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Thème

**Développement d’une simulation des voitures autonomes**

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***Résumé***

À travers les âges, la science nous a réservé beaucoup de surprises dans le domaine de la technologie qui élève le niveau de luxe et de confort des individus, car cette technologie vient faire remplacer tous les vieux concepts auxquels les humains sont habitués et nous présente de nouveaux concepts. L’une de ces idées dans le domaine de l'intelligence artificielle et celui des voitures est les voitures autonomes. Ces véhicules peuvent conduire et détecter l'environnement d’une manière autonome, à l'aide de caméras et de capteurs. L’un des concepts du l’intelligence artificielle qui peut contribuer énormément dans l’autonomie du véhicule est le concept de l’agent.

Dans ce contexte, on a développé une simulation d'un véhicule autonome appliquant les concepts de base des agents et en particulier ceux de modèle BDI des agents

**Mots clés :** voitures autonomes, agents, agent BDI.

***Abstract***

Throughout the ages, science has brought us many surprises in the field of technology that raises the level of luxury and comfort of individuals, as this technology comes to replace all the old concepts that humans are used to and presents us with new concepts. One of these ideas in the field of artificial intelligence and cars is autonomous cars. These vehicles can drive and detect the environment in an autonomous way, using cameras and sensors. One of the concepts of artificial intelligence that can contribute enormously in the autonomy of the vehicle is the concept of the agent.

In this context, we will develop a simulation of an autonomous vehicle applying the basic concepts of agents and in particular those of BDI model of agents.

**Keywords**: self-driving cars, agents, BDI agent, multi-agents systems, object-oriented programming.

**الملخص**

على مر العصور، قدم لنا العلم العديد من المفاجآت في مجال التكنولوجيا التي ترفع من مستوى الرفاهية والراحة للأفراد، لأن هذه التكنولوجيا تحل محل كل المفاهيم القديمة التي اعتاد عليها الإنسان وتقدم لنا مفاهيم جديدة. إحدى هذه الأفكار في مجال الذكاء الاصطناعي والسيارات هي السيارات ذاتية القيادة. يمكن لهذه المركبات القيادة والاستشعار بالبيئة بشكل مستقل باستخدام الكاميرات وأجهزة الاستشعار. أحد مفاهيم الذكاء الاصطناعي التي يمكن أن تساهم بشكل كبير في استقلالية السيارة هو مفهوم الوكيل.

في هذا السياق، سنطور محاكاة لمركبة مستقلة تطبق المفاهيم الأساسية للعوامل ولا سيما تلك الخاصة بنموذج وكلاء. BDI

**الكلمات المفتاحية:** المركبة ذاتية القيادة، وكلاء، وكلاء BDI، أنظمة متعددة العوامل، البرمجة الشيئية.

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**Introduction générale**

À partir des développements actuels qui touchent le monde, le domaine des technologies produit de plus en plus de nouvelles inventions qui rendent la vie des humaines plus confortable. Parmi ces inventions figure les véhicules autonomes.

Les véhicules autonomes n'en sont qu'à leurs débuts, mais ils suscitent l'intérêt des plus grandes entreprises de l'industrie automobile, qui travaillent à développer et à améliorer leur degré d’autonomie. Ces voitures sont censées être capables de naviguer dans n'importe quel environnement sans aide d'un être humain.

L'autonomie de ces véhicules peut être prise en charge par l’utilisation du paradigme agent pour le développement de la partie logiciel contrôlant le véhicule. Ce paradigme est l’une des abstractions les plus utilisés pour concevoir des systèmes autonomes. L’agent peut être tout ce qui prend des décisions, en tant que personne, entreprise, machine ou logiciel. En intelligence artificiel, un agent est un système informatique situé dans un environnement et capable d'agir de manière autonome dans cet environnement afin de répondre à ses objectifs. Parmi les modèles les plus populaires et les plus utilisés pour les agents, figure le modèle BDI (belief–desire–intention).

L'objectif de ce mémoire est d’explorer et maîtriser les concepts de base des deux domaines d’agents et des véhicules autonomes à travers le développement d’une application simulant le comportement des voitures autonomes.

Ce mémoire est organisé comme suit :

* Le premier chapitre est consacré aux concepts de base des agents et des systèmes multi- agents, et donne une idée générale sur les véhicules autonomes.
* Le deuxième chapitre est consacré à la présentation des différentes architectures et approches de développement des systèmes d'agents BDI.
* Dans le troisième chapitre nous allons présenter l'analyse, la conception et l’implémentation de notre application.

**Chapitre 1**

***Véhicules autonomes et agents***

# Introduction

Le domaine véhicules autonomes (VA) est un domaine très actif et en plein effervescence vu son importance et son utilité pour l'amélioration de la qualité de vie des humains. L'élément clé des VA est leur autonomie. Le concept d'agent est l'un des abstractions les plus utilisées pour concevoir des systèmes autonomes. Ainsi, plusieurs travaux et expérimentations de logiciels ont utilisé ce paradigme pour concevoir la partie contrôlant le véhicule et rendant ainsi ce dernier plus ou moins autonome.

Le véhicule entièrement autonome appartient au futur proche. Ce que l'on appelle aujourd'hui une voiture autonome est en fait une voiture ordinaire dotée de capteurs intelligents et de systèmes d'assistance à la conduite. Les automobilistes restent responsables de leur comportement au volant.

Le fonctionnement des systèmes d'une voiture autonome repose dans de nombreux cas sur la connectivité : la voiture est connectée à Internet. Dans les années à venir, la voiture deviendra rapidement plus intelligente et plus autonome et pourra à terme participer (en partie) de manière autonome au trafic.

# Définition de véhicule autonome

‘‘ Les véhicules automobiles autonomes sont des robots mobiles évoluant dans un environnement ouvert dans lequel ils doivent respecter des règles strictes du code de la route, mais aussi être capables de réagir face à des situations. Selon leur niveau d’autonomie, ils doivent être capables d’assurer leur mission dans des contextes variés et en réalisant des tâches complexes, ce qui nécessite des mécanismes d’intelligence artificielle pour le traitement de la perception et des décisions’’ [1].

## Niveaux d'automatisation

Il est important de distinguer le degré d'automatisation des véhicules. On ne parle de véhicule entièrement autonome que si les tâches de conduite sont automatisées à 100 % et que le véhicule peut trouver son chemin en toute autonomie. La phase de "pas d'automatisation" à "entièrement automatisé" est donc divisée en différents niveaux d'automatisation. La classification la plus connue est celle de SAE (**l'organisation internationale des véhicules autonomes)**, qui distingue 6 niveaux [1]:

* Niveau 0 (No automation) : Le niveau 0 fait référence à un véhicule dépourvu de technologie d'automatisation de la conduite. Dans ce cas, le conducteur est entièrement responsable de la conduite du véhicule, y compris la direction, l'accélération, le freinage, le stationnement et toute autre manœuvre nécessaire pour déplacer la voiture dans n'importe quelle direction.
* Niveau 1 (Driver assistance) : Au niveau 1, le plus bas échelon d'automatisation, un véhicule possède au moins un système d'aide à la conduite qui fournit une assistance à la direction OU une assistance au freinage et à l'accélération. Le conducteur reste responsable de la conduite du véhicule et doit être prêt à en reprendre le contrôle à tout moment et pour quelque raison que ce soit.
* Niveau 2 (Partial automation) : L'automatisation de la conduite de niveau 2 s'applique aux véhicules équipés de systèmes d'aide à la conduite avancés ADAS (Advanced Driver Assistance Systems) qui peuvent prendre en charge la direction, l'accélération et le freinage dans des scénarios spécifiques. Mais, même si l'assistance au conducteur de niveau 2 peut contrôler ces tâches de conduite principales, le conducteur doit rester vigilant et doit surveiller activement la technologie à tout moment.
* **Niveau 3 (Conditional automation):** Le niveau 3 est connu sous le nom d'automatisation conditionnelle. Il utilise divers systèmes d'assistance à la conduite et l'intelligence artificielle pour prendre des décisions en fonction de l'évolution des situations de conduite autour du véhicule. Les personnes à l'intérieur du véhicule n'ont pas besoin de superviser la technologie, ce qui signifie qu'elles peuvent se livrer à d'autres activités. Cependant, un conducteur humain doit être présent, alerte et capable de prendre le contrôle du véhicule à tout moment, notamment en cas d'urgence due à une défaillance du système.
* **Niveau 4 (High automation)** **:** Appelée conduite automatisation à haute, l'autonomie de niveau 4 ne nécessite aucune intervention humaine dans le fonctionnement du véhicule car il est programmé pour s'arrêter en cas de défaillance du système. Puisqu'un conducteur humain n'est jamais nécessaire, un véhicule de niveau 4 peut ne pas avoir de volant ni de pédales.
* **Niveau 5 (Full automation) :** En tant que classification la plus élevée de l'automatisation de la conduite, le niveau 5 signifie qu'un véhicule peut se conduire partout dans toutes les conditions sans aucune interaction humaine. Un véhicule de niveau 5 n'est ni limité par la géo localisation ni affecté par les conditions météorologiques et transporte les êtres humains confortablement et efficacement sans nécessiter de chauffeur. La seule implication humaine sera de fixer une destination. Nous pouvons mettre le véhicule dans n'importe quel environnement et il prend le contrôle contrairement au niveau 4 qui a une limitation dans les environnements de pratique.

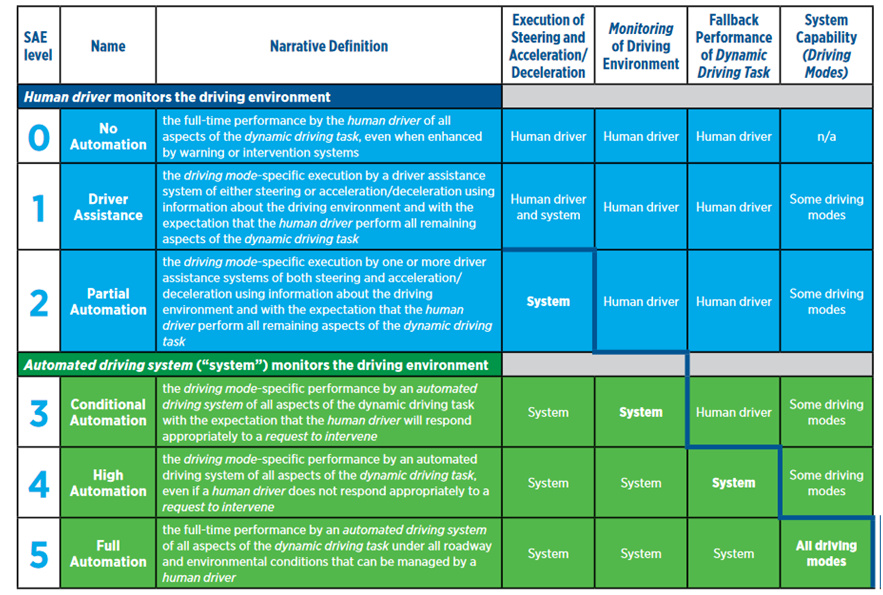


Figure 1. Niveaux d’automatisation [2].

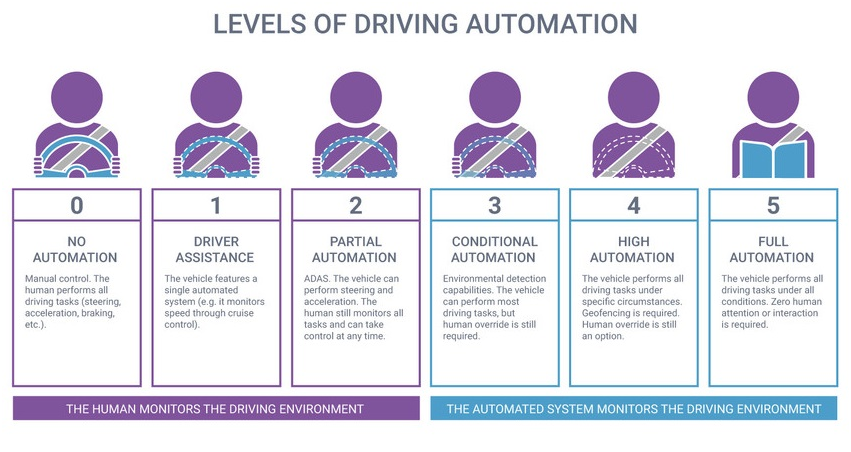
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Figure 2. Niveaux d'automatisation de la conduite [26]

# Classement des components des véhicules autonomes

Le processus de conception d'une architecture fonctionnelle commence par l'élaboration d'une liste des composants fonctionnels et de leurs dépendances [3]. Dans le but de cette fin, la norme SAE J3016 définit trois classes de composants [1]:

**Opérationnel :** Il contrôle le niveau bas du véhicule (communication avec le hardware).

**Tactique :** Ici ou la planification se produit, on trouve là l’observation et l’exécution des événements.

**Stratégique :** Il est concentré en destination et le mappage des routes pour générer les chemins .il est considéré comme le haut niveau de ces classes.

Chaque classe de composants a un rôle progressif dans une structure de contrôle hiérarchique qui va du contrôle de bas niveau au contrôle de haut niveau hiérarchique qui commence par un contrôle de bas niveau, passe par la classe opérationnelle et se termine par une vue d'ensemble de haut niveau à travers la classe de composants stratégiques. Entre les deux, les composants tactiques s'occupent de la planification de la trajectoire et de la réponse aux événements de trafic. Cette vision hiérarchique Cette vision hiérarchique de l'accroissement du niveau d'automatisation des un facteur de décision important dans la conception de l'architecture.

# Définition d’agent :

Il n’y a pas une définition globale pour l’agent à cause des attribues associée avec lui, mais comme une définition un agent est un système informatique situé dans un environnement et capable d'agir de manière autonome dans cet environnement afin de répondre à ses objectifs de conception [4] :

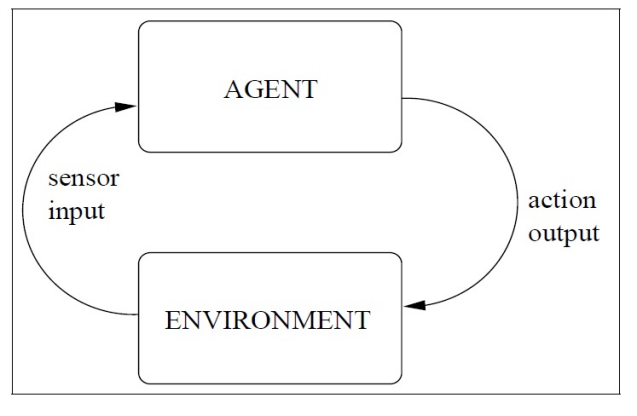


Figure 3. Architecture d'un agent [4]

# Propriétés d’agent

Pour parler sur les propriétés d’agent il faut parler d’agent intelligent qui L’agent des plusieurs caractères tel que [4] :

* **L’autonomie :** L’agent peut réagir tout seul sans l’intervention des autres agents (c.à.d.) l’agent pend ses décisions et des actions pour satisfaire les intentions de son prioritaire et décider de ce qu'il doit faire pour satisfaire ses objectifs de conception.
* **Réactivité :** L’agent est capable d’observer l’environnement et le percevoir, après il répond d’une manière ponctuelle aux changements qui s'y produisent afin de satisfaire leurs objectifs de conception.
* **Proactive :** Les agents intelligents sont capables d'afficher un comportement orienté vers un but en prenant. L’initiative afin de satisfaire leur objectif de conception.
* **Capacité sociale :** L’agent peut interagir avec d’autre agents dans l’environnement, il put communiquer négocier demander à cause de satisfaire leurs objectifs de conception.

# Comparaison Entre l’agent et l’objet

Dans la programmation il y a programmation orienté objet basé sur l’objet qui est un ensemble d'attributs et d'appels de méthode. A l’autre côté il y a la programmation orienté agent basé sur l’agent qui est comme nous l'avons dit précédemment une entité autonome, réelle ou abstraite qui est capable de prendre des décisions tous seul.

L’agent et l’objet sont très similaire car [4] :

* Les deux acceptent le principe d’encapsulation.
* Les deux reconnaissent l'importance des interactions.

Mais le différent vient quand [4] :

* Les agents ont le contrôle de leur propre comportement, alors que les objets sont totalement obéissants les uns aux autres et n'ont pas d'autonomie sur leur choix d’action.
* Les approches orientées objet définissent la relation par héritage statique hiérarchies, alors que l'approche basée sur les agents définit beaucoup plus relation complexe entre agents.
* Les agents intelligents considèrent plus abstrait que les objets.

# Classifications des agents

Pour les types d’agents intelligents ont a 2 classements :

## Classement de Russel et Norvig

Regroupent les agents en cinq classes en fonction de leur degré d'intelligence et de capacité perçues [5].

