 无重叠区间 - 力扣（LeetCode）

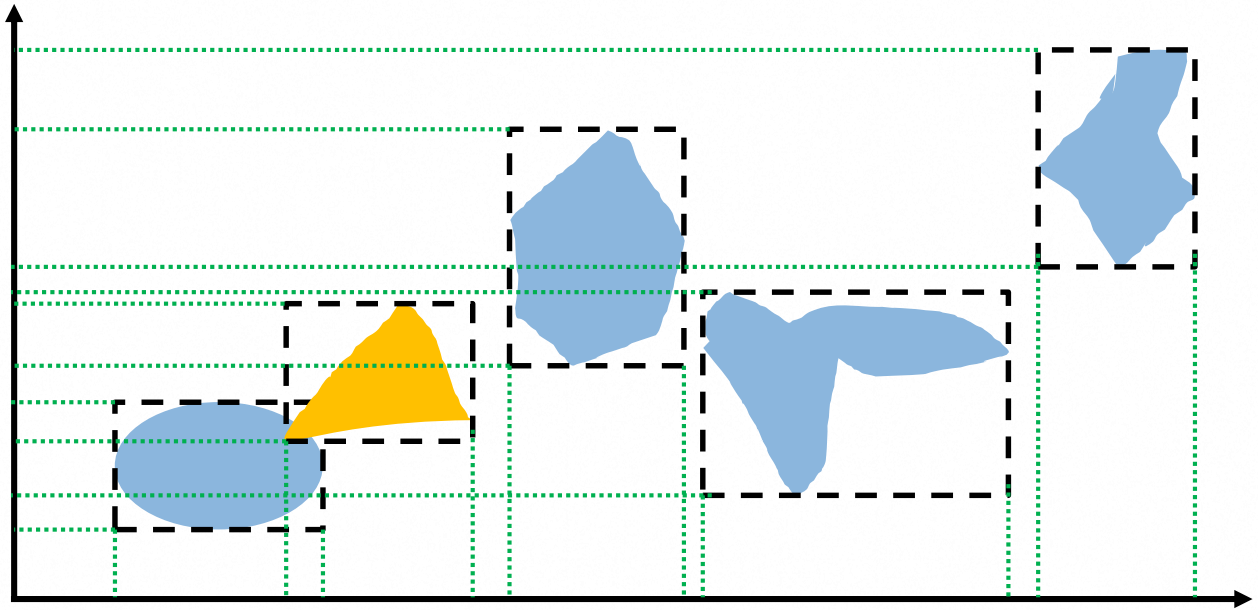
452. 用最少数量的箭引爆气球 - 力扣（LeetCode）

Is it correct?



Axis-aligned bounding box

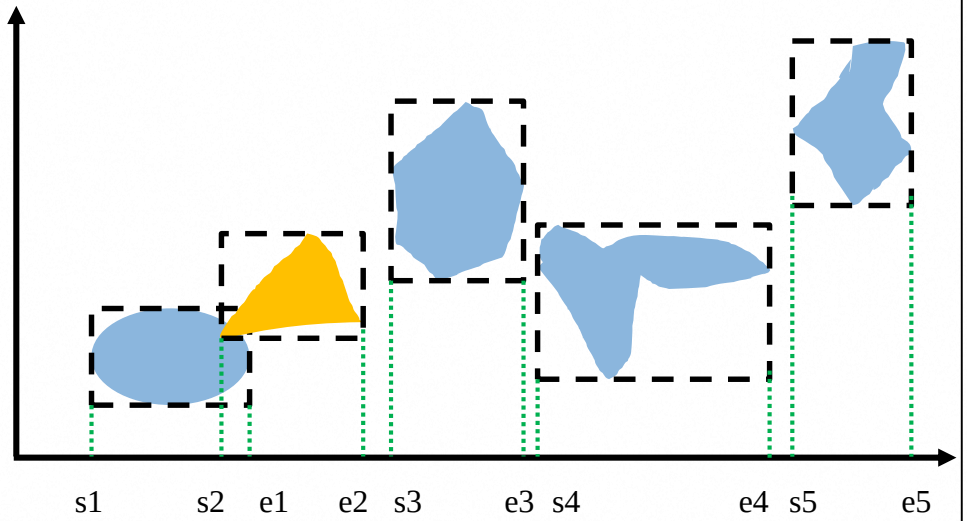
We can filter out unnecessary detection!



