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## Estimation of the Seismic Risk of a small City in Switzerland

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### Seismic risk in Switzerland has long been ignored

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- Switzerland is in a region of “rare but catastrophic” seismic events
- Recent realization that earthquakes constitute the number one natural risk in Switzerland

E.G.: a modern repeat of the “1356 Basle earthquake” would cause direct losses of several dozen billion Euros

De terræmotibus Basileæ factis



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## Objectives and goals

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The rational and effective management of our seismic risk starts with its quantification

*“You can not manage what you can not quantify“  
(D. Packard)*

1. The objective of the pilot study is to estimate the seismic risk of a small City
2. To develop a framework to compare Seismic Risk Management Strategies

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## Pilot Study - City of Aigle -

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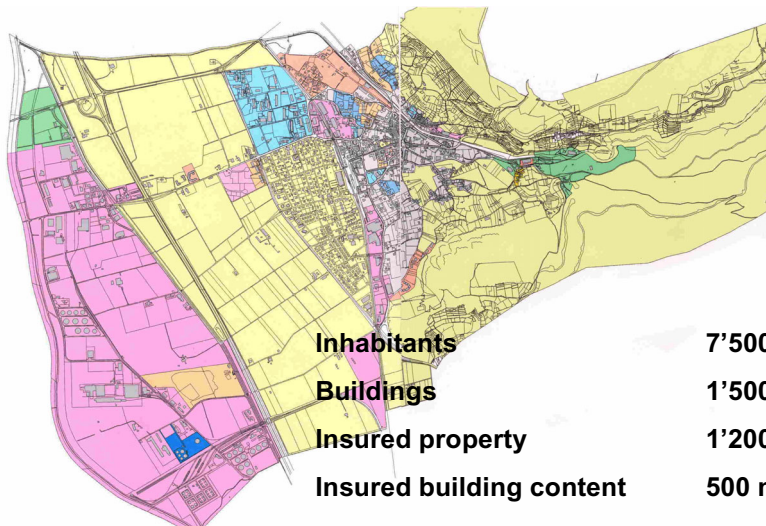
## The City of Aigle was selected for the study



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## Aigle is a typical small Swiss city



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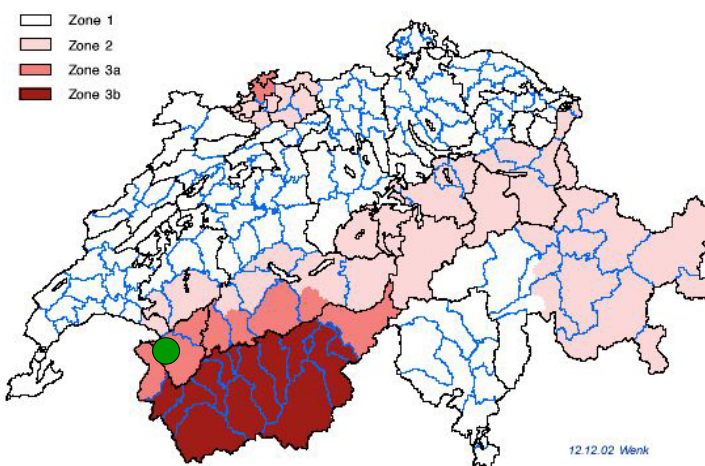
## Aigle's building stock is diverse



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## Aigle is situated in a region of middle seismicity



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## In Aigle, destructive earthquakes are rare ... but unavoidable

### ◆ Macro-seismicity

MSK Intensity	Approximate Return period [years]
VII	500
VIII	2'200
IX	6'000

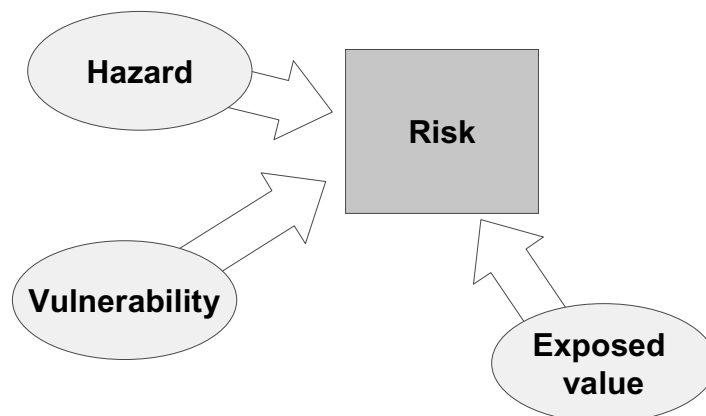
### ◆ Micro-seismicity

- Site effects are currently under investigation

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$$\text{Risk} = \text{Hazard} \times \text{Vulnerability} \times \text{Value}$$



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## Three types of “exposed values” were considered

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### ◆ Estimated losses

- Human life
  - » Deaths and injuries
- Property
  - » ECA insured value
- Building content
  - » ECA insured value

### ◆ Losses not considered

- Business interruption
- Environmental losses
- Historical and cultural losses
- ....