### Agents réflexes simples

Les agents réflexes simples n'agissent que sur la base du percept actuel, ignorant le reste de l'historique du percept. La fonction d'agent est basée sur la règle condition-action : "si condition, alors action".

Cette fonction d'agent ne réussit que lorsque l'environnement est entièrement observable. Certains agents réflexes peuvent également contenir des informations sur leur état actuel qui leur permettent de ne pas tenir compte des conditions dont les actionneurs sont déjà déclenchés.

Les boucles infinies sont souvent inévitables pour de simples agents réflexes opérant dans des environnements partiellement observables. Remarque : Si l'agent peut randomiser ses actions, il peut être possible d'échapper à des boucles infinies.

### Agents réflexes basés sur des modèles

Un agent basé sur un modèle peut gérer des environnements partiellement observables. Son état actuel est stocké à l'intérieur de l'agent en maintenant une sorte de structure qui décrit la partie du monde qui ne peut pas être vue. Cette connaissance sur "comment le monde fonctionne" est appelée un modèle du monde, d'où le nom "d'agent basé sur un modèle".

Un agent réflexe basé sur un modèle devrait maintenir une sorte de modèle interne qui dépend de l'historique de la perception et reflète ainsi au moins certains des aspects non observés de l'état actuel. L'historique des perceptions et l'impact de l'action sur l'environnement peuvent être déterminés à l'aide du modèle interne. Il choisit alors une action de la même manière qu'un agent réflexe.

### Agents basés sur des objectifs

Les agents basés sur des objectifs étendent davantage les capacités des agents basés sur des modèles, en utilisant des informations "d'objectif". Les informations sur les objectifs décrivent des situations souhaitables. Cela fournit à l'agent un moyen de choisir parmi plusieurs possibilités, en sélectionnant celle qui atteint un état d'objectif. La recherche et la planification sont les sous-domaines de l'intelligence artificielle consacrés à la recherche de séquences d'action permettant d'atteindre les objectifs de l'agent.

### Agents utilitaires

Les agents basés sur des buts ne font la distinction qu'entre les états de but et les états de non-but. Il est également possible de définir une mesure de la désirabilité d'un état particulier. Cette mesure peut être obtenue grâce à l'utilisation d'une fonction d'utilité qui mappe un état à une mesure de l'utilité de l'état. Une mesure de performance plus générale devrait permettre une comparaison des différents états du monde en fonction de leur degré de satisfaction des objectifs de l'agent. Le terme utilité peut être utilisé pour décrire à quel point l'agent est "heureux".

Un agent rationnel basé sur l'utilité choisit l'action qui maximise l'utilité attendue des résultats de l'action - c'est-à-dire ce que l'agent s'attend à tirer, en moyenne, compte tenu des probabilités et des utilités de chaque résultat. Un agent basé sur l'utilité doit modéliser et suivre son environnement, des tâches qui ont impliqué de nombreuses recherches sur la perception, la représentation, le raisonnement et l'apprentissage.

### Agents d'apprentissage

L'apprentissage a l'avantage de permettre aux agents d'opérer initialement dans des environnements inconnus et de devenir plus compétents que ne le permettraient leurs seules connaissances initiales. La distinction la plus importante est entre « l’élément d’apprentissage », qui est chargé d'apporter des améliorations, et « l’élément de performance », qui est responsable de la sélection des actions externes.

L'élément d'apprentissage utilise les commentaires du "critique" sur la façon dont l'agent se comporte et détermine comment l'élément de performance, ou "acteur", doit être modifié pour faire mieux à l'avenir. L'élément performance est ce que nous avons précédemment considéré comme l'agent tout entier : il absorbe les percepts et décide des actions.

Le dernier composant de l'agent d'apprentissage est le "générateur de problèmes". Il est chargé de suggérer des actions qui conduiront à des expériences nouvelles et informatives.

## Classement de Weiss

Définit quatre classes d'agents [3] :

### Agents basés sur la logique

L'architecture basée sur la logique, également connue sous le nom d'architecture basée sur la symbolique ou délibérative, est l'une des premières architectures d'agents qui repose sur l'hypothèse des systèmes de symboles physiques Cette architecture classique est basée sur l'approche symbolique artificielle traditionnelle en représentant et modélisant l'environnement et le comportement de l'agent avec une représentation symbolique. Ainsi, le comportement de l'agent est basé sur la manipulation de la représentation symbolique.

Le rôle de l'agent dans cette architecture classique peut également être considéré comme un démonstrateur de théorèmes (Shardlow, 1990). La manipulation syntaxique de la représentation symbolique est le processus de déduction logique ou de preuve de théorème. En tant qu'exemple de preuve de théorème, les spécifications de l'agent décrivent comment l'agent se comporte, comment les objectifs sont générés et quelle action l'agent peut entreprendre pour satisfaire ces objectifs.

### Agents réactifs

L'architecture de l'agent réactif est basée sur le mappage direct de la situation à l'action. Elle est différente de l'architecture basée sur la logique où aucun modèle symbolique et aucun raisonnement complexe ne sont utilisés. L’agent répond aux changements de l'environnement dans un stimulus-réponse basé. L'architecture réactive est réalisée à travers un ensemble de capteurs et d'effecteurs, où l'entrée perceptive est mappée aux effecteurs en fonction des changements dans l'environnement. L'architecture de subsomption de Brook est connue comme la meilleure architecture réactive pure [6]. Cette architecture a été développée par Brook qui a critiqué de nombreux inconvénients de l'architecture basée sur la logique. La figure illustre un exemple d'architecture réactive. La figure montre que chacune des situations de perception est mappée dans une action qui répond spécifiquement à la situation de perception.