Sweep and Prune Algorithm

Sweep and prune is a broad phase algorithm used during collision detection to limit the number of pairs of solids that need to be checked for collision

1. Project all AABBs onto a specific axis.
2. Sort all interval endpoints on the axis in ascending order.
3. Scan the projected axis from smallest to largest.
4. When a start endpoint s(i) is encountered, intersect the AABB(i) belonging to s(i) with all AABBs belonging to s in L, and add S(i) to L.
5. Encountering an endpoint e(i), remove s(i), which belongs to the same AABB as e(i), from L.

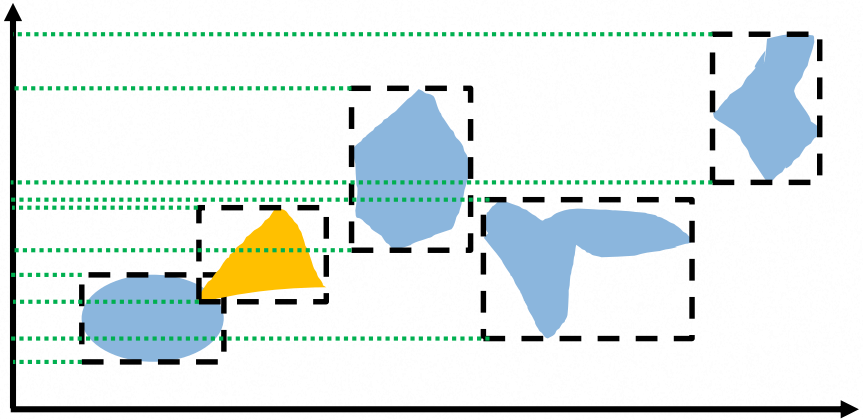


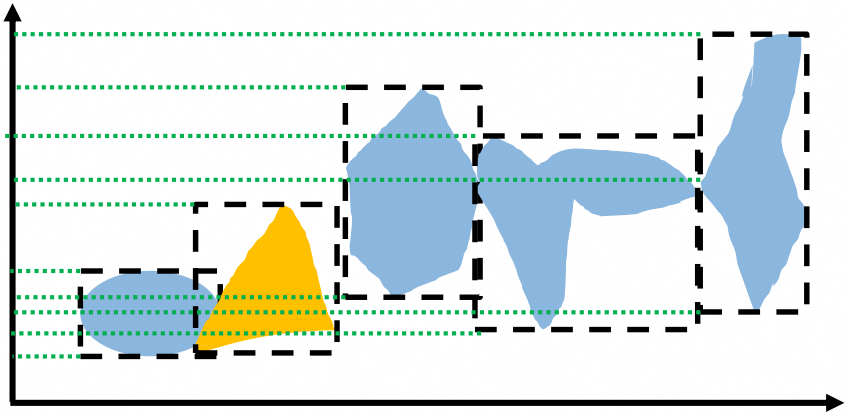
Algorithmic complexity: $\boldsymbol{O(n \log n) + O(n) + O(k)}$

Sort Iterate Collision determine

Sweep and Prune Algorithm Drawbacks

The selection of the projection axis affects the performance, as shown below





More Information

1. **https://learnopengl.com/In-Practice/2D-Game/Collisions/Collision-detection**
2. **https://zhuanlan.zhihu.com/p/163590893**
3. **https://github.com/ApolloAuto/apollo/blob/master/modules/common/math/box2d.cc**
4. **https://blog.csdn.net/AgingMoon/article/details/110328007**
5. **https://en.wikipedia.org/wiki/Sweep_and_prune**
6. **https://sci-hub.se/https://doi.org/10.1016/B978-155860594-7/50014-X**
7. **https://sci-hub.se/10.1109/ivs.2010.5547976**
8. **https://magiciana.github.io/**

Thanks!