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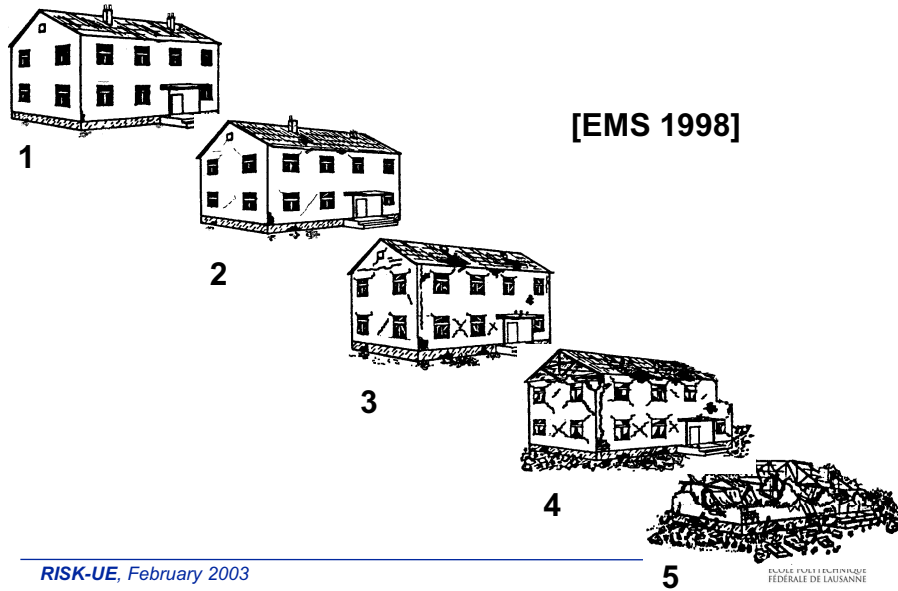
## Seismic vulnerability of Aigle’s building stock

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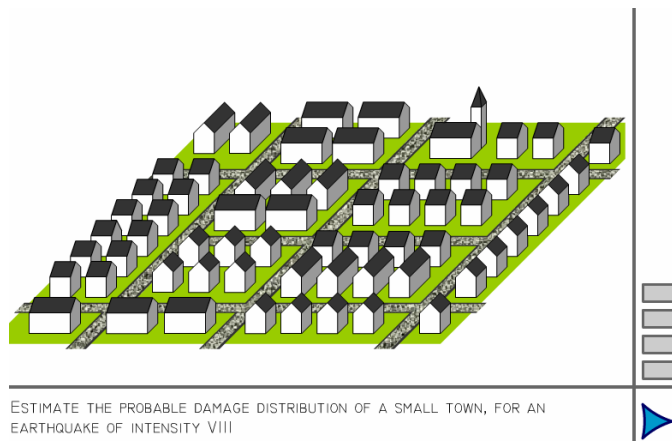
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## EMS defines 5 degrees of damage



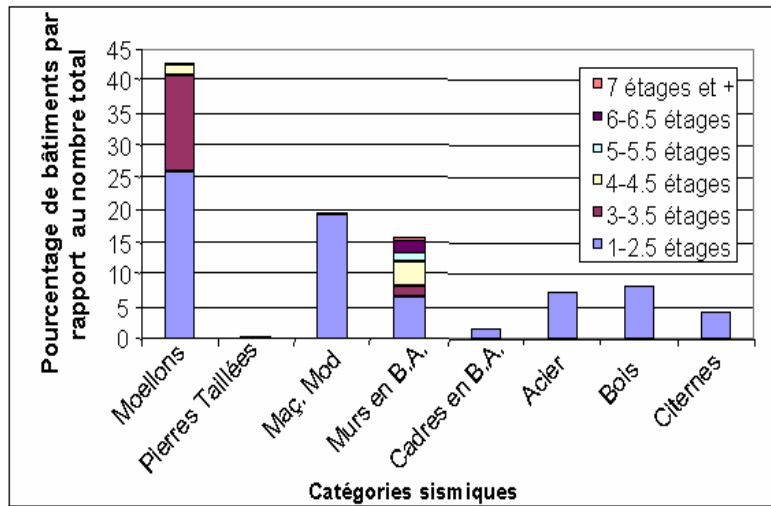
## Aigle's seismic vulnerability was evaluated on the basis of a seismic inventory