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automatiquement](data:image/png;base64,iVBORw0KGgoAAAANSUhEUgAAAncAAAE8CAYAAACivZdQAAAACXBIWXMAAA7EAAAOxAGVKw4bAAAgAElEQVR4AQA5gMZ/Af////8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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AIBAgABAAAAAAECAAAA/gAAAAAA/wAAAAD//wAAAAAAAP8AAAABAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAA/wAAAAAAAAEA/wAAAAAAAAAAAAAA/wAAAAEAAAAAAAAAAAD/AQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAA/wACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAA/wAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD/AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAA/wEAAAD/AAAB/gAAAP8AAAAAAAAAAAAAAAAAAAABAAAAAAAAAAEAAAABAAAAAAAAAAAAAAADAAAAAQAAAAAAAP8AAAAAAAD/Af4AAAD+AAAAAAABAAAAAAAAAP8AAAAAAQAAAAAAAAAAAAAAAAAAAAD+AAEAAAAAAAAAAAAAAAAAAAD/AAEAAAABAP8AAgAAAAEAAAABAAAAAAAAAAAA/wAAAP4AAAD+/v8A/v7+AP39/QD7+/wA+/79AP78/gD+//8AAP//AP3+/gD3+P8A9PX6APP08wDy8/UA8fLxAPDy9AD19/gA7O7wAPv9/gD7+v0A+vz8APr6/AD3+fkA9/f5APv7+gD4+foA/f39APz7/AD6+/oA+/3+APr7+wD8/PwA/f39AP79/wD6/PwA/fz8AP8AAAAAAAAA/wAAAP//AAAAAAAAAAICAP8BAQAAAAAAAAAAAAABAQABAAAAAAAAAAAAAAAAAAIAAAABAAD//wAAAAAAAAACAAEBAQAAAAAAAQEBAP///QAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQAAAAAAAAAAAAD//wD/AAAAAP//AAAAAAABAAAAAAAAAAD/AAAAAAAAAAD+AAEAAAAAAAAAAAAAAP3++wABAAAAAf8AAAAAAAABAgEABAMDAAUGBQAFAwQABgMDAAMEAwAEBAIABgYGAAYEBQAFBgUABQUDAAQEBAAKCAcABgYGAAoHCAAFBgQABQQEAAgIBgANDAwACgkHABMRDAANDAcADg4OAAsLCgALCQoACQkEAAgGAgACAQIAAgEBAAIDAgAGAwMABAQDAAUDBAADAwMAAgEDAAEB/wAAAQAAAQAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQACAAAAAAAAAAAAAAAAAAAAAQAAAAEA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP4AAgD/AAAAAAAAAAAAAAAAAAAAAQAAAAAAAAABAAAAAAD+AAEA/wD/AAAAAQAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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v/+AP/+/gD+/fwA/f38AP39/gD+//wA/fn6APz9+wD+/P0A/f38AP/9/AD6+vkA+/v7AP39+wAA+/sA+vn4AP/9/AD+/v0A////AAEA/wAEAgMAAQH/AAIA/wAFBQIACwoIAAsKCQAJBwcABwcGAA0MDQAODQwAEA0KAAgHBwAOEA0AFxUUABoXFgATFBEADgwCAAUFAwAFAwMABAIBAAUEAwAEBQUABwQFAAMEAQABAQEAAAAAAAD/AAD/AAAAAQEAAAEAAAD//gAAAAEAAAEBAAAA//8AAAAAAAEA/gAAAAEAAAAAAAEA/wAAAAAA////AAABAgD+AAEAAAABAP8BAAAAAAAAAgAAAAEAAAAA//8A/wAAAAAAAAABAAAAAAAAAAAAAAAAAAEAAAAAAAEAAAD+/wAAAQEAAAEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAB/////wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD+AAAAAAAAAAAAAP//AAAAAAAAAAAA//8CAAAAAAAAAQAAAAABAAD/AAABAAAAAAD/AAAAAAD//wAA//8AAAEBAAABAgAA/v//AAAAAAAAAQEAAAEBAAAAAAD//gAAAAAAAAEBAAD+AAAAAAAAAAAAAAD+/gAA+fv6APn6+wD7/PwA+vz9APv9/QD3+P4A6ervAOXm5wDp6+sA8fDzAO/v7wDw8vMA7vH2APb6+wD29fYA8/X1APn6/QD8/v0A/v0AAP3+/wD7/gAAAAEDAAYGCQAEBgYABQUJAAQFBAAEBAYAAgQDAAQGCAAHBwcABQYIAAUFBAABAwUAAwYEAP/9AQAJCwoAAQECAAABAgAAAQEAAgICAAIBAQACAgMAAQICAAABAQADAgYAAQEBAAAAAAAAAAAAAAEBAAAAAAD/AAEAAAEBAAAAAQAAAAEA/wD/AAAAAAAAAAEAAAABAAD/AAAAAAAA///9AAAAAAAAAAAAAAD/AAAAAAAAAAAA//8AAAAAAQD//wAAAAAAAAAAAAAAAAAAAAABAAAA/wAAAAIAAQEAAP///wAAAAAAAAABAAAA/wAAAAEAAAD/AAAAAQAAAP8AAAECAAEA/wAAAAEAAAD/AAAAAQAAAP8AAP8BAP8A/wAAAQAA/wH/AAEBAAAA/wAAAAAAAAAAAAABAf8A////AAIBAQABAQEAAAD/AAABAAAAAAAAAAAAAAAAAAAAAAAA//39AAAAAAABAQEAAAAAAAEAAAAB//4A/wD/AP///QD//f4A/f37AP78/QAAAP4AAAEAAP/8/gD8/f0A/f39AAD9/AD8+/sA//79AP39/QD6+vkA+vv4AP35+wD8/PoA+/n4APr7+QD8+fgA+/v7AP79/AD9/f0AAAAAAAMBAAAGA/8AAwH+AAcHBgAKCggACgkHAAsIBwAQDwwADg8NABIODQALCwgAFxUSABwbGQAZFxYADg8HAAcDBAACBAIACAQDAAUFBAAGBQYABAQCAAEBAQAAAAAA//8AAAD9/gACAgEAAQEAAP/+/gACAgAAAQEBAP///gAAAAEAAAAAAP//AQAAAAEAAQEAAAEAAAAAAAAAAAAAAP8A/wD///8AAAAAAAEBAQAAAAAAAAABAAAAAQAA//8AAAAAAP8AAQABAQAAAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAA/wD/AP8DAQDT0tYAl5mfAODh4QAKCwsALCssACYjKAAKCQoAAAL/AAYJCgAB//UABQUIAAsIAwAHBgUA0NTcAKSirgAjJiIAS0pEAAgCAQDf3NwA5uLkAP///gABA/8A/wD9AAL/AAAICAcA7O/xAK+vswAtKiwARREVAPX3+gD9/v4A9fDwAPPy7QDn5uoAEhMSACstKgAyMjAAAgQBAAIDAQD//v4AAQIAAAACAQAA//8AAAD/AAD//gAAAAIAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP4AAQH+AAIC/wAOEAsAAQEBABQUDQAWFhAAODkyAPf3+AA6OzMAAQACAAEAAQAAAAEAAAAAAP//AAAAAP8AAgIDAP3++wAAAAIAAQEAAAEBAQAA//8AAAAAAAAAAAAAAAEAAAAAAAAAAQAAAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAEA/Pz8AAICAgABAQEAAQEBAP7+/AACAgIAJCUiAC0uKwAeHhwAAAAAAAAA/wAAAAAAAQEBAAAAAAABAgEA/QAAAAABAAAAAAAAAQD+AAEAAAABAAEAAAABAAAAAAAAAAAAAAEAAP8BAgAAAf8A/gAAAP//AQABAQAAAQAAAP8A/AAAAf8AAgD/AAD+/wABAQEAAQEAAAD+/QD7+/gA3dzbAPQX9ADp6ecA0tHRABYSEQD5GRkA6enqANnc2QAbHxkA/v36AAIDAgACAQEAAP3/AAEA/wD/AwEA/gAAAAAA/QAAAAEA/gACAAAAAAACAP4AAQAAAAD/AwAAAAAAAAAAAAABAAAAAAAAAP8AAAEAAAAAAAAA/v8AAP8BAADd4eYAoKSsANvd4wAODREAPz47ADs4NQA9OjAAGxoWAAgIAQABAQEAAAH/AAH//wABAAAAAQEBAAH//gD9/f4AAwMDAAEBAQAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAABAAAAAAD9AP8A/wD+AAMAAAAAAAIA/gAGAgAAQjwzANjaSwCboa4AzM/VAK+zugBnYVcACQYDAAICAQADAQMAAP7/AAD+/wABAQEA/wAAAAQAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/gAAAAAA/v8BAPX3+wCts74At73CAAMFBwBIRkUAV1FIAA8JBAADAAEA//7/AAEAAAD/AAAA/gD+AAEAAAABAQIA/wABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAMA/wD/AAAA/f3+AJiYnADS0NsAJycrAP8B/wDv7vcAz/LVABITEQAqLCoABwcNAPf4/gD7+foA9vb+AAD9/gD8+AEANTA3AAgJBADY0NcA//76APn39QD7/P8A+/v7APz89gD7+/kAAAD+AAIGBwD3/QIAGh4gAA8WFgDq8PAA/vz/AAgFBwANDA8ACwcHANvb2wDU09YA4+HhANLQzQAaHRoASkpIAAEBAAAABAIAAf4AAAAAAQABAwIA/wD9AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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wAAAAEAAAH/AgAAAAEAAAAAAP8AAAAAAQAAAAD/AAAAAAAAAP8AAAAAAAAA/wAAAP8AAAABAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAAAAAABAAAAAQAAAP8AAAAAAAAAAP4AAAACAP///wABAAEAAQAAAAAB/wAAAP4AAQECAAD9AAAJBgMAKCYlAMjMzQDj5OcA7vD0ABIMDwAAAP8AAQACAAQAAAAAAAAAAAAAAAAAAAAAAQD+AAAA/wAAAAAAAAABAAAAAwAA/wAAAP//AAAB/wAAAAEA+/3/APDw9AD6+f8ACQcGACEfHQAA/gAAAQEAAAEBAQABAP4AAgD/AP4B/wD+AAAAAgD/AAAA/gABAP8AAf8AAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///4AAAAAAAEBAAAAAAEA//4BAAAAAAAAAAAAAAEAAAICAgAAAP4AAAAAAAAA/wABAAEAAQEBACQgGwAcFxcA1NrgALyzpQDZ4PcACAIAAO4AAAAzPUMADQ0PAAP//wD+/PwAAQEBAAEBAQD//wAA/f7/AAAAAgABAwMA///+APgB+gAAAfkA9fb3AAADBAAB/QQADAgJAFBPTgCv6lgqAAAgAElEQVTr6OoA8O/2AAwLCgAlJCQABgUDACYlHwABAvgA9fnuAAABBAADAhEA/wAFAP8A/wD8/f4A4+XhAAUF/gBFPDEANTUyACgmIgAAAf8AAAAAAAABAQAAAAEAAAD+AAAAAAAAAP8AAP8BAAAAAQAA/wAAAAAAAAABAAAAAQAAAAAAAAAA/gAAAAAAAAAAAAAAAQAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAADr6+sAs7OzAPf39wAAAAAAAgICAAEBAQD+/v4AAQEBAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAEBAQAAAAAAAAAAAAAAAAD///8AAAAAAAEBAQD///8AAAAAAAAAAAABAQEAAAAAAP///wAAAAAAAAAAAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAAAAAAAAAAAAAAAAA4ODgBOTk4ADw8PAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP8AAAAAAAAAAAAAAAAAAAAAAP4A/gAAAAEAAAD/AP4AAAABAAAA/wAAAAEAAAABAAEAAQAAAAEAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/v7+AAEBAQAAAAAAAAAAAAEBAQD///8AAAABAAEB/wD/AP4A/wD/AAEAAgABAAIA/v39AAECAAABAAEA/wAAAAAA/wD+/f8A/v8AAP/9/wD//AAA//3+AP39/wAWGBcA7vH1AOnu7gDKy8wABAMDAA0IAwCYmp4A+Pj2AC0zKwDZ390AEQwWAD45PgANCg4ALicoAOfl5gDq6u8AAQMAAOzr2QDs7fIACQUUAPPu+wDLx8sAOzk5AC0qKwD7+PwABAYFAP7+/wACAP8AAwMAAAABAQABAQMAAQAAAAH/AAD//wAA/wEBAAEBAQAAAP8AAP8AAAAAAAD+/f0AAQIDAAEBAQD/AAAAAAAAAAAAAAAAAAAA/wABAAEAAQAAAP4AAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD/AQAAAAEAAAAAAAAAAQABAAAAAAABAAAAAAAAAQMAAQAAAP8AAAAAAAEAAQEBAAIBAAAuKiQABQL+APL2+gDi6O0AIxsPAAABAAABAQEABAAAAAAAAAAAAAAAAAD/AAAAAf4AAQD/AAAAAgABAAEAAP4BAAAAAAD/Af4AAP/9AAAAAAAAAAEA+/r9AAD/AwAEAwQABgUEAAAAAAACAAAAAAAAAAABAQABAP8AAQD/AAAAAQD/AAAAAQD/AAAAAAACAP4AAAACAAAAAQD/AAAAAAAAAAEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD//wAAAAAAAAAA/wAAAAAA//8AAAAAAAAAAAAAAAABAAAAAAAAAAAA/v7+AAEBAAABAQAAAP//AP///wAAAQIAAAABAAgHAwAyLSMANS0jAMfHyQAxNjsA//sAACkqLQABAAQAA/4BAAUDBAADAwMA/Pz8AAD/AAADAQEA/v8AAAD9AAD/Af4A4+3bAObo2wDY2NQA+Pj9AOXj7wD//gMABAIEAPb19gD///8A+fj5AOfn6QD4++4A09XFAAMH/AAhJxEA7vD2ABsVNgBPTVUAAQADAO7w8QDc39kALy0nAGBZUQATExEAAwT/AAEA/gAAAAQA//4AAAABAAAAAAEA//79AAAAAAABAQMAAAAAAAAAAAAAAAAA/wAAAP/+/gABAQEAAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAN7e3gCZmZkA6+vrAAAAAAABAQEAAQEBAP7+/gABAQEAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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QD/AfoAAAD+AAEBAgAA/v8A/wD9AAEABQAu/gsA+fwGAAMJDQCvtMQAAP3+AAH/AQAAAAIA/wAAAP4B/wD/Af0AAgIBAAD//gABAQIA/Pv/AP8B/gAJDAgAAwMDAOnp6gDq6usA6uzrAPDx8gAGBwcA/v4AABUVFgDm5ecA5ejlABoZGAAAAAEAAAACAAACAQD+AAAAAQEAAAEAAAAAAP8AAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAEAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wAAAAAAAAAAAAAAAAAAAAAAAQEBAP///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQAJCQkADw8PAAUFBQAAAAAAAAAAAAEBAQD9/f0A+fn5AO7u7gDs7OwA5ubmANPT0wDS0tIA39/fAOzs7ADp6ekA8/PzAAAAAAABAQEAAAAAAAAAAAABAQEA////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQD+/v4AAQEBAAAAAAD+/v4AAQEBAP7+/gDz8/MA7e3tANjY2ADX19cAycnJANfX1wDk5OQA8fHxAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQEBAAAAAAD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQABAQEA/Pz8APHx8QDm5uYAzc3NAMvLywDDw8MA5eXlAPHx8QD///8AAAAAAAEBAQD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD+AAAAAAAAAAAAAAAAAAAAAQAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP/+AAEAAAABAQEA/wAAAAAAAAAAAAAA/wEAAAAAAAABAAAAAQIAAAEA/wACAP8A////AAMDAAAjGxQAIxwVACsmJQAsKSAA4OTqAMPIywDLz9MA4+HjAOPi5gDHytEANzQwAEtFQAAoIR4AGRQJAAMCAgAA/AAAAAD9AAIDAgDCysgAhYiKAD87RwAnIzEA/gEBAPn9/QD4/AAABAMBAPj79wDM1MwAGB0YAElKSgDy8vkA7u7bAAEAAQABAP8AAQABAAH+/wAAAAAAAAECAP/+/gABAgIAAQAAAEsyZ1EAACAASURBVAgICwAaGhoAAQEBAP/9AAAAAQAAAQEAAP//AAD+/v8AAgEBAP3//gAAAAEA/v4AAPv7/gAAAAEA/v//AAAAAAADAwEA8/P2ANnZ4gABAAAABAUCAAQDAgASERUA8vL1AKqqqwAqKSUATlBMAAcLCQAAAAMABAkHABMJDgABAAAA/P/+AAAD/gD//v0AAAH8AP8A/wACAQMAAP8CAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAP8AAAAAAP8AAAH+AAD/AAAAAAIAAAAAAAEAAAAA/wAA/wAEAPwAAADL1+QAo6y1AOPl5gAuKSYAYVtVABUPCQADAQEAAAAAAAD//wABAQAAAAABAAD+/wAAAQEABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQABAAEAAAAAAAH/AAD//wAAAAEBAAECAQD+/v8AAAACAAEB/QAA/f0ABwEBAC0mHAAUExEAKy0iAK20xgDFx8sAz9PYAN/h4wDBwscAR0Q+ADUxLAAaFxQAEA0GAAABAQAAAAAAAQAAAAAAAAAAAP8AAAEAAAAA/wAAAAAAAAABAAAAAQAAAP8AAAD/AAAB/wAAAAIAAP8AAAAAAAAAAAEAAf8AAPn4+QD7+vkAHx4fAA4NDADw8vYAAAAAAAMDAgD19vQAvL+7AFJUSQAnKSQAy8rMAAECAgAEBgYAAgQCAP/8+wD+/v4AAgIBAAD/AAAAAQEA/f//AAMCBQD8/P0AAAAAAAAA/gAAAf8AAAD+AAAA/wAAAP8AAAADAAD/AQACAQMA5ubmANzc2gD/AP0A//8AAAAAAQA3NjoA/wD/AAABAAAAAf4AAAD+AP7//wACAAAAAQAAAP/+AQAAAAEAAgH/AP4A/wADAgMA/P4AAAEAAQABAQEA/wEAAAD//gAA//4AAP4AAAECBwAFBQMA6erqAPn2+gAA/QAABAEBAAEAAgD/AQAA/gH/AP4B/QAAAwIAAP7/AAEAAgD9/f4AAgYCAAgJBgD4+fcADg4PADU0NwDU1NcAp6esAFtcWgAIAQAAUFBSALi3uAC0tbQAPDs2ACIjJQAHBgwAAQIAAAABAAABAAAAAQD+AAAAAAABAAAAAAABAAH/AQAAAAAAAAAAAAABAAAAAAAA/wD/AAAAAAABAAAAAP8BAAAAAQAAAAAAAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD///8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAwMDAAoKCgAKCgoA9vb2AO7u7gD19fUA8fHxAOnp6QDc3NwA1dXVANvb2wDt7e0A6+vrAOzs7AD4+PgA/v7+AAEBAQAAAAAAAAAAAP///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAEBAQAAAAAA+fn5AO3t7QDw8PAA4uLiANfX1wDMzMwA29vbAOrq6gDs7OwA9fX1AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD8/PwA7e3tAOzs7ADl5eUAzs7OAMzMzADa2toA6OjoAO/v7wD+/v4AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAQD+/v4AAgECAAEAAQABAQAA8vL0AOjo6AAHAgEAJiAcABgSDwAFAgEAAQEAAAEA/gD9AQEAAAD/AAIA/wABAP4AAQAAAAH/AgD/AAEAAAAAAAAAAQAB/wEAAAAAAAEBAAAAAAAA/wABAAABAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEBAAAA/wAAAAAAAAEAAQD/AQAAAAAAAP8BAAAAAAAAAAAAAAEAAAAAAAEAAAAAAAAAAAAAAAEAAAD/AAAAAQAAAAAAAQD/AAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAgAAAAAAAAAAAAAA/gAAAf4AAAAAAAD/AwAAAAAAAAAAAP8AAQAAAP8AAQD/ABAMBAA6ODIAqK21ANzc3AC4vMIAI2ZVAP8BAQAB/AAABAMCAAABAAAAAAAA///+AAABAwABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAABAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAD/AQIAAf8AAAAAAQABAAAAAAAAAAAAAAAA/wIAAAAAAAABAAD/AAAAAQH/AAAAAQAAAAEAAAAAAAAAAAAA/wEAAAH/AAAA/gD/AQAAAAAAAAEAAgAAAAEAAP8BAAAAAAD/AAAAAAABAAABAAAB/wAAAAABAAEB/wAA//8AAP/9AAAA/wAAAQAAAAADAPz/AQAPDg4AAQEBAP8BAAD/AP8AAAD/AAAAAAAAAAAAAAACAAAAAAAAAAAAAAABAAAAAAAAAf4AAAD/AP4AAAAAAAEAAQAAAAH/AAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAQAA/wAAAQD/AAABAAD+AAAAAAEAAAP/AQAB/wEAAAAAAAEBAAACAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABChfcoAAAgAElEQVQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAD9Av0AFx0TAFFUSADBu8MAsbGtAODawgBBPgcAJicWAMzN4wAeIDMA7vPvAKapowAACAoA9vgAANba1QABAAYAHhwkAB0fIAAgHx0AAQABAPT2+AD+/QAAAP8DAAEAAQD/AfoABAUCAAUEAgD9/v4A+/v9AP4A/wAAAAEAAAEBAAD//gAHBAUAAwIEAPz6+wD8+/8ABQUCAPwdHwD+AP0A8PDzAPX39wAICQMA+/z2ACouKwDT1tMAMjMlABERDwA2MyoABPc/AJiJeAAmHQAAOTokANng2AAACzUAr8HWADonDQAeGxYAdoygAFRcdwAeGhkA/Pj7APf29wABAQEAAAAAAAAAAAABAQEA////AP///wABAQEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAP8AAAAAAAAAAAAA/wAAAAAAAAABAAABAAEAAAEBAP7/AAD+AAAAAAABAP0BAADi5egA7e7vAAsICAAuKioAAgAAAAH/AAACAf4A/gD9AAD/AQAAAQEAAQD+AAEAAAABAAAAAAD/AAEAAwAAAAEAAAAAAAAAAAAAAAAAAAACAAAAAAAAAAAAAAAAAAIAAAAA/wAAAAD+AAABAAAAAAAAAAAAAAAAAAAAAP8AAAAAAAABAAAAAAAA/wAAAP4AAAAAAAEAAAABAAAAAQABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQABAAAAAAABAAAAAAAAAP8AAAAAAAAAAQAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA5gMZ/BAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAD/AAAAAP8AAAH/AAAAAAAAAAAAAAAAAP8AAAAAAAAAAAEBAAH//wAFAgAAKSYiAC8sJwDFx8sAvcDBAD09OAAtKR0AAQIBAAAAAAAAAQIA/v37AAEBAQABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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/8AAAAAAAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAAAAAAAAAEAAAAAAAEAAAAAAAAAAAAAAAH/AAD/AQAAAAAAAAAAAAABAQEA//8AAPT3/QDGycsAAgMDACAgHAAUEggAAgEAAAEA/wD//v8AAQICAAEBAQAAAAAA/gABAAIAAQAAAAAAAAEAAP4AAAAAAAAAAAABAAAAAAAC/wAAAf8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAA/wAAAAAAAAD+AAEAAAAAAAAAAAAAAAAAAAD/AAAA/wABAAAAAAAAAAAA/wAAAP8AAAABAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAD/AAAAAQAAAAAAAAAAAAAAAAAAAAEAAP//AAADAAEAAQD+AAwKBQBDQTsAv8XFAL7AxQDAw8cAOzk1ADw2JwAAAgEA/wAAAAIDAwAAAP4AAP8AAAEB/wD/AAAAAAABAAAAAAAAAAAA/wAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAP8AAAAAAAAAAAD+AAEAAAAA/wEAAAABAAAA/gD/AAEA/wEBAAAAAAACAAAAAQD+AAAA/QAAAQAAAAAEAAAAAAABAAAAAP8BAAAAAQABAAAAAAD+AP8B/wAAAP4AAAACAAEAAQAAAAAAAAD+AAAAAAAAAAEAAAABAP79/wABAgMAAQEAAAAB/gAAAP4AAwIBAP78/gACAgIAAQEBAAAAAQAAAAIAAP8BAAAAAQAAAQEAAAD+AAAAAAAAAAEAAAABAAD/AgAAAf4AAQAAAAAAAAAAAAAAAQAAAAEAAAAAAQAAAP4BAAAAAAAAAP8AAAH/AP8BAQAAAQEAAgAAAAH/AAAAAAAA/wAAAP8AAAAAAQAAAf8AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD9/gAAAgICAAEAAQAAAAQAAP4BAAABAgDa3OEA0M/RAPf5HQD9AfgALzISAPD07wDIytgA8PMFAAzU8QAcHB0AKiclAA0ODAD8+/wAGBUUADQzMAD7/vwACQkHAP7+/QD//wAAAP8CAAICAgAYGhIA/f76AAMCBgACAQoAAgEHAP/9/gABAv0A/P3zAB8gGAD8/AAA/wAAAAQFBgD9//8A//8AAAECAQAZGzoA+fcxAAoICgADAgEAwsC4AOHh8wD//AIAAQACAAD/AQAAAAQAHyMsAAAC9wDx3BMAQDsIANrb1wAYHykA40BUAOLtAQDs9AAADhAWACYeHAAeIR8AAAICAP//AAABAQEAAAAAAAEBAQABAQEA/v7+AAEBAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAHeOqxgAACAASURBVAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAD+AAEAAQAAAAEA/f0BAAABAAACAgAA1tnfAN/h5QACBQYAPTw5AAcIAQABAAEAAQD8AP///wABAAQAAP8BAAAAAAAAAQAAAAABAAAAAAAAAAAA/wAAAAAAAAAAAAEAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAP8AAAAAAAAAAAABAAAAAAAAAAAAAAABAAAAAQAAAAAAAAAAAAAAAAABAP8AAAD+AAEAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAf4AAAACAP4AAQAAAAAAAAAAAAEAAAAB/f8AAgEBACAeFABVVVIA2+DmANba3QChpKkAFhNlACojGQD/AAEAAQABAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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P8AAAAAAAAA/wAAAAAAAAD/AAAAAAAA//8AAAAAAAAAAQAAAAEAAAAAAAAAAQD/AQEAAAAAAP4A/wAAAAAAAAAAAP/+AQACAAAAAQH/AAD/AAD+/QAAAgIBAAEBAADz+AAA5OjsAOHl6QDi5+kA0dXYAM3P0QDb29sA+vr5AAUEAwAYFxMAJyMhACQiHwA3NDMANTMwAA4MBAAJBgUAAgICAAQBAQABAQAA//4AAAEAAAABAQAAAQD/AAAAAAD/AQAA//8AAAAAAAD9AP8A////AAIBAgACAQEAAQAAAAEAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAB/////wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP8AAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP///wAAAAAAAAAAAAAAAAAAAAAA/gEBAAEAAAD/AAAAAQAAAP//AAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAA/wAAAAAAAQABAAABAAAAAAAAAP8AAP8AAAABAAAAAAEAAAD//wD/AAAAAAAAAAAAAAAAAQAA/wABAAEAAAD/AAAAAQAAAP//AAAAAAAAAQAAAAAA/wABAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAABAQEAAAAAAP///wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQEBAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP//AAAAAAAA/wAAAAAAAAD/AAAA/wEAAP///gABAAEAAQEAAAH/AAABAP8AAP/+AAAAAQABAAEAAP7+AP8BAQD/AQEA/QABAPf8/AD9/f0A5uz7AMzP1ADV2N0A2tveAOLk5gDs7O0A7+3sAP//+gAMCwkAHxwaADAvKwAsKCUAGhYTABUQDwAZGhcAFRQVAAwLAgABAQEAAAAAAP4AAAADAAEAAQEAAAAAAAAAAAAAAAAAAAEAAAAAAAAA/wAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAP4AAAAAAAAAAAAAAAAAAAD/AAAAAAAB/wEAAAABAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wD/AAAAAAAAAAAAAAAAAAH//gAAAAAAAAAAAAAAAQAAAAEAAAABAP8BAAAAAAAA/gAAAP8AAAAAAAAA/f8AAAAAAAABAAAA9vgAAPDv8QDh4eUA5ujpAN7j5QDW2d0Az9PVAObn6wD9AAIABAUFAB4fGwAaGBYAJyQfACwoJAA6NzEAGRMLAAYCAwAHBQMAAgEBAAEAAQAAAAAAAP//AAAAAAD/AP8AAAABAAABAAAAAQAAAAAAAP///wABAAEAAQEBAP3//gABAAAAAQABAAABAQABAAAAAQAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAH/////AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA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Figure 4. Exemple d'agent réactif. [3]

### Agents croyance-désir-intention (Agent BDI)

L'architecture BDI est basée sur un raisonnement pratique (practical reasoning) qui utilise la théorie de Bratman sur la position intentionnelle [7] Le raisonnement pratique est le raisonnement vers des actions - le processus de détermination de ce qu'il faut faire. Ceci est différent du processus de raisonnement théorique car il dérive des connaissances ou parvient à des conclusions en utilisant ses croyances et ses connaissances. Le raisonnement pratique humain implique deux activités, à savoir la délibération et le means-end reasoning. La délibération décide quel état de monde (but) doit être atteint tandis que le raisonnement moyens-fin décide comment atteindre ces états. Dans l'architecture BDI, l'agent se compose de trois composants appelés états mentaux/attitudes mentales, à savoir les croyances, les désirs (buts) et les intentions. Les croyances sont l'ensemble des informations qu'un agent possède sur le monde. Les désirs sont la motivation de l'agent ou les options possibles pour réaliser les actions. Les intentions sont un élément clé du raisonnement pratique. Les intentions sont les engagements de l'agent envers ses désirs et ses croyances. Le modèle BDI des agents est probablement le modèle des agents le plus populaire [7] , nous avons utilisé dans notre projet car il est facile et flexible et plus proche à la logique des êtres humain [8].

### Architectures en couches

L'architecture en couches (hybride) est une architecture d'agent qui permet un comportement d'agent à la fois réactif et délibéré. L'architecture en couches combine à la fois les avantages de l'architecture réactive et basée sur la logique et atténue en même temps les problèmes des deux architectures. Les sous-systèmes sont décomposés en une couche de structure hiérarchique pour faire face à différents comportements. Il existe deux types d'interaction qui circulent entre la couche, à savoir horizontale et verticale. Dans l'architecture de couche horizontale, chaque couche est directement connectée à l'entrée sensorielle et à la sortie d’action. Chaque couche est comme un agent mappant l'entrée à l'action à effectuer.

Touring Machine est un exemple d'architecture d'agent en couches horizontales. L'architecture de l'agent Touring Machine se compose de trois couches productrices d'activités : une couche réactive R, une couche de planification P et une couche de modélisation M Ces trois couches fonctionnent simultanément et indépendamment pour transformer la perception en action. Chacune des couches possède son propre mécanisme de traitement de calcul interne.

# Conclusion

Alors les véhicules autonomes sont des machines qui respectent des règles strictes du code de la route, mais aussi être capables de réagir face à des situations dans des environnements ouverts. Ces véhicules sont soumises un classement ou dans une autre façon ils ont un niveau d’automatisation qui donne une idée sur le système et son contrôle de véhicule.sa autonomie peut être réaliser par le concept des agents. Ce dernier est un système informatique situé dans un environnement et capable d'agir de manière autonome dans cet environnement.

**Chapitre 2**

***Les architectures et les approches de développement des systèmes d'agents***

# Introduction

Dans le domaine d’intelligence artificielle, le paradigme d’agent intelligent est basé sur la notion de réactif, autonome, proactif dans des environnements différents où il perçoit et dans lequel il agit. Il soutient une communauté de recherche nourricière qui a fait des progrès substantiels ces dernières années en fournissant une compréhension théorique et pratique de nombreux aspects des agents et des systèmes multi-agents [1].

D’une autre part, le monde veut des systèmes robustes, autonomes et indépendants dans le cas de prendre des décisions pour les actions qu'ils feront dans leur environnement. Les paradigmes de programmation orientés agent sont pour le travail de diminuer la complexité et le temps de conception.

Et pour cela nous parlerons dans ce chapitre de l'agent BDI, certains d’architectures qui veulent donner la meilleure définition de cet agent et certains de ses approches utilisées dans programmation orientés agents.



# Architecture générale d'un agent BDI

L'idée principale de l'approche BDI est de décrire l'état interne d'un agent en termes d'attitudes mentales et de définir une architecture de contrôle grâce à laquelle l'agent peut sélectionner le cours d'action de ses attitudes mentales [8].Cinq attitudes mentales de base sont définies :

* **Les croyances :** sont les informations que l'agent possède sur l'environnement et sur d'autres agents qui existent dans le même environnement. Les croyances peuvent être incorrectes, incomplètes ou incertaines et, à cause de cela, elles sont différentes des connaissances de l'agent, qui sont des informations toujours vraies. Les croyances peuvent changer au fur et à mesure que l'agent, par sa capacité de perception ou par l'interaction avec d'autres agents, recueille plus d'information.
* **Les désirs :** représentent les états possibles vers lesquels l'agent peut vouloir s'engager. Une caractéristique importante des désirs est qu'un agent peut avoir des désirs inconsistants ou/et des désirs contradictoires. Dans ce cas, il doit choisir parmi ses désirs un sous-ensemble qui soit consistant et non contradictoire.
* **Les intentions :** représentent les actions que l'agent s'engage à exécuter. A partir du moment où les agents sont limités par leurs ressources, ils peuvent leur arriver de ne pas pouvoir poursuivre tous leurs buts. Même si l'ensemble des buts créés est consistant, il est nécessaire que l'agent choisisse un certain nombre de buts pour lesquels il s'engage. C'est ce processus qui est appelé la formation des intentions.
* **Les buts :** décrit les objectifs d’un agent qui peut éventuellement adopter ; et les événements auxquels il peut répondre.
* **Les plans :** décrit l’ensemble des étapes d’un agent peut éventuellement utiliser pour atteindre ses objectifs. Il décrit les propriétés et la structure de contrôle.

# Architecture générique des agents BDI

En philosophie, il existe plusieurs types de raisonnement, qui comprennent le raisonnement théorique et le raisonnement pratique. Le type de raisonnement théorique est présenté comme un raisonnement qui tire des conclusions d'une ou plusieurs prémisses de manière impersonnelle [5], tandis que le raisonnement pratique est un raisonnement orienté vers l'action. Ce type de raisonnement a deux activités, le processus de décider quoi faire et comment faire une action.

Le modèle BDI s'inspire des écrits du philosophe américain Michael Bratman [7], se concentrant sur une théorie philosophique du raisonnement pratique qui explique le raisonnement humain.

Pour Bratman, les intentions et les désirs sont des attitudes de soutien (attitudes mentales liées à l'action), mais la proéminence intentionnelle est une attitude axée sur le soutien qui contrôle le comportement. L'architecture BDI générique comporte sept composants principaux résumés dans la figure suivante :

Une collection de croyances actuelles, représentant les informations dont dispose l'agent sur son environnement actuel.

Une fonction de modification des croyances, qui accepte les entrées perceptives et les croyances actuelles de l'agent, et détermine un nouvel ensemble de croyances basées sur celles-ci.

Une fonction génératrice d'options (ses souhaits), "options", qui détermine les options disponibles pour l'agent en fonction des croyances actuelles de l'agent sur son environnement et ses intentions actuelles.

Une fonction de filtre qui représente le processus de délibération de l'agent et détermine les intentions de l'agent en fonction de ses croyances, désirs et intentions actuels.

L'ensemble (l'intentions actuelles, représentant l'orientation actuelle de l'agent c'est-à-dire les buts vers lesquels il s'est engagé à réaliser.

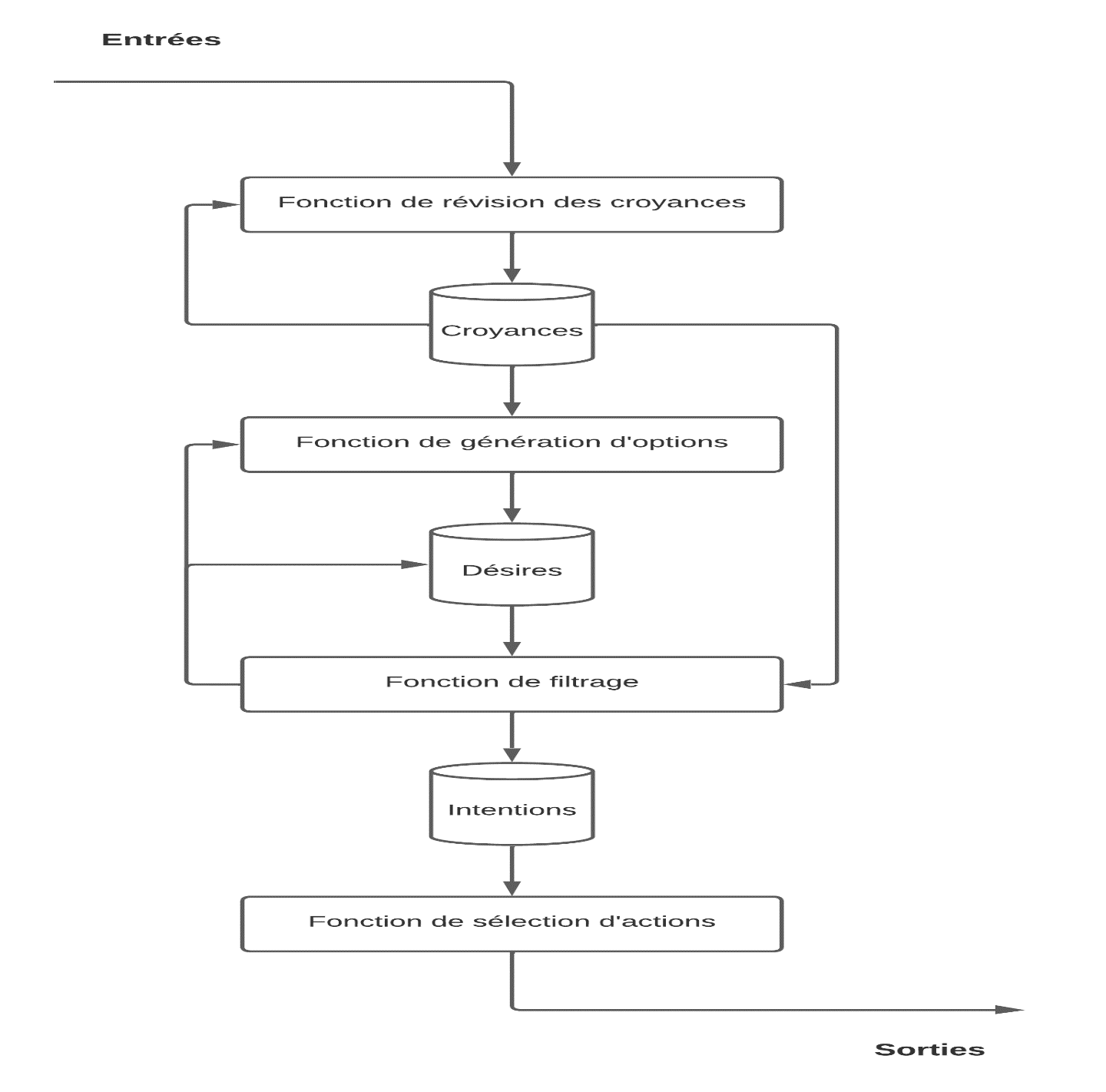
Une fonction de sélection d'action "faire" qui détermine l'action à effectuer en fonction de l'intention actuelle de l'agent.

Figure 5. Schéma d'une architecture générique d’agent BDI [7]

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# Implémentations basé sur logique d’agent BDI

C'est la description de son organisation interne, les données et les connaissances de l'agent, les opérations qui peuvent être effectuées sur ses composantes (composants décision, composants perception, composants interaction). Le choix d'une architecture ou d'une autre est lié à la structure conceptuelle de l'agent et représente la décision du concepteur sur la façon de bâtir l'agent artificiel.

## Système de raisonnement procédural (PRS)

Le système de raisonnement procédural (PRS) est généralement reconnu comme l'une des premières implémentations du modèle Croyance-Désir-Intention (BDI) d'agence et de raisonnement pratique. PRS a été extrêmement influent et est encore largement utilisé, en particulier dans la robotique. [9]

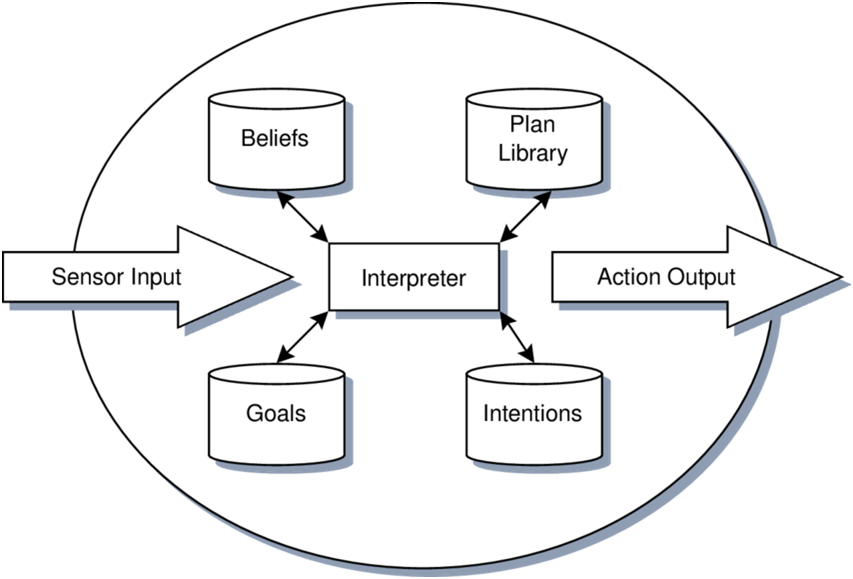


Figure 6. PRS architecture [9]

PRS a également influencé la conception de nombreux langages de programmation d'agents basés sur BDI, bien que la plupart de ces langages n'implémentent qu'un sous-ensemble des fonctionnalités du langage de programmation prises en charge par PRS. Étonnamment, étant donné sa centralité dans le paradigme BDI, PRS manque d'une sémantique opérationnelle formelle, ce qui rend difficile la détermination de son pouvoir expressif par rapport aux autres langages de programmation d'agents BDI, ou la vérification de l'exactitude des programmes PRS. [9]

## Architecture dMARS (Distributed Multi-Agent Reasoning System)

dMARS est une implémentation en C++ de PRS. on a proposé une spécification formelle de l’architecture qui détaille précisément les différentes structures employées et les opérations qui les manipulent réalisant un pas en avant vers l'analyse théorique de PRS. Elle a été mise en œuvre à l'Institut Al Australie(AAII) en 1995, sous la direction de M.Georgeff. Le système de dMARS a été utilisé dans le domaine de l'automatisation des processus industrielle, la simulation et les systèmes de contrôle du trafic aérien. Parmi les organismes qui ont utilisé de dMARS, on peut citer la NASA (traitement de dysfonctionnement de la navette spatiale), Air Services, Thomson Airsys (contrôle de la circulation aérienne, Daimler Chrysler (gestion de la chaine d'approvisionnement, ressources et gestion de la logistique), Hazelwood Puissance (contrôle de processus). [10]

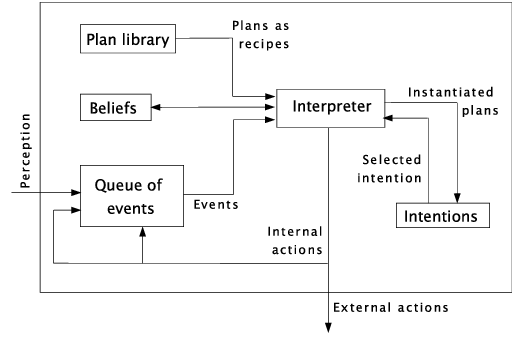
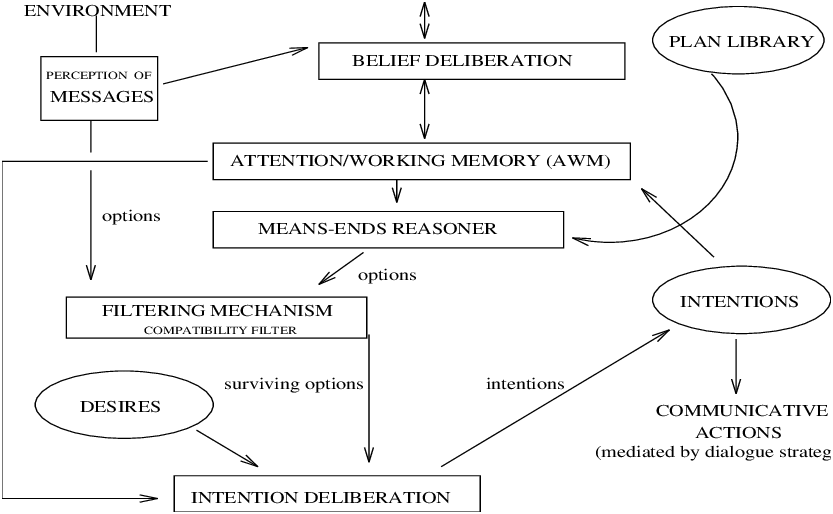


Figure 7. Architecture de dMARS [10].