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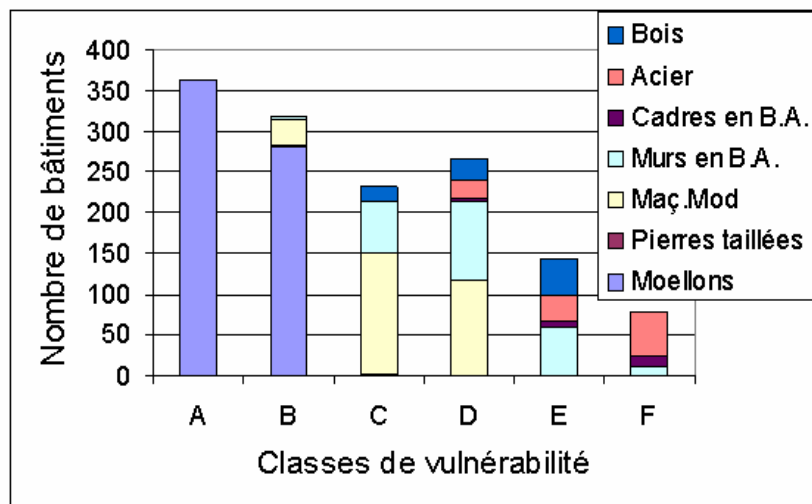
## First, Aigle's buildings were classified in seismic categories



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## Then, they were distributed in six vulnerability classes

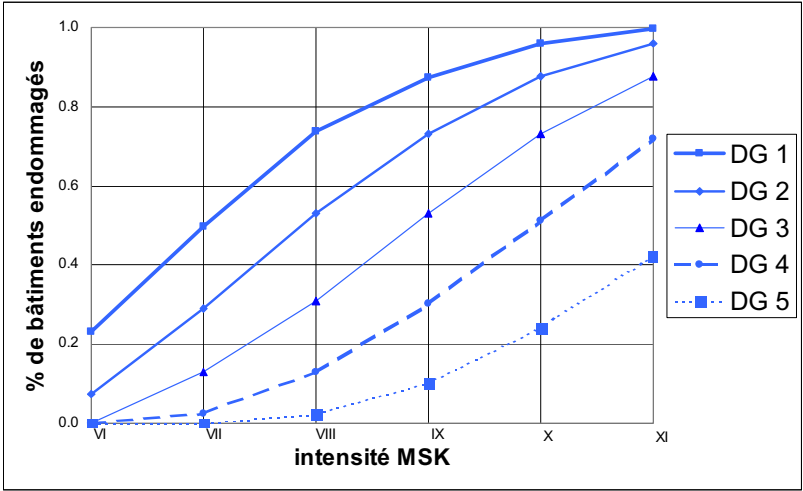


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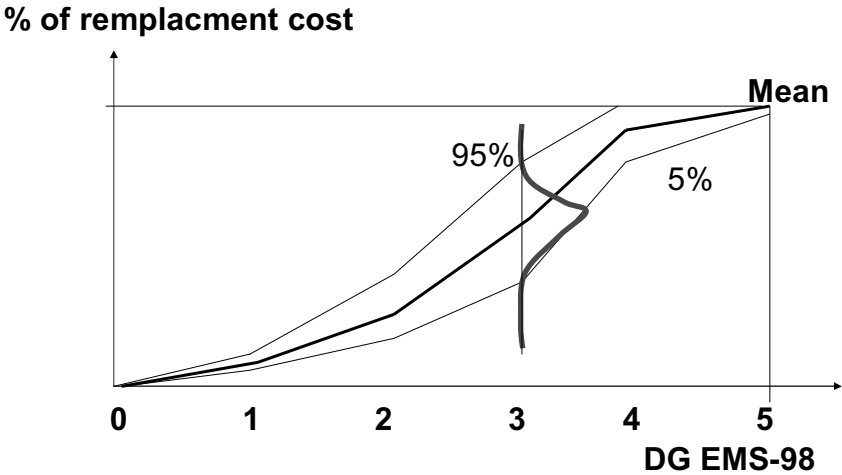
## Global vulnerability curves were obtained