## IRMA (Intelligent Resource-bounded Machine Architecture)

IRMA de Bratman est ne du besoin d’un modèle capable de développer un système de raisonnement pratique (practical reasoning) et d’exhiber un comportement rationnel pour des agents aux ressources limitées. Un système de raisonnement pratique est ‘un système par lequel un agent forme des plans et exécuter des actions. [11]

IRMA propose différents mécanismes permettant de limiter les calculs nécessaires aux raisonnements.

Figure ‎2.4. Architecture IRMA

Figure 8. Architecture IRMA [11]

## Approches de développement des systèmes d’agents BDI

Ces dernières années, les technologies basées sur l’orienté-agents ont été de plus en plus utilisées dans les systèmes complexes. Ces systèmes ont besoin d'abstraction, de décomposition, d'organisation des parties du système et aussi de pouvoir accepter des milliers d'agents. ils ont aussi besoin de techniques modélisation pour le processus de conception. Sans ces techniques, les systèmes ne seront pas fiables, maintenables et difficiles à comprendre.

De nombreuses approches sont apparues et proposées pour résoudre les problèmes de ces systèmes et aussi pour le développement des systèmes multi-agents, parmi eux que nous allons utiliser on peut citer :

* L'approche de David Kinny, Michael George et Anand Rao
* L'approche de Chang-Hyun, Jo Guobin Chen and James Choi

### Approche de David Kinny, Michael George et Anand Rao

En général dans un système d'agent, nous avons constaté qu’il est hautement souhaitable d'adopter un ensemble plus spécialise de modèles qui fonctionnent a deux niveaux distincts d'abstraction. [12]

1. **Point de vue externe**

Notre méthodologie orientée agent préconise la décomposition d'un système en fonction des rôles clés dans une application. L'identification des rôles et de leurs relations guide la spécification d'une hiérarchie de classes d'agents : les agents sont des instances particulières de ces classes. L'analyse des responsabilités de chaque classe d'agent conduit à l'identification des services fournis et utilisés par un agent, et donc de ses interactions externes. La prise en compte de questions telles que la création et la durée des rôles et de leurs interactions détermine les relations de contrôle entre les classes d'agents. Ces détails sont capturés dans deux modèles.

* **Modèle d'agent :** décrit la relation hiérarchique entre différentes classes d'agents abstraits et concrets, et identifie les instances d'agents qui peuvent exister dans le système. Leur multiplicité, et le moment de leur apparition.
* **Modèle d'Interaction** décrit les responsabilités d'une classe d'agent, les services qu'elle fournit dans les interactions associées, et les relations de contrôle entre les classes d'agents. Cela inclut la syntaxe et la sémantique des messages utilisés pour la communication entre agents et la communication entre les agents et d'autres composants du système, tels que les interfaces utilisateurs.

1. **Point de vue interne**

Le paradigme BDI fournit une notion "forte" de l'agence ; les agents sont considérés comme ayant certaines attitudes mentales, croyances, désirs et intentions qui représentent, respectivement, leurs états informationnels, motivationnels et délibératifs. Dans notre architecture BDI, un agent peut être complètement spécifié par les événements qu'il peut percevoir, les actions qu'il peut effectuer, les croyances qu'il peut avoir, les buts qu'il peut adopter et les plans qui donnent lieu à ses intentions. Ces éléments sont capturés, pour chaque classe d'agent, par les modèles suivants.

* **Belief Mode** décrit les informations sur l'environnement et l'état interne qu'un agent de cette classe peut détenir, ainsi que les actions qu'il peut effectuer. Les croyances possibles d'un agent et leurs propriétés, comme le fait qu'elles puissent ou non évoluer dans le temps, sont décrites par un ensemble de croyances. En outre, un ou plusieurs états de croyance - instances particulières de l'ensemble de croyances - peuvent être définis et utilisés pour spécifier l'état mental initial d'un agent.
* **Goal Model** décrit les buts qu'un agent peut éventuellement adopter, et les événements auxquels il peut répondre. Il se compose d'un ensemble de buts qui spécifie le domaine des buts et des événements et d'un ou plusieurs états de buts - ensembles de buts de base - utilisés pour spécifier l'état mental initial d'un agent.
* **Plan Model** décrit les plans qu'un agent peut éventuellement employer pour atteindre ses objectifs. Il consiste en un ensemble de plans décrivant les propriétés et la structure de contrôle de chaque plan.

### Approche de Chang-Hyun, Jo Guobin Chen and James Choi

Cette approche met l'accent sur la phase d'analyse et de conception. Dans la phase d'analyse des besoins, les analystes utilisent les "external use case" (cas d'utilisation externe) pour extraire les désirs (buts) du point de vue externe et aussi pour comprendre pleinement l'exigence et de préparer la phase de conception. Vient ensuite la phase de conception, dans cette dernière, les analystes utilisent les "internai use case" (cas d'utilisation interne) pour capturer l'intention et utiliser également le diagramme de flux de données (DFD) pour trouver les croyances. Enfin, les analystes établissent le "BDI Agent Cards". [8]

La figure suivante montre les différentes étapes du processus de développement de cette approche. Dans ce qui suit, nous allons fait la description de chaque étape.

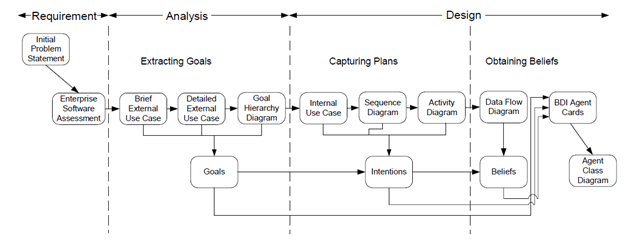


Figure 9. Processus de développement de l'agent BDI [8]

* **Etape 1 : Spécifications du problème initiale (Init problem statement)**

L'objectif de l'énoncé initial du problème est de décrire le problème que le client s'attend à voir résoudre par le système. L'énoncé initial du problème est le point de départ de l'analyse du système. Il constitue l'entrée de l'étape de saisie des objectifs. Normalement, il s'agit de la conceptualisation du système du point de vue de l'utilisateur, et il décrit les fonctions ou services généraux que le système fournira. L'énoncé initial du problème peut aussi être désigné de manière plus descriptive, par exemple par "les exigences du système" ou "les spécifications de l'utilisateur". Comme l'énoncé initial des problèmes est un résultat auquel participent à la fois le client et les développeurs de logiciels, il s'agit d'un accord entre les deux parties sur une vision de haut niveau du système. Une compréhension totale de l'énoncé initial du problème est le point de départ solide de tout le processus.

* **Etape 2 : Évaluation des logiciels d'entreprise (Enterprise Software Assessment)**

Une évaluation du logiciel d'entreprise décrit comment le nouveau système affectera le système actuel. Ce processus décrit essentiellement l'environnement dans lequel le système actuel fonctionne. L'essentiel est le suivant : les clients ont-ils des problèmes pour appliquer le nouveau système à leurs ancêtres, et si oui, comment ? Si nous examinons les résultats précédents, nous aurons peut-être une meilleure idée de la manière de mettre en œuvre le système pour nos clients.

* **Etape 3 : Description de cas d'utilisation externe (Brief External Use Cas)**

Cette étape traite le système comme une boîte noire. Un " Brief External Use Cases" montre l'interaction entre les entités externes du système et le système. Les objectifs peuvent souvent être extraits de ce que le système essaie d'accomplir. Nous capturons les objectifs de l'étape précédente (l'énoncé initial du problème) et l'analyste les décompose en un ensemble de cas d'utilisation (Brief Use Cases). Les analystes déterminent ce que le système doit fournir. Par conséquent, cette étape est utilisée pour capturer chaque participant : son interaction avec le système. L'analyste décrit chacun d'eux à l'aide de caractéristiques et de courts scénarios (Brief Use Cases).

* **Etape 4 : Description détaillée de cas d’utilisation externe (Detailed External Use Case)**

L'objectif du cas d'utilisation externe détaillé est de décrire plus précisément les services du système d'un point de vue externe en décomposant le cas d'utilisation externe bref obtenu lors du processus précédent. Finalement, l'écriture des cas d'utilisation externes détaillés nous aide à trouver des objectifs. Le cas d'utilisation externe détaillé donne la description spécifique de l'action du système, mais toujours d'un point de vue extérieur. Nous prenons une action à la fois dans le cas d'utilisation externe bref, et nous l'explorons dans des descriptions détaillées, comme la décomposition de l'objectif global en sous-objectifs. Le format suivant est le cas d'utilisation externe détaillé, qui peut être systématiquement décomposé et aider les développeurs de logiciels à générer les descriptions détaillées.

* **Cas d’utilisation :** on indique le nom de cas d'utilisation.
* **But :** Les analystes peuvent transformer une phrase en terme nominal qui décrit la fonctionnalité du cas d'utilisation.
* **Acteurs :** Ce sont l'acteur qui déclenche le cas d'utilisation et les intervenants qui jouent un rôle précis dans le cas d’utilisation.
* **Pré condition :** Les analystes peuvent indiquer ce qui doit toujours être vrai avant de commencer un scénario dans le cas d'utilisation.
* **Post conditions :** Indique ce que doit être vrai après la réussite du cas d'utilisation.
* **Scénario nominal :** Décrire le scénario principal pour atteindre le cas d'utile.
* **Scénario alternatif :** Indique tous les scénarios alternatifs**.**
* **Etape 5 : La structuration des buts (Structuring goals)**

Dans cette étape en dériver les buts par mapping les étapes 3 et 4 dans un diagramme de but hiérarchique comme suit.

Comme chaque but est différent en termes de taille, d'importance et de niveau de complication, les analystes doivent analyser soigneusement ces différences et accorder plus d'attention à leur importance et à leurs interrelations. Ensuite, le diagramme de hiérarchie des objectifs devrait présenter ces relations et classer les objectifs dans différents catalogues en fonction du niveau de complication et d'importance.

|  |  |
| --- | --- |
| **Cas d'utilisation** |  |
| **But** |  |
| **Acteurs** |  |
| **Pré condition** |  |
| **Post conditions** |  |
| **Scénario nominal** |  |
| **Scénario alternatif** |  |

Tableau 1. Diagramme de Cas d’utilisation interne détaille

* **Etape 6 : La description de cas d’utilisation interne (Internals Use Cases)**

Le cas d'utilisation interne concerne les interactions entre les éléments à l'intérieur du système. La raison pour laquelle nous appelons de tels cas d'utilisation internes est qu'ils peuvent montrer comment les entités interagissent avec le système en interne et comment les entités s'utilisent les unes les autres pour faire avancer les choses.

Le but de cette étape est d'identifier les intentions (plans). Sur la base des cas d'utilisation externes, nous décomposons le scénario de chaque cas d'utilisation en détails. Cela nous aidera à trouver les intentions pour les objectifs et à découvrir d'autres rôles qui ne sont pas faciles à voir d'un point de vue externe. Afin de créer les cas d'utilisation internes succincts, nous lisons les cas d'utilisation externes décrits à l'étape 4 et décomposons leurs scénarios tout en gardant le reste des parties inchangées. Dans notre recherche, un rôle comprend un objectif particulier ou un ensemble d'objectifs et un ensemble d'intentions. Il sera associé à un agent responsable de la satisfaction de ces objectifs.

* **Etape 7 : Les diagrammes de séquences (Sequences Diagrams)**

Sur la base des scénarios de cas d'utilisation, le diagramme de séquence illustre la séquence des événements qui sont transmis et la relation entre les rôles (un rôle comprend un objectif particulier ou un ensemble d'objectifs et un ensemble d'intentions).

Il montre comment les rôles communiquent entre eux au fil du temps. Le rôle qui initie la communication devient l'initiateur, et le récepteur devient le répondeur. Ces rôles sont des agents candidats. Ils deviendront des agents lorsque nous découvrirons des croyances et que nous leur attribuerons ces croyances.

* **Etape 8 : Diagramme d’activité de l’agent (Agent Activity Diagrams)**

Un diagramme d'activité d'agent, ou diagramme d'événement d'agent, exprime les opérations (les actions) et les événements qui déclenchent les agents [13]. En UML, un Diagramme d'Activité parle davantage de ces transitions et des événements qui provoquent les changements.

Les opérations sont des processus qui peuvent être demandés en tant qu'unité et qui peuvent effectuer les changements d'état. Les événements définissent les changements d'état qui résultent des opérations et invoquent d'autres opérations via des déclencheurs. Diagramme d’activité d’agent ressemble beaucoup aux organigrammes d'autrefois. Il montre des étapes (appelées activités) ainsi que des points de décision et des branches [13].

* **Etape 9 : La liste de croyances de l’agent (Agent belief List)**

Les croyances d'un agent sont un ensemble de données décrivant l'état de l'environnement. Elles sont la connaissance que les intentions utilisent pour remplir leurs buts (désirs).

Nous appliquons le diagramme de flux de données (DFD) dans notre approche. Le DFD est une méthodologie fonctionnelle, qui est également popularisée dans l'analyse et la conception orienté objet.

En se basant simplement sur les cas d'utilisation des étapes 3, 4 et 6, nous générons le DFD et collectons les flux de données entre ces processus.

* **Etape 10 : Cartes d’agent BDI (BDI Agent Cards)**

Dans cette étape l’objectif est de permettre la réunion de toutes les parties des agents en entités : agents, croyances, désirs et intentions. On peut dire que cette étape est une conclusion que nous avons déjà déterminé lors des étapes précédentes. Ici nous nous contentons de les collecter et de les regrouper en groupes basés sur les buts que nous essayons d'atteindre.

L’importance des « BDI Agent Cards » est de pourvoir être utilisés dans la construction de logiciels orienté-agents. Alors ils sont de grande valeur est le fruit de cette étape est un diagramme de classe d’agent qui contient le nom d’agent, ses croyances, ses désirs, et les intentions.



# Conclusion

A la fin de ce chapitre nous avons défini l’agent BDI, ainsi que nous avons donné ses caractéristiques, puis quelque architecture a été démontrées comme PRS, IRMA. ensuite, nous avons met la lumière sur deux approches importantes, on détaille l’approche utilisé dans notre projet.

**Chapitre 3**

***Développement d’une simulation des véhicules autonomes***

# Introduction

Pour mettre en œuvre un projet logiciel, nous devons suivre une méthodologie de développement. Cette dernière nous permettra de faciliter le développement et servira également à documenter notre projet.

Dans le chapitre précédent, nous avons vu deux approches différentes pour développer des systèmes BDI multi-agents. Nous avons choisi la deuxième approche, celle de Chang-Hyun, Jo Guobin Chen et James Choi qui est dérivée de la première approche mais qui est aussi plus détaillée.

Nous avons fusionné également ces conceptions des systèmes multi-agents BDI avec l'architecture globale de l'organisation internationale des véhicules autonomes SAE pour avoir notre système de raisonnement.

Dans ce qui suit, nous donnerons un bref aperçu du projet à réaliser et des résultats obtenus à partir de l'analyse et de la conception de l'application. Enfin, nous terminerons ce chapitre par un bref aperçu de l’implémentation.

# Analyse et conception de l'application

L'approche adoptée contient essentiellement les étapes suivantes :

## Étape 1 : Spécifications du problème initiale (Init problem statement)

Dans cette première étape, nous allons décrire les services généraux du système du point de vue de l'utilisateur. Ce descriptif constitue les spécifications ou bien le cahier des charges de notre application, résumé par les points suivants :

* L'application contient un agent nommé “Car” et une autre agent nommé "Self Driving Car".
* L'application contient plusieurs destinations comme "Bank", "Commune", "Stadium", "Hospital", "POLICE", "University", "Market", "Sports Hall", "Fuel Pump A", "Fuel Pump B", "Fuel Pump C", "Fuel Pump D", "Mosque", "Mall", "Fire Station", "SNTV" et "Airport".
* Chaque véhicule autonome a son propre point de départ.
* Le véhicule à un capteur pour détecter les autres véhicules, les piétons, les obstacles, les feux de circulation. Les plaques de vitesses, les plaques de stops et le niveau du réservoir d'essence.
* Le véhicule peut faire le plein d'essence tout seul, si le réservoir d'essence est inférieur ou égal à 20% ou si le niveau actuel ne peut pas atteindre l'endroit spécifié.
* Le véhicule est en mesure de modifier la vitesse, d’arrêter et de vérifier la droite avec son raisonnement en fonction des résultats de capteur.
* A partir de l'interface graphique, le propriétaire choisit l'endroit où il souhaite aller dans la liste des emplacements disponibles et peut changer de place chaque fois qu'il le souhaite.
* L'application contient des personnes qui traversent la route.
* La simulation permet à l'utilisateur d'ajouter des obstacles à l'environnement de simulation comme il le souhaite.

## Étape 2 : Évaluation des logiciels d'entreprise (Enterprise Software Assessment)

Cette étape vise à décrire l'incidence du nouveau système sur le système existant.

Nous ne disposons pas d'un système existant, donc cette étape n'est pas nécessaire à notre projet.

## Étape 3 : Description de cas d'utilisation externe (Brief External Use Cas)

A partir de l'étape précédente, nous allons extraire les fonctionnalités suivantes de notre future application :

|  |
| --- |
| **Se\_Déplacer** |
| 1. Le propriétaire donne la destination. 2. Le véhicule choisit le chemin. 3. Le véhicule se déplace vers la destination. |

Tableau 2. Description de cas d’utilisation externe "Se\_Déplacer"

|  |
| --- |
| **Prendre\_Droite** |
| 1. Si le véhicule détecte un autre véhicule alors, il va sur son côté droit. |

Tableau 3. Description de cas d’utilisation externe "Prendre\_Droite"

|  |
| --- |
| **Respecter\_Piéton** |
| 1. Si le véhicule détecte qu'un humain traverse,il s'arrête jusqu'à ce qu’il arrive de l'autre côté. |

Tableau 4. Description de cas d’utilisation externe "Respecter\_Piéton"

|  |
| --- |
| **Éviter\_Obstacle** |
| 1. Si le véhicule détecte un obstacle, alors il s'arrête puis il change la route pour arriver à sa destination. |

Tableau 5. Description de cas d’utilisation externe "Éviter\_Obstacle"

|  |
| --- |
| **Respecter\_Feux\_De\_Circulation** |
| 1. Si le véhicule détecte un feu rouge alors il s'arrête, jusqu'à ce que le feu devient vert. |

Tableau 6. Description de cas d’utilisation externe "Respecter\_Feux\_De\_Circulation"

|  |
| --- |
| **Limiter\_Vitesse** |
| 1. Si le véhicule détecte une plaque limite de vitesse, alors il adapte sa vitasse à la plaque. |

Tableau 7. Description de cas d’utilisation externe "Limiter\_Vitesse"

|  |
| --- |
| **Retourner\_vitesse\_initiale** |
| 1. Si le véhicule détecte une plaque fin de limite de vitesse, alors il retourne à sa vitesse initiale. |

Tableau 8. Description de cas d’utilisation externe " Retourner\_vitesse\_initiale "

|  |
| --- |
| **Faire Stop** |
| 1. Si le véhicule détecte une plaque de stop, alors il s'arrête 3 secondes. |

Tableau 9. Description de cas d’utilisation externe "Faire\_Stop"

|  |
| --- |
| **Faire plein** |
| 1. Si le niveau du réservoir d'essence est inférieur ou égal à 20% ou si le niveau actuel ne permet pas d’atteindre l'endroit spécifié, alors il se déplace à la station d'essence la plus proche. |

Tableau 10. Description de cas d’utilisation externe "Faire\_plein"

## Étape 4 : Description détaillée de cas d’utilisation externe (Detailed External Use Case)

Au cours de cette étape, nous allons décrire en détail les diverses fonctionnalités présentées plus haut.

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Se\_Déplacer** |
| **But** | Aller à un endroit spécifié par le propriétaire. |
| **Acteurs** | Propriétaire. |
| **Pré-conditions** | Le propriétaire a donné l'ordre de se déplacer à endoit donné. |
| **Post-conditions** | Le véhicule arrive à sa destination. |
| **Scénario nominal** | 1. Le propriétaire choisit l’endroit. 2. Le propriétaire envoie au véhicule l’ordre d’aller vers l’endroit 3. Le véhicule choisit le chemin. 4. Le véhicule se déplace vers la destination. |
| **Scénario alternatif** | Aucun |

Tableau 11. Description détaillée de cas d’utilisation externe "Se\_Déplacer"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Prendre\_Droite** |
| **But** | Prendre la côté droite |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le capteur doit détecter une voiture |
| **Post-conditions** | Le véhicule va sur son côté droit. |
| **Scénario nominal** | 1. Le capteur doit détecter une voiture. 2. Le véhicule va sur son côté droit. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 12. Description détaillée de cas d’utilisation externe "Prendre\_Droite"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Respecter\_Piéton** |
| **But** | S’arrêter jusqu'à ce que le piéton traverse la route |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le véhicule doit détecter un piéton |
| **Post-conditions** | Attendre que le piéton traverse la route |
| **Scénario nominal** | 1. Le véhicule détecte un piéton. 2. Le véhicule s'arrête jusqu’à ce que le piéton traverse la route. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 13. Description détaillée de cas d’utilisation externe "Respecter\_Piéton"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Éviter\_Obstacle** |
| **But** | Éviter les obstacles |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le véhicule détecte un obstacle |
| **Post-conditions** | Le véhicule évite l’obstacle |
| **Scénario nominal** | 1. Le véhicule détecte un obstacle 2. Le véhicule s’arrête 3. Le véhicule choisi un autre chemin 4. Le véhicule continue sa route |
| **Scénario alternatif** | Aucun |

Tableau 14. Description détaillée de cas d’utilisation externe "Éviter\_Obstacle"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Respecter\_Feux\_De\_Circulation** |
| **But** | Respecter les feux de circulation |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte un feu rouge. |
| **Post-conditions** | Le véhicule attend que le feu passe au vert. |
| **Scénario nominal** | 1. Si le véhicule détecte un feu rouge, il attend que le feu passe au vert. 2. Le véhicule continue sa route |
| **Scénario alternatif** | Aucun |

Tableau 15. Description détaillée de cas d’utilisation externe "Respecter\_Feux\_De\_Circulation"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Limiter\_Vitesse** |
| **But** | Respecter les plaques de vitesses |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte une plaque de vitesse. |
| **Post-conditions** | Le véhicule change la limitation de vitesse. |
| **Scénario nominal** | 1. Le véhicule détecte une plaque de limitation de vitesse. 2. Le véhicule adapte sa vitesse à la vitesse correspondante. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 16. Description détaillée de cas d’utilisation externe "Limiter\_Vitesse"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Retourner\_Vitesse\_Initiale** |
| **But** | Respecter les plaques de vitesses |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte une plaque de fin de limitation de vitesse. |
| **Post-conditions** | Le véhicule change la limitation de vitesse. |
| **Scénario nominal** | 1. Le véhicule détecte une plaque de fin de limitation de vitesse. 2. Le véhicule adapte la vitesse à la vitesse initiale. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 17. Description détaillée de cas d’utilisation externe "Retourner\_Vitesse\_Initiale"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Faire\_Stop** |
| **But** | Respecter les plaques de stops. |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte une plaque de stops. |
| **Post-conditions** | Le véhicule adapte sa vitesse. |
| **Scénario nominal** | 1. Le véhicule détecte une plaque de stop. 2. Le véhicule s'arrête 3 secondes. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 18. Description détaillée de cas d’utilisation externe "Faire\_Stop"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Faire\_plein** |
| **But** | Faire le plein |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le niveau de réservoir d'essence est inférieur ou égal à 20% ou si le niveau actuel ne permet pas d’atteindre l'endroit spécifié |
| **Post-conditions** | Faire le plein |
| **Scénario nominal** | 1. Le véhicule détecte que le niveau réservoir d'essence est inférieur ou égal à 20% ou bien le niveau actuel ne peut pas atteindre l'endroit spécifié. 2. Le véhicule se déplace vers cette station d'essence. 3. Le véhicule fait le plein 4. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 19. Description détaillée de cas d’utilisation externe "Faire\_plein"

## Étape 5 : La structuration des buts (Structuring goals)

Dans cette étape,nous allons structurer les différents buts qu’on a pu extraire des étapes précédentes. Le figures 3.1 présente le diagramme de buts de notre système.

1. Se\_Déplacer
   1. Prendre\_Droite
   2. Respecter\_Piéton
   3. Éviter\_Obstacle
   4. Respecter\_Feux\_De\_Circulation
   5. Limiter\_Vitesse.
   6. Retourner\_Vitesse\_Initiale.
   7. Faire\_Stop
   8. Faire\_plien

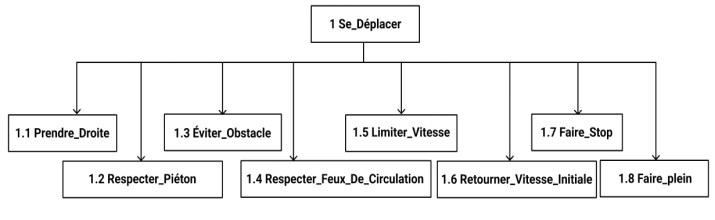


Figure 10. Diagramme des buts

## Étape 6 : La description de cas d’utilisation interne (Internals Use Cases)

Cette étape sert à exprimer les interactions entre les différentes composantes internes du système.

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Se\_Déplacer** |
| **But** | Aller à un endroit spécifié par le propriétaire. |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le propriétaire a donné l'ordre d'aller |
| **Post-conditions** | Le véhicule arrive à sa destination. |
| **Scénario nominal** | 1. Le propriétaire choisit l’endroit 2. Le propriétaire envoie au véhicule l’ordre d’aller vers l’endroit 3. Le véhicule calcule et trouve la liste des points pour arriver à sa destination (le chemin plus court) 4. Le véhicule se déplace à la destination en suivant l’ensemble des pointes choisies. |
| **Scénario alternatif** | Aucun |

Tableau 20. Description détaillée de cas d’utilisation interne "Se\_Déplacer"

|  |  |
| --- | --- |
| **Cas d’utilisation** | Prendre\_Droite |
| **But** | Prendre la côté droite |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le capteur doit détecter un véhicule |
| **Post-conditions** | Le véhicule va sur son côté droit. |
| **Scénario nominal** | 1. Le véhicule doit détecter une voiture. 2. Le véhicule va sur son côté droit. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 21. Description détaillée de cas d’utilisation interne "Prendre\_Droite"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Respecter\_Piéton** |
| **But** | S’arrêter jusqu'au le piéton traverse la route |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le capteur doit détecter un être humain |
| **Post-conditions** | Attendre le piéton traverse la route |
| **Scénario nominal** | 1. Le véhicule détecte un piéton. 2. Le véhicule s'arrête jusqu’à ce que le piéton traverse la route. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 22. Description détaillée de cas d’utilisation interne "Respecter\_Piéton"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Éviter\_Obstacle** |
| **But** | Evite les obstacles |
| **Acteurs** | Le véhicule autonome |
| **Pré-conditions** | Le véhicule détecte un obstacle |
| **Post-conditions** | Le véhicule évite les obstacle |
| **Scénario nominal** | 1. Le véhicule détecte un obstacle 2. Le véhicule s’arrête 3. Le véhicule calcule et trouve la liste des points pour arriver à sa destination. 4. Le véhicule évit l’obstacle en suivant l’ensemble des pointes choisies. 5. La voiture continue sa route |
| **Scénario alternatif** | Aucun |

Tableau 23. Description détaillée de cas d’utilisation interne "Éviter\_Obstacle"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Respecter\_Feux\_De\_Circulation** |
| **But** | Respecter les feux de circulation |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte un feu rouge. |
| **Post-conditions** | La voiture attend que le feu passe au vert. |
| **Scénario nominal** | 1. Le véhicule détecte un feu rouge 2. Le véhicule attend que le feu passe au vert. 3. Le véhicule continue sa route |
| **Scénario alternatif** | Aucun |

Tableau 24. Description détaillée de cas d’utilisation interne "Respecter\_Feux\_De\_Circulation"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Limiter\_Vitesse** |
| **But** | Respecter les plaques de vitesses |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte une plaque de vitesse. |
| **Post-conditions** | Le véhicule change de vitesse. |
| **Scénario nominal** | 1. Le véhicule détecte une plaque de vitesse. 2. Le véhicule lit le contenu de cette plaque. 3. Le véhicule change sa vitesse à la vitesse correspondante. 4. Le véhicule continue sa route |
| **Scénario alternatif** | Aucun |

Tableau 25. Description détaillée de cas d’utilisation interne "Limiter\_Vitesse"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Retourner\_Vitesse\_Initiale** |
| **But** | Respecter les plaques de vitesses |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte une plaque de fin de limitation de vitesse. |
| **Post-conditions** | Le véhicule change de vitesse. |
| **Scénario nominal** | 1. Le véhicule détecte une plaque de fin de limitation de vitesse. 2. Le véhicule adapte sa vitesse à la vitesse initiale. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 26. Description détaillée de cas d’utilisation interne "Retourner\_Vitesse\_Initiale"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Faire\_Stop** |
| **But** | Respecter les plaques de stops. |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le véhicule détecte une plaque de stops. |
| **Post-conditions** | Le véhicule adapte sa vitesse. |
| **Scénario nominal** | 1. Le véhicule détecte une plaque de stop. 2. Le véhicule s'arrête 3 secondes. 3. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 27. Description détaillée de cas d’utilisation interne "Faire\_Stop"

|  |  |
| --- | --- |
| **Cas d’utilisation** | **Faire\_plein** |
| **But** | Faire le plein |
| **Acteurs** | Le véhicule autonome. |
| **Pré-conditions** | Le niveau de réservoir d'essence est inférieur ou égal à 20% ou si le niveau actuel ne permet pas d’atteindre l'endroit spécifié |
| **Post-conditions** | Faire le plein |
| **Scénario nominal** | 1. Le véhicule détecte que le niveau réservoir d'essence est inférieur ou égal à 20% ou bien le niveau actuel ne peut pas atteindre l'endroit spécifié 2. Le véhicule détermine la station d’essence la plus proche. 3. Le véhicule se déplace vers cette station. 4. Le véhicule fait le plein 5. Le véhicule continue sa route. |
| **Scénario alternatif** | Aucun |

Tableau 28. Description détaillée de cas d’utilisation interne "Faire\_Plein"

## Étape 7 : Les diagrammes de séquences (Sequences Diagrams)

Cette étape a pour but de créer un diagramme de séquence qui illustre l'interaction entre les différents agents dans le système. Notre application ne dispose que d'un seul type de véhicule avec de multiples instances, et il n'y a aucune communication directe entre ces instances.  
Ainsi, il est inutile de spécifier ce type de diagramme.