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## Specific damage curves were built for each considered values



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## Four “loss of life” scenarios were studied

Scenarios (MSK Intensity)	Deaths	Heavy injuries	Light injuries
<b>VII</b> [475 yrs.]	[0–4–7]	[4–7–17]	[22–54–72]
<b>VIII</b> [2'200 yrs.]	[12–17–22]	[15–254–71]	[60–74–87]
<b>IX</b> [6'000 yrs.]	[25–54–72]	[53–114–131]	[102 – 183 – 238]
<b>Maximum possible loss</b>	280		

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## Four “property losses” scenarios were studied

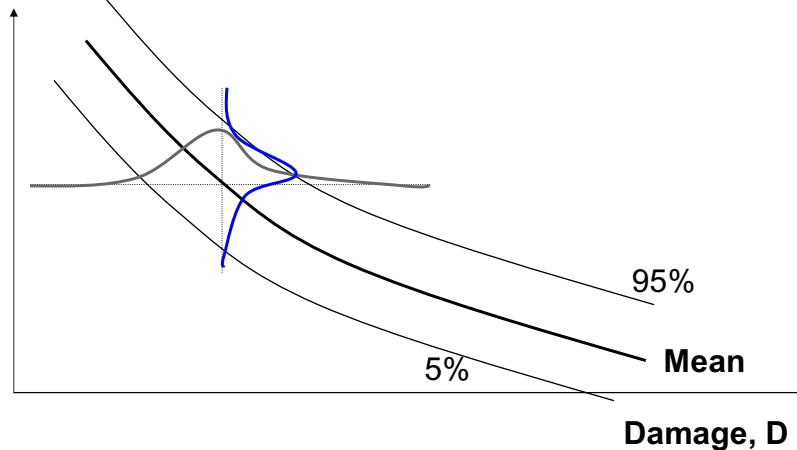
Scenarios (MSK Intensity)	Property losses [mio. €]	Building content losses [mio. €]
<b>VII</b> [475 yrs.]	[27–40–51]	[12–15–18]
<b>VIII</b> [2'200 yrs.]	[135–168–200]	[40–49–58]
<b>IX</b> [6'000 yrs.]	[294–349–404]	[89 – 105 – 122]
<b>Maximum possible loss</b>	627	206

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## The aggregation of scenarios gives an exceedance probability curve for the city

Probability that damage will exceed D



**Exceedance probability curve**

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## The aggregation of scenarios gives an estimate of Aigle's seismic risk

### ◆ Mortality

- About 0.3 death/yr for 100'000 persons ( $3 \times 10^{-6}$ )
- About 2 deaths per century for Aigle

### ◆ Property losses

- About 0.20 € per year for 1'000 € of insured property
- About 235'000 € per year for Aigle

### ◆ Building content losses

- About 0.15 € per year for 1'000 € of insured building content
- 65 to 100'000 € per year for Aigle

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## The Aigle pilot study shows that

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- ◆ **The seismic mortality is very low**

- It is comparable to the mortality from other natural hazards

- ◆ **The economical risk is significant**

- in case of a strong earthquake, direct and indirect losses would be very large, exceeding its self-recovery capacity

***=> Seismic risk is  
a collective and economic issue,  
rather than an individual safety issue***

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## The Seismic Risk Estimation Model shows that (Sensitivity Study)

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**Principal parameters that explain the variability of the results :**

- **Regional Hazard**
- **Site effect**
- **Vulnerability of traditional masonry buildings**

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# Seismic risk management

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## Different generic risk management strategies are possible