## Étape 8 : Diagramme d’activité de l’agent (Agent Activity Diagrams)

Dans cette étape, nous présentons les diagrammes d'activité de tous les cas d'utilisation:

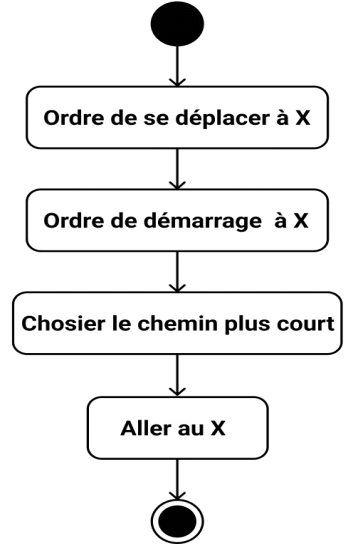


Figure 11. Diagramme d'activité d’agent pour le cas d’utilisation “Se\_Déplacer”

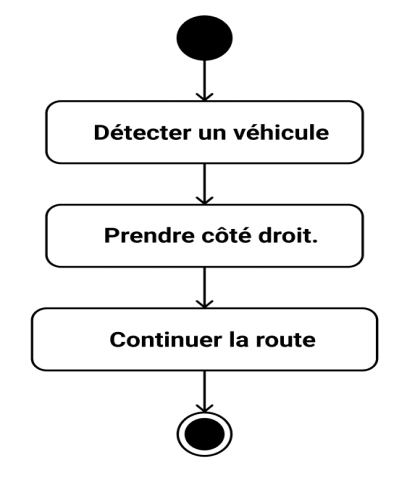


Figure 12. Diagramme d'activité d’agent pour le cas d’utilisation “Prendre\_Droite”

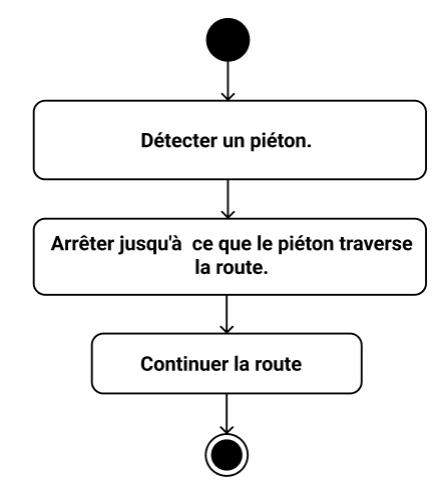


Figure 13. Diagramme d'activité d’agent pour le cas d’utilisation “Respecter\_Piéton”

|  |
| --- |
|  |
|  |  |

Figure 14. Diagramme d'activité d’agent pour le cas d’utilisation “Éviter\_Obstacle”

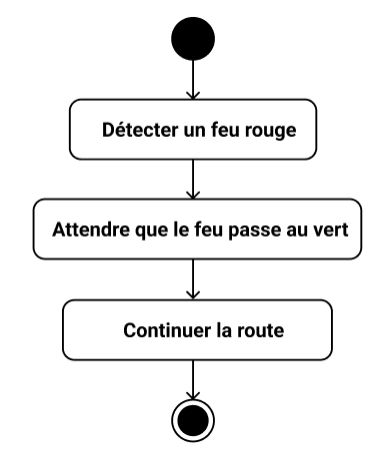


Figure 15. Diagramme d'activité d’agent pour le cas d’utilisation “Respecter\_Feux\_De\_Circulation”

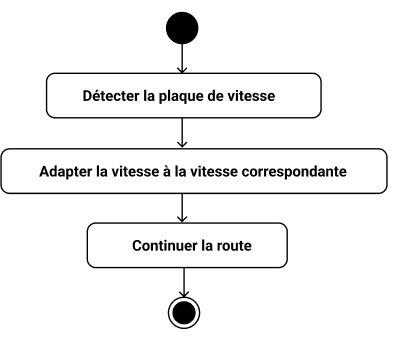


Figure 16. Diagramme d'activité d’agent pour le cas d’utilisation “Limiter\_Vitesse”

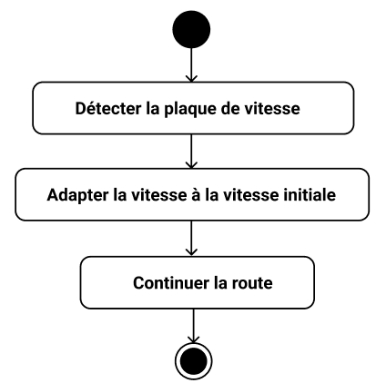


Figure 17. Diagramme d'activité d’agent pour le cas d’utilisation “Retourner\_Vitesse\_Initiale”

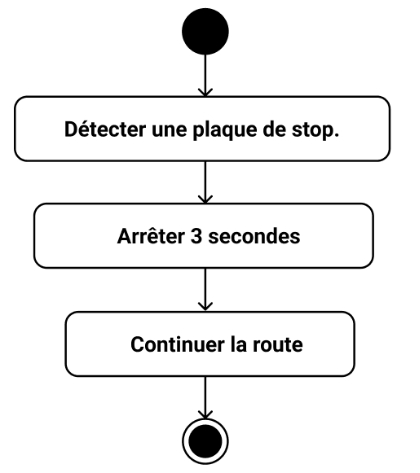


Figure 18. Diagramme d'activité d’agent pour le cas d’utilisation “Faire\_Stop”

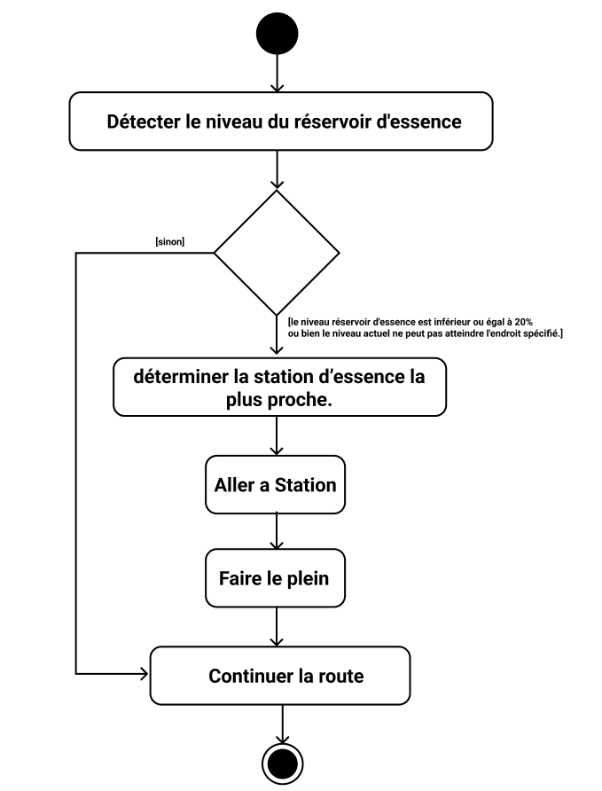


Figure 19. Diagramme d'activité d’agent pour le cas d’utilisation “Faire\_plein”

## Étape 9 : La liste de croyances de l’agent (Agent belief List)

Les figures ci-dessous représentent le diagramme de flux de données du cas "Se\_Déplacer" et un autre général parce que tous les autres cas réellement communiqués avec le cas "Déplacer.

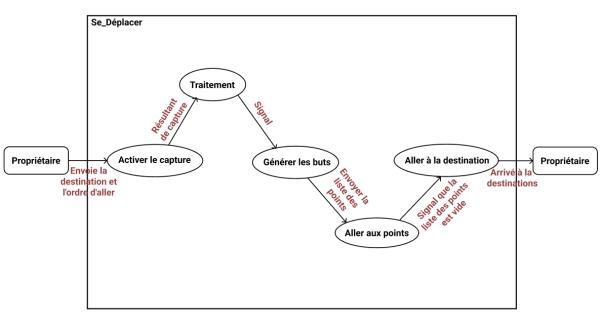


Figure 20. Diagramme de flux de données pour le cas d’utilisation “Se\_Déplacer”

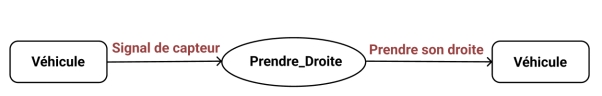


Figure 21. Diagramme de flux de données pour le cas d’utilisation “Prendre\_Droite”



Figure 22. Diagramme de flux de données pour le cas d’utilisation “Respecter\_Piéton”

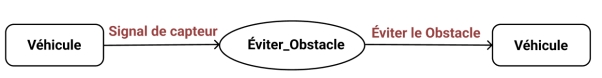


Figure 23. Diagramme de flux de données pour le cas d’utilisation “Éviter\_Obstacle”



Figure 24. Diagramme de flux de données pour le cas d’utilisation “Respecter\_Feux\_De\_Circulation”



Figure 25. Diagramme de flux de données pour le cas d’utilisation “Limiter\_Vitesse ”



Figure 26. Diagramme de flux de données pour le cas d’utilisation “Retourner\_Vitesse\_Initiale”



Figure 27. Diagramme de flux de données pour le cas d’utilisation “Faire\_Stop”



Figure 28. Diagramme de flux de données pour le cas d’utilisation “Faire\_plein”

À partir de ces diagrammes, nous avons extrait les croyants ci-dessous que notre agent utilisé pour former ses interactions :

* Le point de l’endroit
* La liste des points pour arriver à l’endroit
* La carte
* La liste des obstacles
* La vitesse de voiture
* Le volume d’essence

## Étape 10 : Cartes d’agent BDI (BDI Agent Cards)

Enfin, nous avons mis au point notre diagramme de classe d'agent d'application :

|  |
| --- |
| BDI |
| Se\_Déplacer  Prendre\_Droite  Respecter\_Piéton  Éviter\_Obstacle  Respecter\_Feux\_De\_Circulation  Limiter\_Vitesse.  Delimiter\_vitesse.  Faire\_Stop  Faire\_plein |
| * Le point de l’endroit * La liste des points pour arriver à l’endroit * La résultant d'observations * La liste des obstacles * La vitesse de voiture * Le volume d’essence |
| * Arrivé à la destination () * Prendre\_Droite() * Respecter\_Piéton() * Éviter\_Obstacle() * Respecter\_Feux\_De\_Circulation() * Limiter\_Vitesse() * Retourner\_Vitesse\_Initiale() * Faire\_Stop() * Faire\_plein() |

Tableau 29. Diagramme de class de l’agent BDI

# Implémentation

Dans cette section, nous allons décrire dans un premier temps l'environnement logiciel utilisé par les développeurs de notre application, donner quelques précisions sur l'implémentation et finalement introduire l'interface graphique de l'application.



## Environnement logiciel

Nous avons développé notre projet à l'aide d’un ensemble d'outils afin de faciliter l'implémentation des systèmes multi-agents BDI.

### Java (Version 11.0.2)

“Java est un langage de programmation ainsi qu'une plateforme informatique créée par Sun Microsystems en 1995.Beaucoup d'applications et de sites Web ne fonctionnent pas sans Java installé et leur nombre augmente de jour en jour.Java est rapide, sécurisé et fiable. Des ordinateurs portables aux centres de données, des consoles de jeux aux supercalculateurs scientifiques, des téléphones portables à Internet, la technologie Java est omniprésente !

Lorsque vous téléchargez le logiciel Java, vous pouvez accéder à JRE (Java Runtime Environment).Cet environnement se compose de la machine virtuelle Java (JVM), des classes de plate-forme Java standard et des bibliothèques Java prises en charge.L'environnement JRE correspond à la partie courante du logiciel Java et vous permet de le faire fonctionner dans votre navigateur web.” [14]

### Javafx (Version 18 )

“Javafx est une plate-forme d'application client open source de nouvelle génération pour les systèmes de bureau, mobiles et embarqués construits en Java.

Il s'agit d'un effort collaboratif entre de nombreuses personnes et sociétés pour produire une boîte à outils moderne, efficace et globale pour le développement d'applications client riches.” [15]

### IntelliJ IDEA Ultimate (Version 2022.1.2 )

IntelliJ IDEA est un IDE intelligent et contextuel pour fonctionner avec Java et d'autres langages JVM tels que Kotlin, Scala et Groovy sur toutes sortes d'applications.

De plus, IntelliJ IDEA Ultimate peut vous aider à développer des applications Web complètes, grâce à ses puissants outils intégrés, à la prise en charge de JavaScript et des technologies associées, et à la prise en charge avancée des frameworks populaires tels que Spring, Spring Boot, Jakarta EE, Micronaut, Quarkus, Helidon. De plus, vous pouvez étendre IntelliJ IDEA avec des plugins gratuits développés par JetBrains, vous permettant de travailler avec d'autres langages de programmation, notamment Go, Python, SQL, Ruby et PHP. [16]

### Screen Builder (Version 18.0.0)

Scene Builder fonctionne avec l'écosystème JavaFX - contrôles officiels, projets communautaires et offres Gluon, notamment Gluon Mobile, Gluon Desktop et Gluon CloudLink.

La conception de l'interface utilisateur coulissante permet une itération rapide.Séparer le design et les fichiers logiques permet aux membres de l'équipe de se concentrer rapidement et facilement sur leur couche de développement d'application spécifique.

Scene Builder est gratuite et open source, mais est soutenue par gluon. Des offres d'assistance commerciale sont disponibles, y compris des services de formation et de conseil personnalisés. [17]

### Git (version 2.36.1)

“Git est un logiciel de versionning créé en 2005 par Linus Torvalds, le créateur de Linux.

Un logiciel de versioning, ou logiciel de gestion de version, est un logiciel qui permet de conserver un historique des modifications effectuées sur un projet afin de pouvoir rapidement identifier les changements effectués et de revenir à une ancienne version en cas de problème.

Les logiciels de gestion de versions sont quasiment incontournables aujourd’hui car ils facilitent grandement la gestion de projets et car ils permettent de travailler en équipe de manière beaucoup plus efficace.

Parmi les logiciels de gestion de versions, Git est le leader incontesté et il est donc indispensable pour tout développeur de savoir utiliser Git.” [18]

### Github

“GitHub est un service en ligne d’hébergement de dépôts Git qui fait office de serveur central pour ces dépôts.” [18]

### Microsoft word (Version 2010)

“Microsoft Office 2010 est une version de la suite bureautique [Microsoft Office](https://fr.wikipedia.org/wiki/Microsoft_Office), développée et éditée par Microsoft. Sortie en juin 2010, elle succède à [Office 2007](https://fr.wikipedia.org/wiki/Office_2007) et précède [Office 2013](https://fr.wikipedia.org/wiki/Microsoft_Office_2013).

Office 2010 est la première version de Microsoft Office à proposer des versions en ligne et gratuites ([Office Web Apps](https://fr.wikipedia.org/wiki/Office_Web_Apps)) de [Word](https://fr.wikipedia.org/wiki/Microsoft_Word), [Excel](https://fr.wikipedia.org/wiki/Excel), [PowerPoint](https://fr.wikipedia.org/wiki/PowerPoint) et [OneNote](https://fr.wikipedia.org/wiki/OneNote), disponibles sur la plupart des [navigateurs](https://fr.wikipedia.org/wiki/Navigateur_web) actuels : [Internet Explorer](https://fr.wikipedia.org/wiki/Internet_Explorer), [Firefox](https://fr.wikipedia.org/wiki/Firefox), [Chrome](https://fr.wikipedia.org/wiki/Google_Chrome) et [Safari](https://fr.wikipedia.org/wiki/Safari_(logiciel)).

Au [31](https://fr.wikipedia.org/wiki/31_d%C3%A9cembre) [décembre](https://fr.wikipedia.org/wiki/D%C3%A9cembre_2011) [2011](https://fr.wikipedia.org/wiki/2011), près de 200 millions de licences d'Office 2010 ont déjà été vendues.” [19]

### Figma

“Figma est une plateforme collaborative pour éditer des graphiques vectoriels et faire du prototypage. Elle permet de concevoir des design systèmes pour faciliter la création de sites web et d’applications mobiles. C’est une solution à destination des UI et UX designers et des développeurs. L’interface propose de nombreuses fonctionnalités :

* **De design :** avec des outils de conception pour le web, des fonctions de mise en page automatique, des plugins pour réduire les tâches répétitives.
* **De prototypage :** pour tester les concepts très tôt en cours de design.
* **De design system :** pour concevoir des designs cohérents avec des bibliothèques mises à jour en permanence.
* **Collaboratives :** pour travailler à plusieurs et en même temps sur un projet, revenir sur une version antérieure si nécessaire ou encore afficher le travail d’un seul collaborateur par exemple.” [20]

### PNGRepo

Site contient de nombreuses images PNG à télécharger gratuitement. [21]

## Environnement matériel

Pour la réalisation de ce projet nous avons deux PC:

|  |  |
| --- | --- |
| **Caractéristiques** | **Valeurs** |
| **Système d’exploitation** | Windows 10 professional |
| **Disque Dur** | 500 GO |
| **Fréquence de processeur** | Intel Core i7-2820QM |
| **Mémoire vivre** | 8GB |
| **Carte graphique** | NVIDIA Quadro 2000M - 2048 Mo |

Tableau 30. Caractéristiques de 1er Machine

|  |  |
| --- | --- |
| **Caractéristiques** | **Valeurs** |
| **Système d’exploitation** | Windows 10 Home |
| **Disque Dur** | 1 TO |
| **Fréquence de processeur** | Intel Core i5-6200U |
| **Mémoire vivre** | 8GB |
| **Carte graphique** | AMD Radeon R5 M335 - 2048 Mo |

Tableau 31. Caractéristiques de 2eme Machine

## Quelques détails sur l'implémentation

Dans cette section, nous présenterons quelques détails de notre implémentation.

### Buts (les désirs et les intentions)

Nous avons un seul but qui est "se\_deplacer ", mais durant le déplacement le véhicule peut générer d'autres sous-buts.Tous ces objectifs sont des désirs, mais l'objectif que le véhicule autonome tente d'atteindre devient une intention.

### Plans

Nous avons choisi des classes pour implémenter les plans, chaque plan doit être hérité de la classe abstraite **Plan** qui contient un attribut **condition** et un méthode abstraite **body**. L'attribut **condition** représente la pré-condition pour déclencher la méthode **body.** Chaque classe doit redéfinir la méthode **body** pour avoir un plan spécialisé. Ce principe est inspiré par de JadeX [22], voici quelques codes de l’implantation. La code source de classe Plan:

**public abstract class Plan {**

**public boolean condition;**

**public abstract void body();**

**public void setCondition(boolean condition) {**

**this.condition = condition;**

**this.body();**

**this.condition = false;**

**}**

**}**

Dans notre application il y a 8 plans, nous proposons seulement 2 plans et les autres ont le même principe. Le code source de le plan “Faire\_Plein”:

**public class FuelStationPlan extends Plan {**

**private BDI agent;**

**@Override**

**public void body(){**

**if(condition){**

**int fuelRemaining = agent.petrolTank;**

**double distanceToDisere = Math.*abs*(agent.getPhysical().getLayoutX()-agent.getDesires().getX())**

**+Math.*abs*(agent.getPhysical().getLayoutY()-agent.getDesires().getY());**

**if(fuelRemaining>distanceToDisere){**

**if((fuelRemaining-distanceToDisere)>(Constants.*CAR\_MAX\_PETROL\_TANK*\*20/100)){**

**return;**

**}**

**}**

**ArrayList<Circle> list = agent.getContext().feulStations();**

**for(Circle p : list){**

**double distanceBetweenCarAndStation = Math.*abs*(agent.getPhysical().getLayoutX()-p.getLayoutX())**

**+Math.*abs*(agent.getPhysical().getLayoutY()-p.getLayoutY());**

**if(agent.getFuelStation()==null){**

**agent.setFuelStation(new Point(p.getLayoutX(),p.getLayoutY()));**

**}**

**else{**

**double distanceBetweenCarAndSavedStation = Math.*abs*(agent.getPhysical().getLayoutX()-agent.getFuelStation().getX())**

**+Math.*abs*(agent.getPhysical().getLayoutY()-agent.getFuelStation().getY());**

**if(distanceBetweenCarAndStation<distanceBetweenCarAndSavedStation){**

**agent.setFuelStation(new Point(p.getLayoutX(),p.getLayoutY()));**

**}**

**}**

**}**

**if(agent.getFuelStation()!=null){**

**agent.setDirectionToFuelStation(true);**

**BasisAlgorithm.*addPointToList*(agent.getContext(), agent.getPhysical(),agent.getPlanPath(),agent.getFuelStation());**

**}**

**}**

**}**

**public FuelStationPlan(BDI agent){**

**this.condition=false;**

**this.agent=agent;**

**}**

**}**

Le code source de le plan “Respecter\_Feux\_De\_Circulation”:

**public class RedLightFoundPlan extends Plan {**

**private MapController context;**

**private Circle vcar;**

**private LightSensor lightSensor;**

**@Override**

**public void body(){**

**if(condition){**

**Boolean stoped = false;**

**Rectangle passageLight = Check.*checkingLight*(context,vcar);**

**if(passageLight != null) {**

**int passageLightNumber = Integer.*parseInt*(Transformation.*stripNonDigits*(passageLight.getId()));**

**while(context.getFeuxById(passageLightNumber).getColor().equals("RED")){**

**stoped = true;**

**}**

**if(stoped){**

**lightSensor.foundLight = true;**

**}**

**}**

**}**

**}**

**public RedLightFoundPlan(MapController context,Circle vcar,LightSensor lightSensor){**

**this.condition=false;**

**this.context=context;**

**this.vcar = vcar;**

**this.lightSensor=lightSensor;**

**}**

**}**

### Liste des croyances

Nous avons utilisé des structures de données complexes ainsi que des types primitifs pour implémenter notre liste de croyances, voici le code concernant:

**private Point destination;**

**private ArrayList<Point> planPath;**

**private MapController context;**

**private HashMap<String,Plan> plans;**

**private int petrolTank;**

**private LinkedList<Rectangle> knownObstacles;**

Maintenant, nous allons faire une description de cette liste de croyances.

* **destination**: Point auquel le propriétaire peut aller.
* **planPath**: Ensemble des points pour faciliter l'arrivée à désirs, ils sont générés par algorithme (La description de cet algorithme dans la partie les modules principaux ).
* **Context** : Représente l’environnements externe (la carte incluse dans cette croyance).
* **plans**: HashMap qui contient l'ensemble des plans.
* **petrolTank**: Cette variable correspond au volume d'essence du véhicule.
* **knownObstacles**: Chaque fois que le véhicule détecte un obstacle, il l'ajoute à cette liste pour savoir qui connaît tous les obstacles qui ont déjà été aperçus sur la route pour éviter ces routes.

### Modules principaux

Pour rendre notre véhicule intelligent, il doit toujours penser comme un être humain, et de ce point de vue, nous l'avons fait la boucle de raisonnement comme cela :

**public void run(){**

**while(true){**

**System.out.print("");**

**if(hasNewDesires){**

**String observation = observation();**

**deliberation(observation);**

**genererLesButs();**

**realiserLesIntentions();**

**hasNewDesires = false;**

**}**

**}**

* **observation():**La méthode nécessaire pour surveiller l'environnement, et le résultat est fournie à la méthode de délibération,et voilà le code:

**public String observation(){**

**this.plans = addAllPlans(vcar);**

**Boolean isInCollision = false;**

**if(this==context.agent){**

**isInCollision = context.checkCollision(this.physical,context.agentNotSelected.physical);**

**}**

**else if(this == context.agentNotSelected){**

**isInCollision = context.checkCollision(this.physical,context.agent.physical);**

**}**

**if(isInCollision){**

**return "CAR\_FOUND";**

**}**

**Walkway walkway = Check.*checkingWalkways*(context,physical);**

**if(walkway !=null && walkway.getOccupied()){**

**return "WALKWAY";**

**}**

**Rectangle obstacle = Check.*checkingObstacle*(context,vcar);**

**if(obstacle != null) {**

**knownObstacles.add(obstacle);**

**return "Obstacle";**

**}**

**if(!sensor.foundLight){**

**Rectangle passageLight = Check.*checkingLight*(context,vcar);**

**if(passageLight != null) {**

**int passageLightNumber = Integer.*parseInt*(Transformation.*stripNonDigits*(passageLight.getId()));**

**if(context.getFeuxById(passageLightNumber).getColor().equals("RED")){**

**return "RED\_LIGHT";**

**}**

**else{**

**this.sensor.foundLight = true;**

**}**

**}**

**}**

**Rectangle plaque = Check.*checkingSpeedPlaques*(context,this.getPhysical());**

**if(plaque !=null){**

**return "PLAQUE";**

**}**

**else {**

**this.speed=1;**

**}**

**if(!stopSensor.foundPlaque){**

**Rectangle stop = Check.*checkingStopPlaques*(context,this.getPhysical());**

**if(stop !=null){**

**this.stopSensor.foundPlaque = true;**

**return "STOP";**

**}**

**}**

**if(this.directionToFuelStation == false){**

**return "FUEL\_STATION";**

**}**

**return "Empty";**

**}**

* **deliberation(String observation):**La méthode nécessaire pour déclencher le plan correspondant au résultat d'observation,et voilà le code:

**public void deliberation(String observation){**

**if(!observation.equals("Empty"))**

**plans.get(observation).setCondition(true);**

**}**

* **genererLesButs():** La méthode nécessaire à la génération des points pour permettre à notre véhicule d'arriver à sa destination, et c'est le code:

**public void genererLesButs(){**

**BasisAlgorithm.*addPointsToList*(context,physical,planPath,desires);**

**}**

* **realiserLesIntentions():** La méthode nécessaire pour permettre à notre véhicule d'arriver à sa destination en fonction des résultats de l'étape précédente, et c'est le code:

**public void realiserLesIntentions(){**

**if(this.getDirectionToFuelStation()){**

**goToStation();**

**this.setDirectionToFuelStation(false);**

**while (this.petrolTank<= Constants.*CAR\_MAX\_PETROL\_TANK*){**

**try {**

**this.*sleep*(Constants.*TIME\_TO\_ADD\_ONE\_UNIT\_OF\_FUEL*);**

**} catch (InterruptedException e) {**

**e.printStackTrace();**

**}**

**this.petrolTank += 1;**

**if(!forGenerateDesiredAuto)**

**Message.*UIPetrolThread*(getContext(),petrolTank);**

**}**

**BasisAlgorithm.*addPointToList*(this.getContext(), this.getPhysical(),this.getPlanPath(),this.getDesires());**

**doMove();**

**}**

**else{**

**doMove();**

**}**

**}**

A partir de ce code, nous voyons doMove(), cette méthode permet au véhicule de se déplacer à des points de la liste, Nous démontrons également son code et les méthodes importantes.

**private synchronized void doMove(){**

**List list = Collections.*synchronizedList*(planPath);**

**synchronized (list) {**

**Iterator i = list.iterator();**

**while (i.hasNext()){**

**try{**

**Movement.*goToPoint*(this,(Point) i.next(),vcar);**

**}**

**catch (Exception e){**

**BasisAlgorithm.*addPointsToList*(context,physical,planPath,desires);**

**}**

**}**

**}**

**planPath.clear();**

**Movement.*goToPoint*(this,desires,vcar);**

**}**

En général, L’algorithme suivant prend les points d'intersection les plus proches du point courant du véhicule et de la destination.

**public static void addPointsToList(MapController context,Circle physical, ArrayList<Point> planPath,Point desires){**

**planPath.clear();**

**Point physicalPoint = new Point(physical.getLayoutX(),physical.getLayoutY());**

**Point p1Top = Movement.*doMoveInYTop*(context,physicalPoint);**

**Point p1Bottom = Movement.*doMoveInYButtom*(context,physicalPoint);**

**Point p1Left = Movement.*doMoveInXLeft*(context,physicalPoint);**

**Point p1Right = Movement.*doMoveInXRight*(context,physicalPoint);**

**if(p1Top!=null && p1Bottom==null && p1Left==null && p1Right==null){**

**planPath.add(p1Top);**

**}**

**if(p1Top==null && p1Bottom!=null && p1Left==null && p1Right==null){**

**planPath.add(p1Bottom);**

**}**

**if(p1Top==null && p1Bottom==null && p1Left!=null && p1Right==null){**

**planPath.add(p1Left);**

**}**

**if(p1Top==null && p1Bottom==null && p1Left==null && p1Right!=null){**

**planPath.add(p1Right);**

**}**

**if(p1Top!=null && p1Bottom!=null){**

**if(Math.*abs*(desires.getY()- p1Top.getY())<Math.*abs*(desires.getY()- p1Bottom.getY())){**

**planPath.add(p1Top);**

**}**

**else{**

**planPath.add(p1Bottom);**

**}**

**}**

**else{**

**if(p1Left!=null && p1Right!=null){**

**if(Math.*abs*(desires.getX()- p1Left.getX())<Math.*abs*(desires.getX()- p1Right.getX())){**

**planPath.add(p1Left);**

**}**

**else{**

**planPath.add(p1Right);**

**}**

**}**

**}**

**Point p2Top = Movement.*doMoveInYTop*(context,desires);**

**Point p2Bottom = Movement.*doMoveInYButtom*(context,desires);**

**Point p2Left = Movement.*doMoveInXLeft*(context,desires);**

**Point p2Right = Movement.*doMoveInXRight*(context,desires);**

**if(p2Top!=null && p2Bottom==null && p2Left==null && p2Right==null){**

**planPath.add(p2Top);**

**}**

**if(p2Top==null && p2Bottom!=null && p2Left==null && p2Right==null){**

**planPath.add(p2Bottom);**

**}**

**if(p2Top==null && p2Bottom==null && p2Left!=null && p2Right==null){**

**planPath.add(p2Left);**

**}**

**if(p2Top==null && p2Bottom==null && p2Left==null && p2Right!=null){**

**planPath.add(p2Right);**

**}**

**if(p2Top!=null && p2Bottom!=null){**

**if(Math.*abs*(physicalPoint.getY()- p2Top.getY())<Math.*abs*(physicalPoint.getY()- p2Bottom.getY())){**

**planPath.add(p2Top);**

**}**

**else{**

**planPath.add(p2Bottom);**

**}**

**}**

**else{**

**if(p2Left!=null && p2Right!=null){**

**if(Math.*abs*(physicalPoint.getX()- p2Left.getX())<Math.*abs*(physicalPoint.getX()- p2Right.getX())){**

**planPath.add(p2Left);**

**}**

**else{**

**planPath.add(p2Right);**

**}**

**}**

**}**

**}**

En général, l'algorithme ci-dessous amène le véhicule au point souhaité.

**public static void goToPoint(BDI agent, Point point,Circle vcar){**

**while (agent.getPhysical().getLayoutX()!=point.getX() || agent.getPhysical().getLayoutY()!=point.getY() ){**

**if(agent.getStartMoveValue()){**

**Movement.*moveXThanY*(agent,vcar,point);**

**}**

**else{**

**Movement.*moveYThanX*(agent,vcar,point);**

**}**

**agent.setPetrolTank(agent.getPetrolTank()-1);**

**if(!agent.getForGenerateDesiredAuto()){**

**Message.*UIPetrolThread*(agent.getContext(),agent.getPetrolTank());**

**Message.*UISpeedThread*(agent.getContext(),agent.speed);**

**}**

**String observation = agent.observation();**

**agent.deliberation(observation);**

**try {**

**agent.*sleep*((int) agent.speed\*2);**

**} catch (InterruptedException e) {**

**e.printStackTrace();**

**}**

**}**

**}**

### Threads utilisés

Nous implémentons les concepts de l’agent BDI et quelques détails techniques ont utilisé les threads.

Dans cette section, nous montrons tous les threads existent dans notre application :

* **BDI:** Notre agent représente le véhicule.
* **LightSensor**: le capteur des feux de circulation.
* **StopSensor**:le capteur de plaques des stops.
* **DesiredChanger**: Pour changer les buts des autres véhicules, il représente le propriétaire de ce véhicule.
* **FeuxManager**:Pour synchroniser les feux de circulation.
* **HumanManager**:Pour la syncronisation d'êtres humains.

## Présentation de l’interface graphique

Dans cette partie, nous allons introduire l'interface graphique avec une description complète.

### Description de l’interface



Figure 29. Interface graphique de l'application

Cette interface est composée de 2 parties.

La partie supérieure en vert présente la simulation.

La partie inférieure de la couleur noire représente la barre de commande.

### Partie supérieure

La partie supérieure contient plusieurs choses, dans cette section nous décrivons ses éléments.

* La couleur noire représente les routes et les intersections.
* La couleur verte correspond aux espaces verts ou aux endroits où le propriétaire pouvait aller.
* Les points en jaune sont les places de la destination et chaque point à sa propre image et texte de description.
* Le point en rouge est le véhicule qui vous contrôle.
* Le point vert est un véhicule autonome représentant d'autres véhicules en circulation.
* Les points violets représentent des êtres humains qui coupent la route dans un piéton ou directement.
* Le rectangle en jaune représente un obstacle.
* Il y a aussi les plaques de vitesse et les plaques d'arrêt.
* Il y a également des feux de circulation.

### Partie inférieure

La partie inférieure contient trois sections, dans la présente section, nous en décrivons les composantes.

* La première section, sur la gauche, est la clé de simulation pour mieux comprendre les principaux éléments sans la lecture de la documentation.
* La deuxième section, au centre, comprend deux boutons et une liste de sélection:
  + **Start:** pour démarrer le véhicule.
  + **Create obstacle:** pour ajouter des obstacles à la simulation.
  + **La liste de choix :** pour choisir le lieu où vous pouvez aller.
* La troisième section, sur la droite, contient la vitesse du véhicule ainsi que le volume du réservoir d'essence.

## Conclusion

Ce chapitre a été consacré à la phase d'analyse, de conception et de mise en œuvre de notre application. Nous avons présenté les différents résultats de ces étapes, les outils logiciels utilisés ainsi qu'un bref aperçu sur l'interface graphique.

# *Conclusion générale et perspective*

Le domaine des véhicules autonomes est un domaine très actif et en plein effervescence vu son importance et son utilité pour l’amélioration de la qualité de vie des humains. En plus, les véhicules autonomes vont permettre de diminuer les catastrophes et les accidents sur les routes. Le concept d’agent est l’une des abstractions les plus utilisés pour concevoir des systèmes autonomes. Ainsi, plusieurs travaux et expérimentations ont utilisé ce paradigme pour concevoir la partie logiciel contrôlant le véhicule et rendant ainsi ce dernier plus ou moins autonome.

Dans notre travail, nous avons pu réaliser et développer une simulation simple d’un véhicule autonome, en exploitant et utilisant les agents et en particulier le modèle BDI, à travers ses trois composantes de base : croyances, désirs et intentions.

La réalisation de ce projet était pour nous une opportunité pour comprendre et maîtriser certains concepts de base des véhicules autonomes et du domaine des agents.

En ce qui concerne le problème très connu rencontré lors du développement des systèmes à base d’agents, qui est le fossé entre la phase de modélisation (analyse et conception) du système et celle de son implémentation, nous avons essayé de faire notre possible pour réduire cet écart en donnant une représentation proche des concepts de modélisation, même lorsque nous utilisons un langage orienté objet comme Java.

Nous avons des perspectives à court et à long terme pour perfectionner notre travail :

**Court terme**

* Correction de quelques problèmes.
* Améliorer l’interface et l’enrichir.

**Long terme**

* Faire une extension de la simulation en 3D.
* Ajouter d’autres cas pour une expérience optimale.

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