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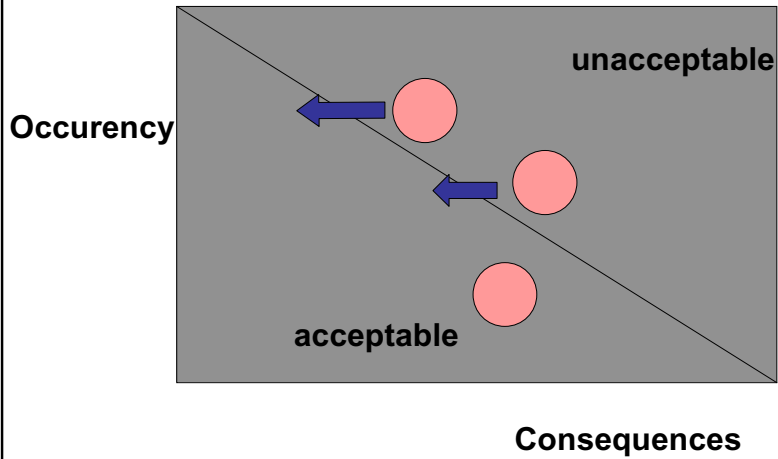
- ◆ **Risk is accepted ...**
  - » "Act of God", "Status quo"
- ... **and passively transferred**
  - » State as the "insurer of last resort"
- ◆ **Risk is actively transferred**
  - Insurance and Reinsurance
- ◆ **Risk is reduced**
  - New buildings
    - » Systematic use of modern seismic design rules (building codes)
  - Existing buildings
    - » Evaluation of vulnerable/critical buildings
    - » Strengthening of building with excessive seismic risk

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## Many measures/techniques are available

Human Risk

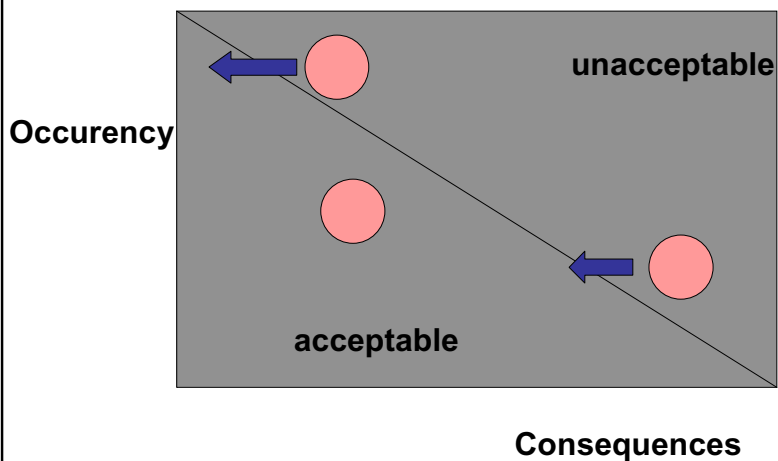


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## Many measures are available

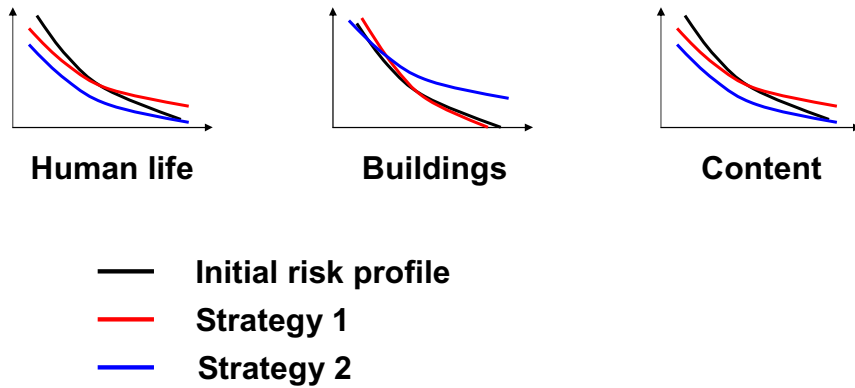
Economical Risk



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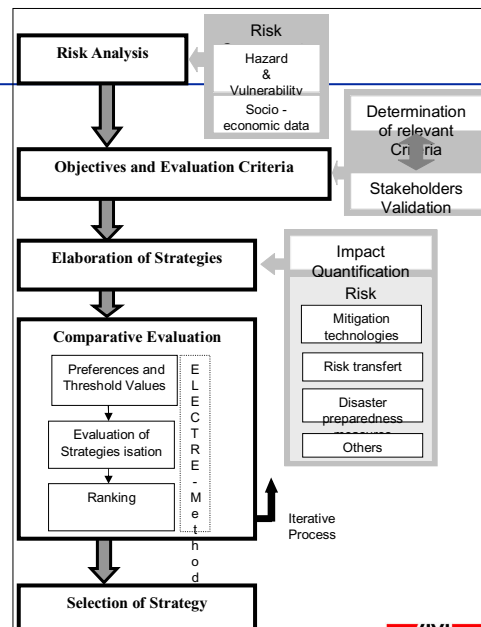
## The impact and the cost of different RM strategies can/must be compared...



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... in a multi-criteria & multi-stakeholder decision framework